None:

None:

HRCT - Basic Interpretation:
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Publicationdate 2006-12-24 / Update 2022-03-19 In this article a practical approach is given for the interpretation of
ferential diagnosis of interstitial lung diseases Introduction
Introduction:
Secundary lobules. The centrilobular artery (in blue: oxygen-poor blood) and the terminal bronchiole run in the cent
he interlobular septa
Anatomy of Secondary lobule:
Knowledge of the lung anatomy is essential for understanding HRCT. The interpretation of interstitial lung diseases i
secondary lobule is the basic anatomic unit of pulmonary structure and function. It is the smallest lung unit that is su
and is made up of 5-15 pulmonary acini, that contain the alveoli for gas exchange. The secondary lobule is supplied
h is parallelled by the centrilobular artery. The pulmonary veins and lymphatics run in the periphery of the lobule wi
of these very thin septa can be seen. There are two lymphatic systems: a central network, that runs along the bronc
al network, that is located within the interlobular septa and along the pleural linings. Centrilobular area in blue and p
al part of the secundary lobule. It is usually the site of diseases, that enter the lung through the airways (i.e. hyperse
bular emphysema). Perilymphatic area is the peripheral part of the secundary lobule. It is usually the site of disease
epta (i.e. sarcoid, lymphangitic carcinomatosis, pulmonary edema). These diseases are usually also located in the ce
ndle.
Basic Interpretation:
A structured approach to interpretation of HRCT involves the following questions: Typical UIP with honeycombing an
brosis (IPF) These morphologic findings have to be combined with the history of the patient and important clinical fi
t we are looking at a selected group of patients. Common diseases like pneumonias, pulmonary emboli, cardiogenic
mon diseases like Sarcoidosis, Hypersensitivity pneumonitis, Langerhans cell histiocytosis, Lymphangitic carcinomat
regular HRCT diagnoses and can be real Aunt Minnies. Image
Aunt Minnie of a typical UIP.
Reticular pattern:
In the reticular pattern there are too many lines, either as a result of thickening of the interlobular septa or as a resu
Septal thickening:
Thickening of the lung interstitium by fluid, fibrous tissue, or infiltration by cells results in a pattern of reticular opaci
ugh thickening of the interlobular septa is relatively common in patients with interstitial lung disease, it is uncommo
nosis (Table). Smooth septal thickening is usually seen in interstitial pulmonary edema (Kerley B lines on chest film);
teinosis. Nodular or irregular septal thickening occurs in lymphangitic spread of carcinoma or lymphoma; sarcoidosi
tosis On the left we see focal irregular septal thickening in the right upper lobe in a patient with a known malignancy
re are also additional findings, that support this diagnosis like mediastinal lymph nodes and a nodular lesion in the l
phangitic carcinomatosis (PLC) In 50% of patients the septal thickening is focal or unilateral. This finding is helpful in
l thickening like Sarcoidosis or cardiogenic pulmonary edema. Hilar lymphadenopathy is visible in 50% and usually th
patients with lymphoma and in children with HIV infection, who develop Lymphocytic interstitial pneumonitis (LIP), a
and ground-glass opacity with a gravitational distribution in a patient with cardiogenic pulmonary edema. On the lef
s a combination of smooth septal thickening and ground-glass opacity with a gravitational distribution. The diagnosis
ulmonary edema generally results in a combination of septal thickening and ground-glass opacity. There is a tenden
ribution. Thickening of the peribronchovascular interstitium, which is called peribronchial cuffing, and fissural thicke
ged heart and pleural fluid. Usually these patient are not imaged with HRCT as the diagnosis is readily made based o
ydrostatic pulmonary edema is found. Alveolar proteinosis On the left a patient with both septal thickening and grou
ted and others are not. This combination of findings is called 'crazy paving'. Crazy paving was thought to be specific f
ses such as pneumocystis carinii pneumonia, bronchoalveolar carcinoma, sarcoidosis,
nonspecific interstitial pneumonia (NSIP), organizing pneumonia (COP), adult respiratory distress syndrome and pul
ase of unknown etiology characterized by alveolar and interstitial accumulation of a periodic acid-Schiff (PAS) stain-p
ng in a patient with UIP
Honeycombing:
Honeycombing is defined by the presence of small cystic spaces with irregularly thickened walls composed of fibrous
ubpleural lung regions regardless of their cause. Subpleural honeycomb cysts typically occur in several contiguous la
om paraseptal emphysema in which subpleural cysts usually occur in a single layer. Honeycombing and traction bro
ysts in several contiguous layers. There is also a lower lobe predominance and widespread traction bronchiectasis. T
UIP or 'end-stage lung' is a pathology diagnosis and usually shown at lungbiopsy, when honeycombing is visible. Idio
he cases of UIP. UIP with lung fibrosis is also a common pattern of auto-immune disease and drug-related lung injur

most commonly the result of cytotoxic chemotherapeutic agents such as bleomycin, busulfan, vincristine, methotrex
Disable Scroll UIP in a patient with progressive shortness of breath. Scroll through the images. Enable Scroll
Disable Scroll UIP in a patient with progressive shortness of breath. Scroll through the images. On the left another ca
u scroll through the images. Notice the ground glass opacity in the left lower lobe as a result of fibrous tissue replaci
Nodular pattern:
The distribution of nodules shown on HRCT is the most important factor in making an accurate diagnosis in the nodu
three categories: perilymphatic, centrilobular or random distribution. Random refers to no preference for a specific l
patients with a perilymphatic distribution, nodules are seen in relation to pleural surfaces, interlobular septa and the
visible in a subpleural location, particularly in relation to the fissures. Centrilobular distribution In certain diseases, n
erilymphatic and random nodules, centrilobular nodules spare the pleural surfaces. The most peripheral nodules are
ibution Nodules are randomly distributed relative to structures of the lung and secondary lobule. Nodules can usual
the subpleural predominance often seen in patients with a perilymphatic distribution.
Algorithm for nodular pattern:
The algorithm to distinguish perilymphatic, random and centrilobular nodules is the following: If pleural nodules are
ar.
* If pleural nodules are visible, the pattern is either random (miliary) or perilymphatic.
* If there are pleural nodules and also nodules along the central bronchovascular interstitium and along interlobular
* If the nodules are diffuse and uniformly distributed, it is likely a random distribution.
Perilymphatic distribution:
Perilymphatic nodules are most commonly seen in sarcoidosis. They also occur in silicosis, coal-worker's pneumocon
ifferential diagnosis of perilymphatic nodules and the nodular septal thickening in the reticular pattern. Sometimes t
cal case of perilymphatic distribution of nodules in a patient with sarcoidosis. Notice the nodules along the fissures i
ook carefully for these nodules in the subpleural region and along the fissures, because this finding is very specific fo
be and perihilar predominance and in this case we see the majority of nodules located along the bronchovascular bu
f sarcoidosis. In addition to the perilymphatic nodules, there are multiple enlarged lymph nodes, which is also typica
s, which is also predominantly located in the upper lobes and perihilar. Ill defined centrilobular nodules of ground gl
Centrilobular distribution:
Centrilobular nodules are seen in diseases, that enter the lung through the airways. The pathogens enter the central
y cases centrilobular nodules are of ground glass density and ill defined (figure). They are sometimes called acinair n
Tree-in-bud:
In centrilobular nodules the recognition of 'tree-in-bud' is of value for narrowing the differential diagnosis. Tree-in-bu
r branching structure, most easily identified in the lung periphery. It represents dilated and impacted (mucus or pus-
dicates the presence of: Typical Tree-in-bud appearance in a patient with active TB. On the left a tree-in-bud is seen.
pread of TB. In most patients with active tuberculosis, the HRCT shows evidence of bronchogenic spread of disease e
ution of nodules in miliary tuberculosis
Random distribution:
On the left a patient with random nodules as a result of miliary TB. The random distribution is a result of the hemato
n: Sarcoidosis usually has a perilymphatic distribution. However, when it is very extensive, it spreads along the lymph
ng and may reach the centrilobular area. This may result in a combined perilymphatic-centrilobular pattern which ca
y nodular stage before the typical cysts appear. Here a typical random nodular pattern in a patient with Langerhans
d by multiple irregular cysts in patients with nicotine abuse. LCH in the early phase is a nodular disease (figure). Thes
oking related diseases, there is an upper lobe predominance.
High Attenuation pattern:
Dark bronchus sign in ground glass opacity. Complete obscuration of vessels in consolidation. Increased lung attenu
ease in lung opacity without obscuration of underlying vessels and is called consolidation if the increase in lung opac
on the increase in lung density is the result of replacement of air in the alveoli by fluid, cells or fibrosis. In GGO the d
r in the surrounding alveoli. This is called the dark bronchussign In consolidation, there is exclusively air left in the br
Ground-glass opacity:
Ground-glass opacity (GGO) represents: So ground-glass opacification may either be the result of air space disease (f
is). The location of the abnormalities in ground glass pattern can be helpfull: Broncho-alveolar cell carcinoma with gr
itself is rather unspecific. Not suprisingly, there is a big overlap in the causes of ground-glass opacity and consolidati
glass and consolidation. On the left we see consolidation and ground-glass opacity in a patient with persistent chest
suggested a chronic disease. There is no honeycombing or traction bronchiectasis, so we can rule out fibrosis. The w
ed broncho-alveolar cell carcinoma Broncho-alveolar cell carcinoma (BAC) may present as: LEFT: No fibrosis, so pote
ung disease. Treatable or not treatable? Ground-glass opacity is nonspecific, but a highly significant finding since 60-
ive and potentially treatable lung disease. In the other 20-40% of the cases the lung disease is not treatable and the g
there are usually associated HRCT findings of fibrosis, such as traction bronchiectasis and honeycombing. The imag
reatable and the other with traction bronchiectasis indicating fibrosis. Non specific interstitial pneumonitis (NSIP). No
ith GGO as the dominant pattern. In addition there is traction bronchiectasis indicating the presence of fibrosis. This
ial pneumonia (NSIP). NSIP is characterized histologically by a relatively uniform pattern of cellular interstitial inflamm

UIP (usual interstitial pneumonia) it mainly involves the dependent regions of the lower lobes, but NSIP lacks the ext
sociated with collagen vascular diseases or exposure to drugs or chemicals. NSIP has a relative good prognosis and t
. This outcome is quite different from that seen in UIP, which has a poor prognosis.
Mosaic attenuation:
The term mosaic attenuation is used to describe density differences between affected and non-affected lung areas. T
iologist is to determine which part is abnormal: the black or the white lung. When ground glass opacity presents as n
enuation It can be difficult to distinguish these three entities. There are two diagnostic hints for further differentiatio
as compared to the 'white' lung, than it is likely that the 'black' lung is abnormal. Then there are two possibilities: obs
times these can be differentiated with an expiratory scan. If the vessels are the same in the 'black' lung and 'white' lu
disease, like the one on the right with the pulmonary hemmorrhage. Temporary bronchiolitis with air trapping is see
is On the left a patient with ground glass pattern in a mosaic distribution. Some lobules are involved and others are n
, bronchiolitis or thromboembolic disease. The history was typical for hypersensitivity pneumonitis. Hypersensitivity
nd glass density (acinar nodules). When they are confluent, HRCT shows diffuse ground glass. Hypersensitivity pneum
f antigens contained in a variety of organic dusts. Farmer's lung is the best-known HP syndrome and results from the
e to birds as pets (1). HP usually presents in two forms either as ground glass in a mosaic distribution as in this case
nodules). Mosaic pattern in a patient with chronic thromboemboli On the left a patient with ground glass pattern in a
ary arteries (arrow) in the areas of ground glass. The ground glass appearance is the result of hyperperfused lung ac
ic thromboembolic disease. On the left another patient with ground glass pattern in a mosaic distribution. Again the
large vessels adjacent to oligemic lung with small vessels due to chronic thromboembolic disease. Emboli adherent
oemboli in which partial recanalization took place. Crazy Pavin in a patient with Alveolar proteinosis.
Crazy Paving:
Crazy Paving is a combination of ground glass opacity with superimposed septal thickening (5). It was first thought to
in other diseases. Crazy Pavin can also be seen in:
Consolidation:
Consolidation is synonymous with airspace disease. When you think of the causes of consolidation, think of 'what is
or cells (Table on the left). Even fibrosis as in UIP, NSIP and long standing sarcoidosis can replace the air in the alveol
Chronic consolidation is seen in: Most patients who are evaluated with HRCT, will have chronic consolidation, which
solidations as a result of COP (cryptogenic organizing pneumonia) On the left two cases with chronic consolidation. T
peripheral distribution. The differential diagnosis is the same as the list above. The final diagnosis was cryptogenic o
the HRCT findings will be the same, but there will be eosinophilia. In fibrosis there will be other signs of fibrosis like
carcinoma can also look like this. Organizing pneumonia (OP) Organizing pneumonia represents an inflammatory pr
d cicatrization of the exudate rather than by resolution and resorption. It is also described as 'unresolved pneumonia
izing pneumonia (COP). It was described in earlier years as Bronchiolitis-obliterans-organizing pneumonia (BOOP). Pa
nonproductive cough. Many cases are idiopathic, but OP may also be seen in patients with pulmonary infection, dru
d after toxic-fume inhalation. Chronic eosinophilic granuloma On the left a case of chronic eosinophilic pneumonia. I
reath and an abnormal chest radiograph. There was a marked eosinophilia in the peripheral blood. Like in COP we s
Chronic eosinophilic pneumonia is an idiopathic condition characterized by extensive filling of alveoli by an infiltrate
neumonia is usually associated with an increased number of eosinophils in the peripheral blood and patients respon
Low Attenuation pattern:
The fourth pattern includes abnormalities that result in decreased lung attenuation or air-filled lesions. These includ
distinguished on the basis of HRCT findings. Centrilobular emphysema due to smoking. The periphery of the lung is
in the center of the hypodense area.
Emphysema:
Emphysema typically presents as areas of low attenuation without visible walls as a result of parenchymal destructio
raseptal emphysema is localized near fissures and pleura and is frequently associated with bullae formation (area of
to spontaneous pneumothorax. Giant bullae occasionally cause severe compression of adjacent lung tissue. Panlobu
obular emphysema. There is uniform destruction of the underlying architecture of the secondary pulmonary lobules
y vessels in the affected lung appear fewer and smaller than normal. Panlobular emphysema is diffuse and is most s
cteristic appearance of extensive lung destruction and the associated paucity of vascular markings are easily distingu
d even moderately severe panlobular emphysema can be very subtle and difficult to detect on HRCT(1).
Cystic lung disease:
Lung cysts are defined as radiolucent areas with a wall thickness of less than 4mm. Cystic lung diseases as listed in th
s with a wall thickness of more than 4mm and are seen in infection (TB, Staph, fungal, hydatid), septic emboli, squam
cytosis On the left a case with multiple round and bizarre shaped cysts. There was an upper lobe predominance. The
s is typical for Langerhans cell histiocytosis. Langerhans cell histiocytosis (LCH) is an idiopathic disease characterized
ngerhans histiocytes and eosinophils. In its later stages, the granulomas are replaced by fibrosis and the formation o
are young or middle-aged adults presenting with nonspecific symptoms of cough and dyspnea. Up to 20% of patient
cysts appear round, but can also have bizarre shapes (bilobed or clover-leaf shaped). An upper lobe predominance i
plicated by pneumothorax On the left a case with multiple cysts that are evenly distributed througout the lung (in co
f smoking and this was a 40 year old female. This combination of findings is typical for Lymphangiomyomatosis (LAM

ive proliferation of spindle cells, resembling smooth muscle. Proliferation of these cells along the bronchioles leads t
Rupture of these cysts can result in pneumothorax. Other features of LAM include adenopathy and pleural effusion
g age, between 17 and 50 years.
Identical clinical, radiologic, and pathologic pulmonary changes are seen in about 1% of patients with tuberous sclero
. Bronchiectasis Bronchiectasis is defined as localized bronchial dilatation. The diagnosis of bronchiectasis is usually
ing sign represents an axial cut of a dilated bronchus (ring) with its accompanying small artery (signet). The most com
at an early age. It also occurs in patients with chronic bronchitis, COPD and cystic fibrosis. Bronchiectasis may mimic
used by primary airway disease should be differentiated from tracion bronchiectasis as a result of fibrosis. ABPA: glo
sis in a patient with asthma. On the left we see a chest film with a typical finger-in-glove shadow. The HRCT shows fo
the appropriate clinical setting (asthma and serum eosinophilia) typical for Allergic bronchopulmonary aspergillosis
se occurring in patients with asthma or cystic fibrosis, triggered by a hypersensitivity reaction to the presence of Asp
ents with the findings of central bronchiectasis, mucoid impaction and atelectasis.
Distribution within the lung:

Upper versus lower zone distribution:
Upper lung zone preference is mostly seen in inhalation diseases: Lower zone preference is seen in:
Central versus peripheral distribution:
Central distribution is seen in sarcoidosis, bronchitis and cardiogenic pulmonary edema. Peripheral distribution is m
sinophilic pneumonia and UIP.
Additional findings:

Pleural effusion:
Diseases that manifest with pleural effusion are listed in the table.
Lymphadenopathy:
In sarcoidosis the common pattern is right paratracheal and bilateral hilar adenopathy ('1-2-3-sign'). In lung carcinom
eral. Eggshell calcification
This is commonly seen in lymph nodes in patients with silicosis and coal-worker's pneumoconiosis and is sometimes
and scleroderma.
Differential diagnosis of interstitial lung diseases:
Examples of reticular pattern: Examples of nodular pattern More nodular pattern Examples of High Attenuation patt
tion pattern (2) Lymphangiomyomatosis (LAM): regular cysts in woman of child-bearing age. Practical Approach to HI
2. 'Crazy-Pavin' Pattern at Thin-Section CT of the Lungs: Radiologic-Pathologic Overview Santiago E. Rossi, MD et al Ra
3. Role of HRCT in diagnosing active pulmonary Tuberculosis M. Bakhshayesh Karam MD et al.
None:

None:

Ultrasound of the Breast:
Robin Smithuis, Lidy Wijers and Indra Dennert
Alrijne hospital in Leiderdorp - the Netherlands:
This article provides a basic understanding of breast-ultrasound. We will focus on how mobile ultrasound can be use
aphy or MRI are not readily available. However this article is also a nice introduction for those who do mammograph
of the material of the article.
Introduction:

Video 1:
In this video we will discuss:
Video 2:
In this video we will discuss: Linear array transducer connected to smart phone US is mostly used in addition to mam
However it is an excellent primary tool to examine the breasts in symptomatic women who have a lump or localized
ealing with a benign condition or breast cancer.
In some cases aspiration can help to differentiate complicated cyst from solid lesions and aspiration can be used to t
for breast cancer. This is because it is time consuming and you may miss some early signs of cancer like small not-p
ent as only small calcifications seen on a mammogram. That said, ultrasound is an extremely fast and powerful tool.
It is safe, cheap and mobile and modern handheld-ultrasound machines consist of only a transducer connected to a
These systems provide high resolution images for just over one thousand dollars. We expect that more doctors and
ities like mammography or MRI are affordable or available.
The connection to a mobile phone makes it easy to store images or to share them for a second opinion.
Normal Breast:
The breast consists of a mixture of fibroglandular and fatty tissue. The glandular tissue is not evenly spread in the br

Usually it is more pronounced in the upper lateral quadrant and it radiates from behind the nipple to more peripher
and shows changes during the menstrual cycle.
The amount of glandular tissue decreases with age. Focal collections of glandular tissue may present as a lump, beca
ue. In young women this is a very common cause of a often painful lump in the breast. When we place a transducer
th a mixture of glandular and fatty tissue. The deepest layer is the chest wall with the pectoral muscle, the ribs and th
aging is possible due to the absorption of the sound waves and this results in an artefact called posterior acoustic sh
hat posterior to the ribs, the image is black. The normal lungs are filled with air which also reflect ultrasound waves.
The anterior border of the lung produces a hyperechoic or white line which moves as a result of normal breathing (s
ngs produce what we call a dirty shadow (see next image).
This is not as pronounced as in the ribs. Enable Scroll
Disable Scroll Press Command + to enlarge images - Scroll for text Enable Scroll
Disable Scroll Press Command + to enlarge images - Scroll for text Here we see a normal ultrasound image of the br
fat (dark or hypoechoic) and glandular tissue (light grey or hyperechoic). The striped layer posterior to the breast tiss
here is a black area or posterior shadowing. The lungs are the deepest visible layer.
The air in the lungs reflect most of the sound waves resulting in a bright or hyperechoic line with a dirty shadow pos
ovements of the lung during breathing. In this video a breast cancer is seen within the glandular tissue.
Breast composition:
With ultrasound we can determine the composition of the breast: homogeneous fibroglandular - heterogeneous tiss
Notice that the mammografic and ultrasound images are very much alike. In young women the breast mostly contai
g pregnancy and lactation and can show cyclic changes in premenopausal women resulting in breasts that feel lump
ed by fat, although some older women still may have a reasonable amount of glandular tissue. In adipose women th
e the ribs are only composed of cartilage and are not calcified. The cartilage does not produce a white echo on the a
Instead a hypoechoic structure is seen anterior the the lungs. Do not mistake this structure for a breast tumor.
At first glance this may look like a fibroadenoma when you image the rib on cross section.
By turning the transducer you will notice that it is a long structure connected to the calcified part of the rib. The smal
uss later. Within the same breast there may be areas with more fatty tissue and areas with mostly fibroglandular tiss
he glandular tissue (arrow), you can imagine, that this can feel bumpy on palpation and sometimes give the impressi
present on an ultrasound image may differ between machines of different manufacturers. This means that you have
are of a Philips (left) and Siemens (right) ultrasound machine. Look for instance at the difference in the presentation
Ultrasound findings - overview:
By far the most common abnormalities in the breast, which usually present as a lump in the breast are cysts, fibroad
the typical ultrasound findings are listed (click to enlarge). We will discuss each of these findings in more detail in a r
e benign tumors which are commonly seen in young women (especially 15-25 years) and seldom as a new finding in
50 years of age and not that common in younger women. Palpable glandular tissue is seen in young women, in preg
It usually changes during the menstrual cycle.
Cyst:
Cysts are the most common lumps in the breast.
They are fluid-filled sacs inside the breast and are always benign. It is extremely important to determine the cystic na
the patient that everything is fine. On ultrasound the typical features of a cyst are: Posterior to a cyst, there is usuall
, which refers to the increased echoes deep to the cyst, because fluid transmits sound very well. When the fluid is un
ere a typical example of multiple cysts in a woman who felt a lump in her breast. Although there a many cysts, only t
uid under tension.
The other cysts were not palpable, because they just felt like the surrounding normal breast tissue. It is very commo
t. This woman had multiple small cysts in both breasts. These cysts were not palpable. Here a video of a palpable cys
puncture with aspiration of the fluid. Notice that the wall is a little bit thickened.
This is frequently a sign of low grade infection and explains why the cyst was painful.
Uncomplicated cysts are usually not painful. This is another infected cyst, which was aspirated. Aspiration is a quick a
In most cases the fluid has a transparent yellow color, but it can be green or brown.
Examination of the aspirated fluid is not necessary.
Complicated cyst:
Most cysts have the typical appearance as shown above. Complicated cyst have an atypical appearance: A complicat
that move when the patient changes in position.
When there is still doubt whether a lesion is a cyst or a solid tumor, then puncture with aspiration can solve this prob
lesion with some irregularity of the wall, which is thickened.
There is however posterior enhancement, which made us think, that this probably was a cyst.
A puncture was performed and the cyst was totally aspirated, which was the final proof. Enable Scroll
Disable Scroll Intracystic breast cancer Enable Scroll
Disable Scroll Intracystic breast cancer
Intracystic tumor:
Sometimes a part of a cyst is not echolucent, but hypoechoic or hyperechoic. This can be the result of pus or debris,

Intracystic tumors are rare. When you see vessels with color doppler then you know it is an intracystic tumor, which
This is a tumor with a cystic component and not a cyst. In absence of flow with color doppler and in absence of any l
hould be performed to differentiate between a complicated cyst and a solid mass. Pus and debris can be aspirated u
a. Intracystic breast cancer Here another breast cancer with a cystic component. Notice the large solid component w
Fibroadenoma:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Fibroadenomas are benign tumors which are commonly seen in young women especially 15-25 years
Enable Scroll
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Disable Scroll Here another typical fibroadenoma. Notice that the margin is somewhat lobulated. This woman has br
e placed posteriorly to the pectoral muscle.
Scroll image for text. Here some examples of fibroadenomas. Number 1-4 are in the same patient.
This is a common finding.
When you see one fibroadenoma, you can usually find more. The lesion number 6 was biopsied because of the age
biopsied because it had an irregular shape and looked like a carcinoma.
This also turned out to be a fibroadenoma. Fibroadenomas sometimes have calcifications but these are larger than t
fications as seen in ductal carcinoma in situ (DCIS), which can be a precursor of a carcinoma, are frequently not visib
In the detection of DCIS mammography has advantages.
Breast cancer:
Breast cancer is the most common malignant tumor in women.
A woman's risk of getting breast cancer increases with age. Most women diagnosed with breast cancer are over the
oticeable clinical symptoms are: Here are some examples of breast cancer. The key-features are: We will now discuss
croll
Disable Scroll Enable Scroll
Disable Scroll These images are of a 50-year-old woman who felt a lump in her breast. Describe the ultrasound findi
calcifications are also seen on the mammography.
The white area on the mammogram is the tumor. Continue with the video. Click on the image to start the video. Clic
Disable Scroll Enable Scroll
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Hyperechoic halo:
A common finding in breast cancer is a hyperechoic halo surrounding the hypoechoic mass. This halo is part of the t
e Scroll
Disable Scroll LEFT: no harmonic imaging RIGHT: with harmonic imaging Enable Scroll
Disable Scroll LEFT: no harmonic imaging RIGHT: with harmonic imaging
Harmonics:
Harmonic imaging is an ultrasound technique that employs the resonance characteristics of tissue.
It is also calles tissue harmonic imaging or THI. If you have this possibility on your ultrasound machine, you will notic
esolution and are associated with fewer artifacts than conventional ultrasound imaging.
Posterior shadowing can be enhanced. Notice that the small breast cancer is better seen with harmonic imaging.
There is a hypoechoic tumor with a hyperechoic halo and a little bit of posterior shadowing. The orientation is vertica
The border is indistinct and the shape of the tumor is irregular. This is a difficult and uncommon case. When you loo
It almost looks like normal glandular tissue. However a mass was felt and when we look at the image with harmonics
east cancer. If you have harmonics on your machine, it is best to view with and without harmonics in cases that aren
Disable Scroll Enable Scroll
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Examples of breast cancer:
Scroll through eleven examples of biopsy proven breast cancers.
Video-examples of breast cancer:
Click on the image to start the video.
Click again on image to stop video. he video contains 3 examples of breast cancer. Notice that the last video is of a 2
This is uncommon, but unfortunately breast cancer is sometimes seen in young women.
Breast cancer versus Fibroadenoma:
Sometimes breast cancer can look like a fibroadenoma and fibroadenomas can look like a cancer on ultrasound. In t
ge of the patient is another important issue, since fibroadenomas are commonly seen in young women especially 15
ost commonly diagnosed in women over the age of 50 and is not common in younger women. In some cases it is no
psy is needed for a final diagnosis. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through these images. The differences between a fibroadenoma and a carcinoma are summariz
Disable Scroll Breast carcinoma versus fibroadenoma Enable Scroll

Disable Scroll Breast carcinoma versus fibroadenoma Here we have two oval-shaped hypoechoic lesions. At first glar
Study the images and determine the differences. The lesion on the left is a carcinoma. The lesion on the right is a fib
enoma Age How does the age of a woman help us in the differentiation between a fibroadenoma and breast cancer?
On the other hand when we see a mass in the breast in a younger woman that does not full-fill all the criteria of a typ
ma.
For instance because the lesion is not circumscribed or taller than wide. The same holds true for a new mass that loo
on, that at first glance looks like a fibroadenoma.
Yet there are two things that don't fit.
First the age of the woman is 49 years and secondly on the posterior side the contour shows some irregularities.
A biopsy was performed and the mass proved to be a cancer.
Palpable glandular tissue:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Fibroglandular tissue is not evenly spread in the breast and is usually more pronounced in the upper la
n be very pronounced and causes a lump, that on palpation cannot be differentiated from a tumor. The ultrasound s
Since the glandular tissue is more firm than the fatty tissue, this feels like a mass on palpation. A mammogram was p
cal collection of normal glandular tissue. The video is of a woman who felt a lump in her breast. On ultrasound pron
more firm than the surrounding fatty tissue, you can imagine that when you glide with your finger over the skin, this
onounced that it is difficult for the ultrasound beam to pass through the tissue. This may give the impression of an in
a carcinoma (video). However when you compress the tissue, you will see that it is just hyperechoic pronounced fibro
th a large painful lump in their breast.
Abscess:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll A breast abscess is a painful build-up of pus in the breast caused by an infection.
It mainly affects women who are breastfeeding as a complication of mastitis and is uncommon in non-breast feeding
e red and thickened. The ultrasound is of a woman who presented with fever and a painful lump in the breast behin
During mild compression and decompression with the transducer it was noted that the fluid in the abscess was mov
Notice also the posterior enhancement which is another indication that the structure contains fluid. Continue with n
the first choice treatment of abscesses. No need for surgery or antibiotics in this case, although antibiotics are some
ple, which was aspirated. This can be a painful procedure.
It is best to inject local anesthesia in the skin and subcutis and to try to drain the pus through that same needle. If th
Take some time for the local anesthesia to work.
Skin and subcutis:
Abnormalities that originate in the skin or subcutis may present as a lump in the breast, but they do not represent b
ates in the skin or subcutis, you know that you are not dealing with a breast tumor. The ultrasound images show a le
of these lesions are dermoid cysts.
Try to find the connection to the skin, although this is not always visible. This woman presented with a painful lump i
lesion.
Notice that the skin is thickened. This probably is a dermoid cyst with inflammation. It healed without any treatment
Disable Scroll Enable Scroll
Disable Scroll Here another dermoid cyst. It is located in the subcutis and connected to the skin. This is not a breast t
Disable Scroll Enable Scroll
Disable Scroll Scroll through more benign lesions that originate in the skin or subcutis.
Lipoma:
Lipomas are not that common in the breast, but when they occur, they just look like any other lipoma in the body. Th
are always benign. Sometimes a lipoma cannot be differentiated from fat necrosis, which we will discuss now.
Fat necrosis:
Fat necrosis is a benign entity frequently presenting as a superficially located palpable small mass within the breast.
ugh the patient often does not recall a specific traumatic event. As a result of the trauma, the fatty tissue undergoes
tion. On ultrasound it usually presents as a part of the fatty tissue that is mildly swollen and hyperechoic compared t
Hence the similarity to a lipoma. The content may liquify and result in an oil cyst, which on ultrasound just looks like
.
Ribs:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll A protruding rib can cause a hard swelling which may simulate a breast tumor. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll This patient complained of a painful hard swelling within her breast. On ultrasound a protruding costo
This is the part where the calcified part of the rib meets the cartilage part.

Frequently calcifications can be seen within the cartilage like in this case. This video shows normal rib cartilage. By tu
inal structure anterior to the lung and posterior to the pectoral muscle..
Axilla:
Normal axillary lymph nodes are usually small oval shaped hypoechoic structures with a hyperechoic centre. The hyp
The surrounding hypoechoic cortex is the actual lymphogenic tissue. A normal intramammary lymph node Sometim
ible hyperechoic center. When you see vessels in the hilus like in this case, then it definitely is a lymph node.
In fact this lymph node was located within the breast, i.e. an intramammary lymph node, which is a benign finding. L
a
Enlarged lymph nodes:
Enlarged lymph nodes in the axilla can be the result of lymphogenic metastatic disease of breast cancer. The images
the axilla, that represented round enlarged hypoechoic lymph nodes. Subsequently there was an ultrasound examin
regular cancer.
Ectopic glandular tissue in the axilla:
Some women have fibroglandular breast tissue in the axilla. This tissue behaves just like the glandular tissue in the b
al cycle. The ultrasound image is of a young woman who felt a painful swelling in her axilla.
The image shows normal glandular tissue in an atypical location.
Breast implants:
Most breast implants are silicone-filled prostheses.
On ultrasound they look like a large cyst.
The implant is most commonly placed posterior to the breast tissue or posterior to the pectoral muscle. Implants fill
tients, breast implants have a regular aspect with lobulated margins. Sometimes this lobulation can give the impress
kage **
Silicone leakage:
When silicone leaks out of the implant it will cause a hyperechoic shadow or dirty shadow, just like we can see in the
of silicone anterior to the prosthesis. Free silicone breast injections are an alternative form of breast augmentation t
They have serious adverse effects and are banned in many countries. The whole image looks blurred.
This is called snow storm appearance. You will get the same image as when there is massive leakage. Here a fibroad
Ultrasound in Men:

Gynecomastia:
Gynecomastia is the most common male breast disorder and commonly presents as a palpable lump or tenderness
subareolar mass.
Any mass that is not subareolar is not gynecomastia. On ultrasound the abnormality should be located right behind
omen. These images are of 70-year-old male who presented with a painfull swelling behind the right nipple.
Notice that there is some fibroglandular tissue on the right, while on the left there is only subcutaneous fat. Bilateral
oing through puberty and older men may develop gynecomastia as a result of normal changes in hormone levels. A
athletes to build muscle and enhance performance. This patient had used steroids and has gynecomastia on both si
Sometimes gynecomastia can result in images that simulate a carcinoma, like on the images here, but luckily the find
. The diagnosis of gynaecomastia is usually easier to make on a mammogram.
Nipple region:
The region of the nipple can be difficult to examine. In most cases you see only some thickening of the skin and behi
presented with a retracted nipple. There is an irregular tumor behind the nipple with ingrowth into the nipple (arrow
e very difficult to detect. In every woman who complains of a retracted nipple this area should be examined carefully
amine the region behind the nipple. A lot of gel (g) was used to get a good contact with the skin. A large tumor is see
Cardiovascular devices:

on Chest X-Ray:
Frederieke Elsinger, Robin Smithuis and Anje Spijkerboer
Vancouver General Hospital in Canada, Alrijne hospital and the Amsterdam University Medical Center, the Netherlan
Publicationdate 2018-12-01 The number of implanted cardiovascular devices has dramatically increased in recent ye
ardiac resynchronization therapy, devices have become more complex. There is also an increase of minimally invasiv
ommon cardiovascular devices and procedures. Radiology plays an important role in the initial assessment and follo
Pacemakers:
There are two types of cardiac conduction devices (CCD's): Pacemakers can have leads, that pace: The images show a
al lead is pointed upward and anteriorly, because the ideal position is in the right atrial appendage, where it is ancho
lead is positioned in the apex of the right ventricle, which is located to the left of the spine on a frontal chest X-ray ar
with wires in the right atrial appendage, the apex of the right ventricle and a lead to the left ventricle in the posterio
the ICD as thicker white bands along the course of the lead.
Cardiac Resynchronization Therapy:
Cardiac resynchronization therapy with a biventricular pacer is performed to synchronize the contraction of the right

re and left or right bundle branch blocks or other intraventricular conduction defects. Here a biventricular pacemake
n the atrial appendage. This lead first travels inferiorly into the right atrium and then turns upward and anteriorly wh
age. The left ventricular lead travels through the right atrium and the sinus coronarius and is finally positioned poste
Epicardial pacing leads:
Epicardial leads are frequently placed during cardiac surgery in order to allow cardiac pacing post-surgery. Some cer
ly in those who have rhythm disturbances intra-operatively. After a few days they can be removed by simple traction
ot seem to present a hazard to patients in the MR environment. However, this conclusion applied mostly to non-card
The findings are: Pacemakers can have various complications: The image is taken immediately after placement of an
n complication.
Aberrant lead position:
This patient has a persistent left-sided superior vena cava (LVCS). This is a rare congenital anomaly that may be foun
LVCS communicates with the right atrium through the coronary sinus. The transvenous placement of cardiac device
es not possible.
Lead fracture:
Obvious fracture of one of the leads. Subtle lead fracture in malfunctioning pacemaker. Extremely subtle fracture lin
Retained leads:
Here a patient with an ICD with one lead and two shock coils. There is an retained lead still visible of an old pacemak
leads left in place after pulse generator removal. The safety of MR in patients with retained endocardial pacemaker w
due to the potential threat that they may act as "antennas" with significant heating - it is not recommended to scan t
Twiddler's Syndrome:
Twiddler's syndrome is a malfunction of a pacemaker due to the patient's manipulation of the device and the subsec
pacemaker or sometimes stimulation of other structures like phrenic nerve or brachial plexus. Here a patient with a
lfunction due to ICD box and lead rotation (yellow arrow) and retraction (white arrow). Here another patient with the
ker and at the tip in the right ventricle (arrows). Here another patient with Twiddler. There was malfunction of the pa
Wiireless pacemaker device:
A Micra device is a small wireless pacemaker device, that is transfemorally implanted in the apex of the right ventricl
Brain stimulators:
Parkinson brain stimulators have similar generators as cardiac pacemakers and are also placed in the subcutaneous
Implantable cardioverter-defibrillators:
Implantable cardioverter-defibrillators or ICD's are devices that can recognize ventricular tachycardia and fibrillation
e implanted in patients with cardiomyopathy and a low left ventricular ejection fraction because they are at risk of ve
diac death. This patient has a single coil ICD system (figure). The arrows point to the shock coil. Continue with next im
h an ICD with only one lead and one shock coil. Here an ICD with one lead and two shock coils.
Subcutaneous ICD:
The S-ICD or subcutaneous implantable cardioverter-defibrillator is not connected to the heart or the vessels. A pres
th the heart located between the wire and the box. This system is not capable of pacing the heart.
Loop recorders:
Loop recorders are implantable cardiac monitors to continuously record the cardiac rhythm in patients with unexpla
devices are getting smaller and smaller and should not be mistaken for an USB flashdrive. Loop recorders have a va
pal episodes and assessment of patients with atrial fibrillation, ventricular arrhythmias, or conduction disturbances.
t may be activated by the patient or be automatically activated. Another example of a loop recorder.
Valve replacement and repair:
This is an illustration of the heart valves in the coronal plane. The heart valves are best determined on a lateral radio
n from the apex to the base of the heart, while the mitral and tricuspid valves are below that line Here we see the no
teral chest film the aortic and pulmonary valves are located above the line from base of the heart to the apex and tri
f valves: These are from synthetic material. These patients are on anticoagulant therapy.
* Biological or bioprosthetic valves These are made from animal valves. No anticoagulation therapy needed
Mechanical valves:
The images show some examples of mechanical heart valves. These are manufactured mechanical valves. They last f
r use is decreasing. The St. Jude bi-leaflet mechanical valve is most commonly used and has a radiopaque peripheral
Bioprosthetic valves:
Here some examples of prostetic heart valves. The main limitation of bioprosthetic valves is their limited durability, w
Last about 10-15 years but do not require anticoagulation. Typically chosen for older patients, those with a contrain
(mitral and tricuspid). Aortic valve prosthesis in good position
Tricuspid valves:
Tricuspid stenosis is the result of rheumatic heart disease and is treated with valve replacement. Tricuspid regurgitat
ed with annuloplasty. This patient has three valves repaired: There is a pacemaker with epicardial leads. This was do
ght ventricle would interfere too much with the function of the tricuspid valve prosthesis. White arrow points to aort
TAVR:
TAVR is a transcatheter aortic valve repair. The stenotic aortic valve is repaired by placing a prosthetic valve within th

for an open procedure. The procedural success rate is 90%. TAVR is associated with higher rates of vascular injury, p
placement.
Pulmonary valves:
The Melody valve is a transcatheter pulmonary valve (TPV). It is a bovine jugular vein sewn within a platinum-iridium
eously. This Melody stent has multiple fractures (yellow arrows)
MitraClip:
In patients with severe mitral regurgitation and who are not a candidate for open heart surgery, a transcatheter mitr
py. The centre of the mitral leaflets are approximated by the Mitraclip to reduce the regurgitation while still leaving e
left ventricle (figure). Here a patient with three different valves: aortic, mitral and tricuspid. Aortic valve replacement.
ement and an annuloplasty of the tricuspid valve.
Closure devices:

Atrial Septal defect:
Closure devices are used in patients with ASD and signs of right ventricle overload which can lead to heart failure an
and lie flat against the atrial or ventricular septum. This flat design helps create a natural profile. Here a lateral view
lateral view of a child with an ASD and an Umbrella Rashkind closure device. Images of a patient with an ASD and an
was closed with two devices. Continue with the CT-images. Transverse CT-image and coronal reconstruction of the s
the closure device. CT demonstrates, that the Amplatz device is dislocated into the aortic arch. First look at the imag
close the left atrial appendage. This is an alternative to oral anticoagulation for prevention of thromboembolic strok
Watchman:
A commonly used left atrial appendage closure device is the Watchman implant. It is a preventive measure for stroke
l fibrillation for which anticoagulants are contraindicated.
Patent Ductus Arteriosus:
A patent ductus arteriosus (PDA) is a persistent communication between the descending thoracic aorta and the pulm
of the fetal ductus. During the first 60 hours of life, spontaneous closure of the ductus occurs in 55% of full-term ne
han 95% of healthy infants. Large PDA in older children and adults can lead to pulmonary hypertension and chronic
s of a patient with a persistent ductus arteriosus. The ductus was closed with an Amplatz plug device.
Scimitar vein plugging:
Scimitar syndrome is characterized by partial anomalous pulmonary venous return, in which an abnormal right pulm
d in adults with signs of pulmonary volume overload or right heart dilation. Images: Scimitar vein pre- end post plugg
Vascular Stents:

Coarctation:
Intravascular stent therapy is considered a primary therapeutic option for most adults and adolescents with coarctat
sition. Continue... MRA-image of the same patient pre-stenting. CTA-image post-stenting. Image: dislocated stent. ..
TEVAR:
Thoracic EndoVascular Aortic Repair (TEVAR) is a procedure that involves placement of a covered stent in the aorta in
is delivered in a collapsed state through a catheter, that is most often inserted into the femoral artery and positioned
an and cover the site of aortic injury (reference).
Coronary stents:
X-rays show a stent projecting over the anterior ventricle wall, where the LAD is located. First look at the images. The
nary stents are positioned in the right coronary artery (yellow arrow) and the left anterior descending artery (white a
are the stents positioned? The coronary stents are positioned in the left circumflex artery (yellow arrow) and the left
Left ventricular assist device:
A left ventricular assist device (LVAD) is a surgically implanted device that takes over ventricular pump function in pa
itially implanted as a bridge to cardiac transplant or during myocardial recovery, but are now also used in patients n
The outflow cannula is inserted in the apex and the radiolucent outflow cannula is connected to the ascending aorta
MA graft clips.
Impella:
An Impella is a small, temporary heart pump, attached to a transfemoral (or axillary) catheter.
It is intended for short term use (from 6 hours to < 14 days, depending on the type) during high risk PCI or in patient
s placed in the left ventricle, where blood is apirated and delivered to the outlet which is situated in the ascending ao
inlet (yellow arrow) and outlet (white arrow) in the left ventricle and acsending aorta. In this video you can watch ho
Intra-aortic balloon pump:
The intra-aortic balloon pump (IABP) is a mechanical device that increases myocardial oxygen perfusion and indirect
ts of a cylindrical polyurethane balloon that sits in the aorta, approximately 2 centimeters (0.79 in) from the left subc
pulsation, meaning it actively deflates in systoleand inflates in diastole. Systolic deflation decreases afterload throug
m the heart. Diastolic inflation increases blood flow to the coronary arteries via retrograde flow. These actions comb
l oxygen supply (reference).
Vascular surgery clips - CABG:

The standard bypass operation involves LIMA-to-LAD graft combined with vein grafts. LIMA stands for Left internal m
e post-stenotic LAD and surgical clips extend from the apex of the aortic arch (image). RIMA grafts are used less freq
and usually does not reach the target arteries. The left IMA is separated from the chest wall and connected to the co
ws the vascular clips of a left and right IMA CABG.
Mini Maze procedure:
The Mini Maze procedure is a minimally-invasive ablation in patients with persistent atrium fibrillation. Through incis
irect visualization of the heart. Next the ablation device produces conduction blocks in areas like around the pulmon
called Atriclip is placed to close the left atrial appendage to avoid thrombi from this area (figure).
ICU monitoring device:
.....
Swan Ganz catheter:
The Swan GAnz catheter is a flow directed balloon tip catheter. The balloon is inflated within the left or right main pu
lmonary artery pressure. Potential complications are intracardiac knotting, pulmonary infarction, pulmonary artery p
e inferior vena cava. The images show anincorrect placement of the Swan Ganz catheter on the left with the tip in th
adequate position of the catheter tip in the left pulmonary artery after repositioning. by Yingxu Ma et al Medicine (B
Lines and tubes in Neonates:
Joost van Schuppen, W. Onland and Rick van Rijn
Paediatric Radiology and Neonatology of the Emma's Children Hospital, Academical Medical Center, Amsterdam:
Publicationdate 2013-11-05 In this review we will discuss the normal and abnormal position of tubes and lines on a r
Umbilical artery line:
Umbilical artery catheterization provides direct access to the arterial system and allows accurate measurement of ar
r fluids and medications. The catheter should be passed through the umbilic artery and enter the aorta via the interr
umbilicus inferiorly into the internal iliac artery. In order to avoid placement into aortic branches, the catheter shoul
and renal arteries or in a low position below the inferior mesenteric artery: The high position is advisable since it lea
ne (2) First study the images. Then continue reading. The findings are: Umbilical artery line (3) First study the images.
ine (4) First study the images. Then continue reading. The findings are: Umbilical artery line (5) First study the images
Umbilical vein catheter:
An umbilical vein catheter should pass through the umbilic vein into the left portal vein. Then through the ductus ven
tip should be positioned in the IVC at the level of the diaphragm. Several line malpositions are possible: Not all medi
* Intrahepatic into the portal venous system, both right and left, or even into the superior mesenteric or splenic vein
* Perforation of the portal vein can cause haemorrhage or abscess formation in the liver.
* Position too deep in right atrium or in the left atrium through a patent foramen ovale or atrial septal defect. This ca
us line (2) First study the images. Then continue reading. The findings are: Umbilical venous line (3) First study the im
s the umbilical vein line following the traject of the umbilical vein into the liver (blue arrow). The line is not deep enou
2. The umbilical arterial line first passes caudally and enters the iliac artery (red arrow). Umbilical venous line (4) Stud
ilical venous line (5) Study the image. Then continue reading. The findings are: Umbilical venous line (6) Study the ima
cm above the trachea bifurcation. Umbilical venous line (7
) Study the images. Then continue reading. The findings are: The line probably went through a patent foramen ovale
ultrasound detected a thrombus in the left portal vein after umbilical venous line (arrows). Catheter malposition in t
thrombosis. Clinically silent portal venous thrombosis is frequently associated with catheterization of the umbilical v
hout any treatment is expected in many cases. Umbilical venous line (8
) Study the images. Then continue reading. The findings are: Notice that the endotracheal tube is too deep.
Peripherally Inserted Central Catheter:
A peripheral inserted central catheter or PICC line is positioned in the great vessels, preferably in the superior or infe
now if the line is in a superficial position, because then not all medication can be given. The left image shows a PICC
ne the exact location of the tip. The lumen of the line was filled with contrast, showing the tip of the line high in the s
than the volume of the line, in order to prevent hypothyroidism in reaction to iodine containing contrast, although t
ue reading. The findings are: *PICC line* (3) Study the image. Then continue reading. The findings are: Probably locat
rough a patent foramen ovale. *PICC line* (4) Study the image. Then continue reading. The findings are:
Endotracheal tube:
The tip of an endotracheal tube should be inbetween the thoracic aperture and 1 cm above the carina. The tip travel
. The most common malpositioning is in the right mainstem bronchus, because of the shallower angle of the right m
thorax on the left. Endotracheal tube (2) Study the image. Then continue reading. The findings are: Endotracheal tub
ndotracheal tube (4) Study the image. Then continue reading. The findings are:
Chest drainage tube:
Chest drainage tube are placed in case of respiratory distress caused by pleural fluid or pneumothorax in order to al
hould be positioned in the midaxillary line via the 4th - 6th intercostal space. The position should be apical anterior i
ue reading. The findings are: In this patient, who has a large pneumatocele, a pigtail catheter is placed in the pneuma
an aberrant position of the drain and dysfunction.
Gastric catheters:

Gastric catheters should be positioned with the tip in the stomach.
Reploggel's suction catheter:
Replogle's suction catheters are used in case of oesophageal atresia to remove saliva. They are positioned in the blir
ter form a dashed line. Here a preterm infant with oesophageal atresia with a fistula. There is a Reploggel's drain in s
s of left upper lobe.
Extracorporeal membrane oxygenation:
Extra corporal membrane oxygenation or ECMO is a extracorporeal technique to oxygenate the child when conventi
he superior caval vein and one in the brachiocephalic artery. by Barrington KJ. et al Cochrane Database of Systematic
2. Does Umbilical Vein Catheterization Lead to Portal Venous Thrombosis? Prospective US Evaluation in 100 Neonate
None:

None:

None:

None:

None:

None:

HRCT - Common diagnoses:
Robin Smithuis, Otto van Delden and Cornelia Schaefer-Prokop
Radiology Department of the Rijnland Hospital, Leiderdorp and the Academical Medical Centre, Amsterdam, the Net
Publicationdate 2007-12-20 / update 2022-03-15 In this review we present the key findings in the most common inte
s, but in clinical practice only about ten diseases account for approximately 90% of cases. Knowledge of both radiolo
lung diseases is therefore important for recognizing them in daily practice and including them in the differential diag
be presented because their HRCT presentation may be very typical, allowing for a 'spot diagnosis' in selected cases. I
nd a practical approach is given for the interpretation of HRCT examinations.
Introduction:
More than 100 entities manifest as diffuse lung disease. Fortunately only about 10 of these account for about 90% o
. Knowing the common and also uncommon HRCT-presentations of these frequently encountered diffuse lung disea
diagnoses. Accounting for 80 - 90% of all diagnoses according to various literature references. In some of them the c
r the first list is 'SHIT FACED' (alternative shaded fit).
Sarcoidosis:
Sarcoidosis is a systemic disorder of unknown origin. It is characterized by non-caseating granulomas in multiple org
monary manifestations are present in 90% of patients. Systemic symptoms such as fatigue, night sweats and weight
idosis, consists of arthritis, erythema nodosum, bilateral hilar adenopathy and occurs in 9-34% of patients. Erythema
mmon in men. Two third of patients have a remission within ten years. One third have continuing disease leading to
die from sarcoidosis usually as a result of pulmonary fibrosis. Sarcoidosis stage I: left and right hilar and paratrachea
have been classified into four stages: These stages do not indicate disease chronicity or correlate with changes in pu
A patient with stage I disease. There is hilar and paratracheal adenopathy and no sign of pulmonary involvement. Sa
ular bundle and fthe issuesNotice the partially calcified node in the left hilum. HRCT findings in Sarcoidosis Image
A typical presentation of sarcoidosis with hilar lymphadenopathy and small nodules along bronchovascular bundles
A detailed view with the typical HRCT-presentation with nodules along bronchovascular bundle (red arrow) and fissu
of the nodules. Sarcoidosis: typical presentation The HRCT appearance of pulmonary sarcoidosis varies greatly and i
proximately 60 to 70% of patients with sarcoidosis have characteristic radiologic findings. In 25 to 30% of cases the r
hest radiograph is normal. On the left another typical presentation of sarcoidosis with mediastinal lymphadenopathy
scular bundles and along fissures (yellow arrows). Always look for small nodules along the fissures, because this is a
h conglomerate masses of fibrous tissue Fibrosis in Sarcoidosis. Progressive fibrosis in sarcoidosis may lead to perib
e. The typical location is posteriorly in the upper lobes, leading to volume loss of the upper lobes with displacement
in this appearance are: Sarcoidosis with fibrosis in the upper lobes. Typical chest film. Here a typical chest film of lor
er zones and volume loss of the upper lobes resulting in hilar elevation. Fibrosis results in obliteration of pulmonary
s with fibrosis in the upper lobes. Typical HRCT findings. Here another case of stage IV sarcoidosis. Notice the distrib
part of the lungs. In addition there are multiple small well-defined nodules. Some of these nodules have the typical s
Disable Scroll Enable Scroll
Disable Scroll Alveolar Sarcoidosis. This is a case of alveolar sarcoidosis. Scroll through the images. The appearance m
ou may appreciate that the increased attenuation is the result of many tiny grouped nodules. Also notice the hilar ly
nfection Alveolar Sarcoidosis (2) On the left a 47-year old female patient with a dry cough, slightly breathless and a n
ted with antibiotics. A follow up film was made, because she did not improve. The first chest film shows bilateral con

s infection. After two weeks of treatment with antibiotics, there is no improvement. The differential diagnosis now in
lic pneumonia , organizing pneumonia, Wegener's disease or an uncommon presentation of sarcoidosis. Now contin
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images on the left . There are multiple areas of consolidation. Ancillary findings are
osis of the CT-images is basically the same as of the chest film. Histology revealed alveolar sarcoid. There is only one
les that can be identified in image 3, but these are difficult to see. This case nicely demonstrates that sarcoidosis true
in our differential diagnostic list!. On the left a case of fibrosing sarcoidosis, showing fibrosis, traction bronchiectase
the perihilar region and upper lobes. Nodular abnormalities are absent, but the appearance and the location of the f
erential diagnosis of Sarcoidosis. On the left some diseases with a nodular pattern.
Silicosis / Coal worker pneumoconiosis:
Silicosis and Coal worker pneumoconiosis (CWP) are pathologically distinct entities with differing histology, resulting
aphic and HRCT appearances of these diseases, however, may not be distinguishable from each other and may be si
re rare compared to sarcoidosis. Silicosis and CWP occur in a specific patient group (construction workers, mining wo
y). HRCT findings in Silicosis/CWP On the left a case of silicosis showing nodules of varying sizes with a random and s
One nodule contains calcification (arrow).
Note the absence of a lymphatic distribution pattern (peribronchovascular and along fissures), which would be sugge
es showing a conglomerate mass in a perihilar location in the right upper lobe. The left lobe shows multiple nodules
iosis.
Lymphangitic Carcinomatosis:
Lymphangitic Carcinomatosis results from hematogenous spread to the lung, with subsequent invasion of interstitiu
can predate the radiographic abnormalities. In many cases however the patients are asymptomatic. Lymphangitic Ca
eas, prostate, cervix, thyroid and metastatic adenocarcinoma from an unknown primary. HRCT findings in Lymphang
A patient with Lymphangitic Carcinomatosis. Notice the focal distribution. This finding is helpful in distinguishing Lym
ptal thickening like pulmonary edema or sarcoid. There is also lymphadenopathy. Image
Another patient with Lymphangitic Carcinomatosis with interlobular septal thickening (yellow arrow). Additional pleu
f Lymphangitic carcinomatosis and differential diagnosis
Cardiogenic pulmonary edema:
Patients with pulmonary edema are not imaged with HRCT as their diagnosis is usually based on a combination of cl
sis is not that straightforward and knowledge of the HRCT appearance of pulmonary edema can be helpful in avoidin
enic pulmonary edema On the left typical features of cardiogenic pulmonary edema There is smooth septal thickenin
In addition there is bilateral pleural fluid. In a patient with a known malignancy lymphangitic carcinomatosis would b
ry edema Differential diagnosis of cardiogenic pulmonary edema. On the left another example of cardiogenic pulmo
is smooth septal thickening and ground glass opacity in a more patchy distribution. Note: edema can have a very un
lled with fluid as opposed to other areas in immediate vicinity which appear normal.
Hypersensitivity Pneumonitis:
Hypersensitivity pneumonitis (HP) is also known as extrinsic allergic alveolitis (EAA). HP is an allergic lung disease cau
ng, bird fancier's lung, 'hot tub' lung, humidifier lung). The radiographic and pathologic abnormalities in patients can
ly HRCT is performed in the subacute stage of HP, weeks to months following the first exposure to the antigen or in t
-defined centrilobular nodules Subacute hypersensitivity pneumonitis The key findings in the subacute hypersensitiv
y pneumonitis. There are ill-defined centrilobular nodules of ground-glass opacity. Here another case of subacute hy
of the secondary lobules (arrows) with sparing of the subpleural region. This HRCT-image also demonstrates subtle
l-defined these centrilobular nodules are. Sometimes the centrilobular opacities are more nodular in appearance as
ttern Here another case of hypersensitivity pneumonitis. There is a mosaic pattern. Some secundary lobules demons
e more lucent due to bronchiolitis with air trapping. LEFT: HRCT at presentation. RIGHT: HRCT ten days later This pat
hown). The HRCT at presentation (left) shows lobular areas of ground glass attenuation. A control HRCT ten days late
y treatment. The findings were thought to be due to hypersensitivity pneumonitis. Chronic hypersensitivity pneumon
ensitivity pneumonitis The key findings in chronic hypersensitivity pneumonitis are: On the left a patient with chronic
with hyperaerated secondary nodules and secondry nodules of increased attenuation. Additionally there is septal an
rreversible fibrosis. UIP with honeycombing (left) and chronic HP (right) Differential diagnosis of Hypersensitivity Pne
tion. In chronic HP fibrotic changes are typically seen throughout the whole lung parenchyma from the periphery tow
persensitivity pneumonitis (2) The case on the left shows an inspiratory and expiratory scan: the mosaic pattern with
that become more evident on the expiratory scan, indicating air trapping. Signs of fibrosis such as distorted vessels
n the mid and lower lung zones, but not limited to the subpleural area. The images on the left suggest the diagnosis
, alveolar proteinosis and other diseases with a mozaic pattern should be included in the differential diagnosis.
Tuberculosis:
Primary TB:
Initial infection with consolidation, adenopathy and pleural effusion.
Secondary TB :
Post-primary or reactivation TB. This is the reactivation of the original infection. Usually located in the apical segmen
Endobronchial spread: May occur in both primary and secondary TB, when the infection is not contained.

Hematogenous spread (miliary TB): May occur in both primary and secondary TB, when the infection is not containe
On the left a patient with TB.
There is a cavitating lesion and typical tree-in-bud appearance.
The blue arrow indicates the biopsy needle. Miliary TB Miliary TB This represents a hematogenous dissemination of i
rimary disease. It is characterized by uniform small nodules with a random distribution. TB with cavitation Cavitation
lar air space opacifications. The HRCT demonstrates multiple nodules in peribronchial distribution, partially confluen
tuberculosis. Other diseases in the differential are Wegener granulomatosis or malignancy (both show no tree-in-bu
d of TB This can occur with primary or postprimary infection. In most subjects, the primary infection is localized and
rimary TB, the infection is poorly contained and dissemination occurs. This is termed progressive primary tuberculos
obronchial spread of the infection. Rupture of necrotic lymph nodes into the bronchi can also result in endobronchia
obronchial spread of infection. It occurs in acute tuberculosis but also in any other bacterial infection. LEFT: miliary T
miliary TB and metastases the nodules have a random distribution. In miliary TB the nodules are more uniform in siz
Chronic eosinophilic pneumonia:
Chronic eosinophilic pneumonia is an idiopathic condition characterized by filling of the alveoli with eosinophils. It is
eripheral blood and patients present with fever, cough, weight loss, malaise, and shortness of breath. The symptoms
promptly to treatment with steroids. Chronic eosinophilic pneumonia HRCT findings in Chronic eosinophilic pneumo
nophilic pneumonia. Notice peripheral distribution of the consolidations. Chronic eosinophilic pneumonia (left) versu
eosinophilic pneumonia The images on the left show the similarities between chronic eosinophilic pneumonia and c
clinical and laboratory findings.
Pneumocystis carinii pneumonia:
Pneumocystis carinii pneumonia (PCP) or pneumocystis jiroveci as it is currently named, is an opportumistic infection
cted patients at some point during the course of their disease, but with the new anti-viral drugs it has become less co
i.e. transplant recipients and patients on chemotherapy. HRCT findings in PCP PCP with diffuse ground-glass opacific
indings are diffuse ground-glass opacification. The findings are not specific for PCP, but in this clinical setting PCP is t
Disable Scroll PCP: Scroll through the images Enable Scroll
Disable Scroll PCP: Scroll through the images On the left another patient with PCP. Scroll through the images.
ARDS:
Acute respiratory distress syndrome (ARDS) is a sudden, life-threatening lung failure requiring mechanical ventilation
combination with injury to the respiratory epithelium. A variety of underlying conditions, from infections to major tr
spiration, pneumonia, toxic inhalation and pulmonary contusion.
Extrapulmonary risk factors are sepsis, pancreatitis, multiple blood transfusions, trauma and the use of drugs such a
re forms result in irreverible fibrosis. Why some people develop ARDS and others do not is unknown. Extra-pulmona
left a patient who was involved in a traffic accident and within hours developed ARDS. The dominant pattern is groun
some consolidation, so there is a gradient from front to back. An important finding in extra-pulmonary ARDS is the s
chy distribution of consolidations. Pulmonary ARDS On the left a patient who developed ARSD as a result of pneumo
ase and the almost complete distorsion more basal. Patient is ventilated with PEEP (positive end expiratory pressure
iple subpleural cysts and a bilateral pneumothorax. LEFT: ARDS. RIGHT: Fibrosis in the anterior parts as a result of da
s have a protecting effect on the lung parenchyma under PEEP ventilation, while the ventrally located areas of more
ult we find cystic destruction ventrally and residual fibrosis mostly in the ventral lung areas.
Idiopathic interstitial pneumonias:
The idiopathic interstitial pneumonias (IIPs) comprise a heterogenous group of disorders. They represent fundamen
per se. Idiopathic indicates unknown cause and interstitial pneumonia refers to involvement of the lung parenchyma
seven entities listed in the table on the left in order of relative frequency. These diseases have specific patterns of m
hese findings idiopathic or cryptogenic, we should realise, that these patterns are also common findings in collagen v
drug-related lung diseases. For instance in patients with rheumatoid arthritis findings of NSIP, UIP, OP and LIP have
UIP:
Usual Interstitial Pneumonitis (UIP) is a histologic diagnosis. UIP has distinctive HRCT findings and is usually shown a
lf the UIP pattern is of unknown cause (i.e. idiopathic), the disease is called Idiopathic pulmonary fibrosis (IPF). IPF ac
nce of a surgical biopsy showing a UIP pattern the diagnosis of IPF requires exclusion of other known causes of UIP i
collagen vascular diseases like RA, SLE, polyarteritis nodosa and sclerodermia. A long list of drugs have been implicat
chemotherapeutic agents such as bleomycin, busulfan, vincristine, methotrexate, adriamycin, and carmustine (BCNU
implication for the patient. UIP is more progressive and more than 50% of patients with UIP die within 3 years. Ches
in basal and subpleural distribution due to honeycombing. On the left a chest film of a patient with UIP due to IPF. T
c changes in the basal lung area. The radiographic appearance of honeycombing comprises reticular densities cause
h long standing reticulation with a lower lobe and peripheral preference also think 'UIP'. Typical UIP HRCT findings in
Disable Scroll UIP: Lower lobe predominance Enable Scroll
Disable Scroll UIP: Lower lobe predominance Differential diagnosis of UIP. Chronic HP may be indistinguishable. It is
bases or when there are centrilobular nodules. Sarcoidosis is a more likely diagnosis if the fibrosis is located in the p
and if there are also nodules in a perilymphatic distribution or if there is extensive mediastinal lymphadenopathy. Th
ween IPF and asbestosis. On the left a patient with UIP. Notice the honeycombing and the preference of the subpleu

ecognize the pattern of UIP on HRCT.
NSIP:
Nonspecific interstitial pneumonia (NSIP) is by some considered as a specific entity, with specific histologic character
ing cases of idiopathic interstitial pneumonia that cannot be classified as UIP, DIP, or OP. NSIP is histologically charac
stitial inflammation associated with variable degrees of fibrosis. In contrast, UIP is associated with extensive fibrosis
of different ages). NSIP is a very inhomogeneous group. NSIP ranges from type I which is a cellular pattern seen as g
which may be indistinguishable from UIP. Enable Scroll
Disable Scroll Scroll through the images. Enable Scroll
Disable Scroll Scroll through the images. On the left a patient with a NSIP. This patient had a rash and muscle weakn
d glass opacity (GGO). There is very subtle traction bronchiectasis, indicating that the GGO is the result of fibrosis an
not see the classic distribution of UIP, from which NSIP has to be differentiated. The history of this patient is suggest
ost common interstitial lung disease in patients with connective tissue disease. NSIP (2) NSIP is not a diagnosis on it's
e key feature is the uniformity of the abnormality within the lung. The role of the radiologist is more to 'exclude UIP
osis of NSIP requires histological proof. In all patients with a NSIP pattern, the clinician should be advised to look for
r drugs . On the left two cases of NSIP. Note the varying combination of GGO and fibrosis (traction bronchiectasis), b
g pattern in systemic sclerosis and polymyosisits/dermatomyositis (more than 90%), but also may occur in RA, SLE, S
gain the spectrum of findings seen in NSIP. All three patients were suffering from connective tissue disease, all cases
GGO. Note the difference in the density of the air within the bronchus and surrounding lungparenchyma (dark bronc
ith a superimposed fine reticular densities as a result of thickening of the intralobular septa. The last image also sho
ycombing in all three cases, excluding UIP as diagnosis. NSIP (4) The HRCT of this patient with scleroderma and NSIP
more extensive abnormalities in the lower lung zones. There are also areas of ground-glass and traction bronchiecta
dilated esophagus, which is consistent with scleroderma.
COP:
Cryptogenic organizing pneumonia (COP) used to be described as bronchiolitis obliterans with organizing pneumoni
terstitial pneumonias. It is a inflammatory process in which the healing process is characterized by organization of th
Organizing pneumonia is mostly idiopathic and then called cryptogenic, but is also seen in patients with pulmonary i
anulomatosis and after toxic-fume inhalation. OP presents with a several-month history of nonproductive cough, low
onse to corticosteroid therapy and a good prognosis. OP is again a great mimicker and can show a broad variety of H
actually represents a diagnosis of exclusion. Frequently biopsy is needed for final proof. HRCT findings in OP On the
tions of OP. After exclusion of other diseases such as lymphoma, infection, bronchoalveolar carcinoma, the diagnosi
th collagen vascular disease On the left a patient who complained of arthritic pain. There are multiple small bilateral
ot as specific as in the former case, but this was also organizing pneumonia, but now related to collagen vascular dis
umatoid arthritis and bilateral peripheral consolidations as a result of organizing pneumonia. Patients with OP assoc
py with steroids. Chronic eosinophilic pneumonia (left) versus Organizing pneumonia (right) Differential diagnosis of
ies between chronic eosinophilic pneumonia and organizing pneumonia. Differentiation has to be made on the basis
RB-ILD and DIP:
Respiratory bronchiolitis (RB), respiratory bronchiolitis-associated interstitial lung disease (RB-ILD), and desquamativ
severity of small airway and parenchymal reaction to cigarette smoke (8). All smokers have various degrees of respi
0% of smokers have a clinically significant lung disease in association with RB, presenting with symptoms, lung functi
term RB-ILD was proposed to describe the bronchocentric (or centrilobular) lung disease in these patients and the t
cally however these diseases cannot be clearly separated because of the overlap of CT findings. HRCT findings in RB-
ound glass opacification and there are some thickened interlobular septa (arrow). Usually these patients will also hav
dence that respiratory bronchiolitis is the precursor of emphysema. RB-ILD (2) On the left a smoker with RB-ILD with
fication. Additional findings in this patient are paraseptal emphysema in the upper lobes and some subtle septal thic
gs there is a broad differential diagnosis and additional clinical information is mandatory for the interpretion of the H
n a immunocompromised patient PCP would be on top of the list. If this patient was coughing up blood, this probabl
onary densities in these patients). If this patient was a bird-fancier we would first think hypersensitivity pneumonitis,
ker. RIGHT: Hypersensitivity pneumonitis in non-smoker On the left two different patients with similarl HRCT findings
ght has hypersensitivity pneumonits.
Note the difference in severity of ground glass opacities and the well defined areas of airtrapping in HP. Somehow sm
riterium but is quite helpful for differential diagnosis. RB-ILD (3) On the left a patient with DIP. The HRCT shows diffu
mosaic pattern as the sole abnormality. Reticular abnormalities and signs of fibrosis are typically absent. These abn
tion of smoking. AIP
AIP:
Acute interstitial pneumonia (AIP, earlier named Hamman Rich Pneumonitis) is a rare idiopathic lung disease charact
a fatal outcome in many cases. The histologic pattern aswell as the HRCT findings in AIP are indistinguishable from a
tics are diffuse or patchy consolidation, often with a crazy paving appearance like in the case on the left. There are ar
sity with a crazy-paving appearance.
These abnormalities developed in several days and this rapid progression of disease combined with these imaging f
LIP:

Lymphocytic interstitial pneumonitis or LIP is uncommon, being seen mainly in patients with autoimmune disease, p
are nonspecific and often those of the patient's underlying disease HRCT findings are usually nonspecific. On the left
is, LIP and Langerhans cell histiocytosis On the left three different patients with lung cysts. From left to right: Lympha
Drug-induced lung disease:
Drug-induced lung disease is a major source of iatrogenic lung injury. The major diagnostic problem is, that it may pr
nt as organizing pneumonia, eosinophilic pneumonia, fibrosis, hypersensitivity pneumonitis or even as ARDS. The dia
on. Drug-induced interstitial lung fibrosis On the left a patient who is treated with cytotoxic drugs for a hematologic
ss opacity, some traction bronchiectasis and subtle honeycombing in the left lower lobe. This could be the result of a
s and non-specific interstitial pneumonitis or fibrosis in chronic hypersensitivity pneumonitis and longstanding sarco
t we commonly encounter in patients with a UIP pattern or NSIP pattern seen in collagenvascular diseases. When the
ith fibrosis always consider drug-related lung disease in the differential. Drug-induced organizing pneumonia Drug-in
yclophosphamide and other drugs like Methotrexate, Amiodarone, Nitrofurantoin and Penicillamine (9). The HRCT fi
ced non-specific interstitial pneumonita (NSIP) occurs most commonly as a manifestation of carmustine toxicity or o
gic findings are the same as in other forms of NSIP.
Uncommon interstitial lung diseases:

Lymphangiomyomatosis:
Clinical findings: Key findings in Lymphangiomyomatosis: On the left a typical case of LAM with multiple evenly sprea
l diagnosis of Lymphangiomyomatosis: On the left another typical case of LAM.
Langerhans cell histiocytosis:
Langerhans cell histiocytosis is also known as pulmonary histiocytosis X or eosinophilic granuloma. LCH is probably a
tients are active smokers. In the early nodular stage it is characterized by a centrilobular granulomatous reaction by
ration causes alveolar wall fibrosis and cyst formation. Early stage Langerhans cell histiocytosis with small nodules H
ly stage Langerhans cell histiocytosis with small nodules. There are no cysts visible. Late stage Langerhans' cell histio
a later stage the nodules start to cavitate and become cysts. These cysts start as round structures but finally coalesc
ts with LCH 95% have a smoking history. Specimen of Langerhans cell histiocytosis in three different stages On the le
iocytosis in respectively nodular stage and early and late cystic stage. Langerhans' cell histiocytosis On the left a ches
cytosis. The dominant findig on the chest film is a reticular patern and that's about as far as you can go. There is also
pattern was caused by multiple cysts. This is late stage Langerhans cell histiocytosis. The most challenging differentia
sema however is defined as airspaces without definable walls. Usually we can identify the central dot sign. The uppe
appreciate this in many inhalational diseases and also in emphysema. Langerhans cell histiosytosis: early phase and
tosis. It started as small noduli, which progressed over time to cavitating nodules. In the end this will progress to biza
Images of a young male smoker with Langerhans cell histiocytosis. Notice progression on second scan 7 years later.
mimicking Langerhans cell histiocytosis Emphysema, when it is severe, can mimick Langerhans cell histiosytosis. Wh
ondary lobule, it may look as if it is cystic with walls. In patients with LCH, the pathologist may find LCH, but also area
s. So these smoking-related diseases do not represent discrete entities. Alveolar proteinosis with crazy paving patter
Alveolar proteinosis:
Alveolar proteinosis is a rare disease characterized by filling of the alveolar spaces with PAS positive material due to
sed on the suggestive HRCT pattern (crazy paving) and the characteristic features of BAL fluid (Broncho Alveolar Lava
ase of alveolar proteinosis with extensive thickening of interlobular and intra-lobular septa. This is caused by the fact
alveolar space by macrophages is transported to the interstitium and thus leads to thickening of septa. The crazy pa
s may present with this finding and are listed in the differential diagnosis. Differential diagnosis of alveolar proteinos
of the King's College Hospital in London for his inspiring lectures. Some of the images used in this overview were pr
produced such a fabulous educational CD (1). European Radiology 2001;11: 373-392
2. High Resolution Lung CT, UCSF Interactive Radiology Series on CD-ROM This browser-based learning file is based o
with common HRCT patterns of disease, diffuse lung diseases and their significance, and clinical characteristics. It is
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4. by Webb, Mueller and Naidich.
5. by Zampatori M, Sverzellati N, Poletti V et al. Semin Ultrasound CT MR 2005;20(3): 176-85
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the American Thoracic Society (ATS), and the European Respiratory Society (ERS) was adopted by the ATS Board of D
7. What Every Radiologist Should Know about Idiopathic Interstitial Pneumonias by Christina Mueller-Mang, MD, Clau
d Alexander A. Bankier, MD RadioGraphics 2007;27:595-615
8. Respiratory bronchiolitis, respiratory bronchiolitis-associated interstitial lung disease, and desquamative interstitia
the same disease process? by LE Heyneman, S Ward, DA Lynch, M Remy-Jardin, T Johkoh and NL Muller American Jou
9. Pulmonary Drug Toxicity: Radiologic and Pathologic Manifestations by Santiago E. Rossi, MD, Jeremy J. Erasmus, M
MD. Radiographics. 2000;20:1245-1259
TI-RADS - Thyroid Imaging Reporting and Data System:
Habib Ahmad and Aad van der Lugt
Radiology department of the Erasmus Medical Center in Rotterdam:

Up to 67% of the population evaluated with US will have an incidental thyroid nodule. The high prevalence of thyroid
ancer present a challenge for optimal patient care. The Thyroid Imaging Reporting and Data System (TI-RADS) of the
intent to decrease biopsies of benign nodules and improve overall diagnostic accuracy.
TI-RADS categories:
Click to enlarge The five ultrasound features of thyroid nodules used in TI-RADS are: composition, echogenicity, shap
. The points are added from all categories to determine the TI-RADS level, each with a recommendation. Nodules sm
5.
This is because it is very unlikely that nodules smaller than 5 mm will become a clinical significant malignancy. The cu
ly suspicious TR3 lesions is based on studies showing that thyroid carcinomas don't have a decreased survival until t
shown to have good correlation with the malignancy risk in large studies. The risk of malignancy is: This table is the
Click for a larger image. There are several exceptions for TI-RADS, where this system cannot be used for. Each of thes
erwise normal adult population:
Composition:
Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. There is a mixed composition with a cystic component in the center. Enable S
Disable Scroll Enable Scroll
Disable Scroll Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll This is mostly a solid lesion. The cystic part is s o small, that 2 points are given for composition.
Cyst:
Here a typical cyst.
No further evaluation is needed.
Spongiform:
Spongiform nodules have a sponge-like appearance, with at least 50% cystic composition of tiny cystic parts.
No further characterization is needed.
Mixed cystic/solid:
In mixed cystic/solid lesions the amount of cystic and solid parts is not important. This lesion gets 1 point for the mix
Solid lesions:
The lesion in A is almost completely solid.
While there are small cystic parts, it is not considered a spongiform nodule, because the small cystic parts are far les
solid. In solid nodules at least 95% of the nodule should be solid.
This percentage should be an estimation, it is not needed to calculate this.
Echogenicity:
First study the image.
Then continue reading. There is posterior acustic enhancement.
This means that this could be a cystic lesion.
In such cases color-doppler can be helpful, but unfortunately was not performed. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Study the image and score for TI-RADS.
Then scroll the image for the TI-RADS score. This nodule is hypoechoic compared to the normal thyroid tissue which
2 points for hypoechoic echogenicity. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. This is a hyperechoic nodule.
This means 1 point for echogenicity. Enable Scroll
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Disable Scroll
Shape:
Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. 3 points for the shape, which is taller than wide. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll
Margin:
Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. Enable Scroll
Disable Scroll Enable Scroll

Disable Scroll Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score.
Then continue reading. Although the margin is ill-defined on the cranial side, this still means 0 points for the margin.
Disable Scroll Enable Scroll
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Echogenic foci:
Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score.
Then continue reading. Only 1 point for the macro calcification.
This is a TI-RADS 5 lesion mainly due to the very hypoechoic echogenicity. Maybe the lesion is also taller than wide, w
Disable Scroll Enable Scroll
Disable Scroll Study the image and score for TI-RADS.
Scroll the image for the TI-RADS score. Notice the very subtle echogenic foci.
A total of 6 points results in a TI-RADS score 4.. Radiology 2008; 247:602–604
Comet tail artefact:
Echogenic foci is the only category where multiple options are possible and you have to choose all that apply.
Points will be added to the total score.
This means that when both punctate echogenic foci and rim calcifications are present, the TI-RADS points are 3 + 2 =
Macrocalcification:
This nodule has large macrocalcifications with acoustic shadowing. TI-RADS: 1 point.
Rim calcification:
Peripheral rim calcifications can be complete or incomplete. TI-RADS: 2 points.
Microcalcifications:
Punctate echogenic foci are also knows as microcalcifications. They are a strong predictor of malignancy and therefo
ecause in the normal thyroid there also may be echogenic foci visible.
Punctate echogenic should be called in the situation where they are obvious and only visible within the nodule. Smal
ded in this category. TI-RADS: 3 points.
Growth:
Growth of a nodule according to TI-RADS is also defined, and is in accordance with the ATA guidelines. There should
can be considered as having a benign behavior, and further follow up is not needed. Comparison should be made w
is interval growth without fulfillment of FNA criteria, the next follow-up should be after 1 year, regardless of the TI-RA
Multiple Nodules:
When there are multiple nodules, there should be no more than 4 nodules classified. FNA is not recommended of m
ling the TI-RADS FNA criteria should be sampled, which is not necessarily the dominant or largest nodule.
Overdiagnosis and Overtreatment:
Once a thyroid nodule is detected, the binary question remains, is it benign or malignant?
Depending on the published series referenced, 6%–13% of thyroid nodules chosen for FNA will yield malignancy (1).
in origin.
Unlike its malevolent associate anaplastic thyroid cancer, which while accounting for only 1%–2% of thyroid cancers
cancer is very benign. Since papillary is the dominant thyroid cancer and is well differentiated, the prognosis is rema
As most of these cancers would never have caused symptoms during life, the increased diagnostic scrutiny is causing
Our research focus should be the discovery of the small percentage of thyroid cancers that are aggressive and alter
Examples:
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Bone tumors - Differential diagnosis:
Henk Jan van der Woude and Robin Smithuis
Radiology department of the Onze Lieve Vrouwe Gasthuis, Amsterdam and the Alrijne hospital in Leiderdorp, the Ne
Publicationdate 2010-04-10 / update 2022-03-17 In this article we will discuss a systematic approach to the differenti
ntial diagnosis mostly depends on the review of the conventional radiographs and the age of the patient. Abbreviatio
Systematic Approach:
The most important determinators in the analysis of a potential bone tumor are: It is important to realize that the pl
ng these lesions.
CT and MRI are only helpful in selected cases. Here are links to other articles about bone tumors: Approach Most bo
ng whether these lesions are benign or malignant is the zone of transition between the lesion and the adjacent norm
ic or osteolytic and whether it has a well-defined or ill-defined margins, the next question should be: how old is the p

r clues need to be considered, such as a lesion's localization within the skeleton and within the bone, any periosteal
Age:
Age is the most important clinical clue in differentiating possible bone tumors.
There are many ways of splitting age groups, as can be seen in the table, where the morphology of a bone lesion is
nts into two age groups: younger or older than 30 years.
Most primary bone tumors are seen in patients under 30 years.
In patients over 30 years we must always include metastases and myeloma in the differential diagnosis. Notice the f
Zone of transition:
In order to classify osteolytic lesions as well-defined or ill-defined, we need to look at the zone of transition between
tion is the most reliable indicator in determining whether an osteolytic lesion is benign or malignant (1). The zone of
lesions usually have a narrow transition zone. Narrow zone of transition: NOF, SBC and ABC Small zone of transition
r and is a sign of slow growth.
A sclerotic border especially indicates poor biological activity. In patients
In patients > 30 years, and particularly > 40 years, despite benign radiographic features, a metastasis or plasmacyto
h a narrow zone of transition. Based on the morphology and the age of the patients, these lesions are benign. Notice
d. Images Metastases and multiple myelomaIn patients > 40 years metastases and multiple myeloma are the most c
Metastases under the age of 40 are extremely rare, unless a patient is known to have a primary malignancy.
Metastases could be included in the differential diagnosis if a younger patient is known to have a malignancy, such a
f transition indicates malignancy or infection or eosinophilic granuloma Wide zone of transition An ill-defined border
(1). It is a feature of malignant bone tumors. There are two tumor-like lesions which may mimic a malignancy and ha
ions and eosinophilic granuloma. Both of these entities may have an aggressive growth pattern. Images Infections a
Infections and eosinophilic granuloma are exceptional because they are benign lesions which can mimick a malignan
s may have ill-defined margins, but cortical destruction and an aggressive type of periosteal reaction may also be see
Periosteal reaction:
A periosteal reaction is a non-specific reaction and will occur whenever the periosteum is irritated by a malignant tu
of periosteal reaction: a benign and an aggressive type. The benign type is seen in benign lesions such as benign tum
t tumors, but also in benign lesions with aggressive behavior, such as infections and eosinophilic granuloma. Fibrous
They will not present with a periosteal reaction unless there is a fracture.
If no fracture is present, these bone tumors can be excluded. Benign periosteal reaction Detecting a benign perioste
use a benign periosteal reaction. A benign type of periosteal reaction is a thick, wavy and uniform callus formation re
growing lesions, the periosteum has time to lay down thick new bone and remodel it into a more normal-appearing
Large arrow indicates solid periosteal reaction.
Small arrow indicates nidus. Aggressive periosteal reaction This type of periostitis is multilayered, lamellated or dem
t may be spiculated and interrupted - sometimes there is a Codman's triangle. A Codman's triangle refers to an eleva
re the elevated periosteum and bone come together. In aggressive periostitis the periosteum does not have time to
eaction (2) Osteosarcoma (left) and Ewings sarcoma (right)
Cortical destruction:
Cortical destruction is a common finding, and not very useful in distinguishing between malignant and benign lesion
s, but also in locally aggressive benign lesions like EG and osteomyelitis. More uniform cortical bone destruction can
scalloping of the cortical bone can be seen in benign lesions like Fybrous dysplasia and low-grade chondrosarcoma.
ooningBallooning is a special type of cortical destruction.
In ballooning the destruction of endosteal cortical bone and the addition of new bone on the outside occur at the sa
nd uninterrupted, but may also be focally interrupted in more aggressive lesions like GCT. Images A benign, well-defi
and a peripheral layer of new bone.
2. Giant cell tumor A locally aggressive lesion with cortical destruction, expansion and a thin, interrupted peripheral
the marrow cavity, which is a sign of aggressive behavior (red arrow). Ewing's sarcoma with permeative growth thro
Cortical destruction (3) In the group of malignant small round cell tumors which include Ewing's sarcoma, bone lymp
rmal radiographically, while there is permeative growth throughout the Haversian channels. These tumors may be a
le bone destruction. Images Location within the skeleton The location of a bone lesion within the skeleton can be a c
shows the preferred locations of the most common bone tumors. In some locations, such as in the humerus or arou
bone tumors in alphabethic order: Aneurysmal Bone Cyst - tibia, femur, fibula, spine, humerus
Adamantinoma - tibia shaft, mandible
Chondroblastoma - femur, humerus, tibia, tarsal bone (calc), patella
Chondromyxoid fibroma - tibia, femur, tarsal bone, phalanx foot, fibula
Chondrosarcoma - femur, rib, iliac bone, humerus, tibia
Chordoma - sacrococcygeal, spheno-occipital, cervical, lumbar, thoracic
Eosinophilic Granuloma -femur, skull, iliac bone, rib, vertebra
Enchondroma -phalanges of hands and feet, femur, humerus, metacarpals, rib
Ewing's sarcoma - femur, iliac bone, fibula, rib, tibia
Fibrous dysplasia - femur, tibia, rib, skull, humerus

Giant Cell Tumor - femur, tibia, fibula, humerus, distal radius
Hemangioma - spine, ribs, craniofacial bones, femur, tibia
Lymphoma - femur, tibia, humerus, iliac bone, vertebra
Metastases - vertebrae, ribs, pelvis, femur, humerus
Non Ossifying Fibroma - tibia, femur, fibula, humerus
Osteoid osteoma - femur, tibia, spine, tarsal bone, phalanx
Osteoblastoma - spine, tarsal bone (calc), femur, tibia, humerus
Osteochondroma - femur, humerus, tibia, fibula, pelvis
Osteomyelitis - femur, tibia, humerus, fibula, radius
Osteosarcoma - femur, tibia, humerus, fibula, iliac bone
Solitary Bone Cyst - proximal humerus, proximal femur, calcaneal bone, iliac bone
Location: epiphysis - metaphysis - diaphysis:
Only a few lesions are located in the epiphysis, so this could be an important finding. In young patients it is likely to b
er 20, a giant cell tumor has to be included in the differential diagnosis. In older patients a geode, i.e. degenerative su
nosis. Look carefully for any signs of arthrosis.
* Metaphysis NOF, SBC, CMF, Osteosarcoma, Chondrosarcoma, Enchondroma and infections.
* Diaphysis Ewing's sarcoma, SBC, ABC, Enchondroma, Fibrous dysplasia and Osteoblastoma. Differentiating betwee
lesions can be located in both or move from the metaphysis to the diaphysis during growth. Large lesions tend to ex
Location: centric - eccentric - juxtacortical:
SBC, eosinophilic granuloma, fibrous dysplasia, ABC and enchondroma are lesions that are located centrally within lo
* Eccentric in long bone Osteosarcoma, NOF, chondroblastoma, chondromyxoid fibroma, GCT and osteoblastoma ar
* Cortical Osteoid osteoma is located within the cortex and needs to be differentiated from osteomyelitis.
* Juxtacortical Osteochondroma. The cortex must extend into the stalk of the lesion. Parosteal osteosarcoma arises
Matrix:
Calcifications or mineralization within a bone lesion may be an important clue in the differential diagnosis. There are
in chondroid tumors have many descriptions: rings-and-arcs, popcorn, focal stippled or flocculent. Images Osteoid m
matrix Mineralization in osteoid tumors can be described as a trabecular ossification pattern in benign bone-forming
osteosarcomas. Sclerosis can also be reactive, e.g. in Ewing's sarcoma or lymphoma. Notice the aggressive, interrupt
* right Trabecular ossification pattern in osteoid osteoma. Notice osteolytic nidus (arrow). LEFT: Polyostotic Fibrous D
Polyostotic or multiple lesions:
Most bone tumors are solitary lesions. If there are multiple or polyostotic lesions, the differential diagnosis must be
ocal osteomyelitis, enchondromas, osteochondoma, leukemia and metastatic Ewing' s sarcoma. Multiple enchondro
seen in Maffucci's syndrome.* Polyostotic lesions > 30 years Common: Metastases, multiple myeloma, multiple ench
hyroidism, bone infarcts. Mnemonic for multiple oseolytic lesions: FEEMHI: Fibrous dysplasia, enchondromas, EG, Me
Spine lesions:
Here some typical examples of bone tumors in the spine. This 'Mini Brain' appearance of plasmacytoma in the spine
Foot lesions:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. by Clyde A. Helms W. B. Saunders company 1995
2. Aneurysmal Bone Cyst: Concept, Controversy, Clinical Presentation, and Imaging by Mark J. Kransdorf and Donald
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6. Bone Tumors and Tumorlike Conditions: Analysis with Conventional Radiography by Theodore Miller March 2008
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COVID-19 Differential Diagnosis:
This pictorial essay presents the differential diagnosis, mimickers and overlapping CT features of COVID-19. Perform
likelihood of disease before the test was done.
If regional COVID-19 prevalence is high, the likelihood of SARS-CoV-2 infection is substantial in a patient with fever, d
al signs are less suspicious, or if regional prevalence of COVID-19 is low.
Introduction:
Proven COVID-19 cases. Click on image to enlarge. During the peak of the first wave of COVID-19 the a priori probab
ing and fever, actually had COVID-19 was high especially if they have an abnormal chest-CT. The images are all of pat
s CO-RADS 5, which indicates a very high probability of COVID-19. Chest CT can be helpful in the diagnosis of COVID-
logy. The CO-RADS classification uses features of COVID-19 on chest CT to indicate the likelihood of COVID-19 pulmo
e for more information about CO-RADS. The CO-RADS classification is accurate in the clinical setting of hospitalized p

ration of more than 2 days (ref Schalekamp et al). The performance of the CO-RADS classification decreases in patien
ration, and in patients with overlapping or pre-existing pulmonary disease.
In those cases we have to consider other diseases in the differential diagnosis. The differential diagnosis of COVID-19
portant to take the appropriate clinical setting into account when applying CO-RADS, as a false positive CT-result may
aming bias should be avoided by taking the differential diagnoses of COVID-19 CT signs into consideration and to co
Groundglass mimickers:
Diffuse high density of the lung parenchyma can be caused by inadequate inspiration.
Inadequate inspiration:
Notice the presence of inward bowing of the posterior membrane, indicative of inadequate inspiration. Repeat exam
taion in a patient with bronchopathy with hypoxic vasconstriction.
Mosaic attenuation:
Mosaic attenuation of lung parenchyma based on multifocal hypoperfusion or hypoventilation can mimic ground-gla
ty pulmonary parenchyma that is abnormal.
It is caused by bronchopathy with hypoventilation and secondary hypoxic vasoconstriction.
The relatively high density parenchyma is normal.
Differential diagnosis:
Centrally distributed groundglass with interlobular thickening in cardiogenic edema.
Pulmonary cardiogenic edema:
Pulmonary cardiogenic edema presents with bilateral ground-glass opacities reflecting extravascular fluid in the alve
trally distributed with sparing of the peripheral parenchyma and do not fulfill the complete obligatory COVID-19 feat
ravity dependent groundglass with interlobular thickening in cardiogenic edema. In addition, distribution of edema c
onstructions. Pulmonary cardiogenic edema with centrally distributed groundglass, diffuse vascular enlargement, lym
stive of cardiogenic edema:
Pulmonary infarctions:
Infarctions secondary to pulmonary emboli cause peripheral densities adjacent to the pleural surfaces. Although the
in the early stage, infarctions are frequently more peripheral, triangular and dense. The images show: Alveloar hem
Alveolar hemorrhage:
Bilateral and confluent airspace opacities caused by diffuse alveolar hemorrhage such as in e.g. systemic lupus eryth
scular bundles, and predominantly spare the peripheral pleural surfaces and costophrenic angles. These opacities sh
alveloar hemorrhage with patchy groundglass along the bronchovascular bundles in a patient with secondary vascul
more peripheral and diffuse. More chronic or subacute hemorrhage causes crazy paving and fibrosis. In addition, cl
ss common in patients with alveolar hemorrhage, although the clinical presentation of diffuse pulmonary hemorrhag
emoptysis Peripheral groundglass in chronic eosinophilic pneumonia
Eosinophilic pneumonia:
Eosinophilic pneumonia can also present with fever andcough just like COVID-19.
On CT it presents like COVID-19 with peripheral ground-glass and consolidations, with or without a crazy paving patt
alone. Differentiation from COVID-19 is possible based on: Drug-induced pneunmonitis with groundglass, reticulatio
ug withdrawal (right).
Drug-induced pneumonitis:
Drugs can cause CT patterns similar to confirmatory patterns of COVID-19, including ground glass, peripheral consol
opriate clinical setting of potentially pneumotoxic drugs and clear improvement after drug withdrawal (right) helps in
drugs and the findings on CT is found on www.pneumotox.com. Stationary groundglass and consolidations in the rig
Radiation pneumonitis:
Inflammatory and fibrotic changes associated with radiotherapy can cause peripheral ground-glass and consolidatio
ganizing pneumonia outside the radiation field can also occur, mimicking one of the confirmatory feature of COVID-1
of abnormalities over time can virtually always confirm radiation pneumonitis. Hypersensitivity pneumonitis with he
Hypersensitivity pneumonitis:
Ground glass opacities in hypersensitivity pneumonitis (HP) are also bilateral, but show a more geographical pattern
age shows typical bilateral groundglass opacities in hypersensitivity pneumonitis with head cheese sign: a mixture o
le). Peripheral, faint groundglass (arrows) in a patient with nonspecific interstitial pneumonia
NSIP:
Other interstitial lung diseases, such as nonspecific interstitial pneumonia can present with peripheral ground glass
ecific interstitial pneumonia and presented on CT with faint ground glass resembling cellular and, to some extent, fib
ndglass and consolidations resembling extensive, bilateral non-mucinous invasive adenocarcinoma and adenocarcin
Adenocarcinoma:
Especially adenocarcinoma and its precursors can present with pure ground glass opacities with or without solid com
carcinomain situcan present as bilateral ground glass opacities, which might look like COVID-19. Here, distribution is
distribution and no peripheral predominance. Alveolar proteinosis with diffuse crazy paving
Alveolar proteinosis:
Alveolar proteinosis is a rare condition, frequently associated with elevated lactate dehydrogenase, antibodies again

alveolar fluid findings typical for alveolar proteinosis. Crazy paving in alveolar proteinosis is much more diffuse than
and is frequently disproportional with severity of complaints.
Overlapping diseases:
With overlapping diseases we mean diseases of the lung that have the exact pattern as COVID-19.
Distinction can only be made with clinical parameters. Organizing pneumonia. LEFT typical peripheral and central pe
post treatment
Organizing pneumonia:
Patterns compatible with organizing pneumonia commonly occur in COVID-19. It is regarded as a confirmatory patte
ymal abnormalities. This pattern in COVID-19 overlaps with organizing pneumonia due to other causes with typical p
rway dilatation (figure). The lung abnormalities decreased after treatment with corticosteroids. Influenza pneumonia
ar groundglass nodules.
Influenza pneumonia:
Viral pneumonias show overlapping features on CT. Influenza virus infection can result in bilateral ground-glass opac
VID-19. Typical features of influenza are: In addition, vessel thickening and upper lobe involvement seem to occur m
viral pneumonias. Bilateral groundglass in PCP in an immunocompromised patient.
Pneumocystis pneumonia:
Pneumocystis pneumonia also causes bilateral ground-glass and in later stages consolidations with or without crazy
tion than in COVID-19, and only in immunocompromised patients. PCP is furthermore associated with pulmonary cy
also present in a small minority of hospitalized COVID-19 patients. ARDS. Bilateral, in part gravity dependent ground
went a gastro-esophageal resection.
Adult respiratory distress syndrome:
Diffuse alveolar damage can also show peripheral ground-glass, consolidations and crazy paving, which can be simila
o more gravity dependent reflecting permeability edema (right). ARDS can only occur in the appropriate setting, such
al ventilation. However, ARDS can concomitantly occur with COVID-19 in ICU patients. Special thanks to Lauran Stoge
diothoracic radiologists of Radboud UMC including Jesse Habets, Miranda Snoeren, Bram Geurts and Steven Schalek
Characterisation of liver masses:
From a practical point of view, the approach to characterizing a focal liver lesion seen on CT begins with the determi
homogeneous, has sharp margins and shows no enhancement, then it is a cyst. If the lesion does enhance, then the
since this is by far the most common liver tumor. The enhancement should be peripheral and nodular, with the sam
emangioma, then we further have to study the lesion. Based on the enhancement pattern, we divide masses into hy
ancement pattern and gross pathologic features, like the presence of fat, blood, calcifications, cystic or fibrotic comp
he differential diagnosis (figure).
Radiology department of the University of Chicago:
Publicationdate 2006-07-15 This article is based on a presentation given by Richard Baron and adapted for the Radio
ogy at the University of Chicago and well known for his work on hepatobiliary diseases. He has been president of the
art I a basic concept is given on how to detect and characterize livermasses with CT. In Part II the imaging features of
ses are presented in the menubar to test your knowledge (Liver mass 1 and 2).
Detection of liver masses:
Small Hepatocellular carcinoma in cirrhotic liver not visible on NECT (left), clearly visible in arterial phase (middle) an
ty of a liver lesion depends on the attenuation difference between the lesion and the normal liver. On a non enhance
e inherent contrast between tumor tissue and the surrounding liver parenchyma is too low. Only a minority of tumo
ill be detected on a NECT. So i.v. contrast is needed to increase the conspicuity of lesions. When we give i.v. contrast,
upply to the liver. Normal parenchyma is supplied for 80% by the portal vein and only for 20% by the hepatic artery,
however get 100% of their blood supply from the hepatic artery, so when they enhance it will be in the arterial phase
t patterns between liver tumors and normal liver parenchyma in the various phases of contrast enhancement (figure
n liver and lesion.LEFT: Arterial phase showing hypervascular FNHMIDDLE: Portal venous phase showing hypovascul
iocarcinoma In the arterial phase hypervascular tumors will enhance via the hepatic artery, when normal liver paren
rtal venous system. These hypervascular tumors will be visible as hyperdense lesions in a relatively hypodense liver.
in the portal venous phase, these hypervascular lesion may become obscured. In the portal venous phase hypovasc
aximally. These hypovascular tumors will be visible as hypodense lesions in a relatively hyperdense liver. In the equil
ors become visible, that either loose their contrast slower than normal liver, or wash out their contrast faster than n
ively hyperdense or hypodense to the normal liver. CT of the liver in the early arterial phase (left) and the late arteria
Arterial phase imaging:
Optimal timing and speed of contrast injection are very important for good arterial phase imaging. Hypervascular tu
te arterial phase). This time is needed for the contrast to get from the peripheral vein to the hepatic artery and to dif
nt two phases of arterial imaging at 18 and 35 seconds.
In the early arterial phase we nicely see the arteries, but we only see some irregular enhancement within the liver. In
r masses. Notice that in the late arterial phase there has to be some enhancement of the portal vein. The only time t
ogram, for instance as a roadmap for chemoembolization of a liver tumor. Patient with liver cirrhosis and multifocal
of scanning is important, but almost as important is speed of contrast injection. For arterial phase imaging the best r

asons for this better enhancement: at 5ml/sec there will be more contrast delivered to the liver when you start scanr
left a patient with cirrhosis examined after contrast injection at 2.5ml/sec and at 5ml/sec. At 5ml/sec there is far bett
ular metastases seen as hypodense lesions in the late portal venous phase. Notice some rim enhancement of the m
Portal Venous phase:
Portal venous phase imaging works on the opposite idea. We image the liver when it is loaded with contrast through
oment to start scanning is at about 75 seconds, so this is a late portal venous phase, because enhancement of the p
is late portal venous phase is also called the hepatic phase because there already must be enhancement of the hepa
If you do not seen enhancement of the hepatic veins, you are too early. If you only do portal venous imaging, for inst
orectal cancer, fast contrast injection is not needed, because in this phase the total amount of contrast is more impo
Equilibrium Phase:
The equilibrium phase is when contrast is moving away from the liver and the liver starts to decrease in density. This
imaging is best done at 10 minutes after contrast injection. This phase can be valuable if you're looking for: fast tum
ontrast in the blood pool as in hemangiomas or the retention of contrast in fibrous tissue in capsules (HCC) or scar t
in portal venous phase (left), but seen as relative hyperdense lesion in the delayed phase (right). Relative hyperdense
ized and dense is very slow to let iodine or gadolineum in. Once contrast gets in however, it is equally slow to get bac
nchyma washes out, the fibrous components of a tumor will look brighter than the background liver tissue. Cholangi
y be the only time when you see the tumor (figure). HCC in a cirrhotic liver. Notice fast wash out in equilibrium phase
lesions in the delayed phase On the left the importance of the delayed phase in a cirrhotic patient with an HCC is der
ced scan and also not in the portal venous phase. This is often the case and demonstrates the importance of the arte
n a cirrhotic liver whether it is a benign lesion like a regenerating nodule or a HCC. In the delayed phase we see that
chyma. Benign lesions typically will not show this kind of wash out. For instance a FNH or adenoma will show fast en
nous phase, but it will stay isodense with liver in the equilibrium phase. These benign tumors do not have enough ne
rrhotic patients you have to rely heavily on this delayed phase to differentiate benign little enhancing lesions from sm
ous and equilibrium phase. Notice that the attenuation of the hemangioma matches the bloodpool in every single ph
Blood pool and Hemangioma:
Normally when we look at lesions filling with contrast, the density of these lesions is always compared to the density
compare the density of the lesion to the liver, but to the blood pool. This means that the areas of enhancement in a
els (bloodpool) at all times.
So in the arterial phase the enhancing parts of the lesion must have almost the same attenuation value as the enhan
hancement of the portal vein. If it does not match the bloodpool in every single phase of contrast enhancement forg
angioma.
Notice that on the NECT the density of the tumor is the same as the density of the vessels. In the arterial phase it is n
as the aorta.
In the portal venous phase it matches the density of the portal vein.
In the equlibrium phase it has the same enhancement as the vessels. Eventually the lesion will become iso-attenuati
ng with the liver.
It has nothing to do with the density of the liver parenchyma itself. So think of bloodpool rather than liver if you're th
Tailored CT protocol:
You have to adapt your protocol to the type of scanner, the speed of contrast injection and to the kind of patient tha
l take about 20 seconds to scan the liver. For late arterial phase imaging 35 sec is the optimal time, so you start at ab
ave a 64-slice scanner, you will be able to examine the whole liver in 4 seconds. So you start scanning at about 33 se
indow is narrow, since you have only limited time before the surrounding liver will start to enhance and obscure a hy
ent. Here you don't want to be too early, because you want to load the liver with contrast and it takes time for contra
Besides you have more time, because the delayed or equilibrium phase starts at about 3-4 minutes. So you start at 7
Only when you inject with high speed at 5ml/sec you may start earlier at about 65-70 seconds. Use arterial phase ima
Hypervascular lesions:
Arterially enhancing lesions are mostly benign lesions and include primary liver tumors as FNH, adenoma and small
ve to be differentiated from the most common hypervascular malignant liver tumor, which is HCC and metastases fr
sarcoma and neuroendocrine tumors (islet cell tumors, carcinoid, pheochromocytoma). Four different tumors with e
rhotic liver; FNH with central scar in adolescent; adenoma in young woman on contraceptives and finally a hemangio
ascular lesions may look very similar in the arterial phase (figure). Differentiation is done by looking at the enhancem
ic features together with clinical findings. Hypervascular metastases will be considered in patients with a known prim
of cirrhosis, while FNH is considered in young women and hepatic adenoma in patients on oral contraceptives, anab
Hypovascular lesions:
Hypovascular liver tumors are more common than hypervascular tumors. Most hypovascular lesions are malignant a
are mostly hypervascular, there are exceptions. 10% of HCC is hypovascular. Cholangioca is hypovascular, but may s
hyperdense scar tissue in the equilibrium phase (arrow). On the left a hypovascular mass with irregular enhanceme
n of malignancy. On the delayed images a relative dense structure is seen centrally, which looses its contrast slower
composed of fibrous tissue.
The fibrous tissue has also retracted the liver capsule. These imaging findings are very suggestive of a cholangiocarc

Scar:
Liver lesions which may have a central scar are FNH, fibrolamellar carcinoma, cholangiocarcinoma, hemangioma and
odense structure. On MR scar tissue is hypointense on both T1WI and T2WI due to intense fibrotic changes. An exam
n to this rule is the central scar in FNH which is hyperintense on T2WI due to edema. T2WI can be very helpfull if ther
MRI scar tissue will enhance in the delayed phase. FNH with central scar seen in NECT, portal venous phase and equ
It has a hypodense centre on the NECT. In the portal venous phase there is homogeneus enhancement of the lesion
scar is seen only on the delayed phase images. The combination of homogeneous enhancement and central scar is
g hypodense capsule of HCC
Capsule:
Liver lesions which may have a capsule are Adenoma, HCC and cystadenoma or cystadenocarcinoma. The most com
ial phase and even in the portal venous phase it will be hypodense, because the fibrous tissue enhances very slowly.
e hyperdense structure. Capsule in Adenoma not seen in portal venous phase and well appreciated in delayed phase
It has a well defined contour and subcapsular feeding arteries. LEFT: Bright enhancing capsule of HCC in equilibrium
t with HCC. Only in the equilibrium phase a relatively bright capsule was seen. The image on the left was taken 8 min
elative hypodense in the equilibrium phase. So it has a fast wash out. NECT of a Fibrolamellar carcinoma with centra
Calcifications:
Central calcifications are seen in: These calcifications are hyperdense on CT and hypointense on T1 and T2 MR image
as seen on the left. Low density area due to fat in Adenoma
Fat:
Fat within liver tumors is seen in: The case on the left shows an adenoma with fat depositions within the tumor. Hem
Hemorrhage:
Hemorrhage in liver tumors is seen in: Hemorrhage is most commonly seen in adenomas. The case on the left show
proved to be an adenoma.
Cystic components:
If a lesion has a near water density in the centre and does not show enhancement in the centre, we usually will call it
tumor as in cystic metastases or metastases with central necrosis. Secondly you always have to add absces to the dif
ons with a low density, so it may be cystic i.e fluid containing. These lesions are multiple, but not spread out through
ons. This is a typical finding which makes the lesions suspective for liver abcesses. This was a case of diverticulitis. Th
bdominal infection. The bacteria enter the slow flow portal system, where they layer within the vessel and finally the
lobe. CT and T2W MR-image of echinococcus cyst. On the left a typical case of a echinococcus cyst with 'daughter cys
ver are not that typical. If you look at the CT image on the left, the first impression might be that there are only simpl
ly, you will notice that some of the hypodense lesions show vague rim enhancement. And although you might think t
that these lesions are hyperechoic solid masses. So you have to be very carefull in calling a lesion cystic, because you
for a differential diagnosis. Hepatic and delayed phase in a patient with breast metastases causing retraction of liver
arrows)
Retraction of liver capsule:
Most liver tumors will present as a mass. Some tumors however have an infiltrative growth pattern with a lot of fibro
tures, the tissue will contract and cause retraction of the liver capsule (figure). Breast cancer metastases can be infilt
s. This will give a pseudo-cirrhosis appearance. Delayed phase image of a cholangiocarcinoma with relative dense fib
r however to cause retraction is cholangiocarcinoma. The delayed image on the left shows a large cholangiocarcinom
apsule. Notice the resemblance with the case above. Another cause of local retraction is atrophy due to biliary obstru
phase in a patient with multifocal cholangiocarcinoma causing retraction of liver capsule. On the left another case o
tion and the delayed enhancement of the fibrotic component of the tumor. LEFT: rim enhancement in metastasis. RI
Peripheral enhancement and progressive fill in:
Many will regard 'peripheral enhancement and progressive fill in' as a typical feature of hemangioma, but it is not. Pe
ions and only discontinuous nodular peripheral enhancement that matches bloodpool is a typical feature of hemang
(middle) and metastases (right). Many lesions will show progressive fill in. In hemangiomas this progressive fill in mu
etastases will show contrast diffusion into a lesion starting on the outside. Usually the center does not fill in. Cholang
ous centre will enhance slowly. You will see it enhance in the delayed phase (see part II) So if you want to make the d
ses to see if the enhancement matches the bloodpool.
None:

Pancreatic cystic Lesions:

Diagnosis and management:
Marc Engelbrecht, Jennifer Bradshaw and Robin Smithuis
Radiology department of the Academical Medical Centre, Amsterdam and the Alrijne hospital in Leiderdorp, the Neth
Publicationdate update 21-3-20 Cystic pancreatic lesions are increasingly identified due to the widespread use of CT
Certain pancreatic cysts represent premalignant lesions and may transform into mucin-producing adenocarcinoma.
hese pancreatic cysts is associated with a large degree of anxiety and further medical investigation due to concerns a

e to differentiate between benign serous cystadenomas and premalignant mucinous cystic neoplasms and intraduct
is often not possible. This means that many pancreatic cysts remain undetermined and guidelines are needed for fo
Introduction:

Classification:
Pancreatic cysts can be categorized into the following groups:
Systematic Approach:
When a cystic pancreatic lesion is detected, the first step is to decide whether the lesion is most likely a pseudocyst o
the differentiation of pancreatic cysts. LEFT: Pseudocyst. RIGHT: Cystic neoplasm. The left CT-image is of a patient w
ple cysts. Notice also the retroperitoneal fat-stranding on the right. The most likely diagnosis is pseudocysts. The CT
old woman, which was found incidentally with US. The cyst has a thick irregular rim and contains solid 'non-depende
CN with central scar seen on MRI
MRI versus CT:
CT will depict most pancreatic lesions, but is sometimes unable to depict the cystic component. MR with heavily weig
the internal structure of the cyst and has the advantage of demonstrating the relationship of the cyst to the pancrea
plasm (SCN) on a CT.
MRI better shows the central scar. Serous cystic neoplasm with central calcification. There are cases when CT can be
or peripheral calcification in a mucinous cystic neoplasm (MCN). CT images of a mucinous cystic neoplasm with septa
pseudocyst MRI is usually of more diagnostic value than CT.
MRI can show the cystic nature of a pancreatic fluid collection and its internal structure.
The MRI shows a pancreatic fluid collection with dependent internal debris typical of walled off necrosis in necrotizin
iple small cysts. This could be a serous cystic neoplasm or a branch-duct IPMN. The connection of the cystic lesion to
Pseudocyst:
Pseudocyst Key findings: The CT demonstrates a large cyst in the upper abdomen in a patient who had an acute pan
luid.
There is wall enhancement. Traumatic pseudocysts CT demonstrates two large cysts in a 45 year old woman, who ha
ce (arrow).
The imaging findings combined with the history make it very likely that these are traumatic pseudocysts. Enable Scro
Disable Scroll Chronic pancreatitis with pseudocyst extending to the mediastinum Enable Scroll
Disable Scroll Chronic pancreatitis with pseudocyst extending to the mediastinum Most pseudocyst occur in the peri
croll through the images. This patient has a chronic pancreatitis. Notice the calcifications in the pancreatic head (curv
way to the mediastinum compressing the heart (red arrow).
Cystic Neoplasms - differential diagnosis:
The diagnosis of a cystic neoplasm should be considered when there is no history of pancreatitis or trauma. Morpho
discriminating features of cystic neoplasms.
In many cases however it is not possible to make a definitive diagnosis, because often the cyst will be too small.
However it is important to diagnose a serous cystic neoplasm, since this is the only tumor with no malignant potenti
Age and gender:
Mucinous cystic neoplasm
MCN is exclusively seen in middle-aged women with a mean age of 47 years (8) .
Only 12 cases reported in males up to date (9). Serous cystic neoplasm
SCN is also most commonly seen in women (75%) with a median age of 58 years (4). Solid pseudopapillary epithelial
SPEN is seen exclusively in young women (88%), with a mean age of 29 years (10).
It is an uncommon solid tumor that may have cystic components. Hence the following rule:
Serous cystic neoplasm:
Figure 14. Serous cystic adenomas contain multiple small cysts resulting in a lobulated contour. Some have a central
ith cmultiple small cysts. Courtesy of Dr Allen, HPB surgery, Memorial Sloan Kettering Cancer Center, NY The patholo
bulated appearance. A macrocystic serous cystic neoplasm is rare and, although benign, can be similar in appearanc
. Serous cystic neoplasm with multiple small cysts. Courtesy of Dr Klimstra, pathology of the Memorial Sloan Ketterin
neoplasm is a central scar, sometimes with calcifications. Sometimes the microcystic component of this tumor is dif
chitecture. MRI is also useful in determining if the cysts communicate with the pancreatic duct or not to differentiate
y specimen shows a cystic tumor with multiple small cysts and a central scar. There are no calcifications. Serous Cyst
allstones and abdominal pain. There is a hypodense lesion with central calcification in the head of the pancreas. The
stic Neoplasm (SCN) MRI better demonstrates the morphologic features of the lesion (fig). On T2WI the lesion is mult
calcifications. Although some of the cysts are rather large, this is still a characteristic appearance of a serous cystic a
nother example of a serous cystic neoplasm (Fig). The contrast-enhanced image on the right shows a hypodense lesi
enhancement of septations Notice that on CT it is very difficult to appreciate the cystic nature of these lesions and y
rcinoma. Serous Cystic Neoplasm (SCN) MRI will easily demonstrate the cystic nature of these lesions (fig).
The T2WI with fatsat nicely demonstrates a lobulated hyperintense lesion with central scar, which is characteristic of
ferentiate a serous microcystic adenoma from a branch-duct IPMN or intraductal papillary mucinous neoplasm.

IPMN is always connected to the pancreatic duct, but in many cases it is difficult to see the connection. The image sh
nd nondescript upper abdominal complaints.
This was initially thought to be a branch-duct IPMN, but turned out to be a SCN. Notice the central hypointensity.
This is scar tissue in a SCN.
Notice also the characteristic lobulated surface. Serous Cystic Neoplasm. Courtesy Koenraad Mortel, Dept Radiology
rous cystadenoma. Notice the central enhancement. Sometimes differentiation from a hypervascular cystic neuroen
tions are helpful. Enable Scroll
Disable Scroll Serous cystic neoplasm. Scroll through the images. Enable Scroll
Disable Scroll Serous cystic neoplasm. Scroll through the images. Scroll through the images.
In the pancreatic tail is a cystic lesion with a central scar with calcifications (arrow).
Even though some of the cyst are larger than 2 cm, this presentation still is typical for a serous cystic neoplasm, beca
lated contour. This patient had abdominal complaints which were attributed to the tumor, which was resected and p
s the resected specimen. The tumor was attached to the spleen, which also had to be resected. Serous cystic neopla
There is a microcystic lesion with a central scar in the pancreatic head.
This patient felt a mass in her abdomen.
Otherwise there were no complaints.
Because resection would mean extensive surgery, it was decided to follow the lesion.
During 5 year follow up there was no growth and the patient has no symptoms otherwise.
Mucinous Cystic Neoplasma:
Key findings: MCN in pancreatic tail in a 32 year-old female ('mother') CT-images of a 32 year-old female with pain in
e cyst in the pancreatic tail with peripheral calcification.
There is subtle septation as seen on the left image and wall thickening. You may have to enlarge the image to see th
of a 46 year old female with vague right abdominal complaints. The imaging findings are: MRI revealed a septated pa
n and no connection to the pancreatic duct. Surgery showed a low grade mucinous cystadenoma with ovarian strom
ry of a biliary pancreatitis and cholecystectomy.
She had sudden increased left abdominal pain. US showed increased size of a cystic lesion, which was diagnosed as
n the pancreatic tail with internal enhancing septation without connection to the pancreatic duct (fig). Continue with
m better depicts the internal septations. Pancreatic tail resection revealed a 14 cm mucinous cystadenoma including
Intraductal Papillary Mucinous Neoplasm:
IPMN key findings: Macroscopic specimen of a IPMN showing mucinous tumor, with extensive mucin producing papi
Disable Scroll Main duct IPMN Enable Scroll
Disable Scroll Main duct IPMN
Main-duct IPMN:
On imaging Main-duct IPMN is usually distinct from branch-duct IPMN, but sometimes there is a mixed type. Scroll th
is obstruction of the common bile duct with dilatation of the intrahepatic bile ducts (blue arrows). Notice the extrem
rmal T2WI and heavily T2WI with fatsat of a large main duct IPMN with extremely dilated pancreatic duct. Main-duct
The MRCP shows both a main-duct aswell as a branch-duct IPMN (arrow). IPMN is a lesion with malignant potential.
n CT-images of an IPMN with a dilated pancreatic duct (blue arrows). Notice enhancing solid nodule in the pancreatic
and branch-duct IPMN The US-image shows a large branch-duct component within the pancreatic head. Branch-duct
Branch-duct IPMN:
The CT-image shows a hypodense lesion in the pancreatic head. This could be an adenocarcinoma, but the low dens
es the possibility of a serous cystic neoplasm although there is no calcified scar. On MRCP the cystic nature is better
arrow). Branch-duct IPMN. A detail nicely demonstrates that some of the mucus-filled branches are seen in cross-se
ale a hypoechoic lesion was found in the pancreatic body, that looked like a cystic lesion. CT also identifies the lesion
ranch-duct IPMN The heavily T2WI nicely demonstrates the multicystic lesion with the connection to the pancreatic d
-images of a patient with a branch-duct IPMN who choose not to have surgery. Over time growth of the tumor is see
on. Sometimes it takes 5-8 years before a transformation is seen. Branch-duct IPMN Another branch-duct IPMN four
atsat before (left image) and after contrast (right image). EUS with contrast agent revealed 2 foci without enhanceme
. Branch-duct IPMN 75 year old male with a 2.7 cm side branch IPMN in the pancreatic head (circle). During follow up
EUS showed a resectable adenocarcinoma.
Uncommon Neoplasms with specific findings:
Figure 43. Solid pseudopapillary neoplasm with livermetastasis
Solid Pseudopapillary Neoplasm:
key findings: CT-images of a 26 year old woman with a large mass in the pancreatic head and metastases in the liver
otic degeneration. Solid tumor with cystic components in a 16 year old female diagnostic of solid pseudopapillary tu
Neuroendocrine tumor with cystic degeneration:
key findings: CT-images of a 61 year old woman with weight loss. There is a large mass in the body of the pancreas th
or necrotic parts. Neuroendocrine tumor with central necrosis CT-image of a neuroendocrine tumor with central nec
ripheral enhancement.
Report and Management:

In the table a checklist of what to mention in the report and the relative and absolute indications for resection accor
ystic neoplasms (2). Continue with the guidelines for management. The frequency of imaging follow-up depends on
the table. Although these management guidelines apply to IPMN, in general practice we use these criteria also for p
eoplasms. However in suspected Mucinous Cystic Neoplasm a cyst size ≥ 4 cm is an absolute criterium for resection,
Imaging protocol:
The initial MRI should be done using a dedicated pancreatic protocol (tab).
A possible follow-up protocol for lesions < 3 cm may consist of coronal and axial T2 single shot sequences and T1 we
Possibly adding diffusion weighted images to minimize risk of missing a concomitant pancreatic carcinoma. We have
olinium with the rest of the sequences the same. If we find a possible new nodule we would return the patient and r
None:

None:

None:

None:

Cystic Lung Cancer:
Onno Mets and Robin Smithuis
Amsterdam University Medical Center, Vancouver General Hospital and Alrijne hospital Leiderdorp:
Publicationdate 17-03-2020 Cystic primary lung cancer is increasingly being recognized as a unique imaging morpho
In this article we will discuss the imaging features and management Press ctrl+for larger images and text on a PC or
Most images can be enlarged separately by clicking on them.
Introduction:
CT imaging morphology of pulmonary nodules. Cystic primary lung cancer is often missed or misinterpreted, which i
p with benign entities such as infection. The appearance is different from solid and subsolid nodules, which are the
Terminology:
Examples of cystic lung cancer with an exophytic (left panel) and endophytic (right panel) solid component. A cystic p
enuation in relation to a well-defined parenchymal air space. A cystic nodule may demonstrate: Examples of cystic lu
h a thin (left panel) and thick (middle panel) irregular wall thickening, and a more complex appearance with extensiv
l classification systems have been proposed based on this imaging morphology [1,2]. Clinical implications of any sub
value for routine radiology care. Cystic lung cancer with increase of the solid component over a 2-year scan interval.
Solidification is a process that is often demonstrated by cystic lung cancers – where the solid tissue component incre
nd glass and/or cystic air spaces completely, leading to a solid mass. Cystic lung cancer demonstrating 'solidification'
solidification' from a baseline precursor lesion with subtle irregular wall thickening into a solid mass at time of diagn
process of central lucency formation due to expulsion of necrotic tumour content – can only be assessed on serial C
Although very often encountered in reports of single time point CT, this term should be applied with caution.
It may insinuate a differential diagnosis of infection or other disease that steers away from the correct diagnosis of a
,4]. The images show another example of a cystic lung cancer demonstrating 'solidification'.
Daily practice:
Patient with a T1c adenocarcinoma in the left upper lobe (left panel). Growing synchronous cystic lesion in the right l
rimary adenocarcinoma on histopathology. In daily practice The prevalence of cystic lung cancer is not well establish
n selection [1,5,6].
Presumably, cystic lung cancer morphology is not uncommon at all [4]. Several recognized associations are of specifi
sed awareness and active search should be demonstrated in this population. First, it has been recognized that cystic
either metachronous or synchronous with the first lung cancer (figure). Second, a high percentage of patients with c
ma, although cystic lung cancers undeniably do occur in otherwise normal lungs. Third, cystic lung cancers tend to o
ty to all radiologists who image part of the lungs, specifically neuro, abdominal and ER radiologists. Cystic squamous
r lobe cystic squamous cell carcinoma (left panel), who developed a right lower lobe cystic lesion (right panel) and su
ially considered contralateral metastatic disease, recommended tissue analysis showed an unrelated second primar
Histopathology:
Check-valve mechanism due to tumor cells (in red) in terminal airway Cystic lung cancers are predominantly adenoca
e second most common subtype.
A rare number of other tumour types like adenosquamous, neuroendocrine and lymphoma have been reported. Mu
n, fibrosis, lepidic tumour growth along alveolar walls, emphysema) relate to the imaging features of cystic lung canc
ns, ground glass, and cystic air spaces [1,5,7]. The most widely quoted mechanism of air space formation is "check-va
turn during expiration due to partial obstruction of the terminal airway proximal to the cystic air space due to tumou
d enlargement of the cystic air space. courtesy of JC English Radiologic-histopathologic correlation of a squamous ce
A cystic air space lined is by tumour cells (asterisk) most likely represents a dilated distal airway.
Check-valve ventilation due to more proximal airway narrowing by malignant cells and/or fibrosis is presumed. A jux

into the lumen (arrow).
Natural history:
Example showing transition from pure ground glass (left panel) to cystic lung cancer morphology (right panel). Cystic
nt aetiology.
Although they may be aggressive, many are rather slow-growing adenocarcinomas. CT morphology may remain cyst
g histopathologic substrates changes, lesion morphology may change over time. Example showing transition from cy
ght panel). Cystic nodules will either show increase of solid components, develop additional ground glass and cystic
retrospectively been shown that cystic lung cancers can both develop from small subsolid precursor lesions, as well
ancers at time of diagnosis. Lung cancer morphology is thus fluent and cystic components may be temporary. This e
cystic (middle panel), to solid lung cancer morphology (right panel).
Mimickers:
There are multiple benign diseases that may look like cystic primary lung cancer, including [3,4,8]: Previous imaging
ues, as well as past medical history are often helpful to differentiate a suspected primary lung cancer from other aet
In the absence of an overt underlying benign cause, any new lung cyst or cystic air space with associated subsolid co
and managed accordingly with CT surveillance or biopsy, if appropriate. Mimickers of cystic lung cancer: Persistent l
el and a scar - right panel. The images are examples of mimickers of cystic lung cancer morphology. Absolute malign
would require prospective surveillance of all benign and malignant cystic nodules in a given cohort.
Nodule management:
Multiloculated cystic lesion (left panel) interpreted as “non-specific”, despite a 6-month follow-up CT (for another rea
and overall lesion size. The next CT was obtained for chest pain 2 years later, showing a large mass invading the ches
rcinoma. The currently available screening (Lung-RADS) or clinical (BTS and Fleischner) nodule management guidelin
Although no uniform guidance is provided and optimal surveillance strategy is unknown, it is crucial that these lesion
y and associated patient burden. Pending potential incorporation into future guideline versions, the following strateg
tered: The images show a small cystic precursor lesion (left panel) initially interpreted as “thin-walled cavity, likely inf
, showing a T4 squamous cell carcinoma (right panel). Patient was alive 2 years after resection and systemic treatmen
Staging:
Possible overestimation of tumour burden due to inclusion of the cystic air space component in the total lesion size,
e solid line (left panel) may better represent the invasive tumour component and associated prognosis. Despite the u
rding to the ‘standard’ TNM 8th edition, which stages patient groups based on their prognosis. However, measuring
y posit that total lesion size (including the sometimes large cystic component) overestimates the total tumour burden
to the prognosis. Future consideration of an adjusted classification might be reasonable, as is available for subsolid
None:

TLICS Classification of fractures:

Thoraco-Lumbar Injury Classification and Severity score:
by Clark West, Stefan Roosendaal, Joost Bot and Frank Smithuis
Department of Radiology and Regional Spinal Cord Injury Center of the Delaware Valley, Thomas Jefferson University
iversity Medical Center and the Academical Medical Center, Amsterdam:
Publicationdate 2015-05-01 The Thoraco-Lumbar Injury Classification and Severity score (TLICS) is a classification sys
nical management. Unlike other classifications, the TLICS is an easy scoring system that depicts the features importa
sive neurologic compromise. TLICS also facilitates appropriate treatment recommendations.
Introduction:
Most classification systems of spine injuries are based on injury mechanisms and describe how the injury occurred.
flexion should be treated by undoing the flexion by positioning the patient in an extension brace, or by surgical inter
e injuries thought to be due to extension mechanisms, however, turn out to be due to flexion and vice versa. These c
s such as the AO-classification is that they are usually complex, leading to high inter-reader variability. Using the pop
ituation since it uses the terms stable and unstable. In many cases, however, there is no good correlation with the ne
ambiguous and may refer to direct osseous stability; it may refer to neurological stability and finally, to long-term (lig
il to systematically take into account the neurological status of the patient and the indication for MRI to determine th
easons the Spine Trauma Study Group introduced in 2005 the Thoracolumbar Injury Classification and Severity Scale
e clinical decision making and as a practical alternative to cumbersome classification systems already in use. The TLI
scored 0-4 points and the total score is the sum of these parameters with a maximum of 10 points. The total score p
A total of more than 4 points indicates surgical treatment. A compression fracture gets 1 point. When it is complicate
nts. The integrity of the posterior ligamentous complex plays an important role in the TLICS. Sometimes it will be pos
When there are several fractures, each level has to be scored separately. The level with the highest TLICS score will d
separately. For example, in a translation/rotation injury, the PLC is always involved, making a total of 3+3=6 points. W
always involved, making a total of 4+3=7 points. In case of a distraction on the anterior side, however, the PLC may o
s.
Morphology:

Posterior Ligamentous Complex:
The PLC serves as a posterior "tension band" of the spinal column and plays an important role in the stability of the s
o progressive kyphosis and collapse. The PLC is composed of the supraspinous ligaments, interspinous ligaments, ar
ous ligament is a strong, cordlike ligament which connects the tips of the spinous processes from C7 to the sacrum.
connecting the adjacent spinous processes. The contractile force of the ligamenta flava presses the vertebrae togeth
l forces. CT features of PLC pathology are: When the PLC is definitely injured on CT, it can already be scored as 3. Sin
uctures, MR is sometimes needed to adequately diagnose pathology of the PLC, especially when there is no dislocati
a tendency to overdiagnose PLC injury (4). In some cases it can be difficult to decide whether there is a burst fracture
sion fracture (figure). You have to decide what you think is the main issue: the collapse of the vertebral body or the c
ing will be high, there is usually an indication for surgical treatment. TLICS score In case of multiple fractures, you ha
st TLICS score usually will be decisive for the therapy of choice.
Neurological status:
The third category is the neurological status as determined by the neurologist or spine surgeon. The role of the radio
s that an incomplete cord lesion will likely benefit more from surgery than a complete lesion; therefore a complete c
injury gets 3 points.
Modifiers:
Modifiers are other factors which can affect the decision of appropriate treatment: Sternum fracture Sternum fractu
of the spinous process, but also a fracture of the sternum. Analogous to the 3-column classification of Denis, some i
thoracic spinal fractures and recognize it as an independent variable in the assessment and treatment of these patie
ylosing spondylitis, DISH and rheumatoid arthritis) are more susceptible to spinal fractures, even after minimal traur
f the annulus fibrosus alter the biomechanics of the spine, creating long lever arms and limiting the ability to absorb
e images are of a patient with a typical bamboo spine as a result of ankylosing spondylitis. After a fall on his back no
fracture line through the anterior side of the vertebral body and also through the spinous process. Continue with th
Disable Scroll Enable Scroll
Disable Scroll Look at the images. What are the findings? Then scroll to the next images. The findings are: The TLICS-
LC.
Simple compression:
A simple compression fracture is the most common form of injury and is seen in 90% of cases. It is either loss of heig
the vertebral endplate. The posterior cortex of the vertebral body has to be intact and this feature differentiates a si
. The posterior cortex may bulge slightly posteriorly in a simple compression fracture. As long as there is no free frag
racture and not a burst fracture. The images show a compression fracture. All we see is a cortical disruption in the up
ght ventrally. The posterior vertebral cortex is intact. The sagittal reformatted image also shows the cortical disruptio
ctures. You have to look at the thin slices to detect such a subtle fracture. Enable Scroll
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Disable Scroll Scroll through the images. Notice the horizontal band of density, which is often described as sclerosis.
that is already healing with sclerosis. This is merely a sign of trabecular impaction in an acute fracture. It is very com
on the radiographs. In this case the CT shows 2 fractures and the MRI shows 3 fractures. Pitfalls in diagnosing a com
sis. On the right with kyphosis.
Burst fracture:
This is the severe variant of a compression fracture with higher risk of neurologic deficits. The name is derived from
on the feet. A burst fracture gets 2 points for morphology in the TLICS. This means that a patient can be treated non-
ty should be confirmed at MR imaging, especially if conservative management of a burst fracture is planned (3). In th
olumn injury, calling it unstable and requiring surgical stabilization. Subsequent modifications of the Denis classificat
s complex (PLC), two-column unstable injuries can be successfully treated non-surgically (3). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Retropulsion of posterosuperior vertebral body fragment Retropulsion of a fragment is the typical feat
le compression fracture. Scroll through the images. Sagittal
fracture of vertebral body and
posterior element A sagittal fracture of the vertebral body and a sagittal posterior element fracture is seen in respec
four examples. In the Denis classification this would be a three column fracture -anterior/middle/posterior - indicatin
r this is a burst fracture, i.e. 2 points for morphology. The treatment will depend on the PLC integrity and the neurolo
g of the interpedicular distance, often a result of the sagittal fracture, is seen in 80% of burst fractures. The lateral vie
AP-view notice the subtle widening of the interpedicular distance compared to the levels above and below. The axia
ing on the thecal sac. On the sagittal CT and MRI there are no signs of posterior ligamentous injury. The anterior long
bit widened on the CT and there is some fluid in the joint on the MRI. If there was a lot of fluid in the joint, we should
ble Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. How would you describe the morphology and the PLC? The findings are: You
distraction, i.e. 4 points for morphology. However in this case the compression is the most prominent finding.

Translation - Rotation:
This type of fracture includes all fractures that are the result of displacement in the horizontal plane: side-to-side mo
to-side rotary motion of one vertebral body with respect to another. Often unilateral or bilateral facet dislocation is s
which always involves the PLC. In the TLICS this means 3 points for the morphology and 3 points for the PLC, which r
zation. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here a typical case of translation. The x-ray of the C-spine in this patient was normal and did not show
at is going on. Then scroll to the next images. In this case of translation there is bilateral facet dislocation and also a
re narrowing of the spinal canal. Continue with the MRI-images. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Again look at the first MR-images and decide what is going on. Then scroll to the next images. The find
Disable Scroll Enable Scroll
Disable Scroll In some cases it can be difficult to decide whether there is a translation or distraction injury and we ha
forces. Scroll through the images. What are the findings? At first glance this looks just like another burst fracture. Ho
isplacement at this moment, we should probably call this translation injury. Continue with the axial images. Enable S
Disable Scroll Enable Scroll
Disable Scroll On the axial images we see: These are typical findings in translation-rotation fractures. So we should c
Distraction:
A distraction injury is separation or pulling apart of two adjacent vertebrae. It is a severe injury since there is a high c
porting structures are pulled apart. A distraction injury on the posterior side can lead to a compression fracture on t
y only looking at the compression fracture and overlooking the distraction injury. In some cases it is difficult to decid
ompression fracture or with a compression fracture with PLC-injury. If the distraction is the main feature, then the m
is always involved, resulting in a total of 7 points for the TLICS-score. If compression is the main feature, then the mo
ry making a total of 5 points. In both cases the patient is a surgical candidate. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. What are the findings? In this case the main findings are the horizontal fract
show hardly any compression. Notice that there are 3 vertebrae involved. Only the level with the highest score count
s severe compression of the vertebral body. However the most important findings are the horizontal fractures of the
ble Scroll
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Disable Scroll Scroll through the images. What are the findings? The findings are: In this case some would call this a b
straction is the most important finding, i.e. distraction and PLC injury, i.e. 4+3 points. So here is a typical case of distr
ot much else happening here. The disc space is markedly widened about four times the normal level. The facet joints
which is not a key element but a frequently associated injury. Continue with the MR. The MRI shows exactly the sam
anatomic information. The MRI also shows disruption of the ligamentum flavum and a partial disruption of the inter
eloping a spinal cord injury. Here a fracture that just looks like another compression fracture on the lateral view. At f
we zoom in and look at the distance between the spinous processes. Now when you look carefully at the lateral view
the whole story. You can see the edema related to the fracture of the vertebral body and the massive edema in the p
he ligamenta flava and the interspinous ligament. TLICS: distraction injury + PLC disruption. This is an interesting cas
is patient. However when we classify according to the TLICS-score, we give 4 points for the morphology and 3 points
ent would still get 7 points. Unfortunately, but not unexpectedly, conservative management failed with near-dislocat
her example. You could call these compression fractures. There is loss of height with a dense band of impaction and
ok at the spinous processes. One of the spinous processes is in two pieces and the two pieces are widely separated.
Now when you describe such a fracture the first word in your report should be distraction, i.e. morphology: 4 points
etween the spinous processes. But there are also little pieces ofbone, that have avulsed at least 10mm away. At first
ay be the most important sign of a major injury on a CT-scan. The fact that these little pieces of bone have been so s
this case there are lots of other things going on, but sometimes these little pieces of bone are all you get. If you look
he MRI. The teaching point is: pay careful attention to little pieces of bone. Patients with a rigid spine are more at risk
straction on the anterior side. Notice the rigid spine and how easily this major injury can be overlooked. This patient
e flava ligaments, interspinous and supraspinous ligaments as well as fracture of the posterior elements and compre
ed. Here another distraction injury. At surgery the rupture of the supraspinous ligament was confirmed (red and bla
Additional Cases:
Enable Scroll
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Disable Scroll Case 1 Scroll through the images. How would you describe the morphology and the PLC? The findings
tient is a surgical candidate. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Case 2 Look at the images. How would you describe the morphology and the PLC? Then scroll to the n
Look at the images. How would you describe the morphology and the PLC? The findings are: Case 4 Look at the imag
re: Enable Scroll

Disable Scroll Enable Scroll
Disable Scroll Case 5 Look at the images. How would you describe the morphology and the PLC? Then scroll to the n
nt (black arrow)
2. PLC: widening of both facet joints (yellow arrow) and a fracture of spinous process (blue arrow) - 3 points
3. TLICS based on imaging: 5 points Discussion: based on only these two images it is hard to say whether this is burs
either case the TLICS-score is high and this patient is a surgical candidate. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Case 6 Look at the images. How would you describe the morphology and the PLC? Then scroll to the n
should not describe this morphology as burst - 2 points. The horizontal fractures on the posterior side and the incre
higher score for morphology. Always go for the highest possible score in TLICS. The Importance of Injury Morpholog
ic Status by Alexander R. Vaccaro et al.
2. Chance-Type Flexion-Distraction Injuries in the Thoracolumbar Spine: MR Imaging Characteristics by Clare J. Grove
3. Traumatic Thoracolumbar Spine Injuries: What the Spine Surgeon Wants to Know by Bharti Khurana RadioGraphic
4. Injury of the posterior ligamentous complex of the thoracolumbar spine: a prospective evaluation of the diagnosti
ine (Phila Pa 1976). 2009 Nov 1;34(23):E841-7
5. Vertebral fractures and concomitant fractures of the sternum by Mihai H. Vioreanu et al Int Orthop. Dec 2005; 29(
6. Management of Acute Spinal Fractures in Ankylosing Spondylitis by Saad B. Chaudhary, Heidi Hullinger, and Micha
None:

Non-traumatic Intracranial Hemorrhage:
Amber Bucker, Henriette Westerlaan, Aryan Mazuri, Maarten Uyttenboogaart and Robin Smithuis
University Medical Center Groningen and Alrijne Hospital in Leiderdorp, the Netherlands:
Any type of bleeding inside the skull or brain is a medical emergency.
The most common causes of hemorrhage are trauma, haemorrhagic stroke and subarachnoid haemorrhage due to
Complications are increased intracerebral pressure as a result of the hemorrhage itself, surrounding edema or hydr
s non-traumatic hemorrhages. They will be discussed by their location, because that is frequently the clue to the diff
Then we will discuss further imaging to get to a specific diagnosis.
Finally specific diseases that present with intracerebral hemorrhages will be presented in more detail. Press ctrl+ for
Most images can be enlarged by clicking on them.
Localization of hemorrhage:
Knowing the location of a hemorrhage is often the key to the differential diagnosis especially in non-traumatic bleed
ial hemorrhage- intracerebral 85% of non-traumatic hemorrhages are seen in patients with hypertension or cerebra
ally in a central position in the basal ganglia, pons, thalamus and cerebellum, while in CAA they are typically more in
oral lobes - also called lobar hemorrhages. The differential diagnosis in a patient with an intracerebral hemorrhage h
enous infarction due to sinus thrombosis (yellow arrows)
Lobar hemorrhage:
Lobar hemorrhages are located in the periphery of the cerebral lobes unlike hypertensive bleeding which usually is l
y is cerebral amyloid angiopathy, but also hypertension because of its high prevalence. Other causes: Here some exa
n lobar hemorrhage is not as common as in hypertensive hemorrhage because of the more periferal location. Only v
system (fig). This patient died the next day.
No definitive diagnosis was made, but it was assumed that this was a case of CAA.
Basal ganglia:
Hemorrhage in the basal ganglia is typically seen in hypertension.
Hypertensive hemorrhage typically occurs in elderly patients and is usually in a central location.
This differentiates hypertensive bleeding from hemorrhage in patients with cerebral amyloid angiopathy (CAA) which
mages show a typical hypertensive hemorrhage in the putamen, which is the largest and most lateral part of the bas
Continue with the follow up images... On a follow up scan only parenchymal loss is seen in the putamen where the h
enticulostriate arteries (LSa). The LSa are small diameter end vessels that originate at a right angle from the artery of
the distal cortical vessels. Their internal pressure may be very high and for this reason the LSa are particularly susce
neurysms and rupture (3) (ref). The first three images show a large hematoma in the basal ganglia on the right with r
avitation due to tissue loss (arrow) and hypodensity of the basal ganglia as a result of gliosis. Hemorrhage in the hea
system Caudate nucleus The images show a hemorrhage in the basal ganglia in a patient with longstanding hyperten
It is located in the head of the caudate nucleus. The head of the caudate nucleus receives its blood supply from Heul
A rupture in these arteries causes parenchymal hemorrhage. The presence of an intraventricular haematoma is cons
drocephalus and raised intracranial pressure.
Thalamus:
Bleeding in the thalamus is typically seen in hypertension. This patient presented with hydrocephalus due to an intra
Note the very small hyperdensity in the left thalamus, which is the origin of the hemorrhage. Follow-up one day later
The patient underwent surgery with placement of a ventricle drain to treat the hydrocephalus.
Note the hypodense thalamus on the left side with the persistent medially located hyperdense focus.

Cerebellar:
This patient presented with a cerebellar hemorrhage.
The gradient echo-images show multiple microbleeds. This can be the result of long standing hypertension due to th
Subarachnoid:
Subarachnoid hemorrhage (SAH) is bleeding in the subarachnoid space between the arachnoid and the pia mater. Th
of aneurysmal rupture with spread of blood into the subarchnoidal cisterns (fig). The first choice of imaging modalit
ed CT scan (NECT). NECT is positive for SAH in 98% within 12 hours of onset.
If the suspicion is strong, but the CT is negative, a lumbar puncture is performed to detect blood in the CSF. The imag
aneurysm of the left middle cerebral artery (arrow). Subarachnoid hemorrhage is discussed in more detail here.
Cerebral amyloid angiopathy (CAA):
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Cerebral amyloid angiopathy (CAA) is a disorder characterized by deposits of amyloid in the walls of th
ncephalopathy and hemorrhage.
The hemorrhages can be divided in macrobleeds or lobar hemorrhages, microbleeds and subarachnoid hemorrhage
It is not associated with systemic amyloidosis. The major symptoms are neurologic deficits, dementia and epilepsia.
The epilepsia is caused by the hemosiderin deposits near the cortex of the brain. The major risk factor is increasing a
Notice how numerous these small hemorrhages are and primarily located in the perifery of the brain.
This patient presented with a cerebellar hematoma. Continue with the T1W-image... The T1W-image shows a hyperin
er with CAA make up 80% of the causes of intraparenchymal hematomas.
Think of CAA if you see multiple peripheral or lobar haemorrhages in an elderly patient. Dutch type of hereditary CA
most common form.
Stroke is frequently the first sign of the Dutch type and is fatal in about one third of people who have this condition.
Survivors often develop dementia and have recurrent strokes.
About half of individuals with the Dutch type who have one or more strokes will have recurrent seizures. Cortical sup
cial siderosis the proximity to the cortical surface appears to be the trigger for transient focal neurologic symptoms c
ficial siderosis have a far greater chance for recurrent hemorrhage compared to patients without cSS (ref). Lobar he
CAA presented with a large lobar hematoma in the right temporal lobe.
Notice the superficial siderosis (arrow). This patient with CAA has microbleeds, superficial siderosis and multiple infa
There is superficial siderosis in the left occipital region.
The DWI shows infarction in left occipital lobe and reight frontal lobe (with some artifacts).
Subarachnoid hemorrhage:

Aneurysmal rupture:
As mentioned before a subarachnoid hemorrhage (SAH) is bleeding in the subarachnoid space between the arachno
is the result of aneurysmal rupture with spread of blood into the subarachnoid cisterns (figure). CT images of a patie
eurysm. Continue with the DSA... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Notice that there are two aneurysms (arrows): Both were coiled. Click for larger view This patient prese
eningeal irritation. The NECT images show hyperdense blood in the subarachnoid space.
There is an aneurysm of the anterior communicating artery (arrow).
It has a high density and we think that is the thrombus inside the aneurysm.
This means that on a DSA the actual aneurysm may look smaller. MRI has a lower sensitivity for detecting a SAH thar
e phase..
The most sensitive sequence are the T2*gradient echo and FLAIR. These images are of a patient who was suspected
The NECT and most MR sequences were normal. Continue with the FLAIR images... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The FLAIR images show high signal intensity in the subarachnoid space. The arrows indicate the interp
The differential diagnosis of high signal in the subarachnoid space on MRI is large: In this case it was the result of a S
n a NECT. Note the location of blood mainly around the brainstem and in the 3th and 4th ventricle. Often the locatio
eurysm. The next step is performing a CT angiography, to search for an aneurysm as the cause of the SAH. This patie
ebellar artery (PICA). Also note the hydrocefalus. This patient underwent a digital subtraction angiography (DSA) and
eft PICA of 6 mm in maximal diameter with a short, narrow neck. Saccular aneurysms are the most common type of
Circel of Willis. They are multiple in 20%. In 5% they measure over 2,5 cm and are called “Giant aneurysms”. Other ty
lerotic disease) and mycotic aneurysms. The latter are seen as peripheral located intraparenchymal clots with white
emboli in patient with known bacteraemia. The location of the aneurysm can be suspected from the location of the h
rebri media aneurysm.
Complications:
In the table the complications of a SAH are listed. Follow-up MRI performed 4 months after coiling shows parenchym
ation of the aneurysm after coiling (not shown). Intraparenchymal hemorrhage in SAH As discussed earlier an intrac

te is also possible. When an aneurysm ruptures the pressure of the jet can be so high, that the blood will be injected
patient presented with a subarachnoidal haemorrhage due to an aneurysm in the anterior communicating artery. T
arrow).
Perimesencephalic SAH:
Perimesencephalic subarachnoid hemorrhage (PMSAH) is a subarachnoid hemorrhage with a different etiology and
may extend in small amounts into the basal and suprasellar cisterns and even into the Sylvian and interhemispheric
mal form of SAH.
Patients with a perimesencephalic nonaneurysmal subarachnoid hemorrhage are not at risk for rebleeding in the ini
The causes of PMSAH suggest a venous or capillary rupture at the level of the tentorial hiatus. The images show a sli
tern in a patient who presented with acute severe headache.
DSA did not show an aneurysm. This patient complained of sudden onset headache with the sensation of a “burst” in
Neurological exam was normal, except for a stiff neck. The NECT showed a small amount of subarachnoidal blood ar
CTA showed no abnormalities.
DSA was not performed. Here another example of a nonaneurysmal perimesencephalic SAH. Left image: NECT show
image: more cranially, the pentagon, ambiens cistern and the proximal part of Sylvian’s fissures, did not show any b
ephalic SAH.
The blood is solely located around the brainstem. To diagnose a perimesencephalic nonaneurysmal SAH, the patient
apply and the CTA does not show an aneurysm, you do not have to perform a DSA.
Role of CTA and DSA:
In a SAH we usually will find an aneurysm with CTA.
If the CTA does not show an aneurysm we usually continue with a DSA because it has a higher sensitivity. However if
s are compatible with a perimesenphalic hemorrhage, no further investigation is necessary (ref 8) Spontaneous perip
Spontaneous Convexity SAH:
CaseA 68 year old male presented with progressive tremor and weakness of right hand since one week.
The differential diagnosis of the neurologists includes tumor or CVA. Besides hypertension, no relevant medical histo
ent sequence to detect SAH in the subacute phase with almost a sensitivity of 100% from day 4-14. T2W-image confir
gnal intensity corresponding to hemoglobin breakdown products. Susceptibility weighted imaging confirmed the SAH
to the diagnosis of cerebral amyloid angiopathie (CAA). In patients with a spontaneous non-traumatic convexity SAH
Venous infarction:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Whenever you see a hemorrhagic infarction, always think of the possibility of a venous infarction like in
ce the thrombus in the right transverse sinus (arrowheads).
Arteriovenous Malformation:
A cerebral AVM is an abnormal connection between the arteries and veins resulting in arteriovenous shunting throug
idus are fragile and can rupture, which results in hemorrhage. Most AVMs have a bleeding risk of 1-2% per year. The
e several hours after the use of cocain.
She presented with a left sided hemi paralysis. Spetzler-Martin classification The Spetzler-Martin arteriovenous malfo
res of intracranial arteriovenous malformations to give a grade between 1 and 5.
Grade 6 is used to describe inoperable lesions.
The score correlates with operative outcome. eloquent brainsensorimotor, language, visual cortex, hypothalamus, th
ent to these structures non-eloquent brainfrontal lobe, temporal lobe, cerebellar hemispheres Click to enlarge image
. Blood is seen in three different locations: Continue with the CTA... CTA shows a prominent PICA (yellow arrow) with
is. There is a dilated vein (blue arrow) which drains directly into the rectal sinus. In between the abnormal artery (PIC
lar structures is seen (arrowheads), suspected of a nidus. Continue with the DSA... DSA confirms the right PICA with a
rained by either superficial and deep veins (not separately shown here). Findings are concordant with an AVM - Spetz
explained as a flow related aneurysm.
As a result of the changed hemodynamics due to the AVM, the vessel wall can become weakened and form an aneur
The PICA, nidus and abnormal draining veins (together forming the AVM) still show contrast enhancement.
It was decided not to treat the AVM directly and to opt for follow-up and possibly operative exploration in the future.
confused consciousness state. NCCT shows a lobar parenchymal hemorrhage surrounded by edema (left image). CT
to small abnormal vessels (not shown) below the hemorrhage. No feeding arteries of draining veins were visible. The
the acute phase. DSA and 3D images from the Right Internal Carotid artery showed an underlying AVM. Spetzler Ma
f residue. AVM 4 65 year old man complaining of acute onset of headache. NCCT shows bilateral subarachnoid hemo
ocation of the parenchymal hemorrhage a flow related aneurysm of the anterior communicans artery, which was co
Notice the hemorrhage next to the aneurysm (circle). CTA also showed an AVM with the nidus in the left frontal lobe
n a way that the arterial walls become weakened and aneurysms may develop. Lateral view of the CTA: Left image: D
t with separately coiling of the aneurysm and daughter sac (yellow arrow). It was decided to treat the aneurysm first
atient has recovered from his subarachnoid hemorrhage.
Dural arteriovenous fistulas (dAVF):

A dural arteriovenous fistula is an abnormal connection between a dural artery and a vein or venous sinus.
Due to the increased venous pressure a variety of symptoms may occur: pulsatile tinnitus, headache, raised intracra
ral hemorrhage. The presence of cortical venous reflux in patients with DAVF increases the chance of neurological de
eriovenous malformation, a DAVF is usually an acquired disorder and may develop after cerebral venous thrombosis
graphy, DSA is still the gold standard to diagnose and classify the type of DAVF. Treatment consists of endovascular e
ered from an intraventricular hemorrhage. Note the cortical venous reflux (arrowheads) on the CT-angiography with
teral ventricle as the bleeding spot. The DSA images (lateral view) confirmed a dural arteriovenous fistula (DAVF) Bor
eflux with venous ectasia. Embolization with liquid agent (arrow) After trans-arterial embolization with liquid embolic
. dAVF 2 This patient had intermitted speech disturbances. MRI showed a lobar hemorrhage in the left temporal lobe
arrow). dAVF 2 Note the massive venous congestion on the T1 with Gadolineum (arrow). Lateral view of a injection in
. dAVF 2 Note the direct fistula in a subarachnoid vein with cortical venous reflux through the vein of Labbé (arrow).
with embolization through the occipital artery (histroacryl) and middle meningeal artery (Squid ®) with complete obl
Cavernous malformation:
A cavernous malformation, also called cavernoma or cavernous hemangioma, is a vascular hamartoma.
It is a benign mass composed of immature vessels.
Cavernomas may be congenital, but usually form during life. Patient may be asymptomatic or present with intracran
cavernous malformation is composed of immature vessels and may bleed.
Imaging may depict various stages of bleeding. This example shows the typically appearance on MRI named “popcor
sion. They are usually located supratentorial, but may less commonly present in the pons or cerebellum. The Zabran
al cavernous malformations, and although not used in clinical practice it is useful in scientific publications that seek t
mas are only seen when: Multiple cavernomas can be confused with multiple haemorrhagic metastasis. In the table
Infarction with hemorrhagic transformation:
Lobar hemorrhage in hemorrhagic infarction This patient came to the emergency department with a left-sided hemi
decided to dismiss the patient, the symptoms came back suddenly.
It was diagnosed as an acute infarction in the area of the right middle cerebral artery.
Thrombolytic therapy was started right away.
The next day the patient got worse and the second CT-scan showed a large hemorrhagic infarction in the right acm a
the stroke unit with a recent infarct in the left MCA territory.
Due to delay in presentation outside the thrombolytic window, no thrombolytic therapy was given. A follow-up NECT
d a well demarcated hypodense area in the left MCA territory. In the hypodense area, very small subtle hyperdens fo
of hemorrhage (arrow) indicating petechial hemorrhagic transformation of the ischemic infarct.
Hemorrhagic metastases:
This cortically located location at the grey-white matter junction is typical of hematogenously metastatic spread.
They usually follow flow-dynamics: 80% anterior circulation vs. 20% posterior. Metastasis can become so large, that w
hemorrhagic metastases present as a solitary lesion and the other half presents as two or more lesions. The most c
Hemorrhagic Brain tumor:
Intratumoral hemorrhage The glioblastoma (GBM) is the most common primary brain tumour to show intratumoral
mmon known acute presentation of intratumor haemorrhage is apoplexia due to bleeding in a hypophyseal macroa
Pituitary Apoplexia:
This patient presented with sudden headache, nausea and vomiting.
He had ptosis of his left eye. The images show a pituitary macroadenoma with extension into the cavernous sinus.
Note the subtle hyperdensities in the tumour (arrow).
On a T1W non-enhanced image there is mild hyperintensity posteriorly and cranially in the tumor. These findings su
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Anatomy and Pathology of the Infrahyoid Neck:
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Publicationdate 2009-12-07 In this article we will focus on: the 5 anatomical spaces of the infrahyoid neck. Anatomy
Anatomy of the Infrahyoid Neck:

Surgical triangles:
The infrahyoid neck is the region of the neck extending from the hyoid bone to the thoracic inlet. Traditionally the ar

of surgical triangles whose borders are readily palpable bones and muscles (figure). These triangles have a cranial-ca
cross-sectional imaging. Another approach to the anatomy of the neck is the so-called 'spatial approach', which we s
llustration. This is one of the 'strap' muscles, an important landmark in the neck. It is a group of four pairs of muscles
ohyoid, thyrohyoid and omohyoid muscles. They are all attached to the hyoid bone and look like a strap. The other s
ck is separated from the suprahyoid neck by the hyoid bone (arrow) In the spatial approach to the anatomy of the in
s of spaces defined by the various layers of the deep cervical fascia. This facilitates the understanding and interpreta
). Some of these infrahyoid spaces are continuous with the suprahyoid neck and some are continuous with the supe
Spaces of the infrahyoid neck:
The infrahyoid neck is divided into 5 major anatomical compartments or spaces by the various layers of the cervical
nd therefore suited for analysis on axial CT or MR. Central compartment containing several viscera like the larynx, th
2. Carotid space Paired space just lateral to the visceral compartment which contains the internal carotid artery, inte
3. Retropharyngeal space
A small virtual space containing only fat continuous with the suprahyoid space and the middle mediastinum.
4. Posterior Cervical Space
Paired space posterolateral to the carotid space. It contains fat, lymph nodes and neural elements.
5. Perivertebral space This large space completely encircles the vertebral body including the pre- and paravertebral
aneous emphysema after a motor vehicle accident. Air has dissected along the layers of the cervical fascia. Notice th
by air.
Systematic approach:
The systematic approach to pathology in the infrahyoid neck is a three-step procedure: In which space is the lesion l
* Step 2: What are the normal contents of this space?
* Step 3: What pathology arises from these contents and can we recognize a specific radiological pattern and does th
Visceral space:
The visceral space extends from the hyoid to the anterior mediastinum and does not extend into the suprahyoid spa
ceral space. The CT section is at the level of the supraglottic larynx and the thyroid cartilage. Anterior to the thyroid c
id, thyrohyoid and omohyoid . They are all connected to the hyoid and depress the hyoid bone and larynx during sw
trap. We will now continue with a few cases. Although we have provided the diagnosis in these cases, we still want yo
Laryngocele:
Step 1: which space On the left a patient with a swelling on the right side of the neck. Study the image and decide in
swelling is centered within the borders of the thyroid cartilage. Therefore this must be pathology arising in the viscer
ormal contents On the left an additional image is shown at a slightly lower level. Study the images and decide which
hich are not. Then continue reading. The CT section shows the lesion present at the level of the supraglottic larynx a
a, thyroid gland, parathyroid glands and recurrent laryngeal nerve, which lies in the tracheo-esophageal groove. Para
not within the larynx, so they can be ruled out. The hypopharynx is posterior to the lesion and has a normal appeara
nsidered, but these are typically embedded in the laryngeal strap musculature and therefore should be located ante
h this lesion could have arisen is the larynx. Step 3: Pattern recognition This lesion presents as a cystic lesion with sh
in the supraglottic larynx in the right paraglottic space and also has an extralaryngeal component, which explains the
cosal swelling on the right was seen in the larynx. Squamous cell cancer, which is a mucosal disease, can therefore b
the four submucosal entities mentioned in the table on the left, we can make the following remarks: Secondary inter
laryngeal ventricle (enhancing mass on the right image) Laryngocele (2) When a larynocele is suspected you always
cele has no underlying cause.
Secondary laryngocele arises due to pathology in the laryngeal ventricle, which is a slit-like opening between the true
tly caused by a squamous cell carcinoma, as in this case. At endoscopy the tumor may be obscured by the laryngoce
tomy: false cords (F), true cords (T) and ventricle in between (V) RIGHT:Fluid-filled secondary internal and external lar
tricle (T) obstructing the laryngeal ventricle. On the left side, an air-filled primary internal and external laryngocele. M
a slit-like opening between the false and true vocal cords (image far left). It is the anatomic landmark between supra
ranially into the paraglottic space. When the opening of the laryngeal ventricle is completely obstructed by tumor, th
his results in a fluid-filled internal laryngocele. Eventually the paraglottic space becomes filled up and the internal lar
larynx through the thyro-hyoid membrane. When the opening of the laryngeal ventricle is partially obstructed, a pres
yngocele which may, eventually, become external (right image, red arrow).
Squamous cell carcinoma:
On the left, a CT-image at the level of the thyroid cartilage. There is an irregular mass centered in the right piriform s
e most common tumor is a squamous cell carcinoma. This was proven at biopsy. Notice the retropharyngeal space (
ous cell carcinoma (2) On the left, contiguous slices in a craniocaudal direction at the level of the larynx. Study this ca
and then continue reading. Multinodular goiter Strap muscles on right side (yellow arrow) and presumed position of
Multinodular goiter:
Step 1: Which space On the left a patient with a swelling on the left side of the neck, which has existed for years. The
lage. The strap musculature seems to be draped over the lesion (blue arrow). Therefore this lesion lies within the vis
tomical contents of the visceral space rules out many possible tissues and organs from which this pathology may ari
e hypopharynx is slightly displaced due to the retropharyngeal extension of the mass and the lesion lies cranial to th

* Embryological remnants
Remnants like thyroglossal duct cyst can be considered but these lesions are usually cystic.
* Paratracheal lymph nodes
These are located outside of the strap musculature.
* Recurrent laryngeal nerve
This nerve is located within the tracheo-esophageal groove. By exclusion we can say that this mass arises either from
r with intrathoracic extention Step 3: Pattern recognition and clinical information On the chest film we notice a displa
ss. So the mass is located within the visceral space and extends into the anterior mediastinum, since the trachea is lo
rds the surrounding fat and there are a few scattered coarse calcifications. When we combine these findings, we rec
his diagnosis is compatible with the clinical information that the swelling in the neck has been present for years. Thy
evel of the hyoid bone
Thyroglossal duct cyst:
On the left axial T1- and T2-weighted images at the level of the hyoid bone. There was no enhancement on the post
xternal and partly internal to the hyoid bone and located in the visceral space. The lesion is embedded in the strap m
chea, thyroid gland, parathyroid glands or recurrent laryngeal nerve, since these structures are located more caudall
he larynx. By exclusion a thyroglossal duct cyst is the most likely diagnosis. Thyroglossal duct cyst (2) Key facts Param
amedian thyroglossal duct cyst. This lesion not in the midline, but the key finding is that this lesion is cystic and emb
cyst Thyroglossal duct cyst (3) When the diagnosis thyroglossal duct cyst is made, always check if there is a thyroid in
ong the thyroglossal duct. In that case it stays at the tongue base. In these rare cases, the patient has a so-called ling
ct cyst Lingual thyroid (courtesy: Tony Hasso) On the left, a child with a lingual thyroid. This is the only functioning thy
f such a 'lesion' were to be excised. On the left images of a three-year old girl with a slowly enlarging tumor in the mi
on is seen at the level of the hyoid bone and slightly right off midline (left image). During US examination, the lesion
ture and close relation to the hyoid bone makes thyroglossal duct cyst the most likely diagnosis. Notice that a norma
Carotid space:
The carotid space extends from the skull base to the aortic arch. It transverses the suprahyoid and infrahyoid neck in
the carotid space and the derived pathology. Paraganglioma: T1-weighted Gadolineum enhanced MR image at the le
Paraganglioma:
Step 1: Which space On the left a patient with a swelling on the left side of the neck. Study the MR-image at the level
on is located. Then continue reading. The swelling is centered between the external and internal carotid artery. Notic
be located in the carotid space. Please note that there is a smaller, but identical, lesion present, located in the right c
figure out the normal anatomical source that has caused this pathology.
Once again, we use exclusion: As the name implies, these lesions are cystic.
* Neural structures in the carotid space like the vagus nerve and sympathetic plexus are located between the great v
of this patient are coming from these neural structures. Now we are down to a fairly limited and space-specific differ
ule is in patients with neurofibromatosis. Unlike this lesion, schwannomas and neurofibromas occur unilaterally. Alth
* Paragangliomas are frequently multiple in 3% to 5% of patients overall and 20% to 30% with a positive family histo
n this coronal post-Gadolinium MR-image. In the larger lesion on the left, typical flow voids are present (see also axia
ly enhancing lesions with flow voids in the carotid space, most likely carotid body tumors or paragangliomas. Paraga
MR and CECT Paraganglioma (2) On the left images of a 21-year old female with a mass on the right. This lesion is loc
ore is a neural tumor. The differential diagnosis is limited to tumors arising from the vagus nerve and sympathetic pl
and the only possible diagnosis is a paraganglioma. Paraganglioma (3) Key facts Schwannoma: axial T2-weighted im
Schwannoma:
On the left images of a 28-year old female with a nontender mass at the left mandibular angle. Step 1
The mass is located in carotid space. Step 2 Anatomical contents: carotid artery, internal jugular vein, vagus nerve, sy
ants of the 2nd branchial cleft . Step 3 Therefore it is very likely that this mass has a neural origin: They do enhance,
lly absent. It is not possible to discriminate between these two possibilities based on their radiological appearance. T
Jugular vein thrombosis:
Thrombosis of the internal jugular vein is an under-diagnosed condition that may occur as a complication of head ar
drug abuse. An infected jugular vein thrombus caused by extension of an oropharyngeal infection is referred to as L
evere morbidity or even fatal outcome, as eventually septic emboli may spread to the lungs. On the left a patient wh
e present complaint is a painful swelling on the left side of the neck since one day. Step 1 Contrast-enhanced CT at m
the left and the enhancing right thyroid lobe which is still in situ. In addition there is a round, hypodense lesion in the
ar vein Step 2 In this case, analysis of the normal anatomical contents of the carotid space can be short. When we co
rnal jugular vein which is enlarged and does not enhance. An image at a higher level shows the same appearance of
linical information of a painful swelling on the left side of the neck, there is only one possible diagnosis: Acute throm
e Lemierre' s syndrome When you diagnose an acute thrombosis of the internal jugular vein, always look for pulmon
into the neck and causes internal jugular vein thrombophlebitis with subsequent septic emboli. Secondary infected b
Second branchial cleft cyst:
On the left images of a 36-year old female with a progressive swelling on the left side of the neck. She had recently r
a fistula orifice in the left tonsil. The position of the mass on the CT indicates that it is located in the carotid space. An

chial cleft cyst: small fistula tract (arrow) Second branchial cleft cyst (2) Key facts Second branchial cleft cyst On the le
branchial cleft cyst in a 12-year old girl situated between the parotid gland (left image) and the submandibular gland
gular vein (arrow). The cyst contents is hypoechoic with freely moving debris. Second branchial cleft cyst The MR of t
ight carotid space. The lesion is situated between the submandibular gland and the anterior margin of the sternoclei
hial cleft cyst. The lesion shows edge enhancement post-Gadolinium. Notice that these lesions may contain small am
all area of enhancement inside the cyst wall (arrow). Second branchial cleft cyst: high signal intensity on STIR Corona
Retropharyngeal Space:
Retropharyngeal space The retropharyngeal space extends superiorly to the base of the skull and inferiorly to the po
normal circumstances, the retropharyngeal space is a virtual space and contains the retropharyngeal lymph nodes s
spread through this space into the posterior mediastinum. There are two other spaces in close proximity to the retro
ey are often confused with the retropharyngeal space. The danger space actually lies between the alar fascia, which
prevertebral fascia. It extends from the cranial base above to the level of the diaphragm. The prevertebral space is b
the longus colli muscles of the spine. It extends down the mediastinum and continues to the insertion of the psoas
can extend into the posterior mediastinum and we should not stop imaging until the tracheal bifurcation is reached.
Retropharyngeal abscess:
On the left an axial contrast enhanced CT-image of an infant with fever. The child cannot swallow. This pathology is l
re pushed towards the vertebral body. If this were a lesion located in the perivertebral space, these muscles would b
ontains multiple pockets of material with fluid density. Obviously this is a retropharyngeal infection with multiple abs
will expand and may eventually obstruct the airways. Usually these deep abscesses require surgical drainage. On the
al drainage. The drainage catheters run from left to right through the retropharyngeal space. The retropharyngeal sp
l abscess observed in pediatric patients occurs when an upper respiratory infection like pharyngitis or adenoiditis sp
foreign bodies, fish bones or iatrogenic causes such as endoscopy or intubation, can also be involved in retropharyn
Retropharyngeal edema:
On the left two images of a patient with a piriform sinus carcinoma (shown earlier). On the far left the pirifrom sinus
e response after the radiotherapy. The retropharyngeal space is now distended and shows increased density of the
Posterior cervical space:
On the left a table with the normal contents of the posterior cervical space and subsequent pathology. MPNST is sho
r name for a malignant schwannoma.
Lymphoma:
Step 1: Which space On the left a patient with bilateral swelling in the neck. CT image at the level of the hyoid bone s
id muscles and dorsal to the internal jugular veins. These bilateral multiple lesions are located in the posterior cervic
s of the posterior cervical space: The fat looks normal.
* Accessory nerve Accessory nerve pathology is expected to be unilateral.
* Brachial plexus Brachial plexus pathology like neurofibromatosis could be considered.
However we would expect continuous lesions like nerves and not these separate rounded lesions.
* Primitive embryonic lymph sacs: Congenital remnants like cystic hygroma can be bilateral. These are confluent cyst
these are bilaterally enlarged lymph nodes with homogeneous enhancement. Homogeneous enhancement is typica
a metastases. Lymph node biopsy in this patient revealed B-cell Non-Hodgkin lymphoma. Lymphoma (2) On the left
a. She had recently noticed a swelling on the left side of the neck. Step 1 CT image at the level of the true vocal cords
vical space. Step 2 The mass is well-defined and isodense to muscle. Coronal reformation shows the mass to be elon
cervico-brachial plexus.. Continue with the MR images. Recurrent NHL with diffuse infiltration of the left brachial plex
s along the course of the brachial plexus (red arrow). In fact, we are looking at a grossly thickened plexus. Step 3 The
ass. Combined with the history the final diagnosis is diffuse infiltration of the left brachial plexus by recurrent NHL.
Lipoma:
On the left images of a patient with a swelling posteriorly on the left side of the neck. MR image at the level of the hy
ace. Analysis of the normal anatomical components of the posterior cervical space can be short in this case. The mas
signal is completely suppressed with fat suppression. There was no enhancement (not shown), so we can conclude t
the left T1- and T2-weighted images of another patient with a lipoma. Lymphangioma
Lymphangioma or Cystic hygroma:
On the left an axial T2-weighted image with fatsat and a coronal T1-weighted image of a 12-year old girl who present
A multiloculated lesion is present in the posterior cervical space. Step 2
Analysis of the anatomical components: The coronal T1-weighted image shows normal fat around the lesion.
* Nerves: Accessory nerve pathology is rare and we would expect a solitary solid lesion. Brachial plexus lesions are e
* Lymph nodes:
Can be considered, but these are solid or partly solid.
Embryological remnants:
Remnants of the primitive lymphatic system like lymphangioma are most common in this age group and should be c
lesion is multiloculated and has a fluid intensity. There is no enhancement on the T1-weighted image. These findings
present in a child, is specific for the diagnosis of a lymphangioma, also known as cystic hygroma. Cystic hygroma loca
ourtesy: Tony Hasso) Lymphangioma (2) Key facts May occur anywhere in the head and neck. Mostly located in poste

* High signal on T2-weighted images Signal on T1-weighted images depends on protein content.
* Hemorrhage results in rapid growth and fluid-fluid levels as seen on MR.
Perivertebral space:
On the left a table with the normal contants of the perivertebral space and subsequent pathology.
Sarcoma:
On the left a contrast enhanced CT image through the upper neck of a patient who complained of a slowly growing s
e There is a large soft tissue mass adjacent to the vertebral body centered in the perivertebral space. Step 2 Analysis
e: Step 3 The normal fat planes between the individual muscles have disappeared. The imaging characteristics are ot
ial diagnosis of muscle pathology: sarcoma, fibromatosis, lymphoma and infection. The clinical information of a slow
aled sarcoma. Sagittal T1-weighted image and axial image post-Gadolinium
Benign fibrous tumor:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
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RECIST 1.1 - and more:

Response Evaluation Criteria In Solid Tumors:
Fokko Smits, Martijn Dirksen and Ivo Schoots
Radiology Department of the Erasmus MC in Rotterdam and the Isala hospital in Zwolle, the Netherlands:
Publicationdate 2020-7-5 RECIST is a standard way to measure the response of a tumor to treatment. It provides obj
tays the same or gets bigger.
This is called complete response (CR), partial response (PR), stable disease (SD) and progressive disease (PD). In this a
nt to use RECIST 1.1. Recist 1.1 is not used for lymphoma, GIST during Glivec therapy, HCC and malignant brain tumo
Other criteria have been published for these tumors.
In addition a brief overview is given of variations of RECIST and some other response systems.
Introduction:
RECIST is a standard way to measure the response of a tumor to treatment. If a study is eligible, choose target lesion
longest diameters (SLD).
Identify non-target lesions like ascites or pleural fluid that are not suited for exact measurements, but that can be fo
rmine the response.
Baseline Study - five easy steps:

1. Is the study eligible for RECIST?:
Radiographic studies that may be used: Ultrasound is not used for RECIST due to operator dependency.
2. Choose “target lesions”:
Tumors
Choose preferably large well-described lesions to measure with a maximum of two per organ and a maximum of five
Lymph nodes can be used as target lesions provided that the maximum short axis diameter exceeds 15 mm.
Nodes <10 mm are regarded as normal, while nodes 10-15mm are regarded as pathologic, but not suited for target
asurement includes hypervascular rim When a lesion has a hypervascular rim, this is included in measuring the long
es in the arterial and portovenous phase of a 71-year-old male show liver metastases of a neuro-endocrine tumour
Note that the hypervascular rim is better appreciated in the arterial phase.
The large hypervascular rim is included in the measurement of the largest diameter. Measurements of the tumour th
ons at three different levels. Mesothelioma An exception to measuring the longest diameter is in patients with malig
The non-spherical growth pattern in this disease makes reproducible long axis measurements difficult.
Therefore not the longest diameter, but the tumour thickness perpendicular to the chest wall is used.
This measurement has a good correlation with outcome. CT images in a 63-year-old male with malignant pleural me
gnant pleural mesothelioma with measurement of the tumour thickness perpendicular to the chest wall or mediasti
r thorax. Non-measurable lesions Example of non-measurable lesions in a patient with lymphangitis carcinomatosa
et lesions and in the follow up their presence or absence are determined. Left: non-measurable metastasis. Right: m
ases quite often change in appearance while the size remains the same, therefore they are generally considered nor
ytic-blastic bone metastases with identifiable soft tissue component can be considered as measurable lesions if they
ar-old male with osteoblastic bone metastases of a non-small-cell lung carcinoma.
This lesion is not suitable for measurement. The CT image on the right is of a 69-year-old female with an osteolytic m
This metastasis is suitable for measurement and can be used as target lesion. Sometimes the largest lesion is not th

This CT image is of a 61-year-old male with gastric cancer and lymph node metastases.
There is a large lobulated mobile gastric tumor.
We can assume, that on a follow up examination it can not be reproduced in the same way.
Therefore this mobile tumor is not suitable as target lesion, but can be used as non-target lesion. Continue with next
h is more suitable to be used a target lesion (arrow).
3. Calculate Sum of Longest Diameters:
Here an example of 5 target lesions in a 28-year-old male with a neuroendocrine carcinoma of the appendix with live
ary lung metastases of ovarian cancer.
4. Identify non-target lesions:
What are “non-target” lesions”?Non-target lesions are all other disease related lesions that do not meet the criteria fo
g metastases, or those lesions that are supernumerary because the maximum number of 5 target lesions had been
ort and in the follow up look for their presence or absence. The CT image with maximum intensity projection of a 34
he metastases cannot be used as target lesions because they are too small. They can be used as non-target lesions a
5. Report:
The baseline radiology reportshould contain the following elements:
Follow up study:

Is the study technically comparable to previous?:
For follow-up studies, the same imaging modality should be used as for the baseline study and identical imaging par
c. In this case if the same orientation is used in the follow up, the measurement would be too small.
Identify same target lesions:
OrientationIf the orientation of longest diameter varies during follow-up, measure the longest diameter (fig). Do's fo
* Do measure the short axis of mesothelioma. Dont's Fragmentation
If the lesion breaks into separate fragments between baseline and follow-up, the sum of longest diameters (SLD) of t
, then measure the longest diameter of the merged lesion only. Obviously, the short axis diameter is measured in lym
record a measurement of 0 mm.
If the lesion is too small to measure assign a default value of 5 mm to prevent false responses (derived from the 5 m
y lung tumour.
At baseline, the longest diameter is well above 10 mm, therefore this was assigned as a target lesion.
During follow-up the long-axis diameter dropped below 10 mm, which is the lower limit for considering a lesion as ta
However, since this is a follow-up measurement, the target lesion still counts up to the sum of the diameters (SLD) a
Cavitation can occur during treatment.
Cavitating lesions should be continuously measured in their longest diameter.
A different assessment can be provided if the sum of diameters does not adequately correspond to the patients resp
ulmonary metastasis of a malignant peripheral nerve sheath tumour.
Cavitation occured after treatment with pazopanib, but the size remained the same. Although the size remains the s
e has decreased. Lymph node target lesion 18mm at baseline (left). At follow up only 4mm.
Calculate SLD:
If during follow-up the short-axis diameter of a lymph node drops below 15 mm, the measurements are continued a
hort axis diameter is 18 mm.
This was a target lesion. At follow-up, the short-axis diameter dropped below 15 mm. However, the measurements a
nodes decrease to a normal size (<10 mm), they still have to be included in the sum of the target lesions.
This means that whenever the lymph nodes enlarge again, you will not overstate the progression, but also that comp
t zero.
Progression of non-target lesions:
CT images in a 61-year-old male with melanoma during treatment. At baseline the inguinal lymph nodes were to sma
ns. At follow up there is unequivocal progression of the lymphogenic metastases. CT images in a 61-year-old male wi
melanoma during treatment. CT images in a 73-year-old male with progressive liver metastases of colorectal carcino
This is anothe example of progression of non-target lesions. Even if there is partial response or even disappearance
means progressive disease
New lesions:
Any new lesion means progressive disease. CT-images in a 81-year-old female with endometrial carcinoma and occu
sclerotic bone lesions in b and d are not new metastases but an osteoblastic reaction. Courtesy Els van Persijn van M
newly detected lesion is always a true new lesion. In osteolytic bone metastases it can be difficult to determine if a s
a new lesion. The CT images are of a 50-year-old female with bone metastases of a breast carcinoma.
At baseline (a), there is an osteolytic lesion in a thoracic vertebral body (arrow).
After chemotherapy, the thoracic osseous lesion has not changed in size, but has become completely osteoblastic (a
visible metastases were seen in the baseline scan (c).
The ‘new’ sclerotic lesions in the lumbar vertebra (arrowheads in d), are considered to be small osteolytic metastases
They became visible due to the osteoblastic reaction.

PET:
FDG-PET can be complementary to diagnostic CT imaging in assessment of disease progression, especially in the cas
A positive FDG-PET at follow-up, with a negative FDG-PET at baseline, is a sign of progressive disease based on the ne
Without an FDG-PET examination at baseline, findings are dependent on current and previous CT findings. CT image
appearing lung metastasis.
Reappearance of lesions:
Disappearance and subsequent reappearance of a lesion in follow-up examinations should continue to be measured
Depending on the disease status, a reappearing lesion can be considered either progressive disease, when the previ
iameter should be added to the SLD for a calculated response. The rationale is that most lesions do not disappear bu
Response categories:
To determine the response of a tumor in the follow up, we have to look at the target- and non-target lesions and loo
D) Partial Response (PR) Complete Response (CR) *Nadir is the smallest sum of diameters (SLD) during treatment.
Response in target lesions with or without non-target disease:
The overall response is based on the response of all tumor related findings (table). For instance any progression (>2
means progressive disease no matter how the other lesions reacted. When tumor markers are initially elevated, they
ns have disappeared.
Response in only non-target lesions:
In some patients there are no suitable target lesions that can be measured and there are only non-target lesions.
In these cases you have to make an estimation of the response (table).
Radiology report:
The radiology report of each follow-up study should contain the following elements: ReportModality and parameters
Description of target lesions with localization, table position and size
Description of non-target lesions and comparison: unchanged, decreased or increased in size.
New lesions?
Incidental relevant findings Conclusion
Number of target lesions and their localization, overall impression of non-target lesions, clinically important incident
. Calculation of SLD and assigning response categories by the radiologist depend on local agreement with the oncolo
Quite commonly, only measurements of target disease and presence and extent of non-target disease are reported
rt's conclusion.
Other Response systems:

Choi criteria for GIST:
The Choi criteria are based on RECIST and developed for The Choi criteria are based on RECIST and developed for as
l tumors (GIST) treated with imatinib (3). Usually decrease in tumour size occurs in the course of treatment, however
our size can increase due to internal hemorrhage, necrosis or myxoid degeneration. Major difference of Choi respon
ur attenuation as an additional response parameter. Reduction in tumor size is usually minimal in the early posttrea
characteristics like tumour attenuation, nodularity, and number of vessels will occur. The CT images of a 82-year-old
All metastases decrease somewhat in size after treatment with imatinib, but the most remarkable difference is a dec
This is considered to be a good response according to the Choi criteria. Before the introduction of the Choi response
d by an increase in tumour size or identification of new locations of disease.
Although increase in tumour size remains an important parameter for evaluating disease response, recurrent diseas
The CT images in a 66-year-old male show liver metastases of a GIST at diagnosis (a).
At 3 months after treatment with imatinib there is a good response (b).
At a follow up scan at 1 year there is a recurrence (arrow in c).
At a follow-up after 2nd line treatment with sunitinib there is still tumor progression, but the size remains the same
mRECIST for Hepatocellular carcinomas:
Tumour response assessment based on changes in size alone can be deceptive when applied to hepatocellular carci
the European Association for the Study of the liver (EASL) assembled an expert panel on HCC which suggested that t
e the estimation of viable tumour with contrast enhanced imaging. These new criteria were based on RECIST 1.1 and
ature of defining viable tumour as uptake of contrast agent during arterial phase dynamic imaging on CT or MRI. mR
l enhancement, while RECIST 1.1 is applied for atypical enhancing lesions and extrahepatic disease. The table shows
-target lesions in patients with HCC and cirrhosis. Measurement rules in assessing response: Rules of progression: Th
te arterial phase shows a hypervascular tumour in the right liver lobe (arrowheads).
The tumor is well delineated from the surrounding parenchyma.
In the portal-venous phase the HCC is hardly distinguishable from the liver parenchyma due to early washout of con
iRECIST for immune therapy:
iRECIST represents a modified RECIST 1.1 for immune-based therapeutics. The immunotherapeutic agents induce a d
ents. The new mechanism of actions of these drugs, with immune and T-cell activation, can cause uncommon patter
ssion (4).
Pseudoprogression has been described in non-small cell lung carcinoma, melanoma and renal cell carcinoma. These

tional response criteria like RECIST, but can demonstrate late and durable responses. The main criteria to objectively

The most important change is to identify true disease progression, which is defined as subsequent increase in tumou
. *LDi = longest diameter, **SPD = the sum of the product of perpendicular diameters for multiple lesions
Lugano Classification of malignant lymphoma:
The Lugano classification incorporates PET-CT for initial evaluation, staging and response assessment of malignant ly
mphomas or for more accurate measurements of nodal size in clinical trials, to discriminate between bowel and lym
radiation planning. Measurable nodes must have a longest diameter (LDi) greater than 1.5 cm and measurable extra
asurement of perpendicular diameters are noted for calculating the product of perpendicular diameters (PPD) and t
s (SPD). Non-target disease includes the remaining measurable lesions (nodal and extranodal), spleen (> 13 cm vertic
al and pericardial effusion, ascites). Modified Ann Arbor staging system Both Hodgkin and Non-Hodgkin lymphoma a
ing system is based on the anatomical extent of disease and is divided into stages I-IV (see table). Patients with HL ar
disease related symptoms (so called B symptoms), because this can influence the choice of therapy. Bulky disease ca
defined as a single nodal mass ≥ 10 cm or > 1/3 transthoracic diameter at any level of thoracic vertebrae on CT. For
ve been suggested for different subtypes.. Therefore, the recommendation for HL and NHL is to record the longest r
n lymphoma stadium II 'bulky'. Example bi-dimensional measurement with perpendicular diameters for calculating t
. CT images in a 56-year-old male with diffuse large B-cell lymphoma (DLBCL) before (a) and after (b) treatment with
patient show hepatosplenomegaly before (a) and normalization of hepatic and splenic size after (b) treatment with
>13 cm.
Hepatic size is not a reliable measure of hepatic involvement by lymphoma.
Response assessment:
For response assessment the SPD after treatment is compared to the SPD at baseline.
Four response assessment categories are determined; complete remission (CR), partial response (PR), stable disease
gs of lymphoma should be present, and all target nodes should have a LDi ≤ 1.5 cm. For PR the SPD of up to 6 target
-measured lesions and splenic size should be regressed > 50% in length beyond normal. SD is defined as < 50% decr
To meet the criteria for PD just a single target lesion should increase ≥ 50% in product of perpendicular diameters (P
ogresses or occurs, clear progression of pre-existing non measurable lesions is determined or new lesions occur. Sp
w-up examination, the individual product of the perpendicular diameters (PPDs) of the nodes should be summed tog
become confluent, the PPD of the confluent mass should be compared with the sum of the PPDs of the individual no
pared with the sum of individual nodes necessary to indicate progressive disease. Eisenhauer EA, Therasse P, Bogae
2. Individual patient data analysis to assess modifications to the RECIST criteria. Bogaerts J, Ford R, Sargent D, et al. E
3. Correlation of computed tomography and positron emission tomography in patients with metastatic gastrointesti
ate: proposal of new computed tomography response criteria. Choi H, Charnsangavej C, Faria SC, et al. J. Clin Oncol 2
4. Control of peripheral T-cell tolerance and autoimmunity via CTLA-4 and PD-1 pathways. Fife BT, Bluestone JA. Imm
None:

None:

None:

Biliary duct pathology:
Angela D. Levy MD
Chief Gastrointestinal Radiology, University Department of Radiologic Pathology, Armed Forces Institute of Pathology
Publicationdate 2009-04-24 This review is based on a presentation given by Angela Levy and adapted for the Radiolo
Introduction:

Differential Diagnosis of bile duct dilatation:
Whenever there is bile duct dilatation, the first priority is to look for obstruction. Obstruction If there is an obstructio
If there are no gallstones involved, we then look for strictures. The differential diagnosis for a stricture is based on th
on, we have to think about nonobstructive biliary diseases like:
Caroli Disease:
Saccular intrahepatic duct dilatation with normal sized choledochal duct in Caroli disease Caroli disease is an autoso
n. It is associated with polycystic kidney disease, medullary sponge kidney and medullary cystic disease. So looking a
e left we see images of a patient with Caroli disease. Notice the intrahepatic duct dilatation and the normal caliber o
duct dilatation in Caroli disease The hallmark of Caroli disease is intrahepatic duct dilatation. The dilatation can be v
t can be very linear. Normal development of the ductal plate (Illustration by Aletta Frazier) Caroli Disease (2) The duc
ation of the ductal plate, which is the precursor of the intrahepatic bile ducts. On the left we see the normal develop
s as a single layer of cells that surrounds a portal vein. This layer then duplicates. Portions of this double layer fuse a
cts. Abnormal development of the ductal plate(Illustration by Aletta Frazier) So in the normal situation each portal ve
owever if the patient has ductal plate malformation, the bile ducts are too numerous and they are ectatic (right imag

on of the bile ducts is affected. If the large ducts are involved, we see this as Caroli disease. However if only the very
fibrosis. If all ducts are involved, then there is a combination of fibrosis and Caroli disease, which is also known as th
Central dot sign:
Most commonly the intrahepatic duct dilatation is segmental (83%) in distribution. The diffuse form is less common
in 24% of the cases. A very important sign is the central dot sign. The central dot corresponds to the portal vein that
within the dilated ducts. When we put on the color doppler, we will notice that these structures contain blood flow a
aroli Disease (3) On the left CT-images of the same patient. Notice the central dot sign and the segmental involvemer
pertension. Extrahepatic duct dilatation is present in 53% of cases, secondary to cholangitis and stone or sludge pass
mary disease. When there is extensive fibrosis, these patients can develop cirrhosis over time. ERCP: Caroli disease v
ilatation of the choledochal duct due to cholangitis Caroli Disease (4) The cholangiogram is important in the work up
can be done with MRCP or ERCP, as is shown on the left. There was no sign of obstruction. The mild dilatation of the
on the left. Then continue reading. There is focal dilatation with intermixing strictures of the bile ducts in segment IV
normal. In some of the cases of Caroli disease the imaging findings may simulate a cystic neoplasm as is seen in the
ry cystadenoma. However, the gross specimen demonstrates dilated bile ducts and ductal plate malformation was p
n Caroli Disease (5): Complications Patient with Caroli disease are usually brought to our attention, when they develo
biliary stasis, which leads to stone formation and infection. Complications: On the left a patient with dilated bile duc
ft. Then continue reading. The findings are: The mass in the right lobe of the liver turned out to be an abscess. Reme
id. In the differential diagnosis we would also have to include a neoplasm, because patients with Caroli disease have
in a patient with Caroli disease Ultimately if there is substantial fibrosis and the entire liver is involved, these patient
evere liver failure and a resection was performed. Notice the intrahepatic bile duct dilatation, splenomegaly and dila
tral dot sign (blue arrow) and a small pus collection (yellow arrow). LEFT: Infiltrating cholangiocarcinoma with strictur
giocarcinoma Cholangiocarcinoma can take on many forms in patients with Caroli disease. The cholangiogram on th
o be a infiltrating cholangiocarcinoma. The patient on the right has a cholangiocarcinoma in which the tumor was fill
Choledochal cyst:
A choledochal cyst is a congenital dilatation of the extrahepatic bile duct.
These patients do not have a ductal plate abnormality.
The most common theory for the development of a choledochal cyst is that the dilatation is due to an underlying an
biliary and pancreatic duct join proximal to the sphincter of Oddi. In these patients there is a long common channel.
eatic enzymes will flow into the bile duct and causing dilatation and in some cases, narrowing of the distal duct. Toda
Todani Classification:
This classification classifies the choledochal cysts into 5 cathegories. Type V, which is not shown on the left is Caroli d
ype I is a true choledichal cyst with focal dilatation of the extrahepatic duct. This is the most frequent type (90-95% o
ilatation of the entire extrahepatic duct with involvement of portions of the intrahepatic ducts. The intrahepatic duct
obstruction. Type II and III are extremely rare and it is debatable whether or not these are true choledochal cysts. Ty
ieve that this entity is not related to an anomalous pancreatico-biliary junction. Type III is a choledochocele, where th
patients also have a normal pancreaticobiliary junction. Type IV choledochal cyst Choledochal cyst (2) On the left a p
of the intrahepatic ducts. So this is a type IV. Notice that the peripheral ducts are normal, so this is not an obstructive
e IV choledochal cyst. There is dilatation of the extrahepatic duct, cystic duct and a small portion of the left hepatic d
a within a choledocha cyst Choledochal cyst (3) There is an association of bile duct adenocarcinoma and choledochal
ke the case on the left, or in the gallbladder or anywhere else in the biliary ducts. In the bile ducts they can present a
distal cholangiocarcinoma.
Recurrent Pyogenic Cholangitis (RPC):
Recurrent pyogenic cholangitis. Illustration by Heike Blum. Recurrent pyogenic cholangitis is an uncommon disease i
es. The etiology is unknown, although some of these patients have biliary parasites. The disease is characterized by t
ction. These patients are also at risk of developing biliary cirrhosis and cholangiocarcinoma. Recurrent pyogenic chol
is the most common location of the disease due to the delayed drainage of the left system. On the left a typical case
with stones. Recurrent pyogenic cholangitis with resected specimen Recurrent pyogenic cholangitis (2) On the left an
patic lithiasis with focal diatation. A case like this is indistinguishable from focal Caroli disease with secundary stone
Primary Sclerosing Cholangitis:
Primary sclerosing cholangitis: MRCP and ERCP When we see intrahepatic bile duct dilatation with strictures and only
rosing cholangitis (PSC). We know however that there is a long differential diagnistic list which includes: The case on
that there is only mild dilatation, which is common in PSC. Primary sclerosing cholangitis with strictures both in the i
m The hallmark of PSC is strictures, but early on in the disease the strictures can be difficult to appreciate. The under
iology. PSC is strongly associated with ulcerative colitis in up to 70% of patients, but it can also be associated with Cr
sociation with IBD is unknown, but it is thought to be the result of an immune response. Chronic inflammation surro
e far left a histologic specimen demonstrating chronic inflammation surrounding the bile duct. The gross specimen c
using many strictures. The strictures in PSC are short in the order of 3-5 mm in length, which is helpful to remember
t strictures usually exceed 10 mm in length. PSC with thickening of the wall of the bile duct (arrow)
Ultrasound findings:
One of the earliest features in PSC is on sonography where we see thickening of the wall of the bile duct as is seen in

amination to rule out gallstones. Notice that the intrahepatic ducts are normal. The differential diagnosis would inclu
rcinoma would be rather unlikely, because there is no obstruction. Continue with the CT. PSC with thickening of the w
CT findings:
On the CT the liver looks quite normal. However if you look at the common bile duct in the pancreatic head you will n
include an impacted stone or cholangiocarcinoma, but since this patient had no obstruction, it was thought to be the
ckened. Primary sclerosing cholangitis. CT findings Primary sclerosing cholangitis (3) On the left a patient with more s
scontinuous pattern. Primary sclerosing cholangitis. CT findings On the left a patient with more pronounced CT findi
Primary sclerosing cholangitis. late CT findings Primary sclerosing cholangitis (4) Late CT features are seen on the im
The findings are: Primary sclerosing cholangitis. Cholangiographic findings Cholangiography is used in the initial diag
nd in patients known with PSC to look for new strictures that are suspicious for carcinoma. On cholangiography we c
On the left the typical findings in PSC. Notice the diverticula on the image on the right. Diverticula are very specific fo
u should immediately search for subtle strictures in the intrahepatic ducts. MRCP in PSC. There is a long stricture sus
ngitis (5) On the left a MRCP in a pateint with PSC. Notice the large stricture, which is quite worriesome for cholagioca
ssion, while here we see 'shouldering', which indicates mass-efect. In addition there is intrahepatic dilatation proxim
ricture at the hilum On the left a MRCP in a patient demonstrating a stricture at the level of the hilum. On MRCP this
owever, on the ERCP, the ducts have been distended with contrast and we can see that this is a short stricture comp
be just PSC.
Cholangiocarcinoma:
Normal columnar epithelium (left) transforms into adenocarcinoma (right) Cholangiocarcinoma (i.e., adenocarcinom
uct. It is characterized by malignant glands within a desmoplastic stroma. These tumors have an infiltrative growth p
carcinoma. There are four basic patterns of chlangiocarcinoma: (illustration on the left). Cholangiocarcinoma is an ur
enign bilairy disease. The incidence in the U.S. is 2000 to 2500 cases per year (coloncancer 150.000 per year). In Asian
onic biliary infection. High risk groups are patients with: Clinical presentation: Intrahepatic cholangiocarcinoma. Radi
Intrahepatic cholangiocarcinoma:
These arise in the very small peripheral ducts. These tumors have abundant fibrous stroma that can cause retraction
rium and delayed phases (5-10 minutes). Read more about intrahepatic cholangiocarcinoma in Liver : Masses Part II
patic cholangiocarcinoma Although these tumors are usually quite heterogeneous because the contrast uptake is de
retraction and the late enhancement The key findings to look for are: On the left a typical case. Notice the capsular r
). Intraductal Cholangiocarcinoma
Intraductal Cholangiocarcinoma:
These are very rare tumors. They present as a intrabiliary mass with biliary dilatation peripheral to the mass. Klatskin
be of the liver Illustration by Heike Blum
Klatskin Tumor - Hilar Cholangiocarcinoma:
The most common site of biliary adenocarcinoma is at or near the confluence of the right and left hepatic ducts. The
an aggressive biologic behavior. Imaging features: On the left a nice correlation between an illustration and a sonog
mor is. Klatskin Tumor. Barely visible. Stent in situ (arrow) On CT these tumors can be very difficult to visualize. Many
irst come to CT which makes it even harder (figure). Klatskin Tumor: arterial and portal venous phase Klatskin Tumor
fluens of the left and right hepatic duct. The margins of the tumor however are imperceptible because of the infiltrat
or correctly. Hiar Cholagiocarcinoma. Notice the superiority of ERCP to MRCP. The image on the right nicely demonst
these tumors it may be difficult to get a definitive diagnosis pre-operatively. Biopsy is almost impossible and results
done with cholangiography and is based on the finding of mass effect (shouldering), irregular margins and abrupt ta
the spatial resolution and the inability in the evaluation of the secondary ducts. ERCP is superior to MRCP (figure) Kl
e when: Bismuth-Corlette type I tumor with abrupt stricture and shouldering below the confluens
Klatskin Tumor - Bismuth-classification:
Bismuth-Corlette type I A type I tumor is a lesion limited of the common hepatic duct, i.e. below the confluence. Thes
ecause the confluence is normal. Bismuth-Corlette type II tumor with extention into the origin of the right and left he
on that extends to the confluence. These tumors are potentially resectable Bismuth-Corlette type III Klatskin-tumor E
right and a IIIb-tumor extends into the left hepatic duct. Bismuth-Corlette type IIIa Klatskin-tumor On the left PTC-im
The arrow indicates the extention into the right hepatic duct. The left duct is normal. This patient can undergo a rese
Klatskin-tumor Bismuth-Corlette type IV On the left an illustration and ERCP of a type IV-tumor with extention into th
None:

None:

None:

Appendicitis - Pitfalls in US and CT diagnosis:
Julien Puylaert and Julie Tutein Nolthenius
HMC, the Hague and Amsterdam UMC; East Kent Hospitals, Canterbury, UK:
Publicationdate 2020-7-11 In this chapter we will deal with the optimal diagnostic strategy in patients with suspected

false-negative diagnosis. Special attention will be given to: For critical comments and additional remarks: j.puylaert@
Diagnostic strategy in suspected appendicitis:
The policy in patients with an acute abdomen in the Netherlands has a well-established scientific basis (Table) (Lame
impression, play an important role in choosing between complementary CT scan and watchful waiting.
First US, than CT.:
Patients with suspected appendicitis are relatively young, and it seems reasonable to begin with US in most patients
erine pregnancy as well as acute appendicitis.
Note the different cm-scales. Laparoscopic removal of the inflamed appendix was successful.
CT if inconclusive US:
In most patients with an inconclusive US and a high suspicion of appendicitis, CT is the next step.
A fortunate circumstance for CT, is that these patients are often obese.
CT is principally performed with i.v. contrast. If there is serious pain in elderly patients with a wide differential diagno
r hospital of all patients who undergo CT for acute abdomen, in about 15 % a CT thorax is ordered within 24 hours, a
ay be diagnostic as in these three patients. If CT without contrast is non-diagnostic, repeat CT with iv contrast after c
T findings, the report and the ensuing policy When both US and CT are done, it is important to integrate US and CT fi
al CT, is highly accurate for appendicitis, and is inconclusive in less than 1% of high-suspicion patients (maybe 2 to 3
also diagnostic laparoscopy are then helpful.
First CT than US:
When for some reason CT scan is chosen as primary investigation, US after CT can also be useful. In this elderly lady
trast CT revealed a dubiously inflamed appendix. Focused US with a high-frequency probe confirmed that the ventra
fied a deeply located, possibly inflamed appendix (arrow) at a distance of 11 cms from the skin. Focused US with gra
e of a high frequency probe, which showed a non-compressible, inflamed appendix (arrow). In this young man the a
minal fat. US easily demonstrated a normal appendix.
False-negative diagnosis:

US non-visualization of the appendix: tricks and tips:
The most important reason for a false-negative ultrasound examination is overlooking the inflamed appendix.
The greatest problem is non-visualization of the appendix. In adult patients, the numbers are as follows (Table). In ex
-90% of patients with acute appendicitis. Hereunder the pitfalls leading to non-visualization and how to avoid them.
Retrocecal appendicitis:
The appendix is usually found at the spot of maximum tenderness. In retrocecal appendicitis (arrow) the cecum is of
) appears to be localized lateral to the cecum than behind it. Another possibility to visualize the appendix in retrocec
k, thereby avoiding the gas and feces-filled cecum. Another trick in retrocecal appendicitis is to push the inflamed ap
be. To find the appendix, it may be useful at first to identify the ileocecal valve (see also US of the GI tract: normal an
eters caudally, where it leaves the cecal pole at the medial side. The biggest problem for US is a deep pelvic location
nflamed appendix (arrow with question mark) was visualized during forceful compression deep down in the pelvis. S
thin 1 cm of the vaginal probe. Appendicitis with air in the lumen Air in the lumen can make it difficult to identify the
surrounding inflamed fat (*), make clear that appendicitis is present. Tip appendicitis. a and v = iliac artery and vein
is confined to the distal tip. If only the normal, proximal part (arrows in A) is visualized, and the distal end (arrows in
ive diagnosis may be the result. (a and v = iliac artery and vein) The presence of a genera-li-zed, paralytic ileus is susp
pendix cannot be visua-lized, CT is mandatory, also to exclude other conditions. This 66-year old man presented with
RP of 550.
US revealed only dilated small bowel, CT was done for suspected mesenteric ischemia. CT demonstrated appendiciti
e peritoneal cavity.
Mistaking an inflamed appendix for a normal appendix:
In 7 % of patients with appendicitis, the inflamed appendix has a US diameter of less than 7 mm. If there is hypervas
s is usually a case of spontaneously resolving appendicitis (see Appendicitis: US findings). This young man had a rapi
Surgery was nevertheless performed and histology confirmed ordinary, acute appendicitis. Perforated appendix wit
rrow) may have a very small diameter, because it has emptied itself into an abscess. In these two cases, the seconda
correct diagnosis.
Incorrect diagnosis of an alternative condition:
In some patients, US findings may suggest an alternative condition, while in fact appendicitis is present.
This is obviously a dangerous pitfall. Acute appendicitis with enlarged mesenteric lymph nodes In this 16 year old pa
by some inflamed fat (*) were the only US finding and the appendix could not be identified. CT confirmed the enlarg
originating from the cecum in deep pelvic position. Young patients with acute appendicitis often have secondarily en
Mesenteric lymphadenitis:
If enlarged mesenteric lymph nodes are the only US findings in a young patient with RLQ pain, the diagnosis of viral
ory to identify the normal appendix (arrow) with certainty, because enlarged nodes can be secondary to appendicitis
Infectious ileocecitis / ileocolitis:
Another pitfall is when secondary wall thickening of ileum or right colon is visualized, but the underlying appendicitis

nic wall thickening was interpreted as infectious ileocolitis by Campylobacter or Salmonella. Positioning of the probe
rounded by inflamed fat (*).
The presence of inflamed fat in itself is a key finding, because this is never found in infectious colitis. Appendicitis (ar
m.(A and V= iliac artery and vein) In these two patients initially the mucosal thickening of the terminal ileum as a sole
ileitis. A second US exam revealed the underlying appendicitis (arrow) causing secondary thickening of the neighbor
ein)
Right ovarian cyst:
Another pitfall is the erroneous diagnosis of an alternative gynecological condition, while in fact appendicitis is prese
rian cyst (arrowheads) was visualized and held responsible for her RLQ symptoms. Further searching however revea
ng.
Cecal diverticulitis:
In this patient young patient with cecal diverticulitis the most prominent fat stranding (arrowheads) is found around
arrow) is secondarily inflamed due to the nearby cecal diverticulitis. Complete cure with conservative treatment.
Epiploic appendagitis:
This 39-year old man had 24 hours of pain in the RLQ with severe local peritonitis, clinically very suspect for acute ap
e next morning. US shows a 7 mm not well compressible appendix (arrow) with inflamed fat (arrowheads), which wa
h next images... Epiploic appendagitis. Click for animation. During intermittent graded compression, the inflamed fat
on. Continue with next images... Epiploic appendagitis CT confirmed a normal appendix surrounded by normal fat ar
ssured, was given painkillers and caught his flight to Taiwan the next morning. This patient also underlines the obser
ween size and the degree of local peritonitis. So, in epiploic appendagitis size does not matter. Epiploic appendagitis
. The longitudinal US image showed a concentrically layered ovoid structure (arrowheads) surrounded by inflamed fa
however the US image structure was also ovoid (arrowheads). Subsequent CT scan demonstrated that the ovoid str
tified the normal appendix (arrows). Epiploic appendagitis This was a 73-year old lady with severe RLQ pain, CRP an
CT confirmed a small epiploic appendagitis (arrowheads) and a normal appendix (arrows). Again, no relation betwee
Omental infarction
False-positive US diagnosis:
In young children, the normal appendix may be large due to very prominent lymphoid hyperplasia of the deep mucc
Notice that you can identify the normal anatomical layers of the appendix.
Crohn's disease:
Mistaking a normal for an inflamed appendix may also occur if there is secondary thickening of the appendix associ-
e still illustrative.
In this young man with suspected appendicitis both ileum and appendix (arrow) were thickened, due to ileocecal Cr
hn ileitis and shows irregular filling of the appendix, proving that this is a case of non-obstructive Crohn appendicitis
Crohn disease: This patient with pain RLQ, had a complicated appendectomy with abscess formation 4 years earlier,
s with a fistula (*) in the direction of the cecal pole.
CT and bariumstudy confirm Crohn ileitis (arrowheads) and a fistula (arrow) from the ileum to the cecal pole. After il
ars.
Cecal carcinoma:
In cecal carcinoma, atypical clinical findings may lead to serious delay, because the erroneous diagnosis of "appendic
by showing mucinous dilatation of the appendix due to obstructive ingrowth of tumour in the appendix base. Tumo
Scroll
Disable Scroll Enable Scroll
Disable Scroll This is a 79-year old woman with vague RLQ pain since six weeks. Normal lab. CT shows a large cecal c
No fat stranding. A 73-year old man presents with three weeks of nagging pain in the RLQ and a CRP of 45. US finds
nd relatively little inflamed fat (*). The cecal pole has an irregularly thickened wall with increased vascularization.
There is one small, but remarkably round local lymph node. The combined clinical and US findings are suspect for ce
Disable Scroll Enable Scroll
Disable Scroll A patient with a dilated appendix (arrow) due to a cecal carcinoma invading the base of the appendix.
lown appendicitis.
Normal appendix mistaken for appendicitis:
A false positive diagnosis can be made if the normal appendix is mistaken for an inflamed one. Of all normal appenc
resentation and the presence / absence of inflamed fat are the most decisive features. In doubtful cases like in this p
was visualized including the blind end (arrowheads), clinical follow-up and repeated US the next day is a safe policy.
Try to convince the surgeon, that an appendix like this will not rupture overnight. If the patient is painful with a high
r conditions. Epiploic appendagitis
Omental infarction:
Images of a 6-year old boy with three days of progressive painin the RLQ, WBC 11 and CRP 80. US showed free fluid,
(arrowheads) with minimal peripheral vascularization. Clinical and US features were erroneously interpreted as poss
oved as well as a firm mass originating from the omentum. Diagnosis: segmental omental infarction. This condition s
of a previously healthy 50 years old man, who experienced progressive pain right of the umbilicus.

Lab: WBC 10, CRP 33.
Appendicitis was suspected. US showed large, cake-like mass of inflamed fat (arrowheads) with ventrally, echolucent
The appendix was not identified. CT confirmed omental infarction (arrowheads) and a normal appendix (arrow), surr
. Recovery without treatment.
Acute pancreatitis:
Many other conditions may cause secondary thickening of the appendix.
Detection of the underlying condition by US or CT is then mandatory. This obese lady presented with RLQ pain, a CR
arrows) with severe local tenderness. CT scan revealed acute pancreatitis with retroperitoneal fluid (*) descending to
tis. The pancreatic exudate (*) approaches the appendix (arrow) closely.
Abnormal location of the appendix:
Courtesy Dr. Netter The appendix base most often lies near McBurney's point.
However there is a wide variation in location of the cecum and also in the orientation of the appendix (figure). An ing
. In case of an abnormal position of the inflamed appendix far from McBurney's point, it is useful to indicate the loca
s may influence site, size and orientation of the incision and also the choice for laparoscopic appendectomy. In this 3
ing enabled the surgeon to perform a small incision, exactly over the appendix base. In this young man the acute RU
gh position. Note the distance from McBurney's point (dot). The appendix was laparoscopically removed. Appendix i
phritis. On the spot of maximum tenderness with the probe in intercostal position, an inflamed appendix (arrow) wa
ful laparoscopic appendectomy was done. Appendix in unusual location Two patients with unusual clinical presentat
left upper quadrant (left panel) and at the level of the umbilicus (right panel) This 58-year old female presented with
ow CRP. US revealed an incarcerated, edematous appendix (arrow) surrounded by non-compressible fat in a femora
resected. CT scan, performed for other reasons 17 years later (patient now 75 years), showed the appendix (arrows),
painful mass in the right groin, suspect for incarcerated hernia or a purulent lymphadenitis.
CRP was 110. US revealed a puscollection and an inflamed appendix (arrow) within a femoral hernial sac, confirmed
med, with success.
Uneventful recovery thereafter.
No interval appendectomy. Courtesy Dr. Noordmans
"Foie appendiculaire":
Nowadays exceedingly rare, the so-called "foie appendiculaire" was a feared complication in the pre-antibiotic era. Th
s, one of them containing a fecolith (arrow). In the portal vein a septic thrombus (arrowheads) is visualized while ther
Early complications after appendectomy:

Post-operative abscess:
Post-operative abscesses can be seen, even after uncomplicated appendectomy for non-perforated appendicitis. In v
ir role in intra-abdominal abscesses. This 25 year old woman presented ten days after surgery for perforated append
ectum (r.) showing a thickened wall. Vaginal US confirmed the abscess and secondary rectal wall thickening. At the sp
ally obliterated. Follow-up vaginal US showed complete, spontaneous transrectal evacuation. A 9-year-old, with persi
omy for perforated appendicitis.
CRP 220. He was not very ill. US shows a large, irregularly defined Douglas abscess with reactive thickening of the bla
evacuation of pus to the rectum) and made a full recovery without antibiotics or surgery.
Late complications after appendectomy:
Late complications after appendectomy are shown in the table.
Stump-appendicitis:
This patient underwent a difficult appendectomy for longstanding appendicitis, resulting in a so-called "hockeystick-p
bscesses. Three years later, he presented with pain in the RLQ and elevated WBC and CRP. US revealed a 4 cm long,
on of a 4 cm appendix stump. Apparently the appendix was not completely removed during the initial operation. Stu
, conservative management is possible just like in cecum diverticulitis. Stump appendicitis This is a 34-year-old woma
US was inconclusive. CT showed a small stump appendicitis containing a fecolith. At surgery the stump could only be
servative management would have been a good alternative, as the fecolith probably would have evacuated spontane
licated appendectomy with open wound healing, this 52-year-old woman had pain in the RLQ. US and CT revealed a
ia, as a late result of the infected operation wound.
Small bowel obstruction due to adhesions:
A man of 61 years old presents with severe crampy pain over the entire abdomen since 6 hours.
WBC 13, CRP 1. He had an appendectomy 9 years earlier. US of the RLQ reveals dilated small bowel loops, that are n
th next images... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Both clinical and US images are suspect for a closed loop obstruction. CT scan was performed immedi
dilated converging loops with edema, and two transition points (arrowheads), close to each other. The invisible adh
ext images... Immediate surgery confirmed a closed loop obstruction due to an adhesion in the RLQ. After cutting the
and peristalsis. No resection was necessary. Uneventful recovery.
Cicatricial hernia:

Image of a 47-year-old obese woman with a very painful umbilical mass, three years after laparoscopic appendecton
hin an port site hernia.
Head Neck tumors - When to think of malignancy:

Look for red flags:
Frank Pameijer
Radiology Department of the University Medical Centre, Utrecht, the Netherlands:
Publicationdate 2023-06-23 Benign head neck tumors are common, while malignant tumors
are rare. The question is, when do we need to think of a malignant
tumor, since many radiologists will not frequently be confronted with a
malignant tumor. In this article we provide you with some red flags, that may help
you to recognize the occasional malignant lesion in daily practice.
Introduction:
In the table you will find the red flags, that makes the lesion suspicious for malignancy, although there are exception
More red flegs means more suspicious. We will discuss all these items in the next chapters.
Growth pattern:
The table shows the different etiologies between lesions with a destructive versus an expansile pattern A destructive
This is most frequently seen in malignant tumors, but also in aggressive benign tumors and inflammation. Expansile
of osteoclasts and osteoblasts.
This is less frequently seen in malignant lesions, but common in benign neoplasms and chronic inflammation.
Mucocele:
These images are of a 47-year old male, who complained of tension in his forehead. First look at the images.
What are the findings?
Is the lesion expansile or destructive or both? Then continue reading... Findings: MRI was performed to confirm the r
lesion with only rim enhancement. There is no enhancement within the lesion. This confirms the diagnosis of a muc
s when the opening of (part of) a paranasal sinus
becomes obstructed. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the MRI images. Here more examples of mucocele. There is complete fill with soft tissue
as expansion with intact bony margins of the sinus.
2. Frontal sinus mucocele. Sometimes, thinning of the bony margin is present simulating destruction. On
thin CT-slices it is usually possible to see the intact bony structure.
3. Mucocele of an anterior ethmoid sinus cell.
4. Right sphenoid sinus mucocele. The intersphenoidal septum is expanded over the
midline.
5. Frontal sinus mucocele.
6. Mucocele of the right ethmoid sinus with thinning and expansion of the
lamina papyracea into the ipsilateral orbit. Mucocele versus Retention cyst In order to fulfill the criteria for mucocele
be both complete fill-in as well as expansion of a sinus. Image This patient has a mucocele in the left maxillary sinus
a little bit of expansion (white arrow). On the right there is a mass without expansion (yellow
arrowhead) and there is still some air in the maxillary sinus. This is a retention cyst. Image
This patient also has a mucocele in the left maxillary sinus.
On the right there is a complete fill in of the maxillary sinus, but no expansion .
Therefore it does not fullfill the criteria for the diagnosis of a mucocele. The most common site of a mucocele is the l
Other
locations include the oral cavity.
If the lesion originates from the obstructed
sublingual gland, it is called a ranula.
Sinonasal undifferentiated carcinoma:
These images are of a 75-year old male who complains of a stuffy nose and bleeding from the nose. First look at the
Continue with the coronal reconstructions... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. What are the findings?
Is the lesion expansile or destructive (red flag)?
Is there another red flag? Then continue reading... The two red flags are: In patients with rhinosinusitis there may be
even sometimes bony destruction, but the disease is (almost) always bilateral. Continue with the MRI... On these STI
intensity between the obstructed maxillary and ethmoid sinuses (black arrows)
and the tumor (white arrows). In patients with a mucocele the entire lesion would have had the
same signal intensity unlike this case. On the diffusion images the lesion has a high signal
intensity on b1000. On ADC, the lesion has a very low signal intensity, even

lower that brain tissue, indicative of marked restriction.
This means that we
are dealing with a hypercellular tumor. This is a third red flag. On the CT you might get the impression that the tumo
However on the MRI we can clearly see that the frontal sinus is only obstructed and has a higher signal intensity (whi
arrows). The final conclusion is: Biopsy showed a sinonasal undifferentiated carcinoma (SNUC), which has a very poo
The patient was treated with resection and post-operative radiotherapy and to our surprise there is no sign of recurr
Squamous cell carcinoma:
Here another example of a lesion with a destructive growth
pattern. Notice the tumor enhancement on the MRI (arrow). There is invasion of the (medial) orbit. Biopsy showed a
Localization:
In the nasal cavity and the paranasal sinuses the most common diseases are sinusitis and polyposis.
These diseases are almost always bilateral. Any disease which is unilateral, should raise the question: could this be a
Adenocarcinoma:
This is a patient who complains of obstructive nasal
congestion. Now, if you would only report this case as subtotal
opacification of the paranasal sinuses on the right, the treating physician could
would be inclined to think, that it is (just another case of) ordinary
sinusitis. As we have discussed before, the red flag here is the
unilateral localization of the abnormality. A unilateral sinusitis is extremely uncommon. and if you look carefully, the
septum, which is a second red flag. Continue with the MRI... The MRI-images show a unilateral tumor in the right nas
e also of the maxillary sinus. There is diffusion restriction (high on DWI and low on ADC), which is the third red flag. E
The patient was treated with resection followed by proton radiation and is now disease-free for 14 months. Case cou
Inverted papilloma:
Here another unilateral tumor.
The enhancing tumor has a higher signal intensity compared to the obstructed maxillary sinus.
Notice that the tumor has a lobulated border.
This is frequently seen in inverted papillomas, but is not highly specific and anyhow a biopsy has to be performed. Fi
illoma. It presents as a lobulated mucosal mass with a 'cerebriform' appearance. As if we are looking at gyri (arrowhe
This finding is somewhat specific for inverted papilloma Next to a malignant lesion, another cause of unilateral paran
This is illustrated in this case. This is a 62-year old female patient.
CT sinus was requested by the otolaryngologist. Clinical information: 'chronic unilateral sinusitis'. Images
There is a soft tissue obliteration of the right maxillary, ethmoid and frontal sinus (a so-called 'infundibular pattern').
As discussed above, this is a red flag. Look at the following images and try to decide if there is a malignant lesion cau
mages
There are periapical lucencies around the roots of a right upper molar indicative of dental infection (black arrowhead
Compare to the normal left side on the axial image (white arrowhead).
Further clinical examination excluded a malignant lesion.
The patient was referred for dental evaluation because a dental infection may well be the cause of a unilateral chron
e maxilla in the field of view of a sinus CT.
Vascularization:
As a single feature,
vascularity is not very specific in the discrimination between benign and
malignant in head and neck tumors.
But in combination with other imaging
features, it can be quite helpful in the differential diagnosis. Think of the
strong enhancement and flow voids on MR in glomus tumors (paragangliomas) in
combination with the localization (i.e. from the carotid bifurcation up to the
jugular foramen). In any vascular lesion in the head-neck region we should check:
Rhabdomyosarcoma:
These images are of a 16-year old male with proptosis and
nasal bleeding. First study the images. Look for red flags. Then continue reading. Based on the CT examination in an
suspicion of a juvenile angiofibroma, which is a hypervascular locally
aggressive tumor in young males with severe nasal bleedings, that can be
life-threathening. On these images there is a destructive lesion with invasion
of the orbita. A juvenile angiofibroma always originates from the posterior
nasal cavity and is centered around the sphenopalatine foramen and pterygopalatine fossa. Continue with the addit
n inverted pyramidal-shaped, fat-filled space located on the lateral side of the skull, between the infratemporal fossa
tween the orbit, the nasal cavity, the nasopharynx, the oral cavity, the infratemporal fossa, and the cranial fossa. Giv
nduit for the spread of inflammatory and neoplastic diseases in the head and neck. These images are of two differen
broma unlikely. Continue with the MR-images... The MRI shows a unilateral destructive tumor with marked diffusion

restriction (low signal intensity on ADC). So we have three red flags. The diffusion restriction is another argument aga
diagnosis of an juvenile angiofibroma, because a vascular lesion would not
cause diffusion restriction. There is invasion of the orbit and also of the anterior soft
tissue of the cheek (arrow). A biopsy was performed which revealed a rhabdomyosarcoma,
which was treated with chemotherapy.
Juvenile angiofibroma:
First look at the images. Why is this a typical juvenile angiofibroma? Findings: Continue with the DSA... The DSA show
with the characteristic localization) is
strongly indicative of juvenile angiofibroma. Pre-operatively this patient was treated with embolization. Surgery has t
recurrence. First look at the images. What are the findings? Findings: This is a typical juvenile angiofibroma. Continue
I and DSA.
There is strong
enhancement and hypervascularity.
Cystic lesion in the neck:
Cystic lesions in the neck are very common. In young patients the chance of malignancy is low. However a cystic lesio
over 30 years, is a red flag.
Branchial cleft cyst:
These images are of a 59-year old man, who is a smoker and
presents with a swelling in the neck. The original MR-report stated that there was a cystic lesion
posterior to the submandibular gland and anterior to the sternocleidomastoid
muscle; no associated lymphadenopathy.
Most likely diagnosis: branchial cleft
cyst. This seems a logical conclusion since the typical location of
a (second) branchial cleft cyst is between the submandibular gland and the
sternocleidomastoid muscle. However the age of the patient is a red flag. Continue reading... Five months later the s
Look at the images.
What is your diagnosis? The findings are: These findings were thought to be the result of infection and a cystic metas
cause of the age of the patient. The patient was treated with antibiotics and one month later the lesion was excised.
The specimen proved to be a branchial cleft cyst. Typical branchial cleft cysts are thin walled cystic lesions. However,
ly lymph node metastases of a papillary thyroid
carcinoma and of an (HPV associated) oropharyngeal carcinoma. Human papilloma virus is the cause of cervical canc
associated with vaginal and vulvar cancer It is also associated with cancer of the oropharynx (back of
the throat, including the base of the tongue and tonsils). As a rule of thumb: Any cystic neck lesion in an adult patien
when over 30 years, should be considered suspicious and a malignant origin
should be excluded. Case courtesy R.H. Hermans, Leuven This is a branchial cleft cyst in a ten-year old in the typical l
HPV associated oropharynx carcinoma:
These images are of a 69-year old man with a left neck swelling. It was reported as brachial cleft cyst.
The fluid fluid level (arrowhead) was thought to be debris as a result of prior infection or bleeding. In the follow up th
cised.
Pathology: Metastasis of a squamous cell carcinoma, positive for P16 marker.
This is a marker for human papilloma virus positivity. Continue... In search of the primary tumor, the ENT specialist n
rea of low signal on the ADC is smaller that the area of high signal on the DWI (b1000).
This means that only the center of the tonsil is cancer. The carcinoma lies deep within the crypts of the tonsil and is f
V-associated squamous cell carcinoma and the patient was treated with radiotherapy. Here two more cases of (seem
(arrow). This is never seen in a branchial cleft cyst.
Conclusion:

MRI Protocol:

Tips:

Reporting:
This
standard report is applicable to any head and neck tumor. In
the description of local spread we recommend using nomenclature and landmarks
that are also used by otolaryngologists and head-neck surgeons. by Robert Hermans Department of Radiology, KU L
Spine fractures - TLICS Classification:

Thoraco-Lumbar Injury Classification and Severity score:
by Clark West, Stefan Roosendaal, Joost Bot and Frank Smithuis

Department of Radiology and Regional Spinal Cord Injury Center of the Delaware Valley, Thomas Jefferson University
iversity Medical Center and the Academical Medical Center, Amsterdam:
Publicationdate 2015-05-01 The Thoraco-Lumbar Injury Classification and Severity score (TLICS) is a classification sys
nical management. Unlike other classifications, the TLICS is an easy scoring system that depicts the features importa
sive neurologic compromise. TLICS also facilitates appropriate treatment recommendations.
Introduction:
Most classification systems of spine injuries are based on injury mechanisms and describe how the injury occurred.
flexion should be treated by undoing the flexion by positioning the patient in an extension brace, or by surgical inter
e injuries thought to be due to extension mechanisms, however, turn out to be due to flexion and vice versa. These c
s such as the AO-classification is that they are usually complex, leading to high inter-reader variability. Using the pop
ituation since it uses the terms stable and unstable. In many cases, however, there is no good correlation with the ne
ambiguous and may refer to direct osseous stability; it may refer to neurological stability and finally, to long-term (lig
il to systematically take into account the neurological status of the patient and the indication for MRI to determine th
easons the Spine Trauma Study Group introduced in 2005 the Thoracolumbar Injury Classification and Severity Scale
e clinical decision making and as a practical alternative to cumbersome classification systems already in use. The TLI
scored 0-4 points and the total score is the sum of these parameters with a maximum of 10 points. The total score p
A total of more than 4 points indicates surgical treatment. A compression fracture gets 1 point. When it is complicate
nts. The integrity of the posterior ligamentous complex plays an important role in the TLICS. Sometimes it will be pos
When there are several fractures, each level has to be scored separately. The level with the highest TLICS score will d
separately. For example, in a translation/rotation injury, the PLC is always involved, making a total of 3+3=6 points. W
always involved, making a total of 4+3=7 points. In case of a distraction on the anterior side, however, the PLC may o
s.
Morphology:

Posterior Ligamentous Complex:
The PLC serves as a posterior "tension band" of the spinal column and plays an important role in the stability of the s
o progressive kyphosis and collapse. The PLC is composed of the supraspinous ligaments, interspinous ligaments, ar
ous ligament is a strong, cordlike ligament which connects the tips of the spinous processes from C7 to the sacrum.
connecting the adjacent spinous processes. The contractile force of the ligamenta flava presses the vertebrae togeth
l forces. CT features of PLC pathology are: When the PLC is definitely injured on CT, it can already be scored as 3. Sin
uctures, MR is sometimes needed to adequately diagnose pathology of the PLC, especially when there is no dislocati
a tendency to overdiagnose PLC injury (4). In some cases it can be difficult to decide whether there is a burst fracture
sion fracture (figure). You have to decide what you think is the main issue: the collapse of the vertebral body or the c
ing will be high, there is usually an indication for surgical treatment. TLICS score In case of multiple fractures, you ha
st TLICS score usually will be decisive for the therapy of choice.
Neurological status:
The third category is the neurological status as determined by the neurologist or spine surgeon. The role of the radio
s that an incomplete cord lesion will likely benefit more from surgery than a complete lesion; therefore a complete c
injury gets 3 points.
Modifiers:
Modifiers are other factors which can affect the decision of appropriate treatment: Sternum fracture Sternum fractu
of the spinous process, but also a fracture of the sternum. Analogous to the 3-column classification of Denis, some i
thoracic spinal fractures and recognize it as an independent variable in the assessment and treatment of these patie
ylosing spondylitis, DISH and rheumatoid arthritis) are more susceptible to spinal fractures, even after minimal traun
f the annulus fibrosus alter the biomechanics of the spine, creating long lever arms and limiting the ability to absorb
e images are of a patient with a typical bamboo spine as a result of ankylosing spondylitis. After a fall on his back no
fracture line through the anterior side of the vertebral body and also through the spinous process. Continue with th
Disable Scroll Enable Scroll
Disable Scroll Look at the images. What are the findings? Then scroll to the next images. The findings are: The TLICS-
LC.
Simple compression:
A simple compression fracture is the most common form of injury and is seen in 90% of cases. It is either loss of heig
the vertebral endplate. The posterior cortex of the vertebral body has to be intact and this feature differentiates a sim
. The posterior cortex may bulge slightly posteriorly in a simple compression fracture. As long as there is no free frag
racture and not a burst fracture. The images show a compression fracture. All we see is a cortical disruption in the up
ght ventrally. The posterior vertebral cortex is intact. The sagittal reformatted image also shows the cortical disruptio
ctures. You have to look at the thin slices to detect such a subtle fracture. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. Notice the horizontal band of density, which is often described as sclerosis.
that is already healing with sclerosis. This is merely a sign of trabecular impaction in an acute fracture. It is very com

on the radiographs. In this case the CT shows 2 fractures and the MRI shows 3 fractures. Pitfalls in diagnosing a com
sis. On the right with kyphosis.
Burst fracture:
This is the severe variant of a compression fracture with higher risk of neurologic deficits. The name is derived from
on the feet. A burst fracture gets 2 points for morphology in the TLICS. This means that a patient can be treated non-
ty should be confirmed at MR imaging, especially if conservative management of a burst fracture is planned (3). In th
olumn injury, calling it unstable and requiring surgical stabilization. Subsequent modifications of the Denis classificat
s complex (PLC), two-column unstable injuries can be successfully treated non-surgically (3). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Retropulsion of posterosuperior vertebral body fragment Retropulsion of a fragment is the typical feat
le compression fracture. Scroll through the images. Sagittal
fracture of vertebral body and
posterior element A sagittal fracture of the vertebral body and a sagittal posterior element fracture is seen in respec
four examples. In the Denis classification this would be a three column fracture -anterior/middle/posterior - indicatin
r this is a burst fracture, i.e. 2 points for morphology. The treatment will depend on the PLC integrity and the neurolo
g of the interpedicular distance, often a result of the sagittal fracture, is seen in 80% of burst fractures. The lateral vie
AP-view notice the subtle widening of the interpedicular distance compared to the levels above and below. The axia
ing on the thecal sac. On the sagittal CT and MRI there are no signs of posterior ligamentous injury. The anterior long
bit widened on the CT and there is some fluid in the joint on the MRI. If there was a lot of fluid in the joint, we should
ble Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. How would you describe the morphology and the PLC? The findings are: Yo
distraction, i.e. 4 points for morphology. However in this case the compression is the most prominent finding.
Translation - Rotation:
This type of fracture includes all fractures that are the result of displacement in the horizontal plane: side-to-side mo
to-side rotary motion of one vertebral body with respect to another. Often unilateral or bilateral facet dislocation is s
which always involves the PLC. In the TLICS this means 3 points for the morphology and 3 points for the PLC, which r
zation. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here a typical case of translation. The x-ray of the C-spine in this patient was normal and did not show
at is going on. Then scroll to the next images. In this case of translation there is bilateral facet dislocation and also a
re narrowing of the spinal canal. Continue with the MRI-images. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Again look at the first MR-images and decide what is going on. Then scroll to the next images. The find
Disable Scroll Enable Scroll
Disable Scroll In some cases it can be difficult to decide whether there is a translation or distraction injury and we ha
forces. Scroll through the images. What are the findings? At first glance this looks just like another burst fracture. Ho
isplacement at this moment, we should probably call this translation injury. Continue with the axial images. Enable S
Disable Scroll Enable Scroll
Disable Scroll On the axial images we see: These are typical findings in translation-rotation fractures. So we should c
Distraction:
A distraction injury is separation or pulling apart of two adjacent vertebrae. It is a severe injury since there is a high c
porting structures are pulled apart. A distraction injury on the posterior side can lead to a compression fracture on t
y only looking at the compression fracture and overlooking the distraction injury. In some cases it is difficult to decid
ompression fracture or with a compression fracture with PLC-injury. If the distraction is the main feature, then the m
is always involved, resulting in a total of 7 points for the TLICS-score. If compression is the main feature, then the m
ry making a total of 5 points. In both cases the patient is a surgical candidate. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. What are the findings? In this case the main findings are the horizontal fract
show hardly any compression. Notice that there are 3 vertebrae involved. Only the level with the highest score count
s severe compression of the vertebral body. However the most important findings are the horizontal fractures of the
ble Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. What are the findings? The findings are: In this case some would call this a b
straction is the most important finding, i.e. distraction and PLC injury, i.e. 4+3 points. So here is a typical case of distr
ot much else happening here. The disc space is markedly widened about four times the normal level. The facet joints
which is not a key element but a frequently associated injury. Continue with the MR. The MRI shows exactly the sam
anatomic information. The MRI also shows disruption of the ligamentum flavum and a partial disruption of the inter
eloping a spinal cord injury. Here a fracture that just looks like another compression fracture on the lateral view. At f
we zoom in and look at the distance between the spinous processes. Now when you look carefully at the lateral view

the whole story. You can see the edema related to the fracture of the vertebral body and the massive edema in the p
he ligamenta flava and the interspinous ligament. TLICS: distraction injury + PLC disruption. This is an interesting cas
is patient. However when we classify according to the TLICS-score, we give 4 points for the morphology and 3 points
ent would still get 7 points. Unfortunately, but not unexpectedly, conservative management failed with near-dislocat
her example. You could call these compression fractures. There is loss of height with a dense band of impaction and
ok at the spinous processes. One of the spinous processes is in two pieces and the two pieces are widely separated.
Now when you describe such a fracture the first word in your report should be distraction, i.e. morphology: 4 points
etween the spinous processes. But there are also little pieces ofbone, that have avulsed at least 10mm away. At first
ay be the most important sign of a major injury on a CT-scan. The fact that these little pieces of bone have been so s
this case there are lots of other things going on, but sometimes these little pieces of bone are all you get. If you look
he MRI. The teaching point is: pay careful attention to little pieces of bone. Patients with a rigid spine are more at risk
straction on the anterior side. Notice the rigid spine and how easily this major injury can be overlooked. This patient
e flava ligaments, interspinous and supraspinous ligaments as well as fracture of the posterior elements and compre
ed. Here another distraction injury. At surgery the rupture of the supraspinous ligament was confirmed (red and bla
Additional Cases:
Enable Scroll
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Disable Scroll Case 1 Scroll through the images. How would you describe the morphology and the PLC? The findings
tient is a surgical candidate. Enable Scroll
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Disable Scroll Case 2 Look at the images. How would you describe the morphology and the PLC? Then scroll to the n
Look at the images. How would you describe the morphology and the PLC? The findings are: Case 4 Look at the imag
re: Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Case 5 Look at the images. How would you describe the morphology and the PLC? Then scroll to the n
nt (black arrow)
2. PLC: widening of both facet joints (yellow arrow) and a fracture of spinous process (blue arrow) - 3 points
3. TLICS based on imaging: 5 points Discussion: based on only these two images it is hard to say whether this is burs
either case the TLICS-score is high and this patient is a surgical candidate. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Case 6 Look at the images. How would you describe the morphology and the PLC? Then scroll to the n
should not describe this morphology as burst - 2 points. The horizontal fractures on the posterior side and the incre
higher score for morphology. Always go for the highest possible score in TLICS. The Importance of Injury Morphology
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None:

MRI examination of the ankle:
Frank Smithuis and Robin Smithuis
Radiology department of the Amsterdam University Medical Centre in Amsterdam and Alrijne hospital in Leiderdorp
Publicationdate 2019-03-01 In this article a systematic approach is presented on how to describe a standard MRI of t
Systematic approach
Systematic approach:
We use a checklist when evaluating an MRI of the Ankle: When you have evaluated all these structures, combine you
Bones:

Bone marrow edema:
Start your exam with fatsat images of the bones to screen for edema. Bone marrow edema is only an indication that
is patient has bone marrow edema on the posterior side of the distal tibia. On the axial image, the edema is localised
s edema due to a ligamentous avulsion injury. Here two patients with bone marrow edema. The patient on the left h
ht has edema in the medial talus. Both patients have had an eversion injury, with stretching of the deltoid ligament.
ry on the insertion sites of the deltoid ligament. This patient has bone marrow edema in both the medial malleolus a
ickening. The bone marrow edema is likely due to impaction of talus and medial malleolus secondary to inversion in
Stress fractures:
Stress fractures of the calcaneus are a frequently unrecognized source of heel pain. This patient has edema in the ca

sults from overuse, especially in runners. When the fracture is not seen on the T2W fatsat-images, look at the non-fa
etimes the fracture line is not seen on MR. In those cases you may consider a CT-scan which can be more sensitive. T
is patient there is very subtle edema in the distal fibula. No fracture line is visible. There is subtle thickening of the co
ere is edema like in this case and no visible fracture line, you may consider CT. Do not mention the edema without h
easy to miss on MR alone and this could lead to a wrong diagnosis like for instance osteomyelitis. In this case there i
y depicts the stress fracture.
OCD:
OCD is an abbreviation which can stand for either Osteochondritis Dissecans or Osteochondral Defect. Osteochondr
exactly known, yet most probably due to repetitive microtrauma. Osteochondral defect is mainly used when a patie
f the defect. Both describe a joint defect which involves the articular cartilage and the underlying subchondral bone.
aarticular fluid will erode the subchondral bone, which will result in bone marrow edema. This process can evolve in
t, the OCD can become unstable and may result in a corpus liberum. Here three patients with various stages of OCD
Os Trigonum:
In the foot and ankle many accessory ossicles can be seen. The most common ossicle is the os trigonum, which is a p
he os trigonum is present in the normal population in about 5-15%. Compression of the os trigonum and surroundin
xion can be a cause of posterior impingement. This is especially seen in ballet dancers. The term Stieda process is us
lead to posterior impingement. Here another patient with an os trigonum. On the fatsat images edema is present in
posterior impingement due to a symptomatic os trigonum. Here an example of an os trigonum with rather subtle ed
nd tubercles on the posterior side of the talus. This patient has an unfused prominent lateral tubercle with a fibrous
gonum. On the axial image more unfused prominent tubercles on both the medial and lateral side of the lateral tube
Joints:

Effusion:
Once you have studied the bones, scan the joints for effusion. The left image shows a normal fluid accumulation in t
The right image shows massive joint effusion as a reaction to degenerative osteochondral defects in the tibiotalar jo
tendon (FHL), since this tendon sheath is continuous with the joint. Two examples of diffuse joint effusion in the tibio
caneal joint.
Capsular thickening:
The ankle joint is lined by the joint capsule. When the capsule is thickened, it may cause impingement or synovitis, w
ning can be posttraumatic or postoperative. On the right a patient who developed postoperative fibrosis after resect
calcaneus and the posterior joint capsule. In this patient there is only a small effusion in the ankle joint. On the non
th reactive changes in the surrounding soft tissue. This patient had anterior ankle pain due to impingement by the th
le. On the fatsat images, you may think that there is only some edema in the subcutaneous fatty tissue. On the non f
on the anterior side. Capsular thickenig and soft tissue abnormalities are usually better seen on non-fatsat images. I
This patient has secundary degenerative changes in the joint with subchondral edema and cyst formation. It is a res
ring dorsal flexion.
Ligaments:
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Anatomy in axial plane:
Scroll through the image stack for the ligamentous anatomy in the axial plane. You can click on the image to enlarge
are usually involved in exorotation injuries like:
Anterior syndesmosis:
In A - a normal anterior syndesmosis is seen as a thin low intensity band. In B - the anterior syndesmosis is thickened
C - the anterior syndesmosis is thickened and there probably is a focal discontinuity (arrow) and that is the reason w
ated injury of the anterior syndesmosis can be seen in low grade exorotation injuries. In this patient there is a full th
re is also a fracture of the malleolus tertius (blue arrow). More proximal, edema is seen around the membrana intero
nation exorotation injury in the Lauge-Hansen classification.
Posterior syndesmosis:
Acute injury presents as edema and thickening, while an old injury presents with thickening and low signal intensity
the anterior and posterior syndesmosis (arrow), indicative of acute grade 2 injuries. In B there is edema and thicken
ury. The anterior syndesmosis is also thickened but shows low signal. This is scar formation as a result of prior injury
hich again can be a cause of posterior impingement.
ATFL:
There are three ligaments on the lateral side: The ATFL runs from the lateral malleolus anteriorly to the lateral borde
en on axial images. This is the most commonly injured ligament of the ankle and it is also the first to be injured on th
injured, it is very likely that the ATFL is injured aswell. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the coronal images. You can enlarge the image by clicking on it. Here we see three patie

around the ATFL-ligament, while the ligament itself looks normal. This probably represents a mild strain (grade 1). Us
the middle has thickening and architecture distortion representing a partial tear (grade 2). The patient on the right h
presents as a fine linear band of high signal intensity which is the result of a small avulsion of cortical bone in a grad
tear with a bright rim sign (arrow). It is thought that it is caused by a chemical shift artifact when subcortical fatty ma
CFL:
The Calcaneofibular ligament runs from the distal fibula to the lateral side of the calcaneus and is best appreciated c
int and the talocalcaneal joint. Isolated injury of the CFL is uncommon. Most of the time the ATFL is injured as well.
PTFL:
The Posterotalofibular ligament courses posterior to the lateral tubercle on the posterior aspect of the talus. Isolated
ury to the other lateral ligaments. Here a normal PTFL and a grade 2 tear. Notice that there is also a grade 2 tear of t
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Deltoid ligament:
The deltoid or medial ligament is more difficult to evaluate, since seven components have been described. Some con
s seen on a standard MR. The deltoid ligament is best evaluated in the coronal plane. The deep layer connects the in
alus. The fibers are interposed with fatty tissue, giving it a striped pattern on MR. The superficial layer of the deltoid l
the calcaneus posteriorly. At the insertion on the medial malleolus, it blends with the periosteum of the medial mall
the Spring ligament, which is the superomedial part of the calcaneonavicular ligament. This ligament serves as a han
has a close relation with the deltoid ligament and the posterior tibial tendon. Surgical repair of the spring ligament i
omponent of the adult-acquired flatfoot. These images show injury to the deep deltoid ligament. It is difficult to diffe
ll blur the normal striped pattern. The image on the right shows fiber discontinuity making it a full thickness or grade
findings are: On these images we can recognize the close relationship between the deltoid ligament and the periost
ge in the middle there is a deltoid ligament injury with separation of the periosteum or "periosteal stripping". In addi
e right there is thickening of the deltoid ligament with a low signal intensity as a result of chronic injury. Note that th
ickening of the periosteum is a common finding and indicates injury of the deltoid ligament in the past.
Plantar fascia:
The plantar fascia is a thick aponeurosis which supports the arch on the plantar side of the foot. It runs from the tub
Plantar fasciitis, the most common cause of heel pain in the athlete, is a low-grade inflammation involving the planta
a around the insertion of the plantar fascia on the calcaneus and spurring. When the patient is treated, the edema w
en on a X-ray therefore can be seen in symptomatic and asymptomatic patients.
Tendons:
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Anatomy in the axial plane:
The tendons can be divided into four compartments: Tendinopathy is a collective term to describe different tendon d
pathogenesis of these disorders is different, but the clinical presentation and imaging features are not always distinc
ty as tendinopathy without trying to further specifying the abnormality. MR findings in tendinopathy are: Most tendo
f fluid around the tendon therefore can be normal. The amount of fluid should not exceed the volume of the tendon
a paratenon. Fluid around the Achilles tendon is always abnormal.
Posterior tibial tendon:
The posterior tibial tendon is the most commonly injured tendon. Tendinopathy is seen as abnormal swelling of the
endon can measure twice the size of the flexor digitorum tendon. Posterior tibial tendon dysfunction is more comm
pain and swelling on the medial aspect of the ankle and an acquired flatfoot deformity. Posterior tibial tendon injury
posterior tibial tendon is injured, be sure to check the spring ligmanent, since they together maintain the arch of the
don and the spring ligament can be injured. The images show tendinopathy of the PTT, aswell as injury to the spring
Achilles tendon:
The Achilles tendon is the largest and strongest tendon in the human body. The two most common injuries are tend
eries of microtears that weaken the tendon and cause swelling of the tendon (image on the right). On sagital images
round it and no focal thickening. A transverse diameter of 8 mm is the cut off. Three fat sat axial images of the achill
is within 7mm, no paratenon fluid is seen.
* Middle Normal achilles tendon. Note that the other tendons all contain fluid, but the achilles paratenon shows no f
* Right Fluid alongside the paratenon, i.e. paratenonitis and achilles tendinopathy. Normally, a small amount of fluid
ive of bursitis. Thickening of the Achilles is seen with paratenonitis. The Haglund syndrome consists of the triad of: T
on (yellow arrow) after resection of a Haglund exostosis. This was the cause of continuing impingement. This image s
ndon. Another example of Achilles tendinopathy. Rupture of the Achilles tendon usually occurs in the part of the ten
us. This part is prone to rupture because the blood flow in this area is poor, which also can impair its ability to heal. T
Peroneal tendons:
The peroneus brevis tendon is injury-prone, because it is positioned inbetween the fibula and peroneus longus tend
is repeatedly compressed between the peroneus longus tendon and the lateral malleolus, predisposing to tear. Onc

y. The peroneus longus tendon migrates forward into the peroneus brevis tendon tear, thereby preventing healing (t
eformity, indicative of partial split rupture. This can be challenging, because the actual tear cannot be seen, only the
nversion injuries, most likely due to greater force on these tendons after ligamentous injury. Split tears of the perone
nt calcaneal tubercle. Anterior The extensor tendons are rarely injured. Tom Hates Dick is a useful mnemonic.
Accessory muscles:
Accessory muscles are frequently seen around the ankle joint. Since they have a normal signal intensity, they are eas
l patient on the left, you will detect the big accessory soleus muscle. Some examples of accessory muscles. They are
fic patient groups (dancers, athletes). Accessory FHL or FDL are associated with tarsal tunnel syndrome. The patient
cause of Achilles tendinopathy.
MRI protocol:
Standard axial, coronal and sagittal planes are used in the ankle both on 1.5T and in 3T. In addition to the standard p
ular to the peroneus and tibialis posterior tendons. Small tears or subtle tendinopathy are better visualized on these
eral malleolus can cause the 'magic angle artifact' to occur. The tendons will show relatively hyperintense signal at 55
ears. This artifact is visible on short TE images (f.e. PD). On long TE images (like T2) this artifact does also occur but le
687-695
Neck Masses in Children:
Annemieke Littooij, Cécile Ravesloot and Erik Beek
Radiology department of the University Medical Center Utrecht in the Netherlands:
Publicationdate 2016-11-01 A mass in the neck is a common finding in children. In this article we present a pictorial e
ach based on the location of the lesion and whether it is cystic or solid. Ultrasound is the imaging method of choice a
if the lesion is cystic. MRI is of value in large lesions, to determine whether the lesion infiltrates into deep spaces. CT
ons to assess whether an abscess is present. In suspected malignant lymphoma ultrasound can demonstrate which
T is used for staging.
Introduction:

Diagnostic approach:
In a neck lesion in a child, ultrasound can usually determine whether a lesion is cystic or solid. Often more than one
nodes, lymphadenitis due to TB or cat-scratch disease and malignant lymphoma.
* Solid - not a lymph nodeIf a solid lesion is not a lymph node look for a possible site of origin, like the salivary gland,
cutaneous solid lesions sometimes have a typical appearance, like pilomatrixomas, lipomas or hemangiomas. In ma
an only be made through biopsy or excision. Click on image to enlarge
Location of cystic lesions:
Once you have decided that the lesion is cystic its location will often point to its nature (figure). Midline lesions Midlin
ts or ranulas. Older children can be asked to protrude their tongue. A thyroglossal duct cyst will move upward with t
he mouth. Off-midline lesions Off-midline lesions can be branchial cleft cysts or lymphangiomas. Branchial cleft cysts
en multicystic. In the posterior neck they are often single.
Cystic lesions:
Sorry, your browser doesn't support embedded videos. In neck lesions we first try to figure out whether a lesion is cy
It can however be a problem if the cyst has been inflamed or when a cyst has bled, since children often present with
he contents by compressive movements of the probe or by changing the position of the child and look for acoustic e
a 13-year-old girl. A hypo-echoic lesion is seen superficial to the carotid artery and deep to the sternocleidomastoid m
d with the probe. When the girl was asked to sit upright the contents swirled.
Thyroglossal duct cyst:
Thyroglossal duct cysts are common lesions in children. The thyroglossal duct runs from the base of tongue at the fo
avels through the duct to reach its final normal position. Normally, the thyroglossal duct then involutes, but when th
along this tract (figure). Thyroglossal duct cysts move upward if the tongue is protruded or during swallowing (see ne
is. Always look for the presence of a normal thyroid gland and make an image of it. Sorry, your browser doesn't supp
ent of the thyroglossal duct cyst together with the hyoid bone during swallowing. Thyroglossal duct cyst Thyroglossa
due to infection, hemorrhage, or proteinaceous content. The majority of thyroglossal duct cysts is located within 2 c
lossal duct cyst with some internal echoes located in the midline. Thyroglossal duct cyst Here a tranverse image of a
cal hyper-echoic dermoid cyst in the suprasternal notch.
Dermoid cyst:
Dermoid cysts are inclusion cysts, that contain epithelium and skin adnexa like hair follicles, sebaceous glands and s
ion, especially around the orbit and in the midline of the neck, with a predilection for the suprasternal notch. Here a
dermoid cyst, which was located in its favorite location, the suprasternal notch. Dermoid cyst In the neck dermoid cy
e inhomogeneous. The differentiation from a thyroglossal duct cyst can be difficult if the dermoid cyst is located nea
ally hypo-echoic and may contain internal echoes, while dermoid cysts generally have a more homogeneous hyper-e
yst in front of the thyroid gland (figure). Orbital dermoid cyst The most common location of a dermoid cyst in the hea
corner. On ultrasound they are anechoic and one should look for the presence of a bony lining. If the integrity of the
ne possible intracranial extension. Here a typical orbital dermoid cyst. It was firm on palpation and located at the lat

emodelling of the underlying bone.
Branchial cleft cyst:
Most branchial cysts are remnants of the second brancial cleft. Cysts at the level of the thyroid gland can be remnan
on results in either a cyst (75%), a sinus or a fistula (25%). Cysts present as painless masses, sometimes appearing su
nterior border of the sternocleidomastoid muscle, lateral to the common carotid artery, and if more cranially betwee
may be seen as a curved rim of the lesion pointing medially between the internal and external carotid. Typical ultras
. On ultrasound they often contains internal echoes caused by debris, which consists of cholesterol crystals. The cyst
ent. This may not be the case in a cyst with a fresh internal hemorrhage. They can inflame and present with an empy
al to the carotid artery bifurcation. Branchial sinuses Branchial sinuses are blind ending tracts, presenting anterior o
las end in the tonsillar fossa, as can be demonstrated with a contrast fistulogram or MRI. With ultrasound a tract can
e to depict the proximal ending. Here a two-year-old boy with a dirty spot in the right lower neck. A small tract could
stula was excised. Here a ten-year-old girl with a pit in the right neck, anterior of the sternocleidomastoid muscle. On
o the right submandibular region. At operation, the fistula extended towards the right tonsillar fossa and was excise
Lymphangioma:
Lymphangiomas are cystic lesions, caused by maldevelopment of the lymph channels. The majority occur in young c
lymphangioma usually has one or more larger cysts. In the anterior neck a lymphangioma can consist of innumerab
m. This is also called a hygroma colli. The sonographic appearance depends on the size and number of cysts. Larger
c lymphangioma can be hyper-echoic due to the high number of closely related reflecting walls. Here an ultrasound
of the lesion was not clear. Here the T2-weighted image of the same patient. On T1-weighted images the content has
tent. It generally has a high signal intensity on T2-weighted images. Contrast enhanced T1 can show enhancement of
udden swelling in the left neck. There were several small anechoic cysts and one large cyst containing internal echoe
lymphangioma. A 3-year-old boy presented suddenly with a supraclavicular mass. Ultrasound showed a lesion with
ected. Continue with the MRI. The T1-weighted image shows a slightly hyperintense lesion with a fluid-fluid level (arr
e cyst wall. The lesion subsided with conservative therapy. Ranula
Ranula:
A ranula is a fluid filled cyst originating from the sublingual salivary gland. It can extend into the floor of the mouth a
o extend through or over the mylohyoid muscle and is then called a "plunging ranula" and present as a submental o
firm swelling under the tongue on the left side. Ultrasound showed an anechoic mass continuous with the sublingua
os.
Jugular ectasia:
In some children a swelling can appear in the lower neck during straining. This is often caused by dilatation of the int
d that will show the variations in caliber of the vein. An example is shown on the video of a seven-year-old boy, initia
Solid lesions - Lymph nodes:
This image shows a commonly used classification for the location of lymph nodes. Submental and submandibular no
* Level 2 Nodes along the internal jugular vein, above the level of the hyoid bone
* Level 3 Nodes along the internal jugular vein, between the hyoid bone and cricoid cartilage
* Level 4 Nodes along the internal jugular vein, below the cricoid cartilage
* Level 5 Posterior to the sternocleidomastoid muscle, above the clavicles
* Level 6 Anterior to the thyroid gland Normal lymph nodes are always visible with ultrasound in children. A normal
w the mandibular angle can have a short axis of 15 mm. Enlarged lymph nodes in the neck are very common in child
infection. Less commonly it is due to a primary infection of the lymph nodes itself, which is called lymphadenitis. Us
used synonymously. Although ultrasound cannot always reliably distinguish lymphadenitis from a malignant lympho
biopsy should be done or that a "wait and scan" policy can be adopted. Supraclavicular lymph nodes should always b
Reactive lymph nodes:
Reactive lymph nodes are a reaction to nearby inflammation. They are slightly enlarged and more hypoechoic than n
weight loss, fatigue and lymphadenopathy. On ultrasound a string of enlarged lymph nodes with preservation of a e
. Here a two-year-old girl with a palpable swelling in the left neck since a few weeks. On ultrasound the lymph nodes
l perfusion. It was decided to wait and see and the nodes slowly shrunk.
Bacterial or viral lymphadenitis:
A bacterial or viral lymphadenitis is an infection of the node itself. Bacterial lymphadenitis is often caused by Staphyl
h are frequently located in the submandibular region, are painful and the skin is warm and red. Bacterial lymphaden
image is of a one-year-old boy with a swelling in the neck for three weeks. A partly liquefied lymphnode is seen with
disappeared on antibiotic treatment. Abscess formation is clinically difficult to detect, and ultrasound is also not relia
and more hypoechoic center or areas with mobile, moving echoreflections. According to the literature there are 30%
y with a swelling in the right neck for one week. Ultrasound shows an enlarged lymph node with areas of liquefaction
Cat-scratch disease:
Cat-scratch disease is caused by Bartonella henselae. The infection is the result of a scratch or bite of a cat. It is the m
symptoms are often mild and lymph node swelling can be prolonged. The clinical diagnosis can be difficult and PCR
d, heterogeneously hypoechoic, hypervascular, and with some surrounding inflammation. The nodes are a bit tende
nodes. Here an ultrasund image of a sixteen-year-old girl, who was treated for recurrence of acute lymphatic leukae

g in the left shoulder region. A hypoechoic node without any internal structure was seen. It was excised. The final dia
wser doesn't support embedded videos. Cat-scratch disease 2 Here a video of a fifteen-year-old boy with a swelling i
trated tissue. Continue with next video. Sorry, your browser doesn't support embedded videos. After a week suppur
The boy was successfully treated with antibiotics. Two-year-old boy with a progressive swelling in the neck. No effect
s confirmed. The anechoic parts (arrow) in the node are often seen in atypical Mycobacteria infection.
Mycobacteria:
Infection with atypical Mycobacteria generally occurs in patients between one and five years of age. There are few cli
ymph nodes are usually unilateral and in the pre-auricular or submandibular area. There is often a pronounced skin
tly present with a single enlarged node and some smaller satellite lesions. There is central necrosis, thickening of the
confluent mass. Fistulas may be present. Calcifications are seen more commonly in TB infections than in atypical My
next image... Three months later the swelling is still present. The deeper lymphnode has liquefied. After another fou
in the surrounding tissue. Here an ultrasound image of a 6-year-old boy with a swelling in the neck. Fine calcification
e positive, but cultures for tuberculosis were negative. The patient was treated with tuberculostatics with good result
Malignant lymphoma:
Malignant lymphoma presents with painless lymphadenopathy. In Hodgkin lymphoma the cervical nodes are most c
ring are often involved. On ultrasound the affected nodes are round, homogeneously hypoechoic and the normal ec
iopsy or excision. PET/CT will demonstrate the extension of the disease. The images are of a fourteen-year-old boy w
veral enlarged hypoechoic lymhnodes, that lack an hyper-echoic hilum. Here another fourteen-year-old boy with a p
d lymhnodes. Continue with the MR and PET/CT... A coronal STIR image shows the pathologic lymph node masses sin
Solid lesions - not lymph nodes:
The most common cause of a solid lesion in the neck is an enlarged lymph node as we just discussed. Other solid les
. In many cases the imaging findings in a solid lesion will be non-specific and a diagnosis can only be made through b
Thyroid lesions:
Congenital anomalies The most common anomalie is a partial or complete agenesis of the gland. In partial agenesis
ongue and the thyroid cartilage. Mostly near or in the tongue, a lingual thyroid. Here an image of a newborn with an
neither in its usual position nor higher up in the neck. Thyroid nodules Thyroid nodules are common. They can be sin
trasound they are isoechoic with the normal gland. In a goiter a multitude of solid nodules are seen. If there is conce
one. Preferably a technician of the cytology department is present to make a quick assessment of the retrieved cells
d. This is an ultrasound image of a six-year-old girl with a small cyst with a septum in the right thyroid lobe. It remain
ged thyroid gland with a diffuse inhomogeneous structure and hyperemia is seen in a ten-year-old girl Thyroiditis Th
d Graves disease. Both Hashimoto's thyreoiditis and Graves disease can present as an enlarged and hyperemic thyro
auto-immune disease. It presents with hypothyroidism. Although primarily a disease of the middle-aged it can prese
inhomogeneous. On color doppler the blood flow is often normal but can be increased like in Graves' disease. In a la
thyroid gland is also enlarged and shows an increased perfusion. On color Doppler it has been described as an infer
rthreoidism. A diffusely enlarged thyroid gland is seen with hyperemia. The final diagnosis was Graves disease. She w
onths-old boy.
Thymus:
The thymus is located in the upper mediastinum and can be visualized with a suprasternal scan plane. With increasin
ound is ideal to demonstrate the thymus as a cause of a widened upper mediastinum in infants. Sometimes the thym
erniating thymus can be demostrated with ultrasound. Sorry, your browser doesn't support embedded videos. The t
suprasternal scan plane. Ultrasound image of the thymus in an eight-year-old boy. Sorry, your browser doesn't supp
ss which was sometimes visible in the suprasternal notch. While crying the thymus was seen to herniate in front of th
Ectopic thymus:
Ectopic thymic tissue may occur anywhere along the path of descent through the thymopharyngeal duct. When it pro
t of the thymus has the same echo characteristics as the normal thymus. The video shows an ectopic thymic remnan
the brain in a 2-year-old boy. The ectopic thymus has the ultrasound characteristics as the normal gland. Here image
mination shows a mass between the parotid and submandibular gland (yellow arrow). The signal characteristics are
hymic remnant (yellow arrow), with identical sonographic characteristics as the orthotopic thymus (green arrow). Lef
eidomastoid muscle. RIGHT: Hyperechoic mass in sternocleidomastoid muscle.
Fibromatosis colli:
Fibromatosis collis is a swelling of the sternocleidomastoid muscle in a newborn. It is probably caused by pressure n
it is not caused by hemorrhage. 50% of affected babies are born in breech. The swelling becomes apparent one to th
ing will usually regress spontaneously within a few months. On ultrasound an enlargement of the sternocleidomasto
sternal head is always affected, and often the cleidal head as well. It can be hypo-, iso- or hyperechoic. Longitudinal
Sorry, your browser doesn't support embedded videos. Here a video of a two-month-old boy with a torticollis. A ma
nosis is fibromatosis collis Hemangioma
Vascular anomalies:
Vascular anomalies are classified into proliferative vascular tumors and vascular malformations. This classification is
will regress spontaneously or after administration of beta-blockers. Vascular malformations however need excision,
ifications of these lesions is constantly changing and beyond the scope of this article. A recent article on vascular ano

omas are benign vascular neoplasms. They are the most common tumors of infancy. 60% of hemangiomas are seen
h, show rapid growth, followed by spontaneous involution. Here we see images of a highly vascular lesion in the left
ater it had decreased in size. Infantile hemangioma A soft swelling was present on the side of the head in a six-week
typical for an infantile hemangioma. Venous malformation Venous malformation A six-month-old boy presented wit
s could not differentiate between a hemangioma or a venous malformation. At six months of age, the ultrasound sh
n size on straining. On color Doppler the lesion showed increased flow while crying. The final diagnosis on imaging a
in the right temporal area of a 2-year-old boy. Ultrasound shows an echogenic lesion with a well demarcated wall ar
Pilomatrixoma:
A pilomatrixoma or epithelial inclusion cyst of Malherbe is a benign skin lesion associated with hairfollicles. It presen
scoloration is present. They vary in size from a few millimetres to 3 centimetres. The majority occurs in the head and
tumor lcated between the cutis and subcutis. It is hyperechoic, sometimes with calcification and acoustic shadowing
can be seen in the wall. These images are of a firm mass in the neck of a 17-year-old girl. A cytologic sampling was in
d at pathology after excision. Some perfusion in the wall of the pilomatrixoma is seen. Large pilomatrixoma on the u
Salivary glands:
Enlargement of the salivary glands can be diffuse or focal. Diffuse swelling mostly affects the parotid glands. If it is bi
ren's disease) or infections (HIV). On ultrasound many small hypoechoic lesions are present. Unilateral swelling can b
n parotid gland tumor of childhood, which involute in the course of a few months.
Teratoma:
Teratomas of the neck are rare in children. Teratomas are composed of all three germ layers. They often present at l
nd often contain calcifications. They can have a close connection to the thyroid gland. If the extension is unclear MRI
of a three-day-old boy. Calcifications and solid and cystic parts are seen. Pathology was compatible with a mature te
Paraganglioma:
Here images of a 17-year-old boy with a swelling in the neck, thought to represent a branchial cleft cyst. An echogeni
examination. No specific diagnosis could be made. The final pathologic diagnosis was a paraganglioma, a very uncor
Neurofibroma:
Here a large neurofibroma in the subcutaneous tissue in the neck of a 10-year-old boy with a known neurofibromato
Neuroblastoma:
Neuroblastoma usually presents as an abdominal mass in young children. In the neck it accounts for 1-5% of neurob
ten with some calcifications (1). Here a ten-month-old girl with a lump in the neck. Ultrasound shows a inhomogeneo
ymph nodes with calcifications. Imaging could not make a definitive diagnosis. Pathology showed a neuroblastoma.
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2. Vascular anomalies classification: recommendations from the international society for the study of vascular anom
03-14
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4. Pediatric Neck Masses Powepoint presentation by Mark Domanski, M.D., Michael Underbrink, M.D. of the Dept. of
5. Pediatric Head and Neck Masses ALGORITHMS OF DIAGNOSIS AND MANAGEMENT FOR THE PRIMARY CARE PHYSI
6. The Child With a Neck Mass by Bernadette L. Koch, MD. Medspace.com
Non-Meniscal pathology:
David Rubin and Robin Smithuis
Radiology department of the Washington University School of Medicine, St. Louis, USA and the Rijnland hospital in Le
Publicationdate 2005-8-2 0 This article is based on a presentation given by David Rubin and adapted for the Radiolog
n-meniscal pathology of the knee. See the article entitled Knee MRI - meniscal pathology for the pathology of the me
Rubin and Robin Smithuis
Ligaments:
MR-signs of ligament tear
Anterior Cruciate Ligament:
The ACL has interesting anatomy. It is an intra-articular structure, but it is extra-synovial. The synovium folds over th
. Sometimes when there is a tear ,the synovium layer is intact and only a hemorrhagic ACL is seen. The ACL is compo
r synovium or sometimes a little bit of fluid. This explains why the ACL is not black on PD-images. Do not look at the
athology. Only look at the ACL on T2W-images and even on these images the ACL does not have to be entirely black.
ar are: discontinuity on T2, abnormal orientation or non-visualisation. Many secondary signs of tears have been desc
t visualisation of the ligament. Only bone bruises can be a helpfull secondary sign. Notice that on coronal and axial in
rcondylar notch (arrows). There should never be any fluid between these ACL-fibers and the bone of the lateral cond
d of many fibers. LEFT: Acute ACL-tear. ACL fibers too flat compared to condylar roof.RIGHT: Discontinuity of fibers.
gament that's too flat and we see disrupted fibers so there is abnormal orientation and discontinuity. Based on thes
e partial tear or partial tear. MRI does not accurately differentiate between partial or complete ACL tear. But yes we
gh grade injury is 'not able to see 50% of the fibers'. So if the othopaedic surgeons operate on a high grade injury, th
l tear, that needs to be repaired. On the other hand if most of the fibers appear to be intact on MR indicating a low g
that is stable and doesn't need any treatment. LEFT: ACL-tear with bone bruises on lateral side. RIGHT: Anterior cond
ching. Anterior Cruciate Ligament (3). Bone bruises appear in a very typical location indicating the dislocation, that w

tear Anterior Cruciate Ligament (4) On X-rays an important indirect sign of an ACL-tear is a Segond fracture. Difficult
ond fracture is an avulsion fracture at the attachment of the lateral collateral band due to internal rotation and varus
unhappy triad or O'Donoghues syndrome is a different combination of injuries. The unhappy triad injury commonly
the outside. This causes an injury to three knee structures: Torn ACL. ACL fibers are too flat (yellow arrow) compared
igament (5) Case on the left shows a torn ACL. Fibers have an abnormal orientation (too flat). Yet it is difficult to see i
the ligament is due to fact that the ACL and PCL have scarred together (see below). LEFT: ACL-fibers have a normal c
h sign: fluid against the interior part of the lateral condyle Sometimes it is easier to see whether these fibers are atta
lateral condyle there never should be fluid. If this is the case it is called the 'empty notch sign' indicating that the ACL
plane there is an empty notch sign (yellow arrows) where there should be ACL attached to the condyle. At a lower le
s) Also in the axial plane there should be ligament next to the condyle. At a lower level we see the torn ACL attached
. This is a very common appearance of a chronic ACL tear. This scarring leads to the acute angulation of the ligament
nough and still needs reconstruction. ACL Mucoid degeneration. This patient had an operation for another reason an
ruciate Ligament (6) Case on the left shows a non-visualisation of the ACL on a PD-image. But the lesson is 'do not lo
gament look at the T2W-images. The T2W-images show fibers going all the way from the tibia to the femur with a no
eneration. Normally between the ACL-fibers there can be synovium or fat. In normal aging that can change into gelat
Mucoid degeneration with cyst-formation (intra-osseus ganglion). Mucoid material is squeezed from between the AC
nterior Cruciate Ligament (7) Another case of ACL Mucoid degeneration. Often this is associated with cyst-formation
call it normal because it has no clinical meaning. This is part of normal aging. ACL ganglion cyst Anterior Cruciate Liga
e mucoid degenaration. This is a ganglion cyst. Probably also a form of degeneration. The difference with Mucoid de
cysts will drained under ultrasound guidance. Be sure to use a very large needle, because it is very thick material. Ac
rs are gone so it's a high grade tear.

Posterior Cruciate Ligament:

We use the same criteria for all the other ligaments in the body. The case on the left shows a high grade PCL tear. MC
al geniculate vessels (red arrow) about 7 centimetres below the joint space.

Medial collateral ligament:

The superficial medial collateral ligament (MCL) extends from the medial epicondyle to insert not just near the joint b
andmarks: the inferomedial geniculate artery and paired veins (figure). The deep part of the MCL, even when it is no
dial meniscus and the superficial MCL. Grade 1 MCL Sprain Medial collateral ligament (2) The case on the left shows a
Sprain Medial collateral ligament (3) The case on the left shows a Grade II sprain of the medial collateral ligament. Su
rrow). Medial collateral ligament (4) The case on the left shows a superficial MCL that is torn from it's attachment on
t line. Deep MCL is also torn the ligament is absent. Posterolateral corner anatomy from medial to lateral on sagittal
tendon (yellow) form a letter V and insert as conjoined tendon on fibular head.

Posterolateral Corner injury:

Normal anatomy Posterolateral corner contains seven or eight structures. Only three of them are important to us be
fix them. These structures are: Fibular collateral ligament Biceps femoris muscle and tendon. Popliteal tendon The fi
femoris form the letter V on sagittal images. They inserts on the fibulahead as the conjoined tendon. LEFT: bone bru
o the fibula. Posterolateral corner injury (2) On the left a football player, who was hit in the front part of the knee. Th
. So you suspect ligamentous injury on the contralateral side, which is the posterolateral corner. The next image sho
tached to the fibula. LEFT: distal rupture of fibular collateral ligament.RIGHT: biceps femoris tendon and collateral lig
ient located more anteriorly. The fibular collateral ligament has a normal proximal attachment but is not attached to
emoris tendon and collateral ligament on one side and the fibular head on the other. These findings indicate a conjo
l lig rupture (green), proximal rupture of the fibular collateral ligament (blue).RIGHT: no attachment of popliteus tend
PD-fatsat images after severe injury. There are bone bruises and many ligaments are ruptured. There is a posterolat
ligament. There is also a rupture of the popliteus tendon because it is not attached proximally.

Cysts, Bursae and Recesses:

LEFT: popliteal cyst originating between semimembranosus tendon (red arrow) and gastrocnemius muscle and tend
the muscles. There are about 12 named bursae and recesses in the knee. Some very common and others uncommo
iteal or Baker's cyst. The origin is between the semimembranosus and gastrocnemius tendon. Prepatellar bursitis

Prepatellar bursitis:

On the left the typical imaging findings of prepatellar bursitis. Deep infrapatellar bursitis

Deep infrapatellar bursitis:

An uncommon form of bursitis is the deep infrapatellar bursitis. Sometimes associated with Osgood-Schlatter. Media
arrow) and the superficial MCL (green arrow). These bursae are all named by the structures next to them. So a bursi
called a medial collateral ligament bursitis. Iliotibial Band Friction syndrome: no fat between iliotibial band (yellow ar
) Adventitial bursae are bursae, that are formed in places where normally there is no bursa> The bursa is formed du
place for abnormal friction is between the iliotibial band and the lateral condyle in speedwalkers, bicyclists and som
called the 'Iliotibial Band Friction syndrome'. On the left a speedwalker with lateral knee pain. Between iliotibial band
se it is missing. Iliotibial Band Friction syndrome : Fluid within a bursa is seen between the iliotibial tract and the fem
ame patient. On axial images fluid within a bursa is seen between the iliotibial tract and the underlying femur. Some
fluid. You have to look at all the images. In this case the joint fluid stops at the red arrows. Patient with a palpable m

oma. Remember that not everything that's bright on a T2W-image is fluid. You have to be suspicious, if there is some
ation, where there normally is a bursa, cyst or recess. Give Gadolineum to differentiate cystic from solid.
Quadriceps and Patellar tendon:
Normal Extensor mechanism: The quadriceps tendon comes in three layers (orange arrow). Patellar tendon (blue arr
Extensor mechanism The extensor mechanism of the knee is composed of the quadriceps muscle and tendon, the p
dons but comes in three layers on sagittal images. It has a broad attachment all the way from the front of the patella
e patellar tendon are homogeneous in signal but don't have to be black on PD-images. They have a sharp posterior c
tendon tear: T2W-images.LEFT: Abnormal attachment of tendon.RIGHT: Most of tendon is retracted (red arrow) deep
case on the left shows an abnormal quadriceps attachment. There is only one layer and the attachment does not go
tra images higher up have to be made after repositioning of the coil to see what's going on up there. The missing par
till intact LEFT: Torn tendon with pre-existing tendinopathy (red arrow). RIGHT: Intact vastus intermedius tendon. Sar
ck indicating tendinopathy. Normal tendons do not tear, so always look for signs of pre-existing tendinopathy. Anyw
s no pre-existing tendinopathy, think hard, if you really have the right diagnosis. An image below this level shows nor
ceps tear. Only rectus femoris tendon is torn (blue arrow). RIGHT: Pre-existing tendinopathy (yellow cirkle) on axial im
omplete quadriceps tear. Sag T2W-images. No continuity. Hematoma in between. If there is no continuity between th
Knee Jumper's knee is a spectrum from tendinopathy to tear. Just the same as with the quadriceps tendon or any ot
, indistinct posterior border, increased signal on T2W-images and finally fiber disruption. Patellar tendinopathy and P
he left is a professional ballet dancer with pain underneath the knee cap. Patellar tendon proximally is too thick. Pos
(or bone bruise). If left untreated could end up like...
Partial patellar tendon tear. Image on the right of a different patient. Complete Patellar tendon tear. Image on the rig
e Patellar tendon tear. Images on the left show no continuity between fibers and patella. The tendon is thickened. Pa
images. Patellar sleeve avulsion. In children we have a different situation. They don't develop tendinopathy. The cas
atella after doing gymnastics. Although the X-ray is normal there accually is a fracture through the cartilage part of th
ve. Only on coronal images the dark fractureline within the bright cartilage is visible. Usually these fractures are sutu
fication just below the patella.
Patellar dislocation:
Normal anatomy The patellar cartilage is the thickest in the body. It should have smooth contours. The most importa
ament which inserts all the way posteriorly just in front of the MCL. LEFT: Bone bruise lateral condyle (yellow circle).
nt anterior to it.RIGHT: Medial patellar femoral ligament thorn from femoral attachment. Case on the left is a female
o cranial demonstrate all the imaging features of a patellar dislocation with rupture of the medial patellar femoral lig
umped onto the lateral condyle. The patella has spontaneously reduced. LEFT: Bone bruise medial patella (green arr
rtilage fracture. Patellar dislocation (2) Patellar dislocation is a common condition, but clinically often unrecognized b
normal position. The patient comes with a swollen painfull knee which could be anything from ACL-, MCL- or menisc
zing this condition. Patients who have loose bodies or continuing dislocation may undergo operation with retinaculu
Bone and Cartilage:

Normal and abnormal bone marrow:
In adults the bone marrow is largely composed of fat. Normal islands of red marrow may produce confusing images
high altitude, hemoglobinopathy or for no reason at all. As long as the criteria on the left are fullfilled it is normal. N
s and not into the epiphysis. Comes in islands. On T1 brighter than muscle. Patient with leukemia and abnormal bon
marrow. On T1W the signal intensity is lower than muscle. On T2W-images the signal is very bright. The abnormal sig
mal signal intensity in the form of circles in metaphysis and epiphysis. Another case with abnormal marrow. In this c
n the marrow after many blood transfusions in a patient with hemosiderosis. Avascular Necrosis: fluid underneath th
mal.
Avascular Necrosis:
The most common marrow abnormality is Avascular Necrosis (AVN). Some people will say 'AVN, Osteochondrosis Dis
nct difference. AVN has the following features: Focal abnormality is subchondral and originates in the bone. Normal
bone infarction. Wedge-shaped bone infarction in AVN The wedge-shaped pattern of bone marrow edema is just the
ey-infarction.
Insufficiency fracture:
On the left a different entity, but the patient had the same symptoms. Acute onset of medial pain. There is diffuse m
not directly subchondral. The abnormality on the T1 is more inside the edema. On the T1W-image a dark line is visib
er with no weight bearing. On the left another patient with knee pain after trauma. There is some effusion but other
osteochondral fracture as the fracture line extends all the way through the cartilage to the joint surface. In the same
point is that any patient who is unable to bear weight in the hip, knee or ankle with normal X-rays needs another stu
Osteochondritis Dissecans:
The diagnosis Osteochondritis Dissecans is usually made on X-rays. The question for MRI is whether it is stable or un
cysts at the base of the lesion (red arrow) even more important is fluid at the base of the lesion (blue arrow) Notice t
is between the cartilage and the bone. Unstable Osteochondritis Dissecans. The only helpfull sign for the diagnosis u
eak in the osteochondral surface (green arrow). Not helpfull for the discussion stable versus unstable OD are bone m

ral surface. So the case on the left is unstable because there is fluid at the base of the lesion. The case on the left sho
ndral surface. But since there is no fluid we cannot tell if this is stable or unstable. At operation the OD was found to
lesion is stable or unstable MR-arthrogram is helpfull. We look for Gadolineum tracking around the osteochondral le
None:

None:

None:

Pulmonary Fibrosis:

A stepwise approach to fibrosis on HRCT:
Onno Mets, Lilian Meijboom and Robin Smithuis
Radiology department of the Amsterdam University Medical Center and Alrijne hospital Leiderdorp:
Publicationdate 1-7-2021 In this article we will discuss lung diseases with a reticular pattern and provide a guidance f
r patterns.
A stepwise approach is presented to identify the key features in fibrotic lung disease and to make it easier to reach a
them. We would like to thank Nestor L. Müller for his comments on the
manuscript draft.
Lung anatomy:
Lung anatomy showing secondary lobules and the axial and peripheral interstitium. The anatomy of reticular lung di
that comprises both a peripheral and axial component (fig). The peripheral interstitium supports the distal secondar
ereas the axial interstitium supports the bronchovascular structures from the hilum towards the periphery. The inte
nces the interstitium itself is below the resolution of CT.
Thickening of the interstitium is the underlying mechanism of a reticular pattern. The Fleischner glossary of terms [1
near opacities that, by summation, produces an appearance resembling a net".
Stepwise Approach:
The
first step is to determine whether reticulation really represents fibrosis. The
next step is to determine if it is definite, probable or indeterminate UIP
pattern, or an alternative pattern. If
it is definite or probable UIP, one needs to realize that not all UIP equals
idiopathic lung fibrosis, as UIP with/without honeycombing can also be seen in
fibrotic sarcoid, hypersensitivity pneumonitis, and end stage connective
tissue disease related-ILD (CTD-ILD).
Step 1 - Is it really fibrosis?:
Click to enlarge Fibrosis causes traction on surrounding structures and will lead to: Hence, these are the first feature
nts lung fibrosis or not. The images show fibrotic lung disease with distortion of the secondary lobule, volume loss a
). Pulmonary edema (A), Lymphangitic carcinomatosa (B), EGPA (C). Not
all reticulation is fibrosis, as the pulmonary interstitium can be thickened by
other pathology. Most
commonly this is: The
images show examples of non-fibrotic reticulation due to interstitial
thickening in pulmonary edema (A), lymphangitic carcinomatosis (B), and
eosinophilic infiltration in eosinophilic granulomatis with polyangitis [EGPA,
former Churg-Strauss syndrome] (C).
ILA -interstitial lung abnormalities:
Incidental mild interstitial changes – in patients clinically not suspected of ILD – have been named 'interstitial lung ab
ay represent an early stage of fibrotic interstitial lung disease, but may also just represent some post-infectious scar
cut-off of 5% lung involvement has been suggested as a discriminator for significant disease [2], however, accurate v
r not it is a relevant incidental finding, which is optional and depending on patient characteristics.
Step 2 – UIP pattern:
A
UIP pattern is based on the disease gradient, distribution of the fibrosis and
absence of another dominant HRCT pattern. Another
HRCT pattern like ground-glass, lung cysts, centrilobular or perilymphatic
nodules and consolidation should be absent, since these are associated with
other underlying disease and point away from a UIP/IPF diagnosis. First the fibrosis has to show a gradient towards t
extensively involved than the mid and upper lung zones. The fibrosis may be somewhat more anterior in the mid/up
twist that is present in a propeller blade. The images show a basal and subpleural dominant pattern in A versus an a

inant (A), subpleural sparing (B), and peribronchial dominant (C) patterns of fibrosis. Second, the fibrosis has to be su
eripheral interstitium and involves the lung directly beneath the pleura.
It should not spare the subpleural lung tissue, nor should it centre around the bronchovascular bundle (ie. predomin
UIP classification:
There are specific imaging guidelines for UIP/IPF evaluation - issued by both a collaboration of worldwide Thoracic So
[3,4].
The bottom line of both guidelines is that HRCT imaging should reach a conclusion of either: In a patient with basal a
features, the presence or absence of honeycombing determines whether to assign a definite or probable UIP patter
However, honeycombing assessment may suffer from substantial interobserver variability, even among experts [5].
Honeycombing on CT imaging is defined as “subpleural oriented clustered cystic air spaces, typically on the order of
Note is made that it is different from the honeycombing seen on histopathology, which is defined as “destroyed and
ck fibrous walls, with complete loss of acinar architecture” [1].
Although both represent established and severe fibrosis, they are seen at significantly different levels of magnificatio
combing combined with basal and subpleural dominant fibrosis indicating a definite UIP pattern. In B there is a prob
eycombing formation. There is a spectrum ranging from normal lung tissue (A), through distortion of the secondary
ion (C). Honeycombing
is the result of progressive fibrosis with architectural distortion and is at
the end of the scale from normal lung tissue, through distortion of the
secondary lobule with traction bronchiolectasis, to end stage cyst
formation. Although
the presence of honeycombing defines the difference between a probable and
definite UIP pattern, honeycombing is not pathognomonic for idiopathic pulmonary
fibrosis (IPF) as it is just a feature of severe fibrosis. Honeycombing
may also be present in the fibrotic (end-)stages of sarcoidosis, NSIP and
hypersensitivity pneumonitis. In short, a UIP pattern does not equal IPF. But,
in the correct clinical setting ina patient clinically suspected of idiopathic
pulmonary fibrosis (IPF) a UIP pattern will seal the case (ie. diagnosis of
UIP/IPF), eliminating the need for further invasive diagnostics like cryo- or
surgical lung biopsy.
Step 3 - Alternative Patterns:

- Axial and non-basal distribution:
Axial and non-basal distribution When
the interstitial disease is not mainly subpleural but rather predominantly
peribronchial, the two main considerations are fibrotic chronic hypersensitivity
pneumonitis (HP) and sarcoidosis. Apical
dominance is often seen in sarcoidosis, but only in a minority of cases of
chronic HP. Typical fibrotic hypersensitivity pneumonitis showing diffuse non-basal dominant (A), peribronchial orien
nd B), and expiratory air trapping (C).
Hypersensitivity pneumonitis:
Typical
fibrotic chronic HP is characterized by peribronchial fibrosis with various
degrees of ground-glass and marked mosaic attenuation due to sparing of
secondary lobules. Expiratory
air trapping due to small airways obstruction is a hallmark finding. Centrilobular
ground-glass nodules may be present, but are more often and dominantly seen in
the subacute (non-fibrotic) stages of the disease. The
fibrosis may show a random or diffuse distribution, or a mid- or upper lung
predominance with relative sparing of the bases. Fibrotic sarcoidosis with peribronchovascular and apical dominant
Sarcoidosis:
Sarcoidosis
is the great mimicker. The
fibrosis in sarcoidosis typically shows peribronchovascular and mid to upper
lung zone predominance with architectural distortion and central traction bronchiectasis,
a varying amount of reticulation and, occasionally, even honeycombing. While
sarcoidosis initially typically manifests with bilateral hilar and mediastinal
lymphadenopathy, in the late fibrotic stage of the disease the nodes are usually
normal in size and calcified. The
images show typical fibrotic sarcoidosis with peribronchovascular and apical
dominant disease, showing (confluent) nodularity, reticulation and mild ground-glass, as well as extensive traction br

- Ground-glass pattern and Consolidation:
Ground-glass Although some ground-glass may be seen in areas of reticulation – a finding that does not exclude the
t suggests an alternative diagnosis. Ground-glass may point to a wide range of diseases, including connective tissue
as smoking-related and drug-related ILD.
Ground-glass is often a feature of non-specific interstitial pneumonia (NSIP) pattern. Pure ground-glass without fibro
from fibrotic NSIP pattern in which there is reticulation, traction bronchiectasis, and architectural distortion due to f
d-glass, reticulation and traction bronchiolectasis. Subpleural sparing of the dorsal regions of the lower lobes is pres
feature in making the diagnosis. Consolidations Consolidations are not part of a probable UIP pattern. Small focal ar
onsolidation in HRCT imaging is often due to organizing pneumonia component and suggests a diagnosis other than
Active pulmonary infection or malignancy should always be considered.
Connective tissue disease related ILD:
The table shows the imaging patterns in connective tissue disease related interstitial lung disease (CTD-ILD), where f
esult in many different patterns.
Within the overall heterogeneous group, disease manifestation with NSIP pattern as well as other components such
sts due to LIP (lymphoid interstitial pneumonia) may hint toward a specific diagnosis (see Table). NSIP in Sjögren's dis
NSIP:
Classic
fibrotic NSIP pattern in Sjögren's disease with
fibrotic changes and dominant ground-glass in a basal dominant pattern that
extends somewhat more centrally. Subpleural
sparing is not a dominant feature in this case. ibrotic NSIP in anti-synthetase syndrome The images show a combinat
bined with limited perilobular arcade-like consolidations due to co-existing organizing pneumonia (OP). The final diag
etase syndrome is an immune-mediated multisystem disorder that can include (among others) interstitial lung disea
enon. UIP pattern in Rheumatoid Arthritis
Rheumatoid Arthritis:
Severe fibrotic changes in a subpleural and basal dominant orientation, with extensive honeycombing, consistent wi
itis can show multicompartment involvement and result in airways disease, pleural disease and interstitial lung disea
Smoking-related ILD:
Smoking-related interstitial lung disease is a difficult subgroup which typically shows profound emphysema with mil
abnormalities, less severe basal volume loss and more ground-glass when compared to (probable) UIP pattern. How
interstitial lung disease as a substantial number of ILD patients are (former) smokers. Smokers rarely suffer from ch
Smoking-related interstitial fibrosis (SRIF) and combined pulmonary fibrosis and emphysema (CPFE) are regularly us
Drug-induced ILD:
Drug-induced interstitial lung disease is a difficult subgroup with often non-specific imaging features.
It should always be considered in every differential diagnosis, especially in cases showing a non-UIP pattern.
Classically, drug-induced ILD is associated with dominant ground-glass and/or organizing pneumonia consolidation p
ofurantoin are well-known examples of pneumotoxic drugs, although a near endless list has been recognized.
Compared to the past decades, the increasing use of immunotherapy will likely lead us to encountering drug-induce
See www.pneumotox.com for more information on pneumotoxic drugs and their reported associated imaging patte
Radiologically non-classifiable disease:
Not uncommonly HRCT findings do not conform to one of the well known radiological patterns.
This may be due to limited and nonspecific interstitial changes, or due to a combination of features that are truly ind
For example, there may be subpleural dominant reticulation and traction bronchiectasis, but without a clear gradien
dings to suggest a specific diagnosis. It is often felt to be an act of weakness to not conclude on an imaging pattern, h
disease" is also a valid conclusion of the HRCT report.
In fact, it is much better than "possibly UIP, differential NSIP or HP".
Multidisciplinary approach:
Diagnosing a classic disease based on typical imaging findings is not that common.
Instead, it is more common to have a differential diagnosis as imaging features may be nonspecific.
In a multidisciplinary team imaging findings can be correlated to clinical information, pulmonary function test, lab re
h a consensus diagnosis and treatment plan.
Clinical information:
During
the evaluation of an ILD patient clinical information is gathered (table) Despite
that for example over 200 agents have been associated with chronic
hypersensitivity pneumonitis, yield of occupational and environmental exposure
analysis is unfortunately often limited.
Pulmonary Function Tests:
A basic understanding of pulmonary function test mechanics is helpful.
There are three major components in lung function testing: Index parameters in static lung volume assessment are:

eg. lung fibrosis, neuromuscular disease) and increased in obstructive lung disease (eg. COPD, asthma). DLCO measu
te marker for the ability of oxygen to be delivered to the blood.
DLCO is directly proportional to the alveolar-capillary membrane surface area and inversely proportional to alveolar-
Typically, DLCO is decreased in diseases that either lower the membrane surface area (eg. emphysema, thromboem
(eg. lung fibrosis). The classic PFT pattern in lung fibrosis is restrictive, showing relatively normal spirometry with de
However, a mixed pattern can be seen if patients who have both restrictive and obstructive disease components.
For example, advanced stages of chronic hypersensitivity pneumonitis or sarcoidosis may show both small airway di
Also, summative contributions of emphysema and fibrosis in 'combined pulmonary fibrosis and emphysema' (CPFE)
e clinical symptoms and DLCO are usually profoundly abnormal.
Laboratory analysis:
The search for inflammatory markers and auto-antibodies are part of standard ILD evaluation.
It is important to realize that the presence of an auto-antibody does not equal a diagnosis of an autoimmune disease
Rather, a positive serology helps to support a diagnosis if accompanied by appropriate clinical signs and symptoms.
Bronchoalveolar lavage (BAL):
Immunologic BAL is a diagnostic procedure to retrieve respiratory secretions.
There is limited value of BAL results in UIP/IPF diagnosis, other than exclusion of other underlying aetiologies.
Pathology:
If there is still no diagnosis after clinical evaluation, CT imaging and additional diagnostic tests, the MDT may decide t
This is however highly dependent on the patient's wishes, co-morbidities and the available treatment options, as the
ality. Most often a video-assisted thoracoscopic (VATS) surgical lung biopsy is performed, in which typically three sam
A more recent option is an endoscopic cryobiopsy, however, yield is often suboptimal compared to surgical biopsies
mbination with the histopathology (table).
Treatment and follow-up:
ILD patients are most often followed with PFT and HRCT imaging to assess for disease progression.
Depending on the final diagnosis, medical therapy may be available.
A dichotomous split of therapeutic options is anti-fibrotic medication (in primarily fibrotic lung disease such as IPF) v
ng disease such as chronic HP or CTD-related ILD). Medication may be combined with termination of exposure to an
on, etc. A lung transplantation may be the ultimate endeavour, if available.
Esophagus II: Strictures, Acute syndromes, Neoplasms and Vascular impressions.:
Terrence C. Demos, MD, Harold V. Posniak, MD, Wayde Nagamine, MD and Mary Olson, MD
Department of Radiology of the Loyola University Medical Center, USA:
Publicationdate 2007-12-07 In Esophagus II we will discuss: Vascular impressions. Strictures
Strictures:
The table shows common and uncommon causes of esophageal strictures. To the far left is an image of a stricture (a
t view. This patient had Barrett's esophagus. Mid esophageal strictures and ulcers are suspicious for Barrett's esopha
h an irregular stricture due to adenocarcinoma. Here an image of a long, symmetric tapered benign stricture months
icture high in the esophagus (arrow). There is bilateral lower lobe lung consolidation due to repeated aspiration. App
US every year. About 50%-80% occur in the pediatric population. On the left a high stricture (arrow) following caustic
d hypopharynx. However they rarely cause symptoms. Multiple structures are uncommon. The table shows diseases
Here is an image of a patient with benign pemphigoid. Mucosal bullae have led to multiple strictures (arrows). Epide
lysis bullosa. Multiple strictures (arrows) are a residual of mucosal bullous disease. Extensive bullous skin disease ha
Corrosive ingestion can result in multiple strictures.
Acute esophageal syndromes:
In the table on the left are etiologies of an acute esophageal syndrome.
Boerhaave syndrome:
Boerhaave syndrome is rupture of the esophageal wall. It is most often caused by excessive vomiting in eating disor
ceful coughing or other situations, such as obstruction by food. Boerhaave syndrome is a transmural or full-thickness
ome, a nontransmural esophageal tear also associated with vomiting. These syndromes are distinct from iatrogenic
e, typically as a complication of an endoscopic procedure, feeding tube, or unrelated surgery. This image is of a patie
stinum (arrows). Esophagram with extravasated water soluble contrast material in left hemithorax (asterisk) Perforat
raphs show mediastinal gas, effusion, and later pneumothorax. Esophagram is used to confirm leak, first with water-
e's syndrome On the left a patient with Boerhaave syndrome. The barium study shows extraluminal gas (arrow) with
of distal left esophagus confirmed at surgery. CT can show small amounts of extraluminal gas or extravasation not v
Mallory-Weiss tear:
A Mallory-Weiss tear results from prolonged and forceful vomiting, coughing or convulsions. Typically the mucous m
acerations which bleed, evident by bright red blood in vomitus, or bloody stools. It may occur as a result of excessive
esolves within 10 days without special treatment. Mallory-Weiss tear On the left a patient with a Mallory-Weiss tear.
troesophageal junction. Tears may be in distal esophagus, gastric fundus, or extend across the GE junction.
Esophageal hematoma:
These unusual lesions have been associated with increased esophageal

intraluminal pressure, most often vomiting, instrumentation, and anticoagulation
or bleeding disorders. Some are spontaneous. Blunt trauma is a rare cause. Hematomas are self-limited and almost
1-2 weeks with conservative treatment. On the left a patient with an esophagus hematoma. He presented with chest
adiograph is normal. The barium study shows a narrowed lumen (arrows) on AP view and flattened lumen on lateral
nosis of an intramural hematoma was confirmed. A high density mural hematoma (arrowhead) is seen next to NG tu
um study was normal. On the left a patient who had a complicated endoscopy. Instrumentation caused a mucosal te
eparating stripe of mucosa (arrows). On the far left an intramural extravasation (arrow) after distal dilation for achala
complicated endoscopy. On the right a perforation after biopsy with extravasation of contrast material (arrow).
Benign neoplasms:
Here a list of benign esophageal masses. Esophageal leiomyoma
Leiomyomas:
Leiomyomas are the most common benign esophageal neoplasm and are often large yet nonobstructive. Gastrointe
ft an asymptomatic patient with a leiomyoma. On the chest film an abnormal opacity is seen behind the heart (arrow
not obstruct despite its large size. Esophageal leiomyoma Mucosal lesions are indicated by mucosal irregularities. Su
in profile, the margins often form close to a right angle with the esophageal wall. Extrinsic lesions tend to form longe
ir epicenter may be outside the esophagus. In practice, the location of a lesion may be difficult to determine. On radi
On esophagram, the inferior margin of this intramural lesion forms close to a right angle (arrow) with esophageal wa
almost always a leiomyoma. On the left a patient with a calcified esophageal lesion (arrows) protrudes into azygoeso
specimen radiograph showing calcification. On the left a patient with granular cell myoblastomas, an uncommon ben
but the proximal lesion does demonstrate overhanging and right angle margins indicating mural location. Peduncul
Fibrovascular polyp:
Pedunculated fibrovascular polyps are rare lesions, that are difficult to diagnose on esophagrams. Their movement c
may be suggestive as in this patient. The stalk is often difficult to identify.
Duplication:
On the left a patient with an esophageal duplication. The findings on the barium study are non-specific. Lesion (arrow
ing (arrows) is caused by duplication. A foregut duplication cyst is a congenital cyst. In the case on the left it displaces
and trachea and larynx (asterisk) anteriorly.
Malignant neoplasms:
Here a list of malignant esophageal masses. Early and small esophageal carcinoma are not synonymous. Early esoph
e metastases. Most are small (Small esophageal carcinoma is defined by the size of the lesion, a diameter So an earl
or metastatic and thus not an early carcinoma. This image is of a patient with an early esophageal carcinoma. Lesion
agram shows surface irregularity (arrows) indicating a mucosal lesion. This was both a small lesion and a pathologica
GHT: Large polypoid lesion. Advanced carcinoma has many gross appearances: On the left two cases of polypoid car
t angle junction with esophageal wall (arrowheads) This image is of a patient with an infiltrative ulcerated carcinoma
nd overhanging edge. This indicates mural involvement and is different than obtuse angles usually produced by extr
ma These images are of a patient with a varicoid carcinoma. Unchanging appearance of filling defects indicate tumor
tion (arrows) LEFT: Varicoid carcinoma. RIGHT: Superficial spreading carcinoma. To the far left an image of a patient w
t did not vary during fluoroscopy. Note large irregular folds and soft tissue mass (arrow) of gastric fundus Next to it a
Extensive superficial spread involves distal esophagus. This appearance can be seen with both early and advanced l
T: Distal narrowing is not tapered and more proximal than achalasia. Irregularity (arrow) at narrowed site is subtle bu
tricture. An irregular, asymmetric stricture is highly suggestive of carcinoma. Smoothly tapered, symmetric strictures
res can have similar characteristics and mimic benign lesions. Next to it a patient with a carcinoma with stricture reso
semble achalasia. If esophageal motility is normal, achalasia can be excluded. If abnormal, however, subtle imaging f
al abnormality, or fixed abnormality suggest diagnosis. On the left another case of pseudoachalasia. Distal narrowing
asymmetric (arrows), and the mucosa is irregular at the tip of narrowing. CT shows gastric fundus thickening (arrows
xtaposed posterior tracheal and anterior esophageal walls > 5 mm on a lateral chest radiograph is suspicious for pat
a patient with a widened 1 cm stripe (arrows). Esophagram shows widened stripe (arrows) and irregular margins of
achea. The tumor invades mediastinum adjacent to aortic arch (arrow) Barrett's esophagus with ulcerated (arrow) ad
Barrett's esophagus and Adenocarcinoma:
Barrett's esophagus is a proven risk factor for the development of an adenocarcinoma. The incidence of cancer in Ba
hould be screened is unresolved. Adenocarcinoma was 10% of esophageal malignancies in 1960s. Since 1960s, incid
approaching or exceeding squamous carcinoma in Caucasian men in the USA and Europe. On the left a patient with
gus. Primary gastric fundus adenocarcinoma can invade the esophagus, but means of differentiating invasion from a
ient with a gastric fundus adenocarcinoma. The barium study demonstrates marked irregular thickening of distal eso
rregular lesser curvature wall (arrows) near gastroesophageal junction. Spindle cell carcinoma Spindle cell carcinoma
n bulky but nonobstructive as in the case on the left. Leiomyosarcomas and rare primary melanomas of the esophag
iomyosarcoma of the esophagus On the left a patient with a leiomyosarcoma of the esophagus. Margin (arrows) of b
hows marked irregularity and esophageal narrowing (arrows). Leiomyosarcoma of the esophagus On the left anothe
esophageal lumen. CT shows lesion distorting but not obstructing esophageal lumen (arrow). Esophageal obstructio
ts with esophageal narrowing as a result of metastatic mediastinal lymphnodes. On the far left a bronchogenic carci

at the interface with esophagus. In the middle another bronchogenic carcinoma. Irregular distal esophageal wall du
arcinoma. There is mediastinal lymphadenopathy with esophageal invasion and obstruction. LEFT: normal esophagu
confuse normal esophageal irregularities for impressions by lymphnodes. On the left a normal esophagus. The esop
w. Next to it mediastinal nodes (arrows) that displace the esophagus to right in a patient with bronchogenic carcinon
Vascular impressions:
On the left a list of vascular structures that may cause impressions on the esophagus. Uphill varices in a patient with
Uphill varices:
With portal hypertension, elevated portal venous pressure leads to reversed (hepatofugal) flow bypassing the liver th
geal veins that anastamose with the azygos and hemiazygos veins which drain uphill into the superior vena cava. Fill
nce during the examination related to breath holding and thoracic pressure. On the left are CT images of a patient w
tension. Large mediastinal and esophageal (arrows) varices On the left CT images of a patient with uphill varices. LEF
owing varices (arrows) Uphill varices can be mass-like as seen in the case on the left. Continue with next image. Med
) The CT shows mass-like mediastinal and esophageal varices (arrows). Varicoid carcinoma Varices have to be differe
of filling defects indicates tumor rather than varices. Note sharp upper margin of lesion (arrows) Downhill varices in
es With superior vena caval obstruction, upper body venous blood flows caudally downhill through esophageal veins
to the obstruction. If the obstruction is at or below the azygos, the blood flow extends further caudally to the portal
and the right atrium. On the left downhill varices in a patient with a superior vena cava obstruction due to histoplasr
represent downhill varices in upper esophagus. The angiogram demonstrates collateral vessels including a dilated le
t with a superior vena cava obstruction The barium study demonstrates inconstant filling defects (blue arrows) due t
(red arrow) and mediastinal varices. Continue with venogram. Upper arm venograms show SVC obstruction. Aberra
Aberrant right subclavian artery:
This is the most common thoracic arterial anomaly and rarely causes symptoms. The artery extends up and to the ri
. The CT demonstrates that the aberrant artery (arrow) is last vessel from arch and extends dorsal to trachea and es
Right aortic arch with aberrant left subclavian artery:
A right aortic arch with an aberrant left subclavian artery is most often an incidental finding. A right aortic arch with
with congenital heart disease. CT shows right arch (R) and aberrant left subclavian artery (arrow) arising low off arch
left the esophagram of a patient with a right arch that produces a dorsal indentation on this lateral view (blue arrow
A) dorsal to the trachea and esophagus. Double ArchLEFT: Right and left arch indent esophagus (arrows) at different
old
Double Arch:
Double arch most often presents with airway obstruction, dysphagia, aspiration in children. The arches indent esoph
rch. Chest radiograph with right lung consolidation due to aspiration in 6-year-old. Right and left arch indent esopha
: aberrant artery extends between trachea and esophagus indenting both (arrows)
Aberrant left pulmonary artery:
The aberrant left pulmonary artery indents the trachea dorsally and esophagus ventrally as it extends between them
. Tortuous aorta A tortous descending aorta is a common cause of extrinsic impression on the esophagus. The imag
ws esophageal indentation by aorta with obtuse margins (arrows) characteristic of extrinsic compression. Normal ar
On the far left the normal aortic arch impression on the esophagus. This impression can be enlarged if there is dilat
c arch aneurysm (arrows). Coarctation: 'Reverse figure 3' indention of esophagus
Coarctation:
On the left 3 images of a patient with a coarctation. On the chest film the 'Figure 3' shape of aortic knob due pre and
tes the 'Reverse 3 figure' indention of esophagus by pre and post stenotic aortic dilatation (arrows). An angiogram de
in another patient. by Gore RM, Levine MS.
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Prostate Cancer - PI-RADS v2.1:
Georgios Agrotis, Rhiannon van Loenhout, Frank Zijta, Robin Smithuis and Ivo Schoots
Radiology Department of University Hospital of Larissa in Greece and the Haaglanden MC, Alrijne Hospital and Erasm
Publicationdate 2018-08-01. Update 2023-07-01 The introduction of the PI-RADS classification for prostate MRI in 20
orting of prostate MRI.
The PI-RADS Steering Committee has recommended several modifications to the PI-RADS version 2.0.
Because the overall framework of the system is maintained, the updated version is termed PI-RADS version 2.1 rathe
in the new version include: Modifications to the version 2.0 will be highlighted. For the prostate anatomy click here.
Introduction:
The PI-RADS assessment categories are based on the findings of multiparametric MRI, which is a combination of T2-w
t-enhanced (DCE) imaging.
It is an accurate tool in the detection of clinically significant prostate cancer. In PI-RADS v2.1 clinically significant canc
The Gleason score is used by pathologists to grade prostate cancers.
If the cancer cells and their growth patterns look very abnormal, a grade 5 is assigned. The Gleason score is the sum

These 2 grades are added to yield the Gleason score. The highest Gleason score therefore is 10.
For example, if the Gleason score is written as 3+4=7, it means that most of the tumor is grade 3 and the second mo
PI-RADS version 2.1:
This is the PI-RADS version 2.1.
Changes from the old version 2.0 are indicated in light red. Assignment of a PI-RADS assessment category for each le
according to zonal anatomy.
Since the dominant sequence for PI-RADS assessment in the peripheral zone is different from the transition zone, id
l zone (PZ)The peripheral zone is situated on
the posterior and lateral side of the prostate, surrounding the transition
zone.
For the peripheral zone the DWI/ADC
is the primary determining sequence (dominant technique) to assign the PI-RADS
assessment category.
A lesion assessed as suspicion category
3 based on ADC/DWI, remains a PI-RADS score 3 if there is no focal enhancement (negative),
however, it becomes a PI-RADS score 4 if there is focal enhancement (positive). Changes in PI-RADS version 2.1: Tran
prostatic urethra and enlarges in aging men as a result of benign prostatic
hyperplasia.
For the transition zone the T2W
imaging is the primary determining sequence (dominant technique) to assign the
PI-RADS assessment category.
A lesion assessed as category 2 based
on T2W images remains PI-RADS score 2 if the DWI/ADC is ≤ 3, however it becomes PI-RADS score 3 if the DWI is ≥ 4.
A lesion assessed as category 3 based
on T2W images remains PI-RADS score 3 if the DWI is ≤ 4, however, it becomes a PI-RADS score 4 if the DWI/ADC is s
A lesion assessed as suspicion category 3 based on DWI/ADC, remains a PI-RADS score 3 if there is no focal enhance
focal enhancement (positive). Transition zone (TZ)
A lesion assessed as category 2 based on T2W images remains PI-RADS score 2 if the DWI/ADC is ≤ 3, however it bec
A lesion assessed as category 3 based on T2w images remains PI-RADS score 3 if the DWI is ≤ 4, however, it becomes
Peripheral zone:

PI-RADS:
Transitional zone - T2W category 1 Transitional zone - T2W category 2 Transitional zone - T2W category 3 Transitiona
Examples of PI-RADS 1-5:
In the transition zone, the PI-RADS
assessment category of a lesion is determined primarily on T2W-images and then
correlated to DWI/ADC. Examples of PI-RADS categories 1-2 are given in the table.
Click to enlarge the image. In the transition zone an equivocal or indeterminate lesion (category 3) is assigned to PI-R
intense greater than 1.5cm). The lesion remains assigned to PI-RADS category 3 if the DWI corresponds to DWI score
s of PI-RADS categories 3-5 are given in the table.
Click to enlarge the image.
Prostate cancer in PZ:
For the peripheral zone the DWI/ADC
is the primary determining sequence to assign the PI-RADS assessment category. First look at the images and descri
what you see. A 16 mm lesion (measurement not
shown) was detected and located dorsally in the peripheral zone of the
mid-portion of the prostate on the right. This lesion was assigned to PI-RADS
category 5, based on marked hypointensity on ADC and marked hyperintensity on
DWI (score 5 - dominant sequence), correlated to markedly hypointensity on T2W
(score 5). The Gleason score was 3+4, which
means intermediate risk of an aggressive cancer. The lesion does not abut the
pseudocapsule and there is no sign of extraprostatic growth. Suspicious lesions in the peripheral zone typically have
T2W-images: Less suspicious features are the following characteristics on T2W-images: First look at the images and t
continue reading. The findings are: This lesion was assigned to PI-RADS
category 5 with suspicion of extraprostatic extension. The Gleason score was 4+3.
This suspected lesion has significant
diffusion restriction .
The ADC measured 440 mm2/s.
Low ADC values indicate a higher risk
of malignancy. The actual ADC value is inversely

correlated to the likelihood of a clinically significant malignancy.
Values above 900 mm2/s are considered
likely benign and below 750 mm2/s likely malignant.
However quantification results may
vary substantially between scanners and protocols. First look at the images and then continue reading. The findings
eft
peripheral zone in the mid-portion of the prostate.
Focal marked hypointensity on ADC
(yellow arrow) (score 4), corresponding an hypointense area on T2W (score 4).
The Gleason score of this lesion was
3+4. A lesion with PI-RADS assessment category 3 is located in the right
peripheral zone, with mild focal hypointensity on ADC (green arrow) with
isointensity on DWI (score 3). No DCE was performed and no further
discrimination could be determined.
Biopsy did not show any sign of
malignancy.
Transition Zone:

Prostate cancer in TZ:
Suspicious lesions typically have the following characteristics: Images
There is a lesion in the right anterior part of the transition zone.
It has irregular margins on T2W images (score 4) and is focal markedly hypointense on ADC (680 mm/s) (score 4), not
This lesion corresponds to a PI-RADS category 4.
MR-Ultrasound fusion-guided biopsy resulted in a Gleason 3+4. In the right peripheral zone there is a wedge-shaped
tics on DWI/ADC (score 2).
It was assigned as PIRADS category 2.This region is benign and has
most likely glandular atrophy or focal inflammatory findings on histopathology. High-grade tumors often reveal a
lower T2W signal intensity than low-grade tumors. Extension into the anterior
fibromuscular stroma or the urethral sphincter can be seen. In general, suspicious lesions in the
transition zone are frequently challenging to distinguish from the surrounding
hyperintense glandular and hypointense stromal tissue. ImagesThere is a lesion located anteriorly in the midline, mo
the base and the mid-portion of the prostate.
There is no extraprostatic extension.
The lesion has irregular margins on T2W images with an
"erased charcoal" appearance, exceeding 15 mm in maximum length (score
5) and is markedly hypointense on ADC (score 5).
Category: PI-RADS 5.
MR/Ultrasound fusion-guided biopsy resulted in a Gleason
3+4. Images
27mm lesion anterior in the apex of
the transition zone, with an "erased charcoal" appearance.
This corresponds to an area of
restricted diffusion with a droplet-shape. The lesion was scored a PIRADS category
5.
MR/Ultrasound fusion-guided biopsy
resulted in a Gleason 3+4.
Anterior Fibromuscular Stroma:
The normal AFMS shows bilaterally
symmetric shape (“crescentic”)
and symmetric low signal intensity similar to that of the obturator or pelvic
floor muscles on T2W, ADC, and high b-value DWI without early enhancement. Since prostate cancer does not origin
AFMS, when reporting a suspicious lesion in the AFMS, criteria for either the
PZ or TZ should be applied, depending on the zone from which the lesion appears
most likely to be originating. This is an example of an adenocarcinoma involving the AFMS. ImagesT2W: The left ante
hypointense lesion.
A focal markedly hyperintense region on DWI corresponds to
hypointense focal markedly area on ADC.
DCE: The region of interest shows early
enhancement. PI-RADS score: 4.
Histopathology: Gleason score 4+4 following

MRI fusion-guided targeted biopsy.
TNM-stage:
TNM-staging is based on clinical (c) and pathological (p) findings, and if indicated on additional imaging findings. For
creased utilization of prostate MRI in the primary diagnostic work-up. The table only shows the stages that are releva
ted adenocarcinoma of the prostate
Locally advanced prostate cancer:
The prostate does not have a true capsule. However on MRI the outer border of the prostate does have a thin, hypoi
ar band. This hypointense line can be used to assess extraprostatic tumor growth. The neurovascular bundles are lo
o'clock position, see example on the left). Involvement of the neurovascular bundle should be specifically reported, a
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images of locally advanced prostate cancer. There is a large lobulated tumor origina
he rectum as well as the left pelvic wall (i.e. T4). There are large para-iliac and mesorectal lymphnodes distributed ma
prostate needle biopsies proved localization of adenocarcinoma of the prostate. Gleason score 9 (5 +4), volume perc
apex are susceptible locations for extraprostatic extension.
Seminal vesicle invasion can be observed by direct tumor extension into the vesicles.
Expansion of the vesicles, focal or diffuse low T2W signal intensity, abnormal contrast enhancement or restricted dif
In addition, involvement is likely present when the angle between the prostate base and the vesicle is obliterated.
When the external urethra is involved at the apex, surgical excision can cause sphincter malfunction, resulting in inc
te base demonstrates low signal intensity replacing the normal signal intensity of the left peripheral zone, with direc
nal vesicles (arrow).
Restricted diffusion appears as an area of low signal intensity on the ADC map.
Gleason score: 4+3.
N-stage:
DWI is the best sequence for detection of lymph nodes. T1W series are useful for interpretation of the border contou
y for distinguishing positive or negative lymph nodes if characterization is based on size alone. The following charact
n) are below the level of the common iliac junction and are staged N1: Distant lymph nodes (red) are outside these r
Benign findings:

Benign prostate hyperplasia:
Benign prostate hyperplasia (BPH) results in the formation of well-circumscribed, encapsulated nodules in the transi
Some of these nodules have dense stroma with low T2W signal intensity and low ADC (yellow arrow). The most impo
y is the generally well-defined and well-circumscribed morphology interpreted in axial, coronal and sagittal series. Th
arrow).
MRI- targeted biopsy revealed a Gleason 3+4. T2 hypointense BPH nodules can be less distinctly circumscribed withi
ion. Also, these nodules tend to enhance early and intensely on DCE, making conclusive characterization difficult. He
s stroma with a large cystic area (arrow). Biopsies showed chronic benign prostatitis. Not all nodules exist in the tran
Some can be ectopic and may be found in the peripheral zone (arrow).
This entity shouldn’t be confused with prostate cancer. BPH consists of a mixture of stromal and glandular hyperplas
dules with circumscribed or encapsulated margins. ImageThis coronal T2W
image shows various types of BPH nodules. Predominantly glandular BPH nodules and cystic atrophy exhibit modera
s by their signal and capsule. ImageAxial T2W image shows
a glandular BPH nodule with hyperintensity on T2W image surrounded by a
capsule.
Prostatitis:
Prostatitis or rather inflammation is
a common finding in men and can occur in the absense of any clinical history or
symptoms.
Prostatitis and other benign features
like glandular fibrosis, scarring, atrophy and post-biopsy hemorrhage can mimic
prostate cancer in the peripheral zone, since all present as a focus of low
signal on ADC.
However benign features mostly
presents as a band-like or wedge-shaped or diffuse area of low signal
intensity, while prostate cancer is more round or droplet-shaped. The hypointensity on ADC in inflammatory
prostatic tissue is usually not accompanied by hyperintensity on high b-value
DWI series. Also ADC values in prostate cancer
tend to be lower than ADC levels in prostatitis.
On DCE there is increased
enhancement, which is therefore not helpful in the differentiation.
In case of chronic inflammation,

concordant fibrosis and focal atrophy may be observed, which presents as focal
retraction in the normal anatomic convexity of the peripheral zone. Differences between prostatitis (images on the l
ifferences between prostatitis (images on the left) and prostate cancer (images on the right). Left The images on the
ADC with no concordant high signal on DWI located dorsally in the right peripheral zone of the midportion of the pr
(PI-RADS category 2). No biopsy performed. Right The images on the right show a clinically significant prostate cance
ADC and focal high signal intensity on DWI dorsally in the left peripheral zone (PI-RADS category 4). MRI-targeted bio
wedge-shaped, sharply demarcated hypointense lesions in the peripheral zone with minimal low ADC signal. These
. Biopsies showed focally some inflammation with glandular hyperplasia. The T2W-images show a diffusely
hypointense peripheral zone. The ADC does not show any foci of
significant low signal intensity. The DWI is hyperintense on both
sides. The ADC value was 830 mm2/s. This was interpreted as benign
characteristics (PI-RADS category 2) and diagnosed as chronic inflammation. Biopsies showed focal chronic active pr
th a raised PSA of 9ng/ml, a PSA density 0.10.
A PI-RADS score of 5 was
given to a hypointense area in the right peripheral zone at the midgland, with
diffusion restriction (black arrow). The DCE showed vivid and peripheral enhancement of the lesion (arrowheads). A
s formations. Peripheral enhancement and diffusion restriction are typical imaging findings of an abscess. Hemorrha
Hemorrhage:
Hemorrhage in the peripheral zone and in the seminal vesicles is common after biopsy.
It appears as focal or diffuse hyperintense signal on T1W and iso- or hypointense signal on T2W.
However, chronic blood products may appear hypointense on all MR sequences. This is a case of a 78-year old patien
with raised PSA that underwent a prostate biopsy the previous year before
undertaking one again. ImagesHypointense lesions are seen on T2W in the anterior TZ zone.
These small lesions have high signal on T1W, indicating blood products. No cancer was found after fusion-guided tar
Hemorrhage findings should always be reported.
Cysts:
A variety of cysts can occur in the prostate and adjacent structures.
As elsewhere in the body, cysts in the prostate may contain “simple” fluid and appear markedly hyperintense on T2W
However, they can also contain blood products or proteinaceous fluid, which may demonstrate a variety of signal ch
image shows a focal region of hyperintensity in the left peripheral zone of the
prostate.
This area corresponds to a hypointense area in DCE images (images
prior to enhancement).
Restricted
diffusion is present.
This corresponds to a proteinaceous cyst.
Prostate volume and PSA density:
Prostate volume determines the feasibility of external radiation therapy, which can be performed up to a volume of
xtern radiation. For proton radiation this limit don't exist. PSA density-values of ≥ 0,20 contribute towards the suspic
case the measurements of the prostate are 36 x 50 x 60mm (AP x LR x CC). This results in a volume of 0,52 x (3,6 x 5,
density is 5 : 56,2 = 0,09. This is a low PSA density and this patient probably has no clinically significant malignancy. E
Maximum AP and longitudinal diameters on a mid-sagittal T2W image and maximum transverse diameter on an axia
MR-protocol:
In PI-RADS v2.1 the recommended sequences and settings are:
Spasmolytic agents:
Spasmolytic agents can be considered prior to examination to reduce movements of the small and large bowel. Air a
es are of a patient who did not receive any preparation prior to the MR-exam. The presence of air and stool in the re
n of the prostate, restricting the diagnostic accuracy of both the DWI and ADC series. Here an example of a patient w
urs prior to the exam. This resulted in an evacuated rectum. Although an enema may induce rectal peristalsis, no art
T1W:
T1W-images determine the presence of post-biopsy hemorrhage.
This patient had systematic TRUS-guided biopsies 3 weeks earlier ImagesHigh signal
intensity on T1W image in the right peripheral zone, with little signal
reduction on T2W images, and no restricted diffusion on DWI / ADC (yellow
arrow).
Furthermore, a suspicious lesion was
identified right anteriorly in the transition zone with low signal intensity on
T2W and ADC and high signal intensity on DWI (black arrow). This lesion showed a Gleason score
4+3 following MRI-targeted biopsy. A large FOV up to the aortic bifurcation helps to assess extraperitoneal and pelvic
n figure).

T2W:
High-resolution T2W FSE sequences are obtained in the axial and sagittal plane. T2W images show anatomical inform
isitions can be used for reconstruction in all three anatomic planes and potential radiotherapeutic purposes. The vid
images with coronal and sagittal reconstructions.
DWI:
Diffusion restriction is present when a lesion with high DWI signal corresponds to low signal on the ADC map, which
The exact ADC value of the lesion is inversely correlated to the likelyhood of a malignant lesion. High b-values are ne
least 1400 is recommended.
Notice the difference between the B1000 and B1400 images. A fusion guided biopsy of the lesion anterior in the pros
score on DCE in PI-RADS v2.1 are in italic. Criteria for a positive score on DCE remain unchanged.
DCE:
The criteria for a negative or positive dynamic contrast enhancement series are shown in the table.
DCE can be of additional value in confirming the suspicious conspicuity of a lesion, but are frequently non-specific as
t also normal enhancement compared to normal prostate tissue.
Lack of enhancement does not exclude malignancy, and increased enhancement can be the result of acute or chron
3D T1W GRE is preferred.
Timing of the examination:
Post-biopsy changes, i.e. hemorrhage and inflammation, are usually located in the peripheral zone or the seminal ve
ultiparametric MRI whereas signal intensities might be altered. As these changes tend to diminish over time, an time
recommended in the PIRADS guideline. In current daily practice there is a tendency to perform multiparametric MRI
PI–RADS 2.1 Lexicon examples:
Markedis defined as “a more pronounced signal change than any other focus in the same zone”. Images
Marked signal change in a patient aged 69 years old showed a raised PSA
of 13.3ng/ml, PSA density 0.16.
A score of PI-RADS 5 was given due to a low
intensity area in the right peripheral zone of the midgland with
characteristics of extraprostatic extension.
There is marked restriction of
diffusion.
The diameter of the lesion is 1.7cm. Biopsy was performed with fusion guided targeted mpMRI – TRUS method.
Histopathology results showed
adenocarcinoma of Gleason 8 (4+4) with extraprostatic extension. Non-circumscribedNon-circumscribedmeans"Ill-d
A non-circumscribed region (ill-defined)
shows restriction of diffusion corresponding to a PI-RADS 3 nodule. Wedge in the peripheral zone is defined as “havi
iscrete and different from the background”. Images
Focal lesion in a patient aged 79 years old.
Due to a raised PSA
of 6.4ng/ml, PSA density 0.05, mpMRI was followed and a score of PI-RADS 4 was
given due to a low intensity area in the right anterior TZ zone in the
midgland.
There is focal restriction of diffusion and the diameter of the
lesion was 1.2cm. Biopsy was performed with the fusion guided targeted mpMRI –
TRUS method that showed an adenocarcinoma of Gleason 9 (4+5) Linear is defined as in a line or band-like shape. In
Linear configuration in the
left peripheral zone, corresponds to a PI-RADS 2 score. Lenticular is defined as having the shape of a double-convex
tinct, uniform, smooth low-signal line (BPH nodule).
Completely encapsulated nodule is entirely surrounded by a smooth low-signal line in at least two imaging planes ar
mpletely or incompletely encapsulated nodule is not entirely surrounded by a smooth low-signal line (“atypical nodu
omogeneous mildly hypointense area (arrowheads) between nodules in
the TZ zone corresponds to a PI-RADS 2 score. Heterogeneous signal intensity with obscured marginsThis means“no
intensity (green arrowheads) suggesting benign features
(T2W - score 2), however with possible obscured margins (T2W) with limited restricted diffusion
(DWI/ADC - score 3), corresponds to a sum PI-RADS 3 score.
Check list and Reporting:
Reporting is done according to the checklist as shown in the table. Before we start the interpretation of the MRI, we
ngs, the index lesion is the lesion with the highest PI-RADS assessment category. ACR American College of Radiology
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Urol. 2019. September;76(3):340–351.
None:

MRI of the Breast:
Publicationdate 2009-05-29 This review is based on a presentation given by Leonard Glassman and adapted for the I
is able to detect cancer not visible on conventional imaging, it can be used as a problem-solving instrument, and it c
better at monitoring the response to chemotherapy than other imaging modalities used today. It can change the tre
ss the interpretation of breast MRI by looking at: Specific breast lesions Introduction
Introduction:
Enhancing lesions are divided into three main categories: focus/foci, masses, and areas of non-mass enhancement (
margins and its internal characteristics: this includes its T1- and T2-characteristics as well its enhancement pattern.
* Non-masslike enhancement
are areas of enhancement without a detectable three-dimensional mass. Features of non-mass enhancement includ
nhancement is symmetric or asymmetric.
Focus and foci:
One of the things we run into are 'little bright objects'. These foci are enhancing areas of less than 5mm in diameter
curves. These lesions are typically stable on follow-up and are considered to be a part of the normal
background enhancement pattern in the breast.
Masses:
Enhancing mass with an irregular shape, which proved to be an angiosarcoma
Morphology:
Shape A mass can be round, oval, lobulated, or irregular. Lobulated masses have undulating contours. Irregular mas
l, or lobulated. If a mass is irregularly shaped, it has a 32% chance of being malignant. The image on the left shows a
e image on the far left is a juvenile fibroadenoma - it is oval in shape and has smooth margins, i.e. typically benign. T
mage on the right is another example of a fibroadenoma: a lobulated mass with non-enhancing septations. Epiderm
as smooth, irregular, or spiculated . Spiculated margins are frequently a feature of malignant breast lesions and radi
scars. If a mass has spiculated margins, it has an 80% chance of being malignant. On the left is an image showing a la
epidermal inclusion cyst. Invasive ductal carcinoma with spiculated margins The image on the far left shows a spicula
orresponding gross pathologic specimen. You can see the spiculations invading the surrounding tissue in both. Just l
nancy and would be labelled BIRADS 5. The image on the far left shows an irregularly shaped mass with irregular ma
ht shows a similarly irregularly shaped and irregularly marginated lesion, this time an adenoid cystic carcinoma. LEF
arcinoma with enhancing septations The image on the left is a classic benign fibroadenoma. It is a lobulated mass wi
irregular here and there, which may be a reason to biopsy this lesion anyway. The image on the right is a classic carc
and enhancing internal septations (the enhancement is not well seen on this image). Fat-containing hamartoma with
T1-T2 characteristics:
High signal on T1 The pre-contrast T1, non fat-suppressed sequence can show the presence of fat in a lesion. Centra
ymph nodes or fat necrosis. Fat is also seen in hamartomas. The image on the left shows an example of a fat-contain
ign unless they are rapidly growing. Rapidly growing lesions should be biopsied. High signal on T2-fatsat In T2 fat-sup
ht on T2 include cysts, lymph nodes and fat necrosis. These are all benign lesions. Unfortunately there is one malign
weighted images. This is the colloid carcinoma. It is the exception to the rule that all things with bright signal on T2 f
there are multiple rounded areas in both breasts. These are multiple cysts. Fibroadenoma (left) and a colloid carcino
hows a round lesion with bright signal on T2. This is a a fibroadenoma. On the right is an example of a colloid carcino
on to the rule that all things with bright signal on T2 fat-suppressed images are benign. Moderate and low signal on T
ons with high signal, not moderate or low signal. Moderate and low signal intensities can be caused by cancer.
Enhancement pattern of a mass:
Mass enhancement occurs in six main patterns: Homogeneous enhancement The image on the left shows a homoge
nvasive lobular carcinoma with heterogenous enhancement Heterogenous enhancement On the left, the image sho
al enhancement pattern, which proved to be an invasive lobular carcinoma. Invasive ductal carcinoma with rim enha
of a lesion invading the surrounding tissue in a case of invasive ductal carcinoma. Type 1 curve with slow rise and a c
Temporal Resolution - Kinetic Analysis (Curves):
First we look at the initial upslope of the curve during the first one to two minutes. This is either slow, medium or rap
after the injection of contrast. This part of the curve shows either an increase, plateau or washout. The kinetic analys
d can lead to three types of curve. Type 1 On the image on the left is a type 1 curve. There is a slow rise and a contin

of 6% of being malignant. Type 3 curve with rapid initial rise, followed by washout in the delayed phase Type 3 The t
with time (washout) in the delayed phase. A lesion with this type of curve is malignant in 29-77%. This is the red on th
pe 2 curve, which is in the middle: a slow or rapid initial rise
followed by a plateau in the delayed phase, which is allowed a variance of 10% up or down. The chance of a lesion w
the 6% of the type 1 curve and the 29-77% of the type 3 curve. Many physicians will biopsy lesions with type 2 curves
re is clumped enhancement in a breast it must be biopsied, even though there are no areas with a type 3 curve. CAD
CAD:
Computer Aided Detection is a purely kinetic evaluation. It does not evaluate the anatomy or pathology of the image
(automated kinetics). It also has some very nice features, including motion registration during subtraction, which can
ot all MRI scanners can do. It can do multiplanar reconstruction and subtraction very well and very quickly – it also ha
ed superimposed on the breast lesion in the image on the left. In CAD, red is bad: it means type 3 washout, and prob
ncing area in the left breast. The CAD has detected some very small areas with type 3 washout (in red). When you loo
arge invasive ductal carcinoma.
Non-mass enhancement:

Distribution:
Non-mass enhancement is enhancement without three-dimensional characteristics. It is important because it occurs
tion, its enhancement pattern and its symmetry or asymmetry. The table on the left summarizes the terms used to d
l refers to non-mass enhancement in less than 25% of a quadrant of the breast. Ductal involvement is enhancement
ncement is similar to ductal enhancement, but does not have a ductal orientation. This finding means cancer in 31%
78% chance of being cancer. Regional enhancement is not ductal or segmental but larger than focal and is cancer in
The image on the left shows focal non-mass enhancement. This proved to be a focal DCIS. The image on the left sho
The image on the left shows a mass as well as areas of linear non-mass enhancement. This proved to be linear DCIS
ional DCIS On the left examples of segmental and regional non-mass enhancement in DCIS. The image on the far left
s,
which corresponds to anterior and posterior expansion of the tumor in this case of DCIS. The image next to it shows
ion to that of the ducts in stromal fibrosis. LEFT: Heterogeneous enhancement in invasive ductal carcinomaRIGHT: Pu
Internal Enhancement Pattern - Nonmass:
Non-mass enhancement can be termed homogeneous and heterogeneous, just as mass enhancement can. As ment
y. In that case there is a 25% chance of cancer. Clumped enhancement is the most important non-mass enhancing p
or non-mass enhancement, kinetics are not very useful. If there is clumped enhancement in a breast it must be biop
ft heterogeneous enhancement in an invasive ductal carcinoma. The image next to it shows punctate enhancement
DCIS Clumped enhancement Clumped enhancement is the most important non-mass enhancing pattern to recogniz
of clumped enhancement in DCIS.
Associated findings:
Carcinoma with extensive thickening of the skin Associated findings can be: The image on the left shows a relatively s
f the skin. Inflammatory carcinoma with thickening of the skin The image on the left shows a large inflammatory carc
node (arrow) in a patient with breast cancer The image on the left shows a large enhancing lymph node on the right.
Specific breast tumors:

Cysts:
Cysts have a high signal on T2 fat-suppressed images. After the injection of gadolinium, they will show up as filling de
Fibroadenoma:
Fibroadenomas are the most common benign breast lesions after cysts.
In order to be certain a lesion is a fibroadenoma, certain criteria must be met: A fibroadenoma must have benign sp
microlobulated border. On the left an example of a classic fibroadenoma: a round, smoothly marginated lesion
with some black or gray areas on the inside, which are the non-enhancing septations. This lesion has a type 1 curve.
ther example of a fibroadenoma with clear non-enhancing septations.
These septations are also visible on the gross pathology. Two examples of a hamartoma with dark areas of fat on a f
Fat containing lesions:
The pre-contrast T1, non fat-suppressed sequence can show the presence of fat in a lesion. High signal on a T1-weig
nd hamartomas. These areas will be dark on fat suppressed images. On the left two classic examples of hamartomas
se images after the administration of intravenous gadolinium.
DCIS:
Kinetics are usually not useful in DCIS, especially not in cases when low-grade. Many cases of DCIS show no washout
f the enhancement however is important. DCIS typically shows clumped, ductal, linear or segmental non-mass enhan
oth breasts (DCIS). There is a small enhancing mass medially in the left breast, which was a small invasive carcinoma
the left breast. This proved to be an invasive carcinoma. Lateral to it is an area of ductal non-mass enhancement, wh
with diffuse, bilateral DCIS. DCIS bilaterally Another case of DCIS, located laterally in both breasts. The cases on the l
s had large homogeneously enhancing areas in the right breast. In both patients this proved to be DCIS. Two cases o

Invasive ductal carcinoma:
Most invasive carcinoma are ductal, some are lobular, and there is a group of rarer types. Regardless of the type of c
aped,
spiculated mass with rim- or heterogeneous enhancement after the administration of intravenous gadolinium. On th
cinoma presenting as a large, heterogeneously enhancing mass. Next to it an example of an invasive ductal carcinom
ntraductal carcinomas The image on the far left shows an irregular mass with some ductal extension, and
on the right an irregular mass extending to the chest wall, but not invading it. There is no chest wall enhancement. T
Invasive lobular carcinoma:
Invasive lobular carcinoma is one of the types of cancer that does not always
show a lot of enhancement on breast MRI, which can make it difficult to diagnose. In these two cases however, this w
ive lobular carcinoma. On the right is a MIP showing a large area of abnormal enhancement, which proved to be a di
Colloid carcinoma:
The image on the left is a T2WI with fat suppression. It is a colloid carcinoma in a breast with dense, glandular tissue
signal on T2 fat-suppressed images are benign. Terminal duct carcinoma
Others:
Terminal duct carcinoma On the left a large, irregular, enhancing mass in a male patient. This was a terminal duct ca
ation Sarcoma with osseous differentiation The case on the left is a patient with a sarcoma with osseous differentiat
cystic carcinoma On the left an image of an irregular enhancing mass which was an adenoid cystic carcinoma. Metap
etaplastic carcinoma with rim-enhancement.
This is not necessarily a typical presentation.
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None:

None:

...:
Answers to ankle and foot cases
Foot:

case 1 - distortion:
The findings are: A vertical fracture of the medial malleolus is a push-off fracture. According to Lauge-Hansen the fra
The lateral side is under extreme tension with stretch on the lateral collateral band. In stage 1 there is either a ruptu
hich we also know as Weber A). In stage 2 there is always a vertical fracture of the medial malleolus and there has to
the collateral band as these sequences always are in this order with first stage 1 and then stage 2. This means, that
't matter.
There must be an injury to both the medial aswell as the lateral side and we now know that the ankle is unstable, be

unstable ankle fracture. According to Lauge-Hansen this is SA stage 2.
According to Weber this is Weber A with additional fracture to the medial malleolus. Go back to the cases...
case 2 - chronic pain post ankle sprains:
The findings are: The calcaneus and navicular bone do not normally articulate.
With osseous coalition, a bony bar that bridges the two bones is seen. Compare to the normal situation. With fibrous
th have irregular surfaces, and the anteromedial calcaneus is abnormally widened or flattened.
On lateral radiographs, elongation of the anterior dorsal calcaneus may simulate an anteater's nose.
Hypoplasia of the talus is sometimes observed in calcaneonavicular coalition. On the CT we see a coalition between
bchondral cysts as a sign of 'friction' due to the neoarticulation. The MRI shows bone marrow edema as a sign of a sy
case 3 - distortion:
This is another case of a fracture of the posterior malleolus. Again we have to look at the algoritm for ankle fractures
B or a Weber C fracture. In this case we have already seen an oblique fracture of the lateral malleolus, which means
Now we only need to determine which stage it is.
The most common stage 2 is stable, but stage 3 and 4 are unstable. In this case we already in stage 3 and we wanna
A painful soft tissue swelling at examination would already indicate stage 4, but in this case there is more. Maybe you
... In this case we are looking for a stage 4. Now you notice the soft tissue swelling on the medial side (arrow).
The most important finding however is the irregularity and radiolucency of the upper part of the medial malleolus.
If you use your imagination, you can identify a fracure line here, which you would not have seen if you did not use th
case 4 - distortion:
The only thing that we notice is soft tissue swelling especially on the medial side. Continue with the ankle injury algor
Weber B fracture stage 4.
However there are no signs of a WeberB fracture. The other possibility is that there is a Weber C fracture with a high
e.
The medial band rupture is stage 1 and the injury may stop there or continue to stage 2,3 or even 4.
We need additional x-rays of the entire lower leg to find out which stage we are dealing with. Continue with the x-ray
ve).
Usually the patient will only feel pain at the level of the ankle since ligament ruptures are very painful and not notice
case 5 - chronic pain:
The findings are: The subtalar joint consists of the anterior, middle, and posterior facets. Talocalcaneal fusion most c
aculum tali. Talocalcaneal coalitions may be difficult to visualize on the standard radiographic views of the foot becau
of secondary radiographic signs of talocalcaneal coalition have been described, including: A talar beak occurs becau
ular overriding the talus. Periosteal elevation occurs at the insertion of the talonavicular ligament, and, ultimately, a
eak. The "C sign," is a C-shaped line on the lateral view, that outlines the medial talar dome and posteroinferior suste
alar dome and sustentaculum, as well as the prominent inferior outline of the sustentaculum.
As the x-ray beam strikes the posteroinferior outline of the abnormal sustentaculum tangentially over a long distanc
th osseous and nonosseous coalitions. ImagesOn the T1W-image there is a bony coalition and ankylosis of the talus
Ankle:

case 2 - distortion:
In this case the most obvious finding is a fracture of the posterior malleolus.
This should urge you to look for other findings, since an isolated fracture of the posterior malleolus is extremely unc
goritm for ankle fractures.. Algoritm for ankle fractures In the algoritm a fracture of the posterior malleolus is either:
Since there is no sign of a Weber B fracture, this must be a Weber C fracture. Are there any other signs that are in fav
Now we recognize the soft tissue swelling on the medial side and a small avulsion, which is stage 1 of this injury. We
a radiograph of the whole lower leg. Go back to the cases...
case 5 - distortion:
There is a subtle fracture visible on the Morrison's and the lateral view.
This is a large tertius fracture.
There is no sign of a Weber B type of fibula fracture. The combination of this fracture and the soft tissue swelling on
ype of injury (or pronation exorotation injury according to Lauge-Hansen). The medial collateral band injury is stage
This means that this is an unstable fracture.
There must be a high fibula fracture. Go back to the cases...
None:

None:

None:

Incidentalomas in the liver:

What to do with incidentally found lesions in the liver?:

Maarten van Leeuwen, Joost Nederend and Robin Smithuis
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Publicationdate 2007-05-12 This review is based on a presentation given by Maarten van Leeuwen for the Dutch Rad
ederend and Robin Smithuis. With the increasing use of multidetector CT small hepatic lesions are frequently depicte
und liver lesions or incidentalomas is not known. This results in a diagnostic problem, which is initiated by radiology
orizing these lesions as to their clinical significance. In this article we will discuss the management of two different ty
ons. TSTC (too small to characterize lesions)

TSTC (too small to characterize lesions):

Contrast enhanced CT (portal phase) showing multiple small hypodense lesions. First study the images on the left. Th
diagnose them with certainty as: For this type of lesions which, due to their small size and atypical imaging features,
o characterize) lesions has been coined.

TSTCs in patients without a known malignancy:

Jones (1992) studied 1500 patients who had an abdominal CT examination (1). He found:

TSTCs in patients with a primary malignancy:

Schwartz (1999) studied 2978 patient with a known malignancy (2). He found TSTCs in 12% of patients with a known
ey proved to be metastases (1.4% of all patients). The percentage of malignancy depended much on the known prim
This is in accordance with the observation that breast metastases usually present as multiple small lesions, while live
as a solitary or a few larger masses. Probability of a lesion being benign using size and edge as characterization Rob
r correlation with malignancy (3). The lesions where classified by their behavior on follow up CT, as either stable or u
l size and sharp edge. Heterogeneity and soft tissue attenuation were associated with unstable behavior, but only se

TSTCs in breastcarcinoma:

Krakora (2004) studied the prognostic importance of small hypoattenuating hepatic lesions seen at initial CT in patie
ases at initial examination (4). One or more small hypoattenuating hepatic lesions (TSTCs) were seen in 54 of 153 pa
atic metastases developed in 43 of 153 patients (28%). No difference was found in the chance for development of liv
kora concluded that in patients with breast cancer, who do not have definite hepatic metastases at presentation, the
at initial CT contribute to an increased risk of subsequently developing hepatic metastases.

Conclusion:

In a patient without a known malignancy these small hypodense lesions, as a rule, should be considered as benign. I
be assumed to be benign. Even multiple TSTCs in these patients are mostly benign, especially when they are small, s
be too defensive! Don't dictate 'we can't rule out metastases'. In patients with breastcancer and no known livermeta
ctive value for the development of livermetastases in the long term.

Incidental hypervascular lesions:

Incidental hypervascular lesions are also very common findings in liver imaging. It is important to differentiate betwe
ervascular tumors include hemangioma, FNH and small adenomas. 'Touch' lesions include large adenomas (more th
amellar carcinoma (FLHCC) and metastases. These enhancing, solid lesions should be differentiated from vascular le
, like hepatic aneurysm,
aortaportal shunt or pseudoaneurysm.

Incidence of hypervascular lesions:

Karhunen (1986) found at autopsy an incidence of 20 % hemangioma, 3% FNH and 1% adenoma (5). A study in 1989
psies (6). Typical hemangioma with nodular peripheral enhancement. Enhancement in Hemangioma A hemangioma
t will
follow, but lag behind the arterial system. Hemangiomas less than 1 cm frequently demonstrate
immediate homogenous enhancement, isodense to the aorta. Hemangiomas larger than 1cm generally show slow
centripetal spread of nodular enhancement, slowly decreasing in density. On the left a typical hemangioma. Enhance
trast diffuses toward the center of the lesion, the level of enhancement lowers slowly, and in the late phase is still hy
in FNH. Notice early enhancement, but not as bright as in hemangioma. In venous and delayed phase the enhancem
he typical, slowly perfused vascular space enhancement of a hemangioma has
to be differentiated from the 'capillary blush' due to an abundant capillary network
which characterizes FNH, adenoma, HCC and
hypervascular metastases. As capillaries are surrounded by tissue the overall enhancement will be less
dense compared to the
enhancement of the vascular spaces in
hemangioma. Hence, in capillary blush, the enhancement occurs slightly later compared to the aorta and is less den

Hemangioma:

Hemangiomas on dynamic MR will show the same
enhancement characteristics as on contrast-enhanced CT. The advantage of MR over CT is its higher sensitivity to co
esion on CT On the left an atypical, apparently hypovascular lesion on CT, possibly metastasis. MR depicts enhancem
the nodular, peripheral, slowly progressing enhancement (blue curved arrow) which CT failed to depict. Small hemar
ma on CT. On the left an atypical hypoechoic lesion, surrounded by a small but definite halo. In the arterial phase the

enhancement of arterial intensity, frequently seen in small hemangiomas. In the portal venous phase and in the equ
earances are consistent with a hemangioma, a benign, non-solid
vascular lesion. Once we have excluded hemangiomas, our
main goal is to determine whether a hypervascular lesion is a
FNH, which is the most prevalent hypervascular
solid lesion, or whether it is a lesion
which needs further management like adenoma,
HCC, FLHCC or hypervascular metastases. For this purpose we have to look for morphologic features
like inhomogeneity and presence of capsule, scar,
calcification or fat. Two FNHs with late enhancing central scar
Focal Nodular Hyperplasia (FNH):
On the left two adjacent hypervascular lesions with
homogeneous enhancement in arterial phase and hypodense
central scars in arterial and venous phase, which
enhance in the equilibrium phase. This is characteristic of FNH. Notice that the small FNH, which is
anterior and right to the bigger one, has the same enhancement pattern. FNH is considered a non-neoplastic, hyperp
response to a congenital vascular malformation. Histologically, FNH is not a tumor and
consists of benign-appearing hepatocytes
occurring in a liver that is otherwise normal (i.e. no
cirrhosis). At late arterial phase, FNH typically presents
with a bright homogeneous enhancement, but less intense than the aorta with
a hypodense central scar. Smaller (
The radiating hypodense fibrous bands or
septa, arising from the scar, are not infrequent and
quite characteristic. At portal phase, FNH is often iso-attenuating
to the normal liver and may be difficult to
deliniate. Delayed phase often shows hyperattenuation of
the central scar and septa due to late
opacification of the fibrotic components. No calcifications, inhomogeneity or capsule should be seen
in FNH. Typical FNH on MR Focal Nodular Hyperplasia (2) On the left a typical FNH on MR. Slightly hypointense on T1
hyperintense on T2WI. The scar is somewhat hyperintense
on T2. The enhancement is as we
expect with 'capillary blush' with a scar that
enhances late in the equilibrium phase. Atypical FNH with non-enhancing central scar Focal Nodular Hyperplasia (3)
characteristics of FNH except for lack of late
enhancement of the central scar. In addition, it is slightly hypodense to normal parenchyma in
the portal and equilibrium phase. However, all other characteristics are present
like lobular enhancement, central scar and no
capsule, and therefore we characterize this lesion as FNH. Hemangioma and FNH on ultrasound and dynamic MR. Fo
lesions. The small one (blue arrow) is characteristic of a
hemangioma, while the larger one (green arrow) is non
specific on US. On T2WI the hemangioma shows the typical
homogeneous hyperintensity . The larger lesion is somewhat hypointense on T1 and somewhat hyperintense on T2.
small septae that do not enhance in the arterial
phase and do show late enhancement (yellow arrows). On T2WI the hemangioma shows the typical
homogeneous hyperintensity . The larger lesion is somewhat hypointense on T1 and somewhat hyperintense on T2.
small septae that do not enhance in the arterial
phase, and do show late enhancement (yellow arrows). We also characterize this lesion as FNH. Small FNH Focal Noc
most isointense to liver on T1WI and T2WI, but shows more contrast to the liver on a T1W-MPRGRE (gradient-echo). T
septation and in the equilibrium phase the lesion is not different from normal liver parenchyma. Notice that the lesi
r on imaging and even not on pathologic examination. Incidental hypervascular lesion on a CTA for pulmonary embo
get really familiar with these common lesions. On a CTA for pulmonary emboli a small hypervascular lesion is seen i
ion is not seen and on T2WI it is only slightly hyperintense. In the arterial phase there is homogeneous enhancement
is patient does not have liver cirrhosis, this is probably a benign lesion, probably FNH. As the appearance was not pa
esion had not changed, making the
diagnosis FNH most likely. When does it stop, this comfortable feeling, that something is a FNH? It stops when there
on the left. Decide for yourself which findings are compatible with the diagnosis typical FNH and which are not. The
like FNH , but on the T1WI the lesion is inhomogeneous and not sharply defined. On T2WI the scar has a low signal in
igh and the lesion is again
inhomogeneous. In the arterial phase the lesion does enhance

like FNH, but in the portal and equilibrium
phase the enhancement persists and is inhomogeneous. In addition, the central scar does not enhance in the
late phase. So there are many findings that are not
compatible with the diagnosis FNH. Since the specificity for diagnosing a lesion as
benign should be very high, we cannot stop
here and we have to get a histological diagnosis.
Fibrolamellar HCC:
When we encounter lobulated hypervascular masses in the liver, an important diagnosis that you don't want to miss
r form of HCC may mimick FNH on imaging. In contrast to HCC, the prognosis is reasonable. Like FNH, FLHCC also is
. Both FNH and FLHCC appear in normal liver, unlike
HCC that is most frequently seen in a cirrhotic liver. In distinction to FNH, FLHCC is inhomogeneous,
large (> 5 cm), frequently has calcifications (>70%), a
blunt central scar and usually there is
lymphadenopathy. Calcifications in FNH are so uncommon that it
should make you consider another diagnosis like
FLHCC. Pathologic specimen of FLHCC and FNH (Courtesy Dr. Baron) Fibrolamellar HCC (2) On the left a pathologic sp
wever when you look carefully you will notice the more lamellar and heterogeneous structure of FLHCC compared to
tesy Dr. Federle and Dr. Ichikawa (3) Fibrolamellar HCC (3) On the left CT- and MR-images of a left-lobe fibrolamellar
hows calcification (curved arrow) within the hypoattenuating tumor (straight arrows). B. Hepatic arterial contrast-enh
ithin the tumor (arrows). C. Ten-minute delayed transverse CT scan demonstrates subtle areas of hyperattenuation t
ta, and capsule (open arrows).
Curved arrow = calcification. D. Transverse T2-weighted MR image (5,000/105) also demonstrates the central scar an
isointense to liver (the only such case in our series). Left-lobe fibrolamellar HCC. Courtesy Dr. Federle and Dr. Ichikaw
ss pathologic specimen shows a large tumor with eccentric and central scars (open arrows) and radiating septa. The
a variegated appearance with areas of bile staining. In a series of 31 cases of FLHCC, Ichikawa et al (7) found the follo
ase
Adenoma:
An adenoma is regularly characterized by bleeding, fat or peliosis. Although we cannot see peliosis itself, it can result
lomas. Decide for yourself why these are not FNH lesions. In the arterial phase there are two
hypervascular lesions, somewhat less
dense than we would expect in FNH. Both lesions demonstrate a halo of a capsule,
which should not be apparent in FNH. Unlike in FNH, the enhancement is
inhomogeneous and in the portovenous and
equilibrium phase the lesions are not isodens to
the liver. Adenoma with hemorrhage Adenoma (2) Regularly adenomas present with bleeding. On the left images of
seen and free fluid surrounding the liver. This is a typical presentation of an adenoma. On portal phase CT, the lesio
nding subcapsularly. Adenoma: non-specific features on CT Adenoma (3) On the left an US image of an incidentally fo
y non-specific features were found without signs of hypervascularity. . Continue with next images. Adenoma: capillar
ndicating the presence of fat. In contrast to the CT, there clearly is
enhancement in the arterial phase on MR, again demonstrating that MR
depicts enhancement better than CT. The enhancement is due to a capillary blush, most intense in the arterial phase
eater enhancement of the surrounding parenchyma. In the 'out of phase' image there is signal loss
indicating that the lesion contains fat,
which is very suggestive for adenoma. A HCC may also contain fat, but in this case
there is no cirrhosis and the entire
lesion shows signal loss,
which we would not expect in HCC. HCC: hypervascular lesion in a cirrhotic liver
Hepatocellular carcinoma (HCC):
Concerning the diagnosis of HCC, there is
one thing to remember: 'Every hypervascular lesion in a cirrhotic liver is
HCC until proven otherwise'
'. On the left we see a cirrhotic liver with irregular
margins (arrows), suggesting that the hypervascular lesion is a HCC. The inhomogeneous
enhancement and the partial capsule are helpful
for the diagnosis HCC, but even if these
features were not present, our diagnosis still
would be HCC. Hypervascular metastases with typical peripheral enhancement
Hypervascular metastases:
Characteristics of hypervascular metastases are: On the left hypervascular metastases. Notice that the larger ones sl
Differential diagnosis of Hypervascular lesions:

Work up:
In the workup of incidentally found
hypervascular lesions, we first have to decide
whether the lesion is a hemangioma, because
these are the most common lesions and usually have
specific imaging findings. If not, we have to find out whether it is an FNH. For this differentiation we have to look at
differences in enhancement pattern and
differences in morphology like presence of a
capsule, scar, calcification and inhomogeneity. Hypervascular lesions most often can be characterized, even when sm
t. The preferred modality to characterize incidentalomas is MR, as it is better for lesion characterization and incident
hould be minimized. If HCC or FLHCC is considered further investigation is always needed.
Differential diagnosis:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. EC Jones, JL Chezmar, RC Nelson and ME Bernardino Department of Radiology, Emory University School of Me
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None:

None:

CT and MRI of the Eye:
by David Youssem
Neuroradiology department of the Johns Hopkins Hospital in Baltimore:
Publicationdate 2008-09-19 This review is based on a presentation given by David Yousem and adapted for the Radio
ctor of Neuroradiology and Professor of Radiology at the Johns Hopkins Hospital. He is also the editor of the book 'N
roach to orbital pathology is presented based on division of the orbit into the following compartments: Extraconal sp
Anatomic Considerations:
The first thing you do when you see a lesion in the orbit, is to decide whether it is an ocular lesion or a non-ocular les
ures outside the globe. If it is a non-ocular lesion, the next question is whether the lesion is located within the intraco
d by the extraocular muscles, or whether it is located within the conal or extraconal space? Once you have decided w
possibilities using the mnemonic VITAMIN C and D. We will first describe the anatomic spaces of the orbit and summ
ologies are not visible radiologically. Then we will discuss the radiological findings in certain orbital diseases. Ocular s
es: Anterior chamber When we move from anterior to posterior the first area is the anterior chamber. It is bounded
ic pathologies within the anterior chamber are: Posterior chamber This is a very small area posterior to the iris, whic
rea are: glaucoma, uveitis and ciliary melanoma. Vitreous body The larger area posterior to the lens is the vitreous b
reous body is surrounded by the membranes of the retina, the choroid and the sclera. Retina pathology: Choroid pat
and is located within the muscle cone It contains the optic nerve, vessels and cranial nerves III, IV and VI. Intraconal s
. These ocular muscles are connected via the annulus of Zin, which is a fibrous connective tissue sheet and together
extraconal space. Intra-orbital pathology which is non-ocular is either in the intraconal, conal or extraconal space. In
ed by the ocular muscles and an envelope of fascia. Conal space pathology: Extraconal space The extraconal space is
ital appendages The lacrimal gland is located superolaterally in the orbit. Diseases of the lacrimal gland can be divide
. Secretions go medially across the globe and are collected in the punctum and then go into the lacrimal sac. From th
l duct, which drains under the inferior terminate into the nose. In children congenital obstructions of the valves in th
t also known as dacryocystoceles. In adults obstruction is more often due to strictures from ethmoid sinusitis or stor
or increased tearing. Drainage can be improved with balloon dilatation.
Ocular pathology:
Retinoblastoma: axial FLAIR (left) and coronal enhanced T1WI (right)
Calcifications:
In adults the most common intraorbital calcifications occur at the tendinous insertion of the ocular muscles. Other c
also called 'optic disc drusen'. These are usually asymptomatic, but when the ophtomologist inspects the eye, there

ildren calcifications in the globe means retinoblastoma until proven otherwise even if it is bilateral. On the left an im
Retinoblastoma:
As you can see in the table on the left, retinoblastoma is a one of the more common tumor in the first year of life. Th
or, leukemia and teratoma. All bilateral cases are hereditary and result from a deficient tumor suppression gene on
iagnosis are all uncommon. Bilateral retinoblastoma On the left images are of a 13 month old female with bilateral le
omas are treated with different kinds of therapy (cryoablation, laser photocoagulation, chemothermotherapy, brach
ucleation. If the patent is treated with radiation, there is a 30% chance of a second malignancy within the radiation fi
suppression gene. Outside the radiation field there is an 8% chance of malignancy. In order of frequency: Osteosarc
alcification These patients are also at risk for pineal tumors and parasellar PNETs. The pineal gland is considered as t
retinoblastoma in the pineal gland, i.e. trilateral retinoblastoma, but also germinoma. Always examine the brain in t
is the peak age for retinoblastoma, the pineal gland does not calcify, so any calcification in this region is suspicious o
with retinoblastoma. This tumor presents as a large calcification. When a retinoblastoma occupies more than half o
oria Usually, when a light shines through the iris, the retina appears red to the observer. In leukocoria (white pupil) t
y detected through leukocoria as it occurs in two third of patients with retinoblastoma. These children are usually to
s of leukocoria as listed in the table on the left. Melanoma
Melanoma:
On the left images of an adult with an ocular mass. The most common intraocular lesion in an adult is melanoma (as
Number two is metastases and others like hemangioma, leiomyoma and osteoma are uncommon. Persistent hyperp
Persistent hyperplastic primary vitrous (PHPV):
On the left another cause of leukocoria. This is persistent hyperplastic primary vitrous (PHPV). There is a persistent h
he images we see a persistent canal that goes from the optic nerve to the lens. There is also retinal detachment (occ
most common cause of leukocoria. These patients also develop glaucoma and cataract.
Coats' disease:
Coats' disease is a rare eye disorder of unknown cause, leading to full or partial blindness, characterized by abnorma
aract
Globe rupture:
On the left images of a patient who presented in the ER with post-traumatic orbital swelling. This patient has globe r
iologists we are used to looking at the vitreous body if we think of globe rupture, but that is not enough. Notice that
eased density anteriorly as a result of hyphema (blood in the anterior chamber). Also notice that the lens on the righ
umatic cataract. Maybe you would have expected the lens to be more dense, but that is usually not the case. Globe r
a. Study the images for 5 findings and then continue reading. The findings are : Globe rupture is seen most common
the ora serrata (arrows)
Retinal and choroidal detachment:
Blood can be located in the following locations: Retinal detachment can be distinguished from choroidal detachment
Evidently a retinal detachment will not go beneath this point. Retinal detachment with haemorrhage is seen mostly i
it can be seen as part of a shaken baby syndrome. In choroidal detachment recent intraocular surgery is the most co
r left a CT of a choroidal detachment going beyond ten and two o'clock (with the lens at twlve o'clock) and evidently r
nt ends at the optic nerve but, if you look carefully, the choroidal detachment actually crosses the optic nerve. That w
es seen in choroidal detachment. On the right a T1WI of a retinal detachment. It ends at the optic nerve and at the o
case of choroidal detachment. Bilateral colobomas
Coloboma:
Coloboma is a congenital malformation in which part of the eye does not form due to failure of fusion of an embryon
htalmia and the eye protrudes inferiorly. In 10% there are other CNS anomalies. On the left images of a patient with
E syndrome: Coloboma can also be part of the COACH syndrome: On the left images of a patient with a small colobo
m with lipoma The patient on the left had a coloboma and also agenesis of the corpus callosum with an associated m
Intraconal pathology:
Neuromyelitis optica
Devic's syndrome:
Devic's syndrome is also known neuromyelitis optica. Let's first look at the images and then discuss it in more detail.
side. Notice that the optic nerve is white matter tract. It has the same signal intensity as the white matter in the brain
in the optic nerve. This is therefore extra-ocular intraconal disease and we will be thinking of neoplastic versus demy
s optica On the left a FLAIR image with fat-sat. Notice the abnormal signal intensity and the fact that the optic nerve i
mor. Devic's syndrome Images of the cervical spinal cord show a long segment of non-space occupying disease. Base
ome (also caled neuromyelitis optica). Since MS is far more common, this would be the most likely diagnosis, but this
as a form of MS, but Devic's syndrome differs from MS: Multiple sclerosis
MS:
On the left images of a different patient, who also has optic neuritis. There is high signal in the optic nerve and in the
lesions did not occur at the same time, so there is dissemination in time and in place, which is specific for MS. Menin
Meningioma:
On the left images of another patient with extra-ocular intraconal disease. First look at the images, describe them an

the fact that the title of this paragraph is meningioma). The optic nerves are normal, but there is abnormal mass-like
probably a neoplasm and of the neoplasms meningioma is by far the most common optic nerve sheath tumor. Men
ase as a result of ischemic neuropathy due to venous obstruction. Clinically this presents as a pale disk. Abnormal en
e differential diagnosis of abnormal enhancement of the optic nerve sheath, also called
optic nerve tram track sign. Meningioma of nerve sheath is a result of subdural growth leading to progressive visual
with NF-2. The pale disk is due to venous outflow impairment. Calcifications are seen in 20-50%. Seeding into the sub
optic sheath due to the fact, that the sheet of the optic nerve communicates with the intracranial compartment of th
Optic nerve glioma:
First look at the images on the left. Which side is abnormal and what is the most likely diagnosis? There is sphenoid w
ar the chiasma is enlarged (visible on the MR). So the diagnosis is neurofibromatosis type I with sphenoid wing hypop
optic nerve glioma is a misnomer. Actually the tumor can present anywhere along the optic tract from the occipital r
rather non-specific. These tumors are juvenile pilocytic astrocytomas WHO type 1, which is the most benign form of
of patients who have an optic nerve glioma have NF1, but in NF1 only about 10% have optic nerve glioma. They are lo
is 4-5 years and only 20% of these patients have visual symptoms, because the glioma does not affect the optic nerv
n problems. On the left another case with a more typical example of optic nerve glioma also in a patient with NF1. LE
ckling (small brown spots) and caf? au lait spots The criteria for the diagnosis of NF1 are met in an individual if 2 or m
Conal pathology:
Thyroid eye disease
Thyroid eye disease:
Take a look at the images on the left, describe them and come up with a differential diagnosis and again disregard th
and the differential diagnosis is pseudotumor of the orbit. In a moment we will discuss how to differentiate these tw
This however suggested that the patient is hyperthyroid. Nowadays we know that patients that are treated for Grave
hyroid eye disease and therefore nowadays we use the term thyroid eye disease. The great danger of thyroid eye dis
on by the muscles or ischemic by compression of the vessels. The key feature to look for is the orbital apex. If you do
nce of compression. These patients are treated with decompression through an endoscopic procedure in which the
umor of the orbit
Pseudotumor:
Take a look at the images on the left. This is a case of pseudotumor. Pseudotumor is idiopathic inflammation of the o
at, optic nerve, nerve sheet, lacrimal gland etc. Thyroid eye disease versus pseudotumor The key distinction between
mor not only the muscles, but also the tendons are involved. These patients feel pain when they are moving their ey
ce the tapering of the swollen muscle at the point of the tendinous insertion in a patient with thyroid eye disease. Ne
at the swelling includes to the tendinus insertion.
Extraconal pathology:
Periorbital abscess
Periorbital abscess:
On the left nonenhanced CT-images of a patient with a evident periosteal or periorbital abscess as a result of a comp
lowing:
Do not wait for peripheral enhancement to call it an abscess! In every other location you wait for nice rim enhancem
he treatment is the treatment of the sinusitis. Periorbital abscess Here MR-images of an eleven year old boy, who ex
oke up with a proptosis. The enhanced T1W-images with fatsat nicely demonstrate a periorbital abscess which cause
int to make is the following:
In children be very careful about extension outside the sinuses! Any change outside the sinus should be called an ab
ease will easily spread. So be aggressive in calling small abnormalities an abscess. Periorbital abscess can lead to ver
n certain fungal sinusitis (e.g.aspergillosis) you can even get cavernous sinus thrombosis and cavernous-carotid fistu
Orbital and periorbital cellulitis:
On the left images of a patient who presented in the ER with a 'red hot eye' and proptosis. Now the difference betwe
based on an anatomic structure, which is called the orbital septum. If a patient comes in the ER with a red hot eye ar
uperficial to it, the diagnosis is periorbital cellulitis and the patient is treated with oral antibiotics on an outpatient ba
terior to the septum are also involved. This patient has an orbital cellulitis and will have to stay in the hospital to rece
phenoid wing
Sphenoid wing lesions:
On the left a CT image of a patient with proptosis due to a sphenoid wing lesion. There are four sphenoid wing lesion
noid wing and proptosis These images are of a patient who had a slowly progressive proptosis. On the T2W-image th
to the CT-image. Notice the small extra-axial lesion (arrow). This is a meningioma. On the coronal T1W-image post G
enigioma grows like this along the neurocranium, it is also called a meningioma en plaque.
Lacrimal gland lesions:
Lacrimal gland lesions are listed in the table on the left.
Inflammatory conditions are by far the most common lesions of the lacrimal gland (i.e. Sj?gren's, TB, fungus, pseudo
These conditions do not cause masses. The most common mass of the lacrimal gland is lymphoma followed by pleo
Epithelial tumors including adenoid cystic tumors are uncommon.

Vascular Malformations:
Vascular malformations can be intraconal, extraconal or multicompartment and that is the reason why they are not
have to discuss the
Mulliken and Glowacki system for the categorization of vascular anomalies in the head neck region, which is widely a
Capillary hemangioma:
The first lesion in the Mulliken & Glowacki system is the capillary hemangioma. Capillary hemangiomas have the follo
Venous Vascular Malformation:
The second lesion in the Mulliken & Glowacki system is the venous vascular malformation. On the left an image of a
compartment with a phlebolith. Most are unilocular, but this one is multilocular. Venous vascular malformations hav
-fluid levels locaed both in the intraconal and in the extraconal compartment.
Lymphatic malformations:
The next entity is the lymphatic or veno-lymphatic malformation. These are little cystic areas, that often bleed after r
to high protein or hemorrhage. they usually do not enhance unless there is a venous component, that may show enh
acteristics are: Varix visible during valsalva at the moment of sneezing.
Orbital varix:
On the left images of a patient with an orbital varix, who had noticed that during straining there was a propulsion of
The upper image is during rest and the lower image is during valsalva at the moment of sneezing.
During valsalva the varix shows extreme dilation (red arrow).
Notice that during valsalva also on the normal side the superior ophthalmic vein dilates (blue arrow).
Conclusion:
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o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift.
None:

Enhancement Patterns in CNS disease:
Linda Jacobi-Postma and Debbie Duyndam
Maastricht University Medical Center and Onze Lieve Vrouwe Gasthuis in the Netherlands:
Publicationdate 15-08-2023 Under normal conditions there will be no enhancement of
the brain parenchyma in the central nervous system, because the brain is the only organ with a barrier for proteins,
This barrier is called the Blood-Brain Barrier. The Blood-Brain Barrier can be damaged by various diseases like: Unde
e image assessment and differential diagnosis.
In this article eleven patterns will be discussed with many examples. We want to honour James Smirniotopoulos, wh
His article in 2007 in Radiographics and his animated lectures inspired us writing this article.
He was so kind to review this article.
Introduction:

Pattern approach:
In this table the most common patterns of enhancement in CNS diseases are illustrated.
The first three are extra-axial (diffuse and focal dural and leptomeningeal), while the others are all intra-axial pattern
les of a specific pattern.
Normal enhancement:
Structures in the brain, that do not have a blood-brain barrier or structures that are extra-axial will show normal enh
vessels (2), the pituitary stalk (3) and pituitary gland (4), the choroid plexus (5) and the area postrema (arrow). The ar
edulla oblongata in the brainstem and is located just inferoposterior of the floor of the fourth ventricule.
Diffuse Dural pattern:
The diffuse dural pattern of enhancement is a common finding in MR examinations.
It is most commonly seen in post-surgery and intracranial hypotension. Normal dural enhancement The dura mater
not have a blood-brain barrier. In half of the population enhancement can be seen on a
contrast-enhanced MRI as a thin, smooth and discontinuous layer as seen in
these images.
Intracranial hypotension:
Intracranial hypotension is a condition in which there
is abnormally low pressure or volume within the skull due to a reduction in
cerebrospinal fluid (CSF).
The classical presentation is a persistent orthostatic
headache. Intracranial hypotension can be caused by surgery, lumbar puncture, ventricular drains and “spontaneou
CSF leakage. Spontaneous CSF leakage is seen in an
anterior dural tear (type 1), a leaking nerve root diverticulum (type 2) or a
CSF-venous fistula (type 3). Further

work-up to find the cause for CSF leakage requires spinal imaging, either with
MRI of CT-myelography.
The CSF leakage can be treated by placing an epidural bloodpatch. MRI findings include small
ventricles, subdural hygromas and
eventually hematomas, diffuse (supra-and
infratentorial) smooth dural enhancement,
sagging of the midbrain and acquired tonsillar ectopia, pituitary engorgement and distention of
the dural venous sinuses. When the CSF pressure drops, the volume of the veins in the subarachnoid space increase
e dura.
Imaging findings can be normal in 10% of cases. These images are of a 58 year-old male who presented with headac
standing position. Images
A
smooth dural enhancement is present in both the supratentorial and the infratentorial compartment.
Notice the small ventricles. Continue with the sagittal images... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Image 1The findings are rather subtle, but there is: Conclusion: findings
typical for intracranial hypotension. Image 2
After therapy, which was a non-targeted epidural bloodpatch, the brain and brainstem have returned to their norma
onfigurations. These images are of a 44-year old male, who presents with longstanding headache, which increases v
T2W-image demonstrates small bilateral subdural hygromas (arrowheads).
After gadolinium there is
smooth dural enhancement. Continue with the sagittal images... Images
There is engorgement of the venous structures, as is depicted in the superior sagittal sinus (arrow heads), the straigh
There is downward placement of the brainstem with shortening of the pontomammilary distance, flattening of the p
The venous plexus in the cervical anterior epidural space is widened. ConclusionThese findings are typical for intracr
The patient was later diagnosed with a connective tissue disorder. These images are of a male with a history of left-s
infarction, who presented with headache, worsening on standing and forward bending
and tinnitus. Images
There is thick and somewhat irregularenhancement of the dura, with thicker apposition
over the tentorium, left temporal and left
frontoparietal dura. ConclusionIdiopathic
hypertrophic pachymeningitis.
This turned out to be a biopsy proven IgG4-related disease. Continue with the post-treatment images... After treatm
ing and enhancement.
IgG4-related pachymeningitis:
It has now become clear that many of the cases, that we used to call idiopathic hypertrophic pachymeningitis are act
e that can affect many organs of which the pancreas is the most common.
In the brain the meninges can be involved.
It is important to suggest this diagnosis as it is a treatable disease. This is a companion
case of a patient with headache and bilateral hearing
loss. Images
There
is thickening of the dura with enhancement with a slight irregular aspect.
there is no
engorgment of the veins
The enhancement extends into
the internal acoustic meatus (yellow arrowhead). Continue with the images post-treatment... Same patient before an
therapy with resolution of the abnormalities . This patient had a craniectomy for surgical evacuation of a left-sided s
hematoma. Images
A thin linear enhancement of the left parietal dura is shown,
demonstrating postsurgical dural enhancement.
(PS you might also call a focal dural pattern).
Focal Dural pattern:
The most common tumor that presents with a focal dural pattern is a meningioma, which is an extra-axial lesion. Ly
ses characterized by uncontrolled production of lymphocytes, including lymphomas, lymphocytic leukemia, multiple
Lymphomas that present as a dural tumor are secondary CNS lymphomas, i.e. the lymphoma starts elsewhere in the
are primary.
They start in the brain and are not located in other organs.
Meningioma:
Which findings are typical for the diagnosis meningioma? Findings: The illustration shows favorite locations of menin

the skull base, the falx, tentorium and convexity. Most meningiomas are WHO grade 1. An atypical meningioma is gr
meningioma is grade 3. The meningo-endothelial cells arise from the arachnoid cap cells, which
is the inner most layer of the dura. On CT a meningioma is relatively hyperdense and may contain
calcium.
When they contain calcium, they usually grow very slowly. On MRI a meningioma is iso-intense to the grey matter on
and T2W-images. There is vivid enhancement due to the fact that the
extra-axial dural capillairies do not have a blood-brain barrier. A dural tail is a common finding. It is caused by vasoc
nearby dura and mostly not caused by tumorcells. The images show a more aggressive looking lesion with edema
and midline shift. Which findings favor the diagnosis of a
meningioma? Findings: The intraparenchymal
extension suggests a higher grade meningioma, while the presence of
edema is not a reliable sign of a higher grade. The following signs are described in meningiomas: The
sunburst sign can give the appearance of a flower like in this anterior skull base
meningioma's These
images are of a 56-year old woman with breast cancer.
She had a skull lesion at a bone scan nine years earlier
which was thought to be a metastasis. Now she presented with vomiting and headache. Images
There is a a large extra-axial lesion compatible with a meningioma.
There is profound hyperostosis of the skull and invasion of the superior sagittal sinus.
This is not a bone metastasis because of these findings and the fact that the lesion is present for nine years.
Metastases:
First look at the images and then continue reading. Question: The findings are: In 25-45% of the cases metastases ca
 at the gray/white matter interface (white arrowheads) Here another patient with metastases. Again notice the locati
er interface (white arrowheads)
Lymphoma:
These images are of a 76-year old woman, who was confused after a fall.
First look at the images and then continue reading. Question: The findings are: All these findings are typical for a prir
a.
These tumors make up for 6-7% of all CNS tumors and the histology is a B-cel NHL.
They are mostly located periventricular subependymal, in the corpus callosum and in the basal ganglia.
Always think lymphoma in a solid enhancing lesion which is located near the ventricles. The
hyperdense appearance on CT and the slight hypointensity on T2W-imaging,
as well as the restricted diffusion are attributed to the dense cellularity of
the lymphomatous tissue. In immuno-compromised patients the enhancement can be ring-like.
This patient has a lot of edema, but in many cases the edema is very limited. This is a 81-year old man with Waldenst
tion
by lymphoplasmocytoid cells. This is called Bing-Neel syndrome. Notice in this patient multiple solid enhancing lesion
boli
Leptomeningeal:
The leptomeningeal enhancement follows along the pial surface of the brain and
fills the subarachnoid spaces of the sulci and cisterns. The most common cause is infectious meningitis followed by
meningeal carcinomatosis. This
patient presented with headache. Images Images
Sagittal images demonstrate a small osseous defect at the posterior border of the frontal sinus with a small frontal c
There is leptomeningeal enhancement (arrow). Conclusion
The
presence of a frontal encephocele lead to opacification of the frontal sinus and meningitis due to direct communicat
via the osseous defect. Leptomeningitis
represents inflammation of the subarachnoid space. MRI demonstrates FLAIR
hyperintensity in the CSF space, especially in the sulci, and leptomeningeal
enhancement. Possible complications of leptomeningitis are subdural empyema,
secondary communicating hydrocephalus, infarction and ventriculitis. Diffusion
restriction can be seen in the ventricles, sulci and VR spaces. these images are of a 2 year old child, who presented w
paresis and eventually loss of consciousness. Images
There is obliteration of the prepontine cistern on FLAIR with
restrictive diffusion.
There is hyperintense signal on DWI in the
bilateral ventricles, consistent with pus.
High-resolution T2W-images demonstrate loss of hyperintense signal in the cisterns and subarachnoid space, based
pus. Final diagnosis

Haemophilus influenzae type B meningitis and ventriculitis. These images are of a 55-year old immunocompromised
cognitive complaints and headache. Images
FLAIR shows non-supressed enhancing CSF in the subarachnoid
space.
Look along the cerebellar foliae, these are hyperintense on FLAIR (black arrowheads).
There is faint leptomeningeal enhancement (yellow arrowhead).
Furthermore there is high FLAIR signal at the
perivascular spaces in the semioval centre with enhancement. ConclusionThis turned
out to be cryptococcal meningitis.
The spread
along the perivascular spaces in an immunocompromised patient is suggestive.
Sometimes in these patients there are also pseudocysts. Basal meningitis
Neurosarcoidosis:
These images are of a 31-year old male, who presented with
headache and hemihypesthesia. Images
FLAIR demonstrates high signal at the basal structures, with enhancement at and around
the basal cisterns and vallecular cisterns.
These findings are compatible with the diagnosis of basal meningitis. Meningitis at the base of the brain is usually ca
e chronic granulomatous process.
For this reason a chest CT was performed. Continue with the CT-images… The chest CT shows the typical findings of
There are small nodules along the fissures in a perilymphatic distribution and enlarged hilar nodes. Sarcoid
can have different neurological and radiological presentations.
The cranial nerve symptoms are the result of basal meningitis. In most cases there are also abnormal chest findings.
They have high signal post contrast and relatively low signal on T2-weighted images, compatible with granulomatous
nodules. This proved to be neurosarcoidosis. 'Trident' sign in a patient with spinal neurosarcoidosis Classical spinal n
ere is
enhancement of the leptomeninges and peripheral white matter (*) and central canal of the spinal cord. In this patie
rowhead), the dura and both optic nerves.
The enhancement around the left optic nerve is best seen on the axial image (yellow arrowhead), while the enhancer
Tuberculous meningitis In this companion case there is high
signal intensity along the basal cisterns on FLAIR-images and leptomeningeal
enhancement along the ambiens cistern and tegmentum.
Note the small enhancing foci in the right hippocampus and left occipital lobe. This
turned out to be a tuberculous meningitis. "Sugarcoating" leptomeningeal enhancement in medulloblastoma.
Meningeal carcinomatosis:
These images are of a 9-year old boy who is known with a posterior fossa medulloblastoma. Images
The medulloblastoma presents as a large enhancing mass (arrow).
There are many small enhancing foci as sign of leptomeningeal metastases.
At follow-up after surgery and
radiotherapy there is irregular and nodular leptomeningeal enhancement.
This
"sugarcoating" enhancement is well demonstrated at the pons and the lining of
the vallecular cisterns. Depiction
of leptomeningeal foci and enhancement can be improved by using contrast-enhanced
FLAIR.
As with meningitis also look at the subarachnoid space at non-contrast FLAIR.
Normally on these images the CSF is suppressed, but in case of pathology the CSF appears more
hyperintense.
A helpful clue for metastasis as differential for meningitis is
the appearance of thick nodular enhancement and the presence of intracerebral
and dural metastases.
Always check the cranial nerves for enhancement.
The clinical signs and history of the patient can be a helpful clue. This is a patient with lungcancer which was complic
nerves are involved? Now on these images it is very difficult to see, but if you were able to scroll through the enhanc
w pathologic enhancement: Also note the pontine metastasis. Carcinomatous meningitis in a patient with lungcance
examples show the advantage of FLAIR+Gd over T1W+Gd in a patient with lung cancer with cerebral metastases and
meningitis. ImagesThe FLAIR-image better shows the leptomeningeal enhancement around the pons (yellow arrow)
Gyral pattern:
The gyral pattern of enhancement is enhancement of the
cortex, most frequently seen in ischemia as a result of reperfusion during the healing

phase in subacute and acute ischemia This can be caused by
luxury perfusion and/or cortical laminar necrosis. Another cause of gyral enhancement is the vasodilatation
phase of migraine headache and posterior reversible encephalopathy syndrome
(PRES). SMART is Stroke-Like Migraine Attacks After Radiation Therapy, which is an uncommon delayed complication
cerebral radiotherapy.
Subacute infarction:
These images are of a 86-year old man who has a wobbling walk since a couple of weeks. Study the images and then
What are typical findings in this case? Typical findings: This type of gyral enhancement is the result of luxury perfusio
vascularization. Continue with more images of this patient.. Question: what is the hyperintensity on the non-contrast
The FLAIR shows an infarction with cytotoxic edema and
swelling of the gyri. The hyperintensity on the non-contrast T1W-image is called laminar necrosis and although first c
as anoxic encephalopathy, it represents cytotoxic oedema with degradation of
proteins within the metabolic active cortex.
It is a poor prognostic
indicator. In this table the findings in luxury perfusion and laminar necrosis are summarized. In patients who are trea
n start earlier. Gyral enhancement in a woman with breast cancer Sometimes it can be difficult.
This patient had a history of breast cancer.
An MRI was done because she had some neurological failure. On the FLAIR image there is a tiny hyperintense spot (v
Now this could have been diagnosed as a possible metastasis, but on the T1W-image with Gd there is definitely linea
This makes a small subcortical infarction the most likely diagnosis.
A follow up scan (not shown) was performed and definitely excluded the possibility of a metastasis. Multiple infarctio
on, which was complicated by clotting problems and this resulted in multiple infarctions. Notice the gyral pattern of t
gain notice the gyral enhancement on the T1W+Gd images as a result of luxury perfusion and notice the widespread
areas are involved? These areas are called the watershed or border zone areas.
A border zone area receives a dual blood supply from the most distal branches of two large arteries.
In times of systemic hypoperfusion, such as in disseminated intravascular coagulation or heart failure, these regions
ed by the most distal branches of their arteries, and thus the least likely to receive sufficient blood.
SMART:
These images are of a 59-year old man, who had a partial resection of a glioma in 2008.
In 2016 there was progression of the tumor which was treated with radiotherapy followed by chemotherapy.
In 2021 there was no sign of residual tumor and in 2022 this patient presented with migraine. Images In 2008 a tumo
at the right basal ganglia and insular region. In 2021 everything is stable, but in 2022 there is gyral
enhancement of the grey matter of the temporal lobe (arrowheads). Continue with two more images of this patient..
DWI shows cortical diffusion restriction in the right temporal lobe.
The sagittal T1W+Gd-image at a different level again shows the gyral enhancement pattern. This is called SMART (Str
It is an uncommon delayed complication of cerebral radiation therapy characterized by cortical swelling and gyral en
ure and hemiparesis is also a possible presentation.
In the context of prior brain radiotherapy this should raise the suspicion of SMART syndrome.
Prompt diagnosis is essential to avoid unnecessary invasive investigations.
It is a self limiting disease. It is a diagnosis per exclusionem and you have to rule out ischemia, PRES and seizures. He
Herpes encephalitis:
A 13-year old girl was admitted to the hospital with acute headache and confusion. Images
FLAIR images show widespread hyperintense areas in both temporal lobes and insula.
This is more pronounced on the right side where the T1W+Gd
shows gyral enhancement of the insular cortex. This is a typical case of Herpes encephalitis. Continue with more ima
the NECT compard to the findings on MR. The right temporal lobe is more hypodense compared to the
left with some compression of the right temporal horn (white arrow).
Note also
the small hypodensity at the insular ribbon (black arrow). CT is less sensitive than MRI and can detect abnormalities
only in half to two-thirds of the patients.
It may take 3-4 days to manifest
the changes in the temporal or frontal lobes.
Hypodensities, hemorrhage and
edema are often noted, while contrast enhancement may take almost a week. The DWI
shows diffusion restriction on both sides.
MRI
is more sensitive and subtle abnormalities as diffusion restriction can be
present at an early stage.
In case of suspicion a lumbar puncture is warranted
and prompt treatment should be started. Herpes encephalitis

Herpes encephalitis is a reactivation of the HSV-1 virus which is located in the trigeminal ganglion.
Herpes encephalitis has a bimodal spread.
It is seen in young children and in patients over fifty. Limbic encephalitis
Limbic encephalitis can present with similar imaging findings, but usually has a more indolente course, whereas herp
presents more acutely. It is a paraneoplastic or auto-immune disease where neuronal antibodies attack the cells in t
Antibodies can sometimes be found in the CSF, but a normal CSF and brain imaging does not exclude the diagnosis.
Patients are treated with immune therapy.
Vascular / Perivascular:
Perivascular enhancement is a linear type of enhancement
along the smaller vessels and in the perivascular space. On axial images this type of enhancement can present as sm
dots (see figure) or stripes in the distribution of the perivascular spaces. The differential diagnosis of perivascular en
contains many rare diseases, which makes it difficult.
PML-IRIS:
PML-IRIS is a paradoxical deterioration of the patient
following abrupt improvement of the patients immune function. The improvement of the immune system results in
of the inflammatory response to a JC virus infection. It is seen in HIV patients following initiation of
antiretroviral therapy (HAART). The same mechanism with development of PML-IRIS, that we see in
these HIV patients, can be seen in MS patients who are treated with Natalizumab. These images are of a HIV-patient
ehaviour disturbances. Images
On the T2W-image there is hyperintensity of the right frontal white
matter.
Notice the punctate enhancement on the axial images, which is actually
linear on coronal or sagittal images (not shown). This is a perivascular pattern and combined with the history
the diagnosis is PML-IRIS. PML-IRIS in a patient with HIV Here another patient with HIV, who had started HAART two
months ago. The CD4-count is good. However, there is a progressive paresis and the patient is experiencing
more seizures.
Large bilateral white matter lesions are shown with punctuate
enhancement on the post-contrast T1W-Image. The diagnosis PML-IRIS was made and the patient was treated
with steroids.
CLIPPERS:
CLIPPERS is a Chronic Lymfocytic Inflammation with Pontine Perivascular Enhancement Responsive to Steroids. It ca
ymphoma and that is why some cases that were first diagnosed as CLIPPERS turned out to be lymphoma. These ima
of function of the oculomotor nerve on the left side. Images
FLAIR images show widespread hyperintensity in the pons and
mesencephalon.
There is punctate and linear enhancement.
When we combine the punctate enhancement of different levels,
we can imagine that it actually is part of a linear or perivascular
enhancement. Differential diagnosis: Continue with post-treatment images of this patient... CLIPPERS This patient wa
nymore seen on the follow up exam. Continue with the sagittal images... CLIPPERS pre- and post treatment. Also on
n the follow up image (green arrow). Metastases in the watershed areas These images are of a patient with stage IV l
She presented with nausea, vomiting and confusion. Initially it was thought that this was PML-IRIS.
The treatment was stopped.
Tests however didn't find any sign of a JC-virus infection and the patient got worse. Finally this proved to be metasta
essels in the watershed areas.
Periventricular:
Periventricular enhancement follows the subependymal lining of the ventricles.
In case of thin enhancement this is most often caused by an infection, whereas one should think of tumor in case of
Ventriculitis:
These images are of a 62-year old male, who presented
with headache, fever and lethargy. Images On the contrast-enhanced FLAIR-images there is a hyperintense lining of
visible than on the contrast-enhanced T1 W images. This proved to be a Lyme meningitis, which was complicated by
ventriculitis. Continue with some additional images... There is restricted
diffusion in the left ventricle.
The leptomeningeal enhancement is well appreciated on the contrast-enhanced FLAIR-images (arrowheads). This fin
should be considered in the differential diagnosis.
When bilateral enhancement of the facial nerve is present, always consider lyme meningitis. These images are of a p
The abscess shows central diffusion restriction with a relatively thick enhancing wall.
The yellow arrowheads points towards the thin enhancement of the ventricular wall. Conclusion
Intraventricular

extension of the abscess, which resulted in ventriculitis. These images are of a 63-year old male, who presented with
arrow) in the right semioval centre.
Notice that there is significant ventricular
involvement.
Next to the ventricular enhancement, there is diffusion
restriction in the abscess and the ventricle (arrowheads)
GBM subependymal spread:
This patient was previously treated for a GBM and now has a
recurrence in the left frontal lobe. Images
There is thick enhancement along the left
lateral ventricle, which is subependymal tumor spread.
Nodular pattern:
Solid nodular enhancement can be solitary or multiple, ranging from minuscule to larger lesions, with a wide differen
Always take a close look to the location of the lesions as this can aid in differential diagnosis. On axial images norma
Septic emboli:
These four images are of a young patient with a pneumococal sepsis who deteriorated and became comatous. Imag
areas and at the gray/white matter interface.
There is diffusion restriction (white arrowheads).
This pattern is identical to the previous cases. Conclusion
This was regarded as septic emboli. Mutiple Sclerosis
Multiple sclerosis:
This patient is known with MS. Notice that some of the hyperintense lesions, that are seen on the FLAIR
image, show enhancement on the T1W+Gd image. which is a sign of active disease.
The enhancing lesions
show different patterns of enhancement: nodular and (incomplete) ring. The
lesions are also located in the corpus callosum.
This
is not a frequent location for metastases or ischemia, but commonly seen in MS.
The location of the
FLAIR abnormalities perpendicular to the ventricles (Dawson fingers), the
juxtacortical location of the white matter lesions and the incomplete
enhancement make the diagnosis of a d emyelinating disease, i.e. MS most likely.
Smooth Ring:
The differential diagnosis of ring enhancing lesions is shown in the table. In this table some findings, that can help to
Pyogenic Abscess:
The various MR-findings of a pyogenic abscess are shown in the table.
The most typical finding is a peripherally-enhancing lesion with central diffusion restriction. The MR-findings can be f
can be false positive when there is a tumor with infected central necrosis. These images are of a 55-year old male wi
First look at the images and then continue reading. Question: The findings are: All these findings are
consistent with the diagnosis of cerebral abscesses.
A double rim on T2W-images can be seen in up to 75% of cases.
Classically there is a complete rim
enhancement and diffusion restriction, but sometimes there is incomplete enhancement as the abscess points
towards the ventricle, ready to empty the pus into the ventricular system. You
can see the beginning of that process in the right frontal abscess.
When this abscess ruptures into the ventricle the rim will be interrupted and there will be
diffusion restriction within the ventricle. These images are of a patient, who presented with headache. Images
There is a right parietal lesion, with rim enhancement and central diffusion
restriction.
SWI shows susceptibility at the rim, this is thought to be due to
paramagnetic free radicals, produced by macrophages.
There is also a
hemorrhagic spot at the ventral side, where diffusion is not restricted.
The faint enhancement
outside the inner rim, due to blood-brain-barriere leakage, can make
differentiation from a tumor difficult, but the restricted diffusion,
together with a low rCBV (not shown) makes the diagnosis of an abscess the most likely Here a more difficult case.
This is a patient, who presented with acute cerebellar
signs. Images
On the T2W-image there is a hyperintense lesion, which shows rim enhancing after contrast

administration.
This is luxury perfusion in an enhancing subacute infarction.
Note also the older infarctions in the left cerebellar hemisphere. When in
doubt, follow-up imaging can help.
Irregular Ring:
In the table the various causes of an irregular ring enhancement.
There is some overlap with smooth ring enhancement. These images are of a 47-year old male, who presented with
A ring enhancing lesion is present in the left basal ganglia.
Note the enhancing structures within the inner border of the
enhancement.
There is no diffusion restriction, which makes the diagnosis of an abscess unlikely. This is a pathologically proven
GBM. These images are of a 55-year
old patient, who presented with headache and aphasia. First look at the images and then continue reading. ImagesT
frontotemporal lesion, which is bright on T2W, with thick and irregular ring enhancement.
The lesion follows - and extents into the white matter like
the uncinate fasciculus and the u-fibers.
The centre of the lesion shows no diffusion restriction and no enhancement and is most likely necrosis. The most lik
Glial
tumors originate from glial cells in the central nervous system and are
infiltrative tumors.
GBM's are the most malignant primary brain
tumors.
They diffusely infiltrate along the white matter tracts, as e.g. the
corpus callosum. These images are of a patient with metastatic lung carcer. There are two enhancing
metastatic lesions in the left hemisphere.
On the T1W-image with Gadolinium there is also
extensive enhancement of the vessels making it difficult to detect the metastases.
On the black blood sequence the signal of the blood in the
vessels is suppressed making the recognition of the enhancing metastases easier. In this patient your eye is attracte
lesion in the right parietal lobe with irregular and partially thick enhancement .
There is mass effect and surrounding edema, without restricted diffusion. One could think of a glioma.
However, there are several other
lesions far apart.
One of them with a characteristic location at the gray-white matter
interface (arrow).
These turned out to be metastases This patient has a history of lungcarcinoma and presented with headache and m
slowness. Take a look at the images and then continue reading.
Question: ImagesThere
are multiple connected ring enhancing lesions with surrounding edema in the right hemisphere.
The
lining is relatively thin and smooth with central diffusion restriction.
There
is extension to the right lateral ventricle with enhancement of the ventricular
lining (arrow).
Note also the diffusion restriction at the trigonum of the left lateral
ventricle.
Many thought that this was metastatic disease because of the history, but the findings are more typical for abscesse
Toxoplasmosis:
These images are of a 50-year old female, who presented with a left-sided
hemiparesis.
Her medical history was unremarkable. Images
There is a rim-enhancing lesion in the right frontal lobe.
There is no central diffusion restriction, but with an eccentric target sign.
This
target sign is highly suggestive of cerebral toxoplasmosis. This sign is thought to represent enhancing inflamed vesse
within the abscess cavity. This is a companion case of a 34-year old female, who presented with seizures. Images
There is a rim-enhancing lesion in the
left frontal lobe with a target sign and rim-like diffusion
restriction.
Note also the low signal intensity on T2W and FLAIR Final diagnosis: toxoplasmosis. As classical bacterial causative ag

demonstrate central diffusion restriction, atypical causative agents like fungi
and toxoplasmosis do not, making the diagnosis of a cerebral abscess more
challenging.
An eccentric target sign as in this case is very helpful for the
diagnosis. This is a challenging case of a 60-year old patient, who presented with headache. Images
There is a right frontal lesion with a thick hyperintense rim, which is already visible on the T1W-image without contra
,
could this be a tumor?
Let's take a look at the other sequences. On the FLAIR-image the lesion is relatively hypointense.
On the gradient echo there are susceptibility artefacts at the rim and centrally constistent with hemosiderine.
There is central diffusion restriction due
to clot formation and the T1W hyperintensity is due to methemoglobine. Findings are consistent with an intraparenc
hemorrhage.
Because of the suggestion of an underlying lesion, the patient was
operated, but no tumor was found.
Open ring enhancement:
The pattern of an open ring usually suggests a demyelinating disease, but is less frequently seen in an abscess. In de
periphery, while an abscess wants to get rid of the pus centrally into the
ventricles, just like an intracerebral hematoma, that leaks into the
ventricular system.
Tumefactive MS:
These images are of a 50-year old woman, who presented with a
hemiparesis of the left arm and leg. No previous history. First look at the images. What are the findings? Images Thes
Here another tumefactive MS-case.
Notice the dilated vein in the centre of the lesion. Most MS lesions in the cerebral white matter expand outward from
This is called a perivenular
distribution. Continue with more images of this patient... There is an incomplete ring enhancement.
Notice that the open ring points towards the ventricle (arrow), which would favor the diagnosis of an abscess. Howev
there
is a central vein on SWI and
on the DWI (not shown) there was no diffusion restriction In this case the open ring does not follow the rule. Here ar
patient with demyelinization. These images are of a 52-year old woman who was treated for AML and now presente
. ImagesOn
the contrast-enhanced
T1W-image
there is a hypointense lesion without any mass effect, with incomplete enhancement
of
the wall.
Only
this enhancing part of
the lesion shows diffusion restriction (arrowheads). Conclusion
We regarded this as demyelinization with open ring enhancement. This proved to be progressive multifocal leukoen
tunistic infection of JC virus in patients with severe immunodeficiency.
Abscess:
Although abscesses classically present with a complete ring, they sometimes present with open ring enhancement li
In the left frontal lobe is a lesion with open ring enhancement next to the frontal sinus.
There is a small defect in the wall of the sinus (arrowhead).
The central part of the lesion shows diffusion restriction. Conclusion
Intracerebral abscess as a complication of a frontal sinusitis.
Cyst with Nodule:
In this enhancement pattern, the age of the patient is important for your differential diagnosis.
In children the differential diagnosis is Pilocytic astrocytoma, Ganglioglioma and Pleomorphic xanthoastrocytoma (P
In adults hemangioblastoma is more
likely.
Pilocytic astrocytoma:
Pilocytic astrocytoma is the most common childhood brain tumor and most often found in the posterior fossa.
Complete resection usually cures the patient. These images are of a 9-year old child who presented with headache. I
there is a large cystic posterior fossa mass with compression and
obstruction of the fourth ventricle and brainstem.
A solid contrast enhancing

nodule is present, as well as enhancement of the cyst wall. Conclusion
Most likely diagnosis at this age is a pilocytic astrocytoma These images are of a 3-year old child who also presented
Take a closer look at the images and then continue reading. ImagesLarge cyst with enhancing nodule in the posterio
Notice that the wall of the cyst enhances.
The nodule is not located on the pial side (inner part of the meninges) unlike in a hemangioblastoma. ConclusionMo
The enhancing wall is part of the tumor and needs to be resected. These images are of a 25-year old man. What are
Take a closer look at the images and then continue reading. Images
Cystic lesion in the suprasellar region with a solid enhancing nodule complicated by an obstruction hydrocephalus. C
For
suprasellar lesions, a large differential diagnosis is present (mnemonic
SATCHMO).
On the NECT
there is no calcium in the tumor, which makes a craniopharyngioma unlikely.
In this location the most likely diagnosis is an optic pathway glioma.
Most of them are
pilocytic astrocytoma.
In older patients a pilocytic astrocytoma can be located above the level of the tentorium.
Hemangioblastoma:
Hemangioblastoma occurs most often in the cerebellum, where it is the most common primary neoplasm in adults.
It is less commonly seen in the spinal cord.
They start as a solid nodule and gradually develop a cyst.
The nodule is located on the pial side (inner part of the meninges).
The wall of the cyst is not a part of the tumor and normally they do not enhance, unless in cases when there has bee
Since the wall is not tumor, it is not necessary to resect the whole cyst. These images are of a 63-year old woman wh
ely visible? ImagesThere is a large cyst with a small enhancing nodule in the right cerebellar hemisphere.
The wall of the cyst does not enhance.
Notice that the tumor nodule is located on the pial side (arrow).
There are two more enhancing small nodules on the posterior side of the cerebellum. Multiple tumors are almost al
a 29-year old man. Images
Cystic lesion with a non-enhancing wall and an enhancing nodule on the pial side. Conclusion
Typical hemangioblastoma.
When this tumor is going to be resected, they only have to remove the nodule.
Ganglioglioma:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. by James Smirniotopoulos et al. RadioGraphics 2007; 27:525–551
None:

None:

Child abuse - Diagnostic Imaging 2.0:

Non Accidental Trauma:
Simon Robben and Rick van Rijn
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Publicationdate 2021-11-19 This is the second version of diagnostic imaging in child abuse. Child
abuse is a relatively common problem in our society.
In the Netherlands
it is estimated that 100,000 to 180,000 children a year are abused in some form
or manner. This means that one in thirty children under the age of 18 years has been a victim of abuse. The
incidence of fatal child abuse differs between countries.
The WHO estimated
that in the year 2000 world-wide 57,000 children were victims of
homicide. More information: Child abuse and neglect. This
overview focusses on the role of diagnostic imaging in depicting the findings
that are specific for physical child abuse.
Awareness
of the radiologist is essential in finding these CNS, skeletal, and abdominal injuries
in order to document child abuse.
This to stop further abuse, provide help and

intervention for the family, and to protect siblings.
Introduction:
Battered
child syndrome, shaken infant syndrome and non-accidental trauma are all terms
to describe the complex of injuries in infants and young children as a result
of abuse. Shaking
is considered a frequent mechanism of trauma in child abuse, causing rib fractures, metaphyseal avulsion
fractures, subdural and retinal haemorrhage.
However the term “shaken baby syndrome” is now considered
obsolete.
Role of the Radiologist:
The
ability to identify child abuse constitutes an important concern to those
involved in the medical care of children.
Studies
show that at least 10% of children under 5 years old who are brought to the
emergency room with trauma have actually suffered non-accidental trauma. As many
as 65% of all abuse cases are initially seen in the emergency room, the first
step in correctly identifying abuse is therefore to train hospital staff
members to recognize abuse indicators. The wide
range of findings, which can mimic other disease processes or normal variants, implies
that the definitive diagnosis of child abuse can only be achieved though
interdisciplinary collaboration.
Several
studies have reported that 30-80 % of confirmed physical child abuse cases were
missed on initial presentation and many infants sustained additional injury
because of the delay in diagnosis. The
radiologist can be the first to suggest the diagnosis on the basis of imaging studies
performed for a wide range of clinical
indications. Other roles for the radiologist are listed in the table.
The
future safety of a physically abused child partially rests on the radiologist's
performance of these roles.
CNS injury:
Bilateral hypoechoic subdural fluid collections that outline the arachnoid membrane very well (arrows). The cloudy a
omas barely show any vessels in contrast with the abundant subarachnoid vessels.
Subdural hematoma:
CNS injury related to non-accidental injury is a leading cause of morbidity and mortality in infants and children.
Some state that eighty percent of deaths of children under 2 years of age result from non-accidental head trauma. A
in proportion to the rest of its body.
The infant brain is poorly myelinated and is surrounded by larger subarachnoid spaces than the brain in older childr
th, much like in a whiplash injury, causing the brain to rotate and hit the front and back of the skull. This can damage
Imaging studies of the head may show subdural or subarachnoid bleeding, diffuse axonal injury and associated cere
browser doesn't support embedded videos. This is a video of a color doppler in another child with bilateral subdura
sels in contrast with the abundant subarachnoid vessels. Although
haemorrhage can occur at any site, the tendency is for blood to extend into the
interhemispheric fissure (arrow on image on the right). Image
Left parietal hyperdense subdural hematoma and small right
fronto-parietal subdural hematoma extending into the interhemispheric fissure. MR
examination is more sensitive in detecting subdural hematomas.
In all
cases we advise to add susceptibility weighted imaging (SWI) sequences to the
imaging protocol. Images
Subtle subdural hematoma on CT is seen to a better advantage on
T2-weighted MRI and the hemosiderin deposits are evident on the SWI (arrows). The American
Academy of Pediatrics proposed to use the term Abusive Head Trauma (AHT). Another commonly used term is Inflict
classic trauma mechanism described is violently shaking the child back and
forth whilst firmly holding the child around the chest.
However, this can occur
with and without an impact trauma.

Direct impact trauma without shaking can
also occur.
A
shaking incident causes the extremities and the head to flail back and forth in
a whiplash movement. It is important to note that there are no pathognomonic radiological findings for abusive hea
s mandatory. Perfusion defects are a major component of long
term damage.
Therefore diffusion weighted imaging (DWI) should also be part of the
standard MR imaging protocol. Images
2-month-old boy with metaphyseal avulsion fractures, rib fractures and
convulsions. T2-weighted image shows subtle right frontal subdural fluid
collection, but massive diffusion restriction on DWI. It is
important to note that there is no evidence base for dating subdural hematomas
on CT or MRI.
From a medico-legal perspective radiologists should therefore
refrain from dating. (ref 1) ImageT1-weighted image shows bilateral chronic subdural hematomas with
internal membranes that create hyperintense compartments.
This is suggestive of
rebleed, but not definitive evidence for that.
Spinal cord injury:
Cervical
spine compression results as shaking or impact injury damages the spinal cord. Infants
are vulnerable to spinal cord injury because of their large head and weak
underdeveloped paraspinous and neck musculature. Spinal cord injury may be
difficult to document. These infants may exhibit apnoea or vasomotor collapse
similar to spinal shock. Subdural
hematomas can also be found along the spine, with a preference for the lumbar
spine. MRI child abuse protocols should therefore include imaging of the spine.
Skeletal Injury:
From Kleinman PK, Rosenberg AE, Tsai A. Skeletal trauma: general considerations. In Kleinman PK. Diagnostic imagin
Specificity of fractures:
When we
look at pediatric radiographs at the emergency department, we have to realize,
that the forces needed to break a bone in an infant or young child are significant.
Any
fracture in this age group indicates a traumatic event. The
levels of specificity for child abuse given a fracture are listed in the table
on the left. The
classical metaphyseal corner or bucket handle fracture is virtually
pathognomonic for abuse, although a differential diagnosis does exist. Rib
fractures are very common and highly specific for abuse in young children less
than 2 year.
The positive predictive value of posterior rib fractures with
respect to child abuse have been reported to be 80% - 90%. Fractures
of the acromion, sternum and spinous processes are so rare in accidental conditions,
that this gives them a high specificity for abuse. Typical corner fracture very specific for non accidental trauma
Corner fracture:
The metaphyseal
corner fracture, also dubbed by Kleinman as the classic metaphyseal lesion, was first described by Caffey who noted
peculiar fractures in children with subdural hematomas. They are often
bilateral and in the distal tibia seen more often at the medial side. When a
small piece of bone is avulsed due to shearing forces on the fragile growth
plate it is seen as the typical corner fracture. These fractures are most
common in the tibia, distal femora and proximal humeri. They are frequently
bilateral. These
fractures are often subtle, and the likelihood of detection is directly related
to the quality of the radiologic studies. It is
for this reason that skeletal surveys in cases of suspected child abuse must be
performed with utmost attention to the quality of the radiographs.
Bucket handle fractures:

Bucket handle fractures are essentially the same as corner fractures.
The avulsed bone
fragment is larger and seen 'en face' as a disc or bucket handle. Images
Bucket handle fracture in proximal tibia. The metaphyseal fracture fragment is seen as a disk or bucket handle.
Rib fractures:
In
violent shaking the child is held very tightly around the chest and squeezed
while being shaken. This compresses
the ribs front to back and tends to break them next to their attachment to
vertebrae and laterally where they are being literally almost folded in half. As a
result of this specific trauma mechanism, lateral and posterior rib fractures
are highly specific for abuse. Cardiopulmonary
resuscitation is rarely, if ever, a cause of such fractures. Old posterior rib fractures very indicative of non accidental t
d incidentally on chest X-rays performed for other reasons, such as evaluation for pneumonia.
Rib fractures are highly specific for abuse. In a study in the Netherlands a total of 254 fractures were found in 56 cas
nce of rib fractures and metaphyseal fractures (ref). Rib fractures pose difficulties similar to those of metaphyseal inj
In the acute stage they are not evident on radiographs, as little displacement occurs.
They are often identified on the repeated skeletal survey when the fractures are in the healing stage showing callus.
fractures at the ventral ends of the ribs are challenging. Ultrasonography
is helpful in detecting dislocation at the ventral costo-chondral junction. Images
Child evaluated for soft tissue mass in costchondral region. The ultrasound shows soft tissue swelling (yellow arrows
ange arrow) of rib. The Initial chest film was negative. Chest film 2 weeks later showed fractures. LEFT: eggshell fractu
n from a height. RIGHT: skull fracture in abused child
Skull fractures:
Skull
fractures are common child abuse injuries, but they are also common in
accidental trauma. Patterns
of skull fracture that suggest child abuse are: The
infant's skull is rather resistant to trauma, so any fracture that is not
consistent with the history should raise the question of non-accidental injury. Two infants with a femur fracture. Chil
nconsistent history given by the parents.
Diaphyseal fractures:
Diaphyseal
fractures are non-specific as they do occur in both accidental and
non-accidental injury.
However
in these cases the age and developmental stage of the child and the clinical
history is very important. A fall
out of a bed will usually not produce a diaphyseal fracture.
In order
to acquire a transverse diaphyseal fracture of the femur a considerable amount
of power has to be applied. Spiral
fractures are a result of twisting forces.
Although
often stated there is no evidence that a spiral fracture of the lower extremity
has a higher specificity of abuse compared to oblique or transverse fractures. Diaphyseal femur fracture with a lot o
Fracture healing:
Callus
in diaphyseal fractures generally forms no earlier than 5 days after a
fracture, but will usually form by 14 days.
Thus,
fractures without visible callus may be up to 14 days old, and fractures which
demonstrate a little bit of callus are at least 5 days old. Large amounts of
callus indicate at least 2 weeks old. These
signs can be used to correlate with the history. For instance a child that fell
out of bed the day before cannot have a fracture with callus formation. Although
it is impossible to exactly date a fracture it is clearly possible to discern
different healing stages within a case. Thus having an evidential value for
multiple incidents leading to the fractures.
Metaphyseal

fractures and skull fractures typically do not heal with callus as there is no periosteal disruption, so dating of metaphyseal fractures is difficult.

Abdominal injuries:

In general visceral injuries in children are rare, however when diagnosed common abdominal injuries in abused children are: Visceral injury is seen at autopsy of young infants, but it is rarely documen It is estimated that 2-10% of all abdominal injury results from child abuse. The mean age of these children is about 2 . It is more common in boys than girls. The mortality rate in abdominal injuries is 50% due to 'patients and doctors d These children are brought to the hospital days after the injury, when a perforation already has resulted in peritoniti The history given by the abusers usually does not correlate with the symptoms, which makes these cases very difficu The CT shows pancreatic laceration in child abuse. These abdominal injuries are non-specific and could also be attrib ld abuse, there is a history that does not correlate well with the injuries, that are found. So you have to look for othe Liver laceration in child abuse

Retinal hemorrhage:

Retinal haemorrhage is seen in a high proportion of cases of infant abuse in which shaking is documented. Ophthalmologic examination is the gold standard, but sometimes the retinal abnormalities can be seen with MRI.

As retinal haemorrhages can resolve in a short time span the ophthalmologic examination should be done within 24 hours after presentation. Images

The SWI shows bilateral subdural hematomas in a 3-month-old abused girl.

The T2W-image shows subtle retinal thickening in the right eye and detached retina on the left.

Imaging survey in suspected abuse:

Initial skeletal survey:

A protocol for imaging in suspected abuse should be present in every hospital. Radiographic skeletal survey is necessary in all children less than 2 years old suspected of abuse. In children over the age of 2 a skeletal survey should only be done on indication. It has been defined by the Royal College of Radiologists and the Society and College of Radiographers and consists of the radiographs shown in the table (ref). The authors do not encourage the use of a exposure of the extremities, but prefer individual radiographs of each long bone.

Follow-up skeletal survey:

After two weeks a limited repeated skeletal survey shown in the table on the left should be performed. This skeletal survey may provide evidence of a healing injury, that was unapparent on the initial study. Expert attention to technique and detail is necessary to get quality radiographs that show some of the very subtle injuries of abuse.

Never ever perform a 'babygram'. Remember that these are the radiographs that will go to court. Nuclear bone scan is usually not necessary. Perform this only if there are equivocal findings on the skeletal survey or if there is a high clinical suspicion of skeletal injury but the skeletal survey is normal.

Conventional radiographs of the areas of abnormality identified at bone scan, are still needed to evaluate for the exact nature of the abnormality.

Brain CT in suspected abuse:

CT of the brain should be performed on all suspected abuse victims under one year old. Children who are older than one year and have external evidence of head trauma and/or abnormal neurological symptoms or signs should also have a CT scan of the head. A CT scan is superior in detecting skull fractures (especially 3D reconstructions) and demonstrates subdural haemorrhages (ref).

Differential diagnosis:

1 day old child with multiple fractures after a problematic delivery. Birth weight was 5500 grams.
Accidental injury:
Accidental
subdural haemorrhages have been reported in infants after motor vehicle
collisions or falls involving substantial angular deceleration. In cases
of accidental head injury, the history is clear and consistent, the infant's
symptoms reflect the forces described, and no unexplained skeletal injuries are
identified. Birth
trauma resulting from high birth weight and traumatic delivery has been
postulated as a cause of rib fractures in infants, but this is extremely rare
(figure). Rib
fractures associated with accidental trauma are rare and require significant
force to produce such as direct chest wall trauma from motor vehicle crashes,
because the elastic and more flexible chest wall of infants allows for greater
compression without injury. Cardiopulmonary
resuscitation also has been implicated as a cause for rib fractures. Many
critically ill children receive CPR and have no evidence of rib fractures. More
important, CPR has not been reported to cause posterior rib fractures.
Coagulopathies:
A variety of coagulopathies is associated with intracranial hemorrhage in infants, including hemophilia and hypoprot
These disorders are suggested by the clinical history, physical findings, and laboratory tests. Osteopenia and fracture
Osteogenesis imperfecta:
Osteogenesis imperfecta is a rare inherited disorder of connective tissue.
Other skeletal findings in these patients are generalized osteoporosis, wormian bones, bowing and angulation of he
, suggestive findings include blue sclerae, hearing impairment, dentinogenesis imperfecta, hypermobility of the joint
plication of the disease.
Menke's disease:
Menke's disease is a very uncommon inborn error of metabolism. In these patient's small metaphyseal hooks can be
Small metaphyseal hooks seen in a patient with Menke's disease.
Spondylometaphyseal dysplasia:
Spondylometaphyseal dysplasia, 'corner fracture' type is a skeletal dysplasia associated with short stature, developm
actures' of long tubular bones and vertebral body abnormalities. Image
The x-rays show a rare case
of spondylometaphyseal dysplasia corner fracture type.
In these
children the form of the metaphysis is irregular resembling an old corner
fracture. However, vertebral anomalies are also present.
Caffey's disease:
This is
a rare disease of unknown aetiology.
These
children have extreme periosteal reactions. This can lead to the erroneous
diagnosis of healing fractures. Image
Abundant periosteal bone formation in a case of Caffey's disease
Normal variants:
The
pointed appearance of the metaphyseal borders (beaks or spurs) may simulate
metaphyseal avulsion fractures.
Another normal variant is the metaphyseal
collar. Image
1.5 year-old-boy with accidental spiral fissure of the left femoral
shaft. Initially, the metaphyseal collar (white arrows) and metaphyseal spur
(red arrow) were interpreted as torus fractures and metaphyseal avulsion
fracture, respectively. This raised suspicion for non-accidental injury. However, these are
normal variants. The
proximal shaft of the tibial may show a small prominence of unknown origin that
may be mistaken for a torus fracture. Christian CW, Block R, Committee on Child Abuse and Neglect; American Acade
2. Age determination of subdural hematomas with CT and MRI: a systematic review. Sieswerda-Hoogendoorn T, Post
):1257-1268.
3. Diagnostic Imaging in Infant Abuse (in PDF) Am. J. Roentgenol. Kleinman 155 (4): 703. Review article by Paul K. Klei

4. The metaphyseal lesion in abused infants: a radiologic-histopathologic studyPK Kleinman, SC Marks, and B Blackb
5. Nonaccidental Head Injury in Infants; The 'Shaken-Baby Syndrome' Ann-Christine Duhaime, M.D., Cindy W. Christia
COVID-19 Imaging findings:
COVID-19 is a viral disease also known as SARS-CoV-2 or severe acute respiratory syndrome coronavirus 2. The diagn
as a higher sensitivity but lower specificity and can play a role in the diagnosis and treatment of the disease.
In this article we will describe the role of imaging. Click hereto go to the covid-19-ct-report-template. Press ctrl+for la
This can be helpful for scroll-images.
Single images can be enlarged by clicking on them.
Introduction:

Clinical Features:
COVID-19 usually presents with fever (85%), cough (70%) and shortness of breath (43%), but abdominal and other sy
Overal mortality rate is 2.3% in some series of patients who had a positive test for COVID-19.
Since we do not know the number of people who were infected but not tested for the virus, the actual mortality rate
ss severity can vary from mild to critical.
PCR-test:
The PCR-test is very specific, but has a lower sensitivity of 65-95%, which means that the test can be negative even w
Another problem is, that you have to wait for the test results, which can take more than 24 hours, while CT results ar
Common laboratory findings in COVID-19 are a decreased lymphocyte count and an increased CRP and high-sensitiv
Chest CT:
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Ground glass:
Ground glass (GGO) pattern is the most common finding in COVID-19 infections.
They are usually multifocal, bilateral and peripheral, but in the early phase of the disease the GGO may present as a
the right lung (6). CT-images of a young male, who had fever for ten days with progressive coughing and shortness o
Saturation at admission was 66%.
The PCR test was positive for COVID-19. There are widespread bilateral ground-glass opacities with a posterior predo
Crazy paving:
Sometimes there are thickened interlobular and intralobular lines in combination with a ground glass pattern.
This is called crazy paving. It is believed that this pattern is seen in a somewhat later stage.
Vascular dilatation:
A typical finding in the area of ground glass is widening of the vessels (arrow).
Traction Bronchiectasis:
Another common finding in the areas of ground glass is traction bronchiectasis (arrows).
Subpleural bands and Architectural distortion:
In some case there is architectural distortion with the formation of subpleural bands. Enable Scroll
Disable Scroll COVID-19 infection. Predominantly bilateral subpleural GGO with some areas of crazy paving. In the lo
ment is approximately 25% by visual assessment. Enable Scroll
Disable Scroll COVID-19 infection. Predominantly bilateral subpleural GGO with some areas of crazy paving. In the lo
ment is approximately 25% by visual assessment.
CT involvement score:
The severity of the lung involvement on the CT correlates with the severity of the disease. Visual assessment
The severity on CT can be estimated by visual assessment.
This is the easiest way to score the severity.
The CT images show a 25% involvement by visual assessment. Severity score
Another method is by scoring the percentages of each of the five lobes that is involved: 75% involvement. The total C
from 0 (no involvement) to 25 (maximum involvement), when all the five lobes show more than 75% involvement.
Some say that the percentage of lung involvement can be calculated by multiplying the total score times 4.
This however is not true. Suppose that all lobes have a 10% involvement, then this would lead to an overall score of
involved. Common Patterns and Distribution on Initial CT Images of 919 patients COVID-19 (4).
Initial CT-findings:
Initial CT-findings in COVID-19 cases include bilateral, multilobar ground glass opacification (GGO) with a peripheral
frequently in the middle lobe (4).
Consolidation superimposed on GGO as the initial imaging presentation is found in a smaller number of cases, main
ural thickening, and subpleural involvement are some of the less common findings, mainly in the later stages of the
cavitation, CT halo sign, and pneumothorax are some of the uncommon but possible findings seen with disease pro
her viral pneumonias. Enable Scroll
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Disable Scroll CT-images of a 78 year old male with coughing for 2 weeks and progressive shorteness of breath, who
cities with a posterior predominance.
In the right lower lobe there is a consolidation and there is bronchiectasis especially in the left lower lobe. About 75%
es of a 59 year old male who had fever for one week with non-productive cough.
The PCR-test was negative. Because of clinical suspicion a CT was performed which showed some areas of GGO and
on sagittal reconstruction). Two days later a sputum test was positive for COVID-19.
Changes over time:
Advanced-phase disease is associated with a significantly increased frequency of: Early phase COVID-19 This 59 year
ughing.
The O2 saturation was 89 and her respiratory rate was 30/min (normal: 12-18). There are widespread GGO's without
ly phase COVID-19. These images are of a 49 year old male with fever, cough and a low saturation. The images show
ly likely - late phase. COVID-19 infection - late phase This patient had fever for one week with some abdominal pain a
On the day of admission she had a dry cough and complained of dizziness.
The O2-saturation was low.
The PCR-test was not known and a CT was performed for triage. The images show: Based on the CT-findings COVID-1
CT Report:
In the tabel a checklist of CT findings to mention in the report. In the first four days after the presentation of the com
patients may have a normal CT. After these first four days, the CT has a very high sensitivity. Click here to go to the
COVID-19 Standard Report CT:

Chest radiograph:
Courtesy Dr. Michael David Kuo (1). The chest film is insensitive early in the disease. Here a comparison of a chest ra
The ground glass opacities in the right lower lobe on the CT (red arrows) are not visible on the chest radiograph, whi
be useful in the follow-up of the disease. These x-rays are of a patient with COVID-19. On admission to the hospital t
Four days later the patient is on mechanical ventilation and there are bilateral consolidations on the chest film. Ches
ary hypertension and atrial fibrillation with COVID-19 infection. Ground-glass opacification and consolidation in right
r Lorente (5) A series of chest films of a 72-year-old woman admitted with acute respiratory failure, fever (38ºC) and c
She was tachypneic (30bpm), with lymphopenia and low oxygen saturation (SpO2 85%). Patient presented to the em
h, odynophagia and general malaise.
She was discharged from hospital because she did not present alarm criteria at that time. The patient required mech
During her stay in ICU, poor evolution to respiratory distress syndrome and to multi-organic failure.
The patient died 24 hours later. Imaging findings:
Possible role of CT:
CT can play a role in: Triage Some published clinical guidelines recommend chest CT for patients with suspected COV
erations:
Video cases of CT Chest:
... This is a 67 year old woman who was coughing for one week and now presented with shortness of breath. This is a
th a halo sign, some areas of ground-glass and consolidations in the lower lobes. Based on the CT-findings she was s
The PCR-test the next day was positive. 60 year old male with complaints of fatigue and coughing for one week.
COVID-19 Lung Disease: a pulmonary vasculopathy:
Watch the presentation by Dr Graham Lloyd-Jones, Director of Radiology Masterclass, given on November 11th 2020
logy, titled - What can the Radiology tell us about the vasculopathy of COVID-19 lung disease? NG Ming-Yen, LEE1 Ela
Mei-sze, LO Christine Shing-Yen, LEUNG Barry, KHONG Pek-Lan, HUI Christopher Kim-Ming, YUEN Kwok-yung, KUO M
2. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia Qun Li, M.Med., Xuhua
3. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmiss
g Yuan, PhD * Kin-Hang Kok, PhD * Kelvin Kai-Wang To, MD * Hin Chu, PhD * Jin Yang, MD et al.
4. Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients Read More: https:/
Sana Salehi, Aidin Abedi1, Sudheer Balakrishnan and Ali Gholamrezanezhad
5. Rapidly progressive ARDS secondary to COVID-19 infection - Eurorad case 16660 Edgar Lorente Martínez - Hospita
6. CT Features of Coronavirus Disease 2019 (COVID-19) Pneumonia in 62 Patients in Wuhan, China AJR 2020; 214:1–8
None:

Arthroplasty of the Hip:

Normal and abnormal imaging findings:
Iain Watt, Susanne Boldrik, Evert van Langelaan and Robin Smithuis
from the Radiology Departments of the Leids University Hospital, Leiden; the Medical Centre Alkmaar, Alkmaar and t
iderdorp, the Netherlands:
Publicationdate 2006-02-01 Radiography is the primary imaging method for the evaluation of Total Hip Arthroplasty.
cemented versus non-cemented hip arthroplasties. Interactive cases are presented in the menubar to test your kno

Total Hip Arthroplasty systems:
LEFT: Assembled cementless Mallory Head prosthesis.RIGHT: Femoral stem with proximal porous coating for bone in
h a porous coated metal backing. Modern Total Hip Arthroplasty (THA) systems are modular. This means that the fe
s modularity allows for greater flexibility in customizing prosthesis sizing and fit. The acetabular part is usually a poly
with cement, spikes, screws or cementless with porous coating for bone ingrowth. The femoral part is composed of a
al or ceramic. Stem-fixation is also either with cement or cementless with porous coating for bone ingrowth. Most m
ing, as this results in a better longterm outcome
than fully coated (less loosening). Some of the non-cemented THA have femoral stems with additional hydroxyapatit
which further improve bone ingrowth. This coating is not visible on radiographs. LEFT: Hybrid THA with cemented fe
roplasty. Density lateral to femoral stem in Gruens zone I is a bone graft. Hybrid total hip replacements are a combi
r components have a tendency to loosen over time, the combination of a cementless acetabular component with a c
cy to use preferably non-cemented THA, which have better longterm results. On the left we see a hybrid THA with bo
to it a non-cemented bone ingrowth THA.
Initial Evaluation:
The initial films serve as a baseline study and are used as reference films for comparison with all future studies, sinc
cting complications. The initial postoperative films are obtained to look for possible dislocation or fracture and to se
th a large femoral stem with periprosthetic fracture.RIGHT: Cement extrusion intrapelvic through acetabular defect.
heses that are not well positioned, but it is most common in the immediate postoperative period (incidence 3%). Per
ients with poor bone stock and long stem revision prostheses or
when the anatomy is abnormal as in hip dysplasia. or prior surgery. They are also more common in non-cemented fe
ring insertion. The incidence of fractures ranges from 0.1 to 1.0 percent for cemented components and 3 to 18 perce
on the femoral side. Cement extrusion When the acetabulum is prepared for placement of the cup a perforation ma
ant.
Cement extrusion is usually asymptomatic.
Rare complications include bowel fistulas, encasement of neurovascular structures and bladder wall burn. Measure
wer in position than the left indicating leg length dicrepancy.Normal horizontal center of rotation (red line).
Alignment and Positioning:
Acetabular and femoral component positioning should mimic normal anatomy. The distance from center of the fem
ilaterally. This is called the horizontal center of rotation. Excessive lateral positioning of the acetabular component in
transischial line is used as a reference to measure the lateral inclination of the acetabular cup (30-50?). This line is al
discrepancy up to 1 cm is well tolerated. A high positionened cup is better tolerated than a lateral positioned cup. D
due to different rotation on a cross table view (left) compared to a lateral view (right). The anteversion of the acetab
a cross-table or true lateral radiograph is not possible
, since the apparent degree of angulation on a radiograph is affected by pelvic or thigh rotation (figure). Measureme
r pelvic angulation. LEFT: Femoral head with large collar. Dislocation due to increased lateral inclination of acetabula
nd lateral position of a steep acetabular cup. Notice polyethylene wear due to increased forces on the superolateral
ion: Increased lateral inclination of the acetabular cup. Decreased or increased anteversion of the cup. Excessive late
nteversion of the femoral stem. Due to increased forces on the superolateral margin of the cup, increased lateral inc
component also may increase the risk of polyethylene wear of the acetabular liner (see figure). Varus position of fem
ion of the femoral component is with the stem centered in the femoral canal. The center of rotation of the femoral h
Varus position of the femoral stem predisposes to loosening and fracture.
Normal Findings at Follow up:
LEFT: Normal cement-metal interface (yellow arrow). However loosening at cement-bone interface (orange curved ar
Cemented THA:
Normal findings in cemented-THA are different from non-cemented prostheses as the native bone shows more reac
ld not expect any lucencies at the bone-cement or cement-prosthesis interface, but even in stable cemented prosthe
e proximal lateral aspect of the femoral stem may be seen on the initial postoperative radiograph as a reflection of s
lucent zone is good, but if the lucency enlarges or develops at the metal-cement interface during follow up, then it is
layer of cement around the prosthesis. Abundant cement packing leads to loosening. Acetabular zones according to
nt interface a thin fibrous layer may form as responce to local necrosis of osseous tissue due to the heat of the ceme
this layer is seen as a lucent zone. Especially in acetabular zone I a 1-2 mm lucency is frequently seen at the bone-ce
e. If also other zones are involved and the lucency widens, it is however a sign of loosening. In your report always inc
u have three zones marked I-III. It is quite common to see a radio lucent line in zone I, but you shouldn't see it in zon
It is very common to see radiolucency in zone 1, occasionally in zone 7, but it should not occur in the subtrochanteric
to the some of the uncemented hip prostheses.
Non Cemented THA:
The implantation of a bone ingrowth prosthesis results in altered stress distribution to the native bone, especially in
ems. Stress shielding proximally may result in proximal osteoporosis and calcar resorption. Stress loading distally ma
ip of the prosthesis (called pedestal). In an effort to avoid these changes, most modern cementless prosthesis only h
stress shielding. The distal part of the femoral prosthesis is not 'loaded', so there will be no distal stress loading. In st

metal-bone interface do occur, as it usually is a combination of bone ingrowth and fibrous tissue ingrowth, that prov
s a lucent zone at the interface. Again it should be stable and well within a range of 1 -2 mm. The figure on the left su
that can be normal. You have to be familiar with the normal and abnormal changes in the types of prostheses, that a
ent zones along the bone-metal interface due to fibrous tissue are therefore common (80%). They should be less tha
tay stable for 2 years than fixation by a strong fibrous tissue has taken place. Progressive calcar resorption during fo
s that are relatively unstressed. The forces are transmitted through the relative stiff femoral stem and is seen as oste
proximal femur with thinning of the cortex and bone resorption of the femoral neck. This is seen medially as calcar r
also called calcar round off.
Complications at Follow Up:
There are many complications in THA. Radiographic follow up and comparison with the oldest films available is the m
ortant complications are mechanical loosening, particle disease and infection. These complications however may hav
typical radiographic changes in Loosening (left) - Particle disease (middle) - Infection (right) Mechanical loosening pre
lucency. Evidence of polyethylene wear, which appears as asymmetric positioning of the femoral head within the ac
. Infection presents as irregular lucency with periosteal reaction, but may be difficult to differentiate from loosening
f loosening, particle disease and infection are straight forward (figure). Infection is often low grade and is difficult to
here will be irregular osteolysis, no sclerotic border, cortical bone resorption and a periosteal reaction. Progressive lu
eper position of the cup indicates migration. Subtle excentric positioning of the femoral head is indicative of polyeth
Loosening:
Mechanical loosening remains the most common indication for revision. Patients are usually symptomatic, although
graphic manifestation of loosening are: Lucent zone > 2 mm at interface (indicative) Component migration (diagnost
ce or at the bone-cement interface is very indicative of loosening. Especially if more zones are involved and if there is
c for loosening. It is seen as tilting or cranial migration of the acetabular cup or as subsidence (>10mm) and varus tilt
ive subsidence, which is diagnostic for loosening, with subsequent break of the screws. Loosening (2) As migration ca
al postoperative films. Do not just compare to the prior examination. The case on the left shows migration of the ace
used (see next figure) Same case as above with white marks on the tear drop figure. Migration is shown more easily
radiographs and we use the tear drop figure as a landmark, the migration becomes more evident. Migration of the c
r wall (blue arrow). Migration of acetabular cup cranially with tilting and subsequent acetabular fracture Migration of
rd movement or tilting of the cup (figure) The case on the left is for several reasons not ideal : High and very lateral p
nt cement packing. Screws are positioned too horizontally (too much stress). Lucency in zone II and III > 2 mm. Espec
ring follow up upward migration with increased tilting is seen causing the fixation screw to break. Eccentric position
ocal osteolysis with endosteal scalloping in proximal femur due to particle disease.
Particle Disease:
Originally this was called cement disease or aggressive granulomatosus. It is a histiocytic response that occurs as a r
e shed of the surface of the components of the arthroplasty. Nowadays it is mostly seen in non-cemented hips as a r
se aggressive granulomatous lesions present as focal radiolucencies around the prosthesis. The condition tends to c
ooth endosteal scalloping. The key feature is that it produces no secondary bone response. These characteristics hel
en has more aggressive features, although the distinction is not always possible. Although particle disease is a result
s of polyethyleen wear in the acetabular cup,
but whenever you see an eccentric position of the femoral head within the cup, look for focal lucencies. Large focal c
le Disease is relentlessly progressive with loosening, fracture and destruction of bone. Sometimes revision of a stabl
ery impossible. Subtle eccentric position of femoral head. Even more subtle focal osteolysis around screw in acetabu
ylene liner are shed into the joint fluid and can be transported around the prosthesis through small channels even in
ew holes (figure). This is why surgeons are more and more reluctant to use screws for the fixation of acetabular cups
nd screws after migration of wear particles through the screwholes. Eccentric position of femoral head within acetab
ding and is superomedial. Wear is superolateral and pathologic
Polyethylene wear:
Normal loading of the polyethylene cup comes up the femoral shaft, along the femoral neck towards the lumbar spi
bearing as the plastic moulds itself. This remoulding of the cup is called creep. Abnormal loading leads to pressure m
al side.
Infection:
Radiologic findings in patients with low grade infection may be unremarkable or may mimic loosening or small partic
id, with bone destruction and sinus tract formation, resulting in radiological findings as listed in the table on the left.
d with prostheses have not been established. In several studies infection was diagnosed if at least one of the followi
synovial fluid. Purulence of synovial fluid at the implant site Inflammation on pathological examination of periprosth
rosthesis. Irregular periprosthetic bone resorption with periosteal reaction typical for infection. On the left the typica
struction and periosteal reaction. In many cases however the infection is really low grade and difficult to establish. R
not specific as they may show findings similar to those occurring in loosening. Negative findings on a bone scan sugg
techniques for infection such as gallium scanning or indium-labeled WBC or immunoglobulin G is not clear,
but they tend to be a bit more specific compared to normal Technetium bone scan. Most researchers advocate fluor
everal samples should be taken to minimize confusion caused by skin contaminants. Infections up to one year after

he risk of intraoperative infection is less than 1% due to the use of antimicrobial prophylaxis and laminar airflow sur
s seeding from respiratory tract, dental and urinary tract infections.
Fractures:
Incidence post-operative: cemented THA: 0.4% press fit prosthesis: 2.5% revision hip arthroplasty: 7.2% Usually it do
Sometimes a control perforation is placed by the surgeon during revision to aid in removal of the previously placed f
Fractures during follow up are a result of loosening, particle disease, infection or severe cases of stress shielding. Lat
Dislocation:
As discussed above, dislocation or subluxation of the components may occur because of patient factors including po
osterior (rather than lateral) surgical approach. Another factor is difficulty in achieving ideal angulation of the acetab
rative changes or dysplasia. Dislocation can be in posterior, anterior or lateral direction. Tilting of loose cup resulting
as a result of tilting of the cup due to loosening.
Component fracture:
Component fracture is uncommon. The case on the left is probably secondary to severe polyethylene wear
resulting in cup and cement fracture. Component dissociation, as opposed to component fracture, most commonly
g. Destruction of polyethylene liner The case on the left shows severe wear and fracture of the polyethylene liner. Th
racture of the metal head of the femoral component. Classification of heterotopic ossification according to Brooker
Heterotopic Ossification:
The classification of heterotopic ossification includes four grades based on an AP radiograph of the pelvis and hip. G
purs leaving > 1 cm between opposing bone surfaces. Grade III = bone spurs leaving < 1 cm between opposing bone
es of heterotopic ossification Heterotopic Ossification occurs when primitive mesenchymal cells in the surrounding s
ture lamellar bone. It typically occurs around the femoral neck and adjacent to the greater trochanter and occurs in
e heterotopic ossification are asymptomatic. If it becomes symptomatic, hip stiffness is the most common complaint
Arthrography:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. Glatt, A. E., Melamed, E., Cohen, I., Robinson, D., Zimmerli, W., Trampuz, A. (2005).. N Engl J Med 352: 95-97
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5. Complications of total hip arthroplasty. Saleh, KJ, Kassim, R, Yoon, P, Vorlicky, LN. Am J Orthop 2002; 31:485
None:

None:

None:

Bosniak Classification 2019:

Cystic Renal Masses:
Chris Lunt and Frederieke Elsinger
BC Cancer Agency Vancouver and Luzerner Kantonsspital:
Publicationdate 1-2-2022 In this article we describe the 2019 Bosniak classification of renal cystic lesions.
The goals of the new 2019 Bosniak classification are to reduce interobserver variability, improve the precision rate o
nd thereby reducing the rate of unnecessary treatment of benign lesions.
Overview:
A cystic renal mass is defined as a lesion in which <25% of the mass is composed of enhancing tissue The Bosniak 20
of the mass is composed of enhancing tissue in order to avoid an aggressive necrosed solid renal mass being terme
d as benign may be described as “cysts” and the term “cystic renal mass” should be applied to Bosniak IIF, III and IV le
be confusing and should be avoided. Bosniak I Bosniak II Six types, all well-defined with thin (≤ 2 mm) smooth walls:
(≥ 4 mm width) or enhancing irregular (displaying ≤ 3-mm obtusely margined convex protrusion[s]) walls or septa. B
with obtuse margins, or a convex protrusion of any size that has acute margins) This table summarizes the Bosniak 2
25 in the anterior right Kidney. According to the new Bosniak criteria all cyst with HU <30 are likely benign and can b
Malignancy rate:
Bosniak I masses are universally considered to be benign, and although there are occasional case reports of maligna
orrect scan technique or incorrect image interpretation leading to incorrectly assigning a Bosniak I grade. Malignancy
caveat to this is in patients with Von Hippel Lindau syndrome, hereditary leiomyomatosis and other RCC syndromes
the application of the Bosniak system is not recommended. The incidence of malignancy in Bosniak IIF lesions is rep
ding of imaging features as well as strong selection bias whereby only the more worrisome lesions are resected. Hov
o category III or IV have a high rate of malignancy of 85%, comparable to lesions initially characterised as Bosniak IV.
half being malignant. Current practice regarding resection or observation varies between institutions and depends h
ce. Bosniak IV lesions are found to be malignant in around 90% of cases and treatment is recommended in most cas
likelihood of cancer, not the biologic behavior.

It is unclear which criteria are more predictive for cancer aggressiveness than others. Size and growth rate are not in
t the smaller the lesion, the more likely it is to be benign. Growth rate and change of morphology do however play ar
to include patients' age, comorbidities, life expectancy, personal preferences and risk tolerance into the consideratio
necrotic components
When not to apply Bosniak:
The Bosniak classification should not be applied to lesions with an infectious, inflammatory or vascular etiology. Lesi
masses. These necrotic solid masses, as opposed to cystic masses, have a less indolent behavior.
It is therefore important not to confuse indolent cystic cancer with more aggressive forms. Lesions with abundant th
esions MRI with subtraction is advised to rule out enhancing soft tissue components. Hyperattenuating non-enhanci
on CT can also benefit from further evaluation with MRI to exclude enhancement before assigning a Bosniak categor
CT of a solid lesion with smaller cystic/necrotic components.
As more than 25% of the mass is composed of solid tissue this likely represents a necrotic mass in stead of a cystic le
Bosniak criteria should not be used. Solid renal tumor with cystic components case 2MRI of a more solid than cystic
hancing area in the left kidney on the T1W-image.
This area has low values in the ADC map in keeping with diffusion restriction. This proved to be an abscess.
Definitions:

Septa:
A septum is defined as a linear or curvilinear structure that connects two surfaces. Up to 3 septa are considered "few
4 or more septa are termed "many" and if enhancing are features of a 2F lesion (in the absence of more worrisome f
ces (Bosniak II), and in the right diagram there are 5 different septa, defined as Bosniak IIF.
Enhancement:
Prior versions of the Bosniak classification divided enhancement between "perceived" and measurable, and all mass
ategorised as Bosniak III or IV. However, there was no evidence base for the distinction between perceived and meas
ification all enhancement is considered equal.
Enhancement can be unequivocally perceived when comparing non-contrast and contrast-enhanced images perform
ly sized regions of interest" (not pixel values).
Specifically an increase of ≥20 HU on contrast-enhanced CT, or ≥15% signal intensity on contrast enhanced MR. If a f
measure accurately then it is considered non-enhancing. ImageT2W coronal image of a cyst with many septa in the
ous enhancement in comparison to the pre-contrast sequence.
A cyst with many, thin septa is categorized as a Bosniak IIF
Septal and wall thickness:
Although there is still likely to be some inter observer variation in the measurement of enhancing septal and wall thi
each Bosniak category, replacing the prior descriptive classification of "minimally thickened" or "thickened". A cyst wi
s considered a Bosniak I cyst. A smooth ≤ 2mm enhancing wall with 1-3 septa ≤ 2mm thickness is Bosniak II A smooth
IIF Any smoothly thickened wall or septa ≥ 4mm is categorized as Bosniak III.
Wall irregularity and Nodularity:
The distinction between irregularity of enhancing wall or septa and a nodule relates to the angle formed with the ass
form acute angles with a wall or septum are considered nodules and are always categorized as Bosniak IV features. I
surface are considered thickening if ≤3mm. An enhancing area with obtuse margins is considered a nodule if ≥4mm
obtuse angled thickening is present on both sides of a septum then the combined thickness on both sides of the sep
eptum itself. This table summarizes the different measurements of the wall and septal thickness in the Bosniak class
Bosniak I:
On contrast CT Bosniak I cyst are well defined with a thin (≤2mm) smooth wall and contain homogenous, simple fluid
case 1
CT in portovenous phase.
There is a typical Bosniak I cyst in the left kidney. The cyst has a well-defined thin smooth wall.
There are no septa or calcifications.
The content of the cyst is homogeneous and has a low HU. MRI characteristics of Bosniak I cysts are the same as on
The fluid within the cyst has a signal intensity similar to CSF. case 2
Right kidney with typical Bosniak I cyst on MR
Bosniak II:
In the 2019 version of the Bosniak classification more types of lesions can be characterized as Bosniak II (see table) in
o image or treat likely benign lesions.
Bosniak II lesion are now allowed to show enhancement, which is no longer a Bosniak III characteristic. Most inciden
dies. If these lesions are homogeneous and have a HU of 21-30, malignancy is highly unlikely and Bosniak II can be a
protocol and have a HU of > 20 and show no enhancement are also assigned Bosniak II. All thin walled cystic masses
ategorized as Bosniak II, as long as the septa are few (1-3) and thin (≤ 2mm). Homogeneous masses with Houndsfield
small to characterize- but otherwise homogeneous and low-attenuating, can be placed in the Bosniak II category. Ma
ormed for other indications not using a dedicated renal imaging protocol. Despite this, many masses can be safely d

ntrast CT measuring between -9 to 20 HU or >70 HU are highly likely to be benign cysts and can be ignored. On contr
se measured density (pseudo enhancement) within benign cysts. Therefore, cystic masses measuring <30 HU in the
defined homogeneous masses which are hyperintense on T1 (around 2.5x normal parenchymal intensity) or well de
ign. Small masses may not be characterizable due to partial voluming if the slice thickness is more than half the diam
masses up to 1.5cm in diameter and if these otherwise appear homogeneous they should be considered benign Bos
septa. Bosniak II cyst case 2On the T2W-image a cyst with 3 smooth thin septa in the medial aspect of the right kidne
The fluid has a high T2W signal intensity. On the T1W-image post Gadolinium there is enhancement of the septa.
The lesion is classified as a Bosniak II cyst. No follow up is indicated. Notice that there is a second solid renal mass po
Disable Scroll Enable Scroll
Disable Scroll case 3The images are axial T2W, a coronal T1W image with fatsat and Gadolinium and finally a coronal
There is a cystic lesion within the right kidney with many (> 4) thin septa.
The septa are better seen on the axial images .
The septa show no enhancement. According to the old classification this lesions would be classified as IIF.
In the updated 2019 classification non-enhancing septa cannot be counted as such, and the lesion is therefore down
nd didn't show any changes in follow-up over 5 years. Click on image for enlarged view. case 4Small masses may not
is more than half the diameter of the mass.
Pseudoenhancement can occur in masses up to 1.5 cm in diameter. If these lesions otherwise appear homogeneous
yellow arrow)A homogeneous, hypodense lesion is seen in the posterior right kidney. This lesion is too small to chara
On the non-enhanced CT (NECT) there is a hyperdense lesion in the left kidney with HU > 70, which would normally c
CT (CECT) in the portovenous phase shows no significant contrast uptake but there is aninhomogeneousappearance
This requires additional imaging with MRI (see next images). MRI of the same patient.
The lesion is hypointense on T2WI and hyperintense on T1WI.
There is no contrast enhancement on the subtraction sequence.
On MRI the lesion could be confirmed as Bosniak II.
Bosniak IIF:
Not much has changed in the IIF category, besides that the criteria are now more well defined. Cystic IIF masses have
imally thickened (3 mm) septa both on CT and on MRI. Heterogeneous masses on CT without significant contrast enh
ecommended to further asses these lesions before applying the Bosniak criteria. New in the IIF section are cystic ma
rated T1W-imaging.
This is the only mass type that is categorized greater than Bosniak II without enhancing features. The reasoning behi
Progression over time is a strong indicator of malignancy, but is not included in the Bosniak classification. Enable Sc
Disable Scroll Enable Scroll
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Axial T2WI and coronal T1WI with fatsat and Gadolinium. There is a cystic mass in the left kidney with many thin enh
re is a cystic mass in the right kidney with many (> 4) smooth thin enhancing septa. The lesion is classified as Bosniak
Bosniak III:
According to the previous criteria, Bosniak III masses are 'indeterminate' with about half of the resected masses bein
ical benefit. In 2019 the criteria have been more clearly defined. Any cystic mass with one or more irregular septa or
eptation of ≥4mm are considered Bosniak III. The term 'irregular' is defined as diffuse convex protrusions that have c
rity above). case 1 MRI of an exophytic cortical cyst in the left kidney with few, irregular thickened (3 mm) septa with
findings of a Bosniak III cyst. It was decided to surgically remove the lesion and it proved to be a clear cell carcinoma
Bosniak IV:
Cystic masses with Bosniak IV characteristics are highly likely to be malignant (90%) and present with larger soft tissu
They are therefore more easily recognized as suspicious lesions. Nodules are defined as focal enhancing convex pro
otrusion of over 4 mm with obtuse margins with the wall or septa. Cystic masses with soft tissue components > 25%
ak criteria do no longer apply to these masses. case 1 The images show a complex large right renal cyst with T1 and T
shows mild enhancement on the subtraction image. This cyst also has an enhancing mural nodule (see arrow corona
ed and the cyst represented a papillary renal cell carcinoma case 2 The images show a cystic mass with a thick walled
contrast images there is no enhancement of the septa or wall but an enhancing mural nodule can clearly be identifie
on was excised and proved to be a clear-cell carcinoma. case 3 The axial and coronal T2 images show a cystic lesion w
ar wall. As less than 25% of the lesion is comprised of solid tissue, the lesion should be classified as a cystic mass ins
ntrast coronal T1 fat suppressed images a wall thickness of more than 4 mm was measured (arrow). The lesion was c
The mass was excized and proved to be a clear cell carcinoma. case 4 Portovenous scan with an inhomogeneous cys
The hyperdense area shows enhancement on the T1W-image with fatsat, in keeping with a solid nodule in a Bosniak
Differential of Breast Calcifications:
Robin Smithuis and Ruud Pijnappel
Radiology department, Rijnland Hospital, Leiderdorp and Martini Ziekenhuis, Groningen, the Netherlands.:
Publicationdate 2008-05-11 - Update 2023-3-21 Ductal carcinoma-in-situ (DCIS) represents 25-30% of all reported bre
mammographically detected microcalcifications. In this review we will focus on: BIRADS classification Anatomy
Anatomy:

Terminal Ductal Lobular Unit
Terminal ductal lobular unit:
The basic functional unit in the breast is the lobule, also called the terminal ductal lobular unit (TDLU). The TDLU con
terminal duct drains into larger ducts and finally into the main duct of the lobe (or segment), that drains into the nip
0 lobules. The terminal ductal lobular unit is an important structure because most invasive cancers arise from the TD
CIS), lobular carcinoma in situ, fibroadenoma and fibrocystic disease, like cysts, apocine metaplasia, adenosis and ep
n the terminal ducts (intraductal calcifications) or within the acini (lobular calcifications). LEFT: Lobular calcifications:
calcifications: pleomorph and form casts in a linear or branching distribution. Lobular calcifications These calcificatio
uniform, homogeneous and sharply outlined calcifications, that are often punctate or round. When the acini becom
hese cavities. However when there is more fibrosis, as in sclerosing adenosis, the calcifications are usually smaller ar
ntiate them from intraductal calcifications. Lobular calcifications usually have a diffuse or scattered distribution, sinc
the calcifications. Lobular calcifications are almost always benign. Intraductal calcifications These calcifications are ca
al lumen. The uneven calcification of the cellular debris explains the fragmentation and irregular contours of the calc
e, density and form (i.e. pleomorphic from the Greek pleion 'more' and morphe 'form').
Sometimes they form a complete cast of the ductal lumen. This explains why they often have a fine linear or branch
us of malignancy and are classified as BI-RADS 4 or 5.
Diagnostic Approach:
The diagnostic approach to breast calcifications is to analyze the morphology, distribution and sometimes change ov
rtant factor in deciding whether calcifications are typically benign or not. If not, they are either suspicious (intermedi
y biopsy in these cases is needed to determine the etiology of these calcifications.
Morphology:
The form of calcifications is the most important factor in the differentiation between benign and malignant. If calcific
'high probability of malignancy', they are termed of 'intermediate concern or suspicious'. If a specific etiology cannot
e their morphology and distribution using the descriptions given in the BI-RADS atlas (1).
Distribution:
In the BI-RADS atlas the following descriptions are given for the distribution of calcifications (1) : Diffuse or scattered
hen clusters of calcifications are scattered throughout the breast, this favors a benign entity. Regional distribution ac
bution (i.e. benignity), while Segmental distribution would favor a ductal distribution (i.e. malignancy). Sometimes thi
tiation between 'regional' and 'segmental' is problematic, because it is not clear on a mammogram or MRI where the
cations are both seen in benign and malignant disease and are of intermediate concern. When clusters are scattered
r of calcification favors a malignant entity. Linear distribution is typically seen when DCIS fills the entire duct and its b
Change over time:
There are conflicting data concerning the value of absence of change over time. It is said that the absence of interval
basis of morphologic criteria is a reassuring sign and an indication for continued mammographic follow-up (2). On th
e and suspicious clusters of microcalcifications, stability could not be relied on as a reassuring sign of benignancy (3)
5% of patients had stable microcalcifications for 8-63 months. It seems that the morphology of calcifications is far m
n if the calcifications have a probably benign form. In the same study it was shown that the odds for invasive carcino
ients with increasing or new microcalcifications. The likelihood that carcinoma will be invasive increases significantly
is new or increasing. On the left a patient with a few heterogeneous coarse calcifications. They were classified as BIR
han 3%). At six month follow up they had increased in number and DCIS was found at biopsy.
Benign Calcifications:

Skin Calcifications - Tatoo sign:
Many calcifications can be classified as typically benign and need no follow up (i.e. BI-RADS 1 or 2). Many of these are
its. Atypical forms may be confirmed by tangential views to be in the skin. Usually they are located along the inframa
consider the possibility of dermal calcifications, always study the portion of the skin that is seen en face to look for s
fications Tatoo sign Skin calcifications may simulate parenchymal breast calcifications and may look like malignant-ty
resented for biopsy. During the vacuum assisted biopsy procedure it was not possible to biopsy these calcifications,
craniocaudal view, notice that the calcifications look exactly the same in configuration. This is called the tattoo sign .
lcifications. Click to enlarge Here another example of the tatoo-sign. First notice that there are some calcifications tha
calcifications on the MLO-view has the exact configuration as the cluster on the CC-view (next image). Click to enlarg
is exactly the same. If these calcifications were located in the centre of the breast they should have a different config
ifications are located within the skin their configuration stays the same.
Tatoo sign video:
Here two cases of skin calcifications presenting as tatoo sign (courtesy Roel Mus).
Vascular Calcifications:
These are linear or form parallel tracks, that are usually clearly associated with blood vessels. Vascular calcifications
If only one side of a vessel is calcified (arrow), the calcification may simulate intraductal calcification, but usually the
Coarse or 'Popcorn-like':
The classic large 'popcorn-like' calcifications are produced by involuting fibroadenomas. These calcifications usually c

an fibroadenoma are small and numerous, they may resemble malignant-type calcifications and need a biopsy.
Large Rod-like, Plasma cell mastitis:
These are formed within ectatic ducts. These benign calcifications form continuous rods that may occasionally be bra
cifications, because they are usually > 1 mm in diameter. They may have lucent centers if the calcium is in the wall of
radiating toward the nipple and are usually bilateral. These secretory calcifications are most often seen in women ol
ese from lineair calcifications as seen in DCIS.
Round and punctate calcifications:
Round calcifications are 0.5-1 mm in size and frequently form in the acini of the terminal duct lobular unit. When sm
te calcifications can be seen in fibrocystic changes or adenosis, skin calcifications, skin talc and rarely in DCIS. Suspec
and show some heterogeneity especially when in cluster, linear or segmental distribution. Round and punctate calcif
Lucent-Centered:
These are round or oval calcifications that range from under 1 mm to over a centimeter. They are the result of fat ne
Eggshell or Rim Calcifications:
These are very thin benign calcifications that appear as calcium is deposited on the surface of a sphere. These depos
hough fat necrosis can produce these thin deposits, calcifications in the wall of cysts are the most common 'rim' calc
ty indicates the presence of fat. This is a typical oil cyst. On a follow up mamogram the wall has calcified resulting in
Milk of Calcium:
These are benign sedimented calcifications in macro- or microcysts. On craniocaudad views they appear as fuzzy, ro
beam when you think of the possibility of milk of calcium, because on a 90? lateral view they may appear as semiluna
ications on oblique viewRIGHT: milk of calcium (teacups) on lateral view with horizontal beam Many calcifications rep
on horizontal beam radiographs. The most important feature of these calcifications is the apparent change in shape
craniocaudal versus oblique or 90? lateral). The images show a different shape on the oblique view compared to the
he calcium. Milk of calcium On the craniocaudal image the calcifications are round, fuzzy and ill-defined. On the med
shaped tea cups. Click on the image for an enlarged view.
Suture calcifications:
They represent calcium deposit on suture material. They are typically linear or tubular in appearance and knots are s
Dystrophic calcifications:
These are coarse irregular 'lava-shaped' calcifications. These calcifications are larger than 0.5 mm and often have a lu
trauma. They develop 3-5 years after treatment in about 30% of women. These calcifications are also described as fa
malignancy. On the left more extensive dystrophic calcifications.
Suspicious Calcifications:
If calcifications are not typically benign, they are either called 'Suspicious or of Intermediate Concern' or they are call
suspicious calcifications. These calcifications have either an amorphous or coarse heterogeneous form. Usually thes
Amorphous calcifications:
Amorphous or indistinct calcifications are defined as 'without a clearly defined shape or form'. These calcifications ar
c morphologic classification cannot be determined. On the left amorphous and pleomorphic calcifications. Based on
iopsy revealed fibrocystic changes (FCC) Amorphous calcifications (2) Many benign and malignant breast diseases ma
hous calcifications turn out to be malignant. Usually it is low grade DCIS. Amorphous calcifications (3) On the left am
s was classified as Bi-RADS 4 (3-95% chance of malignancy). Biopsy revealed DCIS with invasive ductal carcinoma.
Coarse Heterogeneous:
Coarse heterogeneous microcalcifications, formerly called coarse granular, are irregular, conspicuous calcifications t
of intermediate concern, along with amorphous microcalcifications. They have to be differentiated from fine pleomo
y in size and shape, are usually less than 0.5 mm in diameter and are considered to be of higher probability of malig
e heterogeneous microcalcifications tend to coalesce but are not the size of the larger irregular dystrophic calcificati
e classified as Bi-RADS 4. Biopsy revealed DCIS. Coarse heterogeneous calcifications in fibrous stroma The differentia
ltiplicity and bilaterality of such calcifications favors a benign etiology. DCIS is considered when these calcifications h
left a patient in whom new calcifications were detected during follow up for breastcancer in the contralateral breast.
istribution. These calcifications were classified as Bi-RADS 4. Biopsy showed calcifications within fibrous stroma. Ther
High Probability of Malignancy:
Calcifications with a higher probability of malignancy are: Magnified view: fine pleomorphic calcifications in a linear d
Fine Pleomorphic:
These calcifications vary in size and shapes and are usually.
They are more conspicuous than the amorphic calcifications. There is a 25-40% risk of malignancy. On the left fine pl
These were classified as BI-RADS 4B. Biopsy revealed high grade DCIS. Fine pleomorphic calcifications in a segmenta
On the left a mammogram demonstrating two forms of calcifications. There are some round typically benign calcifica
omorphic calcifications. They have a segmental distribution. In the presence of the mass these calcifications were cla
de DCIS with an invasive carcinoma. Amorphous and fine pleomorphic calcifications (Bi-RADS 4)Biopsy: fibrocystic ch
mmogram in a screening program. There is a cluster of amorphous and fine pleomorphic calcifications. These calcifi
nly fibrocystic changes were found. On the left a case that looks quite similar to the one above. New calcifications we
fine pleomorphic calcifications in a cluster. These calcifications were classified as Bi-RADS 4. This proved to be DCIS.

ll whether they are malignant or not and they have to be biopsied.
Fine Linear or Fine Linear Branching:
These are thin, linear or curvilinear irregular calcifications. They may be discontinuous. Usually they are
Their appearance suggests filling of the lumen of a duct, i.e. 'casting' calcifications. These calcifications are classified
distribution. Some have a linear distribution and some have a branching morphology. This is highly suggestive of ma
d branching calcifications in a segmental distribution highly suggestive of malignancy (Bi-RADS 4C). Extensive high gr
and fine linear calcifications in a linear distribution On the left a patient with new calcifications detected in a screeni
lcifications. The distribution is linear. On the basis of the morphology and distribution these calcifications were classi
Artifacts:
On the left artifacts within a cassette that simulate fine pleomorphic calcifications. A repeat exam with a different cas
. The image on the left shows the same artifacts. On the image on the right DCIS. The Breast Imaging Reporting and
dardize breast-imaging reporting and to facilitate outcome monitoring.
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71 Abstract and PDF
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32 cases of suspected COVID-19:

Imaging findings and follow up:
Frank Smithuis and Robin Smithuis
Academical Medical Center Amsterdam and Alrijne Hospital Leiderdorp, the Netherlands:
Publicationdate 29-3-2020 The role of CT in this COVID-19 pandemic still has to be determined.
CT can help to determine the severity of the disease and is a valuable and fast tool to determine whether a patient is
th a high suspicion of COVID-19 infection separate from patients with other diseases, especially when the PCR-test is
to the hospital with suspicion of COVID-19 infection and all were PCR-tested.
The findings at presentation and follow up is provided. In the description we use the CO-RADS classification. Press ct
This can be helpful for scroll-images.
Single images can be enlarged by clicking on them.
Introduction:
The CO-RADS classification is a standardized reporting system for patients with suspected COVID-19 infection develo
classification of likelyhood of COVID-19 infection as proposed by the COVID working group of the Dutch Radiologica
d with the clinical symptoms and the duration of the symptoms as a CT can be negative in the first few days of a milo
However most patients that we see have complaints for a week or more. At the moment most patients that are adm
e a COVID-19 infection or they have a CORADS 1 or 2, which means no COVID-19 infection.
Imaging Findings in suspected COVID-19:
Enable Scroll
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_1 Crazy paving - ventilation:
History
64 year old male with fever and coughing for 2 weeks after a skiing holiday with his family. CT findingsWidespread G
Crazy paving (blue arrows)
Vascular enlargement (black arrow)
Subpleural bands with retraction (yellow arrows)
Consolidation and bronchiectasis posteriorly in the lower lobes CORADS 5 - very high suspicion of COVID-19 PCR pos
ation on the ER the patient became hypoxic and was treated with mechanical ventilation. Later that day the patient w

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_2 CORADS 5 - extubation:
History
55 year old and previously healthy man presented with a history of 2 weeks of fever and coughing. Although he was
that evening. CT findings at arrivalConsolidations mainly posteriorly in lower and upper lobes
Small areas of GGO CORADS 5 PCR
The first PCR was negative, but later a sputum test was positive for COVID-19. Follow up
After three days of mechanical ventilation he could be extubated and was doing well with only oxygen therapy. Nine
g well. Enable Scroll
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_3 CORADS 2 - Mycoplasma:
History49 year old male suspected of having COVID-19.
13 days of fever and coughing. Treated with antibiotics for 7 days. CT findingsConsolidation in right lower lobe
surrounding area with tree-in-bud in lower lobe
also tree-in-bud in other lobes CORADS 2 - some other infection most likely bacterial PCR
First test negative. Test nine days later also negative. Follow up
Tested positive for Mycoplasma pneumoniae. Left the hospital two days after admission. Enable Scroll
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_4 GGO - bronchiectasis- wide vessels:
History
75 year old male with fever for 4 weeks and no coughing. History of lungcancer resection by video-assisted thoracos
Bronchiectasis (green arrow)
Widened vessels (yellow arrow) CORADS 5 PCR2x positive Follow up
Two days after admission to the hospital, there was a rapid decrease in condition of the patient and he had to be tra
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_5 CORADS 2 - Asthma:
64 year old female known with asthma suspected of having COVID-19. CT findings: CORADS 2 - infection not related
Inflluenza A and B. Click image to enlarge
_6 CORADS 5 - bilateral peripheral GGO:
COVID-19 infection. CT-findings:
_7 Fatal COVID-19:
83 year old male with mitral insufficiency and pulmonary hypertension was diagnosed with COVID-19 infection. The
and probably some consolidation in the left lower lobe. The patient decided not to be treat with mechanical ventilat
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_8 CORADS 5 - Crazy paving:
57 year old male without any prior diseases was admitted to the hospital with 14 days of fever and cough.
He was treated with an oxygen mask.
2 days later his condition suddenly worsened and the patient was tranferred to the ICU for mechanical ventilation. C
ive for COVID-19. Crazy paving, consolidation, linear opacities, bronchial wall thickening and high CT scores are featu
oll
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_9 Suspicion pulmonary emboli:
57 year old male with Diabetes type 1 with chronic obstructive lung disease was admitted with shorteness of breath.
Initially there was no suspicion of COVID-19.
A CT was performed to look for pulmonary emboli. CT findings: PCR was two times negative for COVID-19 and all oth
gative. The patient was treated with an oxygen mask for 7 days and then recovered. Enable Scroll
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10 CORADS 5 - Subpleural bands:
69 year old female with mild dyspnoe for one week with cough and fever.
She was treated with 2L O2/min. CT findings: Enable Scroll
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Disable Scroll Click to enlarge
11 CORADS 1 - Colitis:

History89 year old female, who had fever for seven days with diarrhoea. CT findings
Normal lungs
Thickened wall of the descending colon probably colitis CORADS 1no COVID-19 PCR... Enable Scroll
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12 CORADS 5 - Peripheral consolidation:
49 year old male complained of being extremely tired for 12 days with headache and a dry cough and weight loss of
and then recovered.
13 CORADS 5 - 75% involvement:
History 40 year old male, who had fever for ten days with progressive coughing and shortness of breath. Saturation
Widespread bilateral ground-glass opacities with a posterior predominance.
75% of the lungs are involved. CORADS 5 very likely COVID-19 PCRpositive
14 Subpleural bands:
History
75 year old male with fever for 6 days CT findingsBilateral subpleural bands CORADS 5 Comment
Subpleural bands are probably fibrous bands but this is still not certain.
Pan reported 17% COVID-19 patients with fibrous stripes in their study (2).
Fibrous lesions may form during the healing of pulmonary chronic inflammation or proliferative diseases, with gradu
The relation between fibrosis and patients' prognosis is debatable. Click to enlarge
15 CORADS 3 - focal consolidation with halo:
History34 year old female
High fever for 1 day with coughing CT findings
Focal consolidation with surrounding GGO
Only in right lower lobe. CORADS 3 equivocal PCR2 x negative
Influenza negative, RSV negative Clinical course
Continuous fever for two more days. No oxygen. Discharged from hospital on third day. Enable Scroll
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16 Mild infection:
History61 year old male
10 days fever, dyspnoe and diarrhoea after a holiday in Egypt. CT findings
Bilateral faint areas of GGO
Severity index: 5
10% involvement CORADS 5 very likely COVID-19 PCR positive Clinical course
After 2 days of oxygen therapy the patient could be discharged from the hospital Enable Scroll
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17 GGO only in right lung:
History46 year old male
8 days fever, dry cough, dyspnoe and diarrhoea. CT findings
GGO in the right lung
Severity index: 5
10% involvement CORADS 5 very likely COVID-19 PCRnot known Clinical coursenot known Enable Scroll
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18 Mild lymphadenopathy:
History61 year old male had high fever for 10 days. CT findings
Bilateral patchy areas of GGO CORADS 5 very likely COVID-19 PCRpositive Clinical course4 days of Oxygen therapy En
Disable Scroll Enable Scroll
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19 Lobar consolidation and GGO:
History67 year old male, who had fever for fourteen days with coughing and lately hemoptoe. CT findings
Dense consolidation in left lower lobe
Ground glass in right lower lobe (yellow arrows)
Maybe some tree-in-bud in right upper lobe (red arrow) CORADS 2low suspicion COVID-19, probably bacterial pneum
Influenza negative, RSV negative, no pneumococcus, no legionella. Treated with antibiotics and was feeling better 2 d
20 Extubation:
History73 year old male with aorta insufficiency and pacemaker was admitted to the hospital with fever and coughin
ngs
day 4. bilateral consolidations intubated.

day 8. bilateral consolidation
day 13. extubation PCR
positive Follow up
Extubated after 9 days of mechanical ventilation
21 Bilateral patchy GGO - no oxygen:
History71 year old male coughing for 10 days, no fever CT findings
Bilateral patchy areas of GGO CORADS 5 very likely COVID-19 PCRpositive Clinical courseDid not need oxygen therap
22 Bilateral GGO 3 days oxygen:
History
61 year old male with fever, coughing for 1 week. CT findingsBilateral patchy GGO CORADS 5 PCRpositive Follow up
Discharge after 3 days of oxygen therapy Enable Scroll
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23 Vacuolar sign:
History67 year old woman was admitted to the hospital after spending one week in quarantaine with fever, coughing
Patchy areas of GGO bilateral
Bronchiectasis
Wide vessels
Vacuolar sign (1)
Subpleural bands in lower lobes CORADS 5 very likely COVID-19 PCRpositive Clinical courseOne day after admission
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24 Fever and hemoptoe:
History
58 year old male with mild mitral and aortic insufficiency presented with high fever and coughing for 10 days with ex
Extensive widenend vessels
Bronchiectasis 75% lung involvement CORADS 5 PCRpositive Follow up
Immediately after admission the patient was transferred to the ICU and intubated. Patient died eight days later.
25 CORADS 1 Coughing and chest pain:
History
61 year old male with a history of bypass surgery and endocarditis complicated by a total AV block for which he had
T findingsNormal CORADS 1 PCRnegative - results after discharge Follow up
There was no cardiac problem involved. Because of the normal CT the patient was reassured and returned to his ho
e to enlarge
26 Immunodeficiency:
History50 year old female with a common variable immunodeficiency (CVID) had complaints of a cold with a non pro
one day and headache. CT findings
Subtle findings only in left lower lobe
Septal thickening
Subtle areas of GGO
Bronchial wall thickening CORADS 3indeterminate PCR negative Click image to enlarge
27 CORADS 5:
History
47 year old male with flew-like symptoms for 10 days was admitted to the hospital with progressive dyspnoe and an
Bronchiectasis CORADS 5
28 CORADS 4:
History40 year old female presented with acute dyspnoe and hemoptoe CT findings
Areas of GGO and basal consolidation in lower lobes. CORADS 4probable COVID-19 PCRPositive Enable Scroll
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29 RSV infection:
History67 year old male with Non Hodgkin Lymphoma who had a allogeneic stem cell transplantation half a year ago
one day. No coughing. CT findings
Multifocal consilidations with halo sign CORADS 3equivocal COVID-19 PCRNegative. RSV positive Enable Scroll
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30 CORADS 5 subpleural bands:
History79 year old male presented with one week dyspnoe and non productive coughing. Received antibiotics since
Bilateral GGO
subpleural bands CORADS 5very likely COVID-19 PCR

positive Enable Scroll
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31 Chest pain and low body temperature:
History63 year old female presented with dyspnoe and chest pain since one day. She had a low body temperature ar
o pulmonary emboli or dissection
Some GGO and consolidation not the bilateral patchy pattern that we normally see in COVID-19.
Thickened interlobular septa
Pleural fluid CORADS 2low suspicion of COVID-19
Maybe some other infection in combination with heart failure. PCRnegative Enable Scroll
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32 probably heart failure:
History56 year old male with a history of two times renal tranplant with rejection and hypertension and vomiting an
was 74%. CT findings
high position tube
diffuse GGO and thickened interlobular septa
bilateral pleural fluid CORADS 2Low suspicion of COVID-19. Most likely heart failure with pulmonar edema. PCRNega
33 CORADS 5:
History73 year old female known with LBTB had progressive dyspnoe for 3 weeks. CT findings
Bilateral widespread areas of GGO CORADS 5typical COVID-19 PCRpositive
34 CORADS 3 PCR+:
History70 year old male with dementia was admitted to the hospital with chest pain and dyspnoe. No cardiac cause.
breathing artifacts.
maybe some areas with GGO CORADS 3Indeterminate PCRpositive
35 25 year old male:
History25 year old male with fever and dyspnoe for 5 days. Treated with oxygen for one day. Went home but was rea
Bilateral GGO CORADS 5 PCRpositive
Coronary Artery Disease-Reporting and Data System 2.0:

Examples for the different Cad-Rads categories:
Csilla Celeng, Richard Takx, Robin Smithuis and Tim Leiner
University Medical Center Utrecht, Amsterdam University Medical Center, Mayo Clinic, Rochester, USA and Alrijne ho
Publicationdate Update 2023-05-05 CAD-RADS is the Coronary Artery Disease-Reporting
and Data System.
CAD-RADS is developed to standardize reporting of coronary CTA, to improve communication and to guide therapy.
The original article was published in 2016 by the
Society of Cardiovascular Computed Tomography (SCCT), the American College of
Radiology (ACR) and the North American Society for Cardiovascular Imaging
(NASCI) and it has been endorsed by the American College of Cardiology (ACC) (1). CAD
RADS 2.0
In
2022 CAD RADS was updated to version 2.0 (2).
Similar to the
original CAD-RADS version, stenosis severity determines the CAD-RADS score
(from 0 to 5).
New in the current version is the incorporation of plaque burden
(from P1 to P4) and an update of the modifiers.
Understanding Chest pain:
Cardiac chest pain can be categorized into stable angina, unstable angina, non-ST-elevation myocardial infarction (N
latter three are called acute coronary syndromes.
Stable angina:
Stable angina is characterized by exertional chest pain induced by exercise, stress or emotion.
It is a mismatch between myocardial oxygen demand and supply due to the presence of atherosclerosis, microvascu
This type of angina is relieved by rest or administration of nitroglycerin.
Troponin-levels are normal.
Unstable angina:
Unstable angina pectoris (UAP) is defined as chest pain which occurs at rest or minimal exertion and is characterized
vels (3).
UAP is caused by plaque rupture with thrombus formation causing partial occlusion of the affected vessel.

NSTEMI:
NSTEMI or non-ST-elevation myocardial infarction is the result of plaque rupture and thrombus formation which cau
oponin-levels.
The ECG can be normal, or abnormal with inverted-T or ST-depression.
STEMI:
STEMI or ST-elevation myocardial infarction is characterized by complete occlusion of the lumen leading to a transm
The ECG is abnormal with ST-elevation or a hyperacute T-wave.
Target population for coronary CTA:
Pretest probability According to the guidelines of the European Society of Cardiology non-invasive imaging (including
>15% and can be considered in those with a pre-test probability between 5-15% (4).
The pre-test probability is based on the age and gender of the patient combined with the type of complaints: typical
al angina is: Atypical angina meets two of the before mentioned criteria.
Non-anginal chest pain lacks these criteria or meets only one.
CAD-RADS:

Assessment of stenosis degree:

Cad-Rads categories of the different coronary segments are based on the SCCT stenosis grading and coronary segm
All coronary arteries >1.5 mm diameter are graded for stenosis severity and the clinically most relevant stenosis has
e of plaque with positive remodeling but no stenosis. Cad-Rads 4 category is divided into two subcategories: In patie
ssment, i.e. CT-FFR, CTP, stress testing (exercise tolerance test, stress echocardiogram, SPECT, PET or cardiac MRI).
In patients with Cad-Rads 4B ICA is recommended. Click here to go to case 1 for an example of quantitative assessm
egment involvement score. SIS is a semiquantitative measure derived from the coronary CTA scan (7). For each of th
nt for a maximum of 16, or 17 in case a ramus intermedius is present.
P - Overall plaque burden sub-classification:
In CAD-RADS 2.0 overall plaque
burden has been added ranging from P1 (mild) to P4 (extensive).
Plaque burden
should be listed after highest stenosis degree with addition of symbol /
(slash) (e.g. CAD-RADS 3/P2). Plaque burden should be determined
by the technique which is considered most appropriate at the local institution.
This includes calcium score or segment involvement score (SIS) or based on
visual assessment.
Note that CAD-RADS 0 denotes absence of stenosis or plaque,
therefore P0 is not needed as a classification. Society of Cardiovascular Computed Tomography (SCCT) coronary seg
ram of the Society of Cardiovascular Computed
Tomography is used to indicate where the stenoses are located (6). LM: left main LAD: left anterior descending artery
D1: diagonal 1
D2: diagonal 2 LCX: circumflex artery
OM1: obtuse marginal 1
OM2: obtuse marginal 2
L-PDA: PDA from LCX
PLB: posterolateral branch; L-PLB: PLB from LCX. RCA: right
coronary artery PDA: posterior descending artery R-PDA: PDA from RCA PLB: posterolateral branch; R-PLB: PLB from
well as the proximal, mid and distal segments of LAD, LCX and RCA.
Cad-Rads Modifiers:
In CAD RADS 1.0 there were four modifiers.
In CAD RADS 2.0 there are 6 modifiers that can be added to the Cad-Rads category: A modifier is named after the hig
For instance Cad-Rads 3/S. Example of a non-diagnostic scan. Both the RCA and LCX are blurred due to motion artifa
Modifier N - nondiagnostic:
If not all segments (>1.5 mm diameter) are diagnostic (e.g. motion
artifacts), modifier N should be listed. There are two ways of listing modifier
N: Overall plaque burden
should also be reported for non-diagnostic scans (N), if total coronary plaque
burden can be assessed reliably.
In case of stenosis degree < 50% N should be
placed before category P (e.g. CAD RADS N/P2).
If stenosis ≥ 50% then P should precede N (e.g. CAD RADS
3/P2/N).
Modifier HRP - high-risk plaque:

The term “vulnerable plaque” has been replaced by “high-risk plaque
features” as modifier “HRP”. High-risk plaque features include: low-attenuation plaque, positive remodeling,
spotty calcification and napkin-ring sign. If two or more of these
features are present modifier “HRP” should be added to the CAD-RADS category. There are three plaque types on co
e entire plaque appears as
calcium density (>130 HU on non-enhanced CT). The previous terminology “hard plaque” is not recommended. Partia
components of which one is calcification. The previous term was “mixed plaque”, which is no longer recommended.
“soft-plaque”, “low-density plaque” and “fibrous plaque” should be
avoided (8). See also CTA features of stable and high risk plaques
Modifier I - ischemia:
CT-FFR (computed tomography fractional flow reserve) and stress CTP (computed tomography perfusion) are CTA de
hemodynamic significance of a stenosis ranging from 50 to 90% (CAD-RADS 3 and 4A).
CAD-RADS 2 lesions can be also considered if there is a proximal stenosis ≥ 40%, including the presence of high-risk
flow
in the coronary arteries. This figure shows a hemodynamically significant
stenosis in the LAD (0.58) and distal RCA (0.75).
This means the presence of
ischemia; modifier I + should be used. In case of a mismatch between
CT-FFR or CTP and CCTA results, an ischemic segment without a concordant
anatomic lesion, should be classified as I- if the reader is confident that
this is a false-positive result by CT-FFR or CTP or I±
if it is indeterminate and there is questionable and discrepant interpretation. Please note that patients with
prior myocardial infarction and fixed perfusion defects without myocardial
ischemia on CTP should
be classified as I-.
The presence of myocardial infarction should be documented
in the report. Stent in the mid LAD with minimal in-stent restenosis.
Modifier S - stent:
The presence of a stent is indicated by modifier “S”. Examples Note: the location of the stenosis does not matter, wh
CAD-RADS. What matters is that the patient has a severe stenosis and needs further
management. Please note: total coronary plaque burden should also be added and is
placed before the modifier S. Go to case 2 for an example of modifier S. A. example of LIMA-LAD without stenosis. B.
is in the graft. NB: there is a severe stenosis distal to the SVG, which is the bypassed stenosis and as of that is not co
Modifier G - graft:
The presence of coronary artery bypass grafts is indicated by modifier
“G”. Importantly, a bypassed stenosis is not considered for CAD-RADS stenosis classification. Examples: Note: the loc
matters is that the patient has an occlusion and needs further management. Please note: Total coronary plaque bur
(combined assessment of native coronary arteries and bypass grafts) should also
be added and is placed before the modifier G.
Modifier E - exceptions:
Modifier E is exceptions and non-atherosclerotic
abnormalities. The presence of non-atherosclerotic
abnormalities should be added as modifier “E” to CAD-RADS score.
Non-atherosclerotic luminal narrowing of the coronary arteries may require
disease-specific management or subspecialty referral. This image is of a patient with Kawasaki disease.
There is a coronary artery aneurysms (8 mm and 6 mm diameter)
of the LAD. Please also note the presence of
partially calcified plaque in the proximal aneurysm.
CTA features of stable and high risk plaque:
The morphology of high-risk plaques, which are thought to underly acute
coronary syndrome, differs from stable plaques. Stable plaques On histology, stable plaques are characterized by lar
fibrotic tissue and smaller lipid pools. High-risk plaques Conversely, unstable plaques can contain spotty calcification
pool (necrotic core), which is covered by a thin fibrous cap. These
plaques are sometimes referred to as thin-cap fibroatheroma (TCFA).
Some of
these high-risk plaque features can be identified by CTA. Low-attenuation plaque (HU=14) with severe (70-99%) steno
Low-attenuation plaque:
Lesions associated with plaque rupture frequently have a large lipid rich core.
Lipid on CT appears as low attenuation.
Plaques with < 30 HU on CTA were found to be present significantly more often in patients with acute coronary synd

Positive remodeling:
Positive remodeling is defined as a compensatory outward enlargement of the vessel wall at the site of the atherosc
On histology plaques with positive remodeling show a higher lipid content and abundance of macrophages (9).
Patients with positive remodeled plaques can present with an acute coronary syndrome without any prior cardiac hi
n the mid RCA.
There is outward growth of the plaque with minimal stenosis of the lumen. Another example of positive remodeling
Again, the plaque is outward from the lumen causing no stenosis in the LAD. Spotty calcification in the LAD and D1.
Spotty calcification:
Spotty calcifications are usually defined as calcifications < 3
mm.
Small spotty calcifications on CTA are associated with high-risk plaques (12). A: On the coronal image the so-called na
a higher “ring-like” attenuation (white arrows). B: Tissue characterization on CT by HU number
Napkin-ring sign:
The Napkin-ring sign is a qualitative high-risk plaque feature
on CTA (13). It is defined as a central low-attenuation area adjacent to the coronary lumen
and a higher “ring-like” attenuation tissue surrounding this central area (14). On histology, the area of low-attenuatio
while the “ring-like” outer area correlates with fibrous plaque tissue. The Napkin-ring sign is strongly associated with
cardiovascular events (15). Click here to go to case 3
Coronary CTA protocol:
Example of a CTA scan performed on the same scanner in the same patient without (A) and with (B) administration o
he vasodilatory effect nitroglycerine increases the number of assessable (>1.5 mm diameter) segments. Coronary CT
Extra cardiac findings:
Of patients presenting with acute chest pain 5-10% suffer from STEMI,
15-20% from NSTEMI, 10% from UAP, 15% from other cardiac conditions and in the
remaining approximately 50% non-cardiac diseases are the underlying cause (4). Non-cardiac conditions include acu
penetrating atherosclerotic ulcer, dissection or rupture), pulmonary embolism
(see arrows in figure), pericarditis, or other intra-thoracic pathologies. For these conditions the use of double or tripl
alternative explanation for the symptoms. Image
Multiple pulmonary emboli (arrows).
Examples:
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case 1 - CAD-RADS 2/P1:
First, scroll through the scan. Not all images are included. Some images without any abnormalities are skipped
from the series. How would you describe the findings on the coronary CTA? The findings are: Go back to article Enab
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case 2 - CAD-RADS 5/P2/S:
First, scroll through the CTA images. How would you describe the findings on the coronary CTA? The findings are: Du
ase
reads as CAD-RADS 5/P2/S, which means that this patient needs further
diagnostic workup. Back to the article Enable Scroll
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case 3 - Calcium score 0 and severe stenoses.:
First, scroll through the CTA images. How would you describe the findings on the coronary CTA? The findings are: Co
irst, study the CTA image. How would you describe the findings? The coronal image shows a central low-attenuation
of the LAD.
This low-attenuation area is surrounded by a higher attenuation
area.
This finding is the earlier discussed napkin-ring sign, which is a high-risk
plaque feature.
This patient classifies as CAD-RADS 4A/P1/HRP. Continue with the next images of the same patient... Same patient. D
g the
location and the length of the plaque. Also, the stenosis in the D2 branch of the LAD can be appreciated on the volu
rendered reconstruction. Due to the degree of stenosis and the presence of napkin-ring sign (visible on
axial images) this patient underwent ICA where the presence of severe stenosis
was confirmed. Continue with the next images... A: ICA correlates with CTA and shows an 80% stenosis in the mid LA
(white arrows) and a 60% stenosis in the D2 branch (black arrows). The D2

stenosis was overestimated on CTA. B: PCI was performed during which a drug eluting stent (DES) was implanted with good results (white arrows). Enable Scroll
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case 4 - CAD-RADS 3/P1/I+ thrombus left ventricle:
First, scroll through the CTA images. How would you describe the findings on the coronary CTA? The findings are: Thi this patient requires further investigation. ... Same patient. A: Curved MPR of the LAD with non-calcified plaque causi (LAO caudal) of the heart with a 70% stenosis in the proximal LAD. Note the presence of SA nodal artery arising from eluting stent (DES) was implanted into the proximal LAD with good results. Back to the article Enable Scroll
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case 5 - CTA overestimates stenosis due to calcium:
First, scroll through the CTA images.
How would you describe the findings on the coronary CTA? Continue with the curved MPR images of the same patien o severe stenosis in D1, extensive plaque burden, some
non-diagnostic segments and a stent this patient classifies as CAD-RADS
4A/P4/N/S, which means that this patient needs further workup. The ICA shows some wall irregularities to a maximu the proximal LAD. The D1 shows 50% stenosis at the origin (black arrows). The LCX shows some wall
irregularities with no in-stent restenosis. The RCA shows minimal wall irregularities, no in-stent restenosis. This case overestimate the actual luminal stenosis. Continue with SPECT images of the same patient. Myocardial SPECT attenu t. A: apex to base; B: septum to lateral wall; C: inferior to anterior Shortly after the PCI the patient was again admitte atypical angina. SPECT myocardial perfusion was performed to exclude the presence of ischemia,
which showed no perfusion defect in the left ventricle. The patient was treated with optimal medical care and no inte performed. Cury RC, Leipsic J, Abbara S, Achenbach S, Berman D, Bittencourt M, et al. Radiol Cardiothorac Imaging. 2
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Pulsatile and non-pulsatile tinnitus:
Ruud Becks, Sjoert Pegge and Anton Meijer
Department of radiology and nuclear medicine, Radboudumc, Nijmegen, the Netherlands:
Publicationdate 12-6-2020 This article is based on a review by Pegge et al. describing a systematic approach for the d The differential diagnosis is related to findings on different imaging modalities.
A flowchart for choosing the appropriate imaging modality in pulsatile tinnitus is provided.
Introduction and flowchart:
Tinnitus is defined as an auditory perception of internal origin, and can have a significant influence on the wellbeing pulsatile tinnitus, the auditory perception is repetitively synchronous to the patient's heartbeat. All other auditory pe ients presenting with tinnitus have pulsatile tinnitus. In about 70% of the cases with pulsatile tinnitus, an underlying own on the flow chart. Left sided vestibular schwannoma. Axial non contrast-enhanced T1-W (left) and contrast-enha

Non-pulsatile tinnitus:
Non-pulsatile tinnitus is almost always subjective.
Different underlying conditions relate to the development of non-pulsatile tinnitus, including cerumen impaction, mi
bycusis or chronic bilateral hearing loss, hemorrhage, neurodegeneration, and spontaneous intracranial hypotensio
atile) tinnitus with focal neurological abnormalities, or asymmetric hearing loss [4]. The main purpose of diagnostic i
tine angle cistern, (e.g. vestibular schwannoma).
Labyrinthine abnormalities can be identified on MRI supporting the diagnosis of Ménière's disease [3].
Pulsatile tinnitus:
+++ Most optimal, ++ good, + moderate, ± indirect signs, – not suitable, LCH Langerhans cell histiocytosis, ICA interna
Pathology and imaging:
You can click on the table for a large view. For screening for underlying pathology and for the evaluation of a possibl
on with MRI and MR angiography (MRA) is recommended with reported high diagnostic accuracy. For the evaluation
thin-sliced (submillimetric) CT is sufficient. Multi-detector CTA or CT venography (CTV) of the head and neck region c
mic CTA, also referred to as 4D-CTA, is a technique that combines the non-invasive nature of CTA with the dynamic a
onventional angiography (DSA) in the diagnostic work-up of pulsatile tinnitus has been minimized, and should be res
I/MRA and CT/(4D-)CTA have not revealed the cause of pulsatile tinnitus. The role of duplex ultrasound in the diagno
trasound is an effective screening tool for the evaluation of vessel wall pathology of the carotid arteries, e.g. stenosis
During ultrasound, manual compression can be performed to investigate the influence of compression on tinnitus. C
enestram in fenestral otosclerosis (left). Cochlear otosclerosis appears as a hypoattenuated halo surrounding the co
Temporal bone pathology:
Temporal bone pathology like otosclerosis, Paget disease, and LCH can cause pulsatile tinnitus. Otosclerosis
Is also known as otospongiosis, is an idiopathic infiltrative process of the petrous bone.
It causes both sensorineural and conductive hearing loss, and can be the cause of pulsatile tinnitus. High-resolution,
the region of the fissula ante fenestram in fenestral otosclerosis (left). Cochlear otosclerosis
This appears as a hypoattenuated halo surrounding the cochlea on CT (right). Langerhans cell histiocytosis arising fr
Langerhans cell histiocytosis (LCH) is a rare benign disorder of clonal histiocyte proliferation.
Clinical symptoms in LCH depend on the extent of bone and extraskeletal involvement. Imaging typically reveals an a
without surrounding sclerosis.
The image shows an aggressive lytic osseous lesion with soft tissue mass arising from the jugular foramen, which pr
(left), strong enhancement of the lesion (right)
Paraganglioma:
Both CT and MRI can be used for the detection and evaluation of a paraganglioma.
The majority of tympanic paragangliomas are located on the promontory as a small well-defined tympanic soft tissu
Usually, there is no or little surrounding bone erosion.
These small tumours are best evaluated using thin-sliced CT with a bone algorithm. Left Axial CT shows a soft tissue
No visible bony erosion.
Right Axial contrast enhanced T1-W with fat suppression demonstrates strong enhancement of this lesion(arrowhea
Hypervascular metastases or meningioma:
Highly vascularized bone lesions, like osseous hemangioma, basal meningioma, Langerhans cell histiocytosis, or bon
innitus. On the left a meningioma on MRI.
Axial contrast-enhanced T1-W images.
Enhancing mass located in the left cerebellar-pontine angle with extension into hypoglossal canal (arrow), jugular pla
Vascular channel dehiscence or variant:
Venous tinnitus is heard as a continuous murmur that exaggerates in systole.
There seems to be an association with congenital variants such as a high riding, enlarged, or diverticulum of the jugu
tion CT.
Prevalence of sigmoid sinus diverticulum and dehiscence has been reported to be significantly higher in pulsatile tin
Aberrant course of ICA or stapedial artery:
An aberrant course of the internal carotid artery and persistence of the stapedial artery are congenital variants that
An aberrant course of the internal carotid artery in the middle ear may mimic a soft tissue mass or paraganglioma a
artery (arrow) and persistence of the stapedial artery (arrowhead) on thin-sliced CT.
Note the absence of the foramen spinosum (encircled).
Vascular loops, neurovascular conflict:
Vascular loops and elongated arteries are occasionally described as a possible cause of pulsatile tinnitus.
Considering the presence of these vascular loops and elongations also in asymptomatic patients, other possible caus
eavy T2 weighted CISS images on the left demonstrates a neurovascular conflict of the posterior inferior cerebellar a
vestibulocochlear nerve (left image, black arrowhead). The right image shows a grade 3 (>50%) vascular loop of the a
tic canal (white arrow). AVF: abnormal early contrast filling of the sigmoid sinus (left), venous drainage of the sigmoi
Arteriovenous fistula (AVF):
An AVF is an, usually acquired, abnormal connection between an artery and a vein without an intervening nidus.

Located along the dura or within a dural sinus, these are called dural AVF. Dural arteriovenous fistula (dAVF) located
ft 4D-CTA lateral subtracted MIP demonstrating abnormal early contrast filling of the sigmoid sinus (white arrow) cor
Hypertrophic occipital artery identified as arterial feeder (black arrow). Right DSA, selective contrast injection of the e
ipital artery (black arrows).
Venous drainage of the sigmoid sinus into the jugular vein (white arrows). AVM located in the right temporal fossa
Arteriovenous malformation (AVM):
An AVM located in the head and neck region can be the cause of pulsatile tinnitus. Typically, an AVM develops in ado
od. T2-W (left) and phase-contrast MRA (right) demonstrating intracranial arteriovenous malformation (AVM) located
MIP CTA and DSA (black arrows)
Vessel wall pathology:
Vessel wall pathology like atherosclerosis, FMD or dissection can be a cause of pulsatile tinnitus. In the elderly popul
teries is thought to be the most common cause of pulsatile tinnitus.
In a significant stenosed or occluded artery, increased vascular flow on the contralateral side could lead to pulsatile t
mental nonatheromatous, non-inflammatory vascular disease of unknown etiology.
Often it is a disease of the young leading to vascular stenosis and cerebral ischemia. On the left a classical imaging a
IP CTA and DSA (black arrows). Intracranial hypertension with enlarged Meckel cave (left image, white arrowheads), p
white arrow) and bilateral venous sinus stenosis (right image, black arrowheads)
Idiopathic intracranial hypertension:
Idiopathic intracranial hypertension (IIH), which predominantly affects young obese women, may cause pulsatile tinn
che and blurred vision due to increased cerebrospinal fluid pressure. The exact pathophysiology of IIH is unknown b
s. Dural sinus stenosis or compression can also be observed in IHH.
It is therefore advised to perform MRV or CTV in a patient with pulsatile tinnitus and suspicion of IIH. On the left a typ
cave (left image, white arrowheads), prominent subarachnoid space around the optic nerve (middle image, white ar
ads).
None:

Multiple Sclerosis 2.0:

Diagnosis and differential diagnosis:
Frederik Barkhof and Robin Smithuis
Amsterdam University Medical Center and University College London and Alrijne Hospital Leiderdorp, the Netherlan
Publicationdate 2021-12-01 This article is an updated version of the 2013 article and focusses on the role of MRI in th
ng subjects: There is an important role for MRI in the diagnosis of MS, since MRI can show multiple lesions - dissemin
the time of first presentation, and MRI can show new lesions on follow up scans - dissemination in time, much earlie
Introduction:
* In elderly patients or patients with cardiovascular risk factors it is better to look for at least 3 periventricular lesions
McDonald criteria:
More information:
Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria Multiple sclerosis is the most common inflam
ung and middle-age adults, but may also affect older people. According to the McDonald criteria for MS, the diagnos
space, either clinically or radiologically and elimination of more likely diagnoses. There is an important role for MRI i
(dissemination in space), many of which are clinically occult already at the time of first presentation, and MRI can sho
earlier than new symptoms develop. The McDonald criteria are very specific, because if you want to use MRI for the
You do not want a patient to start treatment daily if there is any doubt about the diagnosis. Dissemination in Space F
cal areas of the CNS are required: Dissemination in time For dissemination in time (DIT) there are two possibilities: C
mination 3 months after the first clinical event. The images on the right show a new enhancing lesion on a follow up
This is a coronal T2 image of a brain specimen with MS involvement. The lesions in the deep white matter (yellow arr
MS in this case is: An early diagnosis of MS allows treatment to start earlier and improves prognosis.
This does carry the risk of a false positive diagnosis when MRI findings are misinterpreted.
MS phenotypes:
Relapsing-remitting (RR)A multiple sclerosis course characterised by relapses with stable neurological disability betw
of relapsing-remitting disease becomes secondary progressive. Primary progressive (PP)10-15%, M=F Atypical preser
Marburg, Schilder, Balo, Devic, tumefactive MS (open-ring sign) Clinically isolated syndrome (CIS)A monophasic clinic
reflecting a focal or multifocal inflammatory demyelinating event in the CNS, developing acutely or subacutely, with
he absence of fever or infection. Radiologically isolated syndrome (RIS)MRI findings strongly suggestive of multiple sc
her clear-cut explanation.
MR findings in MS:
The table summarizes typical MRI-findings in MS. Even when a patient is clinically suspected of MS, we still must stud
suggestive of MS, and not incidental age-related findings. LEFT: involvement of U-fibers in MS. RIGHT: U-fibers are no
ion.

Juxtacortical lesions:
Juxtacortical and cortical lesions are specific for MS.
They are adjacent to the cortex and must touch the cortex (yellow circle). In small vessel disease the U-fibers are typi
normal WM between the WML and the bright cortex (white circle). Do not use the word subcortical to describe this l
area of white matter almost reaching the ventricles. Juxtacortical MS lesion located in the U-fiber. You really have to
difficult to differentiate from the hyperintense cortex. FLAIR or Double Inversion Recovery (DIR) can help identify the
cation view. LEFT: Typical Dawson finger with enhancement on T1WI. RIGHT: Multiple lesions and edema around enh
Dawson fingers:
Typical findings for MS as seen in this case are: Dawson fingers are typical for MS.
They represent areas of demyelination along the small cerebral veins that run perpendicular to the ventricles.
If needed this can be demonstrated using SWI The enhancement will be present for about one month after the occu
ed to typical asymmetrical MS lesions (right)
Brainstem lesions:
In MS brainstem lesions are typically peripheral. In small vessel disease there may be involvement of the brainstem,
Temporal lobe involvement:
Temporal lobe involvement is also specific for MS. In hypertensive encephalopathy, the WMLs mostly found in the fr
in the temporal lobes. Only in CADASIL there is early involvement of the temporal lobes. T1WI: enhancing lesions on
ter..
Enhancement:
Enhancement is another typical finding in MS. These are images of a patient who was re-examined 3 months after th
e are: The edema around a new lesion will regress and finally only the center will remain as a hyperintense lesion on
ion in MS. MS starts as inflammation around these veins. In the first four weeks of the inflammation there is enhanc
n barrier. First there is homogeneous enhancement but this can change to (open) ring enhancement. Tumefactive M
Tumefactive MS:
Tumefactive MS is a variant of Multiple Sclerosis.
On MRI it presents as a large intra-parenchymal lesion with usually less mass effect than would be expected for its si
They may show some peripheral enhancement, often with an incomplete ring unlike gliomas or intraparenchymal ab
T1W post-gadolinium images are of a 39-year-old male who presented with subacute onset of hemianopsia.
He was referred for biopsy to differentiate between a glioma or demyelination. There is an intraparenchymal mass i
which only partially enhances (open-ring sign) on the postcontrast images.
There is surrounding edema, but relatively little mass effect. This was a biopsy-proven demyelinating lesion.
The open-ring enhancement pattern with low signal T2 ring and low CBF are all indicative of demyelination.
Spinal cord lesions:
Typical spinal cord lesions in MS are relatively small and peripherally located.
They are most often found in the cervical cord and are usually less than 2 vertebral segments in length.
A spinal cord lesion together with a lesion in the cerebellum or brainstem is very suggestive of MS. Spinal cord lesion
of ADEM, sarcoid, and NMOSD. Proton-density-image of the spinal cord in a patient with MS The images show multip
cord has a uniformly low signal intensity (like CSF), which gives the MS lesions a good contrast against the surroundi
ting for optimal results.
A good alternative for PDW is STIR.
Make sure to have two different sequences or two different planes.
MS Differential diagnosis:
The differential diagnosis of MS is extremely large and includes almost all white matter diseases.
A broader differential diagnosis of white matter diseases is given here. In this chapter we will only deal with a limited
tient is clinically suspected of having MS and the MR-images support that diagnosis, then you should not consider ot
e differential diagnosis if the clinician does not suspect the patient of having MS and on the MR incidental WMLs are
The odds are against the diagnosis of MS, because vascular WMLs are 50-500 times more likely than MS plaques. On
multiple WMLs are found, our major concern is the differential diagnosis MS versus small vessel disease. Then the M
Prevalence and a priori chance:
When we look at the prevalence of the white matter diseases, you will notice that there are enormous differences. H
but as a group they are not that uncommon, but still far more uncommon than MS. CNS involvement in Lyme diseas
the result of small vessel disease, since up to 50% of patients that get an MR examination for whatever reason, will h
le and in patients with vascular risk factors like atherosclerosis, high blood pressure, high cholesterol, diabetes, amyl
c. * Temporal lobe involvement is seen in CADASIL
Small vessel disease:
The differences between small vessel disease and MS are summarized in the table. Typical for MS is involvement of c
d spinal cord.
This pattern of involvement is uncommon in other diseases. Brainstem involvement in small vessel disease (left). Foc
es in vascular brainstem lesions compared to MS (same images as above). The image on the left is an axial T2 weight
a central involvement of the transverse pontine fibers. The image on the right is an axial T2 weighted image of the b

white matter lesions, often in or near the trigeminal tract, or bordering the 4th ventricle. Here is a typical case of sm
e with a symmetrical distribution and a lacune in the right basal ganglia. Patient with NMOSD showing a longitudinal
optica. The diagnosis was confirmed by an AQP4-AB titer of 1:1024.
Neuromyelitis Optica:
A very important differential to keep in mind, especially in patients with a bilateral optic neuritis and myelitis, is Neur
led Devic's Disease.
This is a demyelinating disease caused by antibodies against aquaporin or MOG in which the optic nerves and spinal
ally extensive myelitis (LETM defined as more than 3 vertebral segments) with low T1-signal intensity and swelling of
On axial images the lesions often involve the central gray matter of the cord.
This is unlike MS, in which the lesions are usually smaller and peripherally located. Often there are a few T2-lesions i
Balo's Concentric Sclerosis:
Balo's Concentric Sclerosis is an uncommon demyelinating disease. It is a progressive variant of multiple sclerosis ch
eservation, with a laminated onion-skin configuration. The T2 and post-contrast T1W images show a large lesion in th
bands. On the T1W images after gadolinium there is alternating linear enhancement.
Note that the outermost band shows diffusion restriction. There is a smaller, similar lesion on the right. ADEM exten
lamus.
ADEM:
Acute Disseminated Encephalomyelitis (ADEM) is another important differential diagnosis of MS. This is a monophas
ildren following an infection or vaccination.
Many of the patients have MOG antibodies (MOG= Myelin oligodendrocyte glycoprotein). On MRI there are often diff
l white matter which may enhance simultaneously. There often is preferential involvement of the cortical gray matte
we have axial FLAIR and T2W-images of a young patient with ADEM - notice the extensive involvement of the cortical
. Notice the involvement of the basal ganglia and the middle cerebral peduncle. Here another case of ADEM. Notice t
and MS are summarized in the table. Natalizumab-associated PML. Images were kindly provided by Bénédicte Quivr
Natalizumab-associated PML:
Progressive Multifocal Leukoencephalopathy (PML) is a demyelinating disease caused by JC virus in immunosuppress
approved for the treatment of multiple sclerosis due to a positive effect on clinical and magnetic resonance imaging
ct of this drug is a higher risk of developing PML. The diagnosis of PML according to diagnostic criteria is based on th
CNS (e.g., in the cerebrospinal fluid) and imaging findings preferably on MRI. Compared to other PML populations su
e been described as heterogeneous and fluctuating. Key imaging signs are: It can be difficult to differentiate progres
See table for differences in imaging. How to image natalizumab-associated PML: Further information: www.MS-PML.
Sarcoid:
Sarcoid has surpassed neurosyphilis as the great mimicker. The distribution of the lesions in this case is quite similar
Besides lesions in the deep WM, there are some juxtaventricular lesions and even Dawson finger-like lesions. The fin
case is the linear enhancement (yellow arrow).
This is due to inflammation along the Virchow Robin spaces.
This is also a form of leptomeningeal enhancement. This explains why sarcoid has a similar distribution to MS: the Vi
involved in MS. CADASIL
CADASIL:
CADASIL is short for cerebral autosomal dominant arteriopathy with subcortical infarcts and leukencephalopathy. It
mentia and family history. Key finding: subcortical lacunar infarcts with small cystic lesions and leukoencephalopathy
poral pole and external capsule have a high specificity.
MRI protocol:

MS Brain Protocol:
Indications for MRI of the brain are (Reference: 2021 MAGNIMS–CMSC–NAIMS consensus recommendations on the u
at the start of the examination because the longer you wait the more enhancement you will see on the T1W images
ut contrast administration). The sagittal FLAIR is ideal for detection of lesions in the corpus callosum and the 3D sequ
lesions.
The T2W scan is preferably conventional SE or FSE. Finally the axial T1W-images are made after about 15 minutes to
ntrast or dual plane images
MS Spinal cord Protocol:
Indications for MRI of the spinal cord are (Reference: Spinal cord involvement in multiple sclerosis and neuromyelitis
nly the spinal cord is examined and is only administered when other diagnoses are considered (e.g. sarcoid) . The m
FLAIR should not be used in the spinal cord as it will only demonstrate 10% of the lesions. Click on image to enlarge.
MR timing in monitoring MS:
The table shows a scheme on how to follow-up a patient with MS based on the 2021 MAGNIMS-CMSC-NAIMS conser
Consider the following modifications in the protocol: Less frequent MRI in further follow-ups in clinically stable patie
d of every year while on treatment. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria Lancet Ne
2. Comparison of MRI criteria at first presentation to predict conversion to clinically definite multiple sclerosis F Bark

G Comi, HJ Ader, N Losseff and J Valk Department of Diagnostic Radiology, Vrije Universiteit Hospital, Amsterdam, Th
3. Differentiation of Multiple Sclerosis from Other Inflammatory Disorders and Cerebrovascular Disease: Value of Sp
ert Lycklama ? Nijeholt, MD, PhD et al. Radiology 2002;223:46-56.
4. Spinal cord abnormalities in recently diagnosed MS patients: added value of spinal MRI examination Bot JC, Barkh
Myelopathy:
Majda Thurnher and Robin Smithuis
Department of Radiology of the Medical University of Vienna, Austria and Rijnland hospital in Leiderdorp, the Nether
Publicationdate 2012-10-03 In this article we will focus on spinal cord diseases that are characterised by high signal v
ry and demyelinating disorders like Multiple Sclerosis, Neuromyelitis Optica, Acute Disseminating Encephalomyelitis
is including tumors, inflammatory and vascular disorders.
Introduction:
Spinal cord abnormalities. Common causes in white and uncommon causes in yellow.
Differential diagnosis:
The first question is usually is it MS?
Does it look like spinal cord MS and does the brain look like MS. If the patient has myelopathy and optic neuritis ther
nd do the NMO-IgG test. If both halves of the cord are involved than think of Transverse Myelitis (TM) which is not a s
s autoimmune and infectious stimuli.
2. Tumor The major differential of demyelinating diseases is an astrocytoma, especially if there is swelling and some
rogressive. The other common spinal cord tumors like ependymoma and hemangioblastoma do not cause differenti
. Metastases to the cord are very uncommon.
3. Vascular Acute ischemia is typically seen as a complication of aortic aneurysm surgery or catheterisation. Cord iscl
in vascular malformations like AV-fistula. So always look for abnormal vessels around the cord.
4. Infammatory Vasculitis
5. Infection Infection rarely involves the spinal cord. If we exclude myelopathy due to cord compression as seen in tr
a diagnostic dilemma, then the most common diseases of the spinal cord are demyelinating diseases. MS is by far th
e if there is dissemination over time and space. Many patients who are diagnosed as having acute disseminating enc
sease and later turn out to have MS (red arrow).
Systematic approach:
Whenever there is an abnormality in the spinal cord, we need a systematic approach to analyse the findings. Clinical
cord disorders. On MR look for the following: In MS there is typically a short segment involved, i.e. less than 2 segme
mia there is usually a long segment involved.
* How much of the cord is involved on tranverse images?
Partial involvement is typically seen in MS.
Complete involvement includes both halves of the cord and is typically seen in TM and NMO.
* Location of the involvement on transverse images?
Use high resolution transverse images to detect the location within the cord. Is it posterior like in MS, vitamin B12 de
arction.
* Is the cord swollen? In TM and tumor the cord is swollen, while in MS and ADEM the cord is not swollen or less swo
* Is there enhancement?
Many diseases show some enhancement, but the most important thing is that astrocytoma has to be included in the
Short or long segment involvement:

Transverse involvement:
Transverse images are very helpful in the differential diagnosis. You need high resolution images. Look for how muc
t is the form of the involvement. Brain abnormalities In many cases of myelopathy there will also be brain abnormali
Multiple Sclerosis:
MS: short segment focal wedge-shaped involvement of the posterior column of the spinal cord with typical periventr
isease and there is overlap between these diseases. NMO was first thought to be a form of MS, but is now considere
artial form of transverse myelitis Here we have images of a typical case. Many times the clinical history is very helpfu
urbances on one eye followed by weakness and sensory disturbances of the lower and upper extremities a couple o
r extremities. So we already think MS. In the cord there are some well-defined lesions, but also some ill-defined fogg
he typical triangular shape. Continue with the contrast-enhanced images On the contrast-enhanced images there is
s not that common as we see in active lesions in the brain. Whenever spinal lesions are encountered, it can be helpfu
ceduled for MRI of the spine and you don't have time to do a full brain examinations. In those cases consider to do c
MRI of the brain shows periventricular lesions and a lesion in the corpus callosum. These locations are very specific
nother patient there are non-specific lesions in the cord. Based on the examination of the spine alone, we have a bro
becomes obvious that we are dealing with MS. Continue with the images of the brain. Typical MS in the brain In this
the lesions is very typical: pons, periventricular and subcortical. MS Now what can we expect in the spinal cord of pa
s are focal like we see on the left image. Less commonly there are diffuse abnormalities and then we have a tough di
ing cases atrophy will be seen. One third of MS patients will have spinal symptoms. One third of patients have isolate

ic studies have shown that 95% of MS patients have spinal cord lesions, whether they have spinal symptoms or not.
nd or triangular shape and are located posteriorly or laterally. So can we exclude MS if a lesion is located anteriorly?
located anteriorly like in this patient who has a lesion in the typical location (blue arrow) but also a lesion ventrally in
exclude MS. When MS lesions are active, they can enhance, but enhancement is not as common as in the brain. The
intense and less-intense enhancement. The less intense or vague enhancement is the most common pattern. Acute
th longstanding MS and acute exacerbation. There is enhancement in the active lesions. Continue with the images of
lso in the spinal cord there are multiple lesions. On the transverse image a typical triangular shaped dorsal lesion is
rbation of cerebral and spinal MS Also in the spine there are multiple enhancing MS-lesions. Diffuse abnormalities in
focal abnormalities. Diffuse abnormalities that can look like transverse myelitis or extensive astrocytoma are somet
d secondary progressive MS. Atrophy in longstanding MS Some say that spinal cord atrophy is specific for primary pr
nical disability. It is more prominent in the upper part of the spinal cord. Duration of the disease is the most importa
Neuromyelitis Optica:
NMO presenting with neuritis optica (arrows). The brain is normal.Courtesy Andrea Rossi key facts: On the left image
s of the brain were otherwise normal. Continue with MRI of the spine. Patients who have one episode of optic neurit
for developing the full spectrum of NMO. One month later this child presented with acute transverse myelopathy, i.e
l cord with swelling and some enhancement. An astrocytoma could very well present with these images, but given th
hink of a tumor. This proved to be NMO and the Ig-test for NMO was positive. In the original description of Devic's di
, but now we know that this is not always the case. Periventricular lesions in NMO around fourth and third ventricle.
brain was spared, but now we know, that brain lesions do occur. They are often distinct from those seen in MS. In As
e only 25-40%. The location of the brain lesions in NMO is only around the ventricles. Periventricular lesions in NMO
lesions are located around the ventricles is the following: The NMO IgG auto-antibodies are directed against Aquapo
in the cells, there are also water-channels. The highest concentration of these Aquaporin-4 water-channels is seen a
third and frontal horns of the lateral ventricles. Neuromyelitis optica with callosal lesions. Courtesy Dr Nakamura. Th
to have large lesions in the corpus callosum of patients with NMO as was described by Nakamura (6). So in any CNS
do the test for NMO-IgG.
ADEM:
ADEM key facts: On the left images of a teenage child with a typical history: Eye movement disturbance and impairm
ually the brain is also involved. 30% of cases has spinal involvement. The imaging findings in this case are also typica
nhancement. Continue with the images of the brain. ADEM First look at the images of the brain and decide what is d
MS is: ADEM - follow up The follow up MR shows that the cord has returned to normal again. On the left another cas
use involvement of the spinal cord without enhancement and there is involvement of the brain. Typical ADEM. Court
ical involvement of the pons and basal ganglia. Continue with follow up scan. Courtesy of Andrea Rossi, Genova, IT C
Transverse Myelitis (TM):
key facts: The sagittal image shows a large segment of hyperintensity on T2WI. The transverse image shows that mos
ges are of a 31 year old male with headache, voiding disturbances, urinary retention, sensory level C3. The CSF analy
igher protein level. The images show a long segment myelopathy with full transverse involvement. There is no swelli
e thinking ATM - acute transverse myelitis.
Diseases associated with Transverse Myelitis:
Transverse myelitis may occur in isolation or in the setting of another illness. When it occurs without apparent under
erse myelitis is assumed to be the result of abnormal activation of the immune system against the spinal cord. The t
s with an acute short segment TM (or APTM) are at risk of developing MS if there is one of the following: In children w
e to move their legs.
However the outcome is usually better than in adults and in 30-50% there is complete recovery. Typical for TM is tha
ess or completely resolved on follow up scans. Longitudinal case series of TM reveal that approximately 1/3 of patien
e degree of permanent disability, and 1/3 have severe disabilities. Here images of a typical case of TM. There is multi
of the cord in the transverse diameter is involved. There is no enhancement, which is usually the case in TM. Sometin
sverse myelitis When there is enhancement, it can be difficult to differentiate TM from an astrocytoma. On the left im
th pain in the thoracic region and sensory disturbances in the left lower extremity followed by left hemiparesis. Ther
like we have seen in cases of TM. On CE-T1WI there is a region of enhancement. The region of enhancement is more
Spinal cord tumor:
Spinal astrocytoma
Astrocytoma:
As we have just seen, the major differential of the spinal cord diseases that we have discussed so far is an astrocytor
mass-like. Usually there is some patchy enhancement. On the left an astrocytoma in a 66 year old patient who prese
ma. Continue with the follow up. Spinal astrocytoma - follow up The patient was not operable and a follow up scan s
n spinal cord tumors are ependymoma and hemangioblastoma and they just look like a tumor. They present as enh
tumors are uncommon. The images are of a patient with neurofibromatosis who has multiple ependymomas. They p
Vascular:

Arterial infarction:

Spinal cord ischemia is typically seen as a complication of aortic aneurysm surgery or stenting. The images are of a p
aneurysm. Notice the high signal ventrally in the chord, which is typical for arterial infarction. On transverse images a
rd ischemia Aortic aneurysm stenting is the most common cause of spinal chord infarction. The diffusion images sho
Vasculitis:
The images are of a child with headache, fever, hyperalgesia and numbness of the left side of the body. There is also
focal lesions and probably the first choise would be MS. The differential diagnosis would include inflammation, infec
image of the spine to look for the exact location and perform a MRI of the brain. Continue. The lesions are located do
ection or metastases it would be strange that not all lesions enhance. MS is still on our list. Continue with the MR of t
on shows enhancement. The location of the lesions and the enhancement could very well fit to the diagnosis of MS,
is also seen in SLE, Sj?gren and Behcet. Normally you think of vasculitis as a disease of the vessels in the brain, but a
MS-like images.
Spinal AVF:
The most common vascular malformation of the spinal cord is the dural AV-fistula. It consist of an abnormal connect
venous pressure and predisposes the cord to ischemia and less commonly to hemorrhage. AVF's are mostly seen in
n accurate diagnosis is important because these lesions may represent a reversible cause of myelopathy. Notice the
vessels on the T2WI. On the enhanced T1WI there is subtle enhancement. Another case with myelopathy and dilated
ated vessels surrounding the cord. Notice the hypointense areas on the T2WI which represents hemorrhage. Anothe
Cord compression:
Although beyond the scope of this article, the most common cause of myelopathy is cord compression as seen in tra
fracture with posterior displacement. There is myelopathy due to traumatic cord compression. Another case of cord
e is myelopathy as a result of compression by a dorsally located epidural hemorrhage. The most common cause of c
the vertebral body as a result of a metastasis which extends into the vertebral canal. by Andrea Rossi Neuroimaging
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5. The spectrum of neuromyelitis optica by Dean M Wingerchuk, Vanda A Lennon, Claudia F Lucchinetti, Sean J Pittoc
6. Occurrence of acute large and edematous callosal lesions in neuromyelitis optica. by Nakamura M, Misu T, Fujihar
Mult Scler. 2009 Jun;15(6):695-700
7. Transverse Myelitis: Symptoms, Causes and Diagnosis by Joanne Lynn, M.D.
None:

None:

Pathology of the Male Breast:
Publicationdate 2009-03-15 This review is based on a presentation given by Leonard Glassman and adapted for the I
Glassman
Normal Male Mammogram:
Normal male mammogram Click on image to enlarge When you do breast imaging in a male, always stick to the follo
'If it is not normal, gynecomastia or classically benign,
it needs a biopsy'. So, first we're going to give you a couple of examples of the normal male breast, just to get used t
and finally discuss some specific tumors. Obviously, the lesions in this last category will need a biopsy, unless you are
ph node or lipoma. On the left two examples of a normal male mammogram. The left image shows normal skin, a ni
ge on the right shows a bit more connective tissue, but this is still normal. Normal male mammogram On the left and
a number of blood vessels. There is a small amount of fibrous connective tissue, but basically most of this breast is ju
e left a MRI of the normal male breast. There is a small amount of connective tissue behind the nipple.
Gynecomastia:
Gynecomastia Gynecomastia is the most common abnormality in the male breast. Clinically, it presents as a soft mo
:
soft - mobile - tender - subareolar . So it has to be soft and mobile. It is tender in the acute phase, but not in the chro
is not subareolar is not gynecomastia. Gynecomastia: nodular glandular pattern.Notice how it blends into the surrou
e left a male breast with a nodular glandular pattern of gynecomastia. There is a fan shaped density radiating from t
and, more importantly, it blends into the surrounding fat. If you think about the mammogram on the left as the brea
n ill-defined mass and you might conclude that this is a malignancy . However, in a man this indistinct border is a sig
n of ducts and stroma without encapsulation, so it must blend into the surrounding fat tissue. There is no proliferati
s that start in the lobuli, for example lactating adenomas, fibroadenomas, phyllodes tumors, and also invasive lobula
aleRight: Juvenile hypertrophy in an 8 year old female On the far left a mammogram of a male with gynecomastia an
ertrophy. Notice that they look very much the same. Gynecomastia nodular pattern: Incidental finding on CT-scan On
n a CT-scan done for some other reason. By definition gynecomastia is 2 cm or more of subareolar tissue in a non ob
men at autopsy. The peak incidence is 60 - 69 years. It is significant if it is new or symptomatic. In elderly males gyne
a and 10% are other lesions. Mammogran and rotated ultrasound image
Nodular pattern:

The nodular pattern of gynecomastia is seen in the florid early phase. It begins as an increased number of ducts and roma. This phase is reversible. On the left a mammogram and an ultrasound image of a patient with a nodular glanc the nipple. The ultrasound image shows the typical appearance of gynecomastia: a hypoechoic mass with lobulation this is a mass with microlobulation and spiculation, i.e. Birads IV or V. In a man this is typical for gynecomastia. On th sition. Notice how 'malignant' it looks. Gynecomastia nodular pattern: T2W-fatsat and T1WI+Gd On the left a T2W-im iologist who was not used to looking at 'male' mammograms ordered the MR for problem solving. Obviously this MR problem that can be solved with mammography. Anyhow the MR shows gynecomastia of the nodular pattern. Dend

Dendritic Pattern:

The dendritic pattern is seen in the fibrotic or late phase. There are dilated ducts, moderate epithelial proliferation a nsity with prominent extensions into the fat. Usually the density is smaller than in the nodular pattern. Classic benig gine, that there is fibrosis with extension into the fat. This is different from the glandular edema-like appearance in t lated appearance. These cases clearly demonstrate that gynecomastia can have an appearance which we would call man can look benign and we will show some examples in the next chapter.

Diffuse glandular pattern:

This pattern is seen in males with very high estrogen levels. The images on the left simply look like small female brea te carcinoma. Pseudogynecomastia

Pseudogynecomastia:

This is usually bilateral and there is no palpable mass. Remember that gynecomastia presents clinically as a soft, mo xcessive fat deposition in the breast area. It is seen as a normal variant, in obesity and in neurofibromatosis.

Benign Lesions:

Let's first start with a list of lesions that should not be diagnosed in male patients, because they simply do not get th it is only seen in pregnancy. Because there are very few lobules in a man, lobular tumors are extremely rare. There a oepithelial lesions are also extremely rare because they too start in the lobules. So do not diagnose a fibroadenoma iopsy result that says fibroadenoma, get another pathologist. On the left lesions that do occur in males. Exept for gy will not get a diagnosis from imaging. We just report that there is a Birads IV lesion and do a biopsy. Myofibroblastor

Myofibroblastoma:

Myofibroblastoma is an interesting lesion because it is the only one lesion that is more common in men than in wom . There are no calcifications. The mean age is in the late 50's. On the left a large lesion, that looks like a fibroadenoma logy diagnosis was myofibroblastoma and the lesion was treated with local excision. Myofibroblastoma eccentric to t ly On the left another myofibroblastoma. It presents as a circumscribed lobulated mass without calcification.

Notice that the lesion is eccentric to the nipple.

It is the lobulated mass that needs to be biopsied, not the retromamillary gynecomastia. Myofibroblastoma eccentri marked and the lesion is not retromamillary. On the ultrasound image the lesion is difficult to differentiate from the ed lobulated mass without calcification On the left another myofibroblastoma. Even if this lesion was located behind it is a lobulated mass. Granular Cell Tumor

Granular Cell Tumor:

This is a benign tumor of neural origin. They occur anywhere in the body. 6% occur in the breasts. They are typically d in males, but sometimes they have a spiculated appearance. Notice that the lesion on the left has a indistinct bord s not located directly under the skin. So this is not gynecomastia and a biopsy is necessary. Granular Cell Tumor On t

Epidermal inclusion cyst:

Epidermal inclusion cyst is a skin lesion.

It presents as a round well circumscribed dense mass. On the left a small epidermal inclusion cyst.

Notice how it raises the skin. Epidermal inclusion cyst On the left a large epidermal inclusion cyst. Epidermal inclusio ge demonstrating the cystic nature and the pathology specimen. Granulomatous Mastitis

Granulomatous Mastitis:

Most are idiopathic. Specific causes must be excluded like TB, Sarcoid and fat necrosis. On the left is a male breast th imes be spiculated. Varix

Varix:

On the left a lesion that looks like a cyst, but remember that cysts originate in the lobules and men do not have lobu ture it, you get a big red surprise. Leiomyoma

Leiomyoma:

On the left a lesion, that looks like a fibroadenoma, but men do not get fibroadenomas. It is a solid encapsulated ma e than 2 mitoses per high power field the pathologist calls it a leiomyosarcoma.

Male Breast Cancer:

Invasive ductal carcinoma Malignant disease in men just looks like malignant disease in women. In the USA there are There is a higher incidence in people from China and Africa due to hyperestrogenism secondary to parasitic liver dis mass. This subareolar location is just like in gynecomastia, but usually it is eccentric to the nipple. It sometimes prese tia. Usually it is invasive ductal cancer. As stated above invasive lobular cancer is extremely rare. Also DCIS is rare be resent when there is a palpable mass. On the left an eccentric irregular mass with spiculae. If this was a women you In a man it is the same. Invasive ductal carcinoma Male breast cancer presents as a round, oval or irregular mass. Ca

in women. On the left a small invasive ductal carcinoma. It is subareolar and central, but it is also encapsulated. This
ase of the nipple and skin ulceration are more common than in women. On the left an invasive ductal carcinoma wit
carcinoma risk factors and they are the same as in women: On the left a small eccentric encasulated invasive ductal
ductal carcinoma with some coarse benign looking calcifications.
Other malignancies of the male breast:
Malignancies other than ductal carcinoma are uncommon. On the left a list of all malignancies in men.
Metastases:
Metastases from prostate cancer are the most common metastases in males. It results from hematogenous spread
round or lobulated non-calcified masses. On the left a patient with two metastases of a small cell lung carcinoma. Lip
Liposarcoma:
A liposarcoma is a rare sarcoma. It presents as a slowly enlarging painful mass. It is usually of water-density and is n
sity of the lesion that proved to be a liposarcoma.
Conclusion:

Gynecomastia versus Carcinoma:
In conclusion we can say, that male breast disease either presents as mass, pain or nipple discharge. Gynecomastia
breast, but there are other rarer benign and malignant lesions. Gynecomastia and carcinoma can usually be differen
sions eccentric to the nipple need biopsy unless they are characteristically benign, i.e.contain fat or typical lymph no
sus carcinoma. Notice that there are many similarities. Both gynecomastia and carcinoma occur mostly at the age of
s not help. Carcinoma is usually eccentric, while gynecomastia is never eccentric. Gynecomastia has to have extensio
ions, that can look the same. Actually we call it extension into the fat, if we think it is gynecomastia and spiculation, if
demonstrate, that it can be difficult to differentiate gynecomastia from carcinoma on a mammogram. The carcinoma
on the right. In less than 10% of the cases a biopsy can be needed to make the differentiation. On the left two more
ght a huge cancer which is encapsulated. The last cases on the left look very similar to each other. Based on the mar
ces a biopsy is needed.
None:

Crohn's disease - role of MRI:
Carl Puylaert, Jeroen Tielbeek and Jaap Stoker
the Academic Medical Centre, Amsterdam, the Netherlands:
Publicationdate 2016-02-17 In this article we will discuss the MRI-features used to evaluate Crohn's disease of the sm
grade disease activity resulting in a simple classification of mild, moderate and severe disease. This is sufficient for m
Introduction:
Crohn's disease is characterized by inflammatory lesions in the gastrointestinal tract, most commonly in the termina
lead to complications like stenoses, fistulas and abscesses. While most patients first present with inflammation only,
10 years (1). There is no cure for Crohn's disease. Immunosuppressive drugs can decrease disease activity, maintain
leocolic disease require surgery (2).
MRI protocol:
Bowel distention There are two techniques to acquire distension of the small bowel: We routinely perform MR enter
less burdensome and more time efficient. Oral contrastFor oral contrast several options are available. We use a Mar
n lumen and bowel wall on both T1 and T2 sequences and is well accepted by patients. There is one precaution: no c
er the MRI because of methane resulting from Mannitol breakdown. MRI sequences We use the following sequences
Grading Crohn's disease activity:
Click for enlarged view There are several systems for grading disease activity in Crohn's disease. The scoring system,
and severe. It is based on the score of the bowel wall abnormalities and the presence of complications as presented
be mentioned in the radiology report are:
MRI signs of Crohn's disease:
Bowel wall thickening with deep ulceration (arrow) in the transverse colon.
Bowel wall thickness:
With adequate distension the normal bowel wall has a thickness of 1-3 mm. A common categorization is 3-5 mm for
thickening of the bowel wall. T1 weighted post-contrast images or non fatsat T2 weighted images (if available) are pr
a coronal post-contrast T1 weighted image showing disease activity in the transverse colon with marked wall thicken
age shows marked bowel wall thickening and luminal narrowing of the terminal ileum. Measurement on the balance
rrows). Increased bowel wall thickness is one of the most common signs of inflammatory activity, but not specific for
osis of bowel wall thickening click here. Bowel wall thickness correlates well with the severity of the disease activity. M
uminal distension. Black border artifacts on balanced FFE sequences can distort thickness measurements. Thickened
st T1W image with fatsat.
Enhancement:
Abnormal bowel wall enhancement after administration of gadolinium is the result of increased vascular permeabili
Enhancement can be graded by comparing to the precontrast images, to normal bowel loops and nearby vascular s

categorized in one of the following patterns: The latter two enhancement patterns can only be appreciated when the
enhancement pattern. A layered pattern is regarded to depict more severe disease activity compared to the mucosa
4). However, different degrees of inflammation and fibrosis can be present at the same time and a layered pattern o
a more recent study did not find this association (6). Homogeneous enhancementStrong homogeneous enhanceme
homogeneous enhancement pattern with moderate (green arrow) and marked (red arrow) enhancement on an axia
his is seen as bowel wall thickening with increased enhancement of the mucosal layer relative to the outer layers. Th
attern in the terminal ileum (arrow). There is relatively low enhancement of the middle and outer layers Layered enh
g on an axial post-contrast T1 image (arrow). Continued inflammation with a homogeneous enhancement pattern ca
al cyst is present with enhancing rim (arrowheads). Layered enhancement
pattern This pattern suggests severe disease activity or longstanding chronic disease (4,5). The three-layered appear
a with no enhancement of the middle layer, which is the submucosa and the muscular layer. This middle layer can co
sing a fat sat T2 sequence. Actively inflamed terminal ileum with marked thickening and moderate mural signal inter
T2 mural signal intensity:
Increased mural signal intensity on fat-saturated T2 images indicates the presence of mural edema, suggesting activ
ignal intensity is more suggestive of fibrotic disease. The psoas muscle can be used as a reference when assessing m
e between mural fat depositions and mural edema. Fat depositions are the result of chronic bowel inflammation and
es not indicate active disease. Perimural edema or fluid can be identified as well and is associated with active disease
ural T2 signal (arrow) on an axial T2 with fat sat. Prestenotic dilatation can be seen proximally of the diseased segme
T2 sequence with fat sat: Wall thickening of the terminal ileum in a 67-year-old male with Crohn's disease since 11 y
image with fat sat (left). T2 with fat sat (middle) shows the same pattern with a middle layer of low intensity. T2 witho
ggesting fat depositions. Endoscopy showed only superficial disease. Fat suppression is routinely used to differentiat
s are a result of chronic bowel inflammation, but not typical of active disease. These fat depositions can be diffuse bu
r this pattern is the 'fat-halo sign'. Coronal post-contrast T1 and T2 fat sat images show multiple small ulcerations in
Ulceration:
Moderate to deep ulceration can be seen on T1 and T2 images, but small ulcerations can be difficult to distinguish fr
Ulcerations are active spots of inflammation and usually there is increased enhancement on the post-contrast T1 im
Loss of haustration:
When the colon is involved in Crohn's disease a decrease of haustral folds can be seen. A complete loss of haustratio
ulcerative colitis and known as 'lead pipe' colon. The coronal post-contrast T1 image shows loss of haustral folds thro
ronal post-contrast T1 image shows marked enhancement of the terminal ileum with a prominent comb sign.
Comb sign:
Increased vascularity of the mesentery is seen in active inflammation. The engorged vessels have a linear appearanc
Creeping fat:
Creeping fat, also called fibrofatty proliferation or fat wrapping, are different names for hypertrophy of the subseros
. The image shows creeping fat surrounding the descending colon. It isolates the colon from surrounding bowel loop
Skip lesions:
Skip lesions and patchy inflammation are a typical finding in Crohn's disease, in contrast to the continuous inflamma
o the interspersed inflammation "skipping" parts of the bowel, which are left unaffected (green arrows). The coronal
lesions in the terminal ileum. The affected lesions show increased enhancement with a layered pattern (yellow arrow
Complications:
Coronal post-contrast T1 image with a stenosis at the ileocecal junction (left). No obvious pre-stenotic dilatation is se
Stenosis:
Stenosis can present as bowel wall thickening combined with lumen narrowing. The presence of a prestenotic dilatat
cement of the affected bowel segment is usually present. In the grading system, only severe stenosis is included as a
ilatation and a moderate-to-marked increase in mural T2 signal. Sorry, your browser doesn't support embedded vide
quences before making the diagnosis of a stenosis. There may be a role for motility sequences to demonstrate the p
a stenosis. The video shows a motility sequence (BTFE dynamic) showing wall thickening in the cecum and terminal il
here is no stenosis. Enable Scroll
Disable Scroll Post-contrast T1 images. There are stenoses in the descending and transverse colon. Enable Scroll
Disable Scroll Post-contrast T1 images. There are stenoses in the descending and transverse colon. A 48-year-old fem
n the sigmoid colon, a stenosis was seen, which could not be passed. MR-enterography was performed to examine t
el is normal, but stenotic segments are seen in the descending and transverse colon. Both stenotic segments display
pattern in the descending colon and a layered pattern in the transverse colon. A prestenotic dilatation is seen before
noscopy before anti-TNF treatment, they had most likely developed during the treatment. Therefore it was decided t
ost-contrast T1 image of a patient with a large infiltrate involving multiple small bowel loops.
Infiltrate:
Infiltrate can be seen as creeping fat between bowel loops with replacement of the fat signal intensity and tethering
ns, inflammatory narrowing or fibrosis are common. Fistulas and abscesses are often present. Due to the complex st
ronal Balanced FFE image shows an enterovesical fistula (arrow) originating from the small bowel. Post-contrast T1 in
ack' at the site of the fistula.

Fistula:
Sinus tracts and fistulas are common complications in patients with Crohn's disease. Both show marked enhanceme
can present with a layered 'tram track' configuration or as a linear enhancing structure. It can be seen going from on
to the skin. Enable Scroll
Disable Scroll Multiple fistulas in the terminal ileum on post-contrast T1 images (arrows). The terminal ileum shows v
ttern. Enable Scroll
Disable Scroll Multiple fistulas in the terminal ileum on post-contrast T1 images (arrows). The terminal ileum shows v
ttern. A 50 year-old female with Crohn's disease since 10 years presented with bloody diarrhea and underwent a MR
seen, but the ileocecal valve was stenotic. Scroll through the images. Severe disease activity can be seen at the termi
prompted the gastro-enterologist to start anti-TNF treatment. Small abscess medioposterior from thickened and inf
T1 image (upper) and marked mural signal on the fat sat T2 image (lower)
Abscess:
Abscesses are often seen in patients with severe active Crohn's disease. Abscesses are characterized by rim enhance
on T2 images. The abscess is frequently surrounded by fat stranding.
Diffusion Imaging:
Crohn's disease of the terminal ileum with high signal on axial DWI and low signal on ADC map indicating diffusion re
s and abscesses show restricted diffusion -high on DWI, low on ADC. B values of 600 - 1000 are most commonly used
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diol
Chest X-Ray - Heart Failure:
Simone Cremers, Jennifer Bradshaw and Freek Herfkens
Radiology department of the Albert Schweitzer Hospital in Dordrecht and the Medical Centre Alkmaar, the Netherlan
Publicationdate 2010-09-01 In this article we will discuss the radiographic signs of congestive heart failure on the che
Introduction:
Congestive heart failure (CHF) is the result of insufficient output because of cardiac failure, high resistance in the circ
the most common and results in decreased cardiac output and increased pulmonary venous pressure. In the lungs L
id into the interstitium and the pleural space and finally into the alveoli resulting in pulmonary edema. Right ventricle
ure or pulmonary disease and causes increased systemic venous pressure resulting in edema in dependent tissues a
tures, that can be seen on a chest-film in a patient with CHF. Increased pulmonary venous pressure is related to the
stages, each with its own radiographic features on the chest film (Table). This grading system provides a logical sequ
ractice however some of these features are not seen in this sequence and sometimes may not be present at all. This
isease and in chronic obstructive lung disease.
Congestive Heart Failure:
Views of the upper lobe vessels of a patient in good condition (left) and during a period of CHF (right). Notice also the
Stage I - Redistribution:
In a normal chest film with the patient standing erect, the pulmonary vessels supplying the upper lung fields are sma
e pulmonary vascular bed has a significant reserve capacity and recruitment may open previously non-perfused vess
in redistribution of pulmonary blood flow. First there is equalisation of blood flow and subsequently redistribution o
on applies to chest x-rays taken in full inspiration in the erect position. In daily clinical practice many chest films are t
ional difference between the apex and the lung bases will be less. In the supine position, there will be equalisation o
ution. In these cases comparison with old fims can be helpful. Increased artery-to-bronchus ratio in CHF Artery-to-br
than the accompanying bronchus with a ratio of 0.85 (3). At the level of the hilum they are equal and in the lower lob
redistribution of pulmonary blood flow there will be an increased artery-to-bronchus ratio in the upper and middle l
a patient with cardiomegaly and redistribution. The upper lobe vessels have a diameter > 3 mm (normal 1-2 mm). No
LEFT: normal. RIGHT: CHF stage II with Kerley B-lines due to interstitial edema
Stage II - Interstitial edema:
Stage II of CHF is characterized by fluid leakage into the interlobular and peribronchial interstitium as a result of the
o the peripheral interlobular septa it is seen as Kerley B or septal lines. Kerley-B lines are seen as peripheral short 1-
ines run perpendicular to the pleura. Perihilar haze in interstitial stage of CHF When fluid leaks into the peribroncho
l walls (peribronchial cuffing) and as loss of definition of these vessels (perihilar haze). On the left a patient with cong
of the pulmonary vessels and they have lost their definition because they are surrounded by edema. Previous norm
n the left another patient with congestive heart failure. The lateral view nicely demonstrates the increased diameter
septal lines and the accentuated interstitium. Furthermore the fissura major is markedly thickened. Thickened septa

signs of congestive heart failure. On the image on the left notice the following: In a patient with a known malignancy
diagnostic list. Ground glass opacity is the first presentation of alveolar edema and a precursor of consolidation. Ena
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Stage III - Alveolar edema:
This stage is characterized by continued fluid leakage into the interstitium, which cannot be compensated by lympha
i (alveolar edema) and to leakage into the pleural space (pleural effusion). The distribution of the alveolar edema can
severe dyspnoe due to acute heart failure. The following signs indicate heart failure: alveolar edema with perihilar c
uid (blue arrow); prominent azygos vein and increased width of the vascular pedicle (red arrow) and an enlarged car
enlarged cardiac silhouette, pleural fluid and redistribution of the pulmonary blood flow, but the edema has resolve
Disable Scroll Enable Scroll
Disable Scroll On the left another patient with alveolar edema at admission, which resolved after treatment. When y
e the difference in vascular pedicle width and distribution of pulmonary flow. Both on the chest x-ray and on the CT
measured. Notice that even within each lobe there is a gravity dependent difference in density. This is only seen wh
This is not seen when the consolidations are the result of exsudate due to infection, blood due to hemorrhage or wh
ho first had a chest film in a supine position. Notice the pulmonary edema, which is almost exclusively seen in the rig
that the patient had been lying on his right side for a while before the x-ray was taken.
Cardiothoracic ratio:
Old film for comparison (left) CHF with redistribution, interstitial edema and some pleural fluid The cardiothoracic ra
to the internal diameter of the chest at its widest point just above the dome of the diaphragm as measured on a PA
result of cardiomegaly, but occasionally it is due to pericardial effusion or even fat deposition. The heart size is consi
A CTR of > 50% has a sensitivity of 50% for CHF and a specificity of 75-80%. An increase in left ventricular volume of a
-ray. On the left a patient with CHF. There is an increase in heart size compared to the old film. Other signs of CHF ar
tial edema and some pleural fluid. On a supine film the cardiac silhouette will be larger due to magnification and hig
t helpful, but comparison to old supine films can be of value. Increased CTR due to pericardial effusion On the left a
a large cardiac silhouette, which could be the result of cardiomegaly. Because of the recent cardiac surgery, the poss
s nicely demonstrated on the CT-image. On the left another patient with a large cardiac silhouette on the chest x-ray
ed on the coronal CT-reconstruction.
Pleural effusion:
Pleural effusion more evident on lateral view Pleural effusion is bilateral in 70% of cases of CHF. When unilateral, it is
e. There has to be at least 175 ml of pleural fluid, before it will be visible on a PA image as a meniscus in the costoph
isible. If pleural effusion is seen on a supine chest film, it means that there is at least 500 ml present. On the left imag
ce that it is more evident on the lateral view. Subpulmonic pleural effusion with increased distance of the stomach a
s visible as a meniscus in the costophrenic angle. A subpulmonic effusion may follow the contour of the diaphragm
pleural effusion, is when you notice that there is an increased distance between the stomach bubble and the lung. T
on an erect PA radiograph, the stomach bubble should always appear in close proximity to the diaphragm and the lu
ce you might get the impression that there is a high position of the diaphragm. However when you notice the increas
e that there is a large amount of pleural fluid on both sides (arrow).
Vascular pedicle:
The vascular pedicle is bordered on the right by the superior vena cava and on the left by the left subclavian artery o
scular volume. A vascular pedicle width less than 60 mm on a PA chest radiograph is seen in 90% of normal chest x-r
80% of cases. 5 mm increase in diameter corresponds to 1 liter increase of intravascular fluid. An increase in width o
the azygos vein. Subtle increased width of vascular pedicle (left) and normalisation (right) There are three principal v
overhydration and increased capillary permeability (ARDS). The vascular pedicle width (VPW) can help in differentiati
patient with ARDS On the left a patient with ARDS. There is alveolar edema in both lungs. Notice that the VPW is nor
iac silhouette is not enlarged. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The VPW is best used as a measure to compare serial chest x-rays of the same patient, as there is a wi
tion to the right. On an AP-view the VPW will increase 20% compared to a PA-view. On the left a patient with subtle si
ge 1/2). There is a slightly enlarged vascular pedicle, which becomes more obvious when you compare to the chest fi
Dilatation of azygos vein:
Dilation of the azygos vein is a sign of increased right atrial pressure and is usually seen when there is also an increa
azygos vein varies according to the positioning. In the standing position a diameter > 7 mm is most likely abnormal a
nt > 15 mm is abnormal. An increase of 3 mm in comparison to previous films is suggestive of fluid overload. The dif
an expiration film is only 1mm. This means that the diameter of the azygos is a valuable tool whether or not there is
Right ventricular failure:
Dilatation of IVC and hepatic veins on US images in a patient with RV failure RV failure is most commonly caused by l
ssure and leads to pulmonary arterial hypertension, thus overloading the RV. Other less common causes of RV failur
ilure: The indication for ultrasound examination in many of these patients is abnormal liver function tests. It is there
a patient presents with liver enzyme abnormalities. Under normal conditions dynamic ultrasound will demonstrate

buted to variations in blood flow in the IVC in accordance with the respiratory and cardiac cycles. in Merck manual
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Esophagus II: Strictures, Acute syndromes, Neoplasms and Vascular impressions:

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Publicationdate 2007-12-07 In Esophagus II we will discuss: Vascular impressions. Strictures

Strictures:

The table shows common and uncommon causes of esophageal strictures. To the far left is an image of a stricture (a
t view. This patient had Barrett's esophagus. Mid esophageal strictures and ulcers are suspicious for Barrett's esoph
h an irregular stricture due to adenocarcinoma. Here an image of a long, symmetric tapered benign stricture months
icture high in the esophagus (arrow). There is bilateral lower lobe lung consolidation due to repeated aspiration. App
US every year. About 50%-80% occur in the pediatric population. On the left a high stricture (arrow) following caustic
d hypopharynx. However they rarely cause symptoms. Multiple structures are uncommon. The table shows diseases
Here is an image of a patient with benign pemphigoid. Mucosal bullae have led to multiple strictures (arrows). Epide
lysis bullosa. Multiple strictures (arrows) are a residual of mucosal bullous disease. Extensive bullous skin disease ha
Corrosive ingestion can result in multiple strictures.

Acute esophageal syndromes:

In the table on the left are etiologies of an acute esophageal syndrome.

Boerhaave syndrome:

Boerhaave syndrome is rupture of the esophageal wall. It is most often caused by excessive vomiting in eating disor
ceful coughing or other situations, such as obstruction by food. Boerhaave syndrome is a transmural or full-thickness
ome, a nontransmural esophageal tear also associated with vomiting. These syndromes are distinct from iatrogenic
e, typically as a complication of an endoscopic procedure, feeding tube, or unrelated surgery. This image is of a patie
stinum (arrows). Esophagram with extravasated water soluble contrast material in left hemithorax (asterisk) Perforat
raphs show mediastinal gas, effusion, and later pneumothorax. Esophagram is used to confirm leak, first with water-
e's syndrome On the left a patient with Boerhaave syndrome. The barium study shows extraluminal gas (arrow) with
of distal left esophagus confirmed at surgery. CT can show small amounts of extraluminal gas or extravasation not v

Mallory-Weiss tear:

A Mallory-Weiss tear results from prolonged and forceful vomiting, coughing or convulsions. Typically the mucous m
acerations which bleed, evident by bright red blood in vomitus, or bloody stools. It may occur as a result of excessive
esolves within 10 days without special treatment. Mallory-Weiss tear On the left a patient with a Mallory-Weiss tear.
troesophageal junction. Tears may be in distal esophagus, gastric fundus, or extend across the GE junction.

Esophageal hematoma:

These unusual lesions have been associated with increased esophageal
intraluminal pressure, most often vomiting, instrumentation, and anticoagulation
or bleeding disorders. Some are spontaneous. Blunt trauma is a rare cause. Hematomas are self-limited and almost
1-2 weeks with conservative treatment. On the left a patient with an esophagus hematoma. He presented with chest
adiograph is normal. The barium study shows a narrowed lumen (arrows) on AP view and flattened lumen on lateral
nosis of an intramural hematoma was confirmed. A high density mural hematoma (arrowhead) is seen next to NG tu
um study was normal. On the left a patient who had a complicated endoscopy. Instrumentation caused a mucosal te
eparating stripe of mucosa (arrows). On the far left an intramural extravasation (arrow) after distal dilation for achala
complicated endoscopy. On the right a perforation after biopsy with extravasation of contrast material (arrow).

Benign neoplasms:

Here a list of benign esophageal masses. Esophageal leiomyoma

Leiomyomas:

Leiomyomas are the most common benign esophageal neoplasm and are often large yet nonobstructive. Gastrointe
ft an asymptomatic patient with a leiomyoma. On the chest film an abnormal opacity is seen behind the heart (arrow
not obstruct despite its large size. Esophageal leiomyoma Mucosal lesions are indicated by mucosal irregularities. Su

in profile, the margins often form close to a right angle with the esophageal wall. Extrinsic lesions tend to form longe
ir epicenter may be outside the esophagus. In practice, the location of a lesion may be difficult to determine. On radi
On esophagram, the inferior margin of this intramural lesion forms close to a right angle (arrow) with esophageal wa
almost always a leiomyoma. On the left a patient with a calcified esophageal lesion (arrows) protrudes into azygoesc
specimen radiograph showing calcification. On the left a patient with granular cell myoblastomas, an uncommon ben
but the proximal lesion does demonstrate overhanging and right angle margins indicating mural location. Peduncul
Fibrovascular polyp:
Pedunculated fibrovascular polyps are rare lesions, that are difficult to diagnose on esophagrams. Their movement c
may be suggestive as in this patient. The stalk is often difficult to identify.
Duplication:
On the left a patient with an esophageal duplication. The findings on the barium study are non-specific. Lesion (arrow
ing (arrows) is caused by duplication. A foregut duplication cyst is a congenital cyst. In the case on the left it displaces
and trachea and larynx (asterisk) anteriorly.
Malignant neoplasms:
Here a list of malignant esophageal masses. Early and small esophageal carcinoma are not synonymous. Early esoph
e metastases. Most are small (Small esophageal carcinoma is defined by the size of the lesion, a diameter So an earl
or metastatic and thus not an early carcinoma. This image is of a patient with an early esophageal carcinoma. Lesion
agram shows surface irregularity (arrows) indicating a mucosal lesion. This was both a small lesion and a pathologica
GHT: Large polypoid lesion. Advanced carcinoma has many gross appearances: On the left two cases of polypoid car
t angle junction with esophageal wall (arrowheads) This image is of a patient with an infiltrative ulcerated carcinoma
nd overhanging edge. This indicates mural involvement and is different than obtuse angles usually produced by extr
ma These images are of a patient with a varicoid carcinoma. Unchanging appearance of filling defects indicate tumor
tion (arrows) LEFT: Varicoid carcinoma. RIGHT: Superficial spreading carcinoma. To the far left an image of a patient w
t did not vary during fluoroscopy. Note large irregular folds and soft tissue mass (arrow) of gastric fundus Next to it a
Extensive superficial spread involves distal esophagus. This appearance can be seen with both early and advanced l
T: Distal narrowing is not tapered and more proximal than achalasia. Irregularity (arrow) at narrowed site is subtle bu
tricture. An irregular, asymmetric stricture is highly suggestive of carcinoma. Smoothly tapered, symmetric strictures
res can have similar characteristics and mimic benign lesions. Next to it a patient with a carcinoma with stricture res
semble achalasia. If esophageal motility is normal, achalasia can be excluded. If abnormal, however, subtle imaging f
al abnormality, or fixed abnormality suggest diagnosis. On the left another case of pseudoachalasia. Distal narrowing
asymmetric (arrows), and the mucosa is irregular at the tip of narrowing. CT shows gastric fundus thickening (arrows
xtaposed posterior tracheal and anterior esophageal walls > 5 mm on a lateral chest radiograph is suspicious for pat
a patient with a widened 1 cm stripe (arrows). Esophagram shows widened stripe (arrows) and irregular margins of
achea. The tumor invades mediastinum adjacent to aortic arch (arrow) Barrett's esophagus with ulcerated (arrow) ad
Barrett's esophagus and Adenocarcinoma:
Barrett's esophagus is a proven risk factor for the development of an adenocarcinoma. The incidence of cancer in Ba
hould be screened is unresolved. Adenocarcinoma was 10% of esophageal malignancies in 1960s. Since 1960s, incid
approaching or exceeding squamous carcinoma in Caucasian men in the USA and Europe. On the left a patient with
gus. Primary gastric fundus adenocarcinoma can invade the esophagus, but means of differentiating invasion from a
ient with a gastric fundus adenocarcinoma. The barium study demonstrates marked irregular thickening of distal eso
rregular lesser curvature wall (arrows) near gastroesophageal junction. Spindle cell carcinoma Spindle cell carcinoma
n bulky but nonobstructive as in the case on the left. Leiomyosarcomas and rare primary melanomas of the esophag
iomyosarcoma of the esophagus On the left a patient with a leiomyosarcoma of the esophagus. Margin (arrows) of b
hows marked irregularity and esophageal narrowing (arrows). Leiomyosarcoma of the esophagus On the left anothe
esophageal lumen. CT shows lesion distorting but not obstructing esophageal lumen (arrow). Esophageal obstructio
ts with esophageal narrowing as a result of metastatic mediastinal lymphnodes. On the far left a bronchogenic carci
at the interface with esophagus. In the middle another bronchogenic carcinoma. Irregular distal esophageal wall du
arcinoma. There is mediastinal lymphadenopathy with esophageal invasion and obstruction. LEFT: normal esophagu
confuse normal esophageal irregularities for impressions by lymphnodes. On the left a normal esophagus. The esop
w. Next to it mediastinal nodes (arrows) that displace the esophagus to right in a patient with bronchogenic carcinom
Vascular impressions:
On the left a list of vascular structures that may cause impressions on the esophagus. Uphill varices in a patient with
Uphill varices:
With portal hypertension, elevated portal venous pressure leads to reversed (hepatofugal) flow bypassing the liver th
geal veins that anastamose with the azygos and hemiazygos veins which drain uphill into the superior vena cava. Fill
nce during the examination related to breath holding and thoracic pressure. On the left are CT images of a patient w
tension. Large mediastinal and esophageal (arrows) varices On the left CT images of a patient with uphill varices. LEF
owing varices (arrows) Uphill varices can be mass-like as seen in the case on the left. Continue with next image. Med
) The CT shows mass-like mediastinal and esophageal varices (arrows). Varicoid carcinoma Varices have to be differe
of filling defects indicates tumor rather than varices. Note sharp upper margin of lesion (arrows) Downhill varices in

es With superior vena caval obstruction, upper body venous blood flows caudally downhill through esophageal veins to the obstruction. If the obstruction is at or below the azygos, the blood flow extends further caudally to the portal and the right atrium. On the left downhill varices in a patient with a superior vena cava obstruction due to histoplasm represent downhill varices in upper esophagus. The angiogram demonstrates collateral vessels including a dilated le t with a superior vena cava obstruction The barium study demonstrates inconstant filling defects (blue arrows) due t (red arrow) and mediastinal varices. Continue with venogram. Upper arm venograms show SVC obstruction. Aberra
Aberrant right subclavian artery:
This is the most common thoracic arterial anomaly and rarely causes symptoms. The artery extends up and to the ri . The CT demonstrates that the aberrant artery (arrow) is last vessel from arch and extends dorsal to trachea and es
Right aortic arch with aberrant left subclavian artery:
A right aortic arch with an aberrant left subclavian artery is most often an incidental finding. A right aortic arch with m with congenital heart disease. CT shows right arch (R) and aberrant left subclavian artery (arrow) arising low off arch left the esophagram of a patient with a right arch that produces a dorsal indentation on this lateral view (blue arrow A) dorsal to the trachea and esophagus. Double ArchLEFT: Right and left arch indent esophagus (arrows) at different old
Double Arch:
Double arch most often presents with airway obstruction, dysphagia, aspiration in children. The arches indent esoph rch. Chest radiograph with right lung consolidation due to aspiration in 6-year-old. Right and left arch indent esopha : aberrant artery extends between trachea and esophagus indenting both (arrows)
Aberrant left pulmonary artery:
The aberrant left pulmonary artery indents the trachea dorsally and esophagus ventrally as it extends between them . Tortuous aorta A tortous descending aorta is a common cause of extrinsic impression on the esophagus. The image ws esophageal indentation by aorta with obtuse margins (arrows) characteristic of extrinsic compression. Normal ar On the far left the normal aortic arch impression on the esophagus. This impression can be enlarged if there is dilat c arch aneurysm (arrows). Coarctation: 'Reverse figure 3' indention of esophagus
Coarctation:
On the left 3 images of a patient with a coarctation. On the chest film the 'Figure 3' shape of aortic knob due pre and tes the 'Reverse 3 figure' indention of esophagus by pre and post stenotic aortic dilatation (arrows). An angiogram de in another patient. by Gore RM, Levine MS.
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Neck Masses in Children.:
Annemieke Littooij, Cécile Ravesloot and Erik Beek
Radiology department of the University Medical Center Utrecht in the Netherlands:
Publicationdate 2016-11-01 A mass in the neck is a common finding in children. In this article we present a pictorial e ach based on the location of the lesion and whether it is cystic or solid. Ultrasound is the imaging method of choice a if the lesion is cystic. MRI is of value in large lesions, to determine whether the lesion infiltrates into deep spaces. CT ons to assess whether an abscess is present. In suspected malignant lymphoma ultrasound can demonstrate which T is used for staging.
Introduction:

Diagnostic approach:
In a neck lesion in a child, ultrasound can usually determine whether a lesion is cystic or solid. Often more than one nodes, lymphadenitis due to TB or cat-scratch disease and malignant lymphoma.
* Solid - not a lymph nodeIf a solid lesion is not a lymph node look for a possible site of origin, like the salivary gland, cutaneous solid lesions sometimes have a typical appearance, like pilomatrixomas, lipomas or hemangiomas. In ma an only be made through biopsy or excision. Click on image to enlarge
Location of cystic lesions:
Once you have decided that the lesion is cystic its location will often point to its nature (figure). Midline lesions Midlin ts or ranulas. Older children can be asked to protrude their tongue. A thyroglossal duct cyst will move upward with t he mouth. Off-midline lesions Off-midline lesions can be branchial cleft cysts or lymphangiomas. Branchial cleft cysts en multicystic. In the posterior neck they are often single.
Cystic lesions:
Sorry, your browser doesn't support embedded videos. In neck lesions we first try to figure out whether a lesion is cy It can however be a problem if the cyst has been inflamed or when a cyst has bled, since children often present with he contents by compressive movements of the probe or by changing the position of the child and look for acoustic e a 13-year-old girl. A hypo-echoic lesion is seen superficial to the carotid artery and deep to the sternocleidomastoid m d with the probe. When the girl was asked to sit upright the contents swirled.
Thyroglossal duct cyst:

Thyroglossal duct cysts are common lesions in children. The thyroglossal duct runs from the base of tongue at the fo
avels through the duct to reach its final normal position. Normally, the thyroglossal duct then involutes, but when th
along this tract (figure). Thyroglossal duct cysts move upward if the tongue is protruded or during swallowing (see ne
is. Always look for the presence of a normal thyroid gland and make an image of it. Sorry, your browser doesn't supp
ent of the thyroglossal duct cyst together with the hyoid bone during swallowing. Thyroglossal duct cyst Thyroglossa
due to infection, hemorrhage, or proteinaceous content. The majority of thyroglossal duct cysts is located within 2 c
lossal duct cyst with some internal echoes located in the midline. Thyroglossal duct cyst Here a tranverse image of a
cal hyper-echoic dermoid cyst in the suprasternal notch.

Dermoid cyst:

Dermoid cysts are inclusion cysts, that contain epithelium and skin adnexa like hair follicles, sebaceous glands and s
ion, especially around the orbit and in the midline of the neck, with a predilection for the suprasternal notch. Here a
dermoid cyst, which was located in its favorite location, the suprasternal notch. Dermoid cyst In the neck dermoid cy
e inhomogeneous. The differentiation from a thyroglossal duct cyst can be difficult if the dermoid cyst is located nea
ally hypo-echoic and may contain internal echoes, while dermoid cysts generally have a more homogeneous hyper-e
yst in front of the thyroid gland (figure). Orbital dermoid cyst The most common location of a dermoid cyst in the hea
corner. On ultrasound they are anechoic and one should look for the presence of a bony lining. If the integrity of the
ne possible intracranial extension. Here a typical orbital dermoid cyst. It was firm on palpation and located at the lat
emodelling of the underlying bone.

Branchial cleft cyst:

Most branchial cysts are remnants of the second brancial cleft. Cysts at the level of the thyroid gland can be remnan
on results in either a cyst (75%), a sinus or a fistula (25%). Cysts present as painless masses, sometimes appearing su
nterior border of the sternocleidomastoid muscle, lateral to the common carotid artery, and if more cranially betwee
may be seen as a curved rim of the lesion pointing medially between the internal and external carotid. Typical ultras
. On ultrasound they often contains internal echoes caused by debris, which consists of cholesterol crystals. The cyst
ent. This may not be the case in a cyst with a fresh internal hemorrhage. They can inflame and present with an empy
al to the carotid artery bifurcation. Branchial sinuses Branchial sinuses are blind ending tracts, presenting anterior o
las end in the tonsillar fossa, as can be demonstrated with a contrast fistulogram or MRI. With ultrasound a tract can
e to depict the proximal ending. Here a two-year-old boy with a dirty spot in the right lower neck. A small tract could
stula was excised. Here a ten-year-old girl with a pit in the right neck, anterior of the sternocleidomastoid muscle. On
o the right submandibular region. At operation, the fistula extended towards the right tonsillar fossa and was excise

Lymphangioma:

Lymphangiomas are cystic lesions, caused by maldevelopment of the lymph channels. The majority occur in young c
lymphangioma usually has one or more larger cysts. In the anterior neck a lymphangioma can consist of innumerab
m. This is also called a hygroma colli. The sonographic appearance depends on the size and number of cysts. Larger
c lymphangioma can be hyper-echoic due to the high number of closely related reflecting walls. Here an ultrasound
of the lesion was not clear. Here the T2-weighted image of the same patient. On T1-weighted images the content has
tent. It generally has a high signal intensity on T2-weighted images. Contrast enhanced T1 can show enhancement o
udden swelling in the left neck. There were several small anechoic cysts and one large cyst containing internal echoe
lymphangioma. A 3-year-old boy presented suddenly with a supraclavicular mass. Ultrasound showed a lesion with
ected. Continue with the MRI. The T1-weighted image shows a slightly hyperintense lesion with a fluid-fluid level (arr
e cyst wall. The lesion subsided with conservative therapy. Ranula

Ranula:

A ranula is a fluid filled cyst originating from the sublingual salivary gland. It can extend into the floor of the mouth a
o extend through or over the mylohyoid muscle and is then called a "plunging ranula" and present as a submental o
firm swelling under the tongue on the left side. Ultrasound showed an anechoic mass continuous with the sublingua
os.

Jugular ectasia:

In some children a swelling can appear in the lower neck during straining. This is often caused by dilatation of the int
d that will show the variations in caliber of the vein. An example is shown on the video of a seven-year-old boy, initia

Solid lesions - Lymph nodes:

This image shows a commonly used classification for the location of lymph nodes. Submental and submandibular no

* Level 2 Nodes along the internal jugular vein, above the level of the hyoid bone
* Level 3 Nodes along the internal jugular vein, between the hyoid bone and cricoid cartilage
* Level 4 Nodes along the internal jugular vein, below the cricoid cartilage
* Level 5 Posterior to the sternocleidomastoid muscle, above the clavicles
* Level 6 Anterior to the thyroid gland Normal lymph nodes are always visible with ultrasound in children. A normal
w the mandibular angle can have a short axis of 15 mm. Enlarged lymph nodes in the neck are very common in child
infection. Less commonly it is due to a primary infection of the lymph nodes itself, which is called lymphadenitis. Usu
used synonymously. Although ultrasound cannot always reliably distinguish lymphadenitis from a malignant lympho
biopsy should be done or that a "wait and scan" policy can be adopted. Supraclavicular lymph nodes should always b

Reactive lymph nodes:
Reactive lymph nodes are a reaction to nearby inflammation. They are slightly enlarged and more hypoechoic than n
weight loss, fatigue and lymphadenopathy. On ultrasound a string of enlarged lymph nodes with preservation of a e
. Here a two-year-old girl with a palpable swelling in the left neck since a few weeks. On ultrasound the lymph nodes
l perfusion. It was decided to wait and see and the nodes slowly shrunk.
Bacterial or viral lymphadenitis:
A bacterial or viral lymphadenitis is an infection of the node itself. Bacterial lymphadenitis is often caused by Staphyl
h are frequently located in the submandibular region, are painful and the skin is warm and red. Bacterial lymphaden
image is of a one-year-old boy with a swelling in the neck for three weeks. A partly liquefied lymphnode is seen with
disappeared on antibiotic treatment. Abscess formation is clinically difficult to detect, and ultrasound is also not relia
and more hypoechoic center or areas with mobile, moving echoreflections. According to the literature there are 30%
y with a swelling in the right neck for one week. Ultrasound shows an enlarged lymph node with areas of liquefaction
Cat-scratch disease:
Cat-scratch disease is caused by Bartonella henselae. The infection is the result of a scratch or bite of a cat. It is the n
symptoms are often mild and lymph node swelling can be prolonged. The clinical diagnosis can be difficult and PCR
d, heterogeneously hypoechoic, hypervascular, and with some surrounding inflammation. The nodes are a bit tende
nodes. Here an ultrasund image of a sixteen-year-old girl, who was treated for recurrence of acute lymphatic leukae
g in the left shoulder region. A hypoechoic node without any internal structure was seen. It was excised. The final dia
wser doesn't support embedded videos. Cat-scratch disease 2 Here a video of a fifteen-year-old boy with a swelling i
trated tissue. Continue with next video. Sorry, your browser doesn't support embedded videos. After a week suppur
The boy was successfully treated with antibiotics. Two-year-old boy with a progressive swelling in the neck. No effect
s confirmed. The anechoic parts (arrow) in the node are often seen in atypical Mycobacteria infection.
Mycobacteria:
Infection with atypical Mycobacteria generally occurs in patients between one and five years of age. There are few cli
ymph nodes are usually unilateral and in the pre-auricular or submandibular area. There is often a pronounced skin
tly present with a single enlarged node and some smaller satellite lesions. There is central necrosis, thickening of the
confluent mass. Fistulas may be present. Calcifications are seen more commonly in TB infections than in atypical My
next image... Three months later the swelling is still present. The deeper lymphnode has liquefied. After another fou
in the surrounding tissue. Here an ultrasound image of a 6-year-old boy with a swelling in the neck. Fine calcification
e positive, but cultures for tuberculosis were negative. The patient was treated with tuberculostatics with good result
Malignant lymphoma:
Malignant lymphoma presents with painless lymphadenopathy. In Hodgkin lymphoma the cervical nodes are most c
ring are often involved. On ultrasound the affected nodes are round, homogeneously hypoechoic and the normal ec
iopsy or excision. PET/CT will demonstrate the extension of the disease. The images are of a fourteen-year-old boy w
veral enlarged hypoechoic lymhnodes, that lack an hyper-echoic hilum. Here another fourteen-year-old boy with a p
d lymhnodes. Continue with the MR and PET/CT... A coronal STIR image shows the pathologic lymph node masses sin
Solid lesions - not lymph nodes:
The most common cause of a solid lesion in the neck is an enlarged lymph node as we just discussed. Other solid les
. In many cases the imaging findings in a solid lesion will be non-specific and a diagnosis can only be made through b
Thyroid lesions:
Congenital anomalies The most common anomalie is a partial or complete agenesis of the gland. In partial agenesis
ongue and the thyroid cartilage. Mostly near or in the tongue, a lingual thyroid. Here an image of a newborn with an
neither in its usual position nor higher up in the neck. Thyroid nodules Thyroid nodules are common. They can be sin
trasound they are isoechoic with the normal gland. In a goiter a multitude of solid nodules are seen. If there is conce
one. Preferably a technician of the cytology department is present to make a quick assessment of the retrieved cells
d. This is an ultrasound image of a six-year-old girl with a small cyst with a septum in the right thyroid lobe. It remain
ged thyroid gland with a diffuse inhomogeneous structure and hyperemia is seen in a ten-year-old girl Thyroiditis Th
d Graves disease. Both Hashimoto's thyreoiditis and Graves disease can present as an enlarged and hyperemic thyro
auto-immune disease. It presents with hypothyroidism. Although primarily a disease of the middle-aged it can prese
inhomogeneous. On color doppler the blood flow is often normal but can be increased like in Graves' disease. In a la
thyroid gland is also enlarged and shows an increased perfusion. On color Doppler it has been described as an infer
rthreoidism. A diffusely enlarged thyroid gland is seen with hyperemia. The final diagnosis was Graves disease. She w
onths-old boy.
Thymus:
The thymus is located in the upper mediastinum and can be visualized with a suprasternal scan plane. With increasin
ound is ideal to demonstrate the thymus as a cause of a widened upper mediastinum in infants. Sometimes the thym
erniating thymus can be demostrated with ultrasound. Sorry, your browser doesn't support embedded videos. The t
suprasternal scan plane. Ultrasound image of the thymus in an eight-year-old boy. Sorry, your browser doesn't supp
ss which was sometimes visible in the suprasternal notch. While crying the thymus was seen to herniate in front of th
Ectopic thymus:

Ectopic thymic tissue may occur anywhere along the path of descent through the thymopharyngeal duct. When it pr
t of the thymus has the same echo characteristics as the normal thymus. The video shows an ectopic thymic remnar
the brain in a 2-year-old boy. The ectopic thymus has the ultrasound characteristics as the normal gland. Here image
mination shows a mass between the parotid and submandibular gland (yellow arrow). The signal characteristics are
hymic remnant (yellow arrow), with identical sonographic characteristics as the orthotopic thymus (green arrow). Lef
eidomastoid muscle. RIGHT: Hyperechoic mass in sternocleidomastoid muscle.
Fibromatosis colli:
Fibromatosis collis is a swelling of the sternocleidomastoid muscle in a newborn. It is probably caused by pressure n
it is not caused by hemorrhage. 50% of affected babies are born in breech. The swelling becomes apparent one to t
ing will usually regress spontaneously within a few months. On ultrasound an enlargement of the sternocleidomasto
sternal head is always affected, and often the cleidal head as well. It can be hypo-, iso- or hyperechoic. Longitudinal
Sorry, your browser doesn't support embedded videos. Here a video of a two-month-old boy with a torticollis. A ma
nosis is fibromatosis collis Hemangioma
Vascular anomalies:
Vascular anomalies are classified into proliferative vascular tumors and vascular malformations. This classification is
will regress spontaneously or after administration of beta-blockers. Vascular malformations however need excision,
ifications of these lesions is constantly changing and beyond the scope of this article. A recent article on vascular and
omas are benign vascular neoplasms. They are the most common tumors of infancy. 60% of hemangiomas are seen
h, show rapid growth, followed by spontaneous involution. Here we see images of a highly vascular lesion in the left
ater it had decreased in size. Infantile hemangioma A soft swelling was present on the side of the head in a six-week
typical for an infantile hemangioma. Venous malformation Venous malformation A six-month-old boy presented wit
s could not differentiate between a hemangioma or a venous malformation. At six months of age, the ultrasound sh
n size on straining. On color Doppler the lesion showed increased flow while crying. The final diagnosis on imaging a
in the right temporal area of a 2-year-old boy. Ultrasound shows an echogenic lesion with a well demarcated wall ar
Pilomatrixoma:
A pilomatrixoma or epithelial inclusion cyst of Malherbe is a benign skin lesion associated with hairfollicles. It presen
scoloration is present. They vary in size from a few millimetres to 3 centimetres. The majority occurs in the head and
tumor lcated between the cutis and subcutis. It is hyperechoic, sometimes with calcification and acoustic shadowing
can be seen in the wall. These images are of a firm mass in the neck of a 17-year-old girl. A cytologic sampling was in
d at pathology after excision. Some perfusion in the wall of the pilomatrixoma is seen. Large pilomatrixoma on the u
Salivary glands:
Enlargement of the salivary glands can be diffuse or focal. Diffuse swelling mostly affects the parotid glands. If it is bi
ren's disease) or infections (HIV). On ultrasound many small hypoechoic lesions are present. Unilateral swelling can b
n parotid gland tumor of childhood, which involute in the course of a few months.
Teratoma:
Teratomas of the neck are rare in children. Teratomas are composed of all three germ layers. They often present at
nd often contain calcifications. They can have a close connection to the thyroid gland. If the extension is unclear MRI
of a three-day-old boy. Calcifications and solid and cystic parts are seen. Pathology was compatible with a mature te
Paraganglioma:
Here images of a 17-year-old boy with a swelling in the neck, thought to represent a branchial cleft cyst. An echogeni
examination. No specific diagnosis could be made. The final pathologic diagnosis was a paraganglioma, a very uncor
Neurofibroma:
Here a large neurofibroma in the subcutaneous tissue in the neck of a 10-year-old boy with a known neurofibromato
Neuroblastoma:
Neuroblastoma usually presents as an abdominal mass in young children. In the neck it accounts for 1-5% of neurob
ten with some calcifications (1). Here a ten-month-old girl with a lump in the neck. Ultrasound shows a inhomogeneo
ymph nodes with calcifications. Imaging could not make a definitive diagnosis. Pathology showed a neuroblastoma.
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4. Pediatric Neck Masses Powepoint presentation by Mark Domanski, M.D., Michael Underbrink, M.D. of the Dept. of
5. Pediatric Head and Neck Masses ALGORITHMS OF DIAGNOSIS AND MANAGEMENT FOR THE PRIMARY CARE PHYSI
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None:

None:

None:

Osteolytic - well defined bone tumors:
Henk Jan van der Woude and Robin Smithuis
Radiology department of the Onze Lieve Vrouwe Gasthuis, Amsterdam and the Rijnland hospital, Leiderdorp, the Ne
Publicationdate 2011-01-01 In the article Bone Tumors - Differential diagnosis we discuss a systematic approach to t
In this article we will discuss the differential diagnosis of well-defined osteolytic bone tumors and tumor-like lesions.
Introduction:
On the left the most common well-defined bone tumors and tumor-like lesions. These lesions are sometimes referre
are not cystic, except for SBC and ABC. It is true that in patients under 30 years a well-defined border means that we
rs metastases and multiple myeloma have to be included in the differential diagnosis. On the left a table with well-de
t age-groups. Notice the following:
Fegnomashic:
Most bone tumors present as well-defined osteolytic lesions, sometimes referred to as 'bubbly lesions'. It is importar
ons. You can use the table above, but another way to look at the differential diagnosis of well defined osteolytic bon
zed by Clyde Helms (1). Some prefer to use the mnemonic Fogmachines, which is formed by the same letters, but is
t sclerotic margin, with groundglass appearance, with calcifications or ossifications
Fibrous dysplasia:
Fibrous dysplasia is a benign disorder characterized by tumor-like proliferation of fibro-osseus tissue and can look li
ong bone. FD is often purely lytic and takes on ground-glass look as the matrix calcifies. In many cases there is bone
s invariably affected when the pelvis is involved. When FD in the tibia is considered, adamantinoma should be in the
Enchondroma:
Enchondroma is a benign cartilage tumor. Frequently it is a coincidental finding. In the phalanges of the hand it frequ
n the phalanges, i.e. a well-defined lytic lesion in the hand is almost always an enchondroma. In some locations it ca
farct. It is almost impossible to differentiate between enchondroma and low grade chondrosarcoma based on radiog
fucci's syndrome is multiple enchondromas with soft tissue hemangiomas. Features that favor the diagnosis of a low
Eosinophilic granuloma:
EG is a non-neoplastic proliferation of histiocytes and is also known as Langerhans cell histiocytosis. It should be incl
lytic lesion, either well-defined or ill-defined, in patients under the age of 30. The diagnosis EG can be excluded in ag
scriminator: Giant cell tumor in the tibia abuts the articular surface
Giant cell tumor:
Giant cell tumor is a lesion with multinucleated giant cells. In most cases it is a benign lesion. Malignant GCT is rare a
ossible based on the radiographs. GCT is also included in the differential diagnosis of an ill-defined osteolytic lesion,
Discriminators: NOF: typical presentation as an eccentric, multi-loculated subcortical lesion with a central lucency ar
NOF:
NOF is a benign well-defined, solitary lesion due to proliferation of fibrous tissue. It is the most common bone lesion
racture. NOF usually has a sclerotic border and can be expansile. They regress spontaneously with gradual fill in. NO
is almost always typical, and as such additional imaging and biopsy is not warranted. Discriminators:
Osteoblastoma:
Osteoblastoma is a rare solitary, benign tumor that produces osteoid and bone. Consider osteoblastoma when ABC
osteoblastoma is larger than 2 cm, otherwise it completely resembles osteoid osteoma. Discriminator:
Metastases:
Metastases are the most common malignant bone tumors. Metastases must be included in the differential diagnosis
sclerotic in age > 40. Bone metastases have a predilection for hematopoietic marrow sites: spine, pelvis, ribs, craniu
ncluded in the differential diagnosis if a younger patient is known to have a malignancy, like neuroblastoma, rhabdo
dney, lung, colon and melanoma. Most common osteosclerotic metastases: prostate and breast. Discriminator: Mult
Multiple Myeloma:
Multiple myeloma must be included in the differential diagnosis of any lytic bone lesion, whether well-defined or ill-d
keleton (spine, skull, pelvis and ribs) and in the diaphysis of long bones (femur and humerus). Most common presen
not show any uptake on bone scan. Discriminator: Multiple Myeloma (2) Differential diagnosis: On the left a CT-imag
tic lesions and permeative cortical destruction pattern. In the left sacral wing there is a larger lesion with a high dens
arrow). ABC of the proximal fibula: well-defined, expansile osteolytic lesion with thin peripheral bone shell
Aneurysmal Bone Cyst:
ABC is a solitary expansile well-defined osteolytic bone lesion, that is filled with blood. It is named aneurysmal becau
tive process secondary to trauma or increased venous pressure. Sometimes an underlying lesion like GCT, osteoblas
in the skeleton. Discriminators: More on ABC SBC: well-defined osteolytic lesion without expansion of the proximal m
Solitary Bone Cyst:
Solitary bone cyst, also known as unicameral bone cyst, is a true cyst. Many well-defined osteolytic lesions are often
with a fracture. Sometimes a fallen fragment is appreciated. Predilection sites: proximal humerus and femur. Usuall
FD when cystic. SBC may migrate from metaphysis to diaphysis during growth of the bone. Discriminators:
Hyperparathyroidism:
Brown tumors can occur in any bone and present as osteolytic lesions with sharp margins. Septa and ridges may be

ocation and age. On the left a patient who had a nefrectomy for renal cell carcinoma and who was on dialysis. Multip
can. The differential diagnosis included metastases and Brown tumors in hyperparathyroidism. Biopsy revealed Brow
Infection:
Infection or osteomyelitis is the great mimicker of bone tumors. It has a broad spectrum of radiographic features an
tage it can mimic a benign bone tumor (Brodies abscess). In the acute stage it can mimic a malignant bone tumor wit
of periostitis. Only when there is a thick solid periosteal reaction we can recognize the non-malignant underlying pro
(middle) and fluid-fluid level due to secondary ABC.
Chondroblastoma:
The patella, carpal and tarsal bones can be regarded as epiphysis concerning the differential diagnosis. On the left a
romyxoid Fibroma
Chondromyxoid Fibroma:
Chondromyxoid Fibroma is a rare lesion. CMF resembles NOF. Preferential sites: proximal tibia and foot. Although th
usually not seen. On the left images of a CMF. There is an eccentric osteolytic lesion in the metaphysis of the proxim
e outer side there is a regular cortical destruction with peripheral bone layer. The MR also shows a sclerotic margin v
ures of well-defined osteolytic lesions On the left a summary of things to look for in well-defined osteolytic lesions. C
cal Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Smithuis sr, who is a professor at Oxford university an
the image below to watch the video of Medical Action Myanmar and if you like the Radiology Assistant, please suppo
. Saunders company 1995
Trigeminal neuralgia:
Loes Braun, Carolien Toxopeus and Robin Smithuis
Antoni van Leeuwenhoek and OLVG hospital in Amsterdam and the Alrijne hospital in Leiderdorp, the Netherlands:
Publicationdate 01-09-2022 Trigeminal neuralgia is a disorder characterized by recurrent unilateral brief electric sho
distribution of one or more divisions of the trigeminal nerve.
Several conditions may cause trigeminal neuralgia, but the most common cause is neurovascular compression.
In this article we will discuss the many causes of neuralgia in relation to the anatomical location.
This can help you to systematically study all the important regions in the course of the trigeminal nerve.
Introduction:
The pathology of the trigeminal nerve is related to the location. In the illustration the five different segments of the t
ore detail in the following chapters. Brainstem: trigeminal nucleus *Cisternal segment* *Meckel's cave* Cavernous s
Brain stem segment:
Pathology in the
brain stem segment is most often due to demyelination by multiple
sclerosis.
Other types of pathology in the brain stem segment are neoplasms
(mostly glioma and metastases), vascular lesions (infarction, cavernoma) and
infections (rhombencephalitis). The trigeminal nerve originates from two separate nuclei in
the pons: the sensory division from the sensory nucleus (green dot) and the motor division
from the motor nucleus (red dot).
This first part is called the brain stem segment. From these nuclei, the trigeminal nerve courses anteriorly,
to the ventrolateral surface of the pons to continue with the cisternal segment in the prepontine cistern. The trigemi
It consists of a sensory and a motor division. The sensory division – which is the largest of the two – innervates sensi
es: The sensory nucleus is situated laterally in the tegmentum, anterolateral to the fourth ventricle (green dot). The m
(red dot). This image is of a 26 year old male who developed slowly progressive facial hypesthesy on the
right. The axial T2W image shows a hyperintense lesion at the
trigeminal nucleus (arrow).
This may be a sign of demyelinsation, for
instance in multiple sclerosis
Cisternal segment:
The cisternal segment is – almost without exception - the source of a true trigeminal neuralgia caused by neurovascu
segment causing trigeminal neuropathy are far less common, like neoplasms, mostly schwannoma, meningioma and
on or inflammation, for instance trigeminal neuritis.
Neurovascular compression:
Neurovascular compression is defined by specific radiologic criteria: Neurovascular compression of the trigeminal ne
artery (SCA) or less frequently the anterior inferior cerebellar artery (AICA), or smaller branches of the basilar artery.
compression was caused by contact with an aneurysm, vertebrobasilar dolichoectasia, an AVM, an AV-fistula or even
The cisternal segment starts where the trigeminal
nerve enters the prepontine cistern.
This is called the root entry zone.
The root entry zone comprises the transition zone from central
myelin (oligodendrocytes) to peripheral myelin (Schwann cells). This transition zone measures approximately 2 mm l

pons.
At this point, the nerve is vulnerable to pressure. In the prepontine cistern, the sensory and motor divisions have a p
ke appearance (arrow). Neurovascular compression at the root entry zone A 74 year old male has been experiencing
an '220V-like' pain in his right eyebrow, cheek and mandible.
These symptoms are
evoked by washing his face and brushing his teeth. Scroll through the axial 3D FIESTA images and the
postcontrast axial 3D T1W images. Then continue reading. Both the axial 3D FIESTA and postcontrast axial 3D T1W
images show: These findings fulfill the criteria for a neurovascular compression. Trigeminal schwannoma These imag
male with sensory problems in the left side of his face and pressure behind
his left eye. The axial T2W shows
a lesion in Meckel's cave and the cisternal segment of the trigeminal nerve.
The component in Meckel's cave is solid and shows homogeneous enhancement on
post-contrast T1W imaging (arrow).
The component in the cerebellopontine cistern is
almost completely cystic and shows only rim enhancement. The lesion is a
trigeminal schwannoma.
The growth of this lesion along the nerve, leading to
a constriction at the entrance of Meckel's cave, causes the classic 'dumbbell
shape'.
Meckel's cave segment:
Pathology in Meckel's cave leading to trigeminal
neuropathy, mostly concerns neoplasms, either primary, secondary or extrinsic. Primary lesions, originating from th
are mostly schwannomas, meningeomas, and epidermoids. Secondary neoplasms – involving the nerve, but not
originating from it - are mostly based
on perineural spread. The spread can be
retrograde (from the peripheral branches) or antergrade (from the cisternal
segment). Extrinsic lesions mostly originate from the skull
base. After traversing the cerebellopontine and prepontine
cisterns, the trigeminal nerve enters Meckel's cave, which forms the third
segment.
In Meckel's cave the trigeminal ganglion is located also known as Gasser's or semilunate ganglion. At
the ganglion, the sensory division of the trigeminal nerve divides into three
parts: The motor division does not pass through the ganglion, but rather underneath it. Together with nV3, the moto
intracranial compartment via the foramen ovale. A 45 year-old
female with a history of pain on the right side of the mandible, alleviated
by extraction of multiple dental elements.
However, since one month, she is
experiencing the same type of pain once more. The pain is sharp and radiates
from the chin, via the right side of the face to the skull. The pain is
evoked by talking, eating, and touching the right sides of the face. Image3D FIESTA shows
a lesion in Meckel's cave, hyperintense on DWI, hypo-intense on ADC (not
shown), extending into the cisternal segment.
This lesion is
suspicious for an epidermoid.
Cavernous segment:
Primary lesions originating from the cavernous
segment itself are quite rare. These lesions – mostly schwannomas, meningeomas
and epidermoids – usually originate from the third segment, extending into the cavernous sinus.
Trigeminal lesions in the cavernous segment are mostly secondary due to perineural spread or
metastases. Furthermore, pathology of the cavernous segment may be due to
extrinsic lesions, for instance lesions originating from the skull base, the
meninges or vascular structures, for instance carotid aneurysms. Moreover, the
cavernous segment may be subject to infectious or inflammatory pathology, for
instance Tolosa-Hunt syndrome, which is a severe unilateral periorbital headache associated with painful and restric
branches of the trigeminal nerve – the ophthalmic nerve and the
maxillary nerve – continue their course from Meckel's cave into the
cavernous sinus. The course of the ophthalmic nerve is quite long and follows
the lateral wall of the sinus. The course of the maxillary nerve is much shorter
and follows the caudal border.
Some sources even state that the maxillary

nerve does not pass through the
sinus at all, but rather underneath
it. 67- year old
female with a history of breast cancer with metastases to bone and liver. She
presents with numbness on the left side of her face. Axial 2D FLAIR
show an asymmetric cavernous sinus, with dural thickening on the left. Post-contrast imaging shows increased enha
cavernous sinus, extending into Meckel's cave. Suspicious for
metastasis of breast carcinoma.
Peripheral segment:
Pathology of the peripheral branches of the trigeminal
nerve mostly concerns perineural spread from malignancies in the head and neck
region.
Due to its extensive branching pattern, the trigeminal nerve is especially
vulnerable to this type of pathology. Perineural spread may be recognized as
thickening and enhancement of the nerve, mostly – but not exclusively - in
retrograde direction. Furthermore, the peripheral branches may be subject to
primary neoplasms, mostly schwannomas or neurofibromas. Moreover,
the peripheral branches may be affected by infectious or inflammatory
processes, mostly neuritis originating from the paranasal sinuses. Ophtalmic nerve
The nV1 leaves the cavernous sinus through the superior
orbital fissure and enters the orbit. It subdivides into three smaller
branches. The main branch continues its course via the supra-orbital foramen to
form the supra-orbital nerve. Maxillary nerve
The nV2 leaves the cavernous sinus via the foramen rotundum
and enters the pterygopalatine fossa. There, the nerve subdivides into four
smaller branches. The main branch continues via the infra-orbital foramen into
the orbit and via the infra-orbital canal into the face to form the infra-orbital
nerve. Mandibular nerve
The nV3 does not pass through the
cavernous sinus. Instead it leaves Meckel's cave – together with the motor
division – via the foramen ovale and enters the infratemporal fossa. There, it
subdivides into four smaller branches.
The main branch – the inferior alveolar
nerve – continues its course via the mandibular foramen into the mandible and
through the mandibular canal and the foramen mentale into the face to form the
mental nerve. After entering the infratemporal fossa, the motor
division subdivides into two smaller branches: the masticator nerve and the
mylohyoid nerve. 70 year old male with a history of melanoma and
orbital exenterition. Recently, he has been experiencing tingling and numbness
in the left side of his face. These symptoms cannot be evoked and respond well
to pain medication. Scroll through the axial and coronal postcontrast 3D
T1W images. Then continue reading. Axial and coronal postcontrast 3D T1W images show
thickening and enhancement of nV1 in the supra-orbital fissure (a and b, arrow),
nV2 in the foramen rotundum (a and b, dashed arrow), and nV3 in the foramen
ovale (c and d, arrow). These abnormalities are suspicious for perineural
spread of melanoma. Click on the image below and watch the video of Medical Action Myanmar of Dr Frank Smithuis
If you like the Radiology Assistant please donate to Medical Action Myanmar.
None:

Liver - Segmental Anatomy:
Robin Smithuis and Eduard E. de Lange
Radiology Department of the Alrijne Hospital, Leiderdorp, the Netherlands and University of Virginia Health System,
Publicationdate 2006-05-07 / update 2015-10-15 / 2022-06-13 The anatomy of the liver can be described using two d
traditional morphological anatomy is based on the external appearance of the liver and does not show the internal f
us importance in hepatic surgery. The French surgeon and anatomist Claude Couinaud was the first to divide the live
f segments without damaging other segments.
Segmental anatomy:
Segmental anatomy according to Couinaud. Click to enlarge.
Couinaud classification:
The Couinaud classification of liver anatomy divides the liver into eight functionally indepedent segments. Each segm

n the centre of each segment there is a branch of the portal vein, hepatic artery and bile duct. In the periphery of ea
.
The liver is divided in three vertical planes: Here another illustration of the functional segmental liver anatomy. Porta
The portal vein divides the liver into upper and lower segments.
The left and right portal veins branch superiorly and inferiorly to project into the center of each segment. Left hepati
The significance of the left hepatic vein is somewhat controversial. Some authors have shown it to coincide with the
to the lateral to the umbilical fissure [fig].
While some authors have claimed that the division between segments II and III is formed by the transverse plane of
defined by the left hepatic vein.
In actual practice, when a lesion is located within the lateral segment of the left lobe, both Couinaud segments II and
lical fissure (i.e. left lateral segmentectomy). On a frontal view of the liver the posteriorly located segments VI and VII
esentation of the liver segments. In reality however the proportions are different. On a normal frontal view the segm
steriorly. The right border of the liver is formed by segment V and VIII. Although segment IV is part of the left hemiliv
iver into a functional left and right liver by a main portal scissurae containing the middle hepatic vein. This is known
e gallbladder fossa anteriorly to the inferior vena cava posteriorly. Clockwise numbering of the segments
Segments numbering:
There are eight liver segments. Segment IV is sometimes divided into segment IVa and IVb according to Bismuth. The
caudate lobe) is located posteriorly. It is not visible on a frontal view. Image at the level of the superior liver segment
Transverse anatomy:
This figure is a transverse image through the superior liver segments, that are divided by the right and middle hepat
eft portal vein. This is a transverse image at the level of the left portal vein. At this level the left portal vein divides the
d the inferior segments (III and IVb). The left portal vein is at a higher level than the right portal vein. Image at the lev
of the right portal vein. At this level the right portal vein divides the right lobe of the liver into superior segments (VII
el of the right portal vein is inferior to the level of the left portal vein. Image at the level of the splenic vein. At the lev
he right portal vein, only the inferior segments are visible.
How to separate liver segments on cross sectional imaging:
Left liver: lateral(II/III) vs medial segment (IVA/B) Extrapolate a line along the falciform ligament superiorly to the cont
lue line). Left vs Right liver: IVA/B vs V/VIII Extrapolate a line from the gallbladder fossa superiorly along the middle h
V/VIII) vs posterior segment (VI/VII) Extrapolate a line along the right hepatic vein from the IVC inferiorly to the lateral
upport embedded videos.
Video of MRI anatomy:
Hypertrophy of caudate lobe in a patient with livercirrhosis. Notice the small lobulated right hemiliver.
Caudate lobe:
The caudate lobe or segment I is located posteriorly. The caudate lobe is anatomically different from other lobes in t
veins, that are separate from the main hepatic veins. The caudate lobe may be supplied by both right and left branch
irrhosis with extreme atrophy of the right lobe, normal volume of the left lobe and hypertrophy of the caudate lobe.
the disease process and hypertrophied to compensate for the loss of normal liverparenchyma.
Liver surgery:
Right hepatectomy
segment V, VI, VII and VIII (± segment I). Extended Right or right trisectionectomysegment IV, V, VI, VII and VIII (± segm
). Extended Left or left trisectionectomysegment II, III, IV, V and VIII (± segment I). Many surgeons prefer to use the te
some adjacent tissue of segment 4, or 5/8, as applicable is included rather than the entire segment 4, or 5/8. Right p
segment VI and VII Right anterior sectionectomy
segment V and VIII Left medial sectionectomy
segment IV Left lateral sectionectomy
segment II and III MS van Leeuwen, J Noordzij, MA Fernandez, A Hennipman, MA Feldberg and EH Dillon Department
2. Clinical and anatomical basis for the classification of the structural parts of liver Saulius Rutkauskas et al. Clinic of
as University of Medicine, Lithuania
3. Division of the Left Hemiliver in Man Segments, Sectors, or Sections by Anna C. Botero and Steven M. Strasberg Li
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4. Liver Resection Guidelines
Mediastinal Masses - differential diagnosis:
Sanjeev Bhalla, Marieke Hazewinkel and Robin Smithuis
Cardiothoracic Imaging Section of the Mallinckrodt Institute of Radiology, St. Louis, USA and the Radiology departme
rp, the Netherlands:
Publicationdate 2007-06-05 This review is based on a presentation given by Sanjeev Bhalla and was adapted for the
ev Bhalla is section chief of the Cardiothoracic Imaging Section of the Mallinckrodt Institute of Radiology. This review
of mediastinal lesions by localizing and characterizing them.
Introduction:
Whenever you see a mass on a chest x-ray that is possibly located within the mediastinum, your goal is to determine

iastinal masses. In the next paragraphs we will discuss each compartment separately. Statistically, it is important to r
he most common (> 80%) are: In adults the most common are:
Localize to the mediastinum:
LEFT: A lung mass abutts the mediastinal surface and creates acute angles with the lung.RIGHT: A mediastinal mass w
es with the lung. The following characteristics indicate that a lesion originates within the mediastinum: A lung mass a
e lung, while a mediastinal mass will sit under the surface creating obtuse angles with the lung (Figure). On the left yo
inue. On the x-ray on the left there is a lesion that has an acute border with the mediastinum. This must be a lung m
tuse angle to the mediastinum. This must be a mediastinal mass. Since there is a silhouette-sign with the right heart
ass must be located within the anterior mediastinum. The lesion on the left was a pancoast tumor. The lesion on the
Localize within the mediastinum:
The mediastinum can be divided into anterior, middle and posterior compartments. It is important to remember tha
ral radiograph the anterior and middle compartments can be separated by drawing an imaginary line anterior to the
osterior compartments can be separated by an imaginary line passing 1 cm posteriorly to the anterior border of the
fferential diagnosis. In many hospitals a CT will be made to further analyze and characterize anterior and middle me
d in the posterior compartment because the majority of these masses turn out to be neurogenic in nature. An additi
Anterior Mediastinum:
The anterior mediastinum contains the following structures: thymus, lymph nodes, ascending aorta, pulmonary arte
see in the anterior mediastinum will either be of thymic or lymph node origin. Even the germ cell tumors arise from
n anterior mediastinal mass, do not forget thta some of these lesions can be vascular in origin. The four T's make up
radiographs look for the signs listed in the table on the left. The finding of an obliterated retrosternal clear space is r
bese. In these patients the retrosternal space can be filled with fat.
Obliterated retrosternal clear space:
Describe the images on the left. Then continue. On the PA film there is a lobulated widening of the superior mediast
bliterated. This happened to be a patient with lymphoma. On the left FDG-PET images of the same patient. There are
or mediastinum, spreading to the neck. Hilum Overlay Sign: hilar vessels are seen through a mediastinal mass
Hilum Overlay Sign:
When there is a mediastinal mass and you still can see the hilar vessels through this mass, then you know the mass
sign. Because of the geometry of the mediastinum most of these masses will be located in the anterior mediastinum
there is a mass that has obtuse angles with the mediastinum, so it is a mediastinal mass. The hilar vessels are seen t
bly will arise from the anterior mediastinum. The anterior location was confirmed on a CT. Most commonly this will b
oma in a HIV-positive patient.
Cystic masses:
The anterior mediastinum is an important location for cystic masses. Masses can be entirely cystic (thymic cysts) or h
are cystic with enhancing septations - in these cases you should think of a germ cell tumor. Describe the image on th
with water density attenuation. This is typical for a thymic cyst. Describe the image on the left. Then continue. The C
is cystic but has solid enhancing septa. This finding is very specific for a germ cell tumor. Now many think that germ
it cannot be a germ cell tumor. You have to remember, that only about 60 % of germ cell tumors contain fat, so you
tumor from the differential diagnosis. The more solid components a germ cell tumor has, the more likely the tumor
The CT shows a mass located in the anterior mediastinum. The mass is cystic but has solid enhancing components, s
This proved to be a cystic thymoma.
Middle Mediastinum:
The middle mediastinum contains the following structures: lymph nodes, trachea, esophagus, azygos vein, vena cava
stinal masses will consist of foregut duplication cysts (eg oesophageal duplication or bronchogenic cysts) or lymphad
stinal masses. Fluid containing lesions are usually duplication cysts or necrotic lymph nodes. A pancreatic fluid collec
ss. A fibrovascular esophageal polyp is a mesenchymal lesion which almost always contains fat. Vascular lesions are
ena cava or hyperenhancing lymph nodes. On conventional radiographs look for the signs listed in the table on the l
n the left you may have a pseudoparavertebral line. This is a new interface that looks like a paravertebral line. Descri
ograph of this patient there is widening of the azygoesophageal recess on the right. There is an apparent widening o
s is anterior to the spine and therefore is located in the middle mediastinal. On the CT the azygoesophageal recess is
and there is also a new interface on the left. This is a patient with cirrhosis of the liver and varices as a result of port
lung carcinoma. Describe the images on the left. Then continue. On the PA film there is a lobulated paratracheal stri
verlying the ascending aorta and filling the retrosternal space. These findings indicate a mass in the anterior aswell a
lymphomas in both the anterior and the middle mediastinum. On the left two different patients. One of these patien
ibe the images on the left. Then continue. On the right image there is a lobulated mass surrounding the right bronch
ghnut. On the left image there is only density in the area from 9 o'clock to 3 o'clock and not in the 3 - 9 o'clock area.
moderately enlarged vessels while the patient on the right has sarcoidosis with widespread lymphadenopathy. Wher
concern about mediastinal masses.
Posterior Mediastinum:
The posterior mediastinum contains the following structures: sympathetic ganglia, nerve roots, lymph nodes, parasy
ssels and the vertebrae. Most masses in the posterior mediastinum are neurogenic in nature. These can arise from t

eg schwannoma or neurofibroma). Don't forget lymphadenopathy, the vertebrae and the descending thoracic aorta
ll be either neuroenteric cysts, schwannomas or meningoceles. Fat containing lesions will be extramedullary hemato
stop producing blood and become fatty. On conventional radiographs look for:
Cervicothoracic sign:
The anterior mediastinum stops at the level of the superior clavicle. Therefore, when a mass extends above the supe
r mediastinum. When lung tissue comes between the mass and the neck, the mass is probably in the posterior medi
age on the frontal view on the left, we see a mass extending above the level of the clavicle and there is lung tissue in
inum. On the left the MR of the same patient. It turned out to be a schwannoma. On the left images of a patient, who
emergency department resulting in the number one cause of law suits. Study the images and then continue. Notice
ight on the PA radiograph. On the lateral radiograph there is a severely narrowed disc space. The diagnosis is discitis
high signal intensity of the disc.
More than one compartment:
Since there are no tissue planes separating the mediastinal compartments, there are lesions that do not respect our
an one compartment and include: mediastinitis, hematomas, vascular entities, bronchogenic cancer, metastases and
Characterize:
Once you have localized a mediastinal mass, next try to charcterize it by assessing whether it has any of the followin
Fluid containing masses:
This is a list of mediastinal msses that may contain fluid: If a mass contains fluid it could be a teratoma (on the left) o
es not contain fat. Teratomas are the most common benign germ cell tumors. The most common malignant germ ce
There is are multiple masses in both the anterior and middle mediastinum. The attenuation values are of water dens
n a patient with metastatic disease. Describe the image on the left. Then continue. There is a cystic lesion in the midd
cium. Foregut duplication cysts occasionally contain milk of calcium like in this example of an esophageal duplication
Fat containing masses:
The differential diagnosis of fat containing mediastinal masses is: On the left we see an fat-containing anterior media
eratoma. Describe the image on the left. Then continue. The axial CT and sagittal MR demonstrate a lipomatous lesio
eal lipoma and its fibrovascular stalk. Multiple enhancing lesions in multiple compartments
Enhancing masses:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift.
Chest X-Ray - Lung disease:

Four-Pattern Approach:
Robin Smithuis
Radiology Department of the Rijnland Hospital, Leiderdorp, the Netherlands:
Publicationdate 2014-02-01 On a chest x-ray lung abnormalities will either present as areas of increased density or a
ed density - also called opacities - are the most common. A practical approach is to divide these into four patterns: In
the end we will also discuss diseases that present as areas of decreased density.
4-Pattern approach:
Whenever you see an area of increased density within the lung, it must be the result of one of these four patterns. H
st x-ray (click image to enlarge). Consolidation Interstitial Reticular interstitial opacities You have to realize that it is n
ne of these four patterns, but that should not be a problem. Sometimes you are confronted with an abnormality tha
he work-up of both the differential diagnosis of masses and consolidation. In such a case information from clinical da
the problem. Finally in some cases only biopsy will provide a diagnosis.
Consolidation:
Consolidation is the result of replacement of air in the alveoli by transudate, pus, blood, cells or other substances. Pn
e disease usually starts within the alveoli and spreads from one alveolus to another. When it reaches a fissure the sp
seases are indicated in red.
Differential diagnosis:
The table summarizes the most common diseases, that present with consolidation. Click to enlarge. Chronic disease
is to think of the possible content of the alveoli: Another way to think of consolidation, is to look at the pattern of dis
more than one pattern. For instance a lobar pneumonia caused by streptococcus pneumoniae may become diffuse
nizing pneumonia (OP) and chronic eosinophilic pneumonia. These diseases typically present as multifocal consolida
monia. When it is idiopathic it is called cryptogenic (COP). The old name is BOOP - Bronchiolitis Obliterans Organizing
s adenocarcinoma in situ. It is very important to differentiate between acute consolidation and chronic consolidation
isease we think of: This is known as alveolar sarcoidosis.
* Alveolar proteinosis is a rare chronic disease that is characterized by filling of the alveoli with proteinaceous mater
Lobar consolidation:
The most common presentation of consolidation is lobar or segmental. The most common diagnosis is lobar pneum
typical lobar consolidation. First study the images, then continue reading. The findings are: Lobar consolidation is th

from one alveolus to another through the pores of Kohn. At the borders of the disease some alveoli will be involved, disease reaches a fissure, this will result in a sharp delineation, since consolidation will not cross a fissure. As the alv nchi will become more visible, resulting in an air-bronchogram (arrow). In consolidation there should be no or only m ectasis. Expansion of a consolidated lobe is not so common and is seen in Klebsiella pneumoniae and sometimes in nia. Lobar pneumonia Lobar pneumonia On the chest x-ray there is an ill-defined area of increased density in the rig position. Notice the air-bronchogram (arrow). In the proper clinical setting this is most likely a lobar or segmental pr nding symptoms, we would include the list of causes of chronic consolidation. This was an acute lobar pneumonia ca sually not possible to determine the cause of the consolidation. Other things need to be considered, like acute or chr ere we have a number of x-rays with consolidation. Notice the similarity between these chest x-rays. Hemorrhage po e right upper lobe and a biopsy was performed. The lobar consolidation is the result of hemorrhage as a complicatio ulmonary emboli Lung infarction The radiographic features of acute pulmonary thromboembolism are insensitive ar e Investigation of Pulmonary Embolism Diagnosis (PIOPED) study were atelectasis and patchy pulmonary opacity. In nt had pulmonary emboli, which were seen on a CECT. The peripheral consolidation is seen in the region of the emb nary sequestration Pulmonary sequestration This is an uncommon cause of lobar consolidation. It is a congenital ab th the bronchial tree and receives arterial blood supply from the systemic circulation. Patients present with recurren tice the feeding artery, that branches off from the aorta (blue arrow).

Diffuse consolidation:

The most common cause of diffuse consolidation is pulmonary edema due to heart failure. This is also called cardiog diogenic edema. The increased heart size is usually what distinguishes between cardiogenic and non-cardiogenic. Lo y blood flow, Kerley B-lines and pleural fluid. However some patients, who have an acute cardiac infarction, may still e heart due to a chronic heart disease, may have non-cardiac pulmonary edema due to a superimposed pulmonay in pulmonary edema Congestive heart failure First study the images, then continue reading. The findings are: All these o heart failure. You probably would like to look at old films to see if there are any changes. Bilateral legionella pneum case of diffuse consolidation. This patient had fever and cough. This was thought to be a diffuse bronchopneumonia onia starts in the airways as acute bronchitis. It will lead to multifocal ill-defined densities. When it progresses it can the fissures, but usually starts in multiple segments. Bronchopneumonia can be caused by many micro-organisms. tient with bronchoalveolar carcinoma Diffuse consolidation in bronchoalveolar carcinoma The chest x-ray shows diff nchogram. This patient had a chronic disease with progressive consolidation. The disease started as a persitent cons Final diagnosis: bronchoalveolar carcinoma. This is a difficult case. It demonstrates, that based on the x-ray alone, it nsities masses or consolidation? Continue with the CT. Non Hodgkin lymphoma The CT-image is not very helpful in th . On the other hand this also could be areas of consolidation with hypodense areas due to necrosis. Finally the diagn lateral perihilar distribution of consolidation is also called a Batwing distribution. The sparing of the periphery of the area. It is most typical of pulmonary edema, both cardiogenic and non-cardiogenic. Sometimes it is seen in pneumon d reverse Batwing distribution. It is frequently seen in chronic lung disease.

Multifocal:

Multifocal consolidations are also described as multifocal ill-defined opacities or densities. In most cases these are th As mentioned before bronchopneumonia starts in the bronchi and then spreads into the lungparenchyma. This can e cases however the underlying pathology of multiple ill-defined densities is interstitial disease, like in the alveolar fo nd fill up the alveoli. First study the chest x-ray. What are the findings and what is the differential diagnosis? Notice th ones are ill-defined and maybe there is an air-bronchogram in the right lower lobe. Probably we are dealing with mu ity of multiple ill-defined masses. There is a peripheral distribution. This patient had a several month history of chron . So we are dealing with the differential diagnosis of chronic consolidation. The lab-findings were normal which make no eosinophilia, which excludes eosinophilic pneumonia. Biopsy revealed the diagnosis of organizing pneumonia (OP en vascular disease with vasculitis involving the lung, kidney and sinuses. In the lung the vasculitis causes infarcts wh a later stage these infarcts become more circumscribed and can be seen as multiple nodules or masses, sometimes ill-defined densities in the right lung, which proved to be a manifestation of Wegener's.

Interstitial disease:

Differential diagnosis on HRCT:

Most of our knowledge about imaging findings in interstitial lung disease comes from HRCT. On HRCT there are four a Chest X-Ray it can be very difficult to determine whether there is interstitial lung disease and what kind of pattern w cular. The ground-glass pattern is frequently not detected on a chest x-ray. The cystic pattern is also difficult to appre in Langerhans cell histiocytosis or honeycombing, it frequently presents as a reticular pattern on a CXR. However so P can be suspected based on the x-ray findings. Cystic versus Reticular It can be difficult to determine whether we ar is of a patient with Langerhans cell histiocytosis (LCH). LCH is called a cystic disease. On the CXR it is difficult to see it uch cases a HRCT will give you more information. This problem is also seen in patients with UIP. One of the promine rn on the chest x-ray, because the cysts in honeycombing have thick walls. We will show a case in a moment. Reticula ontinue reading. The findings are: Based on these findings we can conclude that we are dealing with congestive hear Interstitial edema usually presents as reticulation. Sometimes Kerley B lines are visible. Here another example. Kerle ura. The main differential diagnosis of Kerley B lines is: Here another chest x-ray with interstitial edema and Kerley B

ws the septal thickening. Sometimes the reticulation is more coarse like in this case of congestive heart failure. Sarco
t could be described as fine reticulation. In many cases a HRCT is needed to determine the exact nature of the findin
e as a result of sarcoidosis. Notice the subtle irregular thickening of the minor fissure. This is quite specific for sarcoi
in a patient with long standing Sarcoidosis (stage IV). There is fibrosis in the upper zones. The differential diagnosis i
esults in fibrosis with upper lobe predominance. The HRCT demonstrates densities in both upper lobes. These are ca
nodules. Here another patient with sarcoidosis. The is volume loss in the upper lobes as a result of fibrosis. The imag
nodules were seen. A follow-up CXR shows resorption of most of the lung abnormalities. The fibrosis persists.
UIP:
UIP is a histologic pattern of pulmonary fibrosis. On a chest X-ray UIP manifests as a reticular pattern particularly at t
. A HRCT is needed to confirm the diagnosis by demonstrating honeycombing. Here a CXR with a reticular pattern at
tive heart failure, but persisted on follow-up CXR's despite therapy. HRCT demonstrated honeycombing. Here anothe
preference at the lung bases. The HRCT demonstrates honeycombing and traction bronchiectasis. PCP
Interstitial pneumonias:
An acute reticular pattern is most frequently caused by interstitial edema due to cardiac heart failure. The other caus
productive cough and some fever. This was a PCP-infection as a first manifestation of AIDS. Sarcoidosis On a CXR sar
denopathy (example). Parenchymal disease can present as consolidation or even as masses, but the most common p
dules coalesce, they may resemble consolidation. Lymphangitis carcinomatosis Lymphangitis carcinomatosis also pr
Atelectasis:
Atelectasis or lung-collapse is the result of loss of air in a lung or part of the lung with subsequent volume loss due to
luid or a pneumothorax. In many cases atelectasis is the first sign of a lung cancer. Evidently it is very important to re
e of them can be easily misinterpretated. The key-findings on the X-ray are:
Lobar atelectasis:
Lobar atelectasis or lobar collaps is an important finding on a chest x-ray and has a limited differential diagnosis. The
ectasis produces only mild volume loss due to overinflation of the other lungparts. The illustration summarizes the f
lobe atelectasis First study the images, then continue reading. Findings: On the PET-CT a lungneoplasm is seen with
n of the upper lobe bronchus. A common finding in atelectasis of the right upper lobe is 'tenting' of the diafphragm (
with metastases in both lungs (red arrows). Right middle lobe atelectasis First study the x-rays and then continue rea
asis does not result in noticable elevation of the right diaphragm. A pectus excavatum can mimick a middle lobe atel
problem. Right lower lobe atelectasis Chest x-rays of a 70-year old male who fell from the stairs and has severe pain
erolateral as a result of hematothorax. What are the pulmonary findings? First study the images, then continue read
ght lower lobe atelectasis. Notice the abnormal right border of the heart. The right interlobar artery is not visible, be
sed lower lobe, which is adjacent to the right atrium. On a follow-up chest film the atelectasis has resolved. We assur
tilation with mucus plugging. Notice the reappearance of the right interlobar artery (red arrow) and the normal right
udy the x-rays, then continue reading. What are the findings? The CT-images demonstrate the atelectasis of the left u
obstructs the left upper lobe bronchus (red arrow). First study the x-rays then continue reading. What are the finding
ft upper lobe. You would not expect the apical region to be this dark, but in fact this is caused by overinflation of the
the way up to the apical region. This is called the luft sichel sign. First study the x-rays, then continue reading. The fin
the left upper lobe and possibly also partial atelectasis on the right. Since the silhouette of the right heart border is s
e lower lobe and not of the middle lobe. Continue with the PET-CT... Lungcarcinoma on the left obstructing the uppe
the right lower lobe. On the PET-CT there is both a tumor in the left lung, aswell as in the right. There were mutiple b
. Luft sichel means a sickle of air (blue arrow). Notice the bulging of the fissure on the lateral view. This is comparable
is suspective of a centrally obstructing mass. Study the images and then continue reading. There is a total collaps of
m. There is only a subtle band of density projecting behind the sternum. This is the collapsed upper lobe. In this case
sulting in a normal position of the diaphragm and the mediastinum. Left lower lobe atelectasis First study the x-rays
is a triangular density seen through the cardiac shadow. This must be an abnormality located posterior to the heart.
iaphragm is lost when you go from anterior to posterior. As the title suggests this is lower lobe atelectasis. We canno
he atelectatic lobe. Normally when you follow the thoracic spine form top to bottom, the lower region becomes less
The chest x-ray shows total atelectasis of the right lung due to mucus plugging. Notice the displacement of the media
reatment with a suction catheter. The mediastinum has regained its normal position. A common cause of total atelec
nd thus obstructing one of the main bronchi. Total atelectasis in a patient with severe bronchopneumonia. These im
n ventilation. During follow up a white out on the left was seen. This was caused by a large mucus plug. After suction
y shows a nearly total opacification of the left hemithorax. This patient was known to have pleuritic carcinomatosis.
uid. Unlike most of the above cases, which were caused by obstruction, in this case the atelectasis is a result of comp
llections is best seen on the CT-image (blue arrow). The CT-scan was performed, because the patient was suspected
Rounded atelectasis:
The typical findings of rounded atelectasis on CT are pleural thickening, pleural-based mass and comet tail sign. The
nd contract. The underlying lung shrinks and atelectasis develops in a round configuration. The distorted vessels app
rst study the images and then continue reading. On the lateral view there is a mass-like lesion that is pleural-based.
s performed - see next images. Rounded atelectasis The CT shows a lesion that originates in the lung. Many would ha
However there is also some pleural thickening (red arrow) and vessels seem to swirl around the mass (blue arrows).

e a pleural-based lesion that looks like a lungcancer, also consider the possibility of rounded atelectasis. Rounded at
ing, then biopsy is not needed. During follow up these lesions usually do not change in configuration. Rounded atele
posure. The images show a density posteriorly in the left lower lobe. On the PA-film this looks like a mass or possibly
eem to be sharp, which is in favor of a mass. Also notice that the pleura is thickened (red arrow). Although a periphe
possibility of rounded atelectasis. Rounded atelectasis The CT-images show the typical features of a rounded atelect
sign (arrow). This lesion did not change in a two-year follow up. Plate-like atelectasis due to poor inspiration in a pati
like atelectasis is a common finding on chest x-rays and detected almost every day. They are characterized by linear
horizontal, measure 1-3 mm in thickness and are only a few cm long. In most cases these findings have no clinical si
patients, that are in a poor condition and who breathe superficially, for instance after abdominal surgery (figure). Pl
te-like atelectasis is frequently seen in patients in the ICU due to poor ventilation. Platelike atelectasis is also frequen
fic, it is not a helpful sign in making the diagnosis of pulmonary embolism. Cicacitration atelectasis Atelectasis can be
diotherapy and in chronic infection, especially TB. Here we have a patient who was treated with radiotherapy for lun
volume loss. Here we have a patient with atelectasis of the right upper lobe as a result of TB. Notice the deviation of
lobe, which results in a high position of the left pulmonary artery as seen on the lateral view (red arrow)
Nodules and Masses:

Solitary Pulmonary Nodule:
Click here for more detailed information about Solitary Pulmonary Nodule A solitary pulmonary nodule or SPN is def
qual to 3 cm in diameter. It has to be completely surrounded by lung parenchyma, does not touch the hilum or med
l effusion. The differential diagnosis of SPN is basically the same as of a mass except that the chance of malignancy i
m, i.e. SPN's are most commonly benign granulomas, while lesions larger than 3 cm are treated as malignancies unti
chest x-ray - a survival guide. In lesions that do not respond to antibiotics, probably the most important non-invasive
lignancy in focal pulmonary lesions of greater than 1 cm with a sensitivity of about 97% and a specificity of 78%. Fals
ase and rheumatoid disease. False negatives are seen in low grade malignant tumors like carcinoid and alveolar cell
le
Fleischner Society recommendations for follow-up of nodules:
Previous chest radiographs should be reviewed to determine if the lesion has been stable over 2 years. If so, no furth
ass lesions on CT scans, which can be slower growing. For lesions with a benign pattern of calcification, further testin
er than 8-10 mm depends on clinical probability of malignancy, as follows: Any unequivocal growth noted during foll
Multiple masses:
The differential diagnostic list of multiple masses is very long. The most important diagnoses are listed in the table. S
dations from masses. Metastases Metastases are the most common cause of multiple pulmonary masses. Usually th
s and in the subpleural region. HRCT will demonstrate the random distribution unlike other diseases that have a per
cell carcinoma that has invaded the inferior vena cava with subsequent spread of disease to the lungs. Metastases in
spread pulmonary metastases of a cancer, that was located in the tongue. Mucoid impaction
Mucoid impaction:
Mucus plugs or mucoid impaction can mimick the appearance of lung nodules or a mass. Sometimes differentiating
s commonly seen in patients with bronchiectasis, as in cystic fibrosis (CF) and allergic bronchopulmonary aspergillos
illus, that occurs in patients with asthma or CF. It is also seen in bronchial obstruction caused by an obstructing tumo
structures in the right lung. CT demonstrated bronchiectasis with mucoid impaction. A more common presentation
e' appearance of mucoid impaction. The mucus in the dilated bronchi looks like the fingers in a glove. Bronchial atre
ity resulting from interruption of a bronchus with associated peripheral mucus impaction and associated hyperinflat
d lungsegment is caused by collateral ventilation through the pores of Kohn. The characteristic finding is a hyperluce
that extends from the hilum. Notice the central mass surrounded by hyperlucent lung (blue arrow).
Decreased density or lucencies:
Radiologists use many terms to describe areas of decreased density or lucencies within the lung, like cyst, cavity, pne
hese terms are based on the pathogenesis of the abnormality. This makes it difficult to use these terms, since in ma
out what the pathology could be. A more practical approach is to describe areas of decreased density in the lung as:
ion as a result of necrosis. We will discuss them here, because the prominent feature is the lucency. In the differentia
ties can heal and end up as lungcysts and lungcysts can become infected and turn into thick walled cavities. Sometim
1 mm. To differentiate them from cysts, is to look at the surrounding lung parenchyma. Cysts occur without associat
ly contain fluid or solid material. The term is mostly used to describe enlarged thin-walled airspaces in patients with
icker-walled honeycomb cysts are seen in patients with end-stage fibrosis (11). Pneumonia with cavitation
Cavitation:
Pneumonia In virulent pyogenic infections an abscess may form within the consolidated lung as a result of necrosis
up, a cavity can be seen on the chest film. These patients are usually very ill. In granulomatous infection like TB, cavit
Cavitation is not seen in viral pneumonia, mycoplasma and rarely in streptococcus pneumoniae. These images are o
. Within one month after treatment with antibiotics, there was almost complete resolution of the consolidation and t
p. Pneumonia Here another example of a pneumonia with cavitation. Notice the destruction of lung parenchyma as
the CXR. Postprimary TB with cavities TB Primairy TB is usually clinically silent. In 5% of infected individuals the immu

which is known as progressive primary disease (9). Postprimary TB is reactivation of the latent infection and occurs i
on with cavitation in the apical segments of the upper and lower lobes. Miliary TB is the result of hematogenous spre
n the left upper lobe. Postprimary TB TB This patient presented first with the CXR on the left. First study the images.
his is reactivation of a latent TB. Culture was positive for TB. A CXR some years later on the right shows: This is better
avitation especially on the right. In the left upper lobe there is probably some traction-bronchiectasis due to the fibro
ontuberculous mycobacteria Nontuberculous mycobacteria, also known as atypical mycobacteria, are all the other m
atient with active disease in both upper lobes due to infection with atypical mycobacterium. Notice the air-fluid level
bacteria infection with cavitation Here another patient with a mycobacterium infection. Notice the nodules with cavit
infection with cavitation Same patient with nontuberculous mycobacteria infection. Multiple small cavities are seen.
ned nodules. In about 50% cavitation is seen. CT demonstrates more lesions than the chest film and can suggest the
aped peripheral lesions abutting the pleura, air-bronchograms within the ill-defined nodules and a feeding vessel sig
ng vessel sign (8). Here a patient with septic emboli. The chest film shows two ill-defined densities iin the left lung, wh
een and another density with cavitation in the right lung. Continue with folluw up film. Septic emboli Same patient. C
of lungcancers cavitate, most commonly squamous cell carcinoma. Small cell lungcancer does not cavitate. Broncho
onally cavitate and sometimes present as multiple lesions. Here a chest x-ray of a large cavitating lung cancer, which
farcted area. Lung infarction In pulmonar embolism it is not common to see consolidation. The consolidation is a res
a lung cyst has formed in the infarcted area. Here we see an old chest film, which is normal. The pulmonary embolu
e CT we can see, that it is a segmental consolidation. Continue with the follow up films. Cavitation in pulmonary emb
yst is seen. One year later there is a thick wall probably as a result of secondary infection.
Pneumatocele:
The term pneumatocele is used to describe a lungcyst, which is most frequently caused by acute pneumonia, trauma
chanism is believed to be a combination of parenchymal necrosis and check-valve airway obstruction (11). The illustr
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11. Fleischner Society: Glossary of Terms for Thoracic Imaging
Ischemic and non-ischemic cardiomyopathy:
Wouter van Es, Hans van Heesewijk, Benno Rensing, Jan van der Heijden and Robin Smithuis
Radiology and Cardiology department of the St. Antonius Hospital in Nieuwegein and the Rijnland hospital in Leiderd
Publicationdate 2009-11-12 In this presentation we will discuss the MRI features of ischemic cardiomyopathy and no
g in differentiating between the various types of cardiomyopathy. Images can be enlarged by clicking on them. If a vi
utton once more. For proper printing you may have to adjust the print settings of your internet browser.
Introduction:
View larger version
17 segments model:
Myocardial segments with abnormal enhancement or wall motion disturbances are named and localized according t
al myocardial segments can be assigned to the 3 major coronary arteries with the recognition that there is anatomic
or mid anterolateral apical anterior apical lateral apex Click for larger version
Enhancement patterns:
Administration of Gadolinium results in uptake of the contrast agent into both normal and injured myocardium. In n
ed myocardium the wash out is very slow resulting in delayed enhancement after 10 - 15 minutes compared to the r
many pathophysiologic scenarios: LEFT: Long axis late enhancement image in a patient with an inferior wall infarcti
coronary artery RIGHT: 4-chamber late enhancement image in a patient with idiopathic dilated cardiomyopathy with
Ischemic versus non-ischemic:
The causes of cardiomyopathy (CM) can be divided into ischemic and non-ischemic (1-5). Ischemic CM
is defined as dysfunction of the left ventricle as a result of a chronic lack of oxygen due to coronary artery disease. D
ars as high signal intensity in an area of coronary artery distribution. Since all infarctions start subendocardially and
ways involved. Non-ischemic CM
has a variable etiology, i.e. genetic, toxic, metabolic, infectious and idiopathic. In nonischemic myocardial disease th
rtery distribution and is often midwall or epicardial rather than subendocardial or transmural.
Ischemic Cardiomyopathy:
Left: subendocardial infarction, Right: transmural infarction
Infarction and delayed enhancement:

Infarcted myocardium is bright on late-enhancement images. All patients with ischemic cardiomyopathy demonstrat
endocardium is always involved. When a coronary artery is occluded the infarction always starts subendocardially ar
he occlusion [6]. Both acute and chronic infarctions enhance. In acute infarctions the contrast enters the damaged m
farctions the late enhancement is a result of retention of contrast material in the large interstitial space between the
phenomenonRight: four months later there is transmural enhancement indicating a transmural infarction
No reflow phenomenon:
No reflow phenomenon is the failure of blood to reperfuse an ischemic area after the physical obstruction has been
ement images as a dark core surrounded by an enhancing rim. This finding indicates the presence of damaged micro
o reflow' zone is associated with worse functional outcome, larger infarcts and adverse clinical outcome [8,9]. Both a
ut an acute infarction can often be distinguished by the presence of a 'no reflow' zone and high signal on T2 weighte
Stunning:
Cine imaging in combination with delayed-enhancement MR allows identification of: Stunning is defined as postische
mal blood flow. Over time there can be a gradual return of contractile function depending on the transmurality of th
layed enhancement images is less than 50%, the myocardial function is likely to recover [11]. On the left a long axis c
nfarction. First study the video and then continue reading. Continue with the delayed enhancement image. Long axis
wall infarction On the left the long axis delayed enhancement image of the same patient. There is less than 50% enh
can expect a restoration of some of the contractile function. Continue with the cine-view four months later. On the le
nd revascularization. First study the video and then continue reading. The long axis cine shows improved function of
was due to stunning. Myocardial regions that demonstrate little or no evidence of hyperenhancement (i.e. infarction
ral hyperenhancement have virtually no chance of recovery.
Hibernation:
Hibernation is a state in which some segments of the myocardium exhibit abnormalities of contractile function at res
it usually manifests itself in the setting of chronic ischemia, that is potentially reversible by revascularization.
The reduced coronary blood flow causes the myocytes to enter a low-energy 'sleep mode' to conserve energy. There
ancement, and the likelihood of wall motion recovery following revascularization. If the transmural extent of late enh
er revascularization [12]. On the left long axis cine-images of a patient with a severe stenosis of the LAD. First study t
ontinue with the late enhancement image. Hibernation of the anterior wall (blue arrow) and old transmural inferior w
ancement image in the same patient. Noice the following: So it can be concluded, that this is probably the result of h
the anterior wall. The ejection fraction improved from 17 to 49%.
Non Ischemic cardiomyopathy:
Non Ischemic cardiomyopathy is defined as a myocardial disorder in which the heart muscle is structurally and funct
ion, like coronary artery disease, hypertension, valvular disease and congenital heart disease. We will discuss the car
left ventricular outflow tract (yellow arrow), systolic anterior motion of anterior leaflet of mitral valve (blue arrow) ar
Hypertrophic cardiomyopathy:
Hypertrophic cardiomyopathy (HCM) is characterized by a hypertrophied left ventricle, defined as diastolic wall thick
ension or valvular disease. Normal ventricular septal measurement is 8-12 mm. Usually there is asymmetric thickeni
thout abnormal enlargement of the ventricular cavities. It is a genetic myocardial disorder with a prevalence of 1:500
tricular outflow tract (LVOT) due to hypertrophy of the basal septum and a systolic anterior motion of the mitral valv
ve cardiomyopathy is used.
The systolic anterior motion of the mitral valve is probably the result of the increased flow velocity and decreased pr
cular septum (the Venturi effect). In the vast majority of patients the systolic anterior motion of the mitral valva is the
mitral regurgitation. On an end-systolic image the following findings can be depicted (figure): HOCM with hypertroph
e arrow points to the hypertrophic basal septum. Continue with the 3-chamber view movie. On the left the 3-chambe
tinue reading. The video nicely demonstrates: Left: 3-chamber late enhancement image shows the enhancement of t
ber late enhancement image which nicely demonstrates the enhancement of the hypertrophic basal septum (arrow)
typical enhancement at the anterior and posterior right ventricular insertion points (arrows). 3-chamber late enhanc
e the transmural infarction of the basal septum (arrow). The therapy of HOCM is pharmacological, surgical myotomy
ery well depicted with MRI [19]. On the left a 3-chamber late enhancement image before and after alcohol ablation. I
ue with the 3-chamber movie pre-alcohol ablation. HOCM (4) On the left a 3-chamber movie of the same patient befo
e anterior leaflet of the mitral valve and the mitral regurgitation. On the left the 3-chamber movie post-alcohol ablati
function of the mitral valve.
Restrictive cardiomyopathy - Amyloidosis:
The most common cause of restrictive cardiomyopathy is amyloidosis [20].
Amyloid deposits in the myocardium cause abnormal diastolic function with biatrial enlargement, concentric thicken
both ventricles. Cardiac involvement in systemic amyloidosis occurs in up to 50% and has a poor prognosis with a m
patient with amyloidosis. There is diffuse hypokinesia of the left and right ventricle. Same patient, short axis movie. A
hancement over the entire subendocardial circumference, variably extending into the neighboring myocardium [21].
Sometimes it is difficult to find the optimal inversion time for nulling the normal myocardium [1]. On the left the 4-ch
ferential subendocardial enhancement extending into the neighboring myocardium. Axial and coronal black-blood im
oint to the thickened pericardium.

Constrictive cardiomyopathy:
The most important differential diagnosis of restrictive cardiomyopathy is constrictive cardiomyopathy. MRI can diffe
movie in a patient with constrictive CM. Notice the diastolic septal bounce which is typical for constrictive cardiomyo
Dilated cardiomyopathy:
Dilated cardiomyopathy is defined as dilatation with an end diastolic diameter greater than 55mm measured on the
nts with idiopathic dilated cardiomyopathy show either no enhancement or linear midmyocardial enhancement [24]
ates a poorer prognosis. Patients with midmyocardial enhancement are at higher risk of sudden cardiac death and a
pathic cardiomyopathy. Notice the mitral regurgitation. Continue with the late enhancement image. The late enhanc
diopathic dilated cardiomyopathy. Dilated cardiomyopathy (2) The differentiation between idiopathic dilated cardion
mic cardiomyopathy might be treated with revascularization and idiopathic disease not. Late enhancement MRI will
athy. On the left a 4-chamber movie of a patient with dilated cardiomyopathy. Continue with the late enhancement i
diomyopathy . Note the characteristic subendocardial enhancement. The late enhancement MRI shows subendocard
cardiomyopathy as a result of ischemia. Dilated cardiomyopathy (3) In patients with dilated cardiomyopathy it is imp
lines of ACC/AHA/HRS 2008 [26] there is an indication for an automated implantable cardioverter-defibrillator (AICD)
hic dilated cardiomyopathy. The ejection fraction was measured to be 28%. Same patient with the idiopathic dilated
pathic dilated cardiomyopathy with midwall septal enhancement, consistent with fibrosis On the left the late enhanc
hancement consistent with fibrosis. Left: fatty infiltration in the myocardium of the anterior wall of the dilated right v
tract with micro-aneurysm (arrow).
ARVC:
Arrhythmogenic right ventricular cardiomyopathy (ARVC) is an inherited cardiomyopathy whose hallmark is fibrofatt
ved in at least 15% of patients. The patients develop progressive RV failure and present with ventricular arrhythmias
. Morphologically the right ventricle can have regional wall thinning, hypertrophy, dilatation and microaneurysms.
Functionally cine images are evaluated for RV dysfunction, microaneurysm formation, and focal areas of RV dyskine
ormal variations including variable trabeculation and small outward bulges near the insertion of the moderator banc
C. There are two variants of ARVC: fatty and fibro-fatty. The fatty form is characterized by fatty replacement of the m
fatty form is associated with significant thinning of the right ventricular wall. The sites of involvement are mostly fou
 the infundibulum, the 'triangle of dysplasia' [4]. On the left a 4-chamber movie in a patient with ARVC.
Notice the dilated right ventricle with severe segmental hypo- and dyskinesis resulting in small aneurysms. On the le
 right ventricle with severe segmental dyskinesis resulting in small aneurysms. Left: axial black-blood image of a patie
enhancement of the anterior wall of the right ventricle (arrow). ARVC (2) MRI can show segmental hypokinesis, dilata
ll aneurysms and late enhancement of the myocardium [5,27]. Fat infiltration is seldom the only abnormality seen or
ysfunction [28]. The diagnosis ARVC cannot be made on MRI findings alone. On the left a 4-chamber movie of a patie
tal hypokinesis and dyskinesis. ARVC (3) The diagnosis is based on major and minor Task Force criteria, many of whic
a demonstrated by MRI are: Minor criteria shown by MRI include [27] : Myocarditis: midmyocardial enhancement
Myocarditis:
Myocarditis is often caused by a viral infection. Acute myocarditis can be a cause of sudden cardiac death. Most patie
evelop a dilated cardiomyopathy [30]. Acute myocarditis may clinically mimic an acute myocardial infarction with che
ggest an acute coronary syndrome. The MRI findings however are discriminatory between those two diagnoses. The
s is subepicardially or midmyocardially located, and does not originate from the subendocardium [30]. On the left a
 the lateral wall. Myocarditis: 10 months later the midmyocardial enhancement of the lateral wall has diminished. Sa
ement of the lateral wall has diminished. Myocarditis (2) Most lesions with myocarditis occur in the lateral free wall.
 a potential relationship between the location of late enhancement, the etiologic virus and the prognosis [31]. On the
tes hypokinesia of the lateral wall of the left ventricle. Continue with the movie 10 months later. 4-chamber movie 10
pus pot RIGHT: left ventricle angiogram in a patient with Tako tsubo cardiomyopathy. There is only contraction of the
alloon.
Tako-Tsubo cardiomyopathy:
Tako-Tsubo cardiomyopathy or apical ballooning syndrome is a transient cardiomyopathy affecting postmenopausa
ms mimicking an acute myocardial infarction. The ECG changes and abnormal laboratory findings may also mimic ar
 left ventricle angiogram is performed, marked hypokinesia of the apical cardiac segments is noted (figure). The Japa
ure octopus and resembles the shape of the left ventricle during systole in these patients These apical wall motion a
e transient and return to normal within weeks. On the left a patient with Tako-Tsubo cardiomyopathy. Notice the hyp
ansient and returned to normal within weeks. Continue with the late enhancement image. Tako-Tsubo cardiomyopa
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None:

None:

None:

Acute Abdomen in Neonates:
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Publicationdate 2018-05-01 A neonate with an acute abdomen usually presents with vomiting, constipation and diste
birth, the most common cause is a gastrointestinal obstruction. In this article we will discuss the congenital gastroint
sent as an acute abdomen in the neonate.
Differential diagnosis:
The table on the left lists the differential diagnosis for acute abdomen in the neonate. High obstructions are defined
ring in the ileum or colon. Although in high obstruction vomiting will be the most striking symptom, whereas in low o
esent concurrently, and the clinical differentiation between a high and a low obstruction is difficult. Necrotizing ente
t common acquired causes of an acute abdomen in the neonate. NEC is most common in prematures, especially wh
ically presents at the age of 4-8 weeks, but can sometimes present in the early neonatal period.
Imaging:

Abdominal radiograph:
In suspected neonatal obstruction the first step is an abdominal radiograph. On the radiograph an obstruction can o
r-filled after birth. The table shows the normal progression of air in the gastrointestinal tract. The things to look for o
l discuss each of these items separately. In addition to the front view, the dorsal decubitus radiograph (cross-table vi
ct free air and sometimes can aid in differentiating the small intestine from the colon. On the radiograph also check
tal structures. Calcifications in the abdominal wall can be seen in meconium peritonitis.
1. Dilatation?:
When the bowel measures more than the interpedicular width of L2, it is said to be dilated. Massive dilatation is seen
the dorsal decubitus radiograph. However, fluid levels alone do not necessarily correspond to dilatation, but rather
er time indicates absence of perstalsis. On the left image the bowel is dilated and the diameter exceeds L2 interpedi
e right there is massive dilatation in a neonate with jejunal atresia.
2. Number of dilated loops?:
Up til three dilated small bowel loops on an abdominal radiograph generally indicate a high obstruction. The left ima
s indicate a low obstruction. The image on the right is a case of ileal atresia.
3. Small bowel or colon?:
Since neonates do not have haustra in the colon yet, it is often impossible to discriminate between small bowel and
as colonic obstruction may produce long fluid levels. Furthermore, the colon ascendens, descendens and rectum ar
large bowel with certainty is only possible with a colon enema.
4. Airfilled rectum?:
If sufficient time has gone by after birth, the rectum will be filled with air. Absence of rectal air indicates an obstructi
the rectum or only a thin stripe of air. The image shows a neonate with dilated bowel loops. There is no air in the rec
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5. Pneumatosis intestinalis?:
Study the image. What are the findings? Then scroll to the next image. Findings: Pneumatosis intestinalis is defined a
schemia in necrotizing enterocolitis. On the radiograph pneumatosis intestinalis resembles granular feces, which is a
granular feces yet since they only drink milk. So what looks like granular feces in the bowel actually represents intra
tem causing portal venous gas. Pneumatosis intestinalis can lead to perforation seen as pneumoperitoneum.
6. Free air and ascites?:
Large amounts of free air can be seen on the front radiograph under the diaphragms, when visualizing both sides of
of free air can only be detected on the dorsal decubitus radiograph. Ascites can only be suspected on a radiograph
cluster in the center of the abdomen. The presence of both ascites, free air as well as abdominal wall calcifications i
ium peritonitis.
Upper GI study:
In case of a typical complete high obstruction (see below) on the radiograph no further imaging is needed and upper
the obstruction is incomplete or imaging results are equivocal, an upper GI is indicated. First aspirate air from a dist
in neonates and inject slowly. Do not distend the stomach too much. Look for dilatation and stenosis and document
ent, the child has to lie flat and straight as rotation may falsely simulate malrotation. If you do not plan to take more
ch at the end of the examination. Here an upper GI study showing the normal position of Treitz' ligament to the left
r even higher. In malrotation, which we will discuss later, Treitz is positioned to the right of the spine. Microcolon: elo
m has not reached the colon yet. Once the obstruction is relieved and bowel contents pass through the colon, the co
Colon enema:
In cases of suspected low obstruction, a colon enema is indicated. Use water-soluble contrast for two reasons: the th
some and water-soluble contrast can be an effective therapeutic enema in cases of meconium plugging or meconiu
he balloon prior to evaluating the rectum and excluding Hirschsprung disease, as the high pressure from the balloon
n be inflated if this is deemed necessary to reach complete filling and do this under careful fluoroscopic vision. Later

rst followed by frontal images. Focus on the diameter of the rectum versus the remainder of the colon, the presence is sufficient to determine the length of the affected bowel, but in other conditions one should aim for filling of the te
.
Ultrasound:
Ultrasound plays a limited role in depicting GI tract pathology as the gas-filled bowel will strongly reflect the ultrasou images of a neonate who presented with an acute abdomen. An ultrasound antenatally had detected a duplication ion of the cyst and the mesentery had resulted in a volvulus. This is a medical emergency and consequently the neon
Congenital High Obstruction:
Most high obstructions occur at the level of the duodenum. Vomiting will be non-bilious if the obstruction is localized h is green) if it is localized distal to it. Bilious vomiting is an indication for urgent imaging as a volvolus may be presen
Esophageal atresia:
First look at the image and describe the findings. Then continue reading. The findings are: Diagnosis: esophagus atre s an anomaly which arises in the fourth week of the embryogenesis, at a stadium in which the trachea and esophagu paration esopaghus atresia can occur. Clinically the neonate cannot swallow saliva, may blow bubbles and will aspira d distally. A radiograph with a curled up feeding tube will confirm the diagnosis. Contrast swallow studies should not oximal pharyngeal pouch is dilated. In 80% of cases a distal tracheo-esophageal fistula is present. Less common is: F reading. The findings are: Cases without a distal fistula can be suspected antenatally when there is a polyhydramnion omalies as esophagus atresia can be part of the VACTERL association (vertebral anomalies, anal atresia, cardiovascul malies).
Duodenal atresia:
In duodenal atresia the duodenum fails to canalize properly late in the first trimester and a web or several webs occu sia occurs distal to Vater's ampulla. The obstruction causes the duodenum to expand and this creates the double bu a double bubble are present antenatally, the diagnosis can be suspected before birth. First look at the image and de is confirms the diagnosis of duodenal atresia and no further imaging is needed. In extreme prematures the diagnosi to dilate. Here another case of duodenal atresia with the typical double bubble sign. Note that the nasogastral tube tion of the film. One may inject some air through the tube prior to the film. About 30% of the patients with duodenal TERL malformations, malrotation and biliary tree abnormalities.
Duodenal web:
First look at the image and describe the findings. Then continue reading. The findings are: This radiograph was taken small bowel and colon yet. Duodenal web has the same etiology as duodenal atresia, but the web is fenestrated and enosis, patients may present in the neonatal period or at a later age. Radiographs may show a double bubble, but w web. Both radiographs and upper GI series cannot differentiate between duodenal web and annular pancreas. Annu lly or in adults when the associated abnormal biliary drainage causes pancreatitis. Another rare diagnosis with simila associated with other abnormalities in the abdomen (like situs ambiguus). p= pylorus. First look at the images of the . The findings are:
Malrotation:
In the developing embryo growth of the bowel requires herniation into the omphalomesenteric sac. In the tenth wee n is accompanied by a counterclockwise rotation of the midgut to achieve its final position with the ligament of Treitz quadrant, suspended from a long mesentery. Malrotation arises when the rotation is arrested or even reversed. As a and peritoneal bands, called Ladd's bands, may cross from the caecum to the liver or to the anterior abdominal wall stine is predominantly on the left. The cecum is in the right lower quadrant There is a long mesentery. Displacement predominantly on the right. Fibrous bands course over the vertical portion of the duodenum causing obstruction.
* Right Volvulus due to short mesentery. Ischemic bowel. Here a neonate with a malrotation. The abdominal radiogr emonstrates that the small bowel projects to the right of the spine. The malrotation will become symptomatic only w s band obstruct the duodenum Both presentations are most common in the neonatal period. However sometimes it ttent or when the Ladd's bands create relatively little obstruction. Acute volvolus is a life-threatening presentation an shows a malrotation complicated by a volvulus. This results in the typical corkscrew or reversed 3 sign. An overfilled tomach should first be aspirated by use of a nasogastric tube and the volume of injected contrast should be small. S perior mesenteric artery is seen to lie to the right of the superior mesenteric vein. This sign however is neither specif igate for suspected malrotation without a volvulus. An abnormal location of ligament of Treitz on an upper GI series child is acutely sick and ultrasound is often the modality of choice. This will show a whirlpool sign of the vessels whic the bowel on the upper GI is equivalent. Once a volvolus is diagnosed on ultrasound, the child should go straight to maging.
Jejunal atresia:
Jejunal atresia is the most frequent cause of upper intestinal obstruction. It is caused by an ischemic event in utero. A ci can be present simultaneously. A typical case will show a triple bubble sign on a radiograph, with the third bubble e not always straightforward. When in doubt, an upper GI-study is indicated which will confirm the occlusion. Here a
Congenital Low Obstruction:
A low obstruction is an obstruction in the ileum or in the colon. Passage of meconium should normally occur within 4 fficulty passing meconium or will not pass any meconium at all. Because of the constipation the child will start to vor

that the meconium has not reached the colon and the obstruction is situated proximal to the colon.
Ileal atresia:
As with jejunal atresia, ileal atresia results from an in utero ischemic event. More atretic foci can be present simultan
nvolved. Radiographs will show multiple dilated bowel loops and absence of air in the colon as seen on the image or
ing ending blind in the ileum (arrow on image on the right).
Meconium ileus:
Meconium ileus occurs nearly exclusively in patients with cystic fibrosis. In 10% of patients it is the first presentation
creas and abnormal intestinal secretions, the meconium is abnormally thick and becomes impacted in the ileum. It is
ndrome). Sometimes radiographs demonstrate typical 'soap bubbles', which represent captured air between mecon
levels on the decubitus image. Bowel loops are usually of different caliber and not all loops are dilated. Colon enema
Once you have made the diagnosis of a meconium ileus, you can opt to set in moderately hyperosmolar contrast fo
act as an effective enema. Since the hyperosmolar contrast will create a fluid shift and thereby may cause dehydratio
to administer extra fluids and secure continuous careful surveillance. Here two cases of meconium ileus. There is a
small bowel (arrows). Meconiumplugsyndrome: normal rectum and a small diameter to the left colon. Because the c
ntrast and a balloon catheter had to be used.
Meconium plug syndrome:
Meconium plug syndrome is also known as small left colon syndrome. Meconium plugging in the left colon occurs w
an association with maternal diabetes and drug use in pregnancy. The condition is temporarily and when the mecon
. The neonate is otherwise healthy and there is no association with cystic fibrosis. There is no air in the rectum on th
h excludes Hirschsprung disease. A microcolon is absent. Meconium is found throughout the colon, but most typical
Just as with a meconium ileus, you may now opt to give a hyperosmolar contrast enema to help resolve the meconiu
Hirschsprung disease:
In Hirschsprung disease ganglion cells are absent in the distal part of the colon. Because the intestinal ganglion cells
is always involves the rectum. More extensive disease extends orally in a contiguous fashion. The involved bowel has
is dilated. In Hirschsprung disease the ratio between the denervated and the non-affected bowel is <1. It is importan
short-segment and total aganglionosis is rare. In case of total aganglionosis the diagnosis is difficult, because the en
aw tooth contractions in Hirschsprung disease Start the enema in the lateral position to evaluate the rectum. Save ci
filling signs can become obscured by too much bowel distention. Normally the rectum should be wider than the sign
er case of Hirschsprung disease. The definitive diagnosis of Hirschsprung disease is confirmed with biopsy. About 90
ome cases are discovered later in life. Anal atresia: markers are placed on the external sphincter. The rectum ends b
Anal atresia:
The diagnosis of anal atresia is usually clinically straightforward by inspection and digital palpation. Anal atresia is pa
and is a complex disorder. Imaging and treatment should be performed in specialized centers. Initially plain films an
n and the need for a colostomy. At a later stage and prior to definitive surgery a combination of fluoroscopic studies
genitourinary, pelvic and perineal structures and associated fistulas. Anal atresia is part of the VACTERL malformatio
Acquired causes of acute abdomen:

Necrotizing enterocolitis:
Necrotizing enterocolitis is a severe bowel inflammation. The etiology is not entirely clear and seems to be a combin
y radiographs are nonspecific and may only show bowel dilatation. Absence of a changing bowel pattern over time is
ortogram) can both be seen on radiographs and with ultrasound. The most feared complication is perforation. Pneu
ot exclusively, in prematures. Neonates with severe stress, for example with cardiac disease, are also at risk. Clinicall
s. The images show a typical case of NEC with pneumatosis intestinalis. On the horizontal beam image there is no sig
s early stage the radiograph only shows non-specific bowel dilatation. At this stage you cannot make the diagnosis. H
in (arrow) and peripheral portal branches. This is seen on the X-Ray and on ultrasound. In this patient with NEC notic
ver. Pneumoperitoneum in severe NEC. Air can be seen on both sides of the bowel wall. This is called the Rigler sign.
er stage. Sometimes necrotizing enterocolitis can have a subclinical course and strictures are the only sign the newb
ys after birth and shows distended bowel with pneumatosis intestinalis. A colon enema at 6 weeks of age shows a st
he colon transversum in a child who had a NEC.
Hypertrophic pyloric stenosis:
Projectile vomiting is the key feature in patients with hypertrophic pyloric stenosis. The cause of the muscle hypertro
ere is a familial predisposition and it is more common in boys. Hypertrophic pyloric stenosis typically presents after t
esentation can also occur. Ultrasound in a fasting child will show retained fluid in the stomach. There is no passage a
child must be positioned right side down and if the stomach is empty it should be filled by drinking Pedialyte or gluc
, the child can be placed on the left side to help the pylorus to move anteriorly. The transversal diameter of the singl
loric muscle hypertrophy. A measurement of more than 3 mm on a transverse image indicates hypertrophy. A transv
canal more than 15 mm support the diagnosis.
Incarcerated hernia:
Neonates and especially prematures have a relatively weak abdominal wall and inguinal hernias are common, espec
ph, always check the groins for the presence of a hernia containing a bowel loop (figure). Ultrasound is the modality

look for herniation of the ovaries. Study the image. What are the findings and what is your diagnosis. The findings ar
Quiz cases:
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Case 1:
Study the image. What are the findings and what is your diagnosis. Then scroll through the images for the diagnosis.
ation with meconium peritonitis. Enable Scroll
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Case 2:
Study the image. What are the findings and what is your diagnosis. Then scroll through the images for the diagnosis.
Case 3:
Study the image. What are the findings and what is your diagnosis. Then scroll through the images for the diagnosis.
nable Scroll
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Case 4:
Study the image. What are the findings and what is your diagnosis. Then scroll through the images for the diagnosis.
016 Springer
None:

Ovarian cystic lesions.:
Wouter Veldhuis, Robin Smithuis, Oguz Akin and Hedvig Hricak
Department of Radiology of the University Medical Center of Utrecht, of the Rijnland hospital in Leiderdorp, the Neth
g Cancer Center, New York, USA:
Publicationdate 2011-05-18 In this review the imaging features of normal ovaries and the most common ovarian cyst
or the diagnostic workup and management of ovarian cystic masses is presented based on the findings of ultrasoun
application this results in hi-res images at full retina resolution.
Normal ovaries:

premenopausal:
The normal ovary contains over two million primary oocytes at birth, about 10 of which mature each menstrual cycle
es the dominant follicle and grows to a size of 18-20 mm by mid-cycle, when it ruptures to release the oocyte. The ot
the oocyte, the dominant follicle collapses, and the granulosa cells in the inner lining proliferate and swell to form th
the corpus luteum degenerates, leaving the small scarred corpus albicans. Graafian follicles Graafian follicles The no
ages show two normal ovaries with several anechoic, simple cysts consistent with Graafian follicles. On T2-weighted
ded by darker solid ovarian stroma. FDG-PET pitfall - normal premenopausal ovaries In some pre-menopausal wome
in the menstrual cycle. Because in pre-menopausal women a PET-positive ovary may be either an adnexal neoplasm
f physiologic mid-cycle FDG uptake and to correlate this finding with the clinical history. FDG-PET in pre-menopausal
k of the menstrual cycle. In post-menopausal women, the normal ovaries show only minimal uptake of FDG. Any incr
le neoplasm. LEFT: Postmenopausal woman. The ovary is a T2 dark tissue clump near the proximal end of the round
rominent, but is still likely to be normal
Post-menopausal:
Post-menopause is defined as 1 year or more of amenorrhea. In Western countries the average age of menopause is
er and gradually stop forming Graafian follicles. Note, however, that follicular cysts may persist several years after m
l woman the ovary is no more than a dark tissue clump near the proximal end of the round ligament. The axial T2-we
hough a bit prominent, this is likely to be completely normal. Only if, by chance, there happened to be prior imaging
s would start with a benign solid lesion such as ovarian fibroma or fibrothecoma.
Functional cysts:
By far the most common cystic ovarian lesions are benign functional ovarian cysts. Functional cysts are Graafian folli
ut are otherwise benign. In the early post-menopause phase, 1-5 years after the final menstrual period, sporadic ovu
in late menopause, which is defined as more than 5 years since the final menstrual period, when ovulation is unlikel
.
Follicular cyst:
A dominant Graafian follicle sometimes fails to ovulate and does not involute. When it becomes larger than 3 cm, it i
but may become much larger. On ultrasound follicular cysts present as simple unilocular, anechoic cysts with a thin
d components, no enhancing septations, and no more than physiologic ascites. Follicular cysts will usually resolve sp
Corpus luteum cyst:
A corpus luteum may seal and fill with fluid or blood, forming a corpus luteum cyst. The transvaginal ultrasound ima

wer Doppler analysis. The characteristic circular Doppler appearance is called the 'ring of fire'. Note, there is good th
ith a, partially involuted, corpus luteum cyst. Remember that women who are on birth control pills usually won't forr
he other hand, use of fertility drugs that induce ovulation, increases the chance of developing corpus luteum cysts. C
re' on ultrasound. At pathologic examination the collapsed bloody cyst can be clearly seen. Corpus luteum cyst Corp
involuting corpus luteum cyst (arrow). This is a normal finding. The right ovary is also normal. Hemorrhagic cyst with
through-transmission
Hemorrhagic ovarian cyst:
When a Graafian follicle or follicular cyst bleeds, a complex hemorrhagic ovarian cyst (HOC) is formed. On ultrasound
cyst with fibrin-strands or low-level echoes and good through transmission. On MRI hemorrhagic cysts are bright on
l vascularity on Doppler ultrasound or internal enhancement on CT or MRI. Hemorrhagic ovarian cysts have variable
een. Clinically the classic presentation is with acute pain. However HOC can also be an incidental finding in an asymp
show multiple simple and one complex right ovarian lesion (red arrow). The latter demonstrates diffuse low-level ec
nsmission (blue arrow). These findings indicate the presence of a hemorrhagic cyst. Continue with the MR-images. H
patient. The right ovary contains multiple simple T2 bright cysts with thin borders and no solid components. On the
lex cyst (arrow). There is a small amount of ascites around the right ovary, but not enough to raise concern of a poss
lex cyst is bright, indicating either fat or blood content. On the T1-weighted image with fatsat the lesion remains brig
there is no enhancement, confirming that this is a hemorrhagic ovarian cyst. An endometrioma would be in your dif
lack of enhancement in a lesion, that is bright on the pre-contrast T1-weighted image. Hemorrhagic ovarian cyst in b
d left ovary: on both sides there is what appears to be a solid lesion. There is however good through transmission, w
ts. On Doppler US (not shown) there was no vascularity. Continue with the MR examination. Hemorrhagic ovarian cy
at, blood or high protein fluid. Fat saturation does not suppress the signal in these lesions. In an image with overall r
ng teratoma and confirms the suggestion of hemorrhagic fluid. Hemorrhagic ovarian cyst. Left:image without subtra
both lesions show typical 'shading'. The gradual drop in T2 is thought to be caused by a combination of increasing v
s the dependent portion of the lesion. There is no enhancement on the subtraction image (Post-Gd minus Pre-Gd). A
crease over the already very bright pre-contrast image would be very hard to appreciate otherwise.
Other benign cystic and cyst-like lesions:
Vaginal ultrasound showing a large hypoechoic cystic lesion with diffuse low-level echo's
Endometrioma:
Cystic endometriosis or endometrioma is a type of cyst formed when endometrial tissue grows in the ovaries. It affe
ic pain associated with menstruation. The ovaries are involved in approximately 75% of patients with endometriosis.
(about 95%) of patients present with a classic homogeneous, hypoechoic cyst with diffuse low level echoes. Rarely it
can be multilocular and have thin or even thick septations. Transvaginal ultrasound: endometrioma with two hypere
bout one third of patients, on careful examination, small echogenic foci can be seen adhering to the wall. These have
tute small blood clots or debris. It is important to differentiate these foci from true wall nodules. In the presence of t
The transvaginal ultrasound shows a typical endometrioma, with hyperechoic wall foci. At Doppler US no vascularity
al US-image that shows a cystic lesion with a hyperechoic structure. There is a wide differential diagnosis including o
atoma with hyperechoic Rokitansky nodule, hemorrhagic cyst with clot and endometrioma with clot or debris. Contir
ut to show the same, predominantly cystic lesion. If additional imaging is needed for cysts that are indeterminate at
on the right correlates nicely with the ultrasound image. On T2-weighted images endometriomas typically show 'sha
action image. MRI confirms the absence of any enhancement, confirming that it is most likely debris within the cyst.
ght on T1-weighted images. On T1-fatsat images an endometrioma will remain bright. This in contrast to teratomas,
lude a T1 fat suppressed sequence, because this makes small T1 bright lesions more conspicuous. Endometrioma Th
ough transmission. There is no internal or wall vascularity on Doppler. On ultrasound this can again either be a hem
ometrioma 6 months later a follow-up MRI was performed. The lesions are bright on T1-weighted images. The bright
There is T2 shading consistent with a hemorrhagic lesion. There is no enhancement. The fluid-fluid level in the right o
he lesions persist after 6 months makes bilateral endometrioma much more likely than hemorrhagic cysts. Axial MR
Polycystic ovary syndrome:
The Poly-Cystic Ovary Syndrome (PCOS) is also known as Stein-Leventhal syndrome. Imaging can confirm or suggest
l cycle irregularities and either typical clinical signs of hirsutism, obesity, infertility, acne, male balding pattern or bioc
image in a patient with polycystic ovary syndrome On the left a sagittal T2-weighted image in a patient with increase
e small peripherally located simple cysts
The obesity associated with this syndrome is evident from the abundance of fat, showing bright on these FSE T2-wei
Theca lutein cysts. The septations do not show enhancement on Doppler evaluation.
Ovarian hyperstimulation syndrome - Theca lutein cysts:
Ovarian hyperstimulation syndrome is a relatively rare condition. It is caused by hormonal overstimulation by hCG, a
ccur in gestational throphoblastic disease, PCOS or in patients receiving hormonal therapy. It can also be seen in pre
ur in normal pregnancies, the reported natural course is spontaneous resolution after birth. In normal pregnancies t
Hormonal overstimulation more often occurs in molar pregnancy, erythroblastosis fetalis or in plural pregnancies. C
multiloculated cyst that can totally replace the ovary. The clinical history is the distinguishing feature to make the dia
cysts: US images of a young pregnant woman. In both ovaries there are multiple cysts. Right image shows an invasiv

ages are of a young pregnant woman, who had multiple ovarian cysts. The other ovary is not shown but showed a si
n hyperstimulation syndrome are in the clinical history - a young pregnant woman - and in the last image of the uter
e molar pregnancy.
PID with tubo-ovarian abscess:
Tubo-ovarian abscess (TOA) usually arises as a complication of Chlamydia or Gonorrhoeae infection that rises from t
led complex cystic ovarian lesion is seen with abundant flow. The presence of a thickened endometrium or hydrosal
shows a left complex cystic lesion with thick enhancing walls and internal gas. It looks like an abscess. Note the relat
s unlikely to be a peri-diverticular abscess. Continue with the reconstructed images. On the sagittal image notice, tha
this is an ovarian lesion (arrow). The coronal image shows the anatomic connection to the uterus. There is a gasbubb
ection rising from the uterine cavity via the salphinx to involve the ovary (click or tap the image to enlarge).
Benign cystic ovarian neoplasms:
Mature cystic teratoma with a Rokitansky nodule or dermoid plug
Mature cystic teratoma:
A very common benign ovarian lesion that may appear cystic is a mature cystic teratoma, also called dermoid cyst. M
lignant teratoma. Benign cystic teratomas typically occur in young women of child-bearing age. At imaging they are u
lateral in ~15%. Up to 60% may contain calcifications. The cystic component is fluid fat, produced by sebaceous glanc
eristic ultrasound appearance is that of a cystic mass, with a hyperechoic solid mural nodule, which is called a Rokita
In another case the transvaginal ultrasound shows the 'tip-of-the-iceberg' sign: acoustic shadowing from the hyperec
l gas and the lesion may be overlooked. A fat-fluid level may be present, caused by fat floating on more aqueous flui
by hair floating in the cyst cavity. Mature cystic teratomas, even though benign, are often resected because of increa
lication. Other complications associated with teratoma are infection, rupture (spontaneous or trauma) and, rarely, h
on can occur but is also rare (Axial T1-weighted image in the same patient shows a bright lesion with an internal sep
e T1-weighted image with fat suppression there is suppression of the signal. This confirms the fatty content and is di
fat in a right sided cystic teratoma at CT.
Cystadenoma and cystadenofibroma:
Cystadenoma and cystadenofibroma are also common benign ovarian tumors. They can be either serous or mucino
and may look like a simple cyst. Mucinous cystadenomas are most often multilocular with thin (
The locules may contain complex fluid, due to proteinaceous debris or hemorrhage, or both. The finding of papillary
alignancy or a cystadenocarcinoma. Transvaginal ultrasound shows a 5.1x5.2-cm dominant left ovarian cyst. The cyst
There is, however, a nodule on the posterior wall that shows no flow on Doppler. This may be a follicular cyst with sc
th MRI is recommended. T2-weighted image of the same patient shows thin enhancing septations (as well as motion
umor nodules and no adenopathy or peritoneal deposits. There is only a small amount of ascites. This proved to be
ior wall a solid mural nodule is found, which is avascular. No secondary signs of malignancy. Continue with the MRI.
cystic left ovarian lesion, with a solid nodule on the posterior wall. At post-contrast axial T1W-FatSat the thin septa ar
these findings the distinction between a benign ovarian lesion such as a cystadenofibroma and a malignant lesion c
denofibroma. The next case is a transabdominal ultrasound that shows a left-sided multiloculated cystic mass. This l
ied. Enable Scroll
Disable Scroll Scroll through the images Enable Scroll
Disable Scroll Scroll through the images CT of the same patient shows a multi-loculated cystic mass adjacent to the b
ick septations and irregular wall thickening. On the basis of this CT the distinction between a benign ovarian lesion su
ot be made. The lesion was resected and found to be a cystadenofibroma.
Malignant cystic ovarian neoplasms:
Remember, the role of imaging is not to determine the histological nature of a lesion, but to distinguish benign from
e examples given here serve as a demonstration of suspicious imaging features, not as a guide for determination of
Serous ovarian cystadenocarcinoma:
Ultrasound shows a complex solid-cystic mass in the left ovary, and another, very large complex solid-cystic mass in
lid-cystic mass with thick, enhancing septations in the right ovary. These findings are very suspicious for a malignant
ows). Pathology showed a serous ovarian cystadenocarcinoma. This is the most common type of ovarian cancer.
Mucinous ovarian cystadenocarcinoma:
Ultrasound shows a very large multi-loculated cystic lesion in the region of the right adnex. Some locules are anecho
teineous content, such as hemorrhage or, in this case, mucin. The septations are thin, except for the dorsal septation
canresolution at great depth.
The septations are avascular.
There are no solid components.
There was no ascites. Despite the absence of solid components and despite the absence of vascularity on color Dopp
picious for a cystic neoplasm and warant further evaluation. The CECT shows similar findings.
The locules are of different attenuation, consistent with varying protein content. There is no ascites orperitoneal dep
cystadenocarcinoma of low malignant potential. Specimen of the mucinous cystadenocarcinoma The thin, relatively
of ascites and peritoneal carcinomatosis and the absence of invasion, suggest a lesion of low malignant potential (LM
g findings alone. Especially the absence of invasion in ovarian stroma cannot be judged reliably on imaging.

Endometrioid ovarian carcinoma:
On ultrasound both ovaries are markedly enlarged and contain cystic components with intracystic solid components
ateral, are suspicious for a cystic ovarian neoplasm and warrant further evaluation. Again, the role of imaging is to co
sion that can be classified as definitely benign nor a lesion that can be safely followed-up: action is required. CT of th
c lesions, bulging into the abdomen. The purpose of the CT is not to confirm what was already known from the ultras
ot possible to determine the histologic type of the tumor. This is not relevant. This patient will undergo surgery. For e
ovarian tumors - even after surgery, the exact tumor subtype is much less important for the prognosis than factors
surgery was in removing all of the disease. For this patient the relevant findings are on the image on the left. There i
showed this was an endometrioid ovarian carcinoma.
Cystic metastases to the ovaries:
While metastases to the ovary are most commonly solid - such as for example Krukenbergs metastases - cystic ovari
both ovaries. While a serous cystadenocarcinoma may very well be bilateral, they are more often unilocular than mu
cancer (blue arrow). Clearly visible are cystic implants on the peritoneal reflection (red arrow).
These were cystic ovarian metastases of a colorectal cancer.
This is an uncommon finding. by Deborah Levine et al September 2010 Radiology, 256, 943-954.
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None:

None:

Algoritm for Ankle Fractures 2.0:
Frank Smithuis and Robin Smithuis
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Publicationdate 01-08-2021 In this lecture we present a simple algoritm that helps you to find: The algoritm is based
knows it. Since the Weber-classification is a simplification of the Lauge-Hansen classification, it will help you to unde
Introduction:

Algoritm for ankle fractures:
Step 1
The first question you should ask yourself is:
Is it a Weber type A fracture?Is there an avulsion of the lateral malleolus. That’s easy. Step 2
If it is not a type A. Then the next question is:
Is it a Weber type B fracture?This oblique fracture at the level of the syndesmosis is always easy to find on the x-rays
If it is not type A or type B, then the last question is:
Can this be a Weber type C fracture?These fractures are usually not visible on x-rays of the ankle, because the fibula
detection of these fractures. When we've answered the above questions, then we end up in one of these three categ
In each of these categories we need to determine the stage of the fracture, which tells us if the ankle is stable or uns
However when there is also a vertical or push-off fracture of the medial malleolus, then it is stage 2 and the ankle is
n Weber B stage 2 is stable, but stage 3 and 4 are unstable. In Weber C finding a high fibula fracture means unstable
f the ankle, you wanna study the ankle x-rays to look for stage 1 and 4, which can be a clue to image the whole lower
and C always follow a strict order.
This means that when you find a stage 3 fracture, there already must be a stage 1 and 2 even if you can't see them.
We will discuss these stages in the next chapter.
Fracture stages:
This is an overview of the stages of ankle fractures. It was originally described by Christian Lauge-Hansen, a Danish p
1972, a member of the AO-group. Stages of Weber A Stages of Weber B Stages of Weber C Weber B and Weber C fra
In Weber B there is a oblique oriented push-off fracture at the level of the syndesmosis, while in Weber C there is a t
however, that there are many similarities between Weber B and C with only differences in the order of events. For in
ge 4 in Weber C fracture. Another important thing to realize is that traction on a ligament results in either a rupture
that ligament.
Step 1 - is it a Weber A / SA:

Weber A is the result of a pull-off or avulsion on the lateral side due to extreme supination of the foot with adduction
Lauge-Hansen calls this supination-adduction (SA). Although not that common, the injury may proceed and cause a p
of the medial malleolus . This is always stage 2 and is unstable, whether you see a fracture of the lateral malleolus o
edial malleolus in combination with a collateral band rupture on the lateral side. Stage 1: stable ankle fracture
Stage 1:
Here a typical avulsion or pull-off fracture of the lateral malleolus.
The avulsion fragment is quite large. More commonly there is a small avulsion fragment. This is a stage 1 stable Web
Disable Scroll Stage 2: unstable ankle fracture Enable Scroll
Disable Scroll Stage 2: unstable ankle fracture
Stage 2:
This case is more challenging.
This fibula fracture is at the level of the syndesmosis and maybe some people would call this a Weber B fracture, but
nd more vertical because it is a push-off fracture, which we will discuss later. Just by looking at the images, you can u
unstable bimalleolar Weber A fracture. Enable Scroll
Disable Scroll stage 2: unstable ankle fractures. Enable Scroll
Disable Scroll stage 2: unstable ankle fractures. The left image is another example of an unstable bimalleolar fracture
the medial malleolus (arrow). This is always stage 2 and unstable. It means that there already is stage 1, because the
e 1 and then stage 2. The ring of stability is broken in two places (scroll).
Step 2 - is it a Weber B / SER:
If it is not a Weber A fracture, then the next question is: is it a Weber B? When you see a Weber B fracture, which is a
only thing you need to check is whether there is an unstable stage 3 with posterior injury or even stage 4 with media
Disable Scroll Enable Scroll
Disable Scroll Weber B is the most common ankle fracture accounting for 60-70% of all ankle fractures. Just like a We
by the foot.
The only difference is that in Weber B the foot is in supination and the injury starts on the lateral side where the tens
e due to the position of the foot in pronation. Lauge-Hansen called this fracture mechanism supination exorotation o
The fracture mechanism that leads to a Weber C fracture is called pronation exorotation or PER and we will discuss i
njury follows a clockwise fixed order. Things become very easy once you remember the fixed order of the injuries:
Tillaux fracture:
The injury mechanism that causes a Weber B fracture can stop at any stage. Most commonly we see stage 2 which is
1. Usually this is a rupture of the anterior syndesmosis and we don't see anything on the x-rays, but the patient will
ension in the anterior syndesmosis can sometimes lead to an avulsion of the tibial attachment of the anterior syndes
ular attachment is even more rare. Images
On the AP-view and the coronal CT-reconstruction we see a Tillaux fracture as stage 1. No other fracture was seen. S
view. First Question: Is it a Weber A, B or could it be a Weber C? Then try to figure out the stage and determine whet
mages for a discussion of the images. Enable Scroll
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Disable Scroll Scroll through the images. It is a stage 4 Weber B fracture, which is unstable.
Step 3 - Could it be a Weber C / PER:
When the x-rays of the ankle show no obvious fracture like a Weber A or B, then the question is: could this be a Web
Since the fibula fracture in a Weber C is most commonly not visible on the x-rays of the ankle, this can be a tough qu
We will have to look for additional findings that lead us to the right answer and that will help us to make the decision
stage 3, we wanna look for: Enable Scroll
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Mechanism of Weber C:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift.
Closed Loop in Small bowel obstruction:
by Jay P. Heiken and Robin Smithuis
Mallinckrodt Institute of Radiology of the Washington University School of Medicine, St. Louis, Missouri and the Rijnla
Publicationdate 2012-11-01 This article is based on a presentation given by Jay Heiken in 2006 and adapted for the R
was presented. Jay Heiken is professor of radiology at the Mallinckrodt Institute of Radiology of the Washington Univ
t in abdominal imaging and is co-author of the well known book 'Computed Body Tomography With MRI Correlation'
Small Bowel Closed Loop Obstruction:
Closed Loop Obstruction Closed loop obstruction is a specific type of obstruction in which two points along the cours
closed loop. Usually this is due to adhesions, a twist of the mesentery or internal herniation. In the large bowel it is k
s small bowel closed loop obstruction. Especially in the small bowel the risk of strangulation and bowel infarction is h
Disable Scroll Scroll through the images Enable Scroll

Disable Scroll Scroll through the images Case of small bowel obstruction Let first start with a rather difficult case and
bstruction. Here we have a patient with a small bowel obstruction. So the most important question for you to answe
Is there a closed loop obstruction?Because if there is, this patient is at risk for bowel infarction and surgery is the bes
ed loop and what is the cause? When we have a patient in the ER with what appears to be a small bowel obstruction
osis, is to identify the presence or absence of strangulation. Strangulation is defined as obstruction associated with v
BO-group is mainly due to bowel infarction and subsequent necrosis. This is most commonly caused by a closed loop
n of patients suspected of SBO. 'U' or 'C' shaped loops of bowel. Point of obstruction has a beak-like appearance The
depends on two things: If we have a short closed loop oriented within the plane of imaging, we will see a U- or C-sha
dilated loops. There is bowel wall thickening and mesenteric edema indicating ischemia Another important appeara
d small bowel loops with the mesenteric vessels converging to a central point. This is almost always due to a small bo
on are the same as in patients with other causes of mesenteric ischemia: Closed loop obstruction with bowel ischem
ruction. Although there is good enhancement of the vessels there seems to be a lack of enhancement of the bowel v
owel wall thickening. Infarcted bowel was found at operation. Closed loop obstruction presenting as a clump of bow
to the plane of section, we will see a clump of bowel loops as shown in the case on the left. Sometimes this is difficu
ttal reconstructions can be helpful. In this case there is also mesenteric edema and localised ascites in combination v
n and risk of infarction.
Imaging technique in SBO:
CT is the imaging procedure of choise in patients who are suspected for bowel obstruction. When we examine these
some of the patients with a closed loop obstruction a bowel obstruction is not suspected. In the case on the left pos
mall bowel in figure B. Distal to the constriction in figure C we see a cluster of dilated small bowel loops not filled wit
ontrast will pass the point of obstruction and enter the area of the closed loop. If we go back to figure B, you may alr
he small bowel (arrows). Therefore we have two adjacent collapsed small bowel segments representing the point of
mesenteric edema indicate the presence of bowel ischemia. Notice that you cannot appreciate the degree of bowel v
sed loop obstruction and small bowel feces sign in a patient with non-dilated proximal bowel
Small Bowel Feces Sign:
In some of these patients with SBO the proximal small bowel proximal to the point of obstruction may not be dilated
ot suspected. This patient also received positive oral contrast. Look for the major findings and then continue. First yo
o down to the pelvis you see a dilated loop of bowel with inhomogeneous content and finally deep down in the pelvi
ction. The other important finding in this patient is the 'Small Bowel Feces Sign' (SBFS: arrow). The SBFS is a very usef
to obstructed bowel and thus facilitating identification of the point and the cause of the bowel obstruction. The SBFS
all-bowel loop that simulates the appearance of feces. Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images
Case of small bowel strangulation:
The CT images are of a patient with mild left flank pain. At presentation the lab findings were normal. Based on this C
rrow). The mild dilatation of the small bowel adjacent to the descending colon was thought to be a reactive sentinel l
d small bowel with the radiating pattern of the mesentery (image 7/11). Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Three days later the CT was repeated with i.v. cont
progressive dilatation of the small bowel. First study the images, then continue with the next series. Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Notice the radial array of dilated small bowel loops
al point. These bowel loops are wider than other loops and show less enhancement. There are dilated mesenteric ve
is dilated (blue arrow) and efferent loop is collapsed (red arrow). The distal small bowel is collapsed (red arrows). The
rge amount of ascites in Douglas cave, which also indicates the possibility of ischemia (blue arrow). Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Sometimes multiplanar reconstructions can be hel
rough the sagittal images. Notice how the afferent loop enters the strangulated bowel and mesentery (image 8-10/1
is. Enable Scroll
Disable Scroll Coronal reconstructions. Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Coronal reconstructions. Click to enlarge and then scroll through the images The coronal reconstructio
ent loop, the strangulated loop and the collapsed efferent loop. The yellow arrow marks the dilated veins. At operati
niated through a hole in the mesocolon. Here we see the resected part of the small bowel. Notice the areas of necro
Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images Coronal reconstructions of another patient with a c
ated in red arrowheads. The collapsed efferent loop is indicated by a red arrow. Notice the closed loop cranially to th
Go to the axial images of this case
Paraduodenal herniation:
There are various types of internal herniation. The illustrations shows a left paraduodenal hernia. This is an uncomm

Disable Scroll Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Click to enlarge and then scroll through the images The CT-images show a left paraduodenal hernia. N
d arrow) and there is retention of fluid in the stomach. At operation the herniated small bowel was not ischemic.
Volvulus of Large Bowel.:
On the left a plain abdominal film is shown of a 57 year old man with a two day history of increasing abdominal pain
es diffuse dilatation of the bowel, the major finding on this film is a large air containing structure in the pelvis. An imp
olon and many would diagnose this as a sigmoid volvulus because it is located in the pelvis. However this actually is
go almost anywhere
Cecal Volvulus:
A volvulus always extends away from the area of bowel twist. So a sigmoid volvulus can only move upwards and usu
almost anywhere and can even be located in the pelvis (figure). On the left there are additional CT-images of the sam
major findings and then continue. First we see a collapsed descending colon and a non-dilated ascending colon, so t
ucture in the right lower quadrant which is where the bowel is twisted.
In the left lower quadrant we see the dilated cecum. Coronal recontructions can be very helpfull in demonstrating wi
descending colon (straight arrows) and the transition point of the volvulus (curved arrow). Cecal volvulus is due to th
all bowel obstruction. A long narrow based mesentery predisposes to volvulus. An incomplete midgut rotation is a p
estion, while the arterial supply is rarely compromised. Cecal volvulus accounts for about 25% of cases of colonic vol
f bowel twist (arrow) On the left a typical cecal volvulus is seen. We can see the beak-like transition zone located in th
ulus. The dilated cecum is located in the left upper quadrant. Also notice the collapsed descending colon posterior to
cal volvulus. Notice that the dilated bowel points toward the area of twist, which is the area where you expect the ce
Disable Scroll Cecal volvulus. Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Cecal volvulus. Click to enlarge and then scroll through the images Scroll through the images. The area
Sigmoid Volvulus:
On the left a patient with a sigmoid volvulus. We can see the distended sigmoid extending from the pelvis way up int
self why this cannot be a cecal volvulus. Then continue. The key finding is the dilatation of the proximal colon. The di
lon. At CT we can nicely appreciate the area of the twist with the sigmoid extending up to the diafragm. The sigmoid
f large bowel obstruction. Sigmoid volvulus AP supine and erect radiograph of the abdomen demonstrates the chara
ed loops point towards the sigmoid area. Continue with the CT-images. Enable Scroll
Disable Scroll Sigmoid volvulus. Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Sigmoid volvulus. Click to enlarge and then scroll through the images Scroll through the images. Notice
er sigmoid volvulus. On the abdominal x-rays it is difficult to recognize what is going on, since so many bowel loops a
Disable Scroll Sigmoid volvulus. Click to enlarge and then scroll through the images Enable Scroll
Disable Scroll Sigmoid volvulus. Click to enlarge and then scroll through the images CT is very helpful in this case and
last image shows the collapsed rectum posterior to the dilated small bowel loops. In the pelvis dilated small bowel lo
. Balthazar Department of Radiology, New York University-Tisch-Bellevue Medical Center, 550 First Ave., New York, N
2. CT of Cecal Volvulus, Unraveling the Image by Carolyn J. Moore, Frank M. Corl and Elliot K. Fishman Department of
e, MD 21287. AJR 2001; 177:95-98
Solid Abdominal Masses in Children:
Erik Beek, Martine van Grotel, Bart de Keizer, Annemieke Littooij and Rutger Jan Nievelstein
Department of Radiology, Solid tumors and Nuclear Medicine of the University Medical Center Utrecht and Princess
Publicationdate 15-11-2021 Malignant
abdominal tumors in children are rare and usually present as solid masses. Treatment is done in specialized
centers, but the initial diagnosis is usually made in the hospital where the
child first presents. In
this article we will provide tools to make the initial imaging diagnosis of the
most common malignant abdominal tumors as accurate as possible. This will guide the next imaging procedures Sor
uded. Cystic abdominal masses in children are discussed here.
Introduction:
The most common cancers overall in children are leukemia (28%), brain and spinal tumors (26%).
They are followed by tumors that mainly present as an abdominal tumor: Neuroblastoma (8%), Nephroblastoma (5%
ge at initial presentation, because most children come to attention because someone noted severe abdominal disten
sually more difficult to ascertain the organ of origin. The most common intra-abdominal tumors in children are: The
. Ultrasound is the first imaging modality to be used.
It can easily confirm that there is a mass and can often define the site of origin. Search for synchronous movement w
This can be seen in smaller hepatic and renal tumors.
In large tumors the surrounding organs are compressed and will show no movement. Claw sign in renal tumor In ren
This is seen when a part of the kidney is draped around the tumor like a claw (figure). Before we discuss the differen
diagnosis is usually made by pathologic tissue examination. Most tumors are biopsied before treatment.
However renal tumors in children between six months and nine years are not biopsied because the likelihood of it b
outweighs the risk of tumor spill during a biopsy, especially in diffuse anaplastic nephroblastoma.

Neuroblastoma:
Neuroblastomas are embryonic tumors originating from the sympatho-adrenal lineage of the neural crest.
About half of the tumors arise from the adrenal glands.
Other sites of origin are the thoracic and lumbal paravertebral sympathic chain.
A minority develops in the neck. The clinical presentation is variable. Common complaints are pain and an abdomina
typical manifestation is “raccoon eyes”, which is periorbital ecchymosis due to metastatic infiltration of the orbital ar
onus syndrome, a neurological disorder characterized by rapid, multi-directional eye movements (opsoclonus), quick
xia), irritability, and sleep disturbance. The
prognosis depends on the stage of the tumor.
For a low grade tumor the 5-year
survival is > 90%.
For high risk tumors (stage 4 and tumors with MYCN
amplification) it is around 50%. The staging is rather complicated, see reference staging neuroblastoma.
Imaging findings:
The imaging findings are listed in the table. Sorry, your browser doesn't support embedded videos.
Ultrasound:
On Ultrasound the tumor is generally echogenic and inhomogeneous with bright calcifications.
A feature of neuroblastoma is the tendency of vascular encasement and they have a tendency to grow between the
Other tumors that show vascular encasement are lymphoma and rhabdomyosarcoma. Intraspinal spread is commo
If lymphatic spread has occurred many round tumorous lymph nodes can be seen. The left supraclavicular lymph no
deo
The video shows a neuroblastoma in a one year old boy who presented with vomiting. The tumor encircles the aorta
present. Continue with the MRI of this patient. Enable Scroll
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MRI:
MRI is done for more detailed imaging of the tumor. MRI examination: Scroll through the coronal T2 weighted series
Study the images and then continue reading. The findings are: Same patient. This is an axial gadolinium enhanced T1
It shows the encasement of the vessels.
Notice the tumor extension posterior to the aorta, which is displaced away from the vertebral column (arrow). Sorry,
fteen-month-old
boy, who was first suspected of having a tumor in the left
kidney. Ultrasound shows a mass adjacent to the medial
upper pole of the left kidney. It seems to be separate from the kidney. The mass is very inhomogeneous and has mu
roblastoma than a nephroblastoma. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The extent of the tumor is well appreciated on a 3D axial T2 weighted TSE series. The left kidney is com
ses are present (small yellow arrow). The origins of the celiac trunc and superior mesenteric artery are encased by tu
The inferior caval vein is lifted anteriorly (green arrow). Bilateral dorsal atelectasis is often seen on the MRI, because
Biopsy:
Percutaneous biopsy can be difficult for two reasons: Images
The MRI is of a nine-months-old girl with a tumor in the left abdomen. The MRI shows a tumor of the left adrenal gla
are present. The tumor was biopsied. There was constant blood loss through the guiding needle. At the end of the p
ows).
MIBG:
All the activity indicates bone metastases. In metastasized neuroblastoma follow-up imaging can be quite confusing,
fully treated.
Renal tumors:
Renal tumors in children will be discussed in more detail in a separate article.
Here we only show some common findings.
Nephroblastomas:
More than 90% of renal tumors in children are nephroblastomas - also called Wilms tumor. The peak age is 2 - 3 yea
en and they are often very large at presentation. Sometimes they present with hematuria, abdominal pain or hypert
tumors are found during sonographic screening in children with syndromes which
predispose to nephroblastoma, like Beckwith-Wiedemann syndrome and Denys-Drash
syndrome (see the webpage on renal tumors in children). Bilateral nephroblastomas are often syndrome related.
The lungs are the most frequent site of metastases. Liver and bone metastases are rare. ImageNephroblastoma of t
draped over the tumor (“claw sign” arrow). The tumor is rather homogeneous with some cystic areas. Continue with
boy. A bilobar tumor is present in the interpolar region. There is a dilated calyx in the upper pole (arrow). Treatment
In European countries the patient first receives chemotherapy, after which the kidney is resected, followed by post-o

gy, SIOP approach).
In the US, the kidney is primarily resected, followed by chemotherapy (Children's Oncology Group, COG approach). T
The prognosis is excellent with a 5-year survival of more than 90%.
Bilateral disease has a less favorable prognosis. A. The tumor enhances less than the peripheral remnant of normal
ow). Solid parts of the tumor show diffusion restriction (white arrow) UltrasoundThe initial imaging is usually done b
ith the kidney. Large tumors will not move. As mentioned before, it is often possible to detect a remnant of the kidne
a dilated calyx due to obstruction of the pelvis. Small tumors are usually homogenic and echogenic.
Larger tumors are more inhomogeneous with cystic or necrotic parts and hemorrhage.
10% of the nephroblastomas have fine calcifications. Left sided nephroblastoma in a two-year-old girl. Note the para
enal origin of the tumor, study the other kidney for tumor or nephroblastomatosis (see below).
Search for enlarged para-aortal lymph nodes.
Search with color Doppler for patency of the renal vein and of the inferior caval vein, as a nephroblastoma tends to g
liver for metastases, although these are rare in nephroblastoma.
The finding of a liver metastasis should urge you to look for an alternative diagnosis like a rhabdoid tumor. A CT ches
ble Scroll
Disable Scroll Enable Scroll
Disable Scroll MRIThe next imaging step is a MRI of the abdomen. Nephroblastomas are mostly inhomogeneous, wit
. Necrotic cystic parts are often present.
Gadolinium enhancement is inhomogeneous and less than the enhancement of normal renal parenchyma. Solid par
t. Hemorrhagic areas will also show restricted diffusion, so look on the T1-images for signs of bleeding.
Sometimes a disruption of the tumor capsule is seen. Intraperitoneal rupture is a more severe complication than ret
the renal vein and inferior caval vein, and lymph node enlargement. It allows accurate and repeatable measuremen
A three-year-old girl with a tumor of the left kidney and a large tumor thrombus in the renal vein and inferior caval v
g metastasis is seen. Sorry, your browser doesn't support embedded videos. Video of the same patient. Notice the tu
val vein. Sorry, your browser doesn't support embedded videos. Example 2 Video of a three-year-old girl with a large
ducer shows that the tumor originates from the right kidney. The remnant of the collecting system is dilated. Sorry, y
mor thrombus is present in the inferior caval vein. Sorry, your browser doesn't support embedded videos. Same pat
ing towards the level of the hepatic veins. Note the dilated remains of the collecting system Sorry, your browser does
boy with hemihypertrophy. A screening ultrasound showed a homogeneous tumor in the upper pole of the left kidn
aller.
Classification of Nephroblastoma:
The classification of nephroblastomas is done after resection of the kidney.
Other Renal tumors:
More
renal tumors will be discussed in a separate article.
Liver tumors:
Sorry, your browser doesn't support embedded videos.
Hemangioendothelioma:
Hemangioendothelioma of the liver is also known as infantile hemangioendothelioma or infantile hepatic hemangio
ple or diffuse. Most are discovered as an abdominal mass in the first six months of life. They can lead to congestive h
isease, in which the vascular tumor leads to decreased platelet counts and bleeding disorder.
AFP levels are mostly normal. UltrasoundOn ultrasound a well-perfused tumor is seen. It can be hypoechoic or of mi
ogenic. Calcifications are common.
Large arteries and veins are seen and the aorta may be wider than normal due to the large demand of the tumor an
a tumor in the left abdomen.
A tumor is visible with a stalk to the left liver lobe, in which large vessels are present. The lesion has some internal ca
Disable Scroll Enable Scroll
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On unenhanced CT calcifications are present in approximately half of the patients. After intravenous contrast the tu
er tumors the center may not enhance at all. MRIOn MRI a hemangioendothelioma has generally low signal intensity
ng-in is seen as on CT.
Most tumors will show spontaneous involution, and the prognosis is good. Images
Scroll through the images. It is the same tumor as on the ultrasound.
Mesenchymal hamartoma:
Mesenchymal hamartomas are usually multicystic liver lesions, although they can rarely be solid. They are often larg
how a multicystic lesion. MRI will demonstrate this as well. After Gadolinium some stromal enhancement can be see
The image is of a two-year-old boy, who presented with a painless swelling of the abdomen. Ultrasound shows a larg
he MRI. T1 weighted fat suppressed coronal MRI provides a better overview of the liver lesion, which was almost 2 ki
o further follow-up was necessary. Sorry, your browser doesn't support embedded videos. Example 2A four-month-
the caudal part of the right liver lobe, extending into the pelvis. The mass is not hypervascular. MRI shows a large tu

.
After Gadolinium there was very fast enhancement, almost a arteriovenous shunting. The mass was thought to be a
Biopsy was done and pathology was compatible with a mesenchymal hamartoma. Sorry, your browser doesn't supp
Hepatoblastoma:
Hepatoblastoma is the most common malignant liver tumor in young children, while hepatocellular carcinoma prese
Hepatoblastoma usually presents with an enlarged abdomen. Ultrasound will generally show a well demarcated tum
angiography is done preoperatively to define the relation between the tumor and the hepatic vessels. MRI will better
on T1 and mixed signal intensity on T2. After Gadolinium patchy enhancement is seen. Example 1A two-year-old boy
On ultrasound a large solid tumor was seen in the upper abdomen. Some calcifications are present. The mass proba
Continue with the MRI. MRI shows a solid hepatic mass with multiple small cysts. After contrast injection the mass is
bordered by the middle hepatic vein (arrow). The mass has moderate diffusion restriction. Biopsy was compatible w
Disable Scroll Enable Scroll
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Hepatocellular carcinoma:
This disease is rare in young children but can be seen in older children, mostly >10 years of age, although it has ever
sease which predispose to HCC include hepatitis B and Tyrosinemia. Tyrosinemia is a genetic disorder characterized
oteins. Tyrosine and its byproducts will build up in organs and can lead to liver and kidney failure and an increased r
jaundice. AFP levels are elevated (although usually less elevated compared to AFP levels in hepatoblastoma). Exampl
al pain. On ultrasound a large liver tumor was detected.
On MRI a tumor in liver segment 5 and 6 is seen with satellite lesions in segment 7 and 8 (arrows). There is a tumor t
metastases (*).
Hodgkin and Non-Hodgkin:
There are two main types of lymphoma: Hodgkin lymphoma and non-Hodgkin lymphoma. Hodgkin lymphoma more
, while it is rarely confined to the abdomen. Non-Hodgkin is more commonly located in the para-aortic and mesenter
s more frequently with extra nodal disease than Hodgkin lymphoma. For staging of Hodgkin lymphoma the Lugano c
nal Pediatric NHL staging system [10]. Ultrasound
On ultrasound enlarged lymph nodes are very hypoechoic. The almost anechoic aspect of the tumor is typical of mal
wall is lost. MRI
On MRI masses are seen with some enhancement after Gadolinium and remarkable strong diffusion restriction. Anc
astoma, however these tumors are often much more heterogeneous with areas of necrosis and hemorrhage PET-CT
18-F-FDG PET-CT is used for staging. Sorry, your browser doesn't support embedded videos. Example 1This video is c
f a Hodgkin lymphoma. Sonographic examination of the abdomen demonstrates multiple enlarged hypoechoic para
ear-old girl presented with a large mass in the abdomen. Ultrasound could not define an organ of origin. MRI shows
Notice the marked diffusion restriction of the omentum, which makes a lymphoma the most likely diagnosis. This wa
upport embedded videos. Example 3 A four-year-old suffered from hypertension. His kidneys were enlarged and ultr
as in the cortex. There were also enlarged abdominal lymph nodes. Pathologic examination demonstrated a Burkitt
Leukemia:
Leukemia is the most common malignancy in children. It can present with abdominal involvement. Leukemia can aff
The organs can be diffusely infiltrated or have a more nodular pattern. The kidneys are affected in almost half of the
can be uni- or bilateral, and there can be focal lesions or diffuse infiltration. The last has a rather typical appearance
nant lymphoma. Sorry, your browser doesn't support embedded videos. Example 1 An eight-year-old girl presented
An ultrasound examination had shown multiple lesions in both kidneys.
MRI demonstrates not only the renal tumors, but also a lesion in the pancreas, right iliac wing, left sacrum and multi
lignant lymphoma but the final diagnosis turned out to be leukemia.
Germ cell tumor:
The majority of germ cell tumors in children occur in the testis and ovary, but they can arise anywhere in the body, in
They develop from pluripotent stem cells, and therefore have variable cell lines.
Often a mixture of benign and malignant cell lines is found.
The most malignant component on pathologic examination determines the choice of therapy. The tumor can excret
Abdominal germ cell tumors are diagnosed because of mass effects.
The most common non-gonadal abdominal germ cell tumor is the sacrococcygeal teratoma.
This entity is discussed on the page Cystic Abdominal Masses in Children. Germ cell tumors are generally part cystic
On ultrasound solid tumors are often very inhomogeneous with cystic and solid parts. Calcifications are common.
The mixture of cystic and solid parts suggests germ cell tumor. On
MRI calcifications are difficult to observe because they have a variable
signal on different MR sequences. They are mostly of low signal intensity and thus hard to notice,
but sometimes they may have high signal on spin echo T1 and T2.
MRI can demonstrate fatty components in the tumor
which strongly suggests the diagnosis of a germ cell tumor. Example 1 A four-month-old boy with an abdominal swe
ogenic foci are present (arrow). On MRI (not shown) fatty components were visible. At operation a teratoma of the st

was suspected of having an intussusception. During the sonographic examination an intraabdominal tumor was see
A lesion with a multi-layered wall, a cystic part and an echogenic part with a strong acoustic shadow is present. A ger
a generally has smaller calcifications.
Continue with the MRI. MRI T2 weighted axial image shows high signal intensity parts of the tumor, either fat or fluid
suppressed contrast enhanced T1W-image.
The
high signal parts are suppressed, which indicates that it is fat. Note
the close relation with the superior mesenteric artery which can be damaged
during operation. At operation a benign mature cystic teratoma was resected. Example 3 A sixteen-year-old girl pres
CT demonstrates a mass with fat, coarse calcifications and solid parts.
The inferior caval vein was compressed. At operation a retroperitoneal mature cystic teratoma was resected.
Rhabdomyosarcoma:
Rhabdomyosarcomas (RMS) are the most common soft tissue tumors in children and can develop almost anywhere
head and neck region, including the orbit and in the genitourinary tract. About 25% of all RMS arise in the lower abd
, but they can arise almost anywhere, for instance along the biliary tract (where no striped muscle is present!). The m
veolar RMS. The
alveolar type has a worse prognosis. The
age of the patient, generally below 15 years and the location of the tumor in
the prostate, bladder or vagina will point towards the diagnosis, while the imaging features are non-specific. Exampl
(arrow) is seen near the bladder.
Balloon of a catheter in the bladder. MRI A
sagittal image shows a tumor anterior to the bladder neck. There
is patchy enhancement.
DWI
showed strong diffusion restriction (not shown). The location of the tumor
makes a rhabdomyosarcoma the most likely diagnosis. The tumor was biopsied through an anterior approach over t
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Renal Tumors in Children:
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Department of Radiology and Nuclear Medicine, University Medical Center Utrecht and Princess Máxima Center for P
Wilms tumor comprises the vast majority of renal neoplasms in young children and resection with neoadjuvant chem
cannot be reliably distinguished from Wilms tumor at imaging, but some features
may suggest an alternative diagnosis, which in some cases can lead to the
decision to adjust the treatment or in some cases to perform a biopsy before start
of pre-operative treatment. The role of imaging in children with a possible renal tumor is first to determine whether
The next step is to look for signs that would make you consider an alternative diagnosis instead of a Wilms tumor.
The final step is staging. In this article we will discuss common and some less common renal tumors and include som
homa, neuroblastoma and leukemia.
Introduction:

Role of Imaging:
Claw sign
Claw sign:
This sign in renal tumors is useful in determining that the tumor arises from the kidney rather than is located adjace
to the sharp angles on either side of the mass, which the surrounding normal parenchyma forms when the mass ha
Left sided Wilms' tumor in a one-year-old girl.
The remnant of the kidney is draped over the tumor, the “claw sign”.
Management:
Imaging plays a limited role in determining the exact nature and management of a renal tumor in children, since alm
ll be a Wilms tumor.
Age at presentation is a far more important predictor of tumor type. 0-6 months-old Besides Wilms tumor, the
differential diagnosis comprises two tumors that occur predominantly in
infants: congenital mesoblastic nephroma and rhabdoid tumor of the kidney
(MRTK). Both tumors are treated with primary resection. Therefore, renal tumors
in infants below six months are primarily resected if possible. 6-months – 9 yearsA renal tumor in children in this age
mation. >9 yearsIn children above 9 years-old in most cases a primary nephrectomy is performed.
A renal cell carcinoma (RCC) is more common in this age group than a Wilms tumor. This table summarizes the featu
may be differentiated from a Wilms tumor on the basis of their clinical and imaging features.
Wilms tumor:
Nephroblastoma in a five-year-old boy. More than 90% of renal tumors in children are Wilms tumors, also called nep
th and nine years of age with a peak incidence from 2 to 3 years. Wilms tumors are generally very large at initial diag
Children with Wilms tumor are generally not ill. case 1The coronal T2W-image shows an inhomogeneous tumor in th
components.
The tumor enhances less than the peripheral remnant
of normal renal tissue.
The solid parts of the tumor show strong diffusion
restriction (arrows).
This was a Wilms tumor in a five-year-old boy. Pre-operative chemotherapy was given according to the Umbrella pro
was performed. Sorry, your browser doesn't support embedded videos.
Beckwith-Wiedemann syndrome:
Smaller tumors can be detected when haematuria, abdominal pain, or hypertension with headache is the presenting
ich predispose to nephroblastoma, like Beckwith Wiedemann syndrome, WAGR, Perlman
syndrome, DICER 1 and Li-Fraumeni syndrome. Bilateral nephroblastomas are often genetic or syndrome-related. Sr
Larger tumors are more inhomogeneous with cystic necrotic parts and hemorrhage.
10% of nephroblastomas have fine calcifications. The lungs are the most frequent site of metastases.
Liver and bone metastasis are rare. case 2
This is a two-year-old boy with Beckwith-Wiedemann syndrome.
A screening ultrasound showed a small homogeneous tumor in the left part of a horseshoe kidney. Enable Scroll
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MR findings:
Wilms tumors are mostly inhomogeneous, with decreased signal intensity on T1 and increased signal intensity on T2
Necrotic cystic parts are often present.
Enhancement after Gadolinium is inhomogeneous and less than the enhancement of normal renal parenchyma. The
Signs of hemorrhage are often present. Hemorrhagic areas will also show restricted diffusion, so look at the T1 for si
he renal vein and inferior caval vein, as well as lymph node enlargement. It allows accurate and repeatable measure
aminations. case 3This MRI is of a three-year-old
girl with a tumor of the right kidney.
Scroll through the coronal T2W-images.
There is a large tumor thrombus extending from the renal vein into the inferior
caval vein (arrows). Continue with the ultrasound... Sorry, your browser doesn't support embedded videos. This is th
ultrasound of the same patient showing the tumor and tumor thrombus. Sorry, your browser doesn't support embe
This video is of a three-year-old
girl with a large mass in the right flank. Ultrasound with a high frequency
transducer shows that the tumor originates from the right kidney.
The remnant
of the collecting system is dilated, as is often the case. Continue with the MRI... Sorry, your browser doesn't support
Notice the tumor thrombus in the inferior caval
vein. Once you are sure of the renal origin of the tumor, scrutinize the other kidney for tumor or nephroblastomato

Search for enlarged para-aortal lymph nodes.
Search with color Doppler for patency of the renal vein and of the inferior caval vein, as a Wilms tumor tends to grow
liver metastasis should urge you to consider an alternative diagnosis.
Staging and surgery:
Surgery is the cornerstone for the treatment of WT.
The Children's Oncology Group (COG) from North America recommends surgery before chemotherapy, whereas SIO
As the SIOP group, the National Wilms Tumor Study Group (NWTSG) has concerns about performing a biopsy first be
chemotherapy to decrease the risk of intraoperative rupture, downstage the tumor, and to reduce the need for irra
The advantage of preoperative chemotherapy is the identification of chemoresistant high-risk blastemal predominan
short version of Wilms tumor staging.
Nephroblastomatosis:
A
kidney can harbor a nephrogenic rest, which is persisting embryologic tissue.
If
multiple rests are present it is called nephroblastomatosis.
Most nephrogenic
rests resolve spontaneously, but they may transform into a Wilms tumor. On
ultrasound Wilms tumor is difficult to detect as these lesions tend to
show similar echogenicity compared to the renal cortex. ImagePersistent
nephroblastomatosis in a seven-year-old boy who was treated five years ago for
a Wilms tumor. A peripheral rim of echogenic tissue is seen. These
residual lesions are followed up with regular ultrasound untill 5 years after
treatment. Microflow imaging can help to identify hypoperfused areas with nephroblastomatosis. Images
A two-year-old
boy with a Wilms tumor in the left kidney and bilateral nephroblastomatosis.
With microflow color imaging it is less perfused than normal renal tissue.
Continue with the MR images... On MRI nephroblastomatosis is best seen on the post contrast images and diffusion-
MRI
images of the same patient show the hypoperfusion of the pathologic tissue and
the strong diffusion restriction with low ADC values.
Patient
was treated with pre-operative chemotherapy after which the tumor on the left
side was resected through partial nephrectomy. The diffuse
nephroblastomatosis was treated with monthly gift of AV (Actinmycin D and
Vincristin) chemotherapy for one year.
Congenital mesoblastic nephroma:
Sorry, your browser doesn't support embedded videos. Congenital mesoblastic nephroma is almost always a benign
It is the most common neonatal renal tumor and most are detected before the age of one year.
The young age of the patient will strongly suggest this tumor. On imaging there are no clear characteristics to disting
tumor on ultrasound may suggest a congenital mesoblastic nephroma.
The tumor is treated with nephrectomy. video
In
a newborn boy the obstetrician palpated a tumor in the abdomen.
Ultrasound
showed a large mass in the upper pole of the right kidney. The video suggests a
whirled aspect of parts of the tumor. Continue with the MRI. MRI
The tumor has similar signal intensity as normal
renal tissue on all pulse sequences.
It enhances also equal to the remnant of the kidney. The kidney was excised and contained a
mesoblastic nephroma.
Multilocular cystic renal tumor:
Cystic nephroma A
multilocular cystic renal tumor is a confusing lesion.
It can be a benign cystic nephroma, or a malignant cystic partially differentiated
nephroblastoma.
Only the pathologist can make the difference. The radiologist
has to distinguish these multilocular cystic tumors which arise from the kidney
with preservation of some normal renal tissue from a multicystic dysplastic
kidney where no normal renal tissue is visible. ImagesUltrasound and MRI of a four-year-old boy with a multilocular
in the interpolar region of the left kidney (arrow).

It was detected as an incidental finding at the age of nine months. On follow-up no change was seen. The lesion is consistent with a cystic nephroma, a benign condition.
The same lesion is seen on the T2 weighted transverse image. Cystic nephroma These images are of a one-year-old girl.
On ultrasound a multicystic tumor was seen with some perfusion of septa. T2 weigthed image better shows the extent of the lesion. A remnant of the normal renal tissue of the lower pole is visible, distinguishing it from a multicystic dysplastic kidney. This tumor was diagnosed as a cystic nephroma for which right nephrectomy was performed. Multicystic dysplastic kidney An 8-months-old boy with a multicystic dysplastic kidney.
On ultrasound multiple cysts are present and no normal renal tissue is seen.
No additional imaging is needed.
Often follow-up ultrasound is performed to ascertain regression of the MCDK over time and to diagnose contralateral abnormalities (in 30% of cases).
Malignant rhabdoid tumor of the kidney:
Malignant rhabdoid tumor of the kidney with brain (arrows) and bone metastases Malignant rhabdoid tumor of the k malignant tumor with a poor prognosis.
Distant metastases at the time of diagnosis of the tumor are common, to the lungs, liver, brain, lymph nodes, and skeleton. Rhabdoid renal tumors can occur in conjunction with be a primary atypical teratoid rhabdoid brain tumor (ATRT), but also other tumors like medulloblastoma and ependymoma are described. There are no distinguishing features from a Wilms tumor, but one should think of a rhabdoid tumor if the tumor is relatively small with an infiltrative growth pattern, low T2 signal and diffusion restriction. Although rhabdoid tumors are reported to a subcapsular fluid collection, this can occur also as an uncommon manifestation in Wilms tumor, but these collections occur in absolute numbers more in Wilms tumor than in rhabdoid tumors. Images
Two-week-old girl presenting with a mass in the left kidney.
A MRI of the brain at the time of initial diagnosis showed tiny lesions, possibly metastases (arrows).
An MRI four weeks later showed multiple brain and skull metastases.
The patient died two weeks later.
Clear cell sarcoma of the kidney:
Sorry, your browser doesn't support embedded videos. Clear cell sarcoma of the kidney is rare, approximately 3% of pediatric renal tumors. The 5-year survival rate is around 80% year of age.
The tumor has a propensity to metastasize to the bone. The combination of a renal tumor and bone metastases should suggest to the diagnosis of a clear cell sarcoma. The imaging findings are non-specific, but suggestive features are that these tumors are generally homogeneous with limited diffusion restriction. video A ten-month-old boy presented with an abdominal mass. Ultrasound demonstrated a tumor in the right kidney. This is better shown on MRI. The remnant of the kidney has a dilated collecting system.
On ADC images there is limited diffusion restriction.
Histopathology showed a clear cell sarcoma of the kidney. Sorry, your browser doesn't support embedded videos. On ADC images there is limited diffusion restriction. The tumor was thought to be a Wilms tumor, because of the limited diffusion restriction, but pathology showed a clear cell sarcoma of the kidney.
Renal cell carcinoma:
Renal cell carcinoma (RCC) is the second most common renal tumor in children. RCC is rare in young children and occurs mostly in children older than 10 years. It can also occur in patients with von Hippel-Lindau disease and Tuberous Sclerosis Complex, or after treatment for previous malignancies (f.e Neuroblastoma or Leukemia) Image
A nine-year-old boy presented with severe hematuria.

On palpation a left abdominal mass was found.
On ultrasound a predominantly solid mass was seen which seemed to invade the dilated collecting system. Sorry, yo
rcinomas can present in many different ways.
They can appear more solid or have cystic elements and may be homogeneous, or rather heterogeneous.
Hemorrhage can occur and they may contain fat.
Relative small tumor size and prominent peripheral vessels suggests a RCC. Imaging is essential for staging and a co
MRI
nicely demonstrates the mass in the left kidney. Note the large collateral
veins.
Because
of heavy hematuria a left nephrectomy was performed.
Pathology showed a RCC which
was completely resected.
Lymphoma:
Sorry, your browser doesn't support embedded videos. There
are two main types of lymphoma: Hodgkin lymphoma and non-Hodgkin lymphoma. Hodgkin
lymphoma often manifests with cervical lymph node enlargement, and mediastinal
masses.
It is very rarely confined to the abdomen. Non-Hodgkin lymphoma can be
located solely in the abdomen and generally originates from a bowel loop.
Non-Hodgkin
lymphoma presents more frequently with extra-nodal disease than Hodgkin
lymphoma.
Kidney involvement in lymphoma is rarely seen, but imaging features
to look for are multiple focal lesions that are homogeneous and hypoechoic on ultrasound and show strong diffusio
Ultrasound
of a three-year-old boy. Diffuse infiltration of both kidneys was seen.
Furthermore, multiple hypoechoic masses were detected
in pancreas, liver and bowel.
The combination of bowel
involvement and high LDH in de serum was highly suggestive for Burkitt
lymphoma. This diagnosis was confirmed by bone marrow biopsy and flow
cytometry.
Leukemia:
Leukemia is the most common malignancy in children.
It can affect all solid abdominal organs.
Organs can be diffusely infiltrated
or have a more nodular pattern. The kidneys are affected in almost half of the
patients with acute lymphoblastic leukemia.
It can be uni- or bilateral, and
there can be focal lesions or diffuse infiltration with enlargement of the
kidneys. The latter has a rather typical appearance
with a striated pattern around the calices, similar to renal involvement of
malignant lymphoma (figure). Image
A
four-month-old boy presented with fever and anemia with thrombopenia. An
ultrasound examination shows enlarged kidneys with multiple hypo-echoic
lesions and linear abnormalities in both kidneys.
Retroperitoneal
lymphadenopathy was seen as well.
A hematological malignancy,
in particular leukemia was suspected due to the combination of imaging findings
and laboratory findings. Continue with the video... Sorry, your browser doesn't support embedded videos. Distinguis
lt, when a lot of extramedullary disease is seen. Often the final diagnosis
is thus based on clinical presentation, laboratory findings (anemia and
thrombocytopenia) and flow cytometry. For this case the final
diagnosis was leukemia.
Neuroblastoma:
Sorry, your browser doesn't support embedded videos. The
main differential diagnosis of nephroblastoma is neuroblastoma. Typical

features that indicate neuroblastoma are calcifications - causing a specific
ultrasound pattern, shown in the video – and vessel encasement,
without invasion.
This vessel encasement causes the aorta and caval vein to
be lifted anteriorly. On ultrasound the tumor is generally inhomogeneous and
echogenic, with bright calcifications. Children
with neuroblastoma are generally very ill, while children with a Wilms tumor are not.
The Vanillyl Mandelic Acid (VMA) and HomoVanillic Acid
(HVA) levels in the urine are in most cases elevated.
In our hospital these levels are checked in every child that presents with a tumor in the abdomen. video
Three-years-old
girl referred from a peripheral hospital with a diagnosis of a tumor of the
left kidney. Ultrasound shows a mass originating from the left kidney. The mass
is very inhomogeneous with calcifications, and much more compatible with a
neuroblastoma than a nephroblastoma. Chung EM, Graeber AR, Conran RM. RadioGraphics Vol. 36, No. 2
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10. Wilms Tumor and Its Management in a Surgical Aspect
Crohn's disease - role of Ultrasound:
Frank Zijta, Inge Vanhooymissen and Julien Puylaert
Haagland Medical Center in the Hague and the Academical University Medical Center in Amsterdam:
In this section we will discuss the sonographic features used to evaluate Crohn's disease. After reading this section, y
a PC or + on a Mac. Most images can be enlarged by clicking on them.
Introduction:
Crohn's disease is a chronic, recurrent inflammation of the bowel wall of unknown origin.
The disease has a tendency for transmural progression with ulceration, abscesses, fistula formation, fibrosis and (int
volve the entire gastrointestinal tract, colon and ileocecal region are the most frequently involved areas. Patients wit
ical symptoms leading to serious diagnostic delay of months to even years.
On the other hand, ileocecal Crohn disease may also present acutely with appendicitis-like symptoms or small bowe
In both scenarios US can play an important role in making the correct diagnosis. Apart from primary detection, US is
Normal US anatomy:
The US architecture of the normal bowel wall has a typical five-layered morphology of alternating echogenicity, close
his US architecture is essentially identical from the stomach to the rectum.
The normal US anatomy is outlined in the section Ultrasound of the GI tract - Normal Anatomy
US signs of ileocecal Crohn's disease:

Bowel wall thickening:
In ileocecal Crohn's disease, typically all bowel wall layers are involved, and the normal stratification is often locally d
in the terminal ileum, but cecum and appendix can also be involved. Bowel wall thickening is most prominent in the
fibrous tissue as a result of chronic bowel inflammation (4). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Difference between size and compressibility of normal ileum (left) and Crohn affected ileum during in
Disable Scroll Enable Scroll
Disable Scroll Using graded compression, two adjacent bowel segments are compressed against the iliopsoas muscl
rohn's loop can hardly be compressed. Measuring bowel wall thickness is best and most reproducibly performed du
nt with Crohn's disease (right). Measurements are performed from outer contour of the muscular layer to the oppos
5 mm and 6.5 mm for normal resp. Crohn ileum.
See also the section Ultrasound of the GI tract - Normal Anatomy.
Transmural signature:
Commonly, at first presentation, US already reveals the characteristic transmural "signature" of Crohn's disease. This
ges (*) in the otherwise hyperechoic submucosa, closely correlating with endoscopic findings and active inflammator

cute appendicitis-like symptoms and immediate CT was performed.
CT revealed evident ileal bowel wall thickening and a normal appendix (not shown here). Subsequent US showed the
oic submucosa confirming Crohn's ileitis. Note the superior image resolution of US compared to CT. In patients with
e bowel wall may be lost diffusely. Note the hyperechoic fatty tissue (fat) around the ileum, representing the inflame
ation.
In cases like this, the altered morphology and luminal narrowing may mimic malignancy.
Skip lesions:
One of the features of Crohn's disease is the patchy way it affects bowel.
This results in skip lesions, where large parts of the bowel are left unharmed. The affected parts show a relatively sh
abnormal bowel (large arrows) being rather abrupt.
Ulceration:
Bright eccentric foci within the hypoechoic areas are air-configurations representing deep ulceration, here depicted i
These transmural ulcerations herald sinus tract formation, abscesses and fistula formation.
Note the partially surrounding inflamed fat, representing mesentery and omentum, at this point effectively walling o
Sinus tract formation:
Air-configurations reaching beyond the peripheral borders of the bowel wall definitely indicate sinus tract formation
Abscess:
Actively inflamed terminal ileum with a moderately demarcated hypoechoic area outside the bowel wall, surrounded
Scroll
Disable Scroll Enable Scroll
Disable Scroll Two patients with Crohn's abscesses close to the ileum.
Note that abscesses in Crohn's disease are often small and collapsed. The explanation for this phenomenon is that t
, allowing pus to immediately evacuate to the bowel lumen when pressure goes up.
Fistulas:
Ultimately sinus tract formation may proceed to fistula formation. Here two examples of entero-enteric fistulization
Disable Scroll Enable Scroll
Disable Scroll Fistula (arrowheads) from the terminal ileum to the appendix (arrows) in advanced ileocecal Crohn's di
Note the hyperechoic fat, surrounding the fistula complex, representing omentum and mesentery effectively walling
Due to its slow and insidious character, free perforation in Crohn's disease is very rare. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Crohn abscess with bladder fistula
Two different patients with known Crohn's disease who now both presented with micturition symptoms. In the left p
wall (arrowheads), in the right patient an enterovesical fistula is "in state of birth", with massive thickening of the blad
l fistulae the cause is underlying diverticulitis while underlying cancer is the cause in 15 %.
Crohn's disease is the third cause with about 5 %. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Ultimately sinus tract and abscess formation may result in a fistula.
The most frequent targets are small bowel, sigmoid and appendix.
Unusually, fistula to the bladder, the abdominal wall and iliopsoas muscle may occur.
In situations with complex enterocutaneous fistula involving multiple small bowel loops, CT or MRI enterography is t
ing and in follow-up, as in this patient. In patients with such a complex anatomy, US plays a less important role than
Stenosis and prestenotic dilatation:
Inflammatory bowel wall thickening or the ensuing fibrotic strictures may finally result in luminal narrowing, stenosis
The affected segment typically demonstrates dysfunctional motility.
In case of acute abdominal symptoms, US can demonstrate the presence of prestenotic dilatation and therefore pro
had intermittent colicky attacks that were never documented with imaging. She was asked to come back immediate
tic dilatation proximal to a short segment of abnormal ileum (arrowheads). Higher up there was another stenotic seg
sidered a fibrotic stenosis and this patient underwent successful surgery. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here a fibrotic stenosis in an ileal segment. Note the prestenotic dilatation and absence of peristalsis
's disease with long episodes of chronic recurrent small bowel obstruction, an interesting phenomenon in ileal loops
This so-called "inflammation-smooth muscle hyperplasia axis" may be the most important factor in the pathogenesis
Disable Scroll Enable Scroll
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Creeping Fat:
In longstanding Crohn's disease, "creeping fat" can be found, which is hypertrophied mesenteric fat "wrapped aroun
is recognized as a rather well-delineated, moderately compressible, fatty mass surrounding most of the circumferen

During compression a "feather-like" pattern can be observed. Old and inactive Crohn's disease of the terminal ileum
yperechoic third layer, representing fatty deposition and loose connective tissue in the submucosa. Here an example

minent echolucent wall thickening of both terminal ileum and appendix (arrowheads).
This is not a true obstructive appendicitis and appendectomy should be avoided.
After medical therapy, there was normalization of both ileum, cecum and appendix on US. In most patients with ileo
nimally reactively thickened (B). In some patients (C) with ileocecal Crohn's disease, slight transmural changes in the
appendix. In D. there is severe involvement of ileum, cecum and appendix (arrow), with abundant surrounding inflar
sease is not an indication for appendectomy. It should not be confused with true, obstructive appendicitis. If append
ay be a fistula. See * on US and on bariumstudy. The fistula is located between the cecal pole and the terminal ileu
ut it does exist.
In this patient there was transmural inflammation (*) and inflamed fat, indistinguishable from ordinary appendicitis.
Appendectomy is usually performed in such cases.
In truly isolated primary Crohn's appendicitis there are seldom recurrences after appendectomy.
Differential Diagnosis:

Infectious ileocolitis:
One of the most important differential diagnosis is infectious colitis.
The main symptoms of infectious colitis are severe, often bloody diarrhoea, especially in Campylobacter and Salmo
Other causative micro-organisms are E. coli, Shigella and several viruses. US reveals mucosal and submucosal thicke
ferentiate from ulcerative colitis. Since in every patient with suspected IBD, repeated stool cultures are performed,
Right-sided infectious ileocolitis:
In a small group of patients, especially young adults, the bacterial infection for unknown reasons may initially remain
These patients present with prominent RLQ pain and have no or only mild diarrhoea.
This right-sided infectious ileocolitis may therefore present with symptoms mimicking appendicitis or ileocecal Crohn
US plays an important role in the timely diagnosis. The causative bacteria are Campylobacter (80%) and Salmonella (
In the past, Yersinia was a frequent cause of infectious ileitis, closely mimicking Crohn's disease both clinically and o
However, the incidence of Yersinia has strongly decreased over the last three decades and is seen only very rarely no
Disable Scroll Enable Scroll
Disable Scroll Classic US features of right-sided infectious ileocolitis in a young man. Prominent mucosal and submu
inflamed mesenteric lymph nodes and a normal appendix. Note the prominent ileocecal valve, due to both wall thic
cter ileocolitis. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Right-sided infectious ileocolitis in a 33-year old man.
CT scan without contrast (history of severe allergy). Prominent (sub)mucosal wall thickening of ileum and right colon
Note also markedly enlarged mesenteric lymph nodes and normal appendix. Typical, prominent image of the ileocec
oth ileum and cecum. The ileocecal valve is visualized in two planes, perpendicular to each other (note body scheme
lobacter ileocecitis is often intermittent and crampy in nature.
During these crampy pain attacks (remember "Crampylobacter"), the ileum is slightly intussuscepted into the cecum,
se and infectious ileocolitis is usually easy, as in the latter the layer structure is virtually always intact and there is ne
ences between Crohn's disease and infectious ileocolitis. However, differentiation of early Crohn's disease from infec
Follow-up and repeated stool cultures in such cases can solve the problem. In this young patient, USfindings were co
us ileocolitis.
Repeated US after 7 days waspathognomonic for Crohn's disease.
Note that both wall thickening and surrounding inflamed fat have markedly increased in volume (arrowheads).
Tuberculous ileitis:
In this patient from Indonesia with RLQ pain, the tentative US diagnosis of Crohn's disease was made. A chest X-ray
is was tuberculous ileitis.
Follow up US after tuberculostatic therapy showed complete resolution of the abnormalities. Tuberculous ileitis can
formation and fibrotic stenosis.
Typhoid ileitis:
This Dutch student presented with high fever, constipation and RLQ pain after returning from India.
US showed splenomegaly and wall thickening of the terminal ileum (arrowheads) with evident hypoechoic transmura
There was also inflamed fat around the ileum and the mesenteric lymph nodes (ln) were enlarged. Two days later, bl
Complete recovery with antibiotics.
S. typhi is the only bacteria that shows this invasive behavior and may very closely mimic the US features of Crohn's
In endemic areas, ileal perforation is a frequent complication of typhoid fever. Clostridium colitis - (colon tr. = transv
f ulcerative colitis, although the (sub)mucosal wall thickening in Clostridium colitis is usually much more prominent.
stridium colitis may also occur without previous antibiotic therapy. This young patient developed severe diarrhea, se

Colonoscopy was suspect and eventually stool cultures were positive for Clostridium difficile.
Ischemic colitis:
Ischemic colitis has a predilection for the splenic flexure of the colon since that is the watershed area of superior an

demarcated, segmental, hypoechoic wall thickening with transmural features and fat stranding may closely mimic Cr
together with the clinical picture usually give the clue. Ischemic colitis Note the abrupt transition of normal and abn
Crohn's disease. Clinical findings as well as the atherosclerotic origin of the SMA (arrow) give the clue here.
Bowel malignancy:
In patientswith segmental bowel wall thickening and loss of the normal US architecture, active Crohn's disease may r
Yet, in the majority of the cases, the US appearance of the adenocarcinoma is quite typical. In this 52-year old man th
lon was found by US.
Longitudinal view shows a short segment ofirregular, asymmetrical, hypoechoicbowel wall thickening with loss of lay
Note that dorsally the wall is relatively intact.In the transverse view, the proximal segmentof colonis normal, more di
t only the relatively hypoechoic tumor itself is not compressible, but also the surrounding hyperechoic fat (arrowhea
ial wall thickening of the cecum with loss of layer structure and ill-defined borders, separating it from the surroundin
It was impossible here to differentiate Crohn from malignancy.
On the subsequent CT scan, malignancy was considered more likely.
Colonoscopy revealed cecal carcinoma. Sometimes, the US image can be quite confusing.
In this patient, the irregular, asymmetrical wall thickening of the cecum with adjacent inflamed fat (*) and encroachm
stic reaction and ingrowth in the base of the appendix. Concomitant wall thickening of the terminal ileum and especi
uggested the correct diagnosis of ileocecal Crohn's disease with involvement of the appendix. An important pitfall is
endicitis.
In these two different patients (who both turned out to have appendicitis), prominent wall thickening of the ileum in
infectious ileocolitis.
Further US searching brought to light that this was reactive thickening due to an underlying inflamed appendix (arro
wall thickening of the ileum may be misinterpreted and may lead to serious delay of surgery.
In doubt, CT can be very helpful.
Role of US in Crohn's disease:
Crohn's ileitis with enlarged mesenteric lymph nodes (ln), and a normal appendix (arrows)
Primary detection:
The main role of US in Crohn's disease is primary detection in patients who are submitted for US with an unclear diag
of pain and/or diarrhoea or they present with appendicitis-like symptoms or small bowel obstruction. This 28-year
nce 24 hours, suspect for appendicitis.
US and subsequent CT showed a completely unexpected Crohn's ileitis with enlarged mesenteric lymph nodes, and a
cidental finding in a patient, who at that time, has no abdominal symptoms at all.
This 32-year old lady presented with severe LLQ pain and a CRP of 20.
In the LLQ, US revealed a locally painful mass of inflamed fat next to the sigmoid (s.), suspect for epiploic appendagit
al terminal ileum (il.) was found with all US features of Crohn's disease.
The patient denied any present or previous symptoms other than the actual pain in her LLQ, which subsequently sub
arrowheads) and Crohn's ileitis.
In the following years, this patient did actually develop active, albeit rather mild, symptomatic Crohn's disease, witho
Monitoring disease activity during medication:
US can also be used for monitoring disease activity during medical therapy for Crohn's disease, particularly in circum
ell-circumscribed and reproducible lesions. Compare the severely affected terminal ileum in this young patient with
Note that both wall thickening and the mass of acutely inflamed fat around the ileum did decrease (arrowheads). M
vel of the terminal ileum. There is convincing decrease in wall thickening after 4 weeks of medication.
Note subtle residual hypoechoic, transmural changes (*) still visible in the near wall after therapy.
US in abscess drainage:
Although MRI and CT are essential in delineating Crohn's abscesses and in treatment planning, US can be helpful in g
ompression was useful to safely guide the needle to this deeply located abscess.
After insertion of a guide-wire, an 8-Fr pigtail-catheter could easily be placed under fluoroscopic control.
Crohn colitis vs ulcerative colitis:
Finally, US may play a role in the differentiation of ulcerative colitis and Crohn's colitis.
On clinical grounds and even with the help of endoscopy and biopsies, it can at times be difficult to differentiate Cro
In these cases, US can be of help: the demonstration of hypoechoic, transmural inflammation and the presence of n
In severe ulcerative colitis, there may be increased echogenicity of the surrounding fat (*), as here in this young preg
e considered as edema associated with secondary hyperemia rather than as a sign of true transmural inflammation.
Note marked wall thickening of the transverse colon (arrowheads) in the panoramic view. We thank Lars Perk, gastro
None:

None:

Endometriosis - MRI detection:
Jan Hein van Waesberghe, Marieke Hazewinkel and Milou Busard

Radiology department of the VU University Medical Center Amsterdam, the Netherlands:
Publicationdate 2011-11-01 Laparoscopy is the gold standard for the diagnosis of pelvic endometriosis. MRI is helpfu
specially when laparoscopic inspection is limited by adhesions. In this article we will focus on the diagnosis and preo
enlarge images by clicking on them. This item is not available on the iPhone application.
Introduction:
Endometriosis is defined as the presence of endometrial tissue outside the uterine cavity. It is mainly found in the ab
t is an estrogen-dependent disease and is estimated to occur in 10% of the female population, almost exclusively in
hea, dyspareunia, pelvic pain, and infertility - although it may also be asymptomatic. Click on image for enlarged viev
the depth of the infiltration and whether the endometriosis is complicated by adhesions. The illustration shows the
MRI-protocol:
If the only reason for performing MRI is to determine the presence or extent of endometriosis, the sequences listed
ate low to intermediate signal intensity on T2- and T1-weighted images. In some cases punctate foci of high signal int
metrial glands. Foci of high signal intensity may be seen on T1-weighted images. If these foci also have a high signal i
tes the presence of hemorrhage. T1-weighted images with fat saturation are necessary to differentiate blood in endo
h signal intensity on T1-weighted images without fatsat. If the questions that need answering are more diverse, for e
nces before and after the administration of intravenous gadolinium may supplement this protocol. Diffusion-weighte
Superficial endometriosis:
Small superficial endometriotic plaque at laparoscopy In superficial endometriosis – also known as Sampson's syndr
ies and uterine ligaments. These patients tend to have minor symptoms and usually also less structural changes in th
al powder-burn
or gunshot lesions. Coronal T2 and T1-Fatsat images: superficial serosal implants of endometriosis On MRI these lesi
d therefore undetectable. Only when they exceed 5mm or when they appear as hemorrhagic cysts, showing high sig
y may be detected (figure). Neither transvaginal ultrasound nor MRI are sufficiently sensitive to screen for these endo
Deep pelvic endometriosis:
Sagittal T2-weighted images demonstrating endometriosis infiltrating the rectum and endometriosis infiltrating the b
me - there is subperitoneal infiltration of endometrial deposits. The symptoms are more severe and related to the lo
of deep infiltrating endometriotic lesions and for the assessment of disease extension. Preoperative mapping of dis
on is indicated, and if so, for planning complete surgical excision. Endometriosis in the posterior cul-de-sac with infilt
Cul-de-sac localization:
The cul-de-sac is the most common site of pelvic involvement. Presence of deep infiltrating endometriosis in the cul-
on of a false peritoneal floor by endometriosis in the pouch of Douglas, partly caused by anterior rectal wall adhesio
oneal orgin. Consequently, the location of the deep infiltrating endometriosis in the rectovaginal septum may also be
posterior vaginal fornix and, on the basis of normal anatomy, may therefore not be a primary site for endometriosis
resence of endometriosis in the cul-de-sac is readily made using MRI. This sagittal T2-image shows deep infiltrating e
posterior cul-de-sac with infiltration of the rectal wall.
Uterus:
The torus uterinus - where the sacrouterine ligaments attach - and posterior fornix are common localizations of end
ia. Endometriosis involving the torus uterinus T2-images of endometriosis involving the torus uterinus. Retrocervical
in the posterior fornix and torus uterinus. There is no infiltration of the bowel wall. Endometriosis with involvement
ating involvement of the
left sacrouterine ligament. Rectal endometriosis
Bowel involvement:
Bowel endometriosis affects between 4% and 37% of women with endometriosis. Transvaginal ultrasonography is th
iosis. Additionally, MRI can determine the depth of bowel wall infiltration, the length of the affected area and the dist
two fan-shaped hypointense lesions (red arrows). These findings are typical for endometriotic lesions infiltrating the
l swelling, seen as hyperintensity on the luminal side of the bowel wall. Rectal stenosis due to endometriosis In case
osis of the bowel wall can lead to stenosis of the bowel lumen. Patients may clinically present with pencil-like stool o
um as a result of circular endometriotic involvement. Bladder wall endometriosis
Bladder involvement:
The urinary tract is involved in only 4% of women with endometriosis of which around 90% involve the bladder. The
wall endometriosis The sagittal T2-image shows full-thickness bladder endometriosis with isointense signal compare
endometrial glands. The fatsat T1-image shows small cysts with hyperintense signal within the lesion caused by hem
: Coronal T1WI+FS demonstrating small hemorrhages (red arrows)
Adhesions:
Endometriosis is frequently complicated by adhesion formation. On MRI adhesions can be seen as spiculated, low- to
signal intensity strandings on T1 and T2. Adhesions can fixate the pelvic organs, leading to posterior displacement of
and angulation of bowel loops. They may also lead to hydronephrosis, although in most cases hydronephrosis is cau
1-images on the left show a patient with endometriosis in whom the ovaries are stuck together ('kissing ovaries'), as
ll hemorrhagic cyst of the left ovary and a hemorrhagic superficial plaque are also shown (high signal on T1 red arrow
show dilatation of the left distal ureter caused by extensive deep infiltrating endometriosis involving the left sacrout

Endometriomas:
Endometrioma at ultrasound and laparoscopy Endometriomas - also known as chocolate cysts - develop when supe
od produced by such an implant during each menstrual cycle cannot escape and will accumulate within the ovary, fo
lex cystic masses, often thick-walled with a homogeneous content. On transvaginal ultrasound, endometriomas may
cysts with low level echoes. On the left a transvaginal ultrasound image and the corresponding laparoscopic image o
hypointensity on T2 (shading), fluid-fluid levels on T2 (left) and hyperintense blood on T1WI with fatsat (right).. On M
with a homogeneous hyperintense signal intensity on T1- and T1-fatsat sequences. The T1-fatsat helps differentiate
fat. On T2WI, endometriomas may range from having a low signal intensity (also known as shading) to an intermedia
emoconcentration of a cyst. Endometriomas generally have a thick, fibrous capsule with low signal intensity on T2, ca
llow arrow), hydrosalpynx (red arrow) and leiomyoma (blue arrow). These images are of a patient with an endometri
signal on T2 and high signal intensity on T1-fatsat. In addition there is: Endometrioma On the left another example o
with a
bloodclot (hypointense on T2, intermediate on T1). Sometimes these clots are accompanied by fibrotic tissue at histo
nse lesions (on T2) found in the dependent portion of the endometrial cysts. In this case there is also a hematosalpin
the left show an endometrial cyst of the left ovary. The wall of the cyst is hypointense on T2WI and T1WI caused by h
Differential diagnosis:
The differential diagnosis of endometrial cysts includes: hemorrhagic
functional cysts, fibrothecoma, cystic mature teratoma, cystic ovarian neoplasm and ovarian abscess. Click on the lin
Ovarian Cystic Masses I Roadmap for Diagnostic Work up
Ovarian Cystic Masses part II - Common cystic lesions
Abdominal wall endometriosis:
Abdominal wall endometriosis presenting as ill-defined hypo echoic mass. Endometrial implants have been reported
nal wall endometriosis is the most common location of extrapelvic endometriosis and usually occurs after cesarean
al wall , frequently containing internal vascularity on power Doppler examination. These sonographic findings are no
in the differential diagnosis including neoplasms such as a sarcoma, desmoid tumor, or metastasis and nonneoplast
However, abdominal wall endometriosis should always be your prime concern in patients with an abdominal wall ma
and MR characteristics of abdominal wall endometriosis are nonspecific, both showing a solid enhancing mass in th
wall endometriosis. On T2WI, the lesions have an isointense signal to muscle with small foci of
high signal intensity, indicating dilated endometrial glands. They have a slightly higher signal intensity to muscle on t
T1-image (arrow). Abdominal wall endometriosis A characteristic clinical symptom of abdominal wall endometriosis i
sent with continuous pain or no pain at all. The axial T2-weighted image on the left demonstrates another case of ab
4): 760-768.
2. Endometriosis: Radiologic-Pathologic Correlation by Paula J. Woodward, Roya Sohaey and Thomas P. Mezzetti Jr. Ja
3. Endometriosis of the Posterior Cul-De-Sac: Clinical Presentation and Findings at Transvaginal Ultrasound by Jan-He
4. Abdominal Wall Endometriosis: Clinical Presentation and Imaging Features with Emphasis on Sonography by Jan-H
aert. AJR March 2006 vol. 186 no. 3 616-620
5. Posterior Cul-de-Sac Obliteration Associated with Endometriosis: MR Imaging Evaluation by Milliam L. Kataoka et a
6. Deep infiltrating endometriosis of the bowel: MR imaging as a method to predict muscular invasion. by Busard MP
van Kuijk C, Mijatovic V, Hompes PG, van Waesberghe JH. Abdominal Imaging 2011;Doi: 10.1007/s00261-011-9790-1
7. MR imaging of bladder endometriosis and its relationship with the anterior uterine wall: experience in a tertiary re
r MC, Pieters-van den Bos IC, Schats R, van Kuijk C, Hompes PG, van Waesberghe JH. Eur J Radiol. 2011 Sep 9
None:

None:

Swallowing disorders update:
Robin Smithuis
Radiology department of the Alrijne Hospital in Leiderdorp, the Netherlands:
Publicationdate 2018-08-13 Swallowing is a complex movement. It requires the coordination of nerves and muscles i
ynx and finally the esophagus. Radiographic studies of patients with swallowing disorders can help to analyse the pr
ese videos is presented by focussing on four basic findings: Aspiration Normal Swallowing
Normal Swallowing:
LEFT: Oral or preparatory phase. RIGHT: Transport to pharynx and subsequent triggering of the actual swallowing re
Oral phase:
In the oral phase food is prepared for swallowing and then transported to the pharynx. This is a preparatory phase i
ongue and the soft palate close the oral cavity posteriorly to prevent food spilling into the open larynx and trachea. A
n pushed posteriorly toward the pharynx with an anterior-to-posterior tongue elevation. As the bolus enters the pha
haryngeal constrictors push the bolus down. RIGHT: Together with the contraction of the inferior constrictor, the cric
Pharyngeal phase:
This phase is a reflex action. The bolus passes through the pharynx quickly and then enters the esophagus. This take

rts when the bolus passes the anterior faucial arch and reaches the posterior pharyngeal wall. Elevation of the soft p
age is followed by the pharyngeal constrictor muscles pushing the bolus further into the pharynx, toward the cricoph
e trachea by respectively closing the true vocal cords, false vocal folds, and aryepiglottic folds. Contraction of the low
cricopharyngeal muscle, allowing the bolus to pass into the esophagus. Enable Scroll
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Fluoroscopic imaging:
The most important images of the swallowing study are those taken of the lateral view. Click through the images 1-7
(green arrow).
3. the soft palate elevates to prevent spill into the nasopharynx (green arrow) and the tongue pushes the food furthe
4. The hyoid bone elevates and the larynx closes (green arrow). The tongue pushes the food downwards, while the u
5. Contraction of the middle pharyngeal constrictor (yellow arrow), while the cricopharyngeus is already fully relaxed
6. Contraction of the lower pharyngeal constrictor emptying the pharynx.
7. Epiglottis elevates to regain its resting position and the larynx opens (arrow).
Video of lateral view:
Watch in HD. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The AP-view is important to look for asymmetry. Once the series of the pharyngeal phase has been ac
phageal junction.
Indications for a study:
Indications for a swallowing study are dysphagia, globus sensation and aspiration. Dysphagia is a general term used
mouth to the stomach.
Globus sensation is a term to describe the feeling, that there is something in the throat, that is in the way or needs t
Aspiration is the most severe form of swallowing disorders and can result in aspiration pneumonia, chronic lung dise
lowing study can be performed to look for 'silent aspiration'.
Study of Swallowing:
The radiologist is explaining how to perform the modified valsalva First try to find out exactly what the patients prob
piration, i.e. wet voice, recurrent pneumonia or aspiration? If so, do not start the examination with barium contrast,
e first few swallows there is no aspiration, you can switch to barium, as this gives better quality images. Before we st
t and we practise certain manoeuvres like the modified Valsalva (figure). When solid food is the problem, you may w
or bread with bariumpaste. The patient in the video only has problems with solid food. The examination of patients
r two lateral swallows followed by a lateral double-contrast view of the pharynx (see later). Then an AP-swallow is re
ext the passage through the esophagus is recorded, sometimes followed by double-contrast views of the gastroesop
Fluorographic study of the actual swallowing:
The act of swallowing is recorded on video or some sort of digital recording. We use grabs from the fluographic imag
ges back and forth in slow motion. It is very important to always start with the lateral view first, because if the patien
happened. If you have to stop the examination, the most important images will already have been recorded. If you s
p the examination and you will never know why aspiration occurred and what the problem is. If a patient is unable t
amount of barium for the first swallow and if the patient is doing fine, coninue with larger portions. Aspiration of a s
on't want a lot of barium filling the bronchi. LEFT: Lateral view during singing aaa. Hyoid (H) and tongue base (T) mov
top of each other. Tip of soft palate (SP) is seen. RIGHT: Valleculae (V) and pyriform sinuses (P).
Double contrast images of the pharynx:
For the lateral view, ask the patient to sing an aaa, as this will move the tongue in an anterior position and give a bet
the letter eee, as it is pronounced the same as the english aaa. For the AP-view the modified Valsalva manoeuvre is p
s as in trumpet-playing, while relaxing the neck region. Always practise this manoeuvre prior to the examination, so t
x. Outpouching of the lateral wall of the pharynx is normal and can be quite severe (Dizzy Gillespie). These are calle
patient with reflux.
Examination of the esophagus:
Always follow the passage of barium through the esophagus until it enters the stomach. Disorders of the gastroesop
t. The rationale for this is that in patients with a distal obstruction, gastroesophageal reflux or a motility disorder, the
foodspillage back into the pharynx - along with the risk of aspiration. This increased muscle tone gives the patient th
are of a patient with globus sensation. This was due to severe reflux and subsequent increased tone of the cricopha
ause of the complaints. Optimal views of gastro-esophageal junction when air regurgitates from the stomach into th
lent views of the gastroesophageal junction can be achieved by doing the following: You get the best lighting, when t
mage. Do not put the contrast bolus in the center of the image, because on the video you'll get a constant shift of im
Analyzing swallowing studies:
A simple way to analyse a swallowing study is to concentrate on four easily detectable findings: These findings are m
ll the images will clarify the mechanism that causes these abnormal findings. These imaging findings may be isolated
e closure of the cricopharyngeal muscle may lead to stasis of contrast in the pharynx, which may result in aspiration
wing due to head turn. The head is turned to the left and contrast is only seen in the right food channel.

Asymmetry:
Asymmetric swallowing on an AP-view is usually the result of an asymmetric tilting of the epiglottis. Sometimes it is c
nation is found. Even when the head is not rotated, the epiglottis can tilt asymmetrically when it hits the posterior ph
bolus is given, as the pharynx will not fully distend. A larger bolus will result in a symmetric swallow. In the case on t
head is turned (Figure). If a patient has a unilateral pharyngeal paresis, turning of the head towards the affected side
he head towards the affected side, this side will be closed preventing stasis on this side and possible secondary aspi
ou have to exclude a pharyngeal tumour or unilateral paresis. The double-contrast views can be helpful in these case
the modified Valsalva. When a tumour is present in the pharynx, it is usually visible on the DC views. Sometimes end
. Asymmetry (2) The case on the left is an odd case, but it nicely demonstrates the difficulty that sometimes exists in
is seen on the fluorographic study (green arrow). It looks as if there is something in the right pyriform sinus. On the
al (green arrow), but at the level of the vallecula on the right a lobulated proces is seen (yellow arrow). At a higher lev
row). The lobulated tumor at the level of the valleculae proved to be remnants of the lingual tonsil, which is a commo
of the tongue base. Continue with the CT of this patient. Impression of the oropharynx by an elongated internal caro
artery on the left The CT image shows that the smooth indentation of the oropharynx on the right was caused by an
se in which on the fluorographic study a tumor was suspected in the pyriform sinus. Finally a proces was found withi
t a higher level. Due to these processes there was an asymmetric passage of contrast in the hypopharynx simulating
ated internal carotid artery. This patient had swallowing problems and at inspection a pulsating structure was seen i
perform a biopsy in this area make sure that you are not dealing with the carotid artery. Stasis of contrast at the lev
ration (yellow arrows)
Stasis:
Stasis is the result of insufficient cleansing of the pharynx, either due to an obstruction- i.e. dysfunction of the cricop
he pharyngeal constrictors. Insufficient contraction is the result of pharyngeal paresis resulting from a neuromuscula
re sometimes seen on lateral fluorographic studies to compensate for the loss of function of the pharyngeal constric
igure). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Stasis (2) Here a set of images demonstrating a patient with a paresis of the pharynxconstrictors. This
opharyngeal muscle. In this example we can see how the patient tries to compensate for the loss of pharyngeal cons
ient is in extreme stress, because he knows that when he starts breathing and the throat is not empty, he will aspirat
on to facilitate the passage of food to the esophagus. Small impression of the cricopharyngeus. No obstruction.
Cricopharyngeal Dysfunction:
Insufficient opening and premature closure are the most common problems of the cricopharyngeal muscle. Normall
e of the bolus, but a small non-obstructive indentation is sometimes seen and is not clinically significant (Figure). It ca
t is assumed that the passage of food irritates the mucosa that covers the cricopharyngeal muscle resulting in a glob
diverticulum due to premature closure of the cricopharyngeus (yellow arrow)
Zenker's diverticulum:
A Zenker's diverticulum is always the result of cricopharyngeal dysfunction. Premature closure of the cricopharyngeu
the cricopharyngeus, as the pressurewave of the pharyngeal constrictors pushes the bolus downwards. This increas
rior pharyngeal wall (Killian's dehiscence). First this will result in a small pouch, that in time can increase and form a t
Disable Scroll Enable Scroll
Disable Scroll Cricopharyngeal dysfunction (3) On the left a patient who complained of globus sensation in the throat
ood. The digital recordings nicely demonstrate the filling of a large Zenker's diverticle. The contraction of the lower p
ontraction of the lower pharyngeal muscle against the closed cricopharyngeal muscle causes the posterior outpouch
. Cricopharyngeal dysfunction (4) Here a video of a patient with a Zenker diverticulum. Notice that on the AP-view the
spiration before, during or after the actual swallow.
Aspiration:
There are three instances when aspiration can occur: before, during or after the actual swallow. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Aspiration before swallowing When tongue or soft palate are unable to prevent spillage of food into th
Weakness of these muscles in the mouth and the throat is due to paralysis or myopathy. We have to assume that a f
lso that there is no coughing reflex. This patient probably has silent aspiration. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Aspiration during swallowing This is due to an insufficient closure of the larynx when it should be close
g of the larynx which allows the true cords, false cords and finally, the aryepiglottic folds to contract, followed by a ba
The aryepiglottic folds are the main gatekeepers, while the epiglottis plays only a minor role in preventing aspiration
l as failure of the extrinsic muscles (i.e. muscles that lift the larynx) may lead to aspiration during swallowing. Weakn
neurologic disorders and in recurrens nerve paralysis (i.e. neuromuscular dysfunction). Notice that this patient has d
es at many levels on the anterior side of the cervical spine. However they are not the cause of the swallowing disorde
Disable Scroll Aspiration during swallowing Enable Scroll
Disable Scroll Aspiration during swallowing Aspiration during swallowing (2) On the left a digital recording of a patien
t when the contrast enters the throat, the swallowing reflex is not triggered immediately. This allows for barium cont

ce the swallowing reflex is initiated, the larynx closes properly, but contrast is already in. Notice also that while the co
flex. Althoug the digital recording perfectly explains the complaints of the patient, it is difficult to say what causes thi
wing, the problem is at the level of the larynx. Mostly it is the larynx that is unable to close either due to weakness of
ic muscles that lift the larynx and allow it to contract (for instance after neck radiation or surgery). In this case the pr
he pharynx, who are not triggered properly. You could also argue, that this maybe is aspiration before swallowing, b
re forcefull push of the bolus posteriorly from the mouth into the oropharynx could help in triggering these nerves in
e. Aspiration after swallowing This is the most common cause of aspiration. It is the result of stasis of contrast in the
onstrictors or insufficient opening of the cricopharyngeal muscle or an obstructing web or tumor. When the larynx o
deo aspirates due to stasis in the hypopharynx. In this video there is massive aspiration due to stasis as a result of in
sufficient opening of the cricopharyngeal muscle.
Web:
Webs are mucosa folds which are usually located anteriorly in the hypopharynx or upper esophagus. Liquids usually
food may produce irritation or damage to the mucosa, resulting in a globus feeling. They are best diagnosed on the l
a web. Webs are frequently overlooked at esophagoscopy unless special attention is given to this area. During esoph
Pharyngeal ears:
Outpouching of the lateral wall of the pharynx are called 'lateral pharyngeal ears'. Sometimes patients complain of
in their throat, but usually it is an incidental finding. They can be quite prominent as in Dizzy Gillespie the famous tru
Osteofytes:
Although osteofytes can be quite big, they hardly ever cause swallowing problems.
Esophagus pathology:
As mentioned earlier problems in the esophagus can give the sensation of a problem in the throat. In the video there
arcinoma. A common cause of swallowing problems is reflux which irritates the cricipharyngeal muscle and results in
ith reflux and almost no peristatic movements in the esophagus. Here three patients with swallowing problems as a
esophagitis with a Barrett's esophagus. The patient in the middle has a esophageal cancer. The patient on the right h
Lingual tonsils:
The lingual tonsils are nodules of lymphatic tissue at the back of the base of the tongue (yellow arrow). They are simi
e lingual tonsils can be a cause of dysphagia or globus sensation especially if the tonsils compress the epiglottis. In m
sometimes needed to differentiate large tonsils from a carcinoma at the tongue base. Notice that you have to look c
Diagnosis:
The results of the swallowing examination help in establishing a final diagnosis. Based on this examination alone how
vere swallowing disorders are the result of a complex neuromuscular dysfunction. Hence the swallowing study shou
roenterologist, neurologist and speech therapist. The strength of the fluoroscopic examination is, that it is the only e
wallowing and can therefore lead to a rehabilitation plan.
Swallowing Rehabilitation:
Swallowing rehabilitation is a specialty on its own. Here we will make some brief comments on rehabilitation as it ma
nilateral pharyngeal paralysis stasis can be prevented by closing down one of the lateral food channels by turning th
Patients with aspiration before swallowing due to insufficient closure of the mouth, can be helped by flexing their he
t of the oral cavity. In patients with aspiration during or after swallowing the 'supraglottic swallow' may help. Before s
out of the airways by compressing the vocal cords. Immediately after swallowing the patient has to cough forcefully
od. Some patients only aspirate when they ingest fluids. These patients can be helped by changing their fluid intake
3. Radiologic assessment of abnormal oral and pharyngeal phases of swallowing (PDF-file) by WJ Dodds, JA Logeman
ay Soc Page 1. 965 Review Article
None:

Epilepsy - Role of MRI:
Publicationdate 2012-09-01 In many patients with epilepsy antiepileptic drug treatment is unable to control the seizu
epileptogenic lesion in 80 percent of these patients. Resection of these lesions can lead to seizure freedom in many
ings in the most common epilepsy-associated diseases.
Introduction:

Common causes of Epilepsy:
The illustration summarizes the most common causes of seizures in patients with medically uncontrollable epilepsy.
rosis and focal cortical dysplasia are the most common causes and can only be depicted with a dedicated protocol. T
n patients with uncontrollable seizures. Mesial temporal sclerosis is the most common cause of intractable epilepsy.
he epilectogenic lesion is temporal lobe (60%), frontal lobe (20%) and parietal lobe (10%), periventricular (5%) and oc
Seizures and Epilepsy:
Seizures are common. About 4 percent of all people will have at least one seizure during their lifetime. In patients wi
rmalities, because the seizure is provoked by fever, drugs, dehydration or sleep deprivation. The term epilepsy is use
nt of patients with epilepsy can be controlled with antiepileptic drugs. Most patients with uncontrollable seizures hav
al seizures - are seizures which affect only a part of the brain at onset. They usually start in the temporal lobe. In sim

partial seizure can be a precursor to a larger seizure and then it is called an aura. A complex partial seizure affects a
ciousness. If a partial seizure spreads from one hemisphere to the other this will give rise to a secondarily generalise
tonic clonic seizure.
MRI epilepsy protocol:
The table shows a dedicated epilepsy protocol. Some will also use Inversion Recovery and not use contrast on a rout
Superior for cortical thickness and the interface between grey and white matter. On T1WI look for grey matter occur
FLAIR Look very carefully for cortical and subcortical hyperintensities on the FLAIR, which can be very subtle. Since FL
ormalities should be confirmed on T2WI.
T2* or SWI Helpful when searching for haemoglobin breakdown products as in posttraumatic changes and cavernor
avernomas and gangliogliomas.
Mesial temporal sclerosis:
Mesial temporal sclerosis (MTS) is a specific pattern of hippocampal neuronal loss accompanied by gliosis and atropl
TS and prolonged febrile seizures earlier in life, complicated delivery and developmental processes. In 15% of patien
ortical dysplasia. This is called dual pathology. MTS is the most common cause of partial complex epilepsy in adults a
ergoing surgery. Surgical removal of visible MRI changes associated with unilateral mesial temporal sclerosis leads to
oral sclerosis Coronal T2W and FLAIR images are the most sensitive for detecting MTS. On axial slices mesial tempora
erosis is difficult to detect due to the lack of comparison with the unaffected contralateral hippocampus. The corona
is. Notice the volume loss, which indicates atrophy and causes secondary enlargement of the temporal horn of the la
is. Dual pathology: MTS and focal cortical dysplasia Mesial temporal sclerosis may occur in association with other pat
l pathology. The images show mesial temporal sclerosis with a hyperintense and shrunken hippocampus (red arrows
erale ventricle. Also notice associated subcortical hyperintensity in the left temporal lobe indicating focal cortical dys
eft hippocampus (blue arrow) and atrophy (yellow arrow). 35-year-old patient with refractory temporal lobe epilepsy
ial FLAIR (blue arrow) and atrophy of the left hippocampus on coronal images (yellow arrow). Left mesial temporal sc
cesfully treated with amygdalo-hippocampectomy on the left.
Differential of hippocampal hyperintensity:
Hippocampal hyperintensity on T2WI or FLAIR images with volume loss is diagnostic for mesial temporal sclerosis in
ut volume loss is seen in: Status epilepticus. Axial FLAIR, axial DWI and coronal T2WI. Status epilepticus The imaging f
is. In status epilepticus a hyperintense hippocampus can be seen, but there is swelling and no atrophy. Axial FLAIR, a
s with a slightly compressed temporal horn of the lateral ventricle consistent with hippocampal edema. DWI shows d
he status epilepticus. Hyperintense hippocampus due to a DNET DNET mimicking mesial temporal sclerosis Axial T2W
ce. This is typical for a DNET or dysembryoplastic neuroepithelial tumor, which we will discuss in a moment. The coro
uptake of contrast medium.
Focal Cortical Dysplasia:
key findings Focal cortical dysplasia is a congenital abnormality where the neurons fail to migrate in the proper form
negative, therefore a high index of suspicion is mandatory! The most common findings are cortical or subcortical hyp
und at the bottom of a deep sulcus. Another finding is a blurred interface between grey and white matter, because t
tains neurons that did not reach the cortex. Focal cortical dysplasia - coronal T1WI and FLAIR The images show typica
rring of the grey/white matter junction on T1WI (left). The FLAIR image on the right shows the subcortical hyperinten
s demonstrate cortical and subcortical signal abnormalities on T2WI and FLAIR in the left temporal lobe indicating fo
and shrunken hippocampus as a result of mesial temporal sclerosis, i.e. dual pathology. Focal cortical dysplasia. Coro
ypoplastic left temporal lobe with cortical thickening (arrow) and atrophy of the white matter. Focal cortical dysplasia
a 15 year old boy with epilepsy. Notice thickening and hyperintensity of the cortex of the left superior frontal gyrus. T
te matter. These findings are typical for focal cortical dysplasia. Focal cortical dysplasia in the right occipital lobe with
Transmantle sign:
Sometimes the hyperintensity is seen extending from the subcortical area to the margin of the ventricle. This is calle
uronal migration. Images of a 27-year-old male with refractory occipital lobe epilepsy. Coronal FLAIR and axial T2WI s
ex and subcortical region. Notice subcortical hyperintensity extending to the right ventricle indicating transmantle sig
Transmantle sign seen in another patient with focal cortical dysplasia.
Cortical and glial scars - Ulegyria:
54-year-old patient with a history of perinatal asphyxia and longstanding refractory partial epilepsia. Left parietal sca
cortex. Cortical and glial scars usually result from meningitis or birth injury. Ulegyria is a specific type of scar. It is de
hemia. Ulegyria typically affects full term infants. In these infants there is greater perfusion to the apex of the gyri th
pattern is that of a shrunken cortex in which the deep portions of the gyri are more shrunken than the superficial po
appearance. Ulegyria must be differentiated from microgyria. Ulegyria MR will shows tissue loss and gliosis underne
a 3D-T1WI because of its high resolution and the superior delineation of the cortex, while FLAIR will show the hyperi
FLAIR-sequence to search for hyperintensities in an epileptic patient and subsequently correlate these findings with
.
Cavernoma:
Cavernoma is also known as cavernous malformation or cavernous angioma. It is a benign low flow vascular malform
lesions and 10-30 percent occur as multiple lesions. Cavernomas consist of locules of variable size that contain bloo

pcorn appearance. A complete hemosiderin rim surrounds the lesion, but not when there is a recent bleeding. Unen
f cases cavernomas will be occult on CT. T2WI and T2* gradient echo show multiple cavernomas. Notice the popcorn
ns are almost completely black on the gradient echo due to blooming artefacts. T2* and susceptibility weighted imag
cavernomas. The five black dots in the left cerebral hemisphere on the T2* are also cavernomas and are not visible
e associated with developmental venous anomalies (DVA's). The unenhanced CT shows a small calcification in the rig
he cavernoma into the right internal cerebral vein. Coronal T2WI shows the venous anomaly as a curvilinear flow voi
e popcorn appeance and blooming artefact. Same patient. Notice the hemosiderin coating of the precentral gyrus co
avernoma (red arrowheads). CAA - Multifocal subcortical black dots in a older patient.
Differential diagnosis of microbleeds:
In patients with multiple small black dots the differential diagnosis is: Asymmetric microbleeds in peripheral location
CAA is commonly seen in demented patients.
* Hypertensive microhemorrhages Microbleeds in hypertensive patients younger than CAA (
Diffuse axonal injury (DAI) Posttraumatic hemorrhages in corpus callosum, subcortical white matter and brainstem.
er presented with seizures after being hit by a car. CT-image shows only minimal subarachnoidal hemorrhage (arrow
nge in personality. T2*-images show multiple hemosiderin depositions at the interface between grey and white matt
ation of the microbleeds is different from the peripheral located CAA-bleeds.
Epilepsy associated tumours:
All brain tumors may present with epilepsy, but there are some typically epilepsy associated tumors. These tumours
cipital lobe presenting as a cystic mass with rim enhancement. Notice calcification on CT.
Ganglioglioma:
key findings Ganglioglioma is the most common tumor associated with temporal lobe epilepsy. Calcification is comm
NET and pleomorphic xanthoastrocytoma. Ganglioglioma. T2WI and CE-T1WI Ganglioglioma in a young child. Note la
d CE-T1WI Small cystic ganglioglioma with a small enhancing nodule. DNET: T2WI and FLAIR show characteristic bubb
e skull due to slow growth of the lesion.
DNET:
key findings DNET in typical cases present as a bubbly mass which expands the affected gyri. The bubbly cystic appe
very hyperintense on T2WI. DNET. T2WI and T1WI DNET in an 11-year old boy presenting with refractory partial seiz
s subtle scalopping of the skull. Pleomorphic xanthoastrocytoma on coronal T2WI and a coronal and axial CE-T1WI.N
Pleomorphic xanthoastrocytoma:
key findings Pleomorphic xanthoastrocytoma (PXA) is a rare cause of temporal lobe epilepsy. Peritumoral edema ma
r DNET. Thickening and enhancement of the adjacent leptomeninges is highly characteristic but is not always presen
anthoastrocytoma is indistinguishable from a ganglioglioma. LEFT: Normal infundibular recess of the third ventricle (
hamartoma (curved arrow)
Hypothalamic hamartoma:
key findings Hypothalamic hamartoma is also known as diencephalic or tuber cinereum hamartoma. It represents n
cinereum of the hypothalamus. It is seen in infants presenting with seizures and precocious puberty.
Hemimegalencephaly:
Hemimegalencephaly. (Courtesy of Alessandra D'Amico) key findings T2WI shows right hemimegalencephaly. Notice
encephaly is the only condition in which an increase in parenchymal volume is associated with an increase in ipsilate
tical dysplasia involving fronto-parietal regions (blue arrows) and diffuse white matter T2 hyperintensity Hemimegale
of one cerebral hemisphere or part of it. Patients present with early seizures, macrocrania and severe development
show a wide spectrum of abnormalities, such as lissencephaly, pachygyria or polymicrogyria. In the late stage, the in
Most of the affected children die in the first years of life because of status epilepticus. Hemimegalencephaly. Courte
hemimegalencephaly. There is dysplastic thick cortex and ventricular dilatation on the affected side. 9-y-old girl with
eft cerebral hemisphere. T1WI shows heterotopic gray matter lining the left lateral ventricle (blue arrow). In hemime
ies, as these form a contraindication to hemispherectomy.
Rasmussen's Encephalitis:
Rasmussen's encephalitis. Axial FLAIR and coronal T2WI show atrophy of the left cerebral hemisphere with enlargem
is a progressive hemispheric atrophy of unknown origin. Patient develop an increasing frequency of seizures and pro
he smaller hemisphere is the site of abnormality, and the lateral ventricle is larger in the smaller hemisphere.
Tuberous Sclerosis:
Axial T2w shows multiple tubers and white matter abnormalities (fig. a: arrows) and subependymal nodules key find
inherited condition characterized by the presence of hamartomas in many organs including angiomyolipoma of the
e brain. Some patients have lymphangioleiomatosis, a cystic lung disease seen in women. The classic clinical triad is
ic: fits, zits and nitwits). The cortical hamartomas are called tubers and are similar to cortical dysplasia. Subependym
ricles. Sometimes they are calcified. Seizure surgery in TSC is contemplated if a particular tuber can be implicated in
s obstructs the foramen of Monro causing hydrocephalus. CT of a patient with Tuberous Sclerosis shows multiple co
of the American Journal of Neuroradiology. CT and MRI in a patient with Tuberous Sclerosis. There are multiple corte
ns are calcified. Subependymal giant cell astrocytoma (SEGA) This is a tumor that develops from a subependymal no
hey lead to obstruction of CSF flow. They are characterized by marked enhancement and their typical location. Axial

e left foramen of Monro causing obstructive hydrocephalus. Also notice tuber on the left. Sagittal T1WI post contrast
Sturge-Weber Syndrome:
Sturge-Weber. T2WI, SWI and CE-T1WI key findings Sturge-Weber is also called encephalotrigeminal angiomatosis. It
ce (port-wine stain), choroid of the eye and leptomeninges. Venous occlusion and ischemia lead to angiomatosis with
zures, hemiparesis, anopsia, mental retardation and port-wine stain. The MR-images show leptomeningeal angiomat
nd calcifications are best seen on the SWI. Sturge-Weber angiomatosis. CE-T1WI. Courtesy of Alessandra D' Amico M
tient with Sturge-Weber show leptomeningeal enhancement in the right posterior hemispere. Sturge-Weber angiom
r shows huge cortical and subcortical tram-track calcifications involving the left posterior hemispere. Sturge-Weber.
ice atrophy of the left posterior cerebral hemisphere with leptomeningeal enhancement and thickening. Sturge-Web
Diffuse choroidal hemangioma:
In Sturge-Weber a vascular malformation of the choroid of the eye is seen. These patients present with buphthalmos
ia. Eye abnormalities in a 4-year-old boy with Sturge-Weber syndrome. Notice FLAIR-hyperintensity (red arrow) and e
nsistent with a diffuse choroidal hemangioma.
Polymicrogyria:
key findings Polymicrogyria is a malformation due to an alteration of the cortical development in the late stage of ne
small gyri with derangement of the normal lamination and sulcation. LEFT: normal RIGHT: polymicrogyria (arrow) Th
ion on the left and polymicrogyria on the right (arrow).
Heterotopia:
Heterotopia: subependymal nodules (arrows). Heterotopic Grey Matter results from an arrested migration of norma
a) and the subcortical regions. There are two types of heterotopia: subependymal and subcortical. The most commo
as nodular foci of grey matter intensity on all sequences. They do not enhance. Heterotopia Images of a typical sube
e of heterotopia with typical subcortical nodules (arrows).
Schizencephaly:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift AJNR. 2009 Jan;30(1):4-11
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MRI examination:
Ivo Schoots, Mario Maas and Robin Smithuis
Radiology department of the AMC in Amsterdam and the Rijnland hospital in Leiderdorp, the Netherlands:
Publicationdate 2011-03-06 Diabetes-related foot problems like osteomyelitis and Charcot neuro-osteoarthropathy a
hot foot in a patient with diabetic neuropathy is a diagnostic problem. In this overview we will focus on two question
w
Overview:

Osteomyelitis versus Charcot:
Osteomyelitis: Osteomyelitis in a diabetic with neuropathy is infection of the bone that usually results from contiguo
on for osteomyelitis is not in the midfoot, but at the pressure points of the forefoot (metatarsal heads, IP joints) and
neus. To determine whether osteomyelitis is present, place a marker on the ulcer or sinus tract and track it down to
. Active Charcot: Unlike osteomyelitis, Charcot neuro-osteoarthropathy is primarily an articular disease, which is mos
hy will not demonstrate bone abnormalities, but MRI will show subchondral bone marrow edema. The subcutaneous
not discriminate between active Charcot Joint and osteomyelitis. Location, i.e. bone or joint and ulcer or not, are the
hronic stage of Charcot no longer shows a warm and red foot, but the edema usually persists. Joint deformity, sublu
type deformity in which the cuboid becomes a weight-bearing structure. The deformity of the foot with abnormal pr

oss of sensation, makes the foot vulnerable and leads to callus and blister formation aswell as foot ulceration. Charc
ently lead to infections, such as cellulitis and osteomyelitis, and this may eventually lead to amputation. The simplest
ollow the path of an ulcer or sinus tract to the bone and evaluate the signal intensity of the bone marrow (1). Osteom
hile osteomyelitis in diabetic neuropathy without Charcot is usually in the forefoot and hindfoot.

Osteomyelitis:

While diagnosing osteomyelitis is important, it is unfortunately also difficult. Clinical and laboratory signs and sympto
the identification and characterization of an associated foot ulcer, a method that is often unreliable. It is important t
sinus tract and to find its relation to the area of bone abnormality. The probe-to-bone test, i.e. palpation of bone with
ulcers was thought to be highly correlated with ostemyelitis. In later studies, however, it had a relatively low positive
may not show up on the first 2 weeks and in a later stage the radiographic characteristics of neuro-osteoarthropath
lization, destruction and periosteal reaction of the bones, particularly when neuro-osteoarthropathy presents at a la
ct and subcutaneous edema at the metatarsals. A secondary sign, an abscess, is shown in the forefoot, with high sign
, and ring-enhancement of the borders showing high signal intensity on T1+Gd.

Charcot neuro-osteoarthropathy:

Acute Charcot neuro-osteoarthropathy of the midfoot Charcot neuro-osteoarthropathy is a degenerative disease wit
ents with neurological disorders with sensory loss of the feet, including tabes dorsalis, leprosy, diabetic neuropathy,
1868 Jean-Martin Charcot gave the first detailed description of the neuropathic aspect of this condition in a patient w
logy associated with Charcot osteoarthropathy, with the joints of the foot and ankle being most commonly affected.
ro-osteoarthropathy: Chronic stage of Charcot osteoarthropathy The exact nature of Charcot arthropathy is unknow
d by an unperceived trauma to an insensate foot. The sensory neuropathy renders the patient unaware of the osseo
lar theory suggests that the underlying condition leads to the development of autonomic neuropathy, causing the ex
n a mismatch in bone destruction by increased osteoclastic activity and bone synthesis (1). The image shows a progr
anc dislocation) with subchondral cysts, erosions, joint distention and dislocation. A hot red foot in acute Charcot ne

Acute Charcot:

Acute active Charcot neuro-osteoarthropathy is defined by clinical signs. There should be neuropathy and a warm ar
ite of maximum deformity of the affected foot compared with a similar site on the contralateral foot. Osteomyelitis s
tein level is normal or only a slightly elevated. The differential diagnosis is infection (osteomyelitis, cellulitis, septic ar
d deep vein thrombosis. In this early stage, radiographic abnormalities are not present. The acute stage of Charcot n
destruction within days or weeks. Immobility by total contact casting can prevent further bone and joint destruction
red hot foot. In the acute stage, the radiographs are normal and may not exclude the diagnosis of acute Charcot neu
of calcaneal inclination with equinus deformity at the ankle. There is destruction of the tarsometatarsal joint with th
dorsal aspect of the foot. In the acute stage, MRI shows only subchondral bone marrow edema. Here MRI images of
edema typically is not restricted to one or two bones, but is seen in the entire midfoot. Bone marrow edema and its
esting articular disease. The subcutaneous tissues are relatively normal and there is no ulcer or other signs of infecti

Chronic Charcot:

The chronic inactive stage no longer shows a warm and red foot. The edema usually persists. Crepitus, palpable loos
d cartilage destruction. Joint deformity, subluxation and dislocation of the metatarsals lead to a rocker-bottom type
e. This results in excessive skin callus formation, blisters and foot ulceration. At the stage of chronic inactive Charcot
teal reaction will proceed into inactive periosteal reaction and sclerotic borders. The classic radiographic description
ay be present and effusions may decompress along fascial planes, carrying bony debris far from the joint. Dislocatio
radiograph in the acute stage of Charcot. Subsequently progressive Charcot neuro-osteoarthropathy is seen with dis

Charcot with superimposed osteomyelitis:

To determine whether osteomyelitis in a Charcot foot at MR imaging is present, follow the path of an ulcer or sinus t
arrow. If there is bone marrow edema, osteomyelitis is very likely. If there is bone marrow edema in the absence of a
l, both active Charcot as well as osteomyelitis is not likely. Charcot foot with rocker-bottom deformity and ulceration
ical rocker-bottom deformity of the foot due to collapse of the longitudinal arch. Abnormal pressure on the cuboid h
rthropathy with a plantar ulcer (asterix) and osteomyelitis of the cuboid. In a patient with Charcot neuro-osteoarthro
location of osteomyelitis. If the T1-weighted image at that location shows low signal intensity in combination with a
ft STIR and T1-weighted images of a patient with active Charcot neuro-osteoarthropathy with a plantar ulcer along th
sity in the cuboid bone next to the ulcer, indicative of osteomyelitis. Osteomyelitis in chronic Charcot neuro-osteoart
t saturation. Enhancement of the cuboid bone and adjacent soft tissues on postcontrast images, together with the p
chronic Charcot neuro-osteoarthropathy On the left a patient with Charcot neuro-osteoarthropathy with a subcutan
welling. When we follow the fistula tract to the bony protuberances of the cuboid, there is no marrow edema at the
st sign is indicative of neuro-osteoarthropathy with superimposed osteomyelitis. The "ghost sign" refers to poor defi
ome clear after contrast administration. Here, a patient with neuro-osteoarthropathy and superimposed osteomyeli
nhanced T1-weighted image as compared to the native T1-weighted image. The bone marrow edema, which is of low
becomes as bright as normal bone marrow.

MRI protocol:

The MRI examination includes special attention for positioning of the foot. It must be placed in the center of the mag
placed over ulcers or sinus tracts. T1 and STIR or T2 fatsat sequences are needed. Because of the curvature of the fo

th T2- weighted imaging with chemical fat saturation. However, STIR cannot be combined with contrast administratio
emical shift imaging is described (8). Sagittal views are for evaluation of midfoot involvement, the plantar surface and
uate for imaging the metatarsophalangeal and interphalangeal joints. Contrast is used to better depict devitalized re
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Meniscal pathology:
David Rubin and Robin Smithuis
Radiology department of the Washington University School of Medicine, St. Louis, USA and the Rijnland hospital in Le
Publicationdate 2005-07-20 This article is based on a presentation by David Rubin and adapted for the Radiology Ass
enu bar to test your knowledge. by David Rubin and Robin Smithuis
Normal Meniscal Anatomy:
Medial meniscus: The posterior horn is always larger than the anterior horn.
Medial meniscus:
Both horns are triangular in shape and have very sharp points. The posterior horn is always larger than the anterior
al, which can be a sign of a meniscal tear or a partial meniscectomy. LEFT: normal medial meniscal root immediately
rior root due to meniscal root tear. The posterior root is immediately anterior to the posterior cruciate ligament. If it
root tear (figure). The anterior horn has an insertion on the tibia and a second portion that travels from medial to la
(intermeniscal or transverse ligament). Lateral meniscus. Both horns are about the same size.
Lateral meniscus:
On sagittal images the posterior horn is higher in position than the anterior horn. Both horns are about the same siz
The lateral meniscus posteriorly comes up high over the tibial spine to insert near the posterior cruciate ligament. T
r the higher signal intensity of the posterior horn in all planes due to magic angle effect.
Meniscal tears:

Criteria for tears:
The two most important criteria for meniscal tears are an abnormal shape of the meniscus and high signal intensity
ensity not unequivocally contacting surface. Small black line on inferior margin of the meniscus. At arthroscopy the n
d be homogeneously low in signal intensity on proton-density images. The meniscus does not have to be black. Only
cus you can make the diagnosis of a tear. If there is doubt whether the high signal touches the surface, look at all the
se a tear. If you have a questionmark in your head, say "meniscus is normal". (figure) Basic shapes: Longitudinal, Hor
Nomenclature of Meniscal Tears:
Shapes. There are 3 basic shapes of meniscal tears: longitudinal, horizontal and radial. Complex tears are a combina
nd Parrot beak. Displaced Tears Bucket-handle tear = displaced longitudinal tear. Flap tear = displaced horizontal tea
Longitudinal, horizontal and radial tears:
Longitudinal tears Longitudinal tears parallel the long axis of the meniscus dividing the meniscus into an inner and o
er margin of the meniscus is always the same (figure). The tear never touches the inner margin. Three sagittal image
undles that parallel the contour of the meniscus. If a longitudinal tear has other components (horizontal or radial), th
requires a higher energy trauma. LEFT: abnormal shape of posterior horn. A piece is missing. RIGHT: displaced fragm
e tear is a displaced longitudinal tear. LEFT: meniscus is abnormal in shape and there is a displaced fragment. RIGHT
(1), ant cruciate lig (2) and displaced fragment (3). On coronal images bucket handle tears are easier to recognize. No
sa: the anterior and posterior cruciate ligament. Any other structure in the intercondylar fossa is abnormal and a dis
n Bucket handle tears Flipped meniscus: posterior horn is missing because it is flipped over and located on top of the
m of bucket handle tear. There is a capsular detachment or peripheral tear of the meniscus, usually the posterior ho
Flipped meniscus Horizontal tear with a meniscal cyst Horizontal tears Horizontal tears divide the meniscus in a top
y from the apex to the outer margin of the meniscus, they may result in the formation of a meniscal cyst. The synovia
lates within the meniscus and finally result in a cyst. The connection with the joint space is often lost, so they will not
is absorbed and is replaced by a gelatinous substance. There are 3 criteria for the diagnosis of a meniscal cyst: The c
se it takes one operation on the outside of the knee to remove the cyst and another operation on the inside for the r
axis of the meniscus. They violate the collagen bundles that parallel the long axis of the meniscus. These are high en
al or all the way through the meniscus dividing the meniscus into a front and a back piece. Radial tears are difficult to
coronal images to make the diagnosis. LEFT: triangle missing the tip.RIGHT: disrupted bow tie. The following combin
he tip and in the other plane: a disrupted bow tie. Disrupted bow tie indicating a small radial tear. Small radial tears a
upted bow tie. LEFT: Absent or empty meniscus on sagittal image.RIGHT: Axial image shows complete radial tear lead
r directly along the length of the tear you will see an absent or empty meniscus. These complete radial tears open up

ou will not find a displaced meniscal fragment. It is simply separation of the meniscal parts. More on empty meniscu
or empty meniscus-sign adjacent to the posterior cruciate ligament where the meniscal root should be. On coronal i
Meniscal root tear:
A meniscal root tear is a radial tear located at the meniscal root. Normally when you image the posterior cruciate liga
of the posterior horn of the meniscus on that image or the image adjacent to it. If this is not the case it is an absent c
niscal root tears
Post-operative meniscus:
Post-operative menisci are harder to evaluate because the two most important criteria, i.e. abnormal signal and abn
sign of a tear, because if there has been a suture repair, this will heal with scar tissue, which also has high signal on
is also high signal on T2-weighted images, then you can make the diagnosis of a tear, as this is the result of synovial
mon finding. Abnormal shape can be the result of partial meniscectomy. So you need to know what procedure was p
ostoperative images, can you determine, if an abnormal shape is a new finding indicative of a new tear. Sometimes c
t possible on conventional MR-images. In these cases, MR-arthrography with 40cc diluted Gadolinium helps to make
nto a tear are readily visible on fat saturated T1 images. PD and T2W images. Prior partial meniscectomy and suture
s 1 The case on the left shows a meniscus with an abnormal shape aswell as abnormal signal touching the surface or
ctomy and a suture repair. On the basis of these imaging findings, it is impossible to tell if this is a tear or a normal p
or ACL reconstruction. The surgeon looked at the meniscus and the meniscus was found to be normal i.e. no tear. LE
ew exam, there is a new tear (yellow arrow). It is not possible to tell if the old tear has healed. Post-operative Menisc
re was a new injury. On the new MR, it is impossible to determine if the old tear had healed. However a new tear is s
gnal is as bright as in the synovial fluid (yellow arrows). In the healed tear the signal is not as bright. On an MR-arthro
comparable with the synovial fluid, but only moderate signal intensity at the healed old tear. So comparison with the
m showed that the old tear has healed. PD and MR-arthrogram after suture repair for meniscal tear: healed tear. Po
eniscal tear. After a new injury, the PD-images show high signal unequivocally reaching the surface of the meniscus (
ed image on the left). On this image, it is not possible to tell if the tear has healed. So an MR-arthrogram was perform
None:

None:

Breast Implants:

Normal imaging findings and complications:
Esteban van Keulen, Saskia Fuchs, Maud Hegeman and Robin Smithuis
Department of Radiology of the Tergooi MC hospital in Hilversum, University Medical Center Utrecht and the Alrijne
Publicationdate 2022-04-05 Breast augmentation surgery is the most popular cosmetic surgery procedure worldwide
The number of women who have breast implants for augmentation or reconstruction is increasing. The risk of ruptu
construction after mastectomy for breast cancer than in implants for cosmetic augmentation. In this review we will f
dings of common implants. This review is based on a presentation given by Saskia
Fuchs, Esteban van Keulen en Maud Hegeman during the Sandwich course of the Radiological Society of the Netherl
februari 2021.
Introduction:

Location and type of implant:
About 80% of breast implants are for cosmetic augmentation, while about 20% are for breast reconstruction followin
Breast implants consist of a silicone outer envelope and a silicone or saline filling. Capsule
All breast implants will become encapsulated. This can start within weeks to years after implantation.
It is a physiological foreign body reaction of fibrous tissue that will form around the implant. Breast implants are pla
In this technique, the pectoralis major muscle is elevated from the chest wall.
Palpability
of the edges of the implant will be lower in general.
Mammograms are usually less distorted compared to the prepectoral group. Prepectoral implantIn the prepectoral t
rior to the glandular tissue.
Rippling is observed as the most common complication.
Mammograms are somewhat more distorted. The location of the implant in relation to the pectoral muscle is best re
filled implant which is cut to show the form-stable content. Silicone filled implantsThe most used breast implants co
ing of silicone gel.
The silicone filling has evaluated over the years into a more form-stable mass (figure). Saline filled implantsSaline fill
can be primarily used for cosmetic augmentation or
used
as breast tissue expanders in reconstructive surgery as a temporary device and gradually filled with saline. Saline fill
resulting in immediate deflation. Breast implants may be round or anatomically pre-shaped.

The surface of the envelope can be smooth or textured including a polyurethane covering to prevent the implant fro
Some implants have a patch, which is a textured area on its surface to keep the implant in place or as a palpable orie
ain finding if it is only seen as a single sign on a single image (which is uncommon).
Imaging findings:
This table summarizes normal and abnormal findings in breast implants. When the droplet-, noose- or keyhole sign i
it must be considered as an uncertain finding. The Linguine sign is most specific for intracapsular rupture. Normal fi
Calcifications can be found in about 25% of the breast implants. The incidence of capsular calcifications increases wi
e, although associated with some degeneration of the envelope. EffusionA
small amount of periprosthetic fluid is frequently seen and is almost always normal.
However
it still can be a seroma, hematoma or infection and must be correlated to
clinical symptoms. There is no absolute diameter that should be interpreted as
abnormal. Comparing
with the contralateral implant can be helpful. Folding
Palpable folds can occur especially in prepectoral implants with a superficial location in women with few surroundin
xamination. Folding is a normal finding. Capsular calcifications. Possible intracapsular rupture of the breast implant
capsular thickening with severe capsular calcifications. On the right side there also is an irregular content and some
linear lines, which is suspicious for intracapsular rupture. Degenerative changes Capsular contraction The
incidence of contraction of the capsule is up to 25% in 10 years and is seen
more often in breast reconstruction than in cosmetic breast augmentation. The capsule
will become
thick and hardens, the
implant shape will usually become rounder and less compressible. Droplet sign
The droplet sign and inhomogeneous content are degenerative changes that may indicate intracapsular rupture, bu
apsular rupture occurs when the shell of the implant ruptures but the fibrous capsule formed by the breast remains
Silicone does not freely extravasate, but is stuck between the capsule and the envelope.
This makes it difficult to detect on clinical exam or mammography. There are many signs described that indicate intr
capsule and the envelope.
Intracapsular rupture is best seen on MRI. Teardrop signIt is a focal invagination of the silicone envelope where the t
ardrop, which means that it is outside the envelope. Keyhole sign
Also known as nose-sign. It is a focal invagination of the silicone envelope where the two walls do not touch. A small
ope. Linguine sign
The ruptured envelope appears as curvilinear lines that look like Linguine pasta. These signs of intracapsular rupture
n some fluid, which is normal periprosthetic fluid (figure). Extracapsular rupture In extracapsular rupture the silicone
e and the fibrous capsule into the surrounding breast tissue. Capsular calcifications and extracapsular rupture (arrow
and a very round shape of the breast implant.
This indicates a contracture of the implant. At follow up in 2020 the contour has changed and now there is silicone b
upture (arrow). This elderly patient did not not want surgery, but only wanted screening for possible malignancy. In 2
is more cohesive and has less tendency to spread.
Reporting:
When you examine the patient with ultrasound, mention the degree of evaluability.
The condition of the implant can be obscured by capsular calcifications or the posterior border can be hard to see in
ort as the protocol is not able to
detect breastcancer.
Ultrasound:
Envelope (yellow arrow) and capsule (white arrow) anterior to the envelope
Normal findings:
Small effusions are commonly seen.
They have a different signal intensity than Silicone and should not be confused with the keyhole sign. The T2W-imag
filling the virtual space between the envelope and the capsule. This is a
normal finding. The T1W-image shows a hypointens
thickened capsule. The capsule will show hypointense on any sequence. The contour of the implant is more
rounded, which indicates capsular contraction. Although signs of contraction can be well seen on
imaging, the degree of contraction is estimated by physical exanination. Normal radial folds Radial folds are infoldin
ent.
This is also a normal finding.
The content within the fold-lines should not contain Silicone. Normal radial folds More normal radial folds. Normal r
pe.
There is no silicone content within these folds. Normal radial folds Another example of
an extensive deep course of normal radial folds. Water droplet sign Multiple small round internal drops with fluid sig

However there should be more signs to consider a possible rupture.
Folding:
Folds are seen in many forms. They are dynamic.
When turning outwards they are sometimes palpable, especially at the edges of the breast implant and at locations w
e folds are normal findings. Radial folds Deep linear or curved lines within the implant can be hard to call. Are they in
of intracapsular rupture? Try to look for more signs and follow the line to look for continuity with the envelope. In sc
Intracapsular rupture:
When there is silicone within a fold, then it is a sign of intracapsular rupture. The images show: Here another examp
silicone outside the envelope, but within the capsule.
Stepladder sign:
US can detect intracapsular rupture by identifying a series of horizontal echogenic straight or curvilinear lines, somew
y known as the “stepladder sign”. It is important not to confuse the stepladder sign with normal prominent radial fol
More examples of the “stepladder sign”. Stepladder sign in a patient with extreme capsular calcifications. In this pati
of the prosthesis.
However when looking from a different angle it was obvious that there was a stepladder sign indicating rupture. Due
only an intracapsular rupture or also some extracapsular leakage of Silicone. Intracapsular rupture A. The envelope
er content is complete inhomogeneous and degenerated. B. The envelope is collapsed (yellow arrow) and does not f
There is an inhomogenous collection between the envelope and the capsule containing Silicone. .
Extracapsular rupture:
This woman has an extracapsular rupture on the right with silicone outside the thickened capsule (white arrow). In th
subcapsular line with silicone on both sides of the line (yellow arrow). Another example of extracapsular rupture wit
explantation This patient had bilateral removal of the breast implants.
On the right there is high signal of silicone material in lymph nodes (white arrow). On the left there is residual silicon
llow arrow) and also within the muscle. When a new silicone prosthesis is implanted, this residual silicone should no
MRI:

Protocol:
MRI is the gold standard for evaluation of the integrity of the breast implant with a sensitivity of 80-90% and specifici
esolution and the ability to suppress or enhance the signal of Silicone, water and fat.
A combination of sequences can be used to detect complications.
Gadolinium i.v. is not needed. T2W-images
These are best for studying the anatomy and provide high resolution. They also give information about lymph adenc
ppressed, combined with water suppression. As a result there is only signal of the silicone material. This sequence is
one outside the envelope or outside the capsule. Water-only-imagesA combination of fat saturation and silicone sup
the prosthesis.
Linguine sign:
This is the most reliable sign of intracapsular rupture.
The curvilinear lines which are formed by the ruptured envelope resemble Linguine pasta. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll First study the image and answer the following question: Then scroll the image.
BIA-ALCL:

Anaplastic Large Cell Lymphoma:
BIA-ALCL
or breast implant associated anaplastic large cell lymphoma is an important complication
to
know of
silicon-filled and saline-filled breast implants. BIA-ALCL develops primarily if not exclusively in patients with textured
The estimated prevalence in these implants is 1:30.000.
Most BIA-ALCL were seen in Allergan Biocell textured breast implants and they were subsequently taken off the mar
BIA-ALCL present with discomfort and swelling due to the development of
periprosthetic effusion (85%) in which atypical lymphoid cells are found. Sometimes associated with a mass in 15% o
tured and analyzed. Staging is with PET-CT, like in any other lymphoma. Most patients present with Stage 1.
The treatment is surgical excision of the implant, capsule and mass if present. Outcome is
favorable when early treated.
X-Ray and CT:
Chest X-Rays and CT do not play a role in examining breast implants. Sometimes they can be detected on X-rays for i
valve of an expandable prosthesis is seen (arrow). Also on CT sometimes complications can be seen, but usually CT c
hesis. Intracapsular rupture The chest film shows capsular calcifications in a medially displaced breast implant, whic
ient shows also calcifications at the posterior side not following the contour of the implant indicating intracapsular ru

s a homogeneous grey internal density on CT with a surrounding thin more hyperdens envelope and capsule. Locati
een. This patient has a saline filled prosthesis with a low internal density.
A thin slightly hyperdens regular envelope is seen. Metallic valve On CT different types of fill valves of breast implant
nd sometimes the Linguine sign (arrow). In most cases the findings on CT will be inconclusive. The left implant in this
at the periphery and which are discontinuous. Unclear whether this is an extracapsular rupture or whether there is a
Mammography:
Same patient before and after prepectoral breast augmentation.
Especially prepectoral implants can reduce mammographic assessment. Still
mammography and 3D tomosynthesis can be well performed and in fact has the highest
PPV for recognition of extra capsular silicone.
It also objectively detects changes
in time, shows calcifications, can show surrounding fluid shadow and of course adds
important findings in fibroglandular tissue.
Eklund technique:
Special views can be performed such as the Eklund views.
By pushing the implant posteriorly and pulling the breast tissue anteriorly better visualization of the fibroglandular t
Tomosynthesis:
Tomosynthesis can be very useful as in this case.
There is a mass on the lateral side, which is best seen on the 3D tomographic image.
Ultrasound guided biopsy was performed and this mass proved to be a fibroadenoma. On this mammogram there w
. Detail of the specimen showing mass and grouped calcifications. Pathology: breast cancer grade 2, no special type (
diaphragm, which is the fill valve.
There is a mass, which is more obvious on the tomosynthesis (image 56 out of 73). It is a spiculated mass.
Pathology: infiltrating lobular carcinoma grade 2 and LCIS. Another example of the value of tomosynthesis. The tumo
Complications of implants:
The oblique view of the right breast shows a deflated ruptured Saline filled implant. A normal saline filled implant w
ular calcifications of a previous inplant and a subpectoral prosthesis. In B there is a situation after operative capsulec
one leakage Typical appearance of silicone outside of the capsule presenting as dense well deliniated masses outsid
Silicone granulomas:
Silicone granulomas remainig after removal of breast implant because of previous extracapsular rupture in 2013. Sil
and enhancement dynamics on breast MRI or with increased FDG uptake on PET CT.
They
can present at the periphery of the prosthesis or in breast tissue after
rupture. The presence of silicone implants and awareness of the possibility of a rupture and formation of silicone gra
e silicone breast injections
Free silicone breast injections:
This is an alternative form of breast augmentation, although it has serious adverse effects and is banned in many co
painful lumps in the breasts. The massive densities in both breasts are the result of silicone intraglandular injections
ee silicone as areas of high signal on silicone-only sequence.
Surgery:
Sorry, your browser doesn't support embedded videos.
Removal of thickened capsule:
In this video first an incision is made in the thickened capsule.
The implant is subsequently removed through this incision. Finally the thickened capsule is removed. Breast Cancer
2. Imaging of breast implants—a pictorial review Insights Imaging. 2011 Dec; 2(6): 653–670.
Sella Turcica and Parasellar Region:
Walter Kucharczyk and Marieke Hazewinkel
Radiology department of the University of Toronto, Canada and the Radiology department the Medical Centre Alkma
Publicationdate 2008-08-10 This review is based on a presentation given by Walter Kucharczyka and was adapted for
tematic anatomic approach to differential diagnosis of a sellar or parasellar mass is described. By clicking on one of t
this item. If you have printing problems with the margins of the document, you may have to adjust the margins in th
top left of the menu bar.
Anatomic Approach to Differential Diagnosis:
In order to analyze a sellar or parasellar mass on MRI we use the following anatomic approach: Pituitary gland On a
pituitary gland which lies in the sella turcica. It is usually larger in females than in males - in females the superior bor
ncave. The most common abnormalities that arise in the pituitary gland are pituitary adenoma, Rathke's cleft cyst an
fy is the pituitary stalk. This is a vertically oriented structure which connects the pituitary gland to the brain. It is thinn
ly, it is also derived from Rathke's cleft epithelium and therefore the pathologies, which can arise in the pituitary glan
gs to be considered in children, such as germinomas and eosinophilic granulomas. In adults metastases and occasio
r major structure in the suprasellar cistern is the optic chiasm. It is an extension of the brain and looks like the numb

ost common tumors to originate here are gliomas. In the US and Europe another frequent pathology in this region is also be associated with some swelling of the optic chiasm. Hypothalamus Further cephalad lies the base of the brain othalamus forms the lateral walls and floor of the third ventricle. The most common pathologies to arise here are gli loma. Carotid artery A very important structure in this area is the internal carotid artery. It runs a complex anatomic n lateral views. It passes through the cavernous sinus. The segment cranial to this is known as the supracavernous s passes cranially to the optic chiasm, and the middle cerebral artery, which runs laterally. Aneurysms and ectasias are genital variations in the course of the internal carotid Sometimes it is very medially positioned and can actually lie in d complex of venous channels. In the lateral wall of the sinus run nerve III (oculomotorius), IV (trochlearis), V1 and V2 medially and is located caudal to the carotid artery. The most common pathologies occurring in the cavernous sinus on, which can lead to thrombosis. This is known as cavernous sinus thrombophlebitis. Carotid-cavernous fistulas are of the cavernous sinus. Meninges The meninges cover the cavernous sinus. They are thicker laterally and superiorly the meninges is of course the meningioma. Dural metastasis is the second most common tumor to arise here. Also n infection being tuberculous meningitis. Of the non-infectious inflammatory pathologies sarcoidosis is the common id sinus. This structure contains air and is lined by mucosa and bone. Posterior to the sphenoid sinus lies the clivus (gy that arises in this area includes carcinomas arising from the mucosa of the sphenoid sinus - squamous cell carcin rise in the clivus and chondrosarcomas and osteosarcomas also occur in this area. Metastases can occur anywhere. spread intracranially via the cavernous sinus.

Pituitary Microadenoma:

Pituitary Microadenoma By definition, pituitary microadenomas are less than 10 mm in diameter and are located in n about 3-4 mm in diameter, slightly hypointense compared to normal pituitary tissue, located in the pituitary gland. agnosis: pituitary microadenoma or Rathke's cleft cyst (the two can be indistinguishable). The sensitivity of an unenh 0%. It is not always necessary to give intravenous contrast for detecting pituitary microadenomas as patients with a s patients with a microadenoma (usually these patients are women with symptoms of hyperprolactinemia). The purp candidates (for example patients with failed medical therapy or pituitary disease not amenable to medical therapy s alize the lesion as accurately as possible. On an unenhanced scan, approximately 70% of all pituitary microadenoma -negative rate from 30% to 15%. As mentioned earlier, this usually does not affect patient management. Coronal T1 a linium. In this patient the lesion in the pituitary gland is only detectable after the administration of intravenous contr Rathke's cleft cyst.

Pituitary Macroadenoma:

By definition, pituitary macroadenomas are adenomas over 10mm in size. They tend to be soft, solid lesions, often w ow, they first expand the sella turcica and then grow upwards. In this example of a pituitary macroadenoma there is chiasm. Because they are soft tumors, they usually indent at the diaphragma sellae, giving them a 'snowman' config ituitary macroadenoma and a meningioma. Another feature which can help differentiate them is enlargement of the as that originate in the sella. On the left another example of a pituitary macroadenoma. The lesion starts in the sella, Note the classic 'snowman' configuration caused by constriction by the diaphragma sellae. Notice the blood-fluid lev nation of the diaphragmatic leaflets was referred to earlier. On the T2-weighted images on the right you can see that tarted in the sella and is growing upwards. A lesion originating above the sella and growing downwards would push mas for example). Usually the diagnosis of a macroadenoma is straightforward. Sometimes a meningioma can give a e is no diaphragmatic constriction and there is uniform enhancement after the administration of intravenous gadoli enoidal resection of a pituitary macroadenoma. After the bony floor of the sella turcica has been removed, the dura he dura is larger than the pressure below, the macroadenoma then delivers itself into the sphenoid sinus. Intra-oper hether the neurosurgeon had successfully removed all of the tumor. Because using this surgical approach means a l you are operating on. As we will see there are lesions you do not want to operate using this approach! Another comm is not always possible to tell if there is cavernous sinus invasion, but there are three signs to look out for:

-Is there more than 50% encirclement of the carotid artery? Note: meningiomas tend to constrict the carotid artery, n

-Is there lateral displacement of the lateral wall of the cavernous sinus compared to the opposite side?

-Is there an increased amount of tissue interposed between the carotid artery and the lateral wall of the cavernous s of a common lesion is more likely than a rare abnormality. Since pituitary adenomas are the most common lesions rential diagnosis if you can not identify a normal pituitary gland when confronted with a mass in this region. This pat ialist who saw a large endonasal mass and she was referred to the neurosurgeon for planned major skull base resec d her prolactin-level. This was 4000 (25 or less is normal). Endonasal biopsy revealed prolactinoma. After treatment w sary.

Rathke Cleft Cyst:

Rathke's cleft cyst is the second of three pathologies derived from Rathke's cleft epithelium. The cyst is fluid-filled an ell layers. This is illustrated by the microscopic image. These walls can contain cells which secrete fluid, allowing the c ft cysts can occur either in or above the sella turcica. On the images above there is a normal pituitary gland, a norma ituitary stalk is not identifiable, however, due to a round mass in this area. The mass has a high signal intensity on th s bright on unenhanced T1-weighted images are either fluid (blood or proteinacious fluid) or fat. Solid masses are no iginating from the pituitary stalk, probably a Rathke's cleft cyst. A cystic craniopharyngioma is also in the differential These images illustrate the importance of unenhanced T1 images. They allow you to appreciate that the abnormality

with images after the administration of intravenous contrast, you might think the pituitary gland was abnormal as w
rate another Rathke's cleft cyst located in the pituitary gland. Unlike the normal pituitary tissue and pituitary stalk it
ontrast. The normal pituitary tissue is compressed and displaced far to the left. It is important to recognize this as it
mass. In general, all extra-axial masses , i.e. masses outside of the brain like the pituitary gland and stalk, will enhanc
ave a non-enhancing extra-axial mass, there are three possibilities:
Craniopharyngioma:
Craniopharyngioma is the third of the three pathologies derived from Rathke's cleft epithelium. Technically these are
walls and are locally invasive. Macroscopically, it is a complex mass with multiple nodules at the base of the brain, si
resected. The picture on the right shows a thick-walled cyst as part of the craniopharyngioma. In over 50% of cases c
hanced and enhanced T1-weighted sagittal images, a compressed pituitary gland can be identified. There is a large in
ts as well as calcifications. These findings in a child are virtually pathognomonic for craniopharyngioma (perhaps with
of the same mass. And axial images. Unenhanced CT shows the calcifications more clearly. After intravenous contra
h less evident.
Meningioma:
The most common intracranial tumor in adults is the meningioma with 20% of occurring at the skull base. This is an
ing on the diaphragma sellae. Meningiomas are almost always solid lesions, sometimes with a cyst on the edge. They
general rule. On the top-left unenhanced and enhanced CT-images, the main differential diagnosis of the enhancing
he post-constrast MR-image on the top-right rules out an aneurysm as a possible diagnosis (no flow void), but on axi
to differentiate. Notice the spread of the lesion along the meninges. The epicentre of the lesion is above the sella. M
1 and T1-postcontrast), a compressed pituitary gland can be identified at the bottom of the sella turcica. Above it lies
r. Although the diaphragma sellae can not be identified on these images, it is probably a suprasellar mass growing d
have areas of hemorrhage or necrosis - in mengiomas this is less often the case.
Aneurysm:
This is an important case to keep in mind. This patient is a woman in her late forties, who presented to her family do
, including a determination of her prolactin level. This was about 150 (25 or less is normal). Thinking the patient had
It is easy to get tunnel vision when reporting on a scan like this as a radiologist when the clinical information includes
thought is a pituitary adenoma. If you look at the location of the lesion however (partially in the sella turcica and part
s, including a meningioma or an aneurysm. The radiologist reported this as a pituitary adenoma, and the patient was
the patient went to a neurosurgeon for a surgical opinion. The neurosurgeon ordered this MRI. The lesion partly in t
minantly black on this T1-weighted image. In general there are three things that are black on MRI: air, bone and rapi
n a carotid aneurysm. This is the corresponding angiogram. Obviously, this is not a lesion to be operated on transsp
or inhibit (red arrow) the production of pituitary hormones. Why did the aneurysm cause hyperprolactinemia and ga
itary stalk. The pituitary stalk connects the hypothalamus to the pituitary gland and hormones produced in the hypo
nd via portal veins running along the stalk. Most of these hormones stimulate the production of other hormones in t
ase of dopamine inhibits the production of prolactin by the anterior lobe of the pituitary. Therefore when the stalk is
rises while all the other hormone levels decrease. This is known as the 'Stalk Section Effect'.
It is the reason why masses other than adenomas can cause hyperprolactinemia. This is also why an unenhanced M
ze of the microadenoma, but ruling out other pathology that matters. On the left the T1-weighted image of a thromb
originates in the intracavernous segment of the right internal carotid artery.
On the right the T2-weighted images: the thrombosed aneurysm has a dark rim. This is an example of a partially thro
ack on these T1-weighted images. It is surrounded by clot of different ages arranged in layers reaching from the lum
autopsy specimen. You can see that this patient suffered a massive intraventricular and subarachnoid hemorrhage.
Aneurysm vs Meningioma:
One of the most difficult differential diagnoses on CT is aneurysm versus meningioma. In this patient there is a large
inges or cavernous sinus. On CT it is impossible to tell whether this mass is an aneurysm or a meningioma. This is an
ere is a large flow artefact running in the phase-encoding direction. These findings correspond to rapid blood flow, a
e patient. It demonstrates that the flow in the aneurysm is not laminar, but that it swirls, gradually filling the lumen w
Hamartoma:
Hamartomas are masses of dysplastic tissue found almost exclusively in young children. One of the most common lo
imen showing a small nodule hanging in the suprasellar cistern. They are benign lesions, but patients do succumb to
oma suspended from the floor of the third ventricle. It does not enhance after the administration of intravenous con
or of the third ventricle. Hamartoma (red arrow) posterior to the enhancing pituitary gland and stalk. The best image
es. Here you can see the non-enhancing hamartoma attached to the tuber cinereum between the pituitary stalk and
Hypothalamic and Chiasm Glioma:
Optic nerve glioma in a patient with neurofibromatosis Gliomas can occur in any part of the brain and the optic chias
matosis type 1. This enhanced CT shows an example of an optic nerve glioma in a patient with neurofibromatosis. Th
chiasm. Further forward at the level of the orbits the optic nerve is abnormal on both sides. These consecutive coro
optic nerves. On these axial images you can see the optic nerves and chiasm enhance after the administration of intr
ces through the nerves themselves are not obtained. These slices can be used to make oblique images along the axis
of the nerve after intravenous contrast with sparing of the meninges. Approximately 25% of optic nerve gliomas do

making the diagnosis. This is another example of a right-sided optic nerve glioma with enhancement after gadoliniu
Germinoma:
Germinoma (Courtesy of Dr. Susan Blaser) The following case concerns a 9-year-old male with a history of headache
us contrast show a mass in the midline, on the floor of the third ventricle. The mass enhances after gadolinium. Con
e same patient show a similar mass in the epiphysial area. This is a germinoma - an intracranial germ cell tumor that
localisations. These lesions crawl along the floor of the 3rd ventricle.
Chordoma:
Chordomas are the most common lesions of the clivus, also a favored location for metastases and chondrosarcomas
rge, fungating mass positioned at the level of the clivus. The CT shows some calcifications in this area. The differentia
a. Chordomas tend to occur in the midline, whereas chondrosarcomas tend to occur off the midline.
Metastases:
The patient on the left is a patient with lung cancer who presented with a sixth cranial nerve palsy. The abnormality i
this sagittal T1-weighted image (as in the image on the left). A low signal intensity means the normal fatty marrow ha
astasis. Also lymphomas, myelomas or diffuse bone abnormalities can give this appearance. Therefore always take a
or parasellar mass on MRI we use the following anatomic approach:
CT-pattern of Bowel wall thickening:
Richard Gore and Robin Smithuis
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Publicationdate 2014-05-21 This article is based on a presentation given by Richad Gore and adapted for the Radiolo
book of Gastrointestinal Radiology, 3rd Edition and High Yield Imaging: Gastrointestinal. We will discuss a pattern ap
ntion to the CT-enhancement patterns.
Introduction:
Bowel wall thickening is a common finding in imaging. CT can be helpful in the differentiation of intestinal disease. In
discussed in detail in the following paragraphs.
Lenght of bowel wall involvement:
Adenocarcinoma usually presents as a short segment of bowel wall thickening. The borders are shouldering unlike in
* 5-10 cm involvement Diverticulitis, Crohn's disease and ischemia usually present as a somewhat longer segment o
* 10-30 cm involvement See the list in the table. The image shows a submucosal hemorrhage. This is mostly seen in
* Diffuse involvement When the entire colon is involved think of ulcerative colitis. Involvement of both the colon and
ma and SLE.
Overview of enhancement pattern:
The figure shows an overview of the CT-patterns of mural enhancement in patients with bowel wall thickening. Click
Type 1 - White Attenuation:
There are many pathophysiologic events that can cause a white attenuation pattern: Normal bowel wall enhanceme
he late arterial phase, i.e. 35-40 seconds post injection. If the bowel wall is not thickened, this is normal enhancemen
sometimes difficult to differentiate between the white enhancement pattern and the water-target-sign pattern. Acut
Acute IBD:
Here a patient with acute inflammatory bowel disease (IBD). Notice the bright enhancement of a large segment of th
a due to the vasodilatation. Notice the dilated vessels on the ventral side. Shock bowel with hyperenhancement. Slit-
Shock Bowel:
In patients with a hypovolemic shock, there is a redistribution of the blood flow. This can result in abnormal bright en
o is in a hemorrhagic shock. Notice that some bowel loops show a white pattern, while others show a water target si
d arrow). Hyperenhancing adrenal glands in shock. As a result of redistribution of bloodflow to vital organs, these pa
are needed to produce adrenaline in order to manage the shock.
Type 2 - Gray Attenuation:
In the gray-pattern, the bowel wall is thick and despite a nice bolus of contrast there is poor enhancement and you c
is seen in chronic fibrotic Crohn's disease, ischemia and neoplasms like adenocarcinoma and lymphoma. Gray enhan
Chronic Crohn's disease:
Here a patient with chronic Crohn's disease with cicatrization. In these patients the bowel wall is like a rock and these
Mesenteric Ischemia:
Bowel ischemia frequently affects the colon and is more frequently seen in the splenic flexure, descending colon and
hock or congestive heart failure. Especially in elderly with bowel wall thickening you should always put ischemia in yo
n the small bowel is a closed loop obstruction, which we will discuss in a moment. Gray enhancement pattern in a pa
result of thrombosis in the SMV (red arrow). Notice the venous congestion in the mesentery (yellow arrow). Gray enh
another patient with ischemia of a large segment of the small bowel due to a closed loop obstruction. An important
of dilated small bowel loops with the mesenteric vessels converging to a central point. The findings of ischemia in clo
uses of mesenteric ischemia: Click here for more information about closed loop obstruction. Sometimes it can be he
reconstructions. This is nicely demonstrated in this patient, where there is good enhancement of the jejunum (green
t of ischemia. Here another case of closed loop obstruction. Notice the difference in enhancement between the norm
loops (red arrow). In the center are the twisted mesenteric vessels (yellow arrow).

Tumor:
The gray enhancement pattern with loss of identification of the various layers of the bowel wall can be seen in variou
neuroendocrine tumors like carcinoid usually show somewhat more enhancement. Here a patient with an adenocar
Type 3 - Water target sign:
The most common type of enhancement is the target sign with water density. Target sign with submucosal edema. T
a with the edematous submucosa in between (figure). Pseudomembranous Colitis with dilatation of the sigmoid.
Pseudomembranous Colitis:
Pseudomembranous colitis (PMC or sometimes called colitis difficile) is a colitis, that is mostly caused by the bacteriu
lon in patients who are treated with broad-spectrum antibiotics. Here a patient with PMC. There is ascites and hyper
the mesocolon. The dilated bowel in the right lower abdomen is actually the redundant sigmoid. Pseudomembrano
icile toxins in the stool or the presence of C. difficile itself. The endoscopic detection of pseudomembranes on the m
e the above tests and CT were available. Risk factors for developing PMC are: Pseudomembranous colitis Patients pr
that are produced by the bacteria. The disease can be complicated by a toxic megacolon. Pseudomembranous coliti
Portal hypertension:
Portal hypertension is another cause of the water target sign. When a patient has portal hypertension, the increased
neration of inflammatory mediators and increased production of nitrous oxide, which induces tissue injury. This pro
ontinue reading. The findings are: The differential diagnosis is: Right -sided colitis in a patient with cirrhosis and port
tient with right-sided colitis.
Spontaneous bacterial peritonitis:
Patients with portal hypertension and right-sided colitis are at risk for developing spontaneous bacterial peritonitis.
n. A diffuse colitis can be seen with granular, erythematous and mucosal friability, which just looks like ulcerating col
veloping spontaneous bacterial peritonitis: Typhlitis in a patient with neutropenia.
Typhlitis:
Typhlitis is another disease that presents with the water target sign. Typhlitis is a necrotizing inflammation of the cec
o acute leukemia, AIDS or aplastic anemia. There is transmural edema and ulceration, which can cause perforation.
V and E. Coli. These patients are very sick and have fever, watery-bloody diarrhea and neutropenia. Neutropenia is a
that helps fight off infections, particularly those caused by bacteria and fungi. When the neutropenia is severe - few
at normally present in the mouth and digestive tract can cause infections. CMV-colitis.
Infectious Colitis:
Right colon: Diffuse colitis Left colon and Rectosigmoid: Rectosigmoid:
Ischemia:
In young patients ischemia is usually due to trauma or vasculitis. Here are images of a young patient with SLE. There
Type 4 - Fat target sign:
Submucosal fat was first reported in patients with chronic ulcerative colitis and Crohn's disease. Soon it turned out t
cially in the transverse and descending colon. Now the most common cause of the fat target sign is obesity. Rapid su
d with chemotherapy. Here a patient with Crohn's disease and a fat-target sign. 17% of patients with Crohn's disease
t is dependent on the duration of the disease. Submucosal fat is frequently seen in patients with celiac disease. Espe
mal jejunum, that is very suspicious of celiac disease. These patients also have more pronounced folds in the ileum c
ing (figure). The faeces in these patients may contain more fat (blue arrow). How to deal with submucosal fat?
Type 5 - Gas - Pneumatosis:
The most concerning pattern is gas within the bowel wall. Gas within the bowel wall is called pneumatosis intestinali
s in patients with ischemia and impending bowel perforation, who need immediate therapy. However pneumatosis c
complaints. Finally gas adjacent to the bowel wall can mimick pneumatosis. This is called pseudopneumatosis. So th
stinalis and what is the clinical setting of the patient. The clinical course is generally benign when pneumatosis is an i
th obstructive pulmonary disease.
Pseudopneumatosis:
Let's first start with pseudopneumatosis, because we don't want to alarm anybody by mistaking normal intraluminal
gas bubbles can be trapped between fecal debris and the mucosa. In this case we are quite sure that the gas is intra
t. The linear arrangement of the gas bubbles makes it suspective of pneumatosis. However these gas bubbles are tra
u have to carefully study all the images and use different window settings. Give special attention to the non-depende
a and gas bubbles will not be seen. Pseudopneumatosis in SBO. String of pearls signThis is a patient with a small bow
he CT-images show dilatation of the small bowel. In these patients the folds of the small bowel or valvulae connivent
r configuration on the ventral side. On a horizontal beam radiograph of the abdomen this is known as the string of p
. Enable Scroll
Disable Scroll Scroll through the images. Enable Scroll
Disable Scroll Scroll through the images. Scroll through the images and then continue reading. At first glance this rea
cending colon due to an obstructing tumor. Notice how gas bubbles can be seen in a circular arrangement and are a
. However when we scroll through the images, it becomes clear that these gas bubbles are only seen in between the
here is a air-fluid level, there are no air bubbles on the non-dependent portion of the bowel wall. So this is another c
owel and decompression is needed. Such an accumulation of gas bubbles between the mucosa and the bowel conte

ments due to longstanding and severe obstruction.
Portal venous gas:
Now let's continue with some patients, who do have pneumatosis. Here a patient in whom there is no doubt about t
mesenteric or portal veins is diagnostic of pneumatosis. These patients are not only at risk for bowel ischemia and p
radiologic sign and is associated with a high mortality rate. The increased use of CT has resulted in the recognition o
l venous gas of which diverticulitis is the most common. Here a patient with extensive pneumatosis and gas within th
air in the intrahepatic bile ducts and in the common bile duct (arrow). Gas in the portal veins has to be differentiated
. Sometimes an air-fluid level can be seen in the portal vein. Portal venous gas is located peripherally in the liver as o
ed. In this case it is obvious that the air is located within the bile ducts. There is air centrally in the liver and we also s
a common cause of pneumatosis. Here a patient with pneumatosis of the cecum and ascending colon as a result of
l indicates an impending perforation. Here another patient with pneumatosis as result of an obstruction. Post decom
Pneumatosis due to trauma:
Trauma is a well-known cause of pneumatosis. Laceration of the mucosa due to anastomotic surgery or catheter ma
this patient the insertion of a feeding catheter resulted in pneumatosis of the small bowel. Pneumatosis after insert
after a percutaneous endoscopic gastrostomy (PEG). This is a procedure in which a PEG tube is passed into the stom
oral intake is not adequate. Notice the following: Enable Scroll
Disable Scroll Scroll through the images. Enable Scroll
Disable Scroll Scroll through the images. Here a very strange case to show how difficult things can be and that findin
ic and based on the ultrasound findings the diagnosis of an abscess post-cholecystectomy was made. A CT was perfo
(red circle). Scroll through the images. Then continue reading. On the first image there is gas in the portal veins. The
ere is extensive pneumatosis (red arrows). The curved arrow indicates the markers that were placed in preparation o
transferred for emergency laparotomy, because bowel ischemia was suspected. At surgery the bowel was distended
ly and the patient did well. Finally it was concluded that the pneumatosis was probably the result of mucosal damage
u. These CT-findings will always be suspective of bowel ischemia and necessitate emergency surgery in the proper cl
Incidental pneumatosis:
Here images of a patient without any abdominal symptoms. There is pneumatosis, which was regarded as an incider
hma and COPD.
Pneumatosis in mesenteric ischemia:
Pneumatosis is sometimes seen in mesenteric ischemia and is a sign of pending perforation and necrosis. In this pat
arrow). This has resulted in ischemia of the right colon with pneumatosis. Notice the subtle portal venous gas in the
Degree of mural thickening:
The diseases that cause the largest bowel wall thickening are Crohn's disease and Pseudomembranous colitis (PMC)
Mesenteric abnormalities:
Patency of the mesenteric vesselsThe causes of bowel ischemia are arterial occlusion, venous thrombosis, strangula
with poor enhancement. In the mesentery there is edema and venous engorgement. These findings indicate ischem
rmation in a patient with Crohn's disease. Mesenteric changes In the mesentery we look for: Here we see a fistula be
ease. Mesenteric edema Mesenteric edema in association with bowel wall thickening is seen in: These images are of
oup of small bowel loops with a thickened wall in the right upper abdomen (yellow arrow). The mesenteric edema (re
Engorgement of vessels Increased venous pressure in strangulation also leads to engorgement of veins (yellow arrow
ement pattern of the strangulated bowel loops (red arrows). Notice the normal enhancement of small bowel proxim
el and extensive mesenteric edema. At surgery this was all necrotic small bowel.
Lumen contents:
Look at the content of the bowel lumen for: Small bowel feces sign The yellow arrow indicates a small bowel feces sig
hemorrhage Here a patient high density bowel content indicating gastro-intestinal hemorrhage. Fatty bowel content
G. Harisinghani, MD, , Kartik Jhaveri, MD, , Jose Varghese, MD, and , Peter R. Mueller, MD AJR sept 2002 volume 22, is
2. Pneumatosis intestinalis UpToDate
Cerebral Venous Sinus Thrombosis:
Barbara Simons, Geert Lycklama a Nijeholt and Robin Smithuis
Radiology department of the Medical Centre Haaglanden in the Hague and the Rijnland hospital in Leiderdorp, the N
Publicationdate 2010-10-21 Cerebral venous thrombosis is an important cause of stroke especially in children and yo
ly missed on initial imaging. It is a difficult diagnosis because of its nonspecific clinical presentation and subtle imagin
ntroduction
Introduction:
Cerebral venous thrombosis is located in descending order in the following venous structures: Internal cerebral and
* Cavernous sinus. Clinically patients with cerebral venous thrombosis present with variable symptoms ranging from
d dehydration is a common cause of venous thrombosis. In older children it is often local infection, such as mastoidi
70% and infection is the cause in 10% of cases. In women, oral contraceptive use and pregnancy are strong risk facto
When to think of venous thrombosis:
Venous thrombosis has a nonspecific presentation and therefore it is important to recognize subtle imaging findings
Although these findings are often present on initial scans, they are frequently detected only in retrospect. Clinically p

which is not a symptom in patients with an arterial infarction. On a routine non-enhanced MR or CT you should think
Dense clot sign:
Direct visualization of a clot in the cerebral veins on a non enhanced CT scan is known as the dense clot sign. It is see
nser than brain tissue and in some cases it is difficult to say whether the vein is normal or too dense (see pitfalls). In
this problem. Dense clot sign in a thrombosed cortical vein. Dense clot sign (2) Visualization of a thrombosed cortica
known as the cord sign. Another term that is frequently used, is the dense vessel sign. Dense clot sign (3) On the left
oral lobe (red arrow). Notice the dense transverse sinus due to thrombosis (blue arrows). Two cases of empty delta s
Empty delta sign:
The empty delta sign is a finding that is seen on a contrast enhanced CT (CECT) and was first described in thrombosis
ar area of enhancement with a relatively low-attenuating center, which is the thrombosed sinus. The likely explanatio
surrounding the thrombosed sinus, producing the central region of low attenuation. In early thrombosis the empty
tion of the thrombosed vein on the CECT. The sign may be absent after two months due to recanalization within the
the right transverse sinus and the left transverse and sigmoid sinus (arrows). There is enhancement surrounding the
of normal flow void on T2-weighted image..
Absence of normal flow void on MR:
On spin-echo images patent cerebral veins usually will demonstrate low signal intensity due to flow void. Flow voids
also be seen on T1-weighted images. A thrombus will manifest as absence of flow void. Although this is not a compl
e you think of the possibility of venous thrombosis. The next step has to be a contrast enhanced study. On the left a
nus and jugular vein (blue arrow). On the left there is abnormal high signal as a result of thrombosis (red arrow). Ver
image. Absence of normal flow void on MR (2)
The images on the left show abnormal high signal on the T1-weighted images due to thrombosis. The thrombosis ex
e and sigmoid sinus on the right. Notice the normal flow void in the left transverse sinus on the right lower image. Ab
detecting venous thrombosis, but there are some pitfalls as we will discuss later. Slow flow can occur in veins and ca
Venous infarction:
The other sign that can help you in making the diagnosis of unsuspected venous thrombosis is venous infarction. Ve
in vasogenic edema in the white matter of the affected area. When the proces continues it may lead to infarction an
s is unlike in an arterial infarction in which there is only cytotoxic edema and no vasogenic edema. Due to the high ve
arction compared to arterial infarction. Since we are not that familiar with venous infarctions, we often think of them
istribution. However venous infarctions do have a typical distribution, as shown on the left. Since many veins are mid
een in thrombosis of the superior sagittal sinus, straight sinus and the internal cerebral veins. Bilateral infarction in s
Superior sagittal sinus thrombosis The most frequently thrombosed venous structure is the superior sagittal sinus. I
ttal and frequently bilateral. Hemorrhage is seen in 60% of the cases. On the left bilateral parasagittal edema and su
ittal sinus. On the left reconstructed sagittal CT-images in a patient with bilateral parasagittal hemorrhage due to thr
contrast enhanced image indicates the filling defect caused by the thrombus. Venous infarct in Labbe territory Venou
is due to thrombosis of the vein of Labbe. On the left images demonstrating hypodensity in the white matter and les
s a broad differential diagnosis including arterial infarction, infection, tumor etc. Notice that there is some linear den
In the differential diagnosis we also should include a venous infarct in the territory of the vein of Labbe. The subtle d
he key to the diagnosis. This is a direct sign of thrombosis and the next step is a CECT, which confirmed the diagnosi
the left images of a patient with hemorrhage in the temporal lobe. When the hemorrhagic component of the infarct
surrounding vasogenic edema. The clue to the diagnosis in this case is seen on the contrast enhanced image, which
arrow). Hemorrhagic venous infarct in Labbe territory On the left a similar case on MR. There is a combination of vas
rrow). These findings and the location in the temporal lobe, should make you think of venous infarction due to throm
rast enhanced MR or CT to prove the diagnosis. Venous thrombosis of vein of Galen and straight sinus Venous infarc
trating high signal in the left thalamus. When you look closely and you may have to enlarge the image to appreciate t
. These bilateral findings should raise the suspicion of deep cerebral venous thrombosis. A sagittal CT reconstruction
in of Galen (arrows). On the left a young patient with bilateral abnormalities in the region of the basal ganglia. Based
ing small vessel disease, demyelinisation, intoxication and metabolic disorders. Continue with the T1-weighted image
to deep cerebral venous thrombosis Notice the abnormal high signal in the internal cerebral veins and straight sinus
ue to flow void. This was unlike the low signal in other sinuses. The diagnosis is bilateral infarctions in the basal gang
on (5) - Edema In some cases of venous thrombosis the imaging findings can resolve completely. On the left a patien
ession was that this could be a low grade glioma. On a follow up scan the abnormalities had resolved completely. In
ins and the diagnosis of venous thrombosis was made. The high signal intensity can be attributed to vasogenic edem
.
Imaging in suspected thrombosis:
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CT-venography:
CT-venography is a simple and straight forward technique to demonstrate venous thrombosis. In the early stage the
ere is non-enhancement of the thrombus with surrounding enhancement known as empty delta sign, as discussed b

g that you don't want to do, is to scan too early, i.e. before the veins enhance or too late, i.e. when the contrast is gon
just add 5-10 seconds delay. To be on the safe side we advocate 45-50 seconds delay after the start of contrast inject
of a CT-venography demonstrating thrombosis in many sinuses. Enable Scroll
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Disable Scroll On the left images of a patient with an infarction in the area of the vein of Labbe. On the non-enhance
verse sinus and the hemorrhage in the infarcted area. On the enhanced images a filling defect can be seen in the tra
image of a Phase-Contrast angiography.The right transverse sinus and jugular vein have no signal due to thrombosis
MR-venography:
The MR-techniques that are used for the diagnosis of cerebral venous thrombosis are: Time-of-flight (TOF), phase-co
result of being unsaturated, these spins give more signal that surrounding saturated spins.
* Phase-contrast angiography uses the principle that spins in blood that is moving in the same direction as a magnet
he velocity of the spins. This information can be used to determine the velocity of the spins. This image can be subtra
oding gradients, to obtain an angiogram.
* Contrast-enhanced MR-venography uses the T1-shortening of Gadolinium. It is similar to contrast-enhanced CT-ven
ges. On the left a lateral and oblique MIP image from a normal contrast-enhanced MR venography. Notice the promi
y MR techniques has its own pitfalls as we will discuss in a moment. Contrast-enhanced MR venography has the disa
DSA:
Angiography is only performed in severe cases, when an intervention is planned. On the left images of a patient with
icoagulant therapy. There is thrombosis of the superior sagittal sinus (red arrow), straight sinus (blue arrow) and tran
deo of the thrombectomy. Sorry, your browser doesn't support embedded videos. On the left a video of the thrombe
Pitfalls in CT:

Arachnoid Granulations:
Arachnoid granulations are small protrusions of the arachnoid through the dura mater. They protrude into the veno
these granulations are easily to differentiate from thrombosis. Normal transverse sinus (left) and thrombosed trans
Mimick of dense clot sign:
Normally veins are slightly denser than brain tissue and in some cases it is difficult to say whether it is normal or too
to solve this problem. On the left an image of a thrombosed transverse sinus and next to it a normal transverse sinu
s usually less dense than in older children and adults. This results in a relative high density of the blood in the sagitta
t sign. Hematoma mimicking a dense clot sign Hematoma simulating dense clot sign. Usually there is no problem in
ith a peripheral intracerebral hematoma. Because it is located in the area of the transverse sinus it simulates a thron
Pseudo empty delta sign:
Here a patient with a subdural hematoma on the left side, that has spread to the region of the superior sagittal sinus
ign. By scrolling through the data set, it was obvious that it was an extention of the hematoma. A hyperdense empye
Wrong bolus timing:
On the left three images of a patient with venous thrombosis in the superior sagittal sinus. On the far left we see a d
made 25 seconds after the start of the contrast injection. There is arterial enhancement and it looks as if the superio
e through of the dense thrombus. Only on the image on the right, which was made 45 seconds after contrast injectio
mbus in the sinus.
Pitfalls in MRI:

Hypoplastic transverse sinus:
Hypoplasia and aplasia of the right or left transverse sinus is a common finding. It can easily be mistaken for sinus th
missing. When you suspect, that there is a hypoplastic transverse sinus, then you should look at the size of the jugul
the left transverse sinus. Notice the size difference of the jugular foramen. On the left a transverse MIP of phase-con
transverse sinus or thrombosed sinus, you need to look at the source images. On the source image on the right you
re thrombosis of the left transverse sinus. On the left another case that demonstrates that you cannot fully rely on p
locity of the flowing blood and the velocity encoding by the technician. On the far left a patient with non visualization
ous thrombosis or slow flow. On the contrast enhanced T1-weighted image it is obvious that the sinus fills with contr
T2 due to intracellular deoxyhemoglobin (Courtesy dr. Howard Rowley)
Low signal intensity in thrombus:
Normally when there is low signal in a vein, it is attributed to flow void and a sign of patency of the vein. However at
lobin, which is dark on T2 and mimics flow void. On the left there is a thrombosed right transverse sinus with a delta
l intensity on the T2-weighted image as a result of the intracellular deoxyhemoglobin. On the contrast enhanced T1-w
s.
Flow void on contrast-enhanced MR:
On the contrast enhanced T1 images on the left there is an area of low signal intensity within the enhancing transver
within the sinus. This however is the result of flow void. Continue with the phase contrast images. On the phase con
We can conclude that MRI has many false positives and negatives in the diagnosis of venous thrombosis.
Contrast enhanced MR-venography is the most reliable MR technique.

CT-venography is even more reliable, because it is easy and less sensitive to pitfalls. Pitfalls in TOF imaging are:
Chronic dural sinus thrombosis and related syndromes:

DAVF:
Chronic dural sinus thrombosis can lead to dural arteriovenous fistula formation and to increased CSF pressure. A D
en dural arteries, which are branches of the external carotid with the venous sinuses.
Sinus thrombosis is seen in many patients with a dural arteriovenous fistula, but the pathogenesis is still unclear (10
the dural sinus may induce a dural fistula and (b) in the course of a dural fistula flow reversal may lead to thrombosi
e of leptomeningeal reflux related to cerebral venous hypertension leading to cerebral venous infarction or hemorrh
Notice the direct communication between the branches of the external carotid artery and the transverse sinus (blue
s during the follow up. In april 2008 there were no abnormalities. In january 2009 there are signs of intracranial hype
he stalk of the hypophysis.
Thrombosis and increased CSF pressure:
In some patients dural sinus thrombosis may, even after recanalisation, lead to persisting disturbances in venous cir
ssessed by lumbar puncture. Clinically, these patients complain of headaches and they may have vision disturbances
ptic nerve and an empty sella. Apparently in some patients a residual stenosis persists. On the left a T2-weighted ima
the sagittal T1-weighted image. Here the sagittal T1-weighted image demonstrating the empty sella (arrow). It is calle
the hypofysis is compressed downwards due to the increased intracranial pressure.
Venous territories:
On the left an illustration of the territories of the venous drainage. There is great variation in these territories and th
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Hamstring injury:
Anne van der Made, Frank Smithuis, Gino Kerkhoffs and Mario Maas
Department of orthopedics and radiology of the Amsterdam University Medical Centre:
Publicationdate 14-11-2022 The diagnosis of a hamstring injury is a clinical one and fairly straightforward.
The role of MRI is not to determine the presence or absence of injury, but to determine whether there is a partial or
s to the free tendons or the insertion of the tendons on the ischial tuberosity.
In these injuries the question is whether a surgical repair is needed. Partial thickness injuries are most often injuries
These injuries usually do not require surgery. The goal of imaging is to determine the prognosis and to guide the ret
Introduction:

Anatomy:
The hamstrings are the muscles in the posterior compartment of the thigh and consist of the biceps femoris, semite
They are innervated by the sciatic nerve and contraction results in extention of the hip and flexion of the knee.
The conjoint tendon is formed by the long head of the biceps femoris laterally and the semitendinosus tendon medi
The biceps femoris muscle has two heads.
The long head originates from the ischial tuberosity, while the short head originates from the linea aspera on the po
The common tendon of the two heads can be felt laterally at the posterior knee and inserts onto the head of the fibu
The semitendinosus is a largely tendinous muscle, which is located medially to the biceps femoris, and covers the ma
The semimembranosus muscle is flattened and broad. It is located underneath the semitendinosus. Here the anator
(2) on the hamstring origin is partly muscular. The free tendon is attached to the ischial tuberosity, it has no muscle f
e fibers is the musculotendinous junction. The part of the tendon with muscle fibers attached to it is the intramuscul
amstrings insert on the upper region of the ischial tuberosity. On this posterior view you will notice that the semimer
s located medially.
The Conjoint tendon of the biceps femoris and the semitendinosus inserts on the medial facet. The ice cream flavors
an serve as a mnemonic for which tendon is affected:
Caramel - Conjoint medial
Stracciatella - Semimembranosus lateral
Pathology specimen:
This is posterior view of a specimen of the right proximal hamstring complex after removal of the gluteus muscle. Th

tuberosity by means of a conjoint tendon, which has a superficial connection to the sacrotuberous ligament (STL). W
this ligament is intact, the STL can act as a ‘lifeline’ to prevent tendon retraction. Note that the semitendinosus also l
ity. The tendon of the semimembranosus runs underneath the conjoint tendon and attaches more lateral on the isch
side to get a better view on the semimembranosus muscle and tendon.
Notice that the semimembranosus tendon attaches lateral to the conjoint tendon. The sciatic nerve lies in close prox
lateral. On this axial MR-image note the aponeurotic connection between the sacrotuberous ligament and the super
avulsed from the ischial tuberosity while this connection remains intact. In these cases no retraction will be present
British athletics muscle injury classification:
BAMIC is the most commonly used classification system for hamstring injuries. Grade 0-3 are partial thickness injurie
An additional suffix 'a', 'b' or 'c' indicates if the partial thickness injury is: Grade 4 is a full thickness tear with or witho
Partial thickness injuries (grade 0-3):
Partial thickness injuries (grade 0-3) usually involve the musculotendinous junction with or without waviness of the in
Sometimes the area where the muscle attaches to the fascia is involved. This is called a myofascial or epimysial injur
Full thickness injuries (grade 4):
In young patients this can be an apophysiolysis of the ischial tuberosity. In adults it is either a tendon avulsion or a fr
nd part of pre-operative planning are:
MRI report:
There is great interest in and debate how MRI findings can help guide prognosis, progression through the rehabilitat
most for partial thickness injuries. Therefore, all points from MRI report on the left are noted (with special interest fo
ear which finding is best in predicting prognosis.
Partial thickness injury:
The vast majority of partial hamstring injuries are located at the musculotendinous junction (MTJ), where forces are t
r tendon. These injuries are typically seen when athletes reach for the posterior thigh in a sprint. These injuries occu
don. Partial-thickness hamstring injuries are treated non-operatively with a phased rehabilitation program.
Length of edema:
Presence of edema can be used to localize the injury.
Edema is typically present as feather-shaped high signal intensity as it surrounds the intramuscular tendon and fasc
w take a closer look at the tendon (yellow dotted line) and continue reading.
Length of tendon distortion:
When the tendon looks normal, straining is probable low grade.
Tendon thickening, tendon waviness, high signal of the tendon can all be signs of higher grade straining. Case 1: nor
Case 2 slightly thickening and wavy aspect of a short length of the tendon.
Case 3: obvious thickening and waviness All these signs have to be described in your report.
Total length of the distorted tendon is noted.
Coronal versus axial:
Based on coronal images alone, it is sometimes challenging to exactly classify the amount of distortion. Use the axia
l and thickening of the left biceps femoris tendon (yellow dotted circle) is seen when compared to the non-injured sid
In this patient, subtle muscle edema in the semitendinosus was seen, diagnosed as DOMS - delayed onset muscle so
d and noted in the report. In this case, biceps femoris tendon injury was classified as grade 3 partial injury, since the
ength of the distorted tendon is > 5cm (yellow dotted line). Two more cases to demonstrate this classification. A mus
architectural distortion of the tendon, classified as BAMIC 2b. B muscle edema >15cm (white dotted line), at the MTJ
ine). The tendon shows disruption with loss of low signal intensity within the tendon along with a wavy appearance i
doesn't support embedded videos. Video of a partial thickness hamstring injury. Notice the length of the muscle ede
er quite a distance, these are poor prognostic factors. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here you can scroll through the axial images. You can enlarge the images by clicking on them. This is a
vers both the MTJ and intramuscular tendon more distally. Length of edema and tendon distortion are of high grade
Full thickness injury:

Free tendon tear:
In full thickness injuries, the free tendon is torn and discontinuous with the ischial tuberosity. Since tension is lost, th
a gap is seen. The extent of tendon retraction or is considered an important factor for treatment decision-making.
Some experts advocate surgical repair when retraction is more than 2 centimeters.
Direct measurement of retraction:
The most reliable method to quantify retraction is the ‘direct measurement’ on a coronal fluid-sensitive sequence. Fi
roximal hamstring complex origin on the upper region (dotted line) of the ischial tuberosity (IT) is determined.
From this point, the direct (ie, shortest) distance (white arrow) to the most proximal part of the hypointense tendon s
ing the anatomic landmarks is done on different images within one MRI sequence.
Dropped icecream sign:
It is best to determine which tendon is torn on axial images. The ischial tuberosity can be regarded as an icecream co

the conjoint tendon (posteromedial) as two scoops with the flavor StracciatelLa CaraMel. The image shows an avulsi
 conjoint tendon Remember the flavours: Stracciatella - Semimembranosus lateralCaramel - Conjoint medial In this
t tendon are avulsed. Both scoops have dropped. On these images a full thickness injury is seen.
Both scoops have dropped on the axial images, so both tendons are avulsed. On coronal images total retraction was
deos.
Apophysiolysis:
In adolescents, a proximal hamstring injury is most likely located at the level of the ischial apophysis, since the bones
Injury of the tendon itself or at the musculotendinous junction is rare. This video shows an avulsion of the apophysis
Continue with the MRI... Sorry, your browser doesn't support embedded videos. MRI of the same patient.
Ischiadic nerve involvement:
This image shows a partial injury of the conjoined tendon of the right leg (yellow circle).
There is a large amount of surrounding hematoma in the muscle and alongside the fascia. The edema surrounds the
However there is a poor correlation between the MRI findings and the symptoms of the patient. In this case, the part
rged and flattened due to the injury edema. All features of possible nerve involvement (nerve enlargement, flattenin
ted.
Follow up:

Old injury:
After the injury, it is possible that the tendon looks normal after healing. However, in most partial injuries, fibrous sc
otted circle). Quite often, when MRI is made for an acute injury, other sites of fibrous scarring of older injuries are se
Reinsertion:
After a full thickness avulsion, tendons can be reinserted operatively. In this case, the anchors at the tuber can be se
belly can occur.
MRI protocol:
The MRI protocol is based on a coronal fatsat, Axial PD fatsat and axial T2 sequences. The entire hamstring complex
jured side with the non-injured hamstrings.
Especially partial injuries can be very subtle.
We only use coronal and axial planes for anatomy as it is more difficult to assess anatomy on sagittal planes.
Esophagus I: anatomy, rings, inflammation:
Terrence C. Demos, MD, Harold V. Posniak, MD, Wayde Nagamine, MD and Mary Olson, MD
Department of Radiology of the Loyola University Medical Center, USA:
Publicationdate 2007-11-26 In Esophagus part I we will discuss: Vascular impressions. Anatomy and Function
Anatomy and Function:
LEFT: Lateral view: Epiglottis (red arrow). Post cricoid impression (yellow arrows). Cricopharyngeous impression (whit
ws)
Hypopharynx:
Common structures that we can visualize are: If a normal pouch becomes enlarged, it is termed a lateral pharyngeal
* Cricopharyngeal muscle impression:
Extrinsic impression on posterior esophagus by contracted muscle. Esophagus mucosa: normal thin, parallel, uniform
phageal junction (left), Fundal adenocarcinoma invades esophagus (right) At the gastroesophageal junction smooth,
arrow). Image next to it shows abnormal gastroesophageal junction: Barium outlines thick, irregular mucosal folds (a
pharyngeal achalasia in 46-year-old woman. Feeling of lump in throat. Persistent indentation (arrow) by cricopharyng
Upper esophageal sphincter:

Lower esophageal sphincter:
This distention is best demonstrated by breath holding in inspiration or a Valsalva maneuver. Do not mistake this for
arch.
Gastroesophageal reflux:
Spontaneous gastroesophageal reflux has been demonstrated in up to 1/3 of patients with reflux esophagitis. Variou
tivity, but these are generally discredited as not being physiologic. In addition many asymptomatic patients have spo
tive or specific for relating symptoms to reflux.
Esophageal peristalsis:
Normal: Abnormal: On the left tertiary contractions on first swallow (left). Normal primary contraction on next swallo
sient, and intermittent contractions that are inconstant in location and not accompanied by symptoms, usually in old
ree images during examination show collections resembling diverticula C. Image later in examination shows resoluti
ns may simulate diverticula. On the left images of a patient with tertiary contractions, that during the examination lo
nced chest pain during examination
Diffuse esophageal spasm:
Diffuse esophageal spasm produces intermittent contractions of the mid and distal esophageal smooth muscle, asso
e contractions on at least 10% of swallows. Diagnosis is based on imaging, manometry, and symptoms.

Nutcracker esophagus:
Nutcracker esophagus is a non-cardiac cause of chest pain attributed to high amplitude distal esophageal peristalsis
does not have imaging manifestations LEFT: Dilated esophagus (arrows) appears as long, well-defined structure para
Narrowing (arrow) at hiatus.
Achalasia:
LEFT: CT shows dilated esophagus (arrow) that led to esophagram.RIGHT: Esophagram shows narrowing (arrow) at le
ed esophagus (arrows) is projected behind right atrium.MIDDLE and RIGHT: Smooth, tapered narrowing just above d
fluoroscopy some peristalsis was seen with typical smooth, tapered narrowing just above diaphragm (arrows).
Lower esophageal rings:
Esophageal ring due to muscular contraction. It varies during examination and may not persist. No definite anatomic
to muscular contraction. It varies during examination and may not persist. On the left another patient with a non-pe
B-ring The esophageal B-ring is located at the squamocolumnar junction, also termed the 'Z' line. The appearance d
a 'B' ring (arrows) several cm above diaphragm at the apex of sliding hiatus hernia. Note unchanged appearance on
agia. The image on the far left does not show a abnormality, but distal esophagus not distended . With dilation of the
aused intermittent obstruction is demonstrated at the apex of a hiatus hernia (arrowhead). On the left a 71-year-old
lling defect (arrow) is a piece of meat that passed into stomach during study. Follow-up esophagram shows Schatzki
Webs and Diverticula:

Esophageal web:
On the left images of an asymptomatic 52-year-old man. AP and Lateral views show short, thin web (arrows) with mi
man with dysphagia due to web. There is > 50% luminal narrowing Zenker's diverticulum in early and late phase of s
Diverticula:
Pulsion diverticula are due to increased intraluminal pressure.
There are many pulsion diverticula: On the left a patient with a Zenker's diverticulum as a result of premature closur
dary to adjacent disease. Most located in mid-esophagus. Zenker's diverticulum on chest film, barium study and CT
Zenker's diverticulum:
A Zenker's diverticulum is a pulsion hypopharyngeal false diverticulum with only
mucosa and submucosa protruding through triangular posterior wall weak
site (Killian's dehiscence) between horizontal and oblique components
of cricopharyngeus muscle. The etiology is controversial and is probably due to elevated upper esophageal
pressure, cricopharyngeus dysfunction and reflux. The clinical presentation can be dysphagia, regurgitation, aspirati
or a mass or air-fluid level on neck or chest radiographs. The esophagram shows collection with midline posterior or
cricopharyngeus protruding lateral, usually to left, and caudal with
enlargement. Killian-Jamieson diverticulum: AP and lateral view Killian-Jamieson diverticulum is a pulsion diverticulu
ervical esophagus below the cricopharyngeus muscle, unlike the posterior, midline origin of a Zenker's diverticulum.
l view confirms diverticulum does not originate posteriorly as a Zenkers diverticulum would. LEFT: Small diverticulum
w) in patient with aspiration Epiphrenic diverticulum These pulsion diverticula are classified by their location near th
If large they can narrow the esophagus or lead to aspiration. Large epiphrenic diverticulum On the left another exam
verticulum (arrow) extends to the right just above diaphragm. This patient was asymptomatic Aortopulmonary windo
rtopulmonary window.
Fixed protrusion is an inconsequential diverticulum. On the left small aortopulmonary diverticula (arrows), that are i
diverticulum (arrow) due to hilar granulomatous disease.
Calcified adenopathy (asterisk). In the middle a pulsion diverticulum (arrow) due to high intraluminal pressure. On th
ler myotomy for achalasia. On the left a traction diverticulum (arrows) secondary to post primary TB. It simulates a c
can be seen in reflux esophagitis.
On the left a patient with a hiatus hernia, reflux esophagitis, and pseudodiverticula (arrows) at site of proximal strictu
ing esophageal duplication (arrows). RIGHT: Extravasation from iatrogenic perforation of hypopharynx in neonate Ot
On the left two patients with a iatrogenic perforation and a patient with a communicating duplication cyst.
Hiatus hernia:
The types of hiatus hernia are listed in the table on the left. The relationship between hiatus hernia, reflux and reflux
tients with gastroesophageal reflux disease (GERD) have hernias. Many patients with hiatus hernias do not have reflu
of reflux correlates poorly with GERD.
A sliding hiatus hernia is of doubtful significance when an isolated finding in the absence of clinical or imaging findin
endoscopic findings of esophagitis, not presence of a hiatus hernia. Sliding hernia On the left initially, GE junction is l
gh hiatus. Neither the hernia or stricture (arrow) due to reflux esophagitis were visible early in the examination. Para
progressive hiatal widening, increasing protrusion and rotation of the stomach can lead to gastric volvulus that can b
ation. On the left two examples. On the far left gas filled gastric fundus (asterisk) protrudes through hiatus but GE ju
l hernia with most of 'upside down' stomach in chest with greater curvature (arrows) flipped up. On the left a mixed
ndus, but unlike a paraesophageal hernia, the gastroesophageal junction (arrow) is above rather than below the diap
Inflammation and Infection:

Gastroesophageal reflux (GERD) is the most common cause of esophagitis. Other causes of esophagitis are listed in t
Reflux esophagitis:
The findings on barium studies are listed in the table on the left. Air-contrast esophagram shows thick esophageal m
e contrast esophagram shows stricture (arrow) and sliding hiatus hernia On the left Irregular stricture (arrowhead) a
ular mucosa and web-like (arrow) stricture
Barrett's esophagus:
Barrett's esophagus (columnar metaplasia) is the result of long-standing reflux esophagitis. Most patients have reflu
n the left a patient with a Barrett's esophagus.
The reticular mucosa is characteristic of Barrett's columnar metaplasia, especially with the associated web-like (arrow
with an adenocarcinoma. There are abnormal distal mucosal folds. The upper margin of adenocarcinoma makes righ
nt with GERD and Barrett's esophagus.
Infectious esophagitis:
Candida esophagitis On the left a patient with an infectious esophagitis due to candida. The barium stury shows num
mmunocompromised patient. Cytomegalovirus esophagitis On the left an AIDS patient with an infectious esophagitis
ne. Crohn's esophagitis On the left a patient with Crohn's disease. There is a granulomatous esophagitis with aphtho
disease. The figure on ther right shows the more common colonic aphthous ulcers. TB esophagitis On the left a patie
rregular sinus tract from proximal esophagus (arrow). Chest radiograph shows enlarged lymph nodes widening med
Pseudodiverticulosis:
Dilated mural glands or pseudodiverticulosis, is usually associated with histologic or endoscopic signs of inflammatio
patient with esophageal pseudodiverticulosis. Eosinophilic esophagitis This diagnosis may be suggested by peripher
y. Patients often have dysphagia and allergies. Imaging finding include diffuse narrowing, strictures, and a ringed app
e transient or associated with reflux. Steroid therapy is often curative. On the left a patient with eosinophilic esophag
ns (arrows) due to ring-like indentations, that are characteristic of eosinophilic esophagitis. Glycogen acanthosis Glyc
copy. The reported
incidence at endoscopy is 5 to 15% of all patients. These benign epithelial collections of glycogen produce small muc
Nodules are smooth and well-defined. This may be a degenerative process and produces no symptoms. Feline esoph
g study no longer shows folds Feline esophagus The delicate, concentric and transiently appearing folds of a feline e
fixed folds indicative of longitudinal scarring from reflux esophagitis. The characteristics of a feline esophagus are: M
Textbook of Gastrointestinal Radiology. 2nd ed. Philadelphia, PA:W.B. Saunders, 2000:190-257, 316-509 by Gore RM,
2. Levine MS, Rubesin SE, Laufer I. Double Contrast Gastrointestinal Radiology 3rd ed. Philadelphia, PA:W.B. Saunder
3. Levine MS. Radiology of the Esophagus Philadelphia, PA:W.B. Saunders, 1989
4. Eckberg O. Radiology of the Pharynx and the Esophagus. Berlin,Germany: Springer-Verlag, 2003
None:

None:

None:

Gallbladder obstruction:
by Julien Puylaert
Medical center Haaglanden in the Hague and Academical Medical Center in Amsterdam, the Netherlands:
Most gallstones that we find with ultrasound are asymptomatic and should be left untreated.
However when gallstones obstruct the gallbladder or the common bile duct they become symptomatic.
In part 2 we will discuss stones that obstruct the biliary ducts. In part 1 we will discuss gallstones that obstruct the ga
itional remarks: j.puylaert@gmail.com
Introduction:

Symptomatic stones:
Gallstones become symptomatic when they obstruct the gallbladder or the common bile duct (CBD).
Intermittent obstruction results in a simple biliary colic. An impacted stone obstructing the gallbladder results in acu
Persistent production of mucus causes high intraluminal pressure, leading to relative ischemia of the wall. Here anot
stone in the gallbladder neck: It is important to realize that patients only experience pain during the hydrops phase.
Laboratory data only show leucocytosis and the CRP remains normal.
After the hydrops has disappeared, the colic is over but the patient often experiences a “sore feeling” for a while. CT
re two CBD stones best visible on the non-contrast series (arrows).
Asymptomatic stones:
The majority of patients with gallstones however will not experience any problems with these stones during their life
Therefore, asymptomatic gallstones detected coincidentally during US or CT, performed for other reasons, are left u
rgoing cholecystectomy, have unchanged symptoms after the operation, suggesting that the diagnosis of symptoma
agnosis of acute gallstone disease can be missed because the doctor mistakes the symptoms for another condition

This explains why around 15 % of patients with an acute biliary colic are initially referred to the cardiologist.
Biliary colic:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll When a gallstone intermittently obstructs the gallbladder or the CBD, a biliary colic will follow. Sympto
er abdomen, radiating to the back and to the right side, but also sometimes to the left side.
Patients are often nauseous and may collapse from the pain.
Not rarely, the pain awakes patients from their sleep.
During a biliary colic, patients preferably do not sit still, and have an urge to move and walk around.
They continuously "try to find a position to tolerate the pain". When the stone is not obstructing the gallbladder nec
the diagnosis of symptomatic gallstone disease and you will be able to compress the gallbladder fundus (fig). Howe
attacks without signs of cholestasis, in whom stones in the gallbladder are demonstrated on US, the indication for c
typical symptoms, it is not always clear whether the US-demonstrated gallstones are actually the cause of the patien
d symptoms after cholecystectomy. However in patients with a history of typical, uncomplicated colicky attacks with
demonstrated on US, the indication for cholecystectomy is evident (fig). On the other hand, in patients with atypical
allstones are actually the cause of the patient's symptoms, resulting in quite a few patients who have unchanged sy
a few days before the examination.
In the standing position there are no obstructing stones in the gallbladder neck.
Even the cystic duct was seen with its typical course parallel to de common bile duct. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll In case of an obstructing CBD stone, you will also be able to compress the gallbladder fundus, but ther
ts.
Dilatation of the biliary tree will develop within a very short time and the gallbladder may become dilated.
The intraluminal pressure however is much less than in isolated obstruction of the gallbladder (fig). US scanning dur
Patients who undergo US during an acute biliary colic, at that particular moment –invariably- either show a hydropic
rapidly disappear when the obstruction is relieved, either spontaneously or due to spasmolytic medication, which is
Acute Hydrops:

Hydrops sign:
Persistent obstruction of the gallbladder results in a hydropic gallbladder due to ongoing mucus production by the g
compression over the gallbladder. The hydrops-sign is positive if the gallbladder during compression "bulges" into th
st seen in expiration, when the abdominal wall muscles relax. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here we can see how the hydropic gallbladder will keeps its rounded shape during compression.
If the obstruction carries on long enough, the high intraluminal pressure may lead to temporary ischemia of the gall
tone obstructing the gallbladder, are given in the table. The non-compressibility of the gallbladder and direkt demon
duct are the most valuable signs (****). Here images of a patient with acute hydrops of the gallbladder, visualized in
The obstructing stone is impacted (arrow).
Note that during compression the hydropic gallbladder bulges into the abdominal wall (arrowheads), indicating high
ize the hydrops-sign reliably, especially when the gallbladder lies high under the right costal arch.
Also the impacted stone may be impossible to visualize in large persons, due to its deep location, far from the transd
der may be identified (fig), but often complementary US is very useful. Here images of a patient with clinically suspec
lbladder. Complementary US unequivocally demonstrates hydrops (arrowheads). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Even in the case, when there is intervening liver tissue between the abdominal wall and the gallbladde
e shows a gallbladder that keeps its rounded shape, without and during compression, and bulges into the soft inter
ydrops can be demonstrated, even when there is intervening liver tissue, which is soft during compression (image o
How to demonstrate an impacted stone:
In this patient examination in the decubitus position could not identify an obstructing stone due to the presence of
loose stones have migrated to the fundus, the patient is asked to lie down again, immediately turning on its left side
In this way the stones, will remain in the fundus, allowing better visualization of the gallbladder neck and cystic duct
All stones have moved to the fundus except the impacted stone (arrow). There is gallbladder wall thickening indicati
nspissated, viscous bile, stones may change position very slowly, sometimes taking several minutes to go to the lowe
For this reason, we ask patients with suspected gallstones, always to sit or stand up while waiting for their US exami
iliary colic in different patients.
In the supine position a stone (arrow) is demonstrated in the gallbladder neck.
After standing up, bending over and walking, the stone (arrow) does not fall down, and therefore must be impacted.
plane of the longitudinal axis of the gallbladder. Here images of a patieny with acute hydrops due to an impacted st
nal axis of the gallbladder, due to its medial position in the cystic duct (arrow).
Large diameter:

The third sign is a large transverse diameter of the gallbladder.
This is not a very reliable sign, since gallbladder diameters have a wide range.
A 2.5 cm gallbladder can be hydropic and a 5 cm diameter gallbladder can be normal (fig).Therefore, non-compressil
n the US hallmarks of hydrops.
US-Murphy-sign:
Finally, a sign of acute hydrops is circumscribed tenderness on pressure with the US probe over the gallbladder fun
Although often present, this sign is not always reliable.
Especially older patients with an acute cholecystitis have difficulties exactly indicating the area of maximum tenderne
In addition, if another condition like a duodenal ulcer, acute pancreatitis or an acute appendicitis, causes the right up
because of the close proximity of the gallbladder. Secondary wall thickening of the gallbladder may add to the confu
US performed after the biliary colic:

Silent witnesses:
What may cause considerable diagnostic confusion, is the fact that -in daily practice- most US examinations in patien
e symptoms have subsided, with intervals varying from hours to weeks.
Patients also may have received spasmolytic therapy, which may cause the muscle spasm to relax and bile to pass, c
There are silent witnesses that indicate that the patient had an obstructing stone with hydrops of the gallbladder (ta
t the ER treated with spasmolytics and not immediately operated. In 15 acute cholecystitis developed. In 25 the ston
60 patients the stone becomes dislodged and the galbladder returns to normal sometimes with a period of reperfus
ng stone in the gallbladder neck has various pathways. During the colic the stone is impacted in the gallbladder neck
Persistent production of mucinous fluid causes high intraluminal pressure, leading to ischemia of the wall. US perfor
ema and hyperemia of the gallbladder wall. The obstructing stone (arrow) is still visible in the neck, but there was no
Reperfusion edema:
It is important to realize that patients only experience pain during the hydrops phase.
Laboratory data only show leucocytosis and the CRP remains normal. Soon, the intraluminal pressure will be so high
occur.
If the stone is disimpacted or in another way again allows passage of bile to the cystic duct, which may happen spon
r wall may develop very rapidly (fig). This edema disappears again within 12-48 hours and is reperfusion-edema, seco
Sometimes also the secondary hyperemia can be found by Doppler US (fig). After the hydrops has disappeared, the
a while. Images of a young woman with a biliary colic for 8 hours.
US shows an impacted stone and hydrops.
The patient went walking for an hour and US was repeated.
The stone was loose, and reperfusion edema was visible as silent witnesses of the colic.
CRP remained normal. When the hydrops has disappeared, patients do not have colicky pain any more.
However patients often have a vague “sore” feeling in the upper abdomen as if someone has “stumped them in the b
history, the laboratory data and the US findings in the final report of the US examination. At day 0 there is acute hyd
One day later, the patient is symptom free.
The stone is still in place, but apparently allows passage of bile to the cystic duct, since hydrops has disappeared. Re
revious attack .
CRP remained normal. Silent witness of previous attack.
US, performed 24 hours after colicky attack shows a contracted gallbladder with multiple small stones in patient who
(visualized in again fasting patient). Silent witnesses of a biliary colic in six different patient. US was done 6-12 hours
All patients were symptom free at the moment of US. Of course, not all patients are so lucky that their biliary colic sp
Of all patients presenting with a biliary colic, in a minority (10-15 %) progression to an acute cholecystitis is seen.
Acute Cholecystitis:
If the stone keeps obstructing the gallbladder neck or cystic duct, bacterial infection of the stagnating bile and mucus
this a gradual process, the US signs of acute cholecystitis evolve gradually and are superimposed on the signs of acu
uperimposed on the signs of acute hydrops. The additional US signs of cholecystitis are: Here images of a patient wit
Note the obstructing stone (arrow), gallbladder wall thickening and bulging of the gallbladder into the abdominal wa
was 110, confirming the diagnosis of acute cholecystitis. Advanced cholecystitis with inflamed fat (asterisks) around
This represents the omentum, migrating towards the gallbladder in order to wall-off a possible perforation. Bacterem
ll thickening simulating acute cholecystitis However, these additional US signs are not always reliable. These images
CRP of 430.
US shows massive edematous wall thickening of the gallbladder, which has a small lumen and contains no stones.
CT reveals lobar nephritis (asterisk) as the cause of the patient’s symptoms and high CRP.
The gallbladder wall thickening is secondary to the bacterial inflammation.
After antibiotics, complete normalization of gallbladder and kidneys. Acute pancreatitis simulating acute cholecystitis
e, however non-hydropic gallbladder (arrowheads) with mobile stones and edematous wall thickening.
Lab showed CRP 3 and a serum amylase of 985. Diagnosis: biliary pancreatitis with secondary thickening of the gallb
se patient with acute epigastric pain. US showed gallstones and wall thickening, suggestive for acute cholecystitis. Su

liary pancreatitis with secondary gallbladder wall thickening. Here a patient with malaise, RUQ-pain and severe liver
wall thickening and enlarged periportal lymph nodes. Diagnosis: acute hepatitis A.
Differentiation Hydrops - Acute Cholecystitis:
More important than the additional US signs in the differentiation of hydrops versus cholecystitis, are the clinical sig
meters. It must be stressed that especially in the elderly the development from acute hydrops into acute cholecystiti
s that the original colicky attack and fever is often absent.
This underlines the important role of repeated CRP.
Elevation of the CRP –in general- precedes the clinical symptoms. If the patient presents late, the gallbladder may sh
Somewhat confusing may be the fact that in advanced cholecystitis, there can be a less prominent US-hydrops sign,
and the intraluminal pressure has decreased. The images show a longstanding acute cholecystitis. Note the large ar
all, somewhat compressible gallbladder.
This reflects a lumen filled with pus where the diseased mucosa is not capable of producing mucus under pressure a
CT in acute cholecystitis:
CT can be very helpful in cases with a non-diagnostic US.
These images are of an obese patient with acute RUQ pain for 6 hours. CRP 2 . US shows a large gallbladder with slu
Compression of the gallbladder is unreliable due to the high position under the right costal arch.
No other US abnormalities. CT, performed the same day, shows a large gallbladder with only discrete pericholecystic
The next day CRP is 105 and repeated non-contrast CT shows a fuzzy corona around the gallbladder. Subsequent su
cystic duct.
Special forms of cholecystitis:
Emphysematous cholecystitis. US shows air in the gallbladder fundus (arrowheads). CT confirms both intraluminal a
Emphysematous cholecystitis:
This special form of cholecystitis is usually –but not always- found in older diabetics and has characteristic US and CT
te cholecystectomy is usually advised, but successful percutaneous drainage is a good alternative, because surgery is
compromised patients. These images are of a non-diabetic patient with severe pain RUQ, CRP 190 and WBC of 19.
US noted weird aspect of the gallbladder with hyperechoic sludge and bright reflections in the wall.
CT showed emphysematous cholecystitis with also free air in the peritoneal cavity. Conventional cholecystectomy re
orrhagic cholecystitis. US only shows a sludge-like mass. CT scan demonstrates hyperdense blood within the lumen a
t.
Hemorrhagic cholecystitis:
Hemorrhagic cholecystitis is rare and seen when gallbladder wall necrosis has led to intraluminal bleeding
It is more frequent in patients with anticoagulant therapy. US is usually aspecific but may show a large mass of sludg
CT shows hyperdense, non-attenuating masses within the gallbladder lumen (fig). Since hemorrhage is the result of i
ot be treated with percutaneous drainage, although cholecystectomy may also be quite difficult. This is another hem
The CRP was 150. Immediate laparoscopic cholecystectomy was done.
The ydrops was confirmed and peroperative puncture revealed blood. The surgery was complicated by a large post-
Xanthogranulomatous cholecystitis:
This is a rare, but well recognized benign form of protracted cholecystitis.
It is possibly the result of multiple episodes of destructive inflammation due to the presence of stones. It is importan
are of a 82 year old female, who woke up at four o'clock in the morning with excruciating pain in the upper abdomen
ere normal.
US showed a large but non-hydropic gallbladder with one little stone.
No obstructing stone was seen.
There was some free fluid, which at puncture turned out to be bile.
CT was done but did not yield extra information.
At laparoscopic cholecystectomy free perforation was found with 150 ml of bile intra-abdominally. Another free perf
The decompressed gallbladder has a relatively small lumen and shows an irregular and edematous wall. There is fre
ture is identified as bile. Ill patient with pain RUQ since 4 days, CRP 450 and leuko 14. CT shows local perforation at th
left liver lobe. Immediate open cholecystectomy revealed perforated cholecystitis and severe purulent contaminatio
on may eventually lead to distant abscess formation, often with a different location and aspect than the pericholecys
ericholecystic abscess as well as a distant, perihepatic abscess in perforated cholecystitis. Antibiotics were given and
ent to the gallbladder in acute cholecystitis, visible on both US and CT. Percutaneous drainage of the gallbladder was
The abscess drained itself into the gallbladder lumen.
Cholecystitis mimicking malignancy:
Acute cholecystitis sometimes is not recognized clinically, especially in the elderly, and may then be treated with anti
This may cause mitigation and alteration of the normal inflammatory process leading to unusual US and CT findings.
In such cases not infrequently the diagnosis of gallbladder malignancy is suggested which may lead to ill-advised ma
Keep in mind that gallbladder carcinoma in the Western world is very rare, is usually inoperable at presentation and
The combination of clinical history, US and CT image, and the follow-up in time, can prevent unnecessary major surg
Acalculous cholecystitis:

Acalculous cholecystitis is a confusing entity.
True acalculous, non-obstructive cholecystitis is extremely rare and is the result of primary ischemic necrosis of the
ith non-obstructive mesenteric ischemia (NOMI) leading to small bowel infarction.
It is often seen in older patients with other debilitating disease or after severe trauma.
The treatment is acute cholecystectomy. Most patients diagnosed as “acalculous cholecystitis” are in fact patients wit
by US or CT, and also not at operation or in the pathological specimen.
However, when US unequivocally demonstrates hydrops in a patient, it is clear that there must be some sort of lumi
in combination with a narrow cystic duct.
Because of the obstructive origin, these cases have the same risk of complications as acute calculous cholecystitis a
ent pitfall is the large gallbladder filled with sludge and a thickened wall, often found in patients in the ICU.
In case of a high CRP, this is often misdiagnosed and mistreated as acalculous cholecystitis.
To avoid this pitfall, it is essential to test US compressibility of the gallbladder fundus and to perform CT to detect po
gh CRP.
Fistula formation:
Acute cholecystitis can be complicated by perforation.
Most cases of perforated cholecystitis progress slowly and perforation is walled-off with local abscess formation.
Free perforation in acute cholecystitis is quite rare (as we discussed earlier). Undiagnosed or untreated cholecystitis
This is an uncommon complication, but when it occurs, most frequently there is passage of the stone to the small bo
es of duodenal fistulisation, a large gallstone may get “stuck” at the fistula to the duodenum.
Due to secondary inflammatory and fibrous tissue, this may eventually lead to stenosis and obstruction.
This special situation is called “Bouveret syndrome” and its main clinical feature is gastric outlet obstruction.
Gallstone ileus:
When untreated, acute cholecystitis may lead to new complications.
Purulent gallbladder contents including the gallstones may eventually evacuate to the duodenum or sometimes to th
often has remained undiagnosed and/or untreated.
It usually concerns a large stone, which classically gets stuck at the ileocecal valve, but in fact in most cases the ston
jejunum.
The diagnosis in most cases is much easier made using CT than US. Play the video. The key finding is the air in the ga
llbladder. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images (on a Mac with two fingers). This is a typical gallstone ileus. Notice how diffic
Bouveret syndrome:
In rare cases of duodenal fistulisation, a large gallstone may get “stuck” during a longstanding fistulisation process.
Due to secondary inflammatory and fibrous tissue, this may eventually lead to stenosis and obstruction of the duode
main clinical feature is gastric outlet obstruction (fig). Although rare, it is very important to make the correct diagnos
e avoided.
If the stone cannot be removed endoscopically, the best solution is a gastrojejunostomy. Enable Scroll
Disable Scroll Bouveret syndrome Enable Scroll
Disable Scroll Bouveret syndrome This is a patient with intermittent gastric retention and a low CRP.
Scroll through the images. What are the findings? A large stone got “stuck” in the fistulous tract from the deformed g
Secondary wall thickening of the duodenum (arrowheads) and surrounding inflammatory and fibrous tissue, cause i
of an elderly lady, presenting with gastric retention and vomiting.
CRP was 55, but was documented to be 160 a few days earlier. US shows a large stone in a gallbladder filled with deb
The stomach is dilated and there is remarkable wall thickening of the duodenum (arrowheads) and surrounding infla
Gastroscopy was done for suspected malignancy, but biopsy only revealed inflammation. Continue with the CT. Enab
Disable Scroll Bouveret syndrome Enable Scroll
Disable Scroll Bouveret syndrome CT confirms the diagnosis of Bouveret syndrome. Percutaneous gallbladder draina
one apparently managed to evacuate to the duodenal lumen, and she developed a classic gallstone-ileus as yet, whic
Fistula to the colon:
This rare situation often develops subclinically and insidiously. In purulent cholecystitis the pus evacuates to the col
n years.
Patients eventually may develop chronic diarrhoea due to bile irritation. In june 2009 this patient presented with lon
Severe local colonic wall thickening with small intramural abscesses reflect the impending fistulisation process.
The patient was treated conservatively and in september 2009 she was symptomfree.
One of the stones and the pus had evacuated to the colon.
Two years later, also the second stone did evacuate subclinically. A persistent open fistulous tract between gallbladd
e tract is seen (yellow arrow) and there is air in the galbladder. On ERCP the contrast is injected in the bile ducts and
lso the right colon.
None:

Vascular Anomalies of Aorta, Pulmonary and Systemic vessels:
Marilyn J. Siegel and Robin Smithuis
Mallinckrodt Institute of Radiology, Washington University School of Medicine in St. Louis, USA and the Rijnland Hosp
Publicationdate 2007-11-01 This review is based on a presentation by Marilyn Siegel and was adapted and illustrated
specialized in pediatric and chest radiology. The second edition of her book entitled Pediatric Body CT will be out nex
r anomalies of the aorta, pulmonary vessels and systemic veins in the chest. Most of these anomalies are found in ch
y of these anomalies are asymptomatic or 'leave alone' lesions, but some of these anomalies are symptomatic and n
e anomalies. A simple mouse click on an item on the left will bring you directly to this subject.
Overview of Arch Anomalies:
Not a true ring. Usually asymptomatic. Sometimes dysphagia lusoria when dilated suvclavian artery compresses eso
2. Innominate artery compression syndrome In children the brachiocephalic (innominate) artery is located more to t
3. Right Arch Mirror ImageMirror-image variety of the left arch. Asymptomatic. Associated congenital heart disease i
4. Right Arch with Aberrant left subclavianLeft subclavian artery is the last branch. Obstructing anomaly.
5. Double Aortic ArchComplete ring encircles esophagus and trachea. Four vessel sign.
6. Double Arch with Atretic SegmentLeft arch is very small and has atretic posterior segment.Still a four vessel sign.
Embryology:
- Double Arch: - Double Arch with Atretic Segment: - Normal Left Arch: - Right Arch with mirror branching: - Left Arch
ant left subclavian artery: When you look at these illustrations, you have to realize, that these are views from above,
cending aorta will be on the upper part of the image and the descending aorta will be on the lower part.
Aortic Arch Anomalies:
Axial image and volume rendering posterior view
Right Arch Mirror Image:
This is the mirror-image variety of the left arch. On the left a 2 year old girl with wheezing and coughing. Study the im
mages are viewed from the feet, while the illustrations above are viewed from above On the axial image there is a rig
hing of the brachiocephalic arteries, no aberrant subclavian artery, so this is a right arch mirror image. Mirror image
is asymptomatic, because there is no obstructing ring. Almost all of these patients however come to our attention b
ses. This patient had a mirror image aortic arch and a VSD. Mirror image aortic arch in patient operated for tetralogy
ood for a Tetralogy of Fallot (pulmonary stenosis, right ventricular hypertrophy, VSD, overriding aorta). At surgery the
. Notice that there is also a right arch. In the United States there are now more than one million adults who have surv
ese patients because they age and get chest pain like many adults do and so you will see these anomalies more freq
Right Arch with Aberrant left subclavian:
The Right Aortic Arch with an aberrant left subclavian is an obstructing arch anomaly. The first branch of the aorta is
ery and the left common carotid. This also is a true ring. The ligamentum ductus arteriosus between the arch at the l
completes the ring. If this ligament is very short, there will be a lot of compression. Enable Scroll
Disable Scroll Right Arch with Aberrant left subclavian Enable Scroll
Disable Scroll Right Arch with Aberrant left subclavian On the left a patient with a right arch with an aberrant left sub
images on the left. Again you have to realize that the axial CT-images have a 'view from feet'. Which vessels are indic
the left subclavian artery is the last branch of the aortic arch, indicating that this is an aberrant left subclavian. Media
carotid, that originates from the right side and has an oblique course to the left. The yellow arrow indicates the azyg
al vein, a normal variant, that we will discuss later. Posterior oblique view: Right Arch with Aberrant left subclavian (y
rendered image to show the aberrant left subclavian artery. In a mirror type right arch, the left subclavian is the first
common carotid. Right Arch with Aberrant left subclavian On the left images of a symptomatic child. On the axial im
mes off on the posterior side and runs behind the trachea and the esophagus. The compression of the trachea is de
Double Aortic Arch:
On the left a chest film of a 6-month old boy with stridor and cough. The trachea is deviated to the left, otherwise the
ght side. On the left the reconstructions demonstrating a double aortic arch. There are branches coming off the right
The right arch is typically larger and higher than the left. There is a complete ring that encircles the esophagus and th
chiocephalic arteries arise on each side separately (four vessel sign). On the left a chest film of a young adult with a c
diagnosis is tumor, adenopathy or vessel (right arch, dilated azygos vein, dilated aberrant right subclavian artery). On
reconstruction. Describe the findings and then continue. The findings are: The narrowing of the trachea is seen on th
dered image. Pre- and post-operative reconstructions of a double aortic archImage courtesy of Dr. W. Chu (4) On the
female infant with double aortic arch presenting with stridor and repeated apnea. The smaller left arch is partially re
ble arch can have an atretic segment. You should not confuse it for a right arch. The left arch is just very small and th
gment On the left a dominant right arch and a small left arch. The atretic segment is marked by the arrow. Notice the
y demonstrated. Remember that there is still a ring, so there is still obstruction. Another case on the left. Do not call
atretic fibrotic segment on the posterior side of the left arch, that completes the ring. Notice the four vessel sign. Sa
ion the impression on the trachea is better appreciated. Aberrant Right SCA, no compression of the trachea
Left Arch Aberrant Right SCA:
On the left a young patient, who has a CT for another reason. Study the images and then continue. Notice that there
iocephalic artery to branch off the arch. Dysphagia lusoria in patient with dilated aberrant right subclavian artery. On

, when the origin of the right subclavian artery becomes dilated. On a barium study of the esophagus you will see a
right shoulder. On the left a 78 year old woman with dysphagia. There is consolidation in the right upper lobe, mayb
he esophagus and it originates from the left-sided aorta, i.e. an aberrant right subclavian artery. On the left the same
al reconstruction. Enable Scroll
Disable Scroll Left Arch-Aberrant Right subclavian artery. Scroll through the images. Enable Scroll
Disable Scroll Left Arch-Aberrant Right subclavian artery. Scroll through the images. On the left another patient with
you follow the artery from inferior to superior, it starts on the left side of the arch and travels obliquely behind the e
syndrome with compression of the trachea
Innominate artery compression syndrome:
On the left a sagittal scanogram, axial image and sagittal reconstruction of a 5 year old girl with noisy breathing and
n continue. The findings are: The diagnosis is the innominate artery compression syndrome. In infants the innomina
in front of the trachea.
It may compress the trachea, leading to stridor, cough and dyspnea.
This compression decreases with age and these patients will outgrow it. The compression in the innominate artery c
e level of the thoracic inlet. This is much higher than in the double arch or Right Aortic Arch with Aberrant left subcla
rachea.
Aortic Coarctation:
On the left a 2 month old boy with heart failure. First study the image, then continue The findings are: The diagnosis
view of the reconstruction. There are two types of coarctation. The type we usually see is the post-ductal type, which
al type is seen in neonates. They present with severe heart failure, mostly within the first week of life, usually on the
. First study the axial image followed by the sagittal reconstruction, then continue. The findings are: Intercostal collat
ically occur between the 3rd and the 8th rib. Pre-ductal type of coarctation On the left two neonates with the pre-duc
ubclavia and there is arch hypoplasia. Collaterals do not occur, probably because they don't have time to develop. Co
ight) Coarctation is treated with angioplasty, stent placement or patch aortoplasty. The image on the far left is the re
with a stent. Notice that the stent is obstructing the orfice of the left subclavian artery. Pseudo-aneurysm in coarctat
o was treated with a stent. The stent ruptured causing restenosis. Next to it two patients with pseudo-aneurysm. On
ter stent placement. They have to be repaired because they will rupture. Pseudo-aneurysms are seen in
Pulmonary arterial anomalies:
They most common anomalies of the pulmonary arteries are listed in the table on the left. Pulmonary agenesis on th
Pulmonary agenesis:
On the left a young adult, who had cyanotic spells as a child. She is now in good health and comes in for another rea
a or maybe a tumor. The CT shows, that he right lung is not developed and the space around the atresic pulmonary a
pulmonary agenesis. If many collaterals develop there will also be some development of the lung. Pulmonary agene
tery with absence of lung development. On the CT the left lung is absent. These patients may be totally asymptomati
Pulmonary Sling:
On the left a 4 month old girl with abnormal echo, benign heart murmur and no respiratory or feeding difficulties. Th
rior side of the trachea. There is a little mass effect on the trachea. Pulmonary Sling In pulmonary sling the left PA or
and the trachea, where it compresses the right main bronchus. Pulmonary sling is seen more frequent in children as
er, but you can also encounter it in adults. Pulmonary Sling with long segment stenosis of the trachea. (Courtesy J. Sc
The left PA comes off the right PA and runs between the esophagus (with nasogastric tube) and the trachea. Some c
ause of cartilagenous rings. Patent Ductus Arteriosus
Patent Ductus Arteriosus:
On the left an adolescent with a murmur. On axial image and reconstruction the patent ductus arteriosus is seen. Th
ery and the proximal descending aorta. It shunts blood in utero from the right ventricle to the aorta to bypass the no
onal closure and an anatomic closure with fibrosis in the first two weeks. If it does not close these patients come to a
nsion. On the left a young adult with a murmur. The cardiologists are not interested in the flow direction, but just wa
pulmonary artery and the descending aorta. When the duct closes it may also calcify. This a normal variant.
Pulmonary venous anomalies:

Partial Anomalous Venous Return:
The most common features of Partial Anomalous Venous Return are listed in the table on the left. The anomalous ve
vein drains into the superior vena cava. Right upper lobe anomalous venous return
On the left a 2 month old, who is asymptomatic but has a murmur on physical examination. There is a connection be
eturn. Pulmonary hypertension in a patient with partially anomalous pulmonary venous return. All these partially an
n small, they are clinically insignificant. When there is a significant shunt, they may cause (late) pulmonary hypertens
dult shows large pulmonary arteries and a large right atrium and ventricle as a result of pulmonary hypertension. Rig
murmur. Study the images and then continue. On the left a similar case. Notice the anomalous return of the right up
. Right lower lobe anomalous return On the left a right lower lobe anomalous return. The vein drains into the IVC. Th
and is shaped like a Turkish sword ('Scimitar') Right lower lobe anomalous venous return into the azygos vein. On the
into the azygos vein. Upper lobe veins may also drain into the azygos vein. On the left a 10 year old girl suspected of

are three findings and then continue reading. The findings are: This patient has a scimitar syndrome and also a right
another one.
Scimitar syndrome:
The features in scimitar syndrome are listed in the table on the left. Scimitar syndrome with a hypoplastic right lung.
s a hypoplastic right lung with mediastinal shift and there is anomalous venous return. Notice that on the coronal MI
ngs with hypovascularity on the right. Enable Scroll
Disable Scroll Left upper lobe anomalous venous return into brachiocephalic vein. Enable Scroll
Disable Scroll Left upper lobe anomalous venous return into brachiocephalic vein. Scroll through the images on the l
ially into the brachiocephalic vein. The differential diagnosis of a left upper lobe anomalous venous return into brach
C however drains into the coronary sinus.
Systemic veins:

Left Superior Vena Cava:
Enable Scroll
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Disable Scroll Describe the images on the left and then continue reading. On the left side there is a vascular structure
enters into a dilated coronary sinus. The diagnosis is left or double superior vena cava. Left Superior Intercostal Vein
Left Superior Intercostal Vein.:
This is an anastomosis between the accessory hemiazygos vein and the left brachiocephalic vein. It courses along the
mal variant and if you look for this structure you will frequently notice it. Catheters or pacemaker leads may course a
ft superior intercostal vein. Notice the 'aortic nipple sign'. Left Superior Intercostal Vein On the left another example
ateral margin of the aortic arch from the the accessory hemiazygos vein to the left brachiocephalic vein. Summary of
Azygos Continuation of IVC:

Technique and Protocol:
Ideally a 64 slice scanner is used, but even a 4-slice scanner will suffice for studying vascular anomalies. The techniqu
pulmonary embolus detection. Thin collimation is used in combination with a fast table speed in order to get the hig
tch of 1.5 is used. In children we preferably do not use thin collimation, because of the higher radiation exposure, bu
n collimation is necessary. mAs and kVp In a child with a weight of less than 10Kg 40mAs will work in the chest. In chi
ith 100 mAs or more. In small children under 50 kg you can decrease the kVp to 80 and that works very well in the ch
ngs and by dropping the kVp you enhance this contrast. On the left a 3-year old. Non-breath hold images with 50mA
Although the axial images are a little bit grainy, the reconstructions are just fine. Do these patients need sedation?
Well most of the time they don't. If you can get the patient on the table and they are relatively still, even if they are b
patient on the table, because they prefer the floor, you've got to sedate. In about 20-25% of pediatric studies we use
injection is preferred. Scan Initiation Time Bolus tracking is used and the trigger is set at 120 HU. This may not alway
be too small to trigger or due to breathing the cursor may fall to the lungs. If bolus tracking does not trigger, start th
), external volume rendering (middle) and internal volume rendering. Post-processing Multiplanar reconstructions (M
are very helpful. There is no role for shaded surface or mini-IP's. On the left an external and internal rendering which
endering the posterior view is preferred to get a good look at the arch and descending aorta. Thick slab maximal inte
to study peripheral vessels you will need thick slab maximal intensity projections. For instance if you study arteriove
ronal maximal intensity projection image in patient with scimitar syndrome. Notice that on the coronal MIP you can
ovascularity on the right in a patient with scimitar syndrome. High grade coarctation of aorta not seen on axial image
e helpful when there are short focal lesions like coarctation or when vessels course obliquely (figure). Adding 3D reco
90% to 100% (Lee, Siegel AJR 182:777-784) On the left a 17-day old boy with minimal cyanosis, mild heart failure and
ouble diagnosis coarctation, because it is focal and in the same plane as the axial image. If you want to read more ab
Pediatric Body CT, 2nd edition. Lippincott Williams & Wilkins, Philadelphia. 2008 (3) by Marilyn Siegel. by Edward Y. Le
rrez, Sanjeev Bhalla and Juliet H. Fallah of the Mallinckrodt Institute of Radiology, Washington University School of M
4; 182:777-784
2. Diagnostic Imaging: Chest By Jud Gurney, MD et al AMIRSYS Title, ISBN: 1416023348, ISBN-13: 9781416023340 This
gnostic imaging!
3. Great vessels. In: Pediatric Body CT, 2nd edition by Marilyn Siegel Lippincott Williams & Wilkins, Philadelphia. 2008
4. Angiography and dynamic airway evaluation with MDCT in the diagnosis of double aortic arch associated with trac
5; 185:11248-1251
None:

Pancreatic Cancer - CT staging 2.0:

Assessment of Resectability:
Frank Wessels, Otto van Delden and Robin Smithuis
From the Radiology Department of the University Medical Centre Utrecht, the Amsterdam University Medical Centre

Publicationdate 2021-08-01 This is the second version of the role of CT in staging pancreatic cancer. Pancreatic cance
tes and Europe with over 100,000 deaths per year in Europe alone.
The overall 5-year survival ranges from 2–7 % and has hardly improved over the last two decades.
Approximately 15 % of all patients have presumed resectable disease at diagnosis and of those, only a subgroup has
l focus on the criteria for resectability versus irresectability and we will provide a checklist that will help you to make
ermining resectability. At the end of the article there will be videos by Frank Wessels on how to stage pancreatic canc
Introduction:
Complete resection of the tumor is the only curative treatment, but pancreatic cancer is seldom detected at an early
% present with locally advanced pancreatic cancer (LAPC), which is unresectable. When there are no distant metasta
d by: These subjects will be discussed in more detail in the next chapter on staging.
Based on the imaging findings the tumor can be categorized as resectable, borderline resectable or unresectable.
Staging:

Assessment of vascular involvement:
Involvement of critical vascular structures is the most important factor, which determines the resectability of a pancr
At the same time it is an important predictor of survival. The most commonly used resectability criteria for vascular i
cer Network (NCCN). These criteria however are quite complex and that is why several other criteria exist.
For instance in the Netherlands we use the criteria of the Dutch Pancreatic Cancer Group (DPCG). We will first discus
eria you use, you need to realize that assessment of resectability can be subjective and varies between institutions, e
DPCG resectability criteria:
The criteria of the Dutch Pancreatic Cancer Group for vascular compromise are relatively simple compared to the NC
. The resectability is also determined by the presence of distant metastases and the lymph node status in which extr
nt additional findings of interest to the surgeon, that are easily overlooked are: These findings will be discussed in th
NCCN resectability criteria:
Locally irresectable is synonym to locally advanced pancreatic cancer (LAPC). Assessing the degree of circumferentia
Less than 180 degrees contact is called abutment and more than 180 degrees contact is called encasement. The prob
ent, up to 100% when the tumor is completely surrounding the portal vein or SMV. In case of venous involvement the
in assessing the possibility of reconstruction. The specificity of CT for detecting vascular invasion ranges from 82-100
ations improves overall CT performance as seen in this case. A coronal reformat shows a small tumor in the pancrea
re seems to be just limited contact with the portal vein (arrow).
Continue with the next images. A multiplanar reformat perpendicular to the portal vein shows that there is more ext
hout contour irregularity this is classified as borderline resectable according to the DPCG criteria but resectable acco
uction proved to be R1, meaning presence of microscopic tumor invasion of the resection margin. Teardrop sign. A la
th the SMV, but moreover deformation of the SMV into a so called teardrop, highly suspicious for invasion. Morpholo
(yellow arrow) Vessel irregularity Axial CT shows: The coronal reconstruction shows: Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Coronal reformats show a large tumor originating from the pancreatic neck with an infiltrative growth
ry for 360º degrees (arrow in A). The axial MIP at the level of the celiac artery shows narrowing of the encased comm
Location:
65% of pancreatic adenocarcinomas are located within the head, 15% in the corpus and 10% in the tail. The remainin
lly present earlier due to obstructive jaundice. Tumors of the body and tail tend to present late and they are associat
T-stage:
T-staging has been simplified in the AJCC TNM-8 criteria. The T-stage does not determine whether a tumor ia resecta
gories are now based on size only and extrapancreatic extension is no longer part of the definition.
The rationale being that size-based definitions are more objective as it is difficult to determine extrapancreatic exten
teries.
Resectability has been removed from the definition as resectability can be subjective and variable between institutio
N-stage:
It is important to discriminate between regional lymph nodes and extra regional lymph nodes (distant metastases).
The main extraregional locations are para-aortic and to the left of the SMA. Suspicious nodes in these locations shou
mph node stations in pancreatic carcinoma as proposed by the Japan Pancreas Society.
A complete list is provided in the chapter on reporting. Click here. Lymph node metastases are an important progno
otherwise resectable pancreatic cancer. Enable Scroll
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Disable Scroll Scroll through the images for the location of the lymph node stations in the axial plane. The sensitivity
% based on a size criterium of >10mm short-axis alone. The reason for this poor sensitivity is that small regional lym
e reactive. Adding morphological features like rounded shape, heterogeneity, central necrosis and absence of fatty h
than 30%. Axial CT (a) shows multipele para-aortic lymph nodes, up to a short-axis of 10mm (primary tumor in the pa
h node was performed. Pathological analysis showed no metastasis but sarcoid. This patient had a primary tumor in
There is a locoregional lymph node metastasis next to the portal vein (arrowhead).

A second lymph node metastasis is seen between the caudate lobe and left gastric artery (arrow). This second lymph
tended lymhadenectomy. Continue with next image... In
the chest a similar pathological lymph node was seen para-esophageal in station
8. This
was confirmed on EUS guided FNA as an extraregional lymph node
metastasis. Meaning distant metastases and irresectabele disease. Liver metastases shown on DWI but not on CT (ar
M-stage:
40% of patients with pancreatic cancer have distant metastases at the time of presentation. Next to distant lymph no
and pulmonary (<10%). Liver metastases frequently present as multiple lesions less than 10mm in size and are predo
his is a form of peritoneal spread. Subsequently the sensitivity of CT for detecting liver metastases is low, around 75%
thin 6 months of resection of the primary tumor, suggesting synchronous disease and being already present at the t
The images show an axial CT (a,b) with a resectable tumor in the pancreatic head, with no signs of liver metastases.
The patient was randomized for neaoadjuvant chemoradiotherapy in the PREOPANC-2 trial.
MRI for radiotherapyplanning (DWI shown in c,d) within several weeks of CT showed over 10 liver metastases. CT
is not sensitive for the detection of small peritoneal lesions, but larger
lesions may be noted. ImagesPeritoneal
metastases in the right paracolic gutter (arrowhead) and in the rectovesical
space (arrow) in a patient with locally advanced pancreatic cancer (not shown).
In the presence of distant metastases curative intended treatment of LAPC (systemic
therapy with possible subsequent resection) is no longer an option. In
doubtful cases laparoscopy may confirm the diagnosis.
Additional findings of interest to the surgeon:
Next to the assessment of vascular involvement the invasion of other
surrounding structures and organs should be examined (see checklist). Some
of which are directly invaded and don't
preclude resection (for instance duodenal invasion, which is taken out in a
Whipple procedure.)
But both spread to the
transverse mesocolon and root of the mesentery are commonly overlooked and may
warrant extended resections or lead to irresectability.
Perineural invasion:
Perineural spread is a common finding in pancreatic adenocarcinoma and seen in more than half of the cases.
It is an important prognostic factor for early recurrence and metastatic disease. On CT it is detected as infiltrating so
ripancreatic neural pathways, which extend from the pancreatic head to the SMA, celiac trunc and the common hepa
e. Perineural invasion (2)
The axial image shows a double duct sign (arrowheads).
Although a mass in the pancreatic head is not seen, we must assume that there is a small tumor in the pancreatic he
issue infiltration from the medial side of the pancreatic head toward the SMA (yellow arrows). This is a typical pattern
In this case leading to 90 – 180 degrees contact with the SMA. Continue with the scroll images... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Perineural invasion (3) These axial images are of the same patient.
Notice the large area of perineural spread. Although there is a double duct sign and perineural tumor spread which
the CT. Notice the length of the perineural tumor spread. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Perineural invasion (4) Scroll through the coronal images. Axial CT shows a mass in the uncinate proce
tery as demonstrated by encasement of a major SMV tributary (arrowhead) and separate obstruction of proximal jej
Spread to root of mesentery:
The root of the small bowel mesentery
extends obliquely in the abdomen running from the point of termination of the duodenum at Treitz all the way to th
SMA and the SMV and their branches are the predominant vascular structures within the mesentery. A carcinoma of
the uncinate process can easily involve the jejunal mesentery by spreading
along this pathway.
The first jejunal branches of the SMA and SMV serve as landmarks
to identify this type of invasion (figure). If invasion is limited
resection and reconstruction may be possible, but more extensive invasion is
mostly irresectable. Axial CT shows a mass in the pancreatic head (arrowhead). In less then 90 degrees contact with t
nk (asterisk), in this case the venous confluence of the right gastopepiploic vein (RGEV) and the middle colic vein (MC
Spread to transverse mesocolon:
The
transverse mesocolon is in contact with the ventral side of the head of the

pancreas and can be invaded by a tumor of the pancreatic head. It
can be identified on CT by following the middle colic vein and right
gastro-epiloic vein to the point where they join to form the gastrocolic trunk,
which is usually the last vein to drain into the SMV, on the ventral side. Invasion
of the transverse mesocolon does not necessarily preclude resection, but since additional
hemicolectomy might be needed this is essential pre-operative information.
Variations of arterial anatomy:

Anatomic variations:
What we regard as the normal hepatic arterial anatomy is seen in only 55% of the population (figure). Variations of th
omalous arteries may run in close proximity to the head of the pancreas, which predisposes them to tumor extensio
rteries with an anomalous origin can either be accessory or replaced. An accessory right hepatic artery is an extra rig
n anomalous origin and replaces the proper right hepatic artery (figure).
The most common variations are demonstrated in the illustration. In patients planned for pancreatic surgery, it is im
or common hepatic artery. These arteries originate from the right side of the SMA and run in close proximity to the h
r iatrogenic injury.
The reported frequencies of these specific anomalies are 11-21% and 0.5-5%. Replaced right hepatic artery The axial
in close proximity to a hypodense mass in the pancreatic head (arrowhead). The vascular involvement is better appr
of the replaced right hepatic artery (white arrow) by a pancreatic head adenocarcinoma (white arrowhead).
The native left hepatic artery is seen in a more anterior course, the portal vein in between. The operation was a R1-re
Disable Scroll Enable Scroll
Disable Scroll Axial images of the same patient with annotations. Replaced right hepatic artery This coronal MIP show
e of the SMA (yellow arrow in A). It is in close proximity to the pancreatic head . The axial CT shows the course of the
arrowhead) and the native left hepatic artery running anterior to the portal vein (green arrowhead). This was an inci
e Scroll
Disable Scroll Enable Scroll
Disable Scroll Coronal imagers of a patient with a tumor in the pancreatic head and a accessory right hepatic artery.
lous common hepatic artery originates from the SMA. The images show an anatomical variant in which the common
seen within the pancreatic head (yellow and green arrow in B). Celiac trunc stenosis with collateral bloodflow to the l
Arterial stenosis:
Next step in the preoperative evaluation is to look for a stenosis of the celiac artery, which is observed in 2-8% of pat
Celiac artery stenosis can either be caused by compression of the median arcuate ligament or atherosclerotic diseas
by collateral bloodflow from the SMA, via the peripancreatic arcade (of Buhler) and retrograde flow in the gastroduo
pancreaticoduodenectomy the arterial blood supply to the liver is at risk if a celiac artery stenosis is not detected pr
The coronal reformat (a) shows a small tumor in the ampullary region (arrowhead), with obstruction of both the com
nvasion this is regarded as a resectable lesion.
The axial CT (b) however shows hypertrophy of the peripancreatic arcade (arrows), highly suggestive of a significant s
The celiac trunk stenosis is shown on sagittal MIP (arrow in c).
The collateral bloodflow to the hepatic artery via the pancreaticoduodenal arcade (stippled arrow) is nicely appreciat
Re-staging after neoadjuvant treatment:
Follow-up CT after neoadjuvant therapy shows no disease progression and exploration was performed. In the era of
some important restrictions, mainly in the differentiation of remaining fibrosis and vital tumor. Re-staging on CT ove
, therefore RECIST measurements have little to no value in the absence of progression. Furthermore vascular involve
being fibrosis instead of vital tumor. Any reduction in vessel-tumor contact has been shown to be significantly assoc
considered an indication for surgical resection in suitable candidates. The role of re-staging CT at this time is to rule
ld be considered. Data on the additional value of DWI or PET-CT are still limited. Images
Axial CT (a) before neoadjuvant treatment shows a tumor on the medial side of the pancreatic head (arrowhead), irre
asement of the SMA (arrow in b, coronal reformat).
Follow-up CT after 8 cycli of FOLFIRINOX (c,d) shows stable disease with persistent encasement of the SMA. The proc
cal exam.
Imaging:

CT protocol:
Local staging should be done on a high quality pancreatic CT, consisting of a late arterial and portal venous phase.
Pancreatic adenocarcinoma typically presents as a hypodense hypovascular mass, which is best appreciated in the la
ok ofr variants and stenoses. The portovenous phase is best for detection of liver metastases and detection of venou
e CTis the workhorse in staging of pancreatic adenocarcinoma.
It is most widely used and best validated.
CT can assess local extension and distant metastases, with accuracies of up to 77% for predicting resectability and 9
Role of MRI:

MRI is used for the characterization of indeterminate liver lesions on CT, as of yet there is no evidence supporting fo
RI can be used in the characterization of mainly cystic pancreatic lesions, a subject beyond the scope of this article. M
ted sensitivities of 85-100%. With 10-25% of MRI being positive for liver metastases after initial negative CT. These da
ra of neoadjuvant treatment the role of MRI is still debated, given the fact that in >40% of small liver lesions histologi
Surgical treatment:
Whipple procedure before and after Whipple procedure
A Whipple procedure is an operation in which the pancreatic head with the carcinoma and the distal choledochal du
duodenum and a small part of the proximal jejunum.
The stomach, proximal choledochal duct and the body of the pancreas are connected to the jejunum. Pylorus preser
A pylorus preserving pancreaticoduodenectomy (PPPD) is almost the same operation but the pylorus is preserved. D
Operation for a tumor in the pancreatic body or tail. It is carried out with or without splenectomy. Total pancreatecto
Combination of Whipple and distal pancreatectomy.
Reporting:

Checklist:
This list contains all the items that need to be examined. In the conclusion of the radiology report mention the most
Lymph node stations in pancreatic carcinoma:
Lymph node stations in pancreatic carcinoma as proposed by the Japan Pancreas Society.
Video presentation by Frank Wessels:

Case 1 - resectable cancer:
This is case 1 of a series of demonstration on how to stage pancreatic cancer.
More videos will come shortly.
case 2 - Borderline resectable:

Case 3 - irresectable?:
Marc Zins et al. Radiology. 2018 May;287(2):374-390
2. Tumor-Vessel Relationships in Pancreatic Ductal Adenocarcinoma at Multidetector CT: Different Classification Syst
Radiographics. Jan-Feb 2017;37(1):93-112
3. Routine MRI With DWI Sequences to Detect Liver Metastases in Patients With Potentially Resectable Pancreatic Du
Anne-Marie Marion-Audibert et. al. AJR Am J Roentgenol 2018 Nov;211(5):W217-W225.
4. Improving preoperative detection of synchronous liver metastases in pancreatic cancer with combined contrast-e
19 May;44(5):1756-1765.
5. Locally Advanced Pancreatic Adenocarcinoma: Reassessment of Response with CT after Neoadjuvant Chemothera
1—October 2014
6. Response of borderline resectable pancreatic cancer to neoadjuvant therapy is not reflected by radiographic indic
7. /Classification_of_Pancreatic_Carcinoma_4th_Engl_ed.pdf
8. Checklist tbv Radiologisch verslag bij solide pancreastumoren. ABDOMINALE SECTIE NVvR (Versie 1.2) Only in Dutc
None:

None:

US-guided injection of joints:
James Collins, Robin Smithuis and Matthieu Rutten
Department of Radiology of the Medical Center, Leeuwarden, the Rijnland Hospital, Leiderdorp and the Jeroen Bosch
Publicationdate 2012-12-22 This article describes the application of Ultrasound guidance for diagnostic and therapeu
cedures performed either blind or under fluoroscopic or CT guidance.
Shoulder:

Glenohumeral joint:
Anterior approach In the anterior approach the patient is lying supine with the extended arm externally rotated (figu
s of the subscapular tendon. The grey line on the side of the transducer indicates the long axis. Local anaesthetics ar
r thinner. For joint aspirations one may need to use a larger bore needle due to high viscosity of the aspirate. In such
ion of medication or contrast, one may use a connection tube in between the needle and the syringe, the latter being
for are the medial contour of the humeral head and medial to this the coracoid process (C) A 22-gauge, 50mm needl
by an assistant who upon proper needle position injects 15-20 mL of the contrast medium. The needle is advanced
e subscapular tendon. If one hits the cartilage of the humeral head, the needle should be pulled back 1 or 2 mm, slig
ead into the joint with the bevel of the needle facing into the joint (figure). No resistance to injection should be felt ar
and if present into the subscapular recess.
Posterior approach:

A. The needle is in the intra-articular position with the tip underneath the infraspinatus tendon (ISP) and posterior la
he humeral head. B. Corresponding cadaver section showing the optimal needle track (white line). C. Sonogram after
of the needle can be visualized real-time during injection, but is also confirmed by the 'comma'-like configuration of
aarticularly injected fluid. US-image showing a long axis view of the supraspinatus tendon (SSP). The advancing need
between the deltoid and SSP-muscle. Dilatation of the subacromial–subdeltoid bursa after injection of 5 mL fluid (blu
Subacromial bursa:
The subacromial-subdeltoid bursa is a synovial lined space, which contains no observable or only a minimal amount
ner leaves are fused with the deltoid muscle fascia and rotator cuff, respectively. The bursal leaves can easily glide ov
e shoulder. Blind subacromial injection of drugs into the subacromial bursa is a frequently performed therapy by ge
ctions that miss the subacromial bursa range from 12% to 70%.
Elbow:
For injection of the elbow the patient is supine with the arm in 90□ flexion, raised and resting on a cushion. The joint
lpated. The hand is pronated or may be turned into the thumb up position, which is necessary to open the joint max
nt space. The needle (22 gauge, 30 mm) is directed at a slight craniocaudal angle on the dorsolateral side of the joint
the radial head. When seen to have entered the joint and upon feeling the cartilage of the radial head, the needle is
cartilage and facing into the joint. 5-8 mL of contrast media is injected. No resistance to injection should be felt.
Wrist and hand:

Radiocarpal joint:
The patient is supine with the wrist resting flexed over a 45□ sponge or a rolled-up towel. In some cases it may be he
joint space even more. The space between the radius and the scaphoid is identified on ultrasound. A 23-25-gauge, 3
irected toward the articular surface of the radius until one feels contact with the radius. After ensuring that the tip of
st is injected. The bevel of the needle is facing toward the joint space and the contrast is seen to flow into the joint.
Distal radioulnar joint (DRUJ):
A linear array transducer is axially positioned dorsally over the distal radius and ulna. Along the short axis of the tran
ted from proximally to distally in a caudal direction. A total amount of 0.5-1 mL is injected according to rising pressur
Carpal, carpometacarpal and interphalangeal joints:
Physicians and specialists routinely perform intra-articular punctures and injections on small wrist and finger joints t
and frequency of occurrence of peri-articular injections are high: 15% - 32%, especially with the joints of the little fin
ection moreover may affect the surrounding ligaments or tendons, leading to serious complications. A dorsal approa
y linear array transducers with frequencies from 18 to 12 MHz are often used for scanning the superficial soft tissue
may allow better access to the small peripheral joints. Generally, 0.5-1 mL of contrast material is instilled after confir
Sacroiliac Joint:
The sacroiliac joint has been implicated as a source of low back and lower extremity pain, which is thought to be cau
tion of corticosteroids. Diagnostic injections or blocks are frequently performed, to distinguish between the probable
y the SI joint. Upper level SI joint injection The axially orientated transducer is moved from the level of the fifth lumba
acrum with the median and lateral sacral crest, the gluteal surface of the ilium, and the first posterior sacral foramen
er into the hypoechoic cleft located between the surface of the sacrum and the contour of the ilium. Angulations of
c cleft of the SI joint, which presents cranially a more medial to lateral orientation, and caudally a more vertical orien
the transducer is moved downward by delineation of the median and lateral sacral crest, at the dorsal surface of the
sterior sacral foramen is visualized. As with the upper level, the needle is inserted into the hypoechoic cleft between
Hip:
The patient is placed supine. The leg is held in slight endorotation and abduction thereby reducing tension on the ca
ally out of the intended needle path.
Preferably a 5-3.5 MHz curved array transducer is used, which provides the necessary penetration depth.
Usually a 21 gauge needle with a length of 9 cm is used for the average adult. In smaller adults or children a 23-gaug
be injected prior to the main injection but this entails extra manipulation as well as non-contrast fluid (anaesthetic) in
d joint space as well as possibly 2 punctures. The needle may inadvertently be withdrawn from the joint after anaest
trast. This could be avoided by using a three-way connector between the two syringes containing the anaesthetic and
The needle is advanced at a caudo-cranial angle along the long axis of the transducer aiming for the anterior recess
US and illustration). The bevel of the needle should be facing toward the joint.
When the needle makes contact with the femoral head-neck junction it is slightly retracted to prevent inadvertently i
see drawing).
If correctly positioned within the joint capsule, 10-15 mL contrast media or medication is injected and the anterior re
rticular positioning.
Knee:
Indications for CT or MR arthrography of the knee are evaluation of the post-operative meniscus, query intra-articula
nd evaluation of articular cartilage. One may also be requested to inject medication such as corticosteroids and/or a
nce but use the standard "blind" procedure introducing the needle (21-gauge, 50 mm) behind the patella using a late
e introduced from the mid lateral side aiming toward the centre of the patella indicated by the left forefinger. The ne

of the patella until one makes contact with the lateral patellar facet or the lateral femoral condyle and when felt to b
or MR one can choose to apply a tight bandage above the patella thereby forcing contrast from the suprapatellar re
Ankle and foot:
The foot is slightly plantar flexed. The long axis of the transducer is indicated by the grey line on the side, being in a s
Tibiotalar joint:
CT or MR arthrography may be used to query ligamentous, osteochondral or chondral injury, eval- uation for free bo
he ankle (tibiotalar joint) the patient is supine with the foot in slight plantar flexion. The medial side of the tibiotalar j
r- mine a suitable place for injection, at the same time checking for any excessive joint fluid. We use a small curved a
Hz linear array transducer. The long axis of the probe is held in a sagittal plane. Sonogram showing the needle (arrow
a in the tibiotalar joint. The needle, usually 22-gauge (length: 30 mm), is introduced in line with the long imaging axis
space, medial to the anterior tibial ligament, avoiding ligaments and vessels. One should identify the talar dome and
-cranially into the joint under the ventral lip of the distal tibia aiming for the articular surface of the distal tibia. Conta
tip is free from the tibial cartilage and that the bevel is facing into the joint. 8-10 ml of contrast is injected into the tib
up with the fluid. There should be no resistance to injection or pain experienced by the patient.
Posterior subtalar joint:
The subtalar or talocalcaneal joint is composed of 3 facets: a broad posterior facet representing the primary articula
entaculum tali articulates with the medial process of the talus, and an anterior facet. Subtalar arthrography may be p
l approach. 2-4 ml of contrast material is injected into the posterior subtalar joint. Schematic drawing in a coronal vie
achment sites of the cervical ligament (1); the interosseous talo- calcaneal ligament (2); and the medial (3), intermedi
aculum.
Sinus tarsi:
The sinus tarsi is a cone-shaped cavity that courses in a postero- medial to anterolateral direction. It is located in the
nd the anterosuperior surface of the calcaneus. The tarsal sinus continues medially as the tarsal canal, which is a fur
ins fat, an arterial anastomosis, joint cap- sules, nerve endings, and five ligamentous structures-the medial, intermed
the cervical ligament; and the interosseous talocalcaneal ligament (figure). This space can be the cause of foot pain i
nfiltration of the sinus tarsi with a mixture of Depomedrol and local anaesthetic (Lidocaine). This can be challenging
ily and accurately achieved with ultrasound guidance. US-guided injection of the sinus tarsi at the right-hand side wit
que plane. The needle is introduced along the long axis of the transducer. The sinus tarsi can easily be visualized usi
aying the foot to be treated with its medial surface against the table top, the lateral side of the foot being uppermost
ds to the foot. The sinus tarsi is identified as a triangular space between the anterior process of the calcaneus and th
in the cone shaped sinus tarsi, which is bordered by the talus (T) and calcaneus (C). Depending on the degree of infla
tervening vessels visible, which one wishes to avoid. This is relatively easy, especially with colour doppler
Volumes of injection:
Click on the image below to look at the video of Medical Action Myanmar (MAM), an NGO run by Frank Smithuis and
MAM has 12 clinics and 2100 community health workers all over Myanmar.
You can also visit the website of MAM
All donations are extremely well spend. by Collins JM, Smithuis R, Rutten MJ. Eur J Radiol. 2012 Oct;81(10):2759-70
Shoulder Anatomy and Variants on MRI:
Robin Smithuis and Henk Jan van der Woude
Radiology department of the Alrijne hospital, Leiderdorp and the Onze Lieve Vrouwe Gasthuis, Amsterdam, the Neth
Publicationdate 2012-04-02 The glenohumeral joint has a greater range of motion than any other joint in the body. T
joint capsule renders the joint relatively unstable and prone to subluxation and dislocation. MR is the best imaging m
In Shoulder MR-Part I we will focus on the normal anatomy and the many anatomical variants that may simulate pat
we will focus on impingement and rotator cuff tears.
Introduction:
Lateral view of right shoulder The glenohumeral joint has the following supporting structures: Anterior view The tend
osity aswell as to the greater tuberosity giving support to the long head
of the biceps in the bicipital groove. Dislocation of the long head of the biceps will inevitably result in rupture of part
the tendons of subscapularis, supraspinatus, infraspinatus and teres minor muscle. Posterior view The supraspinatu
y all attach to the greater tuberosity. The rotator cuff muscles and tendons act to stabilize the shoulderjoint during m
de up partially out of the glenoid fossa, lessening the efficiency of the deltoid muscle. Large tears of the rotator cuff
a high riding humeral head.
Normal anatomy:
Enable Scroll
Disable Scroll Enable Scroll
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Axial anatomy and checklist:
At this level look for SLAP-lesions and variants like sublabral foramen. At this level also look for Hill-Sachs lesion on t
5. The fibers of the subscapularis tendon hold the biceps tendon within its groove. Study the cartilage.
6. At this level study the middle GHL and the anterior labrum. Look for variants like the Buford complex. Study the ca

7. The concavity at the posterolateral margin of the humeral head should not be mistaken for a Hill Sachs, because t
Hill Sachs lesions are only seen at the level of the coracoid. Anteriorly we are now at the 3-6 o'clock position. This is v
8. Notice the fibers of the inferior GHL. At this level also look for Bankart lesions.
Axis of supraspinous tendon:
The supraspinatus tendon is the most important structure of the rotator cuff and subject to tendinopathy and tears.
e and ABER-series. In many cases the axis of the supraspinatus tendon (arrowheads) is rotated more anteriorly comp
ronal oblique series, it is best to focus on the axis of the supraspinatus tendon. Enable Scroll
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Coronal anatomy and checklist:
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Sagittal anatomy and checklist:

ABER view:
Labral tears The abduction external rotation (ABER) view is excellent for assessing the anteroinferior labrum at the 3
where most labral tears are located. In the ABER position the inferior glenohumeral ligament is stretched resulting in
contrast to get between the labral tear and the glenoid. Rotator cuff tears The ABER view is also very useful for both
duction and external rotation of the arm releases tension on the cuff relative to the normal coronal view obtained w
tial thickness tears will not lie apposed to the adjacent intact fibers of the remaining rotator cuff
nor be effaced against the humeral head, and intra-articular contrast can enhance visualization of the tear (3). ABER-
tained in an axial way 45 degrees off the coronal plane (figure). In that position the 3-6 o'clock region is imaged perp
, which was not seen on the standard axial views. Enable Scroll
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ABER - anatomy:

Labral variants:
Labral variants and SLAP-tear There are many labral variants. These normal variants are all located in the 11-3 o'cloc
e they can mimick a SLAP tear. These normal variants will usually not mimick a Bankart-lesion, since it is located at th
cur. However labral tears may originate at the 3-6 o'clock position and subsequently extend superiorly.
Sublabral recess:
There are 3 types of attachment of the superior labrum at the 12 o'clock position where the biceps tendon inserts. In
labrum. In type II there is a small recess. In type III there is a large sublabral recess. This sublabral recess can be diff
amen. These images illustrate the differences between an sublabral recess and a SLAP-tear. A recess more than 3-5
ral recess The image shows the typical findings of a sublabral recess.
Sublabral Foramen:
A sublabral foramen or sublabral hole is an unattached anterosuperior labrum at the 1-3 o'clock position. It is seen i
hould not be confused with a sublabral recess or SLAP-tear, which are also located in this region. A sublabral recess
tendon at 12 o'clock and does not extend to the 1-3 o'clock position. A SLAP tear may extend to the 1-3 o'clock positi
rum should always be involved. Enable Scroll
Disable Scroll Sublabral Foramen Enable Scroll
Disable Scroll Sublabral Foramen Scroll through the images and notice the unattached labrum at the 12-3 o'clock po
ers unlike the margins of a SLAP-tear.
Buford complex:
A Buford complex is a congenital labral variant. The anterosuperior labrum is absent in the 1-3 o'clock position and t
sent in approximately 1.5% of individuals. On these axial images a Buford complex can be identified. The anterior lab
ed middle GHL. The thickened middle GHL should not be confused with a displaced labrum. It should always be poss
to the humerus. Sorry, your browser doesn't support embedded videos. Video of Buford complex
Os Acromiale:
Failure of one of the acromial ossification centers to fuse will result in an os acromiale. It is present in 5% of the popu
s a normal variant. The os acromiale may cause impingement because if it is unstable, it may be pulled inferiorly dur
cromiale is best seen on the superior axial images. An os acromiale must be mentioned in the report, because in pat
the removal of the acromion distal to the synchondrosis may further destabilize the synchondrosis and allow for
even greater mobility of the os acromiale after surgery and worsening of the impingement (4). The axial MR-images s
sts and osteophytes (arrow). by Jaideep J. Iyengar, MD; Keith R. Burnett, MD; Wesley M. Nottage, MD ORTHOPEDICS A
2. Detection of partial-thickness supraspinatus tendon tears: is a single direct MR arthrography series in ABER positio
ers SA, van der Hulst VP, Willems WJ, Bipat S, van der Woude HJ. Skeletal Radiol. 2009; 38(10):967-975.
3. Indirect MR arthrography of the shoulder: use of abduction and external rotation to detect full- and partial-thickne

M, Hamer OW, et al. Radiology. 2006; 240(1):152-160.
4. MRI of the shoulder second edition by Michael Zlatkin.
RECIST 1.1 - the basics:

Response Evaluation Criteria In Solid Tumors:
Fokko Smits, Martijn Dirksen and Ivo Schoots
Radiology Department of the Erasmus MC in Rotterdam and the Isala hospital in Zwolle, the Netherlands:
Publicationdate 2020-7-5 RECIST 1.1 is a standard way to measure the response of a tumor to treatment. In this artic
e whether a tumor disappears, shrinks, stays the same or gets bigger are complete response (CR), partial response (
ation is given in the article RECIST 1.1 and more in which we will discuss RECIST 1.1 in more detail and discuss other
Introduction:
RECIST is a standard way to measure the response of a tumor to treatment. CT is the preferred modality for the base
treatment starts and slice thickness 5 mm and i.v. contrast are mandatory. Choose target lesions (max 5) that are
SLD). Identify non-target lesions like ascites or pleural fluid that are not suited for exact measurements, but that can
arget lesions and determine the presence or abcense of the non-target lesions and look for new lesions. Then deter
isease or progressive disease. Any new lesion means progressive disease. The response criteria can be seen in the ta
the follow up scan has to be compared with the baseline and the smallest SLD during treatment, called the 'nadir'. Th
ive disease.
Target lesions:
Examples of target lesions Tumors Choose preferably large well-described lesions to measure with a longest diamet
e whole study. Lymph nodes Lymph nodes can be used as target lesions provided that the maximum short axis diam
regarded as normal. Lymph nodes 10-14mm are regarded as pathologic, but not suited for target lesions.
They can be used as non-target lesions. When target lymph nodes decrease to a normal size (<10 mm), their measur
SLD). Special notes on defining target lesions
Sum of Longest Diameters:
Here an example of a 28-year-old male with a neuroendocrine carcinoma of the appendix. There are 5 lesions suited
Non-target lesions:
During follow up there is unequivocal progression of lymph node metastases, which were choosen as non-target les
ot measure non-target lesions, but make a good estimate. In the follow up there are 3 possibilities: Here another exa
r-old male with progressive liver metastases of colorectal carcinoma. At baseline the liver metastases were too small
non-target lesions.
At follow up there is unequivocal progressions. Unequivocal progression of non-target lesions means progressive dis
he target lesions.
New lesions:
Any new lesion means progressive disease. Do consider “new” lesions in an area of the body that was not imaged du
forcing overall response to progressive disease. CT-images in a 81-year-old female with endometrial carcinoma and
apy. Courtesy Els van Persijn van Meerten. Any new lesion means progressive disease, but not every newly detected
t can be difficult to determine if a sclerotic lesion that is detected during follow up is truly a new lesion. The sclerotic
teoblastic reaction to the therapy.
Response assessment:
This table is the same as the table in the introduction, but demonstrates the overall treatment response with varying
Special remarks:
The orientation of the liver metastasis has changed during follow up.
Do's:
The sclerotic bone lesions in b and d are not new metastases but an osteoblastic reaction. Courtesy Els van Persijn v
Don'ts:

Fragmentation of lesions:
If a lesion breaks into separate fragments between baseline and follow-up, the sum of longest diameters (SLD) of the
er is measured for lymph nodes. At follow up the lung metastasis is too small to measure. A default value of 5mm is
Too small to measure:
At each response evaluation each target lesions should be measured, even when they are very small (e.g. 2 mm). If a
e lesion is too small to measure (faintly seen and not possible to give an exact measurement) assign a default value
the 5 mm CT slice thickness). The images are of a patient with a primary lung tumour.
At baseline, the longest diameter is well above 10 mm, therefore this was assigned as a target lesion.
During follow-up the long-axis diameter dropped below 10 mm, which is the lower limit for considering a lesion as ta
However, since this is a follow-up measurement, the target lesion still counts up to the sum of the diameters (SLD) a
Cavitating lesions:
Cavitation can occur during treatment.
Cavitating lesions should be continuously measured in their longest diameter.

A different assessment can be provided if the sum of the longest diameters does not adequately correspond to the p
ale with a pulmonary metastasis of a malignant peripheral nerve sheath tumour. Cavitation occured after treatment
Although the size remains the same, a remark can be made in the report, that the actual tumorvolume has decrease
(2):248-260.
2. Individual patient data analysis to assess modifications to the RECIST criteria. Bogaerts J, Ford R, Sargent D, et al. E
3. Modified RECIST criteria for assessment of response in malignant pleural mesothelioma. Byrne MJ, Nowak AK. Ann
MRI of the Paranasal Sinuses:
Laurie Loevner and Jennifer Bradshaw
Radiology department of the University of Pennsylvania, USA and the radiology department the Medical Centre Alkm
Publicationdate 2009-02-25 This article is based on a presentation given by Laurie Loevner and adapted for the Radi
complimentary roles that CT and MR play in the assessment of: Fibro-osseous lesions Role of CT and MRI
Role of CT and MRI:
CT is of value for determining anatomic landmarks and variants. This information is of vital importance to the ENT-su
acquired developmental deficiencies of the bone. CT is also excellent for determining whether there is intraorbital e
in the ventral 2/3 of the orbit. When pathology approaches the orbital apex, an MRI study is necessary to assess spre
rformed without contrast medium. If additional imaging is necessary, orbital MRI is the next step. Allergic fungal sinu
ollowing: if you see an opacified sinus with hyperdense contents, it is usually a sign of benign disease.
Tumor is not hyper-dense. The hyperdensity is due to one or a combination of the following: On the left you see a ca
material in the posterior right ethmoid, the bilateral spheno-ethmoidal recesses, the sphenoid sinus and there is inv
ign, indicating a benign process. This is an example of allergic fungal sinusitis. Usually it is more anteriorly located. Al
er, more characteristic, example of allergic fungal sinusitis. There is bilateral opacification of the nasal cavities, usual
Note the concentric lamellated appearance of alternating hyper- and hypodensity in the maxillary sinusses. The hypo
hypodensity reflects cysts, mucosal disease, and granulation tissue.
In the ethmoidal region some of the hyper-density reflects periostitis and neo-osteogenesis along the septae. The si
t
Signal characteristics of secretions:
MRI is extremely helpful in complicated sinonasal disease. MRI can discern secretions and mucosa from masses. Wh
distinguish soft tissues masses from inspissated secretions. The signal intensity of secretions can vary and mainly de
erent protein contents result in different signal intensities on T1 and T2W-images (figure). Fungus usually has a high
s because it is low on T1- and T2WI. You need CT to make the distinction! MRI is also useful for determining invasion
lacement of the high signal of the fatty marrow on T1WI by hypointense signal of the tumor. Also look for foraminal e
tumor. MRI is also the study of choice for detecting intracranial extension of sinonasal disease. Pseudo-pneumatized
Pseudo-pneumatized sinus:
Role of CT and MR (2) On the left a T2W-image in an immuno-compromised patient with fever. Initially a MRI was per
e left sphenoid sinus, which also had a low signal intensity on the T1W-image (not shown). Continue with the CT. Pse
ws the opacified sinus, which is slightly hyperdense. The signal characteristics on MRI and the attentuation on CT are
example of the pitfall of the 'pseudo-pneumatized sinus' . This is an example of an Actinomyes infection. So, when in
ve on to MRI to rule out spread to the eye, cavernous sinus and intracranial compartment!
Enhancement:
In general bright signal on T2 is a sign of benign disease, since fluid and mucosal disease usually have a high water c
an enhancing mass, you must rule out tumor. On the left an example of infectious sinonasal disease. On the pre-con
sinusses due to proteineous material. After the administration of i.v. contrast there is only enhancement of the circu
d sinus and skull base Role of CT and MR (3) In complicated cases both CT and MR are needed to demonstrate the ex
transplant with fever and multiple rapidly progressing cranial nerve palsies. We will show you CT- and MR-images of
rst study the images to study the extention od the disease. Then continue reading. Lymphoma of sphenoid sinus and
t is more cranial. There is opacification of the sphenoid sinus with destruction of and osteopenia of the sphenoid bon
soft tissue involvement. Continue with the MR-images. Lymphoma of sphenoid sinus and skull base On the left the c
findings are: Continue with the coronal images. Lymphoma of sphenoid sinus and skull base Coronal images of the
eckel's cave, tissue in the left Meckel's cave extending into the cavernous sinus (blue arrow). The red arrow points to
on both sides of the dura. The disease wraps around the temporal lobe (green arrow) and extents downward in the
rix indicates normal non-enhancing tissue in the masticator space. This patient had a lymphoma. Nine out of ten tim
ne out of ten it will be a lymphoma. CT and MR have a complimentary role in this case, but finally a biopsy is called fo
fferent treatment. Sinonasal carcinoma Role of CT and MR (4) On the left images of a 64-yrs-old, immuno-competent
. On the image on the left hypointense tissue is seen in the pterygo-palatine fossa and videan canal (yellow arrow). C
ntense tissue in the pterygo-maxillary fissure and pterygo-palatine fossa. Continue with the contrast-enhanced T1W-
mality. The differential diagnosis again consists of 2 catagories: neoplasm and chronic invasive fungal infection. In ar
ntinue with the CT-images. Sinonasal carcinoma This is the corresponding CT, performed not to make the diagnosis,
ally the sphenoid sinus. Also, it serves to guide the endoscopist for intraoperative biospy. There is extensive destruct
illustrates a normal foramen rotundum on the left (yellow arrow), which on the right has been obliterated by soft tiss
r biopsy is indicated by the blue arrow. At biopsy the diagnosis of a spindle cell carcinoma was made.

Complications of Sinusitis:
When assessing the complications of sinusitis, CT is excellent for imaging of subperiostial abscesses or orbital extens
sessing intracranial complications, such as brain or epidural abscesses, subdural empyema or sinus thrombosis. Bra
Brain abscess:
On the left images of a patient was initially diagnosed with a glioblastoma multiforme.
There are abnormalities in both frontal lobes. Notice however the abnormal tissue in the frontal sinus (yellow arrow)
reen arrow) in the large intracranial lesion which has ring enhancement. All abnormalities are continuous meaning th
pports the diagnosis of brain abscess. This is a subperiosteal abscess and osteomyelitis of the frontal bone, usually w
d Pott's puffy tumor after Sir Pott, an English surgeon who first described this entity. Brain abscess Brain abscess (2)
treated for sinusitis and now presented with a seizure.
The CT shows an abnormality in the left temporal lobe with shaggy thick rim enhancement, and a large amount of va
This is also a brain abscess, most probably due to reflux of bacteria into cranial veins and the venous plexus around
Mucocele:
Mucoceles are benign, locally expansile paranasal sinus masses most commonly found in the frontal sinus. Seconda
within a mucoperiosteal lined cavity, resulting in erosion and remodelling of the surrounding bone. The most comm
ease, trauma and previous surgery. The most common location of a mucocele is the fronto-ethmoidal sinus, followe
The least common location is the maxillary sinus. On the left a patient with an uncommon cause of a mucocele. Noti
llow arrows). Mucocele secondary to obstructing tumor Pre- and post-contrast MRI of the same patient. The mucoce
he ethmoidal region is hypointense and solidly enhancing. Mucocele (2) The case on the left shows two classic comp
re the clue to a traumatic etiology. Looking at the CT scan on the far left you will notice a convex soft tissue mass in t
intense structure in the same location. Study the images on the left and then continue reading. Posttraumatic muco
Did you notice the bony defect on the left side, at the lateral border of the ethmoid air space (yellow arrow)? The MR
This patient had both a mucocele and an acquired encephalocele. The two most common causes of mucoceles are t
ucoceles Mucocele (3) This companion case nicely demonstrates bilateral mucoceles. This patient has chronic sinusit
y sinusses and huge bilateral mucoceles. The CT shows hyperdensity and the MRI shows hyperintensity on T2WI, bot
indicating a proteinaceous substance. There is smooth bone remodelling and elevation of the frontal sinusses, and a
undary of the frontal sinus, usually the surgeon will still see a fine line of bone in place.
Orbital Cellulitis and Abscess:
Left is an axial T1WI, right is a coronal T2WI. There is an abnormality on the left side, but to a lesser degree also on th
he yellow arrows point to the naso-lacrimal ducts. The naso-lacrimal sac connects with the duct, which then drains in
ptal soft tissue swelling. On the coronal image there is bilateral high signal at the junction of the nasolacrimal duct an
here is also edema of the surrounding tissue. Orbital cellulitis and abscess Post-contrast T1WI, axial and coronal. Lat
luid collections which now show peripheral enhancement. Complicated acute sinusitis The additional images (T2WI)
in the left maxillary sinus, in addition to extensive ethmoidal and sphenoidal sinus disease. This patient had acute sin
ystitis with abscesses. Developmental or inflammatory narrowing of the naso-lacrimal duct is a risk factor for develo
d Youssem for more information about orbital and periorbital cellulitis Tension pneumocephalus
Complication of FESS:
A rare complication of FESS is seen on the images on the left. The Hounsfields Units of the tiny abnormalities that th
ages. Then continue with the coronal images. Tension pneumocephalus There is a bone defect at the fovea ethmoid
t the patient had undergone FESS. The intracranial air is a complication of FESS. With this complication, usually the pa
two weeks later with CSF leak and meningitis, due to the defect in the bone and dura. Tension pneumocephalus occ
ich lets air in but not out (valve-like function). Every time the patient sneezes, air is forced through the defect into the
tain moment the amount of air is sufficient to cause mass effect on the surrounding intra-cranial structures.
Tumor and tumorlike lesions:
Role of CT and MR When it comes to imaging of neoplasms of the paranasal sinuses, CT and MRI play complementar
'is it tumor or not?' and then determining the extent of the disease, for example intracranial or orbital extension. Us
Scanning down to the hyoid bone allows for examination of the levels I and II lymph nodes: about
10% of paranasal neoplasms have nodal metastases at presentation. Encephalocele
Encephalocele:
Coronal T2WI of the patient on the left show an abnormal structure in the right nasal cavity. When you've decided wh
elopmental or acquired. This patient has an encephalocele. There are two findings on the images that let you know t
alocele on the left side (green arrow). Acquired encephaloceles are more often than not unilateral. The second clue i
abnormality. Acquired encephaloceles (ie after surgery) tend to lead to dead gliotic brain, which would have a high s
eft image (red arrow) is surgical packing, placed there after the involuntary encounter with brain tissue. Encephaloce
is hyperintense, due to mucoid impaction as a result of obstruction by the encephalocele. Mucocele (blue arrow) sec
Inverted papilloma:
Inverted papilloma is characterized by inversion of the neoplastic epithelium into the underlying stroma. It presents
, usually in the region of the middle meatus and middle turbinate. Extension into the maxillary and ethmoid sinuses
or epistaxis. Biopsy is necessary to make the diagnosis and because more than 10% of inverted papillomas harbor a
contrast MR When you want to differentiate inspissated secretions from neoplasms it is important to have pre- and

study on the right, you might be tempted to think that there was solid enhancement of the mass in the nasal cavity
right. Looking at the pre-contrast study, however, you will notice that the contents of the ethmoidal and maxillary si
ity (the middle meatal region), because the sinuses are filled with inspissated secretions. This solidly enhancing mass
on-specific and the differential diagnosis includes a polyp or a carcinoma. Biopsy revealed an inverted papilloma. Inv
ent who presented with nasal stuffiness. Study the images on the left. Decide for yourself whether you are looking a
something entirely different. The pre-contrast T1WI shows a hyperintense area within the maxillary sinus, correspon
pointense signal similar to the signal in the orbital globes (so probably cystic). The majority of the soft tissue in the ri
contrast T1WI,
but solidly enhances, meaning tumor. Inverted papilloma in typical location The T2W-image on the left confirms the
remodelling of the bone and expansion (arrowheads). This proved to be an inverting papilloma. The localisation is ra
Malignant tumors of the sinonasal tract:
Malignant tumors of the sinonasal tract are extremely rare. The clinical presentation is non-specific and often mimic
% of all paranasal sinus tumors are Stage T3 or T4 at the time of diagnosis. Perineural spread is a manifestation of a
axial MR-image showing a mass in the ethmoids. The MRI shows no intracranial extension. What is the next step? Sir
e adjacent bone. Notice the bony destruction of the fovea ethmoidalis and planum sphenoidale. This indicates that t
a. If the patient is a surgical candidate, frontal endoscopic sino-nasal surgery won't be enough and a cranio-facial tak
Meningioma:
A meningioma can spread transcranially. On the left is a patient with a meningioma, which spreads along the anteric
Transcranial spread of meningioma MRI nicely demonstrates how the meningioma spreads down into the sino-nasa
Keratocyst:
First look at the images on the left. From where is this lesion arising? The lesion is expansile with bone remodelling a
ant to determine whether or not sinus pathology has an odontogentic origin, simply
because the surgical approach is different. If odontogentic, the surgery will be done preferably by a maxillofacial sur
entirely. This is a keratocyst Keratocyst On the left another case. This patient presented with facial pain. On this cont
the right maxillary sinus. As it doesn't enhance, we know we aren't dealing with tumor. It is tempting to call this a re
d for to make the correct diagnosis. Keratocyst The corresponding CT shows elevation of the maxillary bone (blue ar
ng around the root of a tooth. This is also a keratocyst. Silent sinus
Silent sinus:
On the left a patient who presented with asymmetric eyes. First study the images and try to describe what is going o
d sinusitis and post-surgery.
However, this patient had never undergone sino-nasal surgery. What you in fact see, is adhesion of the middle right
to the floor of the orbit. There is also volume loss of the right maxillary sinus. This is called the silent sinus syndrome
lmos caused by chronic maxillary sinus atelectasis. The most characteristic imaging feature of the silent sinus syndro
umen with associated decrease in sinus volume and enlargement of the middle meatus (2).
In many cases the infundibulum is occluded due to lateral retraction of the uncinate process.
Fibro-osseous Lesions:
Fibro-osseous lesions are very common incidental findings and often misinterpreted as tumor. CT is usually diagnos
fibro-osseous lesion and get an unenhanced CT. The most common skull base lesion is fibrous dysplasia, followed b
. Fibromas are less common and can be ossifying or non-ossifying. Malignancies are rare. Fibrous dysplasia
Fibrous dysplasia:
On the left images of a patient who was thought to have a chondrosarcoma. On the T2W-images there is a hypointer
pre- and post-contrast T1W-images there is solid enhancement of a mass with peripheral enhancement of the cystic
plasia on CT Next step: get a CT! On CT this is classic fibrous dysplasia (FD) with cortical sparing and ground-glass ap
, skull base or sino-nasal cavity and in children may have large cystic components, so don't let that dissuade you fron
ous dysplasia (2) On the left another example of fibrous dysplasia. This lesion originates from the middle turbinate.
ient read as having a soft tissue tumor (yellow arrow) anterior to the temporal bone. Fibrous dysplasia These are the
of the sphenoid wing. The differential diagnosis is a meningioma. Fibrous dysplasia Fibrous dysplasia (4) On the left
sinus on the left, and an abnormality of the left sphenoid wing, which is about 3 times its normal size whilst maintai
lid enhancement. Again the diagnosis is fibrous dysplasia. Fibrous dysplasia is a very vascular lesion and can enhanc
Osteitis:
In contrast, this is a patient with osteitis of the middle turbinate and ethmoid septae. Note the laminated high densit
n with neo-osteogenesis around the septae. Osteoma in frontal sinus
Osteoma:
This is a patient who had been having brain MRI for the past 1,5 yrs for frontal headaches. On the MRI (not shown) it
ontal sinus. The sinus CT clearly shows an osteoma with a bony defect (arrow) indicating progressive growth. This les
as are found in Gardner's syndrome, which also includes cutaneous and soft tissues tumors in addition to colonic po
Monitoring response to therapy:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. in eMedicine by Gerard Domanowski.

2. The Silent Sinus Syndrome by Anna Illner et al. AJR 2002; 178:503-506
Temporal Bone Pathology:
Eric Beek and Frank Pameijer
Radiology department of the University Medical Centre of Utrecht, the Netherlands:
Publicationdate 2009-07-01 The aim of this presentation is to demonstrate imaging findings of common diseases of
the pathologic conditions of the temporal bone, especially for those of the middle ear. MRI is more useful for disease
in the internal acoustic meatus are not discussed.
Normal variants:
Illustration of a cholesteatoma There are several normal variants which may simulate disease or should be reported
y simulate disease: Variants which may pose a danger during surgery: On the left an illustration of a cholesteatoma.
as a line-like lucency lateral to the cochlear apex. (arrows)
Cochlear cleft:
A cochlear cleft is a narrow curved lucency extending from the cochlea towards the promontory. It is often visible in
mistaken for a fracture line or an otosclerotic focus. On the left an example of bilateral cochlear cleft in a one-year o
Petromastoid canal:
The petromastoid canal or subarcuate canal connects the mastoid antrum with the cranial cavity and houses the sub
nfused with a fracture line. On the left a 40-year old female with a sclerotic mastoid. The petromastoid canal is easily
zed mastoid. The petromastoid canal is difficult to discern (arrow). Petromastoid canal On the left another patient wi
this patient would be a trauma victim, the canal could easily be confused with a fracture line (arrow). Cochlear aque
Cochlear aqueduct:
The cochlear aqueduct connects the perilymph with the subarachoid space. The cochlear aqueduct is a narrow cana
nner auditory canal, but situated more caudally. It is a point where infected cerebrospinal fluid can enter the inner e
rinthitis ossificans. On the left a 58-year old male. The blue arrow indicates the cochlear aqueduct coursing towards
. Note there is also opacification of the tympanic cavity and mastoid air cells. High jugular bulb: axial and coronal ima
High jugular bulb:
On the left axial and coronal images of a 64-year old male. The jugular bulb rises above the lower limb of the posteri
etric, with the right jugular bulb usually being larger than the left. If it reaches above the posterior semicircular canal
between the jugular bulb and the tympanic cavity is absent, it is termed a dehiscent jugular bulb. Rarely an outpouch
lar bulb diverticulum: axial and coronal image
Jugular bulb diverticulum:
On the left axial and coronal images of a 50-year old male. Incidental finding of a jugular bulb diverticulum (arrows).
Bulging sigmoid sinus:
The sigmoid sinus can protrude into the posterior mastoid. It can be accidentally lacerated during a mastoidectomy
present. On the left an axial image of a 43-year old male, post-mastoidectomy. The sigmoid sinus bulges anteriorly
Congenital anomalies:
Large vestibular aqueduct bilaterally (black arrows). The bony modiolus is not visible (white arrow).
Large vestibular aqueduct:
The vestibular aqueduct is a narrow bony canal (aqueduct) that connects the endolymphatic sac with the inner ear (v
dolymphatic duct. A large vestibular aqueduct is associated with progressive sensorineural hearing loss. This progres
ses the inner ear to pressure waves via the large vestibular aqueduct. The large vestibular aqueduct is associated wit
On the left a patient with a bilateral large vestibular aqueduct. Notice that the bony modiolus is not visible. On the le
. A large vestibular aqueduct is seen (black arrow). The cochlea has no bony modiolus. (white arrow). External audito
External auditory canal atresia:
In external ear atresia the external auditory canal is not developed and sound cannot reach the tympanic membrane
hether the atretic plate is composed of soft tissue or bone. The extent of ossicular chain malformation can vary from
of malformed ossicles, which is often fused to the wall of the tympanic cavity. The mastoid portion of the facial nerve
important to report to the ENT surgeon in order to avoid iatrogenic injury to the nerve during surgery. On the left a 2
sia. The malleus and incus are fused (arrow). The cochlea is normal. Minor cochlear deformity
Cochlear deformities:
The cochlea develops between 3 and 10 weeks of gestation. Early developmental arrest leads to an inner ear that co
al arrest at a later stage leads to more or less severe deformities of the cochlea and of the vestibular apparatus. An i
mation Instead of the normal two-and-one-half turns, there is only a normal basal turn and a cystic apex. On the left
rior to cochlear implantation. A minor deformity of the cochlear apex is visible – there is no separation of the second
r aqueduct is normal. Malformed lateral semicircular canal
Lateral semicircular canal malformation:
Malformations of the vestibule and semicircular canals vary from a common cavity to all these structures to a hypop
l semicircular canal is the last structure to form, thus in malformations of the semicircular canals the lateral canal is
duled for cochlear implantation. There is a widening and shortening of the lateral semicircular canal. The vestibule is
circular canal On the left a 16-year old boy, examined preoperatively for a cholesteatoma of the right ear. As a coinci
ellow arrow) and an absence of the superior canal (blue arrow). In the expected position of the superior canal only a

Chronic otitis media:
Normal pneumatization (left) and a completely sclerotic mastoid (right) For the ENT-surgeon the differentiation betw
eases often occur in poorly pneumatized mastoids. An important finding which can help differentiate the two condit
m and of the ossicular chain is common in cholesteatoma (around 75%). Erosion can occur in chronic otitis, but repo
chain can be seen in cholesteatoma, not in chronic otitis. Cholesteatoma can present with a non-dependent mass w
diseases the middle ear cavity can be completely opacified, obscuring a cholesteatoma. On the far left a 54-year old
xt to it a 69-year old female. The mastoid is completely sclerotic - no air cells are present. Chronic otitis media On the
amount of soft tissue (arrow) is visible between the scutum and the ossicular chain but no erosion is present. This fa
the left an 11-year old girl with bilateral ear infections. There is calcification of the eardrum (white arrow) and calcific
muscle (black arrow). Chronic otitis media On the left a 37-year old female who was admitted with a peritonsillar abs
also suffered from chronic otitis media. CT shows a tympanostomy
tube (yellow arrow) and almost complete
opacification of the
tympanic cavity and mastoid air cells with soft tissue. Note: No air present in
the lumen of the tympanostomy tube Calcification is visible
around the head of the stapes (blue arrow). No erosions are present. Chronic otitis media On the left a coronal recon
ellow arrow) and complete opacification of the tympanic cavity and mastoid air cells with soft tissue.
Cholesteatoma:
Cholesteatoma: 20-year old woman with recurrent otitis. Granulations on left ear drum. Soft tissue mass between os
e for comparison. Cholesteatoma is believed to arise in retraction pockets of the eardrum. It gradually enlarges over
holesteatomas are acquired, but some are congenital. The ENT surgeon often states that cholesteatoma is a clinical
Scraps of cholesteatoma are visible in the external auditory canal. On CT a small cholesteatoma presents as a soft tis
rge cholesteatomas can erode the auditory ossicles and the walls of the antrum and extend into the middle cranial f
woman with recurrent otitis. There were granulations on the left ear drum. CT demonstrates a soft tissue mass betw
ded. this favors the diagnosis of cholesteatoma. 20-year old woman with recurrent otitis. Granulations on left ear dru
c wall, which is eroded. Right side for comparison. On the left the coronal images of the same patient as above. Notic
e two patterns of spread: A cholesteatoma will then extend laterally towards the ossicular chain and into the epitymp
* Pars tensa cholesteatoma The cholesteatoma begins posterosuperiorly and extends posteriorly towards the facial
Cholesteatoma of the right ear with destruction of body of the incus and the scutum On the left a large cholesteator
f the tympanic cavity. The body of the incus, which is lateral to the mallear head is also eroded (arrow). CT signs of ch
ult to distinguish
because the wall is often so thin that it is not visible at CT. Cholesteatoma On the left a 50-year old male with hearing
sion of the long process of the incus. This location is typical of a pars tensa cholesteatoma. Cholesteatoma with eros
mages of a cholesteatoma, which has eroded the ossicular chain and the wall of the lateral semicircular canal (arrow
o a large cholesteatoma On the left images of a 6-year old boy. A large cholesteatoma has resulted in a so called 'aut
vity wall and destruction of the ossicular chain. Chronic mastoiditis. No cholesteatoma. These images are of a 50-yea
otorrhoea. CT shows erosion of the long process of the incus and of the stapedial superstructure. All these findings
mastoiditis was found and no cholesteatoma was identified. A minority of patients with chronic mastoiditis show bo
ronal images of the same patient. The scutum is blunted (arrow). Cholesteatoma with fistula to the lateral semicircul
aining of vertigo. He had undergone several ear operations in the past. The CT shows erosion of the wall of the latera
a with lateral displacement of the incus with erosion of its lenticular process and of the stapes On the left a 22-year o
a soft tissue mass medial to the ossicular chain with lateral displacement of the incus with erosion of its lenticular p
steatoma (arrow). Cholesteatoma with lateral displacement of the incus with erosion of its lenticular process and of t
ar old man with known recurrent cholesteatoma. The examination shows a mass with mixed intensity on sagittal T1
tensity on diffusion weighted images, which indicates restricted diffusion. (arrows) Cholesteatomas are of mixed inte
-weighted pulse sequences. MRI is particularly useful for evaluating the extension of a cholesteatoma into the middl
on of intracranial contents into the temporal bone - especially after surgery. After intravenous contrast MRI can disti
R can differentiate between a cholesteatoma, which has a restricted diffusion, and other abnormalities - especially g
(figure).
Otosclerosis:
Otosclerosis anteriorly to the oval window (arrow) Otosclerosis is a genetically mediated metabolic bone disease of u
e disease begins with an otospongiotic phase, which is followed by an otosclerotic phase when osteoclasts are repla
of previous bone resorption. When this process involves the oval window in the region of the footplate, the footplate
hearing loss develops early in the third decade and is considered to be the hallmark of the disease. However, involv
sensorineural hearing loss. The process starts in the region of the oval window, classically at the fissula ante fenestra
. It can also occur around the cochlea (retrofenestral otosclerosis). On the left a transverse CT-image of a 23-year old
lerotic focus in the characteristic site: the fissula ante fenestram (arrows). Otosclerosis On CT the detection of otoscl
spread of the disease is often symmetrical. A small lucency at the fissula ante fenestram is typical for otosclerosis. In
chlea. Sometimes the whole otic capsule is surrounded by these 'otospongiotic' foci, forming the so-called fourth rin
eral. This is virtually always limited to a lucency at the fissula ante fenestram. On the left a 49-year old male with left

r to the oval window (arrow) and between the cochlea and the internal auditory canal. This is combined fenestral an
. Notice that the otosclerosis is seen on both sides. Metallic stapedial prosthesis. Lucency between vestibule and coc
atient with a well-positioned metallic stapedial prosthesis: medially it touches the oval window and laterally it conne
ween vestibule and cochlea as a manifestation of otosclerosis (arrow).
Trauma:
Incus dislocation (arrow) On the left images of a 68-year old woman who experienced a traumatic head injury 50 yea
f the right ear. The image shows a subluxation of the incudomallear joint (arrow). Left ear for comparison. Fractures
sequences of the intracranial injuries dominate in the early period after the trauma. A temporal bone fracture can m
te facial paralysis. Hearing loss is of course not a life-threatening event. Temporal bone fractures can be classified as
y spare the inner ear, which is more often breached by transverse fractures. However, many temporal bone fracture
ption of the structures which are crossed by the fracture is needed. Sensorineural hearing loss due to longitudinal fr
wn from the stairs three days earlier. She suffered from severe sensorineural hearing loss on the left side. A longitud
lea through the region of the geniculate ganglion (arrows). There were no signs of facial nerve paralysis. No fracture
middle ear, likely as a result of a hematotympanum. Right ear for comparison. Posttraumatic conductive hearing loss
ane. In these cases the hearing loss usually resolves spontaneously. In persistent conductive hearing loss there is us
uption is a dislocation of the incudostapedial joint which is often a subtle finding. Disruptions can occur at the incudo
the crura of the stapes are difficult to diagnose. Fractures of the inner ear are seen in posttraumatic sensorineural h
out these thin fracture lines. Cochlear concussion with blood in the cochlea can be visualized with MRI. Longitudinal
e region of the geniculate ganglion. Dislocation of the incus with luxation of the incudo-mallear and incudo-stapedial
ed a traumatic head injury two months previously. He complained of intermittent tinnitus. There is a longitudinal fra
gion of the geniculate ganglion. There is a dislocation of the incus with luxation of the incudo-mallear and incudo-sta
ft ear for comparison. Transverse fracture through vestibule and facial nerve canal (arrows) On the left images of a 5
ft-sided hearing loss.
There is a transverse fracture through the vestibule and facial nerve canal (arrows).
The lateral semicircular canal is partially filled with dense material, compatible with labyrinthitis ossificans. Facial ner
tic paralysis a fracture line through the facial nerve canal - usually in the tympanic part - can be observed, sometimes
al paralysis the nerve is probably edematous and fracture lines can be absent. On the other hand, a fracture line ma
nerve dysfunction. Several normal structures may be mistaken for fractures:
Vascular anomalies:
A vascular anomaly can be suspected if the patient complains of pulsatile tinnitus or when there is a reddish or bluis
anomalies which can also manifest as a retrotympanic mass: Aberrant internal carotid artery (courtesy of Hervé Tan
Aberrant internal carotid artery:
In patients with an aberrant internal carotid artery the cervical part of the internal carotid artery is absent. It is repla
h the horizontal part of the internal carotid artery. It courses through the middle ear. Aberrant internal carotid artery
e same patient. On the right side the internal carotid artery is separated from the middle ear (blue arrow). On the lef
ear (red arrow) Dehiscent jugular bulb
Dehiscent jugular bulb:
On the left a dehiscent jugular bulb (blue arrow). This can be dangerous during myringotomy. Note also the bulging s
Tumors:
Tumors of the temporal bone are rare. The following tumors can be seen: Schwannomas will not be discussed Bilate
Exostoses:
On the left bilateral bony lesions of the external auditory canal, typical of exostoses. Exostoses of the external audito
n cause severe narrowing of the external auditory canal. Exostoses are caused by contact with cold water and mostly
unilateral and pedunculated. Glomus tumor in the jugular foramen
Glomus tumor:
On the left images of a 57-year old male with a slowly progressive glomus jugulotympanicum tumor, visible as a mas
meso- and epitympanum. At CT, the glomus jugulotympanic tumor manifests as a destructive lesion at the jugular fo
ated by tumor. The glomus tympanicum tumor is typically a small soft tissue mass on the promontory. Large tumors
rity with flow voids. They enhance strongly after i.v. contrast. Glomus tumor before and after embolization Embolizat
can diminish intra-operative blood loss. On the left angiographic
images of the left external carotid artery before embolisation and the common
carotid artery after embolization (blue arrow). Only a faint blush remains. Glomus tumors arise from paraganglion ce
y of the cochlea around the tympanic branch of the glossopharyngeal nerve. Elderly persons are most commonly aff
ive hearing loss, tinnitus, and pain. At otoscopy a blue ear drum is seen. Glomus tumors of the jugular foramen (also
ors which are confined to the middle ear (glomus tympanicum tumor) EndoLymphatic Sac Tumor: destructive proces
ation, destruction, and calcification are typical for ELST. A small extension of the tumor into the middle ear is present
EndoLymphatic Sac Tumor (ELST):
ELST is a rare entity. These tumors originate from the endolymphatic sac. We will discuss them because their CT app
e dorsal surface of the petrosal part of the temporal bone with punctate calcifications. On MRI there is usually strong
atypical for a meningioma. EndoLymphatic Sac Tumor: T1WI before and after i.v. contrast On the left a large destruct

strong enhancement. There is a cystic component on the dorsal aspect which does not enhance. EndoLymphatic Sac
Postoperative ear:
The postoperative ear is often difficult to describe. A previous CT-examination, if present, can be a lot of help. The be
ation, the state of the ossicular chain (if present), and the aeration of the postoperative cavity. This cavity can be fille
sue implanted during the operation. Attico-antrotomy
Attico-antrotomy:
On the left images of a 15-year old girl with chronic otitis media, who was treated with an attico-antrotomy. An entry
are still present. The ossicular chain is preserved. Attico-antrotomy On the left coronal images of the same patient. N
Disable Scroll Mastoidectomy: scroll through the images Enable Scroll
Disable Scroll Mastoidectomy: scroll through the images
Mastoidectomy:
On the left images of a 42-year old male who was treated with a mastoidectomy. The posterior wall of the external a
e mastoid air cells are removed. Attico-antrotomy On the left coronal images of the same patient. The posterior wall
t. Almost all the mastoid air cells are removed. 4 year old boy with recurrent otitis. The tube is in good position
Tympanostomy tubes:
If the Eustachian tube is assumed to be dysfunctioning, tympanostomy tubes can be inserted into the eardrum to fa
rse of the Eustachian tube between the middle ear and the nasopharynx runs more horizontally than in adults, pred
n. After a while tympanostomy tubes are extruded by the eardrum and can be seen to lay in the external auditory ca
ernal auditory canal. Metallic stapes prosthesis
Stapes prosthesis:
Stapes prostheses are inserted in patients with otosclerosis to replace the native stapes, which is fixed in the oval wi
made of Teflon can be almost invisible. One should describe the position of the prosthesis in the oval window and th
On the left images of a metallic stapes prosthesis. The prosthesis is in a good position. Medially it lies in the oval win
s. On the left a patient with a stapes prosthesis. The metallic prosthesis is dislocated and lies in the vestibule. A re-op
otice the small lucency at the fissula ante fenestram, a sign of otosclerosis (arrow). Synthetic stapes prosthesis On th
. It is connected to the long process of the incus (yellow arrow). The tip lies in the oval window (blue arrow).
Incus interpostion:
A remodelled incus can be used to repair the ossicular chain. Most often it is inserted between the eardrum and the
ient's own or one from a cadaver. Alternatively, a Partial Ossicular Replacement Prosthesis (PORP) or Total Ossicular
f a 13 -year old boy. Five years earlier a cholesteatoma was removed. The following year the ossicular chain was reco
ent. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the left coronal images of the same patient. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the left axial images of a patient with a reconstruction of the ossicular chain with an autologous inc
Postoperative meningocele:
In postoperative imaging look for dehiscence of the bony covering of the sigmoid sinus and for interruption of the te
f the tegmen is disrupted and continuous soft tissue is present between the middle ear and the cranial contents, MR
encephalo)cele. On the left images of a 24 year old female. She was operated at the age of 8 for chronic otitis media.
hows a rounded mass (arrow) in the attico-antrotomy with erosion of the tegmen tympani. An MRI depicts a mass in
s removed. The dura was intact. The
defect was closed with a flap of the temporal muscle and a chain reconstruction was
performed. On the left an MRI image of the same patient. The MRI depicts a mass in the mastoid abutting the dura. T
Cochlear implants:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Cochlear implantation is performed in patients with sensorineural deafness due to degeneration of th
After implantation of a multichannel electrode a wide array of electrical pulses can be produced to stimulate the aco
The electrode is inserted into the scala tympani of the cochlea via the round window or via a drill hole directly into th
Post-operatively its position can be evaluated with CT. ImagesEight-year-old boy with bilateral cochlear implants. No
A well-inserted electrode is positioned with all its channels, visible as a string of beads, in the cochlea and spirals up
mages of the left ear. Enable Scroll
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Malpositioned implant:
case 1
The images show the left ear of the same patient were hearing was impaired.
The implant is not inserted deep enough, five
channels lie in the middle ear and the tip of the implant does not reach the
cochlear apex. Enable Scroll

Disable Scroll Enable Scroll
Disable Scroll case 2
These images show an implant which is malpositioned. The cochlear implant is inserted below the basal turn of the cochlea and ends up in the region of the geniculate ganglion. Criteria for cochlear implantation are: MRI can demonstrate fibrous obliteration of the cochlea, something which is not appreciated on CT. MRI, on the other hand, can show a fluid-filled cochlea while CT depicts small calcifications. Therefore, a combination of both modalities can be used. MRI can also demonstrate absence of the 8th nerve, which precludes cochlear implantation.
Labyrinthitis ossificans:
Labyrinthitis ossificans is seen after meningitis. It is a condition in which the inner ear is filled with fibrotic tissue, wh
estibule and semicircular canals can also be involved. On the left images of a 56-year old male, who is a candidate fo
ochlea as a result of labyrinthitis ossificans (arrows). Labyrinthitis ossificans of the left superior semicircular canal (ye
bilateral sensorineural hearing loss. Calcification of superior semicircular canal on the left (yellow arrow). Right ear f
e left superior semicircular canal (yellow arrow) On the left coronal images of the same patient. by Vercruysse JP, De
diol 2006; 16:1461-1467
None:

None:

Developmental Dysplasia of the Hip:

Ultrasound examination:

Radiology Departement of the Maastricht University Hospital and the Alrijne hospital in the Netherlands:
Publicationdate 2017-12-01 Developmental dysplasia of the hip is a common musculoskeletal disorder in newborns.
according to Graf.
Introduction:
Developmental dysplasia of the hip (DDH) is one of the most common musculoskeletal problems in newborns. It is a
r. It is a developmental disease. There are children who are born with normal hips who develop dysplasia (figure). In
he hip to become dysplastic and dislocate. On the other hand there are children who are born with dysplasia of the
nt, e.g. a Pavlik harness (figure). So we have to realize that DDH is a dynamic disease and it is not always present at b
tment is easier and complications are less likely to occur when DDH is diagnosed early. In this case at 13 months the
ead to ossify. Developmental dysplasia of the hip is more common in girls especially if there has been a breech pres
factors play a lesser role in boys. Clubfoot was thought to be a risk factor, but this no longer holds true.
Ultrasound orientation:
With ultrasound we are looking at the same anatomic structures as on the x-ray. The ultrasound images are in the co
hip dysplasia is mainly based on the morphology of the iliac bone, where we look at the shape of the acetabulum, th
e femoral head. Since ultrasound has the advantage of also displaying the cartilagenous structures, we can also look
abulum and the labrum. Because the infant is lying on its side the anatomy is displayed in a horizontal fashion instea
is displayed on the screen of the ultrasound machine Sorry, your browser doesn't support embedded videos. In this
onal plane.
Examination technique:
A lineair, high frequency probe is used. The focus is set at the acetabular edge. It is important to display an image in
which is the synchondrosis between the iliac, ischial and pubic bones which form the acetabulum. This is shown in th
Instability:
Sometimes in very displastic hips the use of a convex transducer can be of help.
Measurements:
First three points of interest need to be indentified in the image: Sorry, your browser doesn't support embedded vid
of the three points of interest. When you perform the ultrasound examination, make sure that these three points ca
Graf's classification:
This is the Graf classification - short version. The alpha-angle, which is a measurement of the bony roof of the acetab
tion purposes the beta angle is only used to differentiate between type Ia and Ib (both normal hips) and between typ
Another important factor is the age of the child. Up to the age of 3 months (13 weeks) an alpha angle below 60 degr
f 50 degrees provided that the angle gradually reaches the 60 degrees by the age of 12 weeks. At the age of 3 month
idently if a neonate starts with an alpha angle of 60 degrees than everything is o.k. and no follow up is necessary.
Type I:
Type I hips have an alpha angle of more than 60 degrees and are normal. Although there is a distinction between typ
ion shows a good morphology of the bony acetabular roof with a sharp angular bony rim. No problem here in depict
coverage of the femoral head by the cartilaginous roof and the labrum. The alpha angle is above the 60 degrees and

rmal hip. There is good coverage of the femoral head. The only difference with the type Ia-hip is a blunted bony rim.
n type Ia, but still within a normal range. The beta angle is 61º, i.e more than 55º. These hips are normal and follow u
Type II:
Type IIaIf a child is less than 3 months old, then an alpha angle of 50-59 degrees is considered an immature hip. At th
t that the immature hip develops apropriate according to age (IIa+) or inappropriate (IIa-) Type IIa+ The maturation p
ge according to the table. Type IIa-A type IIa- hip is at risk to develop dysplasia. So an alpha angle of 56 degrees at th
0 weeks it is called a type IIa-. Type IIb If a child is older than 3 months or 13 weeks, then an alpha angle of 50-59 deg
IIa Here we see a hip with an alpha-angle of 55º. The bony acetabular roof is less well-formed and there is a rounded
l this a type IIa. About 90 % of newborns with Graf type IIa hips do not develop DDH. Type IIa(+) At the age of 6 weeks
e of 3 months or 13 weeks the same findings result in a type IIb-hip. Type IIc Here a type IIc hip. The bony acetabular
rim. The alpha angle is 46 degrees. The femoral head is still covered by the cartilaginous roof and the labrum.
Type D:
A type D hip is much like a type IIC hip, but the main difference is a decentring hip with a displaced cartilage roof.
Type III:
In type III hips the femoral head dislocated. The labrum is moved upwards.
Type IV:
In Graf type IV there is a severe dislocation of the femoral head which obscures most of the bony roof. The cartilagin
etabular rim. The labrum is dislocated downwards and interposed between the femoral head and the lateral acetabu
Reporting:
In the table a list of things that should be mentioned in your report. by Graf R. Berlin: Springer; 2006.
2. Ultrasonographic Graf type IIa hip needs more consideration in newborn girls by Hakan Ömeroğlu et al. J Child Ort
3. Observational studies on ultrasound screening for developmental dysplasia of the hip in newborns - a systematic
l Med. 2003 Dec; 24(6):377-82.
4. Transinguinal sonographic determination of the position of the femoral head after reposition and follow-up in a sp
Sakkers RJ. Pediatr Radiol 40(11):1794-9.
Bi-RADS for Mammography and Ultrasound 2013:

Updated version:
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Radiology department of the Academical Medical Centre in Amsterdam and the Rijnland hospital in Leiderdorp, the N
Publicationdate 2014-10-08 This article is a summary of the BI-RADS Atlas 2013 for mammography and ultrasound. I
quired in the Netherlands, as described in the updated Guideline breast cancer 2012 (6). The application of BI-RADS
anyone who is involved in breast imaging to order the illustrated atlas to get a full knowledge of BI-RADS edition 201
Introduction:
The ACR BI-RADS Atlas 2013 (4) is the updated version of the 2003 Atlas. BI-RADS® is designed to standardize breast
pretations. It also facilitates outcome monitoring and quality assessment. It contains a lexicon for standardized term
ll as chapters on Report Organization and Guidance Chapters for use in daily practice.
Standard Reporting:
Mention the patient's history. If Ultrasound is performed, mention if the US is targeted to a specific location or suppl
2. Describe the breast composition.
3. Describe any significant finding using standardized terminology.Use the morphological descriptors: mass, asymme
y have associated features, like for instance a mass can be accompanied with skin thickening, nipple retraction, calcif
mation, mammography, US or MRI. Integrate mammography and US-findings in a single report.
4. Compare to previous studies.Awaiting previous examinations for comparison should only take place if they are re
5. Conclude to a final assessment category. Use BI-RADS categories 0-6 and the phrase associated with them. If Mam
n the most abnormal of the two breasts, based on the highest likelihood of malignancy.
6. Give management recommendations.
7. Communicate unexpected findings with the referring clinician.Verbal discussions between radiologist, patient or r
Mammography and Ultrasound Lexicon:
The table shows a summary of the mammography and ultrasound lexicon. Enlarge the table by clicking on the image
inding use the descriptors in the table. The ultrasound lexicon has many similarities to the mammography lexicon, b
will discuss the lexicon in more detail in a moment.
BI-RADS Assessment Categories:
The table shows the final assessment categories. We will first discuss the breast imaging lexicon of mammography a
categories and the do's and don'ts in these categories. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Click image to enlarge. Study the images. If you find any abnormality, make a decription and assessme
Mammography - Breast Imaging Lexicon:

Breast Composition:

In the BI-RADS edition 2003 the assignment of the breast composition was based on the overall density resulting in A
), category 3 (50-75%) and category 4 (>75%). In BI-RADS 2013 the use of percentages is discouraged, because in indiv
that a mass can be obscured by fibroglandular tissue than the percentage of breast density as an indicator for breas
breast composition is changed into a, b, c and d-categories followed by a description: The term density describes the
mammographic findings.
* c- The breasts are heterogeneously dense, which may obscure small masses. Some areas in the breasts are sufficie
* d
- The breasts are extremely dense, which lowers the sensitivity of mammography. Notice in the left example the com
glandular tissue is less than 50%. The fibroglandular tissue in the upper part is sufficiently dense to obscure small m
. Historically this would have been called an ACR 2: 25-50% density. The example on the right has more than 50% gla
Mass:
A 'Mass' is a space occupying 3D lesion seen in two different projections. If a potential mass is seen in only a single p
dimensionality is confirmed. The images show a fat-containing lesion with a popcorn-like calcification. All fat-contain
gnostic for a hamartoma - also known as fibroadenolipoma. The shape of a mass is either round, oval or irregular. A
is the same as the mass that is found with mammography or ultrasound. Location and size should be applied in any
s is a benign finding.
* Obscured or partially obscured, when the margin is hidden by superimposed fibroglandular tissue. Ultrasound can
* Microlobulated. This implies a suspicious finding.
* Indistinct (historically ill-defined). This is also a suspicious finding.
* Spiculated with radiating lines from the mass is a very suspicious finding. The density of a mass is related to the ex
e. High density is associated with malignancy. It is extremely rare for breast cancer to be low density. Here multiple r
ese were the result of lipofilling, which is transplantation of body fat to the breast. Here a hyperdense mass with an i
retraction. This was reported as BI-RADS 5 and proved to be an invasive ductal carcinoma.
Architectural distortion:
The term architectural distortion is used, when the normal architecture is distorted with no definite mass visible. Thi
a point, and focal retraction, distortion or straightening at the edges of the parenchyma. The differential diagnosis is
be seen as an associated feature. For instance if there is a mass that causes architectural distortion, the likelihood of
stortion. Notice the distortion of the normal breast architecture on oblique view (yellow circle) and magnification vie
the specimen.
Asymmetries:
Findings that represent unilateral deposits of fibroglandulair tissue not conforming to the definition of a mass. This h
* Global asymmetry consisting of an asymmetry over at least one quarter of the breast and is usually a normal varia
* Developing asymmetry new, larger and more conspicuous than on a previous examination. Here an example of a f
rasound did not show any mass. Here an example of global asymmetry. In this patient this is not a normal variant, si
of malignancy like skin thickening, thickened septa and subtle nipple retraction. Ultrasound (not shown) detected mu
shows diffuse infiltrating carcinoma. Asymmetry versus Mass All types of asymmmetry have different border contou
ies appear similar to other discrete areas of fibroglandulair tissue except that they are unitaleral, with no mirror-ima
s concave outward borders and usually is interspersed with fat, whereas a mass demonstrates convex outward borc
the term "density" is confusing, as the term "density" should only be used to describe the x-ray attenuation of a mas
Calcifications:
In the 2003 atlas calcifications were classified by morphology and distribution either as benign, intermediate concern
roach has changed. Since calcifications of intermediate concern and of high probability of malignancy all are being tr
group them together. Calcifications are now either typically benign or of suspicious morphology. Within this last grou
rphology (BI-RADS 4B or 4C) and also depending on their distribution. Typically benign Skin, vascular, coarse, large ro
cium and suture calcifications are typically benign. There is one exception of the rule: an isolated group of punctuate
in distribution, or adjacent to a known cancer can be assigned as probably benign or suspicious. Amorphous, indistin
uous than amorphous forms and are seen to have discrete shapes, without fine linear and linear branching forms, u
* Fine linear or fine-linear branching (BI-RADS 4C) Thin, linear irregular calcifications, may be discontinuous, occasion
e on breast calcifications. Distribution of calcifications The arrangement of calcifications, the distribution, is at least a
d according to the risk of malignancy: The 2013 edition refines the upper limit in size for grouped distribution as 2 cr
t for regional distribution. Study the images and describe the calcifications. Then continue reading. The findings are:
inoma.
Associated features:
Associated features are things that are seen in association with suspicious findings like masses, asymmetries and ca
ment. For instance a BI-RADS 4-mass could get a BI-RADS 5 assessment if seen in association with skin retraction.
Special cases:
Special cases are findings with features so typical that you do not need to describe them in detail, like for instance ar
Ultrasound - Breast Imaging Lexicon:
Many descriptors for ultrasound are the same as for mammography. For instance when we describe the shape or m
trasound: Breast Composition: Mass: Echogenicity can contribute to the assessment of a lesion, together with other

* Posterior features: enhancement, shadowing. Posterior features represent the attenuation characteristics of a mas
lue. Alone it has little specificity. Calcifications: Associated features: Special cases - cases with a unique diagnosis or p
Final Assessment Categories:

BI-RADS 0:
Need Additional Imaging Evaluation and/or Prior Mammograms For Comparison: Category 0 or BI-RADS 0 is utilized
or retrieval of prior examinations is required. When additional imaging studies are completed, a final assessment is
itional imaging or retrieving old films before reporting. Even better to have the old examinations before starting the
am at screening, which was assigned as BI-RADS 0 (needs additional imaging evaluation). Additional ultrasound dem
e final assessment is BI-RADS 2 (benign finding). Don't forget to mention in the report that the lymph node on US co
raph on location we will discuss how we can be sure that the lymph node that we found with ultrasound is indeed th
BI-RADS 1:
Negative: There is nothing to comment on. The breasts are symmetric and no masses, architectural distortion or sus
thing to comment on. BI-RADS 1 DO
BI-RADS 2:
Benign Finding: Like BI-RADS 1, this is a normal assessment, but here, the interpreter chooses to describe a benign fi
seen on mammogram proved to be a cyst. BI-RADS 2 DO DON'T
BI-RADS 3:
Probably Benign Finding Initial Short-Interval Follow-Up Suggested: A finding placed in this category should have
over the follow-up interval, but the radiologist would prefer to establish its stability. Lesions appropriately placed in
mass with a group of punctate calcifications. The mass was categorized as BI-RADS 3. Continue with follow up image
and 24 months showed no change and the final assessment was changed into a Category 2. Nevertheless the patien
able to present a clear differential diagnosis. So add the following sentence in your report: PA: benign vascular malfo
up, it will change into a BI-RADS 4 or 5 and biopsy should be performed. The upper image shows a few amorphous c
up more than five calcifications were noted in a group. The findings were now classified as BI-RADS 4. This proved to
n mammography like Noncalcified circumscribed solid mass Focal asymmetry Solitary group of punctuate calcificatio
roadenoma Isolated complicated cyst Clustered microcysts DON'T
BI-RADS 4:
Suspicious Abnormality - Biopsy Should Be Considered: This category is reserved for findings that do not have the cla
justify a recommendation for biopsy. BI-RADS 4 has a wide range of probability of malignancy (2 - 95%). By subdividi
t probabilities for malignancy be indicated within this category so the patient and her physician can make an informe
4a in findings as: Partially circumscribed mass, suggestive of (atypical) fibroadenoma Palpable, solitary, complex cyst
ngs as: Group amorphous or fine pleomorphic calcifications Nondescript solid mass with indistinct margins Do use C
New indistinct, irregular solitary mass The CC mammographic image shows a finding, not reproducible on the MLO v
ign lesion, although unlikely, is a possibility. This could be for instance ectopic glandular tissue within a heterogeneou
Here another BI-RADS 4 abnormality. The pathologist could report to you that it is sclerosing adenosis or ductal carc
ic findings.
BI-RADS 5:
Highly Suggestive of Malignancy. Appropriate Action Should Be Taken: BI-RADS 5 must be reserved for findings
y. The current rationale for using category 5 is that if the percutaneous tissue diagnosis is nonmalignant, this automa
ages and describe the findings. Then continue reading. The findings are: This mass is categorized as BI-RADS 5. High
ce: "Biopsy should be performed in the absence of clinical contraindications". DON'T Then use Category 4c.
BI-RADS 6:
DO DON'T On the left BI-RADS 5 lesion. On the right after neo-adjuvant chemotherapy BI-RADS 6. Here images of a b
in the palpable tumor. Due to the dense fibroglandular tissue the tumor is not well seen. Ultrasound demonstrated
ter chemotherapy the tumor is not visible on the mammogram. Ultrasound showed shrinkage of the tumor to a 18 m
Location in Mammography and US:
A mass is seen in the outer lower quadrant of the left breast at 4 o' clock in the posterior portion of the breast at 4cm
ptors consists of: There may be variability within breast imaging practices, members of a group practice should agre
alities, always make sure, that you are dealing with the same lesion. For instance a lesion found with US does not hav
imes repeated mammographic imaging with markers on the lesion found with US can be helpful. Cysts can be aspira
ound on the mammogram is caused by a cyst. Solid lesions can be injected with contrast or a marker can be placed i
a patient with a new lesion found at screening. With ultrasound an intramammary lymph node was found, but we w
ntinue with the mammographic images after contrast injection. Contrast was injected into the node and a repeated
by an intramammary lymph node, since the mammographic mass contains the contrast. This patient presented with
phous and fine pleomorphic calcifications was seen. Ultrasound examination was performed Ultrasound of the regio
a with fine needle aspiration (FNA). To find out whether the mass was within the area of the calcifications, contrast w
gion of the breast. Now a vacuum assisted biopsy has to be performed of the calcifications, because maybe we are o
rea.
Size measurement:

MassLongest axis of a lesion and a second measurement at right angles. In a spiculated mass the spiculations shoul
mation of its greatest linear dimension. Calcifications The distribution should be measured by approximation of its g
rasound: cortical thickness.
Reporting:
Mention the patient's history. If Ultrasound is performed, mention if the US is targeted to a specific location or suppl
2. Describe the breast composition.
3. Describe any significant finding using standardized terminology.Use the morphological descriptors: mass, asymm
y have associated features, like for instance a mass can be accompanied with skin thickening, nipple retraction, calci
mation, mammography, US or MRI. Integrate mammography and US-findings in a single report.
4. Compare to previous studies.Awaiting previous examinations for comparison should only take place if they are re
5. Conclude to a final assessment category.Use BI-RADS categories 0-6 and the phrase associated with them. If Mam
the most abnormal of the two tests, based on the highest likelihood of malignancy.
6. Give management recommendations.
7. Communicate unsuspected findings with the referring clinician.Verbal discussions between radiologist and referri
Examples of reporting:
Indication for examinationPainful mobile lump, lateral in right breast. No previous history of breast pathology. Findi
sition: b. Scattered areas of fibroglandular density. Lateral in the right breast, concordant with the palpable lump, th
scribed and partially obscured. The mass is equal dense compared to the fibroglandular tissue. Location: Right breas
ation of largest diameter = 3 cm. Additional US of the mass: Concordant with the lump and the mass on the mammo
, Anechoic with posterior enhancement. Size : 3,5 x 1,5 cm. In the right breast at least 2 more smaller cysts. Assessm
st. There are at least two more, smaller cysts present in the right breast. Management The palpable cyst was painful,
e cyst was performed. No indication for follow-up, unless symptoms return, as explained to the patient. Note: Indica
ump, lateral in left breast, since 2 months. No previous history of breast pathology. No previous exams available. Fin
Mammography: Overall breast composition: a. The breasts are almost entirely fatty. Lateral in the left breast, at 3 o'c
with the palpable lump there is a 3 cm hyperdense mass with a rounded, but also irregular shape. The margins are
icrolobulations. Ultrasound: concordant with the lump and the mass on the mammogram there is an slightly irregula
ed and locally indistinct margin. AssessmentBI-RADS 4a (low suspicion for malignancy). The palpable mass is concor
5-year old patient the differential diagnosis consists of an atypical fibroadenoma or a phyllodes. ManagementAfter i
rmed, two specimens were obtained. No complications. It was discussed with the patient and the referring general p
inic is advised. The patient and the referring general practitioner preferred to await the results of the biopsy . Adden
nign phyllodes. Referral to the breast clinic was now strongly indicated and was put in motion by the general practiti
cm highly cellular fibroadenoma. Tutorial by G. Pfarl, MD & T.H. Helbich, MD, Department of Radiology, University of
2. BI-RADS Lexicon for US and Mammography: Interobserver Variability and Positive Predictive Value by E. Lazarus, M
adiology, May 1, 2006; 239(2): 385 - 391.
3. Breast Imaging Reporting and Data System, Inter- and Intraobserver Variability in Feature Analysis and Final Asses
y of Maryland School of Medicine, 22 S. Greene St., Baltimore, AJR 2000; 174:1769-1777
4. Breast Imaging Reporting and Data System? (BI-RADS?) Atlas
5. ACR-BI-RADS® Mammography, 4th edition 2003 Reston, VA, American College of Radiology, 2003
6. Guideline Breast Cancer, NABON 2012
7. ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System, Reston VA, American College of Radiology; 2013
8. Guideline Breast Cancer, NABON 2012 (in dutch)
None:

Systematic Approach to Brain Tumors:
Robin Smithuis and Walter Montanera
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Publicationdate 2008-07-02 This review is based on a presentation given by Walter Montanera and was adapted for
ic approach for the analysis of a possible brain tumor is described.
Introduction:
When we analyze a potential brain tumor, there are many questions that need to be answered. Since different tumo
of the patient. Next we need to know where the lesion is located - is it intra- or extra-axial and in what anatomical co
erebellar region for example? Is it a solitary mass or is there multi-focal disease? On CT and MR we look for tissue ch
trast enhancement and signal intensity on T1WI, T2WI and DWI. Most brain tumors are of low signal intensity on T1W
signal on T2WI can be an important clue to the diagnosis. Finally we have to consider the possibility that we are deali
plaque, vascular malformation, aneurysm or an infarct with luxury perfusion.
Incidence of CNS tumors:
Roughly one-third of CNS tumors are metastatic lesions, one third are gliomas and one-third is of non-glial origin. Gli
s from glial cells like astrocytes, oligodendrocytes, ependymal and choroid plexus cells. Astrocytoma is the most com
pe, the intermediate anaplastic type and the high grade
malignant glioblastoma multiforme (GBM). GBM is the most common type (50% of all astrocytomas). The non-glial ce

is the most common. Note: since the publication of this article, these numbers have changed and metastases now o
overall cancer survival improves.
Age distribution:
The age of the patient is an important factor for the differential diagnosis. Specific tumors occur under the age of 2,
eratomas. In the first decade medulloblastomas, astrocytomas, ependymomas, craniopharyngeomas and gliomas ar
age, metastases of a neuroblastoma are the most frequent. In adults about 50% of all CNS lesions are metastases. C
orme, meningiomas, oligodendrogliomas, pituitary adenomas and schwannomas. Astrocytomas occur at any age, bu
is rare in children, brain tumors are the most common type of childhood cancer after leukemia and lymphoma. Mos
mmon supra- and infratentorial tumors are listed in the table on the left. The most common tumors in adults are list
most common. It is important to realize that 50% of metastases are solitary. Particularly in the posterior fossa, metas
st. Hemangioblastoma is an uncommon tumor, but it is the most common primary intra-axial tumor in the adult. Sup
y gliomas.
Tumor spread:

Intra- versus Extraaxial:
When we study an intracranial mass, the first thing we want to know is whether the mass lies in- or outside of the br
is not actually a brain tumor, but derived from the lining of the brain or surrounding structures. Eighty percent of the
nnoma. On the other hand, in an adult an intra-axial tumor will be a metastasis or astrocytoma in 75% of cases. Schw
(T2WI) The T2W-images show a schwannoma located in the cerebellopontine angle (CPA). This case nicely demonstr
yellow arrow). The subarachnoid vessels that run on the surface of the brain are displaced by the lesion (blue arrow)
curved red arrow). The subarachnoid space is widened because growth of an extra-axial lesion tends to push away th
l tumor. In the region of the CPA 90% of the extra-axial tumors are schwannomas. Coronal enhanced T1WI. Meningio
ancement Another sign of an extra-axial origin is a broad dural base or a dural tail of enhancement as is typically see
ors, but it is less common. Another sign of an extra-axial origin are bony changes. Bony changes are seen in bone tu
o be secondary, as is seen in meningiomas and other tumors. On the left an example of a meningioma with a broad
the adjacent bone and the lesion enhances homogeneously. Extra-axial tumors are not derived from brain tissue an
ously. Melanoma metastasis: T2WI and T1WI Intra- vs Extra-axial (2) The differentiation between intra-axial versus ex
ery difficult and imaging in multiple planes may be necessary. The tumor in the case on the left was thought to be a f
ry. This lesion surely has the appearance of a meningioma: these tumors can be hypointense on T2 due to a fibrocol
edema in the adjacent white matter of the brain. However, there is gray matter on the anteromedial and posterome
s intra-axial. If the lesion was extra-axial the gray matter should have been pushed away. This proved to be a melanc
(blue arrows) and into the foramen magnum (red arrow). Local tumor spread (1) Astrocytomas spread along the whi
se of this infiltrative growth, in many cases the tumor is actually larger than can be depicted with MR. Ependymomas
oramen of Magendie to the cisterna magna and through the lateral foramina of Luschka to the cerebellopontine ang
x. Subarachnoid seeding Some tumors show subarachnoid seeding and form tumoral nodules along the brain and s
rogliomas and choroid plexus papillomas. Primitive neuroectodermal tumours (PNET) form a rare group of tumors, w
clude medulloblastomas and pineoblastomas. One of the most important roles of imaging is to assess the extent of
ented with multiple cranial nerve abnormalities. On the images we see an extra-axial tumor in the region of the left c
ural tail. This is typical for a meningioma. Only by studying all the images we do appreciate that the actual extent of t
the pterygopalatine fossa and extends into the orbit. It also spreads anteriorly into the middle cranial fossa Low grad
ration is the effect on the surrounding structures. Primary brain tumors are derived from brain cells and often have
eir infiltrative growth. This is not the case with metastases and extra-axial tumors like meningiomas or schwannoma
he left is an image of a diffusely infiltrating intra-axial tumor occupying most of the right hemisphere with only a min
seen in primary brain tumors. There is no enhancement so this would probably be a low-grade astrocytoma. Tumor
Midline crossing:
The ability of tumors to cross the midline limits the differential diagnosis. LEFT: Metastases. RIGHT: Multiple meningi
Multifocal disease:
Multiple tumors in the brain usually indicate metastatic disease (figure). Primary brain tumors are typically seen in a
tric glioblastomas and gliomatosis cerebri can be multifocal. Some tumors can be multifocal as a result of seeding m
mas, GBMs and oligodendrogliomas. Meningiomas and schwannomas can be multiple, especially in neurofibromato
umorous diseases like small vessel disease, infections (septic emboli, abscesses) or demyelinating diseases like MS c
Cortical based tumors:
Most intra-axial tumors are located in the white matter. Some tumors, however, spread to or are located in the gray
s includes oligodendroglioma, ganglioglioma and Dysembryoplastic Neuroepithial Tumor (DNET). A DNET is a rare be
with a cortically based tumor usually present with complex seizures. On the left a 45-year-old female with a stable se
nhancing, cortically based tumor. This is a ganglioglioma. The differential diagnosis includes DNET and pilocytic astro
d from non-tumorous lesions like cerebritis, herpes simplex encephalitis, infarction and post-ictal changes. On the le
ne year, complained of headache and neck pain. There is a recent onset of tonic-clonic seizures. The CT shows a mas
though this is a large tumor there is only limited mass effect on surrounding structures, which indicates that this is a
oglioma. The differential diagnosis includes a malignant astrocytoma or a glioblastoma.

CT and MR Characteristics:
Ruptured dermoid cyst. Coronal T1WI (left) and NECT (right).
Fat - Calcification - Cyst - High density:
Fat has a low density on CT (- 100HU). On MR, fat has a high signal intensity on both T1- and T2WI. On sequences wit
ed by subacute hematoma, melanin, slow flow etc. When you see high signal on T1WI always look for chemical shift a
artefact occurs as alternating bands of high and low signal on the boundaries of a lesion and is seen only in the frequ
, dermoid cysts and teratomas. On the left a patient with the classical findings of a ruptured dermoid cyst. Some tum
phoma, colloid cyst and PNET-MB (medulloblastoma). Calcification Calcification is seen in many CNS tumors (Table). W
roglioma since these tumors nearly always have calcifications. However an intraaxial calcified tumor in the brain is m
e astrocytomas, although less frequently calcified, are far more common. A pineocytoma itself does not calcify, but in
the left is an image of a calcified mass in the suprasellar region, causing obstructive hydrocephalus. This location in t
a craniopharyngioma. Craniopharyngiomas are slow growing, extra-axial, squamous epithelial, calcified, cystic tumor
upra)sellar region and primarily seen in children with a small second peak incidence in older adults. Oligodendroglio
tumor with a small calcification. . The calcification is not appreciated on the MR images, but is easily seen on CT. The
re very typical for an oligodendroglioma. An astrocytoma should be in the differential. Calcified meningioma On the
coronal and sagittal TW1I there is a large mass centered around the sella with a broad dural base. There is extensio
y after the CT was performed, was it appreciated how densely calcified this tumor is. It would be impossible to opera
olid There are many cystic lesions that can simulate a CNS tumor. These include epidermoid, dermoid, arachnoid, ne
of Virchow Robin can simulate a tumor. In order to determine whether a lesion is a cyst or cystic mass look for the fo
on all sequences. Tumor necrosis may sometimes look like a cyst, but it is never completely isointense to CSF. On th
the cystic component. In the middle a neuroenteric cyst with the contents of which have the same signal intensity as
l cystic component. The enhancement in GBM is usually more irregular.
High on T1:
Most tumors have a low or intermediate signal intensity on T1WI. Exceptions to this rule can indicate a specific type o
lcifications are mostly dark on T1WI, but depending on the matrix of the calcifications they can sometimes be bright
as bright signal on T1WI and should not be confused with enhancement. This is particularly pronounced on gradient
gnal is not always enhancement. On the left are some images of tumors with high signal intensities on T1WI. On the
signal is due to hemorrhage in a pituitary macroadenoma. The patient in the middle has a glioblastoma multiforme,
On the right is a patient with a metastasis of a melanoma. The high signal intensity is due to the melanin content.
Low on T2:
Most tumors will be bright on T2WI due to a high water content. When tumors have a low water content they are ver
masmic ratio. These tumors will be dark on T2WI. The classic examples are CNS lymphoma and PNET (also hyperden
gnosis of calcified tumors was discussed above. Paramagnetic effects cause a signal drop and are seen in tumors tha
pending on the content of the protein itself. A classic example of this is the colloid cyst. Flow voids are also dark on T
ion. This is seen in tumors that contain a lot of vessels like hemangioblastomas, but also in non-tumorous lesions lik
ith a low signal intensity on T2WI. They can have a high SI on T2WI if they contain a lot of water. They can have a low
hey contain calcifications.
Diffusion weighted imaging:
Normally water protons have the ability to diffuse extracellularly and loose signal. High intensity on DWI indicates re
ularly. Restricted diffusion is seen in abscesses, epidermoid cysts and acute infarction (due to cytotoxic edema). In ce
the viscosity of pus, resulting in a high signal on DWI. In most tumors there is no restricted diffusion - even in necroti
l on DWI.
Perfusion Imaging:
Perfusion imaging can play an important role in determining the malignancy grade of a CNS tumor. Perfusion depen
n of the blood-brain barrier. The amount of perfusion shows a better correlation with the grade of malignancy of a tu
Enhancement:
Blood brain barrier The brain has a unique triple layered blood-brain barrier (BBB) with tight endothelial junctions in
not leak into the brain unless this barrier is damaged. Enhancement is seen when a CNS tumor destroys the BBB. Ex
d from brain cells and do not have a blood-brain barrier. Therefore they will enhance. There is also no blood-brain b
non-tumoral lesions enhance because they can also break down the BBB and may simulate a brain tumor. These les
ons. Contrast enhancement cannot visualize the full extent of a tumor in cases of infiltrating tumors, like gliomas. Th
ain parenchyma where the blood brain barrier is still intact. Tumor cells can be found beyond the enhancing margins
e area of edema. On the left is an image of a 42 y/o male with mild head trauma. On the T2WI there is a lesion in the
t and the DWI was normal. During follow-up there was a slight increase in size. This was diagnosed as a low-grade as
infiltrating tumors cells are within the normal-appearing brain tissue. Low grade tumors with enhancement: gangliog
astrocytomas, oligodendrogliomas and glioblastoma multiforme - enhancement usually indicates a higher degree of
a the tumor starts to enhance, it is a sign of malignant transformation.. Gangliogliomas and pilocytic astrocytomas a
hey enhance vividly. As discussed above, it recently has been shown that tumor angiogenesis as shown by perfusion
ministration of intravenous contrast. LEFT: Schwannoma extending into the middle cranial fossa with homogeneous
he amount of enhancement depends on the amount of contrast that is delivered to the interstitium. In general, the l

e optimal timing is about 30 minutes and it is better to give contrast at the start of the examination and to do the en
No enhancement is seen in: On the left is an image of an intra-axial tumor in an adult. It is centered in the temporal
trative growth involving a large part of the right cerebral hemisphere, there is only minimal mass effect. There is no e
ytoma. Homogeneous enhancement can be seen in: GBM with patchy enhancement and cystic component with ring
a glioblastoma multiforme (GBM). The enhancement indicates that this is a high-grade tumor, but only parts of it en
ancement. The tumor cells probably extend beyond the area of edema as seen on the FLAIR image. This is because g
MR changes. Patchy enhancement (2) On the left are images of a tumor located in the right hemisphere. Although is
e is marked infiltrative growth, a characteristic typical for gliomas. Notice the heterogeneity on both T2WI and FLAIR.
or a GBM. Virtually no other tumor behaves in this way. Ring enhancement Ring enhancement is seen in metastases
abscesses, some MS-plaques and sometimes in an old hematomas. On the left three different ring enhancing lesions
es the value of Gadolinium in the conspicuity of tumors. This is a patient with Neurofibromatosis II. After the adminis
easily seen. Leptomeningeal metastases Leptomeningeal metastases are usually not seen without the administratio
rmal enhancement along the brainstem, along the folia of the cerebellum (yellow arrow) and along the fifth intracran
s.
Differential diagnosis for specific anatomic area:

Skull base:
Common skull base tumors are listed in the table on the left. These tumors either arise from extracranial structures
tself (chordoma, chondrosarcoma, fibrous dysplasia). Chordoma is usually located in the midline, while chondrasarc
sing from the clivus. This is the typical presentation of a chordoma. The differential diagnosis would include a metas
r located off midline. This is a typical presentation for a chondrosarcoma. The differential diagnosis would include a
in the midline and chordomas are sometimes located off midline but those cases are exceptional. On the left an exa
year-old male with a gradual onset of right facial pain and numbness and a recent onset of double vision. First study
to the skull base and also in the region of the right cavernous sinus. In the bone window setting there is sclerosis of t
tinue with the MR images. On the left enhanced sagittal and coronal T1WI. The most striking finding is the black clivu
result of the fatty bone marrow. There is an enhancing mass anterior to the clivus. On the coronal images we see the
the cavernous sinus. The diagnosis is a nasopharyngeal squamous cell carcinoma with intracranial extension. The di
, chronic infection and even a meningioma - although this would be an unusual way for a meningioma to spread.
Sella/suprasellar:
On the left is a list of common sellar and suprasellar tumors. In this region it is important to keep the possibility of an
mages of a mass in the suprasellar cistern. On the NECT we can see that it contains calcium. On the T1WI there is a h
are other components that show enhancement. The tumor is complicated by a hydrocephalus. These findings are ve
mages of a 33-year-old female with severe headache (worse in the a.m.), reduction in visual acuity and visual fields a
inferiorly displaced pituitary gland. This means it is not a macroadenoma. The diagnosis is again a craniopharyngiom
meningioma.
Cerebello-pontine angle:
Common CP Angle Tumors are listed in the table on the left. On the left a 52-year-old male with hearing loss on the r
ations. There is also some enhancement within the internal acoustic canal. Based on the images the most likely diag
ommon, cystic presentation of a meningioma.
Pineal region:
Common pineal region tumors are listed in the table on the left. On the left a tumor located in the pineal region. Bas
is happened to be a meningioma. On the left are typical images of a ruptured pineal region dermoid. On the left ima
located in the pineal region. The tumor contains calcifications. There is homogeneous enhancement, which is comm
ge of the patient, the location and the tumor characteristics, this is most likely a germinoma.
Intraventricular:
Common intraventricular Tumors are listed in the table on the left. On the left a tumor located in the 3rd ventricle. T
l astrocytoma.
4th ventricle:
In children tumors in the 4th ventricle are very common. Astrocytomas are the most common followed by medullob
exophytic component. In adults tumors in the 4th ventricle are uncommon. Metastases are most frequently seen, fo
d epidermoid cysts.
Tumor Mimics:
Many non-tumorous lesions can mimic a brain tumor. Abscesses can mimic metastases. Multiple sclerosis can prese
multiple sclerosis.. In the parasellar region one should always consider the possibility of a aneurysm. Infections and
Charity:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click on the image below to watch the video of Medical Action Myanmar and if yo
mar with a small gift. by James Smirniotopoulos
2. Primary Lymphoma of the Central Nervous System: Typical and Atypical CT and MR Imaging Appearances by Nam
3. Diagnostic Neuroradiology by Anne G. Osborn Mosby 1994

None:

Closed Loop Obstruction with video:
Robin Smithuis
the Alrijne Hospital, Leiderdorp, the Netherlands:
Publicationdate 2017-04-22 The most important diagnosis an abdominal radiologist can make is 'Closed Loop Obstru
Preferably, the radiologist should state in every CT-report of a patient with small bowel obstruction whether it is a sir
closed loop obstruction, in which case emergency surgery is necessary. In this video article, we will combine text and
n CT and in the OR.
Introduction:

Small Bowel Obstruction and Closed Loop:
Ileus is usually the result of a small bowel obstruction (SBO). In most cases this caused by adhesions, even in patient
ction; in these cases, we see a change in caliber of the bowel and both the dilated bowel and the collapsed bowel hav
l bowel is obstructed at two points along its course, thus forming a closed loop. These patients have a high risk of bo
rforation, septic shock and other complications with a high mortality rate. In this video, we have two patients with a s
The patient on the left has a simple obstruction at only one point.
The patient on the right however, has a second obstruction caused by the same adhesion.
This second obstruction is more proximal and usually difficult to detect, because both the closed loop as well as the
rry, your browser doesn't support embedded videos.
Why is closed loop a difficult diagnosis?:
This video taken in the OR demonstrates how difficult it is for the surgeon to inspect the abdomen in a patient with a
In many cases the surgeon will not make the diagnosis of closed loop obstruction. So, if you as a radiologist do not m
you will both not know what you have missed. When the radiologist tells the surgeon that there is a small bowel obst
a closed loop obstruction, there is a good chance that the surgeon - after resecting 2 meters of necrotic bowel two c
ht'. Here the axial and coronal CT images. Closed loop obstruction is hard to diagnose on CT because it looks like a si
in caliber of the bowel and once you have found it, you think that the job is done. Look for an odd position of a group
ond obstruction. The video of the coronal reconstructions better shows the closed loop as well as the two points of c
Radiological signs of Closed loop obstruction:
The most important signs of a closed loop obstruction on CT are: The bowel loops have a strange arrangement. In m
erniation.
2. Mesenteric edema This is edema only on the mesenteric side of the bowel, the result of venous obstruction. Some
terial ischemia).
3. Two points of obstruction This is the ultimate proof of a closed loop obstruction. Other signs that can be seen in p
small bowel loops in patients with a closed loop obstruction
Odd configuration of small bowel loops:
Look for a strange configuration of small bowel loops clumped together. Sometimes it looks like a volvulus. This is no
ruction of the large bowel. In the large bowel this hardly ever leads to ischemia; unlike a closed loop obstruction of th
Mesenteric edema:
Mesenteric edema is the result of venous obstruction due to strangulation. It is only seen on the mesenteric side of t
n's disease. Here is a video of a patient with closed loop obstruction demonstrating mesenteric edema. Try to find th
Two points of obstruction:
Although an odd configuration of bowel loops and mesenteric edema in a patient with a small bowel obstruction are
uction will give you 100% confidence in diagnosing a closed loop obstruction. The two points of obstruction are alwa
hey can be in any plane, so you need reconstructions. The video shows you the images without comment first. Try to
inue the video with commentary.
CT protocol:

i.v. contrast:
Good enhancement of the bowel wall will help you to track the bowel and to find the two stenoses. Sometimes it eve
rence in enhancement. Optimal enhancement of the bowel is in the late arterial phase and starts at about 15-20 seco
ll give a good peak of enhancement in the aorta and thus also in the bowel (see figure). Do not scan in the portal ven
tely, some of the patients with a closed loop obstruction are dehydrated.
Need for reconstructions:
In order to find the two stenoses you need reconstructions. Some closed loops are obvious on axial images, but som
deo, we demonstrate the importance of reconstructions.
Oral contrast:
There are two main reasons to not give oral contrast: In my opinion there is almost never a reason to give a patient c
Adhesions at surgery:
Most closed loop obstructions are the result of adhesions - even in patients without a history of prior abdominal surg

Is there always dilatation of bowel?:
Of course, the answer to this question is no. The dilatation of the small bowel proximal to the closed loop and the di
tion at the two stenoses and the time before the patient gets to CT and surgery. In most cases both the proximal bow
ilatation of the proximal bowel or only of the closed loop. When the obstruction is very acute and there is no time de
agnosis difficult. Watch the next video... This is a patient without prior surgery who presented at the ER with acute ab
struction. Notice that there is no dilatation of the small bowel, both on CT and at surgery. After cleavage of the adhes
ed after 10 minutes. The 1.5 meter of ischemic bowel had regained a normal color. This patient left the hospital the f
Sclerotic bone tumors:
Henk Jan van der Woude and Robin Smithuis
Radiology department of the Onze Lieve Vrouwe Gasthuis, Amsterdam and the Rijnland hospital, Leiderdorp, the Ne
Publicationdate 2013-11-01 In the article Bone Tumors - Differential diagnosis we discussed a systematic approach t
. The differential diagnosis mostly depends on the age of the patient and the findings on the conventional radiograp
sclerotic bone tumors and tumor-like lesions in more detail.
Introduction:
Here an illustration of the most common sclerotic bone tumors. In the table the most common sclerotic bone tumor
us dysplasia and eosinophilic granuloma more commonly present as osteolytic lesions, but they can be sclerotic. No
n younger age groups may heal and appear as sclerotic lesions in the middle aged group. Infection is seen in all ages
ance. Another approach to the differential diagnosis of sclerotic bone lesions is to use the mnemonic I VINDICATE, w
CATE is a commonly used mnemonic for the differential diagnostis of any radiological lesion.
Bone infarction:
Multiple bone infarcts Key facts The term bone infarction is used for osteonecrosis within the diaphysis or metaphys
ascular osteonecrosis is used. The radiograph shows typical bone infarcts in diaphysis and metaphysis of femur and
r serpentiginous margins with low signal intensity on both T1 and T2 WI and with intermediate to high fat signal in th
imal or absent (see right image). At the periphery of the infarct a zone of relative high signal intensity on T2WI may b
r low-grade chondrosarcoma on plain films can be difficult or even impossible. Cartilaginous tumors in particular cho
does not. Chrondroid tumors are more frequently encountered than bone infarcts. Here a lesion in the epiphysis, wh
s we use the term avascular necrosis and not bone infarction.
Bone island:
Key facts Click here for more information about bone island.
Chondroblastoma:
key facts: Here a lesion located in the epi- and metaphysis of the proximal humerus. The lesion is predominantly calc
low SI due to the calcifications. Click here for more examples of chondroblastoma.
Chondrosarcoma:
Low-grade chondrosarcoma Key facts The image shows a calcified lesion in the proximal tibia without suspicious fea
tures that favored the diagnosis of a low-grade chondrosarcoma like a positive bone scan and endosteal scalloping o
agnosed at biopsy. Here a 44-year old male with a mixed lytic and sclerotic mass arising from the fifth metacarpal bo
hted axial MR image demonstrates high signal intensity of the tumor in the metacarpal bone with extension of a lobu
hondrosarcoma of the left iliac bone. Because of the large dimensions with soft tissue extension on plain radiograph
suspected. Biopsy showed grade 2 chondroarcoma. Continue with the bone scan. Intense uptake on bone scintigrap
umeral head and sternum Here two other lesions in different patients that proved to be chondrosarcoma. The sclero
ma based on the imaging findings. Symptoms are usually absent, however, in adult patients with a chondroid lesion
ade chondrosarcoma. Plain radiograph and coronal T1-weighted contrast-enhanced fat-suppressed MR image of a m
the homogeneous thickening of the cortical bone. There are no calcifications. The MR image shows that the lesion ha
ncement in the upper part with edema and cortical thickening are not typical for a low-grade chondrosarcoma. A hig
osis. Biopsy revealed dedifferentiated chondrosarcoma.
Peripheral chondrosarcoma:
Key facts Consider peripheral chondrosaroma in growing osteochondromas with or without pain after closure of the
Use MRI with water-sensitive sequence (T2 FS) to determine cartilage cap thickness. Consider progression of osteoho
k here for more examples of chondrosarcoma.
Periosteal or juxtacortical chondrosarcoma:
A juxtacortical chondrosarcoma has be considered in the differential diagnosis when a mineralized lesion adjacent to
st the proximal humerus with involvement of the cortical bone on an axial CT image. T2-weighted MR image reveals
ment is not involved which is important for the surgical strategy. A periosteal chondroma may have the same imagin
lain radiograph in another patient shows irreglar mineralized lesion with elevation of the periosteum and cortical inv
acortical mass has a high SI and lobulated contours. DD: juxtacortical chondrosarcoma, parosteal osteosarcoma.
Enchondroma:
Most commonly encountered bone tumor in the small bones of the hand and foot. Here on a radiograph the typical
asily MRI depicts these lesions. Enchondroma is a fairly common benign cartilaginaous lesion which may present as
ified lesion or as a mixed leson with osteolysis and calcifications. Enchondromas aswell as low-grade chondrosarcom
who have a MRI or bone scan for other reasons. Click here for more examples of enchondromas.

Eosinophilic granuloma:
key facts: Eosinophilic granuloma as sclerotic lesion in the clavicle. This image is of a 20 year old patient with a sclero
e small areas of ill-defined osteolysis. In an older patient one should first consider an osteoblastic metastasis. If the p
tis would be in the differential diagnosis. Click here for more examples of eosinophilic granuloma.
Fibrous dysplasia:
Fibrous dysplasia FD is often purely lytic, but may have a groundglass appearance as the matrix calcifies. Ossification
rather wel-defined eccentric lesion which is predominantly sclerotic. The differential diagnosis includes: Here a well-
The diagnosis was fibrous dysplasia. DD: old SBC. Bone scintigraphy can be either negative or show limited uptake. T
and ossifications and fibrous tissue (low SI) and cystic components (high SI on T2). Fibrous dysplasia can be monosto
g adults. Not infrequently encountered as coincidental finding at later age. Central location most common with some
rmation about fibrous dysplasia.
Melorrheostosis:
Melorrheostosis is a dysplasia of the bone, characterized by apposition of mature bone on the outer or inner surface
etaphysis and diaphysis may be involved. Usually new bone is added to one side of the cortex only. Complete envelo
ce of candle wax. A surface osteosarcoma could be considered in the differential diagnosis Axial T1-weighted MR ima
apposition. Click here for more examples.
Metastases:
key facts Here images of a patient with prostate cancer. Notice the numerous predominantly osteoblastic metastase
s, which presents as a subtle sclerotic lesion in the humerus metaphysis. This could be an osteoblastic metastasis or
lastic metastases (2) Here a radiograph of the pelvis with a barely visible osteoblastic metastasis in the left iliac bone
ter (red arrows). Here CT-images of a patient with prostate cancer. Notice the numerous ill-defined osteoblastic meta
Non-ossifying fibroma:
Non-ossifying fibroma (NOF) can be encoutered occasionally as a partial or completely sclerotic lesion. Typically a NO
ound as a coincidental finding. These lesions usually regress spontaneously and may then become sclerotic. Other b
lastoma and other benign bone tumors may become inert and may also become sclerotic. The images show on the l
the right is of a different patient who has an old NOF that shows complete fill in. Click here for more detailed inform
ric sclerotic lesions of the distal femur. These are inert filled-in non-ossifying fibromas. No further examination is nee
Osteochondroma:
Osteochondroma is a bony protrusion covered by a cartilaginous cap. Growth of the osteochondroma takes place in
ates. Accordingly, growth of osteochondromas is allowed until a patient reaches adulthood and the physeal plates ar
terized by a thick cartilaginous cap (high SI on T2WI) should raise the suspicion of progression to a peripheral chondr
tice that the cortical bone extends into the lesion. This feature differentiates it from a juxtacortical tumor. Here a pat
e cortical bone into the stalk of the lesion. Notice the lytic peripheral part with subtle calcifications. This part corresp
This represents a thick cartilage cap. This is an example of progression of an osteochondroma to a peripheral chond
uld raise the suspicion of malignant transformation on plain radiographs or CT include:
Osteoid osteoma:
Osteoid osteoma key facts: Here the reactive sclerosis is the most obvious finding on the X-ray. There is reactive scle
lue arrow), but clearly visible on the CT (red arrows). CT scan is usually very helpful in detecting the nidus and differe
osteoblastoma, osteomyelitis, arthritis, stress fracture and enostosis. MRI also may detect the nidus, combined with
In most cases of osteoid osteoma the radiographic appearance is determined by the reactive sclerosis. In some case
gure).
Osteoma:
key facts Osteoma consists of densely compact bone. It is most commonly located in the outer table of the neurocra
Osteomyelitis:
Osteomyelitis is a mimicker of various benign and malignant bone tumors and reactive processes that may be accom
osteolysis. Sclerosis is usually the most prominent finding in subacute and chronic osteomyelitis. A periosteal reacti
olid periosteal reaction is present combined with cortical thickening and broadening of the bone. Here an image of a
fined osteolytic area. The major part of the lesion consists of reactive sclerosis.
Osteosarcoma:
Key facts Osteosarcoma (2) Here images of an osteosarcoma in the right femur. It is barely visible within the bone, bu
R-images. The sagittal T1WI and Gd-enhanced T1W-image with fatsat show a large tumor mass infiltrating a large po
soft tissues.
Parosteal osteosarcoma:
Parosteal osteosarcoma is a sarcoma that has it's origin on the surface of the bone. It grows primarily into the surrou
ow. It is nost commonly located on the posterior side of the distal meta-diaphysis of the femur. Ossification in paros
he periphery. This is opposed to myositis ossificans which may present very close to the cortical bone, but maturatio
Paget's disease of bone:
Paget disease is a chronic disorder of unknown origin with increased breakdown of bone and formation of disorgani
c. In this case we see the pathognomonic triad of bone expansion, cortical thickening and trabecular bone thickening
ht hemipelvis.

Reactive processes:

Myositis ossificans:
Here a patient with a mineralized mass in the soft tissues. Notice that the mineralization is predominantly in the peri
mass and the cortical bone. Contrast-enhanced T1-weighted MR image demonstrates heterogeneous enhancement
iagnosis of a reactive process like myositis ossificans.
Stress fractures:
Stress fractures occur in normal (fatigue fractures) or metabolically weakened (insufficiency fractures) bones. Usually
difficult to differentiate a stress fracture from a pathologic fracture, that occurs at the site of a bone tumor. Uncomm
rom a bone tumor like an osteoid osteoma or from a pathologic fracture, that occurs at the site of a bone tumor. He
bula. Coronal MR image demonstrates subtle low intensity line representing the fracture. Differential diagnosis base
Posttraumatic calcifications:
Here a patient with a juxtacortical sclerotic mass of the proximal humerus (left). This proved to be a reactive calcifica
ortical mass in another patient (right), which was a biopsy proven parosteal osteosarcoma. This shows that different
some cases. When a reactive process is more likely based on history and imaging features, follow-up is sometimes st
Subungual exostoses:
Subungual exostoses are bony projections which arise from the dorsal surface of the distal phalanx, most commonly
f reactive cartilage metaplasia. The radiographic appearance and location are typical.
Nora's lesion:
Here two patients with a bizar parosteal osteochondromatous proliferation (BPOP), also called Nora's lesion. This be
ex of phalanges of hands or feet (75%). The cortical bone and bone marrow compartment are not involved. Rapid gr
of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Smithuis sr, who
r of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar and if you like t
h a small gift. by Clyde A. Helms W. B. Saunders company 1995
2. Aneurysmal Bone Cyst: Concept, Controversy, Clinical Presentation, and Imaging by Mark J. Kransdorf and Donald
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Bluemke, John Eng, Frank J. Frassica and Elliot K. Fishman. AJR 2005; 185:915-924
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Non-traumatic changes:
Mini Pathria and Jennifer Bradshaw
Department of Radiology of the University of California School of Medicine, San Diego, USA and the Medical Centre A
Publicationdate 2010-01-01 This article is based on a presentation given by Mini Pathria and was adapted for the Rad
MR features of various muscle injuries. In part II we will discuss non-traumatic muscle changes.
Introduction:
When assessing muscle pathology try to decide which one of the four basic patterns of abnormality is present: Some
opriate therapy to be initiated. In other conditions, such as myositis ossificans, biopsy should be avoided because it
nappropriate therapy. Clues to the correct diagnosis and whether biopsy is necessary are often present on the MR in
nd the findings from other imaging modalities (1). The patient on the left had slipped on the ice in the hospital parkin
ted with sciatic neuritis, when the sciatic nerve became irritated by the hematoma.
Muscle Edema:
Muscle edema is the most common MR-pattern. It is hard to make a specific diagnosis based on the MR-findings alon
clue. The most common cause of muscle edema is trauma, which was discussed in Muscle MR imaging - Part I. Musc
Inflammatory myopathy:
Inflammatory myopathy is a term that defines a group of muscle diseases involving inflammation of skeletal muscle
to be autoimmune disorders. When using the term inflammatory myopathy, one is actually considering three separa
nd inclusion body myositis (IBM). On the left an example of inflammatory myopathy. Note increased signal of all the
me edema of the subcutaneous tissues. It is very unusual for a trauma, for example, to present with edema in all com
notice the perifascial fluid collections. On the left a patient with myositis. Again we see that multiple compartments
nt and perifascial fluid. It is non-specific but myositis could be suggested. Inflammatory myositis is generally bilatera
itecture on T1-weighted images, feathery edema with enhancement, skin reticulation and abnormalities NOT limited
Polymyositis:
On the left a patient with polymyositis (PM), one of the inflammatory myopathies. The large proximal muscles are inv
all muscles are involved, so MR can help locate the best area for biopsy. Sometimes whole body MR is used for diagn
initiated.
Inclusion body myositis:
Induction body myositis, one of the inflammatory myopathies, is a more recently recognized form of myositis of unk

0 years and makes up about a quarter (16-28%) of all inflammatory myopathies, although inflammation is not a pron
re no skin changes. The muscles that tend to be involved are the deltoid, quadriceps (see next example), finger flexo
, the disease owes its name to the histological finding of vacuoles and filamentous inclusions. Although the findings a
lder patient with abnormalities of the above mentioned muscles. Inclusion body myositis On the left a patient with in
quadriceps and the lack of edema in the surrounding tissues.
Myositis in collagen vascular disease:
Patients with underlying collagen vascular diseases can develop myositis, such as rheumatoid arthritis, systemic lupu
en syndrome. For example, as in this patient with SLE, it can be very focal (coronal image, right leg, adductor loge) or
yositis, it is the least common form. This can be seen in association not only with collagen vascular diseases but also
guishable from lymphoma itself, and biopsy is necessary to make the diagnosis. On the left another patient with foca
, T2-weighted, and post contrast. With a history of lymphoma you could suggest focal nodular myositis, but there is n
to underlying malignancy remains controversial, and the frequency of this association is not well established. 2 type
nd Non-Hodgkin lymphoma
(shown on the left a patient with, strangely enough, metastatic thyroid cancer). Myositis can precede malignancy (as
screening for malignancy
is called for in patients presenting with myositis.
Radiation myositis:
Myositis due to radiation can be seen many years after the therapy. It seems to be a vascular problem which doesn't
the clue, but also you may see a band like appearance where the radiation changes in the muscles stop, correspondi
Graves disease:
On the left a well-known example of inflammatory myopathy which has an endocrine etiology: Graves disease, other
s and orbital fat with subsequent volume increase leads to proptosis. Graves disease Same patient, coronal T2-weigh
Drug induced myositis:
Several drugs can induce myositis and in the author's practice the most frequent culprit seems to be a lipid-lowering
le pain and myositis, the dosage then needs to be decreased or the drug needs to be discontinued. On the left an ex
he buttocks. After discontinuation of the drug, the muscle pain will disappear in about 2 weeks, the MRI however wil
time to do a follow-up MR is about 6 weeks after stopping the drug. Lipitor myositis Coronal T1-weighted and T2-wei
rol who was put on Lipitor. The patient developed muscle aches and pains, CPK was mildly elevated. The changes are
ges of the muscle (the epimysium). Also there are minimal skin changes. HIV myositis
HIV myositis:
Antiretroviral drugs (used in HIV positive patients) can also cause myositis because they interfere with the mitochond
ose in myositis induced by lipid-lowering statins. Again, the patients present with weakness and pain, the changes ar
IV positive patients is relatively long (autoimmune, HIV wasting syndrome with type II muscle fiber atrophy,
denervation and infection). It is obviously important to be able to rule out infection in these patients. One way to diff
e (AZT) myopathy, or HIV myositis, is symmetrical.
Infection is usually unilateral or at least asymmetrical. T1-weighted image with fatsat post contrast Fluid collections w
Myositis due to infection:
Muscle infection or myositis without abscess or necrosis may produce edema as the sole abnormality on MR images
an infection. Bacterial myositis frequently progresses to abscess formation and thus often has a masslike appearanc
tion. Muscle infection can be due to: Important groups at risk for muscle infection are diabetics, immuno-compromis
hat cause infection to spread deep or skin infections). The hallmark of muscle infection is fluid collections present ins
Pyomyositis:
On the left T2-weighted, T2FS, and post contrast sagittal images of the knee. On the T2-weighted image we see a pos
The T2-weighted image with fatsat shows an ill-defined fluid collection and the inflammatory changes in the muscle a
tumor but tumors tend not to have so much inflammatory change around them. Lack of central enhancement comb
elp to make the diagnosis of pyomyositis. Pyomyositis Same patient, T1-weighted image post Gadolineum with fatsa
ore extensive, in a patient with AIDS who had a loculated abscess. Note the thick enhancing walls. On the left anothe
e left extremity. There is subcutaneous, fascial, and muscular inflammation. Generally speaking muscle infection is a
ent of the disease. MR also is helpful to locate fluid collections or abscess formation, which can then be aspirated for
es as a complication of osteomyelitis of the spine in a patient with TB. Necrotizing fasciitis
Necrotizing fasciitis:
Necrotizing fasciitis is a rare infection of the deeper layers of skin and subcutaneous tissues, easily spreading across
reptococcus is the most frequent pathogen found in necrotizing fasciitis. These bacteria are sometimes called 'flesh-
ually eat the tissue. They cause the destruction of skin and muscle by releasing toxins, which include streptococcal p
Sarcoidosis:
On the left an example of another inflammatory disease: Sarcoidosis. Sarcoid is confusing on MR, because you will s
in the muscle. 1-2% of patients with active sarcoid will have muscle involvement and there are always skin changes o
as the 'Stars and Stripes' pattern, mostly because of the stripes on the long axis of the muscle. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here a patient with sarcoidosis of the skin. A MRI was performed because of a small mass within the m

strange these sarcoid lesions are orientated within the muscle. Here another patient. Notice the longitudinal orienta
mage. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the MR the lesions are almost identical compared to the other patient. Notice the orientation on th
ct. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On these axial T2W-images with fatsat notice again the strange appearance of these lesions.
Muscle Atrophy:
Gymnast and a couch potato The fat present in a muscle will be either intramuscular or intermuscular. There obviou
f an olympic gymnast with 6% body fat.
Next to it an example of most of us mortals, the so called couch potato, with much more intra- and inter-muscular fa
Atrophy patterns:
The image on the far left demonstrates fatty infiltration of muscle in Charcot-Marie-Tooth disease. Charcot-Marie-To
thy or peroneal muscular atrophy. It affects both motor and sensory peripheral nerves. The image next to it demons
e is small and there is peritendinous atrophy. This is the pattern that you will see when the tendon is torn and there
Denervation and Peripheral nerve entrapment:
In the acute phase of denervation, the MR is normal. In the early subacute phase after one week, there will be unifor
llen). In the late subacute phase after 3 weeks, there will be mixed edema and atrophy. The chronic phase is charact
On the left a patient with cervical root avulsion. The para-spinal musculature shows a mixture of edema and atroph
entrapment by a ganglion, leading to atrophy of the peroneus longus, peroneus brevis and the anterior compartmen
o edema, meaning early atrophy. On the left an example of atrophy in a patient with a resection arthroplasty of the
musculature and gluteal muscles due to disuse. There is a decrease in size of the muscles and there is fatty replacem
glion (blue arrow) in the shoulder. Stop and think for a moment about what causes ganglions in the shoulder. There
arrow), due to edema. Remember that the early subacute stage of denervation presents with edema. The nerve is b
ctured), which can lead to ganglion formation. It is important to make this diagnosis while the muscle is not yet atrop
e function will be restored before the muscle becomes atrophic. On the left a different patient with a paralabral gang
and infraspinatus muscle. There is volume loss and edema, without any focal fluid colllections. Obturator nerve clipp
as clipped at surgery. This is the chronic phase where there is volume loss and fatty replacement of the muscle. On t
a paralabral cyst. Study the images and try to determine if there is any atrophy. Then continue with the T1-weighted
-weighted image to your exam! If you were to have only the T2-weighted image with fat sat, you would miss the atrop
y fat. The chronic phase of denervation is characterized by only atrophy. On the left images of a patient with an Erb's
on due to polio. On the left a patient with edema of both the deltoid muscle and the supraspinatus. This is an import
nerves. The deltoid muscle is innervated by the axillary nerve and supraspinatus muscle by the suprascapular nerve.
sonage-Turner Syndrome, also known as brachial neuritis. This is an inflammatory disorder characterized by severe
he infraspinatus muscle.
Muscular dystrophy:
Muscular dystrophy is a less common cause of atrophy. It is diagnosed clinically usually in children, with patients exp
e calves and difficulty in standing up. The muscle initially is edematous and then rapidly becomes atrophic. There are
enne. On the left an example of adult onset muscular dystrophy. There is subtle high signal intensity of the quadrice
Most of the adductor muscle is normal. Note the lack of skin edema. This is an important finding to be able to differe
ematous. The imaging findings correspond to the acute stage of muscular dystrophy. In a chronic setting, the muscle
weighted images of the thigh muscles. Notice that there is an obvious difference between the signal intensities of the
d image only the posterior muscles contain normal fat. On the T2-weighted image there is edema of the quadriceps,
gnosis cannot be made by MR, it can be helpful in suggesting a location for biopsy to determine the type of muscle d
ystrophy. The muscle has been entirely replaced by fat. When the muscle loses its nerve supply it becomes atrophic.
n with muscle atrophy as a result.
Accessory muscles:
Accessory soleus muscle Accessory muscles may present as an asymptomatic painless mass or with symptoms of ne
ssory soleus, on the medial side of the ankle, which caused compression of the tibial nerve (i.e. tarsal tunnel syndrom
iar with the anatomy of the area being studied. Patients with accessory muscles will usually present with a painless m
MR appears normal. However, be aware that there are 3 questions that you must consider in these cases: Accessory
owing an accessory forearm flexor muscle. Accessory extensor digitorum manus brevis On the left an example of an
nder the marker is a well-defined mass, iso-intense to normal muscle. It is a muscle at mid-carpal level, with normal
nsor side of the wrist, just tendon. This is an accessory extensor digitorum manus brevis. A recent article in Radiogra
(Sookur PA et al. Accessory Muscles: Anatomy, Symptoms, and Radiologic Evaluation. Radiographics 2008;28:481-499
ry muscle: the accessory soleus. Normally the soleus muscle inserts almost entirely onto the achilles tendon with a v
n. In about 1-2% of the population however, the soleus comes down and inserts directly onto the calcaneus. This will
eral. Accessory soleus muscle On the left a low lying soleus muscle, but it did not have a separate tendinous insertion
ular bundle On the left another example of an accessory muscle which lies medial to the flexor hallucis longus (midd
ssory muscles, and there are a lot of different muscles that can be found here (to differentiate you need to determin

or imaging is because it compresses the adjacent neurovascular bundle leading to atrophy of the muscles of the foo
or weakness. Accessory anconeus epitrochlearis muscle (red arrow)Ulnar nerve with high signal indicating ulnar neu
left. Note that there is a muscle directly behind the ulnar nerve, which in a normal situation whould not be present.
the population. It is a common cause of ulnar neuritis, due to compression, with pain and tingling of the ulnar side o
musculature. Always look carefully at the nerve when you have encountered this muscle. David A. May et al October
2. Long-Standing Morel-Lavalle Lesions of the Trochanteric Region and Proximal Thigh: MRI Features in Five Patients
Arthritis:
Laurens van Baardewijk, Frank Looijmans, Frank Smithuis and Matthieu Rutten
Máxima MC, Cooperative Lumirad U.A., Amsterdam University Medical Center, Jeroen Bosch Hospital and Radboud U
Publicationdate 2023-01-15 In this article we provide an overview of the different imaging findings of common joint d
hritis is a challenging topic. A long list of diagnoses has to be considered when looking at X rays of the hand and feet
Sometimes the abnormalities are pathognomonic for a specific disease, but more often the findings are non-specific
. When you start looking at arthritis cases, remember the following: You can click on all images for an enlarged view.
Systematic Approach:
Modified from Jacobson, et al. Radiology 2008 (2) This flow chart shows the approach to the radiographic evaluation
ortant to differentiate degenerative from inflammatory conditions. Degenerative joint diseaseThis is characterized by
bution both when you compare left and right as well as within the joint itself. Usually it is typical osteoarthritis.
When findings are atypical (unusual combination of age, affected joint and severity) think of posttraumatic, CPPD, ne
ry joint diseaseThis is characterized by bone erosions, osteopenia, soft-tissue swelling and uniform, symmetric joint s
Inflammation of a single joint should raise concern for infection.
Multiple symmetric joint inflammation in a proximal distribution in the hands or feet without bone proliferation sugg
When the inflammation is more in a distal distribution in the hands or feet with bone proliferation it suggests a sero
SpA is a group of chronic inflammatory diseases associated with HLA-B27 (2).
Axial SpA - most commonly ankylosing spondylitis - is located more in the axial skeleton.
Peripheral SpA - like psoriatic, reactive and IBD-associated arthritis - is located more in the peripheral skeleton.
ABCDE-S:
Joint diseases have variable manifestations with an overlap of radiological features.
The ABCDE-S mnemonic is a helpful tool for a systematic and complete radiological interpretation and reporting.
We use the ABCDE-S, which stands for Articular, Bone, Cartilage, Distribution,Extra's and Soft tissue.
There are variants of this mnemonic. Some use ABCDE for Alignment, Bone, Cartilage, Distribution and Effusion.
Articular - erosions:
Marginal erosions
They occur at the bare area of the joint, where the bone is not covered by articular cartilage. They are typically seen i
(DIP). Subchondral erosions
They occur at the subchondral bone plate of the articular surfaces. They are a typical feature of erosive osteoarthriti
of central erosions and osteophytes results in a gullwing deformity. Pencil-in-cup deformity
In psoriatic arthritis the combination of marginal erosions and bone proliferation can result in a pencil-in-cup deform
Gout erosions are a bit more eccentric juxta-articular located, where the joint capsule attaches to the bone. They are
c erosion patterns Alignment Some use the A of ABCDE-S for Alignment.
The problem however is that misalignment or malalignment can be seen in all end-stage joint diseases, whether it is
Bone - formation:
Bone formation or proliferation is seen in many joint diseases and especially in osteoarthritis, DISH and spondyloart
It is NOT present in the active phase of rheumatoid arthritis. Images Two examples of periarticular osteopenia in rhe
Bone - density:
Bone density changes either present as osteopenia or as osteosclerosis.
Periarticular osteopenia (figure)is typically seen in rheumatoid arthritis and not in osteoarthritis. Peri-articular demin
flamed synovium and soft tissues.
Subchondral sclerosis is typically seen in osteoarthritis. Also in patients with neuropathic arthritis. Images
Here two examples of periarticular osteopenia in patients with rheumatoid arthritis.
The osteopenia can be very subtle.
It may help to play with the window width settings (detail views in the center) or to look through your eyelashes to se
Cartilage:
Degenerative diseases affect the cartilage non-uniformly or asymmetrically, since this is the result of mechanical loa
matory diseases affect the cartilage uniformly, since the synovitis is present in the entire joint. Click on image to enla
Distribution:
Understanding distribution patterns is a very powerful tool, since most common diseases (osteoarthritis, rheumatoi
In the following chapters on the various joint diseases, we will start each chapter with an illustration of the distributi
Extra findings:
Serological tests can help when rheumatic diseases are suspected. A positive rheumatoid factor (RF) or anti-citrullina
rheumatoid arthritis is suspected.

A positive HLA-B27 test can aid establishing a diagnosis of ankylosing spondylitis (AS).
Nonspecific inflammatory markers, including the erythrocyte sedimentation rate (ESR) and the C-reactive protein (CR
ologic tests are not always helpful, since they have limited specificity.
Soft tissue:
Soft tissue swelling and calcifications are frequently seen in arthritis and can help to narrow the differential diagnosi
Osteoarthritis:
Key findingsNon-uniform joint space narrowing with osteophytes, most often in weight-bearing joints. No erosions. C
ow secondary osteoarthritis in a later stage. In the knee, osteoarthritis is classified by the Kellgren and Lawrence clas
This classification can be used when grading degeneration in other joints, but it is primarily designed for the knee. A
Joint space narrowing of the 4th DIP joint (arrow) with osteophyte formation and subchondral sclerosis. B
Asymmetric joint space narrowing of the 2-5th DIP joint with osteophyte formation, subchondral sclerosis and slight
The PIP joints are also affected, but less severe. C
Slight narrowing of the cranial joint space of the hip joint at the right side with osteophyte formation and subchondr
Severe narrowing of the glenohumeral joint space with osteophyte formation and subchondral sclerosis (Kellgren-La
Hip osteoarthritis
Severe non-uniform narrowing of the hip joint with osteophyte formation, subchondral sclerosis and large cyst form
In these later stages, joint deformity with broadening and deformation of the femoral head can occur. F
Knee osteoarthritis
Moderate to severe asymmetric narrowing of the medial compartment of the femorotibial joint space with osteophy
on grade 3-4). G
CMC1 osteoarthritis
Non uniform joint space narrowing of the CMC 1 joint with osteophyte formation and subchondral sclerosis.
There is a large subchonderal cyst in the base of the first metacarpal (white arrow). HSTT osteoarthritisNon uniform
with osteophyte formation and subchondral sclerosis. This is a difficult case. Dominant finding is non-uniform joint s
oarthritis. The severity of findings may suggest erosive osteoarthritis. However, there is also joint space narrowing o
thout abnormalities in the PIP joints it is very unlikely that these abnormalities are all due to osteoarthritis. Most like
hritis.
Rheumatoid Arthritis:
Key findingsSymmetrical uniform cartilage damage with marginal erosions predominantly in MCP-joints and the carp
indings Typical marginal erosions and joint space narrowing of MCP 3-5.
Also note the uniform joint space narrowing of the MCP joints.
The PIP-joints only show minimal joint space narrowing. End stage Rheumatoid arthritis. This is a case with end stage
s ruptures causing dislocation of the MCP joints. Scapholunate dissociation (white arrow) is a common finding due to
ion can cause joint space narrowing in the radiocarpal joint. Notice also the erosion in the distal ulna with surroundi
the feet In this case of rheumatoid arthritis there are marginal erosions adjacent to almost all MTP joints (arrowhead
The 5th MTP joint is most frequently involved in rheumatoid arthritis.
When erosions are as severe as in this case, it can look like pencil-in-cup deformity (white arrow) as is frequently see
However, the primarily affected MTP joints distribution and less affected interphalangeal joints is the clue that this is
ow Rheumatoid nodules Rheumatoid nodules are firm lumps that appear subcutaneously in up to 20% of patients w
These nodules usually occur adjacent to overexposed joints that are subject to trauma or pressure, such as the finge
ere are often no joint abnormalities. Images
Soft tissue mass (i.e., rheumatoid nodules) in the subcutis at the dorsolateral side of the olecranon. Atlanto-axial sub
Atlanto-axial subluxation:
The cervical spine is often affected in rheumatoid arthritis and can present as atlantoaxial instability, subaxial sublux
Cranial settling occurs when the dens extends into the foramen magnum. Atlanto-axial subluxation is an important a
s. It is defined when the space between the dens of C2 and the arch of the atlas exceeds more than 3 mm. It is cause
ay result in numerous neurological symptoms due to compression of the spinal cord. Images In flexion of the cervica
and the posterior surface of the anterior atlas ring (normal ≤3 mm). Enable Scroll
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Basilar invagination:
Basilar invagination also called cranial settling or basilar impression occurs in 5-10% of patients with cervical rheuma
psing into the foramen magnum limiting the space for the spinal cord. Clinical presentations range from chronic hea
nal cord and brain stem compression, which can lead to paralysis or even death if the neck is moved in certain positi
tion of the odontoid process into the occipital foramen.
Juvenile Rheumatoid Arthritis:
Key findingsPolyarthritis in the pediatric population with variable manifestations and radiographic findings. Clinicallt
rger joints. Joint changes are distinct from adult RA, however the distribution can be similar.
Radiological findings Juvenile rheumatoid arthritis is a diagnosis of exclusion, when inflammatory changes do not ma
also called juvenile idiopathic arthritis. ImageTypical ankylosis of the carpal bones. Periarticular osteopenia In this pa

e erosions in the carpus and in the base of the metacarpal bones.
Diffuse joint space narrowing is present. Continue with the MR of this patient. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll MR-findings: Diffuse effusion in all wrist joints.
Diffuse bone marrow edema in all carpal bones.
Erosions, for example in scaphoid, capitate and hamate.
Destruction of joint space and cartilage, most striking in STT and CMC4/5. Juvenile arthritis Two patients with juvenile
al bones and MCP joints. Collapse of the scaphoid and lunate bone. B. Adult with a history of juvenile arthritis. Abnor
hyseal overgrowth. Severe joint malalignment. Both cases show periarticular osteopenia. Large erosions of the humo
ritis. Erosions and joint space narrowing of the right hip joint in a patient with juvenile idiopatic arthritis.
Erosive osteoarthritis:
Key findingsArthropathy with the age of onset and distribution of osteoarthritis, with an inflammatory and erosive co
n two patients A
Erosive changes of PIP 2-5 and DIP 3-5.
Typical gullwing deformity in DIP 3 (white arrow).
Ankylosing of PIP 4 (yellow arrow), which occurs in a late phase of the disease. B
Joint space narrowing with central erosions. Gullwing deformity of PIP 2-4, DIP 2 and CMC-1 joint.
Ankylosing of DIP 3. Medial deviation of PIP 2. Ball catcher view of the hands in a patient with erosive osteoarthritis.
Note the symmetrical distribution and sparing of the MCP joints. Typical gull-wing appearance of the DIP-joints, also
This is classically seen in erosive osteoarthritis, but has also been reported in psoriatic and rheumatoid arthritis.
Septic arthritis:
Septic arthritis Key findingsRapid destruction of one joint with extensive erosions and effusion. ClinicalSeptic arthritis
o-arthritis.
It is secondary to bacteremia, local spread of infection or a complication of surgery or injection.
Septic arthritis leads to rapid joint destruction and requires prompt aspiration or drainage. Radiological findings Ima
A. Soft tissue calcifications in the rotator cuff. Patient got a subacromial injection for relief of symptoms. B. After cort
meral joint and bone destruction of the humeral head occured. This was the result of a septic arthritis, which is a rar
nt.
There is enormous soft tissue swelling of the 3rd finger.
There are extensive erosions of the joint with some small bone fragments. Infectious arthritis as a compllication of a
lvis is of a patient with tuberculous arthritis of the left hip joint. There is subtle joint space narrowing with some subc
These radiographic findings are nonspecific and most likely would be the result of osteoarthritis.. Continue with the
Disable Scroll Enable Scroll
Disable Scroll Much to everyone's surprise there were multiple abscesses.
When abscess formation is this extensive and the clinical findings are minimal, always think of tuberculous arthritis.
ation.
Spondyloarthritis - SpA:
Spondyloarthritis (SpA) comprises a group of inflammatory diseases of the joints and spine, with various clinical mar
Spondyloarthritis can further be divided into an axial and a peripheral type.
Ankylosing spondylitis is the most common axial type and the prototypical type of spondyloarthritis.
The most common peripheral types are psoriatic arthritis, reactive arthritis and enteropathic arthritis (associated wit
A from the Assessment of SpondyloArthritis International Society (ASAS) are: The clinical features of spondyloarthriti
Ankylosing Spondylitis:
Key findings
Axial arthropathy, with enthesitis (edema, shiny corners), syndesmophytes and sacro-iliitis. ClinicalSignificant back pa
The onset is in the 3rd and 4th decade and the prevalence is about 1%.
Ankylosing Spondylitis is the prototypical type of seronegative, axial SpA and primarily affects the spine and SI-joints
small joints of the hands and feet can become involved. Radiological Early stage ankylosing spondylitis Enthesitis
Inflammation of the enthesis is one of the hallmarks of SpA.
The earliest sign of ankylosing spondylitis is edema at the enthesis, which is only visible on MRI (white arrow).
In a later stage sclerosis will present as shiny corners on X-rays or CT.
Finally syndesmophytes are formed along these enthesis (see next images). Images
Three different patients with typical features of early stage ankylosing spondylitis: Ankylosing spondylitis Syndesmop
These images show syndesmophytes in the lumbar spine and ossification of the paraspinal ligaments.
When these syndesmophytes fuse, this produces the typical “bamboo spine” appearance. Also note the ossification o
ophytes have a typically vertical orientation.
Bridging and fusing is quite common.
As a result the spine looses its flexibility and can easily fracture even after a minor trauma. Bamboo spine
Bamboo spine in ankylosing spondylitis. Fusion of the lumbar spine by syndesmophytes and ossification of the paras
Notice the ligamentous calcification (arrow). A rigid bamboo spine is prone to hyperextension fractures, even after m

Always have a high suspicion of these fractures in a rigid spine! Ankylosing spondylitis of the cervical spine A bambo
he cervical spine.
Notice the squaring of the vertebral bodies (arrow). Dagger sign The radiopaque central line on frontal radiographs
nown as the “dagger sign”, is a radiographic feature of ankylosing spondylitis.
Also note the complete fusion of the SI-joints. Sacroiliitis in ankylosing spondylitis
Sacro-iliitis:
An important hallmark of SpA is sacro-iliitis.
It starts with inflammation, which is visible on MRI as edema, with or without erosions (visible on MRI and conventio
Later on you will see fatty metaplasia on MRI or sclerosis alongside the SI-joints on radiographs.
In the end stage there is ankylosis of the SI-joints. X-ray Bilateral subchondral sclerosis and erosions of the sacroiliac
MR of the same patient shows an irregular contour of the SI-joints caused by erosions. There is enhancement in the
n. I.V. contrast does not necessarily have to be used for the diagnosis of sacro-iliitis. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the MR-images and compare with the findings on the X-ray (last image). Differential Dia
hallenging based on these X rays alone. It can be helpful to include an X-LWK or other investigation to become more
. Hatchet lesion. Ankylosing spondylitis of the humeral head The Hatchet sign is a circumscribed erosion of the latera
deformity.
A hatchet is a small axe. This deformity is typical for ankylosing spondylarthritis. Avascular necrosis of the humeral h
iffers from the deformity seen in avascular necrosis, where there is progressive collapse of the articular surface of th
rA rare shoulder arthropathy that can simulate the hatchet shoulder is the Milwaukee shoulder syndrome.
It is characterized by rupture of the rotator cuff and large joint and bursal effusions with deposition of hydroxyapatit
oint. Image
Severe destruction of the humeral head with cephalic migration and erosions of the acromion indicating total cuff ru
In the Milwaukee shoulder syndrome, symptoms are often much milder than imaging suggests.
In this case, there was no attempt to diagnose calcium hydroxyapatite crystals in the synovium.
Based on clinical and radiographic findings, Milwaukee shoulder syndrome was diagnosed. Ankylosis of the hip joint
nt with ankylosing spondylitis.
There is also ankylosis of the sacroiliac joints.
Psoriatic arthritis:
Key findings
Erosions and bone proliferation predominantly in a distal distribution, presenting most often as a typical pathognom
ntial diagnosis). ClinicalPsoriatic arthritis is a peripheral type of spondyloarthritis and presents as a peripheral arthrit
It frequently is preceded by psoriasis of the skin, but can occur without skin disease in up to 20% of patients.
Enthesopathy is common.
The hands are most commonly involved followed by the feet. Other locations are the spine, sacroiliac joints and less
s Differential Diagnosis
Rheumatoid arthritis, erosive osteoarthritis, reactive arthritis There are five subtypes of psoriatic arthritis. Due to the
s can sometimes be challenging. Sausage digits and pencil in cup deformity in Psoriatic arthritis Sausage digits Typica
welling and pencil-in-cup deformity of DIP 1-2 and 5 of the left hand in a patient with psoriatc arthritis. Notice that th
hritis Progressive psoriatic arthritis The distribution and the bone formation makes the diagnosis of rheumatoid arth
olvement in other joints makes the diagnosis of erosive osteoarthritis unlikely, although pencil-in-cup can look like th
hritis Pencil in cup deformity A. Pencil in cup deformity of 1st and 5th toe.
B. Acro-osteolysis with resorption of the terminal tuft of digits 2-4 and 5.
There are erosions in MTP 2 and 3. Psoriatic arthritis Periostitis in psoriatic arthritis This is a patient with psoriatic art
Notice the subtle periostitis of the distal phalanx of dig 1 on the right (arrowhead).
There are small erosions of the tuft of dig 2 and 3 on the left (white arrows).
Reactive arthritis:
Clinical Reactive arthritis is a sterile arthritis following soon after an infection
elsewhere in the body, usually of genitourinary or enteric origin.
It is caused
by a cross-reaction of the antigen reaction to bacteria as well as synovial
tissue.
Classically patients present with conjunctivitis and urethritis,
leading to the triad: can't see, can't pee and can't bend the knee. Radiological findings This patient suffered from an
After a
few weeks clinical symptoms of arthritis emerged. ImageOn the right there are
erosions at the base of the 3rd proximal phalanx and at the head of the 5th
proximal phalanx (white arrowheads).
On the left there is an erosion at the base of the 3rd proximal
phalanx and lytic changes of the head of the 1st proximal phalanx (yellow arrowheads). Based on the aspecific imagi

The preceding infection makes it more likely.
Diffuse Idiopathic Skeletal Hyperostosis:
Key findingsBulky spondylophytes, over more than 4 contiguous levels, located at the right side of the lower thoracic
ISH) is also known as Forestier's disease. Most often asymptomatic.
It is characterized by bony proliferation at tendinous and ligamentous insertion of the spine and pelvis mostly affecti
In daily practice, it is the classic differential diagnosis of ankylosing spondylitis, especially in early stages of both disea
Teach yourself the differences between the two (see below). DISH DISH should not be confused with the findings of a
age Other causes of ligamentous ossification in the spine are severe osteoarthritis, and less likely: vitamin A toxicity a
There is enthesopathy of the iliac crest, ischial tuberosities and greater
trochanters. The lower part of the SI joint is normal (unlike ankylosing spondylitis).
Ossification of the ligaments in the upper part of the SI joint is present. Image Typical ossification and calcification of
and connective tissue over more than 4 contiguous levels.
Large
ossifications of the anterior longitudinal ligament.
There is some non-typical
narrowing of facet joints.
No sign of
degenerative disc disease. Ankylosis due to DISH and ankylosing spondylitis can result in a rigid spinal column. Then
These fractures are most often hyperextension fractures. This patient had a minor trauma, which however resulted
ons. Teaching point: you should always have a high suspicion of hyperextension fractures in patients with rigid spine
Gout:
Key findings
Tophi with juxtaarticular erosions at the capsule insertion of a joint, typically MTP1, in patients with risk factors like d
Gout
is an inflammatory arthropathy caused by the deposition of sodium urate
crystals in joints and periarticular soft tissues and tendons. The first MTP
joint is most often affected (podagra). Classically the diagnosis is made
clinically, supported by joint aspiration. Radiological findings Late stage of Gout Characteristic radiologic changes in t
chronic stage of gout.
Typically well-defined "punched-out" eccentric erosions with sclerotic margins in a marginal and juxta-articular distril
These erosions have overhanging edges called rat bite erosions.
There is preservation of joint spaces. Periarticular hyperdense soft tissue swelling due to tophi as a result of crystal d
These are located in the ligamentous structures around the joints. Typical involvement of the 1st MTP joint with pun
The soft tissue swelling represents a tophus. The dislocation is not a common finding in gout, but in this case the res
y Typical dense soft tissue swelling surrounding the 1st MTP joints bilateral.
Juxta-articular erosions at the medial side of the distal MT, which have sclerotic margins.
They are most notably on the right side (arrow). Continue with the Dual Energy CT... Dual Energy CT in a patient with
Energy CT of the same patient with gout showing the urate crystal depositions. In
this 3D reconstruction the crystal depositions are color coded green and can be
seen surrounding the MTP joints and at the insertion of the right achilles
tendon (arrow).
The green pixels in the nail beds of digitus 1 and 5 on the left are artifacts caused by keratin in thickened nails. Dual
Energy CT is a noninvasive method of urate crystal detection that can
make joint aspiration unnecessary.
Dual Energy CT simultaneously scans the subject at two different energy levels.
Because urate crystals show different attenuation at these energy levels, the
crystals can easily be identified with high accuracy. Another case with typical gout tophi and juxtaarticular erosions o
MTP2 and interphalangeal joints of the 3rd digit. DECT is useful for the diagnosis when findings are not so typical.
It is also very useful to show the extent of disease. In this case, a bone tumor was suspected.
There are definitely some findings that could support the diagnosis of an osteosarcoma of chondrosarcoma. Howeve
Continue with the DECT images... With these DECT images, nobody was in doubt anymore. Punched out erosions In t
punched out erosion of the MCP3 joint with an overhanging edge (arrow). The
borders of the erosions in gout can be sclerotic because of the indolence of
the process, creating a punched-out or "mouse bitten" appearance. Calcified tophi The images show extensive tophi
In the knee, these locations (insertion popliteus tendon, insertion quadriceps tendon, insertion MCL) are very typical
There is mild
joint effusion.
The joint space narrowing is likely due to secondary
osteoarthritis. When in doubt, think gout This is a difficult case.

Small bilateral erosions of the PIP
joints on both sides are seen.
The arrowheads show that the erosions are more juxtaarticular in this patient that proved to have gout. Based on th
have been an option.
However then the erosions would have been more marginally located.
Also, the MCPs are spared, making the diagnosis of rheumatoid arthritis less likely. Soft tissue swelling This case is al
Multipele joint are affected, but there is no typical distribution. The only thing that these joints have in common is th
This was due to gout tophi.
CPPD:
Key findingsFine chondrocalcinosis located at the TFCC or menisceal tissue in the knee. Clinical Calcium Pyrophospha
eposition of calcium
pyrophosphate dihydrate crystals into the synovial fluid, synovial lining and
articular cartilage. Some terms regarding CPPD can be a bit confusing: Radiological findings Two patients with typica
cinosis in: B. This patient had an acute joint inflammation. Chondrocalcinosis in the radiocarpal joint and the TFCC (b
s scapholunate dissociation, which can be seen in CPPD, but also in rheumatoid arthritis or posttraumatic. This sudd
mmation and intense pain of a gout attack. Chondrocalcinosis in CPPD There
are faint calcifications of the cartilage and meniscus both on the right side
(white arrow) as well as on the left side (black arrows).
These can be caused
by CPPD, but may be seen in other conditions as well, such as gout or
osteoarthritis. Also note the joint space narrowing and mild osteophyte
formation.
CPPD has many features similar to osteoarthritis. There is a well-circumscribed coarse calcification adjacent to the 4t
d have been more likely. However, aspiration revealed typical CPPD crystal depositions. As in other arthropathies, at
common.
Scleroderma:
Key findingsSoft tissue calcifications and acro-osteolysis Clinical Scleroderma (systemic sclerosis) is an autoimmune d
is characterized by microvascular obliteration and sclerosis of the skin and
internal organs.
The
clinical hallmark of the disease is the appearance of taut tethering of the
skin.
Clinically evident arthritis occurs in up to 65% of patients, and it may
be one of the earliest manifestations of scleroderma. There
is a limited and a multisystem variant. CREST syndrome is a common type of limited scleroderma (skin calcinosis,
Raynaud’s phenomenon, esophageal dysmotility, sclerodactyly
and telangiectasia). The systemic variant can affect virtually every organ system or can be
localized. Radiological findings Soft tissue calcifications Extensive soft tissue calcifications in the distal phalanges in a
Notice the calcifications next to the distal ulna (arrow).
There are no signs of cartilage damage. The pathophysiology of the calcium deposits is not well
understood.
It occurs in tissues that are under chronic stress, such as local
trauma or damage associated with an underlying inflammatory process.
It is usually
more abundant in the dominant hand.
When these findings are present, the diagnosis is usually straight forward. Subtle, but coarse soft tissue calcifications
eroderma. No acro-osteolysis or other signs are seen. Acro-osteolysis in Scleroderma Severe acro-osteolysis of the fi
1-3 in a patient with scleroderma (arrows). Notice the lysis of the soft tissues distally. Acro-osteolysis is a
radiographic finding which refers to bone destruction of the distal phalanges and occurs in 6–65% of patients with sc
Vascular alterations and
reduced capillary density impair tissue oxygenation and the resulting hypoxia
may contribute to osteoclast activation. There is a wide variety of diseases that can cause
acro-osteolysis including psoriatic arthritis, infection, raynaud disease and thermal trauma. A. Subcutaneous and per
rma.
There is also a hallux valgus deformity, which is not caused by scleroderma. B. Subcutaneous calcifications near the
These subcutaneous calcifications often form at pressure points.
Systemic lupus erythematosus:
Key findings
Abnormal joint alignment without erosions. Avascular necrosis. Clinical SLE is a generalized autoimmune connective
Essentially any

organ system can be affected with systemic (weakness, malaise, fever),
mucocutaneous (typical butterfly rash on the face), renal and neurological
symptoms. Radiological findings SLE: Z-thumbs and swan neck fingers Z-thumbs and swan neck fingers in a patient w
The deformities are
thought to be a consequence of low-grade inflammation of the synovial membrane
and capsule resulting in ligamentous laxity and muscular contracture. Swan neck deformity Here another example w
ilage damage in a patient with SLE. Another patient with a swan
neck deformity.
Usually this is reversible in the early stage of the disease.
Avascular necrosis:
Avascular
necrosis is a frequent complication in SLE in up to 15% of patients.
The femoral
head and tibial plateau are the most involved sites, but other sites may be
affected.
SLE patients with bone pain should be suspect of having
avascular necrosis.
Avascular necrosis in SLE can occur even in the
absence of steroid use. Images Increased density in the distal femur in a guirlande-like pattern, representing avascul
patient with SLE. A. Subluxation of the 1st MCP joint without erosions in a patient with SLE. This is not typical for SLE
ce osteoarthritis. B. SLE of the shoulder. Collapse of the humeral head with some loose bony fragments due to avasc
increased risk of avascular necrosis.
Sarcoid:
Key findings
Lace-like granuloma lesions in the bone ClinicalSarcoidosis is a multisystem disorder of unknown etiology characteri
the formation of inflammatory non-caseating granulomas.
Musculoskeletal manifestations of
sarcoidosis occur in about 20% of patients with sarcoidosis and include joint
involvement, bone lesions, and muscular disease.
Primary skeletal involvement
without other organ involvement is extremely rare. Usually arthritis is seen
early in the course of sarcoid disease, chronic sarcoid arthritis is rare.
The most frequent musculoskeletal
manifestation of sarcoidosis is an acute arthritis that occurs as part of
Löfgren's syndrome characterized by the combination of erythema nodosum,
bilateral hilar adenopathy, polyarthritis, and constitutional symptoms. Radiological findings Lace-like granulomas Mu
The osteolytic lesions are quite typical and described as having a lace-like or trabecular pattern.
Once you have seen this, you will recognize it in other cases. The image shows an osteolytic lesion in the distal radius
bone destruction in a patient with sarcoid. There is osseous destruction on both sides of the interphalangeal joint of
of granulomatous tissue (black arrow).
Amyloidosis:
Clinical Amyloidosis is a systemic disease in which normally soluble proteins
(amyloid) are deposited as an insoluble proteinaceous material in the
extracellular spaces.
Amyloid is often deposited into the heart, kidney, gastrointestinal tract and
nervous systems.
The secondary form of amyloidosis is associated with diseases such as multiple myeloma, hemodialysis, RA and chro
Musculoskeletal manifestations are most often depositions in periarticular tendons and capsule.
Amyloid arthropathy is extremely rare and only 5-13% of patients have bone or joint involvement. Radiological findin
ing alone, MR is more useful for the diagnosis. Enable Scroll
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series of a patient with amyloid arthropathy of the shoulder joint. The
findings are: This
soft tissue swelling should not be mistaken for rice bodies as seen in rheumatoid
arthritis.
Neuropathic arthropathy:
ClinicalNeuropathic arthropathyalso known as Charcot arthropathy is a progressive destructive joint disorder in pati
loss of pain sensation and proprioception in the foot, ankle or hands.
Patients may experience fractures and dislocations of bones and joints with

minimal or no known trauma.
The most common cause is diabetes mellitus, which typically affects the tarsal
and tarso-metatarsal joints. Arterial wall calcification is commonly seen in
these patients. Other causes are tabes dorsalis
(tertiary syphilis), syringomyelia, leprosy and CPPD. Radiological findings These radiographs are of two different pati
of the tarsometatarsal joints with periarticular lucencies. B. Typical
radiological changes in the foot of a diabetic patient. There is lateral
subluxation of the TMT joints (Lisfranc dislocation). The changes in bone and joints itself may mimic severe osteoarth
The key in this case is the clinical history with the presence of diabetic neuropathy. Rocker bottom deformity
On this weight-bearing lateral view the dislocation in the TMT joints is even better visible. For a more detailed explan
of the diabetic foot. Diabetic Hand Syndrome
The diabetic hand syndrome is the inability to use the hand due to contractures and stiffness.
It can affect the
proximal and distal IP and MCP-joints and
is often painless.
Prolonged hyperglycemia is thought to result in the accumulation of advanced
glycation end products (AGEs).
These AGEs can break down collagen and
deposit abnormal amounts of collagen in connective tissue around the joints,
resulting in stiffening and hardening of the joints and the skin. ImagesDestruction of the CMC-1 and all DIP-joints.
Erosions and bone destruction adjacent to the IP1, DIP 2-5 and PIP 4-5.
There is subluxation of PIP 4-5 and DIP 2-5.
Notice the extensive vascular calcifications in a patient with
Diabetes Mellitus type 2. The hand of this patient with neuropathy shows a status after removal of the trapezium (ar
There is destruction of all DIP joints and erosions adjacent to the PIP and MCP joints.
There are erosions and bone destruction adjacent to the IP1, the DIP and PIP and MCP joints.
There is subluxation and dislocation of DIP 2, 4 and 5 and PIP 2-4.
Hemophilic arthropathy:
Key findings
Extensive findings that look like osteoarthritis, but in an unusual distribution or pattern. Clinical Hemophilia is an inh
X-linked recessive and therefore occurs almost exclusively in males.
About 50% of the hemophilia patients develop haemophilic arthropathy.
This results from recurrent hemarthrosis, which leads to synovial hyperplasia, chronic inflammation, fibrosis, and
hemosiderosis.
It is frequently mono- or oligoarticular.
Early prophylaxis with coagulation factors considerably reduces the musculoskeletal complications. Radiological find
in an odd presentation or distribution, think hemophilic arthropathy. Hemophilic arthropathy of the right knee (Arnc
ry of hemophilia and repetitive hemarthros. Images
Distention
of the suprapatellar recess of the right knee due to hemarthrosis (black arrow).
There is narrowing of the medial joint space
caused by cartilage destruction and secondary osteoarthritis (white arrow).
Subchondral bone
cyst formation underneath the intercondylar eminence.
No erosions. The Arnold-Hilgartner classification is a plain radiograph grading system for haemophilic arthropathy o
hemarthrosis caused by a vascular malformation (not visible on plain
radiography). Images
The image of the right knee shows joint space narrowing, subchondral cysts formation and
erosions of the medial and lateral tibial plateau.
Normal left knee joint for comparison. This patient has a long term history of repetitive hemarthrosis as a result of h
A slightly widened intercondylar notch on the left hand side, which can also be
found in juvenile rheumatoid arthritis and tuberculous arthropathy.
Bulbous
femoral condyles with flattened condylar surfaces.
The congruent bony
deformation on the left hand side can also be seen in tuberculous arthropathy. This is stage V Arnold-Hilgartner clas
wing, subchondral cyst formation and erosive destruction. Hemophilic arthropathy of the shoulder This image is of a
r joint. There are features of secondary osteoarthritis with subchondral sclerosis and
osteophyte formation at both sides of the glenohumeral joint.
In general

hemophilic arthropathy has similarities with osteoarthritis.
However, the
presence of erosions, extensive subchondral bone cyst formation and the history of recurrent hemarthrosis are disti
arthropathy of the ankle Image of the ankle of a patient with hemophilia. The findings are: Hemophilic arthropathy E
Stage hemophilic arthropathy The findings are: Although the findings itself are not that specific, you can see the rese
CRMO - chronic recurrent multifocal osteomyelitis:
Key findings
Multifocal areas of sterile bone inflammation ClinicalChronic Recurrent Multifocal
Osteomyelitis (CRMO) is an uncommon autoinflammatory disorder of the bone of children
and young adults that is characterized by nonbacterial osteomyelitis.
Patients present with
episodic multifocal bone pain secondary to sterile osseous inflammation. The disease has a relapsing and remitting
unclear. The diagnosis is made by exclusion, and the main causes to be excluded
are neoplasms and infections.
It is sometimes diagnosed along with inflammatory
bowel disease or psoriasis and there seems to be a genetic component.
CRMO is
comparable to SAPHO in adults. Radiological findings Cortical thickening, sclerosis and bone enlargement
of the diaphysis and metaphysis of the right clavicle and the metaphysis of the left
clavicle. SPECT-CT and Bone scintigraphy of the
same patient. Abnormal tracer uptake in corresponding areas, reflecting
increased bone turnover. X-ray of a patient
with CRMO with pain on the left side. There is subcortical osteolysis lateral in the proximal femur (arrow) The MRI (ax
e and soft tissue enhancement.
This was due to non-infectious
osteomyelitis with extra
osseous extension. There is also a small CRMO location visible in the dorsal
aspect of the trochanter major on the right. Multiple CRMO locations This patient has locations in the humeral head
proximal diaphysis and in the coracoid on the right and the distal tibia on both sides.
SAPHO syndrome:
ClinicalSAPHO syndrome (synovitis, acne, pustulosis, hyperostosis, and osteitis)
is an uncommon inflammatory disorder of bone, joints and skin.
The pathogenesis of SAPHO syndrome is not
well understood.
It is sometimes described as an autoinflammatory disorder.
The
pediatric counterpart of the disease is known as CRMO. Radiological findings Teaching point: the degree of inflamma
cur when there is extensive inflammation. Increase of bone activity and sclerosis will occur when there is less inflam
with: Hyperostosis in SAPHO This patient has extensive hyperostosis of the medial side
of the clavicles on both sides. CT of the same patient.
There is
extensive hyperostosis of the medial side of the clavicles and sternum.
Ankylosis of the sternoclavicular and of the first and
second sternocostal joints.
ABCDE-S overview:
In this table the key findings of the various joint diseases are summarized according to the ABCDE-S mnemonic. Click
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6.
None:

Gallbladder wall thickening:
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Publicationdate 2006-02-01 Thickening of the gallbladder wall is a relatively frequent finding at diagnostic imaging st
ded as proof of primary gallbladder disease, and it is a well-known hallmark feature of acute cholecystitis. The findin

range of gallbladder diseases and extracholecystic pathological conditions. In this review we discuss and illustrate th
If you encounter printing problems with the margins of the document, try to adjust the margins or the scale of the d
Introduction:
Distended hydropic and hyperemic gallbladder in acute cholecystitis due to stone obstruction in the gallbladder necl
ation of the normal and thickened gallbladder wall. Traditionally, sonography is used as the initial imaging technique
cause of its high sensitivity in the detection of gallbladder stones, its real-time character, speed and portability [1]. H
omen and often is the first modality to detect gallbladder wall thickening [2], or it may be used as an adjunct to an in
l value of MRI in the evaluation of gallbladder pathology has been shown [3], but it still plays little role. LEFT: US of a
as a pencil-thin echogenic line (arrow).RIGHT: US in the postprandial state shows pseudothickening of the gallbladde
Normal gallbladder:
The normal gallbladder wall appears as a pencil-thin echogenic line at sonography. The thickness of the gallbladder w
ickening can occur in the postprandial state. Contrast-enhanced CT shows the normal gallbladder wall as a thin rim o
rceptible at CT as a thin rim of soft-tissue density that enhances after contrast injection. LEFT: US in a 59-year-old wo
a thickened gallbladder wall, with a hypoechoic region between echogenic linesRIGHT: At contrast-enhanced CT the
ue to subserosal oedema
Thickened gallbladder wall:
Thickening of the gallbladder wall is a relatively frequent finding at diagnostic imaging studies. A thickened gallbladd
arance at sonography [1], and at CT frequently contains a hypodense layer of subserosal oedema that mimics perich
Differential diagnosis of gallbladder wall thickening:
The differential diagnosis of gallbladder wall thickening is listed on the left. Diffuse gallbladder wall thickening may p
d asymptomatic patients, and in patients with and without an indication for a cholecystectomy. Diffuse thickening of
mary gallbladder disease, but in whom the gallbladder is secondarily involved in an extrinsic pathological condition.
dder abnormalities will usually return to normal after correction of its extrinsic cause.
Primary gallbladder disease:
43-year-old woman with acute calculous cholecystitis. Contrast-enhanced CT shows a distended gallbladder (arrowh
g (asterisk). There is an impacted obstructing stone in the neck of the gallbladder (arrow).
Acute cholecystitis:
Acute cholecystitis is the fourth most common cause of hospital admissions for patients presenting with an acute ab
led gallbladder is found at imaging.
This feature, however, is not pathognomonic for acute cholecystitis. Additional imaging signs that support the diagno
ystitis On the left images of a 62-year-old man with acute calculous cholecystitis. Transverse sonogram at the spot of
nded thick-walled gallbladder (arrowheads), with an intraluminal stone and sludge or debris. Contrast-enhanced CT
gallbladder (arrow). 74-year-old man with acute acalculous cholecystitis. LEFT: US at the spot of maximum tenderne
tely filled with sludge (asterisk) without any stones. RIGHT: Power-Doppler sonography shows hypervascularity of the
on.
Acalculous cholecystitis:
Acute acalculous cholecystitis mainly occurs in critically ill patients, presumably due to increased bile viscosity from f
features are those of acute cholecystitis, except for the absence of stones whereas gallbladder sludge is usually pres
malities are frequently found secondary to systemic disease (see below), acalculous cholecystitis can be difficult to d
can be both diagnostic and therapeutic. Chronic cholecystitis. Longitudinal sonogram of the gallbladder shows slight
e
Chronic cholecystitis:
Chronic cholecystitis is a term used clinically to refer to symptomatic gallbladder stones that cause transient obstruc
orrelation of the imaging finding of a stone-containing slightly thick-walled gallbladder with the clinical history is criti
ic cholecystitis. This patient had fasted overnight, so the wall-thickening does not represent physiologic contraction.
current colic-like right upper quadrant pain, due to transient gallbladder obstruction, is essential for the diagnosis. X
thickening with intramural hypoechoic nodules (arrowheads), and an intraluminal stone (arrow).RIGHT: Contrast-en
hypoattenuating nodules
Xanthogranulomatous cholecystitis:
Xanthogranulomatous cholecystitis is an unusual variant of chronic cholecystitis, characterized by a lipid-laden inflar
s. Imaging studies show marked gallbladder wall thickening, often containing intramural nodules that are hypoechoi
r foci of xanthogranulomatous inflammation. These features overlap with those of gallbladder carcinoma, making pr
Xanthogranulomatous cholecystitis. Hypoattenuating nodules (arrowheads) represent abscesses. The lumen contai
nulomatous cholecystitis. Contrast-enhanced CT shows a deformed and thickened gallbladder wall containing hypoa
. Porcelain gallbladder.
Porcelain gallbladder:
A porcelain gallbladder is a rare disorder in which chronic cholecystitis produces mural calcification. In these patients
f its association with gallbladder carcinoma [4]. However, this association appears to be weak. LEFT: Gallbladder carc
, replacing the gallbladder lumen. Multiple gallbladder stones (arrow) indicate the probable location of the filled lum
der (arrowhead), with local infiltration of the mass in the adjacent liver (arrow).

Gallbladder carcinoma:
Gallbladder carcinoma is the fifth most common malignancy of the gastrointestinal tract, and is found incidentally in
at a late stage of the disease, due to lack of early or specific symptoms. Gallbladder carcinoma has various imaging
infiltrating mass replacing the gallbladder, and it may also present as diffuse mural thickening. Associated findings s
ilatation, and liver or nodal metastases may help in differentiating a carcinoma from acute or xanthogranulomatous
may not be possible to differentiate a carcinoma from xanthogranulomatous cholecystitis. Adenomyomatosis in a 39
he characteristic 'comet-tail' reverberation artifact (arrow) due to small cholesterol crystals within Rokitansky-Aschof
Adenomyomatosis:
Adenomyomatosis of the gallbladder is characterized by epithelial proliferation, muscular hypertrophia and intramu
or diffusely involve of the gallbladder. It is a benign condition that requires no specific treatment, occurring as an inc
6]. The sonographic finding of cholesterol crystals, shown as 'comet-tail'
reverberation artifacts (Fig), within a thickened wall of the gallbladder strongly suggests this diagnosis. Air may produ
cholecystitis are usually ill in contrast to those with adenomyomatosis. MR imaging may be able to differentiate aden
schoff sinuses [7].
Secondary gallbladder involvement:
56-year-old man with liver cirrhosisLEFT: US depicts wall thickening (arrow), surrounded by ascites. Note the irregula
e wall of the gallbladder (arrow) appears nearly normal, because subserosal oedema can not be well differentiated f
Liver cirrhosis:
Systemic diseases such as hepatic dysfunction, heart failure, or renal failure may lead to diffuse gallbladder thickenin
ema of the gallbladder wall in these diverse conditions is uncertain, but it is likely due to elevated portal venous pres
ular osmotic pressure, or a combination of these factors. Hypoproteinemia has also been reported as a cause of ext
irrhosis, hepatitis and congestive right heart failure are relatively frequent causes.
The case on the left is a patient with liver cirrhosis. The secondary gallbladder wall thickening is presumably due to e
motic pressure. Drug-induced hepatitis with diffuse gallbladder wall thickening
Hepatitis:
On the left a 75-year-old man with drug-induced hepatitis. Longitudinal sonogram of a non-distended gallbladder sh
which may be confusing. Drug-induced hepatitis. In the same patient with the drug-induced hepatitis MR images wer
tion tests. On the far left Axial SPIR T2-weighted image (A) shows a small amount of ascites (arrowhead) which indica
extrinsic systemic cause. Next to it an oblique HASTE image for MR cholangiography that excludes choledocholithias
Diffuse gallbladder wall thickening in congestive right heart failure
Congestive right heart failure:
On the left a 74-year-old man with congestive right heart failure. Ultrasound depicts diffuse wall thickening of a ston
rrowheads) and inferior vena cava, as supporting evidence of right heart failure. Pancreatitis in a 56-year-old man Co
rrowheads), and thickening of the wall of the gallbladder (arrow) which is secondarily involved in the pancreatic infla
Pancreatitis:
Extracholecystic inflammation may secondarily involve the gallbladder causing wall thickening, due to direct spread
ogic reaction [8]. Theoretically, it may be caused by any inflammation that extends to the region of the gallbladder, b
creatitis (Figure), and pyelonephritis. Gallbladder wall thickening has also been reported in patients with infectious m
tic infections or secondary neoplastic infiltration [2].
Conclusion:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar
ion Myanmar with a small gift. Mosby, 1998:175-200
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Craniosynostosis:
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adiology of Alrijne Hospital in Leiderdorp, the Netherlands:
In this review we will discuss imaging in craniosynostosis.

Craniosynostosis refers to the premature closure of sutures of the skull and results in an abnormal head shape.
It is a rare disorder with a prevalence of around 1 in 1500.
Most cases occur already prenatally and will be diagnosed in the first few months of life.
It may also be diagnosed intrauterine, but antenatal imaging is beyond the scope of this article.
Introduction:

Normal skull:
In the first few years of life the brain grows fast and the skull grows along with it.
This requires open sutures for enchondral growth.
At 1 year of age around 65% of skull growth is accomplished, with the growth rate thereafter slowing down, and reac
esult of an intrinsic defect in the suture.
Craniosynostosis may be part of a syndrome and in those cases the craniosynostosis is often multi-sutural and there
Clinical evaluation:
In the past decades there has been an increase in the number of children seeking medical attention because of an a
ases are a positional plagiocephaly rather than a real craniosynostosis. This is often related to the advice of sleeping
trained clinician will often be able to recognize the typical presentation of a positional plagiocephaly and distinguish
d stenosis (see below).
The parents may then be reassured because the condition is self-limiting and with adequate advice usually reversibl
ly reference to a specialized center may be advisable before diagnostic imaging is started (figure).
Overview craniosynostoses:

Unisutural and Bicoronal:
In craniosynostosis the skull deformity is present from birth and will be progressive.
Timely diagnosis is important, as earlier treatment leads to a better outcome. In unisutural and bicoronal craniosync
nvolved suture.
This is depicted in the illustration. In multisutural involvement the changes are more complex and cannot easily be p
Plagiocephaly:
In plagiocephaly, also known as flat head syndrome, there is an asymmetrical flattening of one side of the skull.
A mild and widespread form of plagiocephaly is caused by remaining in a supine position for prolonged periods, as c
This is called deformational plagiocephaly. There is no synostosis and all the sutures are open. The synostotic form c
losure or on the posterior side due to closure of a lambdoid suture on one side.
Imaging:
When a craniosynostosis is suspected, the first line imaging will be ultrasound or x-rays, depending on local expertis
the preferred method.
In case of high clinical suspicion low dose 3D CT is preferred. The figure shows the US of a normal suture, an unilater
sagittal stenosis with ridge. Skull radiographs
demonstrating open sutures. Be
aware that radiographs have a limited value for assessment of the sagittal
suture and a partial closure of the sagittal suture may be overlooked.
3D CT:
The images show open
sutures in a child with a physiologically closed metopic suture (arrow). Images courtesy of Dr K.A. Eley and Dr C. Dels
MRI:
It is also possible to evaluate the sutures with
black bone MRI, but as MRI often requires anaesthesia this will mainly be done in
conjunction with an indication for evaluation of intracranial abnormalities and
complications. Images
Black bone MRI demonstrating
closed sagittal suture (top) and closed metopic suture (down) in two different
patients.
Positional plagiocephaly:
Positional or deformational plagiocephaly refers to the flattening of the head due to the baby's preferred position.
It is not a synostosis, but the most common form of temporary skull deformity. Typically, the entire side is pushed fo
tralateral side (arrow). This is in contradiction to a posterior plagiocephaly resulting from a unilateral lambdoid sutur
the mastoid and the ear are pulled down and drawn back. The drawing illustrates the differences. In positional
plagiocephaly the form of the head resembles a parallelogram. In unilateral
lambdoid stenosis the form of the head resembles a trapezium, because one side of the head is restricted in its grow
en deformational and lambdoid plagiocephaly. NOTE: unilateral coronal stenosis will also result in
the ear being positioned more forward – however, flattening will be
seen frontal (anterior plagiocephaly) instead of occipital and typically the

eye is drawn up on the affected side. Images Positional
plagiocephaly. The left ear is pushed forward.
Note: Adequate clinical
evaluation and/or ultrasound should have obviated the need for CT.
Monosutural craniosynostosis:

Scaphocephaly:
Scaphocephaly means 'boat shaped' skull and results
from a premature closure of the sagittal suture (arrow).
The skull is narrow and long. It is the most common monosutural craniosynostosis.
Sometimes it is called
dolichocephaly, as 'dolicho' means long. Images
Scaphocephaly: The head has a short laterolateral and a long anteroposterior diameter.
Trigonocephaly:
Trigonocephaly refers to the triangular head form resulting from premature
closure of the metopic suture (arrows). Physiological closure can already start as early
as three months of age, so premature closure typically presents early.
The
frontal head volume is small with a pointy forehead and hypotelorism. Only
pronounced cases require surgery and if there is clinically no indication for surgery, a CT is not needed. Images
Trigonocephaly: Pointy forehead and
hypotelorism. Seen from above the lateral orbital rim will be
visible.
Brachycephaly:
Brachycephaly results from the premature closure
of both coronal sutures.
The frontal skull base is small with
shallow eye sockets with the supraorbital rim drawn back and the head is shortened ('brachy') in the anteroposterior
Bilateral coronal synostosis with brachycephaly.
Synostotic Anterior plagiocephaly:
One of the coronal sutures has closed prematurely.
The
forehead is flattened on the affected side with the eye socket drawn up, also
called a harlequin's eye, and the nose may be deviated. Images
Left sided coronal synostosis. The left forehead is
drawn back with the eye socket lifted up.
Synostotic posterior plagiocephaly:
In this case the lambdoid suture has closed
prematurely.
It is the main differential diagnosis for positional plagiocephaly
(see above). There is a risk for Chiari 1 malformation and MRI of the brain and craniocervical junction
is advised. Images
Right sided lambdoid synostose.
Contralateral occipitoparietal bossing is evident.
Multisutural craniosynostosis:
Multisutural craniosynostosis are complex
deformations.
They are usually linked to syndromes and there are several
genetic defects identified. The best known
craniosynostoses syndromes are Pfeiffer/Crouzon, Apert, Saethre-Chotzen and
Muenke.
In the most severe cases all sutures will eventually close.
Such a
'pansynostosis' is a severe condition. Images
Saethre-Chotzen syndrome. At two months of age there is a bilateral coronal
synostosis with a severely deformed head shape. The fontanel is grossly
enlarged. Same patient as above. At three years
old there is microcephaly from a near pan-synostosis.
Note enlarged bilateral
parietal foramina. Three-month-old with Pfeiffer

syndrome. There is a bicoronal synostosis with enlarged anterior and mastoid fontanels.
Temporal bulging give rise to a trilobate appearance, also called 'clover leaf deformity'. Note the ventriculomegaly with periventricular edema.
Intracranial complications:
Raised intracranial pressure MRI has a main role in detecting associated intracranial malformations and complications from multisutural craniosynostosis. Images
Raised intracranial pressure.
LEFT: Impressions on a skull radiograph have a low sensitivity, especially in young children, but when seen, are highly suspicious for raised intracranial pressure.
RIGHT: Hydrocephalus with inverted diastolic flow indicating high intracranial pressure. Signs that may indicate raised intracranial pressure are listed in the table on the left. One of these findings is non-specific, but a combination of findings should raise suspicion.
Increased intracranial pressure may result in venous collaterals which may be important in preoperative planning.
Chiari malformation may result in spinal syrinx. The images are of a patient with increased intracranial pressure. The crowding at the craniocervical junction.
This has resulted in a syrinx over the entire length of the spinal cord.
Postoperative complications:
Surgery should be conducted timely in order to reach an optimal outcome. Timing is dependent on the deformity, but usually preferably under the age of 6 months. Post-operative complications include blood loss, infection, brain swelling and CSF leak. Images
Direct complications:
LEFT Large effusion/hematoma from migrating spring.
RIGHT subgaleal hematoma with severe blood loss. Image
Liquorroe due to CSF leak from a frontobasal herniation in the upper nasal passage after midface surgery in a patient with Apert syndrome.
Pitfalls:
Metopic ridge
Metopic ridge:
A metopic ridge alone is not equivalent to trigonocephaly.
Children present at a later age, the frontal skull has a normal volume and there is no hypotelorism. It is a common deformity that can be clinically diagnosed and does not need imaging.
As with mild trigonocephaly, there is no need for surgery. Images
Slight metopic ridge in a nine-month-old (arrow). Note that the scan was taken for a different purpose.
Metopic ridge can be clinically diagnosed and should not be imaged.
The anterior fontanelle has already closed but apart from the metopic suture, the other sutures are still open.
Absent anterior fontanelle:
An absent anterior fontanelle does not have to be a reason for concern.
As long as the skull has a normal shape and circumference, and the sutures are patent – it does not have any clinical implications. Image
Large wormian bone occupying the anterior fontanelle (bregmatic bone) in a six-month-old.
The skull has a normal shape

and the sutures are open. The metopic suture has fused physiologically.
Chest X-Ray - Basic Interpretation:
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Publicationdate 2013-02-18 [update 2022-04-04] The chest x-ray is the most frequently requested radiologic examina
ading. The interpretation of a chest film requires the understanding of basic principles. In this article we will focus or
est wall and abdomen. Normal and Variants
Normal and Variants:

PA view:
On the PA chest-film it is important to examine all the areas where the lung borders the diaphragm, the heart and ot
erfaces are seen resulting in a: These lines and silhouettes are useful localizers of disease, because they can be displ
called the silhouette sign, which we will discuss later. The paraspinal line may be displaced by a paravertebral absces
a neoplasm. Widening of the paratracheal line (> 2-3mm) may be due to lymphadenopathy, pleural thickening, hem
aortic line can be due to elongation of the aorta, aneurysm, dissection and rupture. The anterior and posterior juncti
osteriorly. These are usely not well seen and we will not discuss them. An important mediastinal-lung interface to loo
Azygo-esophageal recess:
The azygo-esophageal recess is the region inferior to the level of the azygos vein arch in which the right lung forms a
and vertebral column posteriorly. It is bordered on the left side by the esophagus. Deviation of the azygoesophageal
ine on the PA-film. It is caused by a hiatal hernia.
The arrow point to the barium contrast within the hiatal hernia.
Vena azygos lobe:
A common normal variant is the azygos lobe. The azygos lobe is created when a laterally displaced azygos vein make
is seen as a fine line that crosses the apex of the right lung. Here another patient with an azygos lobe. The azygos ve
some patients an extra joint is seen in the anterior part of the first rib at the point where the bone meets the calcifie
.
Pectus excavatum:
In patients with a pectus excavatum the right heart border can be ill-defined, but this is normal. It produces a silhoue
f the right middle lobe. The lateral view is helpful in such cases. Pectus excavatum is a congenital deformity of the rib
rior chest wall.
Lateral view:
On a normal lateral view the contours of the heart are visible and the IVC is seen entering the right atrium. The retro
he level where the right ventricle borders the sternum (small black arrow).
Any radiopacity in this upper retrosternal area is suspective of a process in the anterior mediastinum or upper lobes
ebral bodies they should get darker, because usually there will be less soft tissue and more radiolucent lung tissue (v
or pathology in the lower lobes. Diaphragm The contours of the left and right diaphragm should be visible. The right
ll (red arrow). Actually we see the interface between the air in the lungs and the soft tissue structures in the abdome
ders the heart (blue arrow). At that point the interface is lost, since the heart has the same density as the structures
ry artery (in purple) passes over the left main bronchus and is higher than the right pulmonary artery (in blue) which
the normal hilar structures look like on a lateral view, it is easier to detect abnormalities. In this case on the PA-view
whether this is due to dilated vessels or enlarged lymph nodes. On the lateral view there are round structures in are
we are dealing with enlarged lymph nodes. This patient has sarcoidosis. Notice also the widening of the paratrachea
eral view spondylosis may mimick a lung mass. Any density in the area of the vertebral bodies should lead you to the
right side (arrows). On the left side the formation of osteophytes is hampered by the pulsations of the aorta. On the
is helpful in this case because it demonstrates a density in the upper retrosternal space. Now the differential diagno
his was a Hodgkins lymphoma. A common incidental finding in adults is a Bochdalek hernia, which is due to a congen
nly contains retroperitoneal fat and is asymptomatic, but occasionally it may contain abdominal organs. Large hernia
ary hypoplasia. A hernia of Morgagni is also a congenital diaphragmatic hernia, but is less common. It is located ante
Systematic Approach:
Whenever you review a chest x-ray, always use a systematic approach. We use an inside-out approach from central t
stinum and hili. Subsequently the lungs, lungborders and finally the chest wall and abdomen are examined. You hav
by using the sihouette sign and mediastinal lines. Once you see an abnormality use a pattern approach to come up
Old films:
It is extremely important to always compare with old films, as we will demonstrate in this case. Actually someone sai
ives you so much information. For instance a lung mass, which hasn't changed in many years is not a lung cancer. Fi
Based on these films, you could make the diagnosis of congestive heart failure, but the findings are subtle. Continue
Disable Scroll Enable Scroll
Disable Scroll Scroll back and forth to the old film.
Once you compare the chest film to the old one, things become more obvious and you will be much more confident
n a consolidation located in the left lower lobe (blue arrow). 2. Silhouette sign in a consolidation in the lingula lobe (y

Silhouette sign:
The loss of the normal silhouette of a structure is called the silhouette sign.This is an important sign, because it enab
chest. Here an illustration to explain the silhouette sign: Silhouette sign (2) The PA-film shows a silhouette sign of the
m, we know, that the pathology must be located anteriorly in the left lung. This was a consolidation due to a pneumo
a consolidation which is located in the left lower lobe (yellow arrow).
Notice that there is a normal silhouette of the left heart border (blue arrow). The absence of a silhouette sign tells us
t in the lingula. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Silhouette sign (4) On this lateral film there is too much density over the lower part of the spine.
First study the lateral film and decide on which side the pathology is located. Then click on the image to enlarge and
f the left and right diaphragm on the lateral film, it is possible to tell on which side the pathology is located. In this ca
ll the way to posterior, which indicates that there is something of water-density in the right lower lobe. Continue with
normal silhouette of the right heart border, so the pathology is not in the anterior part of the chest, which we alread
Why do we still see the silhouette of the right diaphragm on the PA-film? Answer:
What we see is actually the highest point of the right diaphragm, which is anterior to the pneumonia in the right lowe
right diaphragm and there will be no silhouette sign.
Hidden areas:
There are some areas that need special attention, because pathology in these areas can easily be overlooked. These
Disable Scroll Enable Scroll
Disable Scroll Notice that there is quite some lung volume below the dome of the diaphragm, which will need your a
esion in the right lower lobe, which is difficult to detect on the PA-film, unless when you give special attention to the
en areas (3) Here a pneumonia which was hidden in the right lower lobe mainly below the level of the dome of the d
ral film in the lower vertebral region. You may have to enlarge the image to get a better view. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Hidden areas (4) First study the CXR.
Then scroll through the images. Notice the subtle increased density in the area behind the heart that needs special a
t study the CXR. We know that in some cases there is an extra joint in the anterior part of the first rib which may simu
be difficult to detect a mass. In this case a small lung cancer is seen behind the left first rib. Notice that is is also seen
with the PET-CT. The PET-CT demonstrates the tumor (arrow) which has already spread to the bone and liver. The di
iac bone. First study the CXRs. There is a subtle consolidation in the left lower lobe in the hidden area behind the hea
l region.
Heart and Pericardium:
On a chest film only the outer contours of the heart are seen. In many cases we can only tell whether the heart figur
about the different heart compartments. However it can be helpful to know where the different compartments are s
t Atrium Left Ventricle Right Ventricle Left Atrium enlargementThis is a patient with longstanding mitral valve disease
atrium has resulted in bulging of the contours (blue and black arrows). Right ventricle enlargementFirst study the PA
t films the heart is extremely dilated. Notice that it is especially the right ventricle that is dilated. This is well seen on
ic knob (blue arrow), while the pulmonary trunk and the right lower pulmonary artery are dilated. All these findings a
development of pulmonary hypertension. The location of the cardiac valves is best determined on the lateral radiog
the cardiac apex. The pulmonic and aortic valves generally sit above this line and the tricuspid and mitral valves sit b
impression of the enlargement of the left atrium.
Cardiac incisura:
Click image to enlarge. On the right side of the chest the lung will lie against the anterior chest wall. On the left howe
r chest wall, since the heart or pericardial fat or effusion is situated there. This causes a density on the anteroinferior
a normal finding, which can be seen on many chest x-rays and should not be mistaken for pathology in the lingula o
this CT-image. At the level of the inferior part of the heart we can appreciate that the lower lobe of the right lung is s
aker There are different types of cardiac pacemakers. Here we see a pacemaker with one lead in the right atrium and
ided through the coronary sinus towards the left ventricle. This is done in patients with asynchrone ventricular contr
ynchrone contractions and a better cardiac output. More on cardiac pacemakers...
Pericardial effusion:
Whenever we encounter a large heart figure, we should always be aware of the possibility of pericardial effusion sim
ient has a dilated heart while on the CT it is clear, that it is the pericardial effusion that is responsible for the enlarged
rdiac surgery an enlargement of the heart figure can indicate pericardial bleeding. This patient had a change in the h
asound demonstrated only a minimal pericardial effusion. Continue with the CT. There is a large pericardial effusion
. The left ventricle id filled with contrast and is compressed (red arrow). At surgery a large hematoma in the posterio
or side there is only a minimal collection of pericardial fluid, which explains why the ultrasound examination underes
ho had valve-replacement. Notice the large heart size. There is redistribution of the pulmonary vessels which indicat
ge pericardial effusion. Always compare these post-operative chest films with the pre-operative ones.
Calcifications:
Detection of calcifications within the heart is quite common. The most common are coronary artery calcifications and

ch can be associated with constrictive pericarditis. In this case there are calcifications that look like pericardial calcifi
nfarcted area of the left ventricle. Notice that they follow the contour of the left ventricle.
Pericardial fatpad:
Pericardial fat depositions are common. Sometimes a large fat pad can be seen (figure). Necrosis of the fat pad has p
tis. It is an uncommon benign condition, that manifests as acute pleuritic chest pain in previously healthy persons (1
Pericardial cyst:
Pericardial cysts are connected to the pericardium and usually contain clear fluid. The majority of pericardial cysts ar
he rightside, but they can be seen as high as the pericardial recesses at the level of the proximal aorta and pulmonar
-ray it seems as if there is a elevated left hemidiaphragm. On CT however there is a cyst connected to the pericardiu
Hili:
The normal hilar shadow is for 99% composed of vessels - pulmonary arteries and to a lesser extent veins (1). The ve
ilum should never be lower than the right hilum. The left pulmonary artery runs over the left main bronchus, while th
s, which is usually lower in position than the left main bronchus. Hence the left hilum is higher than the right. Only in
the left, but never higher. In this illustration the lower lobe arteries are coloured blue because they contain oxygen-p
pulmonary veins run more horizontally towards the left atrium, which is located below the level of the main pulmona
n a lateral view and should not be mistaken for lymphadenopathy. Sometimes the pulmonary veins can be very pron
us and is higher than the right pulmonary artery which passes in front of the right main bronchus. These images are
view of the hilar structures. The lower lobe pulmonary arteries extend inferiorly from the hilum. They are described
(1). On the right side the little finger will be visible in 94% of normal CXRs and on the left side in 62% of normals (1). S
irs and has severe pain on the right flank.. Notice on the PA-film the absence of the little finger on the right and on th
al column. What is your diagnosis? There is a right lower lobe atelectasis. Notice the abnormal right border of the he
not surrounded by aerated lung but by the collapsed lower lobe, which is adjacent to the right atrium. On a follow-up
lectasis was a result of post-traumatic poor ventilation with mucus plugging. Notice the reappearance of the right litt
arrow).
Hilar enlargement:
The table summarizes the causes of hilar enlargement. Normal hili are: Enlargement of the hili is usually due to lymp
ed hilar shadow on both sides. This could be the result of enlarged vessels or enlarged lymph nodes. A very helpful f
s is known as the 1-2-3 sign in sarcoidosis, i.e. enlargement of left hilum, right hilum and paratracheal. Here some m
Mediastinum:
Mediastinal masses are discussed in more detail in Mediastinal masses. Here is just a brief overview. The mediastinu
nt, each with it's own pathology.
Mediastinal lines:
Mediastinal lines or stripes are interfaces between the soft tissue of mediastinal structures and the lung. Displaceme
as we have discussed above.
Azygoesophageal recess:
The most important mediastinal line to look for is the azygoesophageal line, which borders the azygoesophageal rec
acement of this line are summarized in the table. A hiatal hernia is the most common cause of displacement of the a
al view. Another common cause of displacement of the azygoesophageal line is subcarinal lymphadenopathy. Notice
chest x-ray in the area below the carina. This is the result of massive lymphadenopathy in the subcarinal region (stat
acing the right paratracheal line. On the PET we can appreciate the massive lymphadenopathy far better than on the
nding, since these nodes are accessible for biopsy. Continue with images of CT and ultrasound. Here we see a CT-ima
mpress the left atrium. The final diagnosis of small cel lungcancer was made through a biopsy of a lymphnode in the
the following: Combined with the above this must be a dilated esophagus with residual fluid. The final diagnosis was
3. The density on the left in the region of the lingula is the result from prior aspiration pneumonia. Here we have a p
al mass. The azygoesophageal recess is not identified, because it is displaced and parallels the border of the right atr
f aspiration. Notice the massive dilatation of the esophagus on the CT.
Aortopulmonary window:
The aortopulmonary window is the interface below the aorta and above the pulmonary trunk and is concave or strai
hat fills the retrosternal space on the lateral view. On the CT-images a mass in the anterior mediastinum is seen. Fina
ilm a mass is seen that fills the aortopulmonary window. The PET better demonstrates the extent of the lymphnode
a.
Lungs:
Lung abnormalities mostly present as areas of increased density, which can be divided into the following patterns: L
a or lungcysts. These lungpatterns will discussed in more detail in an article that will be published soon: Chest X-Ray
asis
Nodule - Masses:
Tap on image to enlarge. Solitary pulmonary node - SPN is discussed here.
Interstitial pattern:
Tap on image to enlarge. Interstitial lung diseases are discussed here.
Pleura:

Pleural fluid:
It takes about 200-300 ml of fluid before it comes visible on an CXR (figure). About 5 liters of pleural fluid are present
opacification of the right hemithorax in a patient with pleuritis carcinomatosa on both sides. On the right there is or
chogram within the compressed lung. Pleural fluid may become encysted. Here we see fluid entrapped within the fis
'vanishing tumor'.
Pneumothorax:
The table lists the most common causes of a pneumothorax. The other cystic lungdisease which causes pneumothor
dy the CXR. There are two important findings. The retracted visceral pleura is seen (blue arrow) which indicates that
llow arrow). Normally there are no straight lines in the human body unless when there is an air-fluid level. This mean
all, this air-fluid level can be the only key to the diagnosis of a pneumothorax. Study the CXR. There are 3 important f
the left. Does this mean that there is a tension pneumothorax? Do you have an idea about the cause of the pneumo
ue arrow). The upper lobe is still attached to the chest wall by adhesions. Maybe this patient was treated for a prior p
w). So we can assume that the pneumothorax has something to do with a cystic lung disease. Since this patient is a v
is a rare lung disease that results in a proliferation of smooth muscle throughout the lungs resulting in the obstructi
neumothorax. LAM also occurs in patients who have tuberous sclerosis. Study the CXR. What is your diagnosis? This
d supine with a CR cassette inserted underneath the patient, which resulted in a skinfold. Notice that there are lung
ther patient with obvious skinfolds. Recognition of a pneumothorax depends on the volume of air in the pleural spac
rax can be subtle and approximately 30% of pneumothoraces are undetected. A sign to look for is the 'deep sulcus s
ding toward the hypochondrium (Figure). The image is of a patient in the ICU who is on mechanical ventilation. There
sign on the left. Notice that the left hemidiaphragm is depressed. This is an important finding since it indicates a ten
of an intercostal drain. Notice that the diaphragm has regained its normal appearance.
Pleural opacities:
The table lists the most common causes of pleural opacities. Pleural plaquesThe CXR shows multiple opacities. They
idations. Some of these opacities are clearly bordering the chest wall (red arrows). All these findings indicate that we
ed pleural plaques are usually: Unilateral pleural calcifications are usually due to: Pleural hematoma These images a
It was believed to be a hematoma and resolved spontaneously.
Chest wall:
RibfracturesThe most common identified chest wall abnormalities are old ribfractures. The CXR shows many rib defo
formation may create a mass-like appearance (blue arrow). Sometimes a CT is necessary to differentiate a healing fr
arged pulmonary vessels. Probably we are dealing with pulmonary arterial hypertension in a patient with COPD. The
e metastases in vertebral bodies and ribs. Notice the expansile mass in the posterior rib on the right.
Abdomen:
The most obvious finding on this CXR is free air under the diaphragm. This finding indicates a bowel perforation, unl
till some air left in the abdomen, which can stay there for several days. There is another subtle finding in the left upp
dden area - proved to be a lungcarcinoma. Here another patient with free abdominal air. Notice the very thin regular
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Horner syndrome:
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[1]University Medical Center Groningen and [2]Radboud University Medical Center:
Publicationdate 2023-12-20 Horner
syndrome is a rare clinical condition presenting with partial ptosis,
miosis and facial anhidrosis described in 1869 by Johann Friedrich Horner. The
clinical symptoms allow the anatomic location of the underlying pathology
somewhere in the oculosympathetic pathway.
Imaging plays an important role
in the final diagnosis.
Anatomy:
Horner syndrome is the result of an
interruption of the oculosympathetic nerve system which starts in the

posterolateral part of the hypothalamus and goes all the way through the brainstem and the spinal cord (level C8-Th
sympathetic ganglia and along the internal carotid artery (and some
fibers along the external carotid artery, maxillary artery) and cavernous sinus
to the eye. Horner
syndrome can be anatomically classified into three types depending on where the
oculosympathetic pathway is interrupted: Clinically it can be difficult to
differentiate a central Horner from a pre- or postganglionic Horner.
Pharmacological testing of the eyes
with Apraclonidine or Cocaine can help make the diagnosis.
This means that in patients with a
unilateral Horner all these levels need to be examined unless other symptoms
point to a specific anatomical area.
Only in patients with a bilateral
Horner we can assume, that the pathology is located in the central neuron. Horner syndrome classically presents wit
of the superior tarsal muscle resulting in ptosis and inactivation of the dilator muscle producing a miosis.
The ptosis of Horner syndrome may be subtle, often 2 mm or less and has to be distinguished from the severe ptosi
superior and is accompanied by a dilated pupil due to a loss of innervation to the sphincter pupillae. Pre- and postga
Central Horner syndrome is uncommon.
Clinically frequently the central Horner syndrome goes unnoticed, because the other symptoms of brain pathology c
Central - 1st order neuron:
The most common cause of a central Horner is infarction of the posterior-inferior cerebellar artery or
of the distal vertebral artery territory and is part of the
lateral medullary syndrome. Other causes of a central Horner are demyelination, infection or inflammation (rhombe
signs suggest a brainstem
localization and indicates MRI of the brain.
Myelopathic features suggests
involvement of the cervicothoracic cord and indicates MRI of the cervical spine
and/or brachial plexus.
Hypothalamus:
These images are of a 78-year old man
who is known to have a squamous cell carcinoma of the floor of the mouth and complains of double vision.
At physical examination he is desorientated and has
dysarthria and a Horner.
Based on these findings we assume that the Horner is
caused by a central problem. Images
3D-T1 MPRAGE shows a large ring enhancing lesion at the level
of the hypothalamus on the right and a second lesion in the right
hemisphere. Conclusion
Metastases of a squamous cell carcinoma.
Usually these carcinomas do not metastasize that easily. Continue with the next images... At other levels there were
The illustration shows the level of the pathology.
Brainstem:
These images are of a 58 year-old women with vague
neurological complains for years for which she was treated by a rehabilitation phycisian. ImagesAxial 3D-FLAIR with f
multiple T2 hyperintens lesions infratentorial in the medulla oblongata on the left and
bilateral cerebellar hemisphere).
Coronal 3D-FLAIR with fat suppression shows confluent white matter lesions periventricular and infratentorial. Conti
c spine show multiple intramedullary
lesions.
Sagittal 3D-FLAIR shows multiple confluent Dawsons fingers and the axial 3D-FLAIR shows multiple T2 lesions in de b
Radiological consistent with Multiple Sclerosis.
Spinal cord:
These images are of a 45-year old man who had a traumatic cord injury at the level of T4-5 some years ago.
He now presents with progressive pain in the legs with decreased reflexes in both arms and legs and a bilateral Horn
horacic spine show loss of height of verterbra T4 with cord dissection and a cystic myelomalacia at this level and surr
In 2022 sagittal T2W images
of the cervicothoracal spine show progressive syringohydromyelia. Continue with the next images... The Horner syn
by the progressive syringohydomyelia at the cervical level with disruption of
the first order neurons of the oculosympathetic pathway. Case45 year-old man with sudden onset
Horner syndrome, dysphagia, ipsilateral ataxia, nystagmus and sensory

impairment ipsilateral face and contralateral body. ImagesDiffusion weighted images
DWI (B1000) and ADC images show restricted diffusion in the medulla oblongata on right side due to a lateral medul
Contrast enhanced MRA of the neck (on the right) shows narrowing of the right vertebral artery .
The T1WFS-image of the neck shows a hyperintense crescent signal intensity in the wall of the right vertebral artery
Dissection of the right vertebral artery resulting in a medullary infarction. CaseThese images are of a patient who wa
or three weeks.
She now presented at the ER with a sudden nausea, vomiting, vertigo and diplopia (double vision).
At examination she had a bilateral Horner. Images
This was a limited scan protocol (T2W and DWI) only to find out if there was any sign of ischemia.
There was no diffusion restriction (not shown) and acute ischemia was ruled out.
There is a large lesion with only limited mass-effect in the left cerebellar peduncle and there are bilateral air-fluid lev
scan two days later... First look at the four images.
What are the findings and what is your differential diagnosis?
You can click on the images for an enlarged view. Images DiscussionWith this kind of fast progression of the disease
The differential focussed on demyelinization and rhombencephalitis.
Rhombencephalitis is an inflammatory disease affecting the brainstem and cerebellum with a wide variety of etiolog
ndromes. Continue... Conclusion
Finally the most likely diagnosis was an inflammatory rhombencephalitis.
there was a slow recovery.
Preganglionic- 2nd order neuron:
Preganglionic or second order neuron is
located in the intermediolateral gray substance of the spinal cord (ciliospinal center of Budge-Waller) between
C8 and T2.
Postganglionic fibers exit in the ventral spinal roots C8,
T1, and T2 and pass through the inferior cervical (or stellate ganglion, fusion with
the first thoracic ganglion to form the cervicothoracic ganglion), middle
cervical ganglion thereafter synapse in superior cervical ganglion. The inferior cervical ganglion (ICG) is
located posterior to the vertebral artery between the transverse process of the C7
vertebra and the first rib.
The middle cervical ganglion (MCG) is
at the level of the cricoid cartilage C6, medial of the carotid tubercle and anterior
- superior to the inferior thyroid artery.
The superior cervical ganglion (SCG)
is located at the level of C2-C3 posterior to the carotid sheath and anterior
to the longus capitis muscle. Arm pain or hand weakness are typical
of brachial plexus lesions and indicates CT of the chest or a dedicated MR
study of the brachial plexus. Preganglionic Horner syndrome is a
common cause of Horner syndrome and most often caused by tumor or trauma.
Patients with preganglionic Horner's syndrome
often present with the classic triad: ptosis, miosis, anhidrosis and sometimes
in combination with brachial plexopathy. The most common abnormalities that
cause preganglionic Horner's syndrome are listed in the table.
Cervical ganglia:
Case
These images are of a patient with a metastatic prostate cancer, who now presents with a paralysis of the hypogloss
Where is the pathology.
Then continue reading. Images
The left hypoglossus canal is normal.
On the right there is an enhancing mass. Continue... The image on the right illustrates the enhancing mass within the
 occipital condyle and jugular tubercle and runs obliquely forwards from posteromedial to anterolateral allowing the
atient with metastatic prostate cancer we assume that it is a metastasis.
This finding however does not explain the Horner on the left. Continue... Subsequently a CT of the neck and chest wa
Th1.
This is the exact location of the inferior cervical ganglion. A mass in this location explains the Horner on the left. Case
This young man was involved in a motocross accident.
He was admitted to the ICU with multiple injuries.
After three days he regained consciousness and a paresis of his right side was noted, which could not be explained b
He also had a Horner on the right side. Images
The CT at admission showed fractures of the transverse process of C7 and of the first rib (arrowheads).
On the CECT there was contrast extravasation indicating active bleeding (circle). Continue with the MRI... First an ultr

but this examination was limited by traumatic changes in this area.
Subsequently an MRI was performed. ImagesThe
axial image shows enhancement of nerve roots indicative of a brachial plexus
injury.
Also note the injury to the right paravertebral soft tissues. Continue.... Image
In addition the T2W-image shows some subtle high signal in the myelum on the right (arrow).
This was regarded as post traumatic myelopathy and could also be an explanation for the right-sided Horner. CaseIn
s of swallowing problems and hoarseness.
The physical examination also detected a partial Horner with ptosis and miosis. Images
CT of the head and neck shows an
invasive thyroid mass with paralaryngeal and prevertebral extension and involvement
of thyroid cartilage (yellow arrowhead).
There is a tumor thrombus in the jugular vein (black arrow). Continue with the next images... Images
Notice the invasion of the thyroid cartilage (yellow arrowhead).
On the edge of the scan there was a brain metastasis. DiscussonThe Horner is caused by influencing the preganglion
There are numerous fibers connecting the middle cervical ganglion (MCG) and inferior cervical ganglion (ICG), which
diagnosis
Anaplastic thyroid carcinoma.
This cancer is one of the most aggressive tumors and has a bad prognosis. Caseimages of a 55 year old women wom
The X-ray of the cervical
and thoracic spine shows a mass projecting apically
about the right lung.
Given the cervicothoracic sign most likely originating
from the posterior mediastinum. Differential diagnosis
The most likely diagnosis of a mass in the posterior mediastinum is: Click here for more information on mediastinal
Continue with the next images... At neurologic examination a Horner syndrome on the rigth side was detected.
First a CT was performed because a possible malignancy was suspected. Images
The CT shows an encapsulated lesion in the posterior mediastium.
There is no lymphadenopathy.
The MRI shows a well-defined lesion with T2 hyperintense signal indicating cyst or necrosis. Continue... Images
The sagittal T1W image shows rim enhancement. Conclusion
The lesion has a mass effect on the inferior cervical ganglion on the right side and that is the cause of the Horner sy
The most likely diagnosis is an old schwannoma.
Postganglionic - 3rd order neuron:
The postganglionic neuron starts after the synapse of the superior
cervical ganglion at the level C2-3 where the sympathetic plexus passes posterior to the
carotid space and anterior to the longus
colli muscle.
The neuron travels along the internal carotid artery and the cavernous sinus
along the n VI and n V via the superior orbital fissure to the superior
tarsalis muscle, also called Muller's muscle. Sympathetic fibers traveling with the
external carotid artery follow the internal maxillary artery to the face and innervate the
sweat glands.
Postganglionic causes of Horner are as common compared as preganglionic. For pathology causing
postganglionic Horner syndrome we have to study the internal and
external carotid artery, skullbase , cavernous sinus, orbital apex and the eye. Enable Scroll
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Carotid artery:
CaseThese
images are of a patient who had a swelling in the neck for a couple of years.
Extensive imaging studies followed, but all studies were negative.
She
now presented with and a Horner on the right. Study the images.
What are the findings? Images Images
Seven months later the tumor surrounding the ICA and ECA has enlarged. Conclusion
This turned out to be an adenoid cystic carcinoma with
perineural tumorspread. CaseThese images are of a 73-year old man who presented with a mass in the neck. Exami
What are the findings and most likely diagnosis? ImagesThere is a lesion in the carotid space at the bifurcation splay
On T2W the lesion is hyperintens and on T1W isointens with peper and salt appearance.

There was enhancement after contrast (image not shown). Continue with the Twist-MRA images... Examine the imag
What are the findings and most likely diagnosis? ImagesOn the TWIST MRA there is early artery enhancement in the
Notice that on the left side there is also a early arterial enhancing lesion on the carotid bifurcation. Conclusion
Bilateral paraganglioma.
Bilateral lesions are common in inherited syndromes like SDH gene mutations. Here a companion case with a paraga
3D-TWIST MRA shows intense early arterial enhancement The illustration shows the level of obstruction of the postg
tic neck mass and a Horner
syndrome at physical examination. Images Conclusion
This was a schwannoma.
A paraganglioma would have shown early enhancement on the CT image. CaseThese images are of a patient who pr
The physiacal examination revealed an unequal size of the eyes' pupils and the impression of a hemianopsia on the
The patient was presented to the stroke unit.
The non-enhanced CT was normal, which excluded a hemorrhage. Images
The perfusion images show a slightly decreased cerebral blood volume (CBV) and flow (CBF) in the territory of the mi
ransit time (MTT). This patient had a M3-occlusion, which was visible when we did scroll through the images (not sho
However a M3-occlusion can only explain a small part of the findings on the perfusion images. In those cases you alw
The image on the right shows the typical CTA-appearance of a carotid dissection with the flame shape a couple of ce
MRI was performed. Images
An intramural hematoma of the dissection is nicely shown (arrow). At that time a Horner on the left was also noted a
ma of the ICA on the post-ganglionic system (third order neuron) travelling in the adventitia of the internal and exte
s the Horner can resolve when the hematoma minimizes, as was the case in this patient after treatment with antipla
is a similar case. Images
Notice
on the non enhanced CT on the left that the internal carotid is larger in
diameter as a result of the hematoma. On
the enhanced CT on the right the narrowed true lumen is demonstrated
(arrowhead).
Cavernous sinus:
The list of cavernous sinus pathology is extremely long and contains neoplastic, inflammatory and vascular lesions (t
These images are of a 79-year-old woman who could not be examined properly because she was in fetal position an
She also had a Horner syndrome on the right, but this was diagnosed later, which is not uncommon as we mentione
Because of her clinical condition a CT-scan was preferred over a MRI. First study the CT.
What are the findings and what is your differential diagnosis? Images
Mass lesion on the right at the level of the cavernous sinus.
The lesion contains fat Discussion
Based on the presence of fat within the lesion the differential diagnosis was dermoid cyst and hemangioma. Continu
The MR-images show fat located within the tumor and this is not the normal fat that we sometimes see surrounding
is was a hemangioma.
Imaging protocol:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
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None:

Roadmap to evaluate ovarian cysts:
Wouter Veldhuis, Robin Smithuis, Oguz Akin and Hedvig Hricak
Department of Radiology of the University Medical Center of Utrecht, of the Rijnland hospital in Leiderdorp, the Neth
g Cancer Center, New York, USA:
Publicationdate 2011-05-15 Ovarian cancer is the second most common of all gynecologic malignancies. It is the lead
ting as a complex cystic mass. The finding of an adnexal cyst causes considerable anxiety in women due to the fear o
in postmenopausal women - are benign. In this article we will focus on specific features of ovarian cysts that are help
map for the diagnostic work-up and management of ovarian cystic masses, based on ultrasound and MRI findings. In
the most common ovarian cystic masses will be presented, as well as several less common cystic lesions.
Diagnostic work-up:
If a cystic pelvic mass is present, the first step is to find out if it is ovarian or non-ovarian in origin.
* Step 2 The next step is to determine if the lesion can be categorized as one of the common, benign ovarian masses

atoma), or is indeterminate.
* Step 3 To aid in selecting the proper work-up, the final step is to determine whether a patient falls into a low-risk ca
ctors) or a high-risk category (i.e. post-menopausal or premenopausal with additional risk factors). Based on these st
US, further evaluation with MRI or excision.
Role of imaging:
Role of Ultrasound For characterization of ovarian masses, ultrasound is often the first-line method of choice, especi
lid lesions. Role of CT CT is useful for the N- and M-staging of proven malignant lesions. Role of MRI For complex lesi
urther evaluation with MRI. Even with MRI it is often not possible to make an accurate diagnosis of neoplastic subtyp
ment of potentially malignant ovarian lesions is prevented. This is not only beneficial to the small number of women
roach to the management of sonographically indeterminate adnexal lesions.
Ovarian or non-ovarian:
If a cystic adnexal mass is present and you suspect an ovarian origin, the first thing to do is try to identify the ovaries
tely identifiable normal ovaries, then most likely you are dealing with an ovarian lesion. If both ovaries are separately
arian cystic lesion, or a lesion that mimics a cystic mass. The next step would be to check if there is uni- or bilateral d
ate malignancy. Also look for secondary findings like ascites, enlarged lymph nodes and peritoneal deposits. The tab
ses. Enable Scroll
Disable Scroll Scroll through the images Enable Scroll
Disable Scroll Scroll through the images A helpful tool to identify the ovaries is to follow the ovarian veins caudally. S
in from where it joins the inferior vena cava, and the left ovarian vein where it joins the left renal vein, until you ident
Ultrasound pattern recognition:
Pattern recognition on ultrasound often allows a fairly confident diagnosis of common cystic ovarian masses. This m
ning the probability that we are dealing with a lesion which falls into the category of a simple cyst, hemorrhagic cyst,
to as a dermoid cyst). Most other cystic lesions are indeterminate and therefore possibly malignant. These therefore
.
Simple cyst:
US findings that allow a confident diagnosis of a simple ovarian cyst are: The US-image shows two simple cysts in the
sels are normal and there are no vascularized septations. These were simple follicular cysts in a premenopausal wor
usually follicular cysts.
They are commonly seen in premenopausal women, but functional cysts also still do occur in postmenopausal wom
A hydrosalpinx may also mimic an ovarian cyst. Cystadenomas can also present as simple cysts, but they usually pre
screening study from 1987 to 2002 including 15,106 women of 50 years or older, 2763 women (18%) were diagnosed
s turned out to be ovarian cancer (4). In women of reproductive age, cysts up to 3 cm are a normal physiologic findin
These simple physiologic cysts do not need to be described in the imaging report and do not require follow-up (1). Cy
certainly benign. Cysts larger than 7 cm may be difficult to assess completely with US and therefore further imaging
ies Functional cysts Hemorrhagic cyst
Hemorrhagic ovarian cyst - HOC:
When a Graafian follicle or follicular cyst bleeds, a complex hemorrhagic ovarian cyst (HOC) is formed. US findings th
e: In premenopausal women short term follow-up is recommended in hemorrhagic cysts > 5 cm. The same follow-up
he characteristics of a HOC
Larger hemorrhagic cysts in the early menopause and any hemorrhagic cyst in the late menopause should be consid
idered. Hemorrhagic cyst with a clot mimicking a neoplasm. Notice absence of flow and good through-transmission (
ffuse low-level echoes, their appearance can be similar to that of endometriomas. In the acute phase a hemorrhagic
solid mass (5). Clot in a hemorrhagic cyst may occasionally mimic a solid nodule in a neoplasm. Clot, however, often
has outwardly convex borders. In both cases there will be no internal flow at Doppler US and there will be good thro
eeks. The ultrasound image shows multiple simple and one complex right ovarian cyst, with diffuse low-level echos a
transmission, also through the complex cyst (blue arrow). On the T1 with fatsat the lesion remains bright, ruling out
, confirming that this is a cystic hemorrhagic lesion, most likely a hemorrhagic ovarian cyst, although your differentia
Endometrioma:
US findings that allow a confident diagnosis of an endometrioma are: In women of any age, probable endometrioma
Until surgically removed, endometriomas require follow-up with ultrasound, for example on a yearly basis. This imag
n with diffuse low-level echoes and two small echogenic foci. These have been postulated to be cholesterol deposits,
tant to differentiate these echogenic foci from true wall nodules. Finding these echogenic foci makes the diagnosis o
Mature cystic teratoma:
US findings that are characteristic of a mature cystic teratoma are: Shown are transvaginal ultrasound images of two
c shadowing from the hyperechoic part of the dermoid cyst (arrow). When misinterpreted as bowel gas, the lesion m
Any other cyst - possible neoplasm:
All other cystic lesions are regarded as possibly neoplastic and therefore possibly malignant. Surgical resection is ne
ing-based staging. Findings indicating possible neoplasm: While benign lesions can be very large, the likelihood that
that a neoplastic lesion is malignant, increases with the size of the lesion.
* Vascularized septations The presence of septations indicates a possible neoplasm. When septations have a thickne

- both increase the likelihood that a neoplasm is malignant.
* Vascularized solid components Vascularized nodularities, papillary projections, or frank solid masses all increase th
* Vascularized thick, irregular wall Lesions with thin walls are more often benign and lesions with thick, irregular wall
making wall thickness a less useful criterion. For example a corpus luteum cyst may also have a thickened, vascularize
* Secondary findings associated with malignant lesions: Large quantities of ascites, lymphadenopathy and peritonea
malignancy. Benign cystic ovarian neoplasms Malignant cystic ovarian neoplasms
Low-risk or High-risk:
Once we have determined a cystic ovarian lesion is either a probable simple cyst, hemorrhagic cyst, endometrioma o
place the patient in a low-risk or high-risk group (table). The final decision to ignore, follow or excise a cystic ovarian
ic ovarian lesions is benign. While the risk of malignancy does increase with age, even in post-menopausal women th
Although complex ovarian cysts in post-menopausal women are also most often benign, they do require further wor
'the Roadmap':
The natural history of incidentally detected pelvic masses with benign US morpgology is not known and therefore th
010 Consensus Guidelines published in (1) and (2) and on the findings in (3) and (4). The mentioned size cut-offs and
ules. Local guidelines may differ based on the clinical scenario and institutional practice preferences. Many of the im
asound, CT and MRI, although of course not every feature is equally detectable on all modalities. Risk factors Age is t
nopausal and post-menopausal women are managed differently. Several other factors (see table) may place a woma
ys, one for lower-risk and one for higher-risk patients.
MRI protocol - which sequences, and why:
MRI protocol There are many possible 'Pelvic/Ovarian mass' protocols. The basic building blocks are simple and are t
nly 1, 2 and 3 (e.g., when the request is to 'rule out an ovarian mass'). Many radiologists prefer a slightly more compr
setting is characterization or staging of a known ovarian lesion, 4 (or CT) and 5 should always be included. The role o
a useful aid in the detection of lymph nodes, tumors and peritoneal deposits.
For the purpose of detection, the DW images are sometimes fused with (superimposed on) anatomical T2W images.
DWI cannot discriminate benign from metastatic lymph nodes. Further differences in protocols all arise as variations
* T2W images in more than 2 planes, or obliquely angled orthogonal to the anatomic structure of interest, are often
MR imaging is a valuable adjunct to US, as it allows identification of blood products within hemorrhagic masses that
s may reveal small amounts of fat, which allows the diagnosis of a mature teratoma ('dermoid'). Contrast-enhanced
cing mural nodules and/or enhancing solid areas with or without necrosis (3). These MR images show a lesion with h
ontent or fat. On the image with fat-saturation there is suppression of the signal. This means that we are dealing wit
image shows an echogenic lesion. The corresponding lesion has a high signal on the T1-weighted MR image.
This indicates either blood, high protein or fat. On the image with fat-saturation there is no suppression of the signal
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None:

Ankle Fracture Mechanism and Radiography:
Robin Smithuis
Radiology Department of the Rijnland Hospital, Leiderdorp, the Netherlands:
Publicationdate 2010-12-15 The ankle is the most frequently injured joint. Management decisions are based on the i
focus on: Proper positioning of the ankle for radiography Trauma mechanism in ankle injuries
Trauma mechanism in ankle injuries:

Normal flexibility of the ankle:
The ankle joint has to be flexible in order to deal with the enormous forces applied exerted on the talus within the an
e the medial malleolus - unlike the lateral malleolus - is attached to the tibia and the medial collateral ligaments are v
by the fibula, syndesmosis and lateral collateral ligaments. This lateral complex allows the talus to move laterally an
tly pushes it back into its normal position. The fibula has no weight-bearing function, but merely serves as a flexible

tween the fibula and tibia formed by the anterior and posterior tibiofibular ligaments - located at the level of the tibi
nt, which is the thickened lower portion of the interosseus membrane. The anterior and posterior tibiofibular ligame
Vulnerable positions of the foot:
There are two positions of the foot in which the flexible ankle joint becomes a rigid and vulnerable system: extreme
he talus within the ankle mortise can result in fractures of the malleoli and rupture of the ligaments. In 80% of ankle
lateral side, since that is where the maximum tension is. In 20% of fractures the foot is in pronation with maximum
with either a rupture of the medial collateral ligaments or an avulsion of the medial malleolus.
Pull-off or Push-off fractures:
The shape of a fracture indicates which forces were involved.
An oblique or vertically oriented fracture indicates 'push-off'. A transverse or horizontal fracture is the result of a 'pu
us is pushed off by exorotation of the talus. On the right image the medial malleolus is pulled off by the medial colla
in the coronal plane
Stability:
The ankle can be thought of as a ring in which bones as well as ligaments play an equally important role in the maint
e ring remains stable. When it is broken in two places, the ring is unstable and may dislocate. Now anyone can figure
eral malleoli are fractured. It becomes more problematic when there is a combination of a fracture and a ligamentou
e X-ray. In some fractures there may even be a proximal fibular fracture - which is not visible on the ankle radiograph
he ankle. It is important to realize that in these cases the radiographs of the ankle may be normal, while there still is
ane There is also an ring of stability in the axial plane. When the anterior and posterior syndesmosis rupture or avuls
nations of avulsion fractures and ligamentous ruptures that can produce an unstable ring in the axial plane. A Anteri
ures to rupture. When the posterior syndesmosis also ruptures, then the ankle is unstable. B Less commonly the ant
ture. C On the posterior side frequently the posterior malleolus avulses. Sometimes these fractures are difficult to de
ones frequently align again, which makes it difficult to detect. Stability (2) It is important to realize, that for the stabili
upture of a ligament or an avulsion at the insertion. Almost every ligamentous rupture has a fracture equivalent. Sta
e is stable because there is only an avulsion fracture of the lateral malleolus below the level of the syndesmosis. The
an unstable fracture. The ring of the ankle is broken in two places. There is a lateral fracture and on the medial side
alus to dislocate laterally. Stability (4) The medial clear space should not exceed 4 mm and is usually equal to the dist
he medial joint space up to 6 mm or more requires disruption of the medial collateral ligament. Stability (5) The later
a to the lateral border of the posterior tibia 1cm above the tibial plafond. It is less well defined because its width vari
space indicates syndesmotic rupture. Some state that a width of 5.5 mm is abnormal. It is very important to realize t
amentous rupture. It simply means that there is no dislocation, but there can still be instability. The case on the left s
normal. Both the medial and lateral clear spaces are prominent, but within normal limits. We can conclude that there
medial collateral ligaments or of the syndesmosis. Continue with the images post surgery. Following osteosynthesis
(image on the far left). This indicates that there is a syndesmotic rupture and medial collateral ligament rupture. The
le and dislocated. Resurgery was necessary with placement of a syndesmotic screw to stabilize the ankle joint. Stabil
oth the medial and lateral clear spaces are widened, indicating instability. The talus is displaced laterally. Patient was
lacement of a syndesmotic screw if necessary. After osteosynthesis of the fibula, the ankle was tested in the operatin
ndesmotic screw. It was concluded that the syndesmosis was only partially ruptured, as is usually the case in Weber
g one of them, the ring was stable.
Ottawa Ankle Rules:
These rules are used to determine the need for radiographs in patients with an ankle injury. Ankle X-ray series are or
of the following:
Radiography:

Mortise view:
A basic radiographic examination of the injured ankle consists of an AP-view, a Mortise-view and a lateral view. The M
he foot. The technologist turns the foot inwards until the lateral malleolus is at the same height as the medial malleo
aces. On a true AP-view the talus overlaps a portion of the lateral malleolus, obscuring the lateral aspect of the ankle
t of the distal tibia
Lateral view:
Many think that for a good lateral view the distal fibula should be in the center of the distal tibia. However, since the
ct over the posterior part of the distal tibia (arrow). Malpositioning of the lateral view
Malpositioning of the Lateral view:
Malpositioning of the lateral view is the most common mistake in radiography of the injured ankle. Because the patie
the ankle fully lateral. This is one of the reasons why we miss so many fractures of the posterior malleolus. The CT d
also on the AP- and Mortise views, which will be shown in the paragraph on tertius fractures, this fracture was not vis
bula projects in the middle of the tibia. The x-ray beam is not parallel to the fracture line. Since the fracture line of a
ist on a true lateral view. Good positioning of the lateral view - Tertius fracture On a well positioned lateral view the t
fracture that was seen on the x-rays of the ankle and this patient turned out to have an unstable Weber-C fracture an
leoli. Notice the exorotation of the foot for a proper lateral view.

Videos of severe ankle injuries:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar
ion Myanmar with a small gift. East Lancashire Foot and Ankle Hyperbook
5. Free AO Surgery Reference The AO Surgery Reference is a huge online repository of surgical knowledge, consisting
Appendicitis - US findings:
by Julien Puylaert
Haaglanden Medical Centre in the Hague and Academical Medical Center in Amsterdam, the Netherlands:
Publicationdate 05-07-2020 In this article we will discuss the role of US in appendicitis and the additional role of CT s
endicitis will be dealt with, as well as the problem of spontaneously resolving appendicitis and the appendiceal absce
technique and normal anatomy: see “US of the GI tract” For critical comments and additional remarks: j.puylaert@g
Introduction:
Appendicitis is still the most common abdominal emergency in the Western world. There is a lifetime risk of 8 % to c
dergo appendectomy. The clinical diagnosis can be very difficult, and before the advent of US and CT, the negative ap
al delay of necessary surgery was also not uncommon. This US image shows an inflamed appendix in the axial (left) a
is meant for all those actively involved in acute abdominal US.
Pathophysiology of appendicitis:
The appendix is a blind-ending tube with a narrow lumen.
It contains feces and is easily obstructed. When obstruction occurs, within hours the intraluminal pressure increases
mucosa.
When this pressure exceeds the pressure in the vessels of the appendix wall, ischemic necrosis may occur, leaving th
lumen Depending on the inflammatory reaction of the human defense mechanism, the pathophysiological cascade
with perforation, results in a clinical presentation. This has a wide variation ranging from mild, spontaneously resolvi
and everything in-between. In this very lean patient with early acute appendicitis, US reveals dilatation of the distal a
zation of the wall, however in plane B no vessels are visible in the appendix wall due to high intraluminal pressure. N
ng into the abdominal wall during compression (arrowheads), with only vascularization in the fatty meso-appendix. T
able.
Exact mortality rates in the era before surgery and antibiotics are unknown, but were probably around 10 - 20 %.
Nowadays, mortality due to appendicitis has decreased to around 0,1 % , mainly due to early surgery, antibiotics and
RP. Note that in about one in five cases, appendiceal obstruction is relieved in an early phase.
This results in spontaneously resolving appendicitis, which entity will be discussed later.
Clinical signs of appendicitis:
Courtesy: Hamilton Bailey The classic clinical signs of appendicitis are (sub)acute abdominal pain, starting in the epig
After 4 to 6 hours shifting towards the right lower quadrant (RLQ), where local peritonitis develops.However sympto
n is acute or subacute abdominal pain. The clinical diagnosis of appendicitis is difficult, and is often wrongly made ar
pec-tively to ill-advised delay.
Before US and CT, the negative appendectomy rate reported in the literature was 28 % (Pieper R. Acta Chir Scand 19
nd CT as well as the use of CRP, have brought down both numbers to around 5 %.
The role of lab findings:
In the diagnosis of appendicitis the most valuable lab findings are WBC (White Bloodcell Count) and CRP (C- Reactiv
In early acute appendicitis, the WBC rapidly increases within a few hours and often returns to normal after 12 - 24 ho
The CRP remains normal during the first 6-12 hours, and then increases, with values that -dependent of the inflamm
4 hours of symptoms and a normal CRP, the chance for appendicitis is very low.
The only exception is spontaneous resolving appendicitis. Careful matching patient’s history, lab and US findings is k
tial diagnosis of appendicitis.
US of normal vs inflamed appendix:
The US features of the normal appendix are discussed in “US of the GI tract: normal anatomy”. Differentiating an infl
mal appendix – can be visualized in 20-30 % of cases. Inflamed appendix - can be visualized in 80-90 % of cases. Ther
pendix: The appendix diameter of normal and inflamed appendices on CT shows even a greater overlap. The explan
natomy”. Two asymptomatic individuals with large, feces-filled but non-inflamed appendices demonstrated by US ar
US of appendicitis:
Appendicitis with intraluminal fecolith (arrows) is found at the level of obstruction (a and v = iliac artery and vein). Th
6-12 hours the lumen of the appendix is strongly dilated with a thin wall and there is no inflamed fat yet. This patien
rs and had no localized pain over the dilated appendix. (visceral pain-phase). Note the bulging of the tense appendix
pendices are easily overlooked during US examination, due to the absence of circumscribed local pain ánd due to th
Moreover, these patients are often sent home without US or CT, because their visceral pain symptoms are interprete
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Inflamed fat:
The fatty tissue that is first involved in appendicitis, is the mesentery of the appendix or meso-appendix. The normal

aperitoneal fluid as in this patient, and is moderately hyperechoic, soft and well-compressible. Roughly 4-6 hours aft
meso-appendix, which becomes larger, more hyperechoic and non-compressible (arrowheads). The ensuing fibrin p
the well-known shift of pain from the periumbilical or epigastric area to the right lower quadrant. Interestingly, in th
scan. In this patient with RLQ pain since 18 hours, CT showed only minimal fatty stranding around an 8.5 mm appen
non-compressible, hyperechoic, inflamed fat (arrowheads) around the appendix. Later on in the disease process, th
is repre-sents the fatty omentum, which has migrated towards the appendix in an attempt to wall-off the imminent p
Disable Scroll Enable Scroll
Disable Scroll Slowly applied intermittent compression is the best way to identify the non-compressible inflamed fat.
he negative influence of gas. Eventually, also neighboring bowel and its mesentery become involved in the walling-of
In this patient, US shows large quantities of inflamed fat (*) and the thickened ileum representing successful walling-
Note a calcified fecolith (arrow on CT scan) in the appendix at a higher level. The longer this process of "walling-off" i
e.
This dilemma is discussed in the chapter "appendiceal mass".
Layer structure:
An irregu-lar, asymmetrical echolucent con-tour and loss of wall layer struc-ture indicate perforation or immi-nent pe
nt inflamed fat (arrowheads). The more the layer structure is affected, the higher the chance for perforation. The firs
Predicting of perforation based on the US image is not very reliable but has little therapeutic consequences at that m
Free fluid:
A little echolucent intra-peritoneal fluid (*) has little meaning and can be found in both acute, non-perforated appen
t also in patients with a normal appendix (right). Larger quantities of fluid, especially if circumscribed and/or turbid, c
re suspect for perforation. Usually these patients are ill, painful and have a high CRP. In this 56-year old lady with a C
d possibly an inflamed appendix with fecoliths (arrows). CT confirmed two fecoliths in the RLQ with odd air-configura
onfirmed purulent fluid. Immediate surgery revealed perforated appendicitis with four quadrant contamination of th
Hypervascularization:
As shown earlier,the vascularization of the appendix wall is initially decreased due to high intraluminal pressure.
However, this high pressure will drop again rapidly since the diseased appendix mucosa is not able to maintain its n
As a result, in combination with the massive inflammatory response , strong reactive hypervascularization will occur
also within the appendix wall.
Since this is the point in time, where patients usually seek medical help, this is the most familiar US image of the infla
Secondary signs of appendicitis:
In patients in whom the appendix cannot be visualized by US and also no alternative condition can be found, second
Disable Scroll Enable Scroll
Disable Scroll In this ill and painful patient the only US findings were a generalized paralytic ileus and a little turbid fr
s from in- and expiration. Subsequent CT and surgery confirmed purulent peritonitis from perforated appendicitis. T
US showed a combination of thickened ileal loops, paralytic ileus, inflamed fat and ill-defined fluidcollections (*), but
T confirmed paralytic ileus and an inflamed appendix (arrow).
Surgery revealed severely contaminated purulent peritonitis from perforated appendicitis.
The "appendiceal mass":
courtesy Dr. Netter Not infrequently, patients seek medical help (or are admitted) with considerable delay (> 4-5 day
These patients often present with a palpable mass and relatively mild peritonitis.
US and CT often show a large mass of non-compressible fat around the appendix, often also with wall thickening of n
, the diagnosis is appendiceal abscess. If not, the diagnosis is appendi-ceal phlegmon. *Choice dependent of many f
Appendiceal phlegmon:
Patients with an appendi-ceal phlegmon are usually managed conser-vatively because the surgeon knows from expe
impossible. The problem with the diagnosis of an appendiceal phlegmon is that there is large "grey zone" where the
to opt for conservative manage-ment.
This is understandable since there is a gradual evolution from acute appendicitis to an appendiceal phlegmon.
In the decision between surgery and wait-and-see, in general the clinical symptoms prevail over the US and CT findin
A walled-off pus-collection within the appendiceal phlegmon, is usually a contra indication for immediate surgery. If
, follow up US shows a decrease in size of the periappendiceal mass (arrowheads) within the course of weeks to mo
ows rough objectification of the palpable mass (arrowheads) around the inflamed appendix, and can be used in follo
vantages of US over CT, is that using graded compression, US can estimate the dimensions of the "palpable" inflamm
compressibility can also be tested on CT scan, with the help of a wooden device, strapped to the abdomen of the pa
and symptoms for eight days, CT with compression demonstrated a large, non-compressible inflammatory mass aro
ased on clinical grounds. During operation the McBurney incision was extended at both ends, and an ileocecal resec
Appendiceal abscess:
If next to the inflamed appendix, a more or less circumscribed fluid collec-tion is found, this is suggestive for an appe
equently (~50 %) a fecolith and is surrounded by inflamed non-compres-sible fatty tissue. The latter not only represe
iploic appendages and fatty mesentery. Together with neighboring bowel loops, this represents the -often successfu
ill of pus to the peritoneal cavi-ty. Patient with a small appendiceal abscess, ventrally walled-off by the ileum. The app

nt contents in to the abscess. Note the calcified fecolith (arrowhead) on the bottom of the abscess. Drainage was per
the RLQ. On CT the appendix could not be identified. US confirms an inflamed appendix (arrow). If an appendiceal ab
, percutaneous drainage is the treatment of choice. Dependent of symptoms and US/CT findings, acute laparotomy a
appendiceal abscess, percutaneous drainage is the treatment of choice. CT is necessary to confirm the diagnosis, to
ss route. Drainage using a combination of US and fluoroscopy has several advantages over CT guided drainage: it is
mpression during the procedure. This patient had a large appendiceal abscess, walled-off by ileum and cecum. A sm
n over a guidewire was done under fluoroscopic control. In this obese patient, drainage with the US probe using com
that compression here reduced the distance skin-to-abscess from10 to 3.5 cm. Spontaneous evacuation of appendic
who have no fever and only mild pain, it may be wise to await spontaneous drainage of the abscess to neighboring b
This 75-year old lady had subsiding symptoms after 7 days of RLQ pain, and she told us that she was feeling much be
abscess, walled-off by inflamed fat and the terminal ileum. There were echolucent connections (*) between the absc
ht iliac artery and vein). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll CT scan confirmed the anatomic situation. The patient was completely cured with only antibiotics. Ena
Disable Scroll Enable Scroll
Disable Scroll Three years later she underwent CT for sigmoid diverticulitis which allowed us to take a look at her app
timate contact with the ileum (il.) Another 4 years later, at age 82, she is still doing fine. The process of spontaneous
followed by doing repeated US. At the time of US, this patient with a large appendiceal abscess (arrowheads) was fe
st symptom free after an episode with remarkably smelly stool. In hindsight two air bubbles (arrow) indicated impen
ion of a pus collection to neighboring bowel is nature's most efficient way to get rid of an abscess or empyema. Othe
bladder) are slower and may result in fistula formation. Douglas abscesses, usually evacuate itself to the rectum.
If not, transrectal or transgluteal drainage is indicated. In this patient with a Douglas abscess the surgeon planned tr
abscess.
CT-guided transgluteal drainage under local anesthesia was successful. Some patients with an "appendiceal abscess"
These two patients were both ill with a high CRP and signs of generalized peritonitis.
US and CT confirmed paralytic ileus and large, not-well walled-off air-fluid collections, and in the right patient some f
These combined clinical and CT findings indicate a failing defense mechanism, warranting surgery. Children often pr
esses more rapidly and abscess formation is less effective than in adults. Children with an appendiceal abscess usua
large retrocecal abscess, both drainage and appendectomy was easily performed laparoscopically. Finally, in patien
ws) who have only 3-4 days of symptoms, immediate appendectomy with removal of the small abscess is a good opt
cal situation in a patient with an acute abdomen is rather complex, communication with the surgeon is crucial. Rathe
iscuss the US/CT findings together with the surgeon before the monitor.
Spontaneously resolving appendicitis:
About one in ten patients with acute appendicitis mentions one or more episodes of the same symptoms over the p
ly subsided within a period of 12-24 hours. Laboratory shows an elevated WBC and no or only mildly elevated CRP. T
d that this phenomenon of so-called "spontaneously resolving appendicitis" is not rare. This young lady had typical s
US showed an inflamed appendix.
Within a period of hours her symptoms rapidly decreased and she was not operated. US was performed 5 years late
t, the appendix (arrow) on admission showed a dilated lumen and minimal surrounding fat. After the US examination
ree days later he was symptom free and US showed a compressible appendix (arrow) with a slightly thickened wall a
es, the rather sudden resolution of symptoms and the usually low CRP, suggest that the cause of this phenomenon i
d a classic history of appendicitis but was symptom free again at the time of US. US showed a small appendix (arrow
t. He recalled three similar attacks over the past 9 months, and was operated immediately. Surgical and histological
tion with granulocytes. This young woman had pain in the RLQ for 24 hours (WBC 12, CRP 34), when she noticed rapi
US showed a small 6.5 mm hyperemic appendix (arrow), surrounded by inflamed fat.
She was not operated and was symptom free the next day.
US after 5 days showed normalization of the appendix (arrow).
Three years later, she had recurrent symptoms and US showed acute appendicitis.
Surgery revealed perforated appendicitis. Here the different stages of spontaneously resolving appendicitis are sche
lving appendicitis undergo US, most are then in the stage of reactive hyperemia and reperfusion edema. These are U
ix different patients, all with rapidly decreasing symptoms at that point in time. Note that the appendix is relatively s
Policy in spontaneously resolving appendicitis:
Cobben et al (Radiology 2000, 215: 349-52) followed up 60 patients with spontaneous resolving appendicitis who wer
itis, and in the following 15 years, another 7. This high recurrence rate (50 %) plus the fact that a future attack may co
ing. It is imaginable that after each episode of appendicitis, the appendix wall becomes more vulnerable, leading to a
atients with mild appendicitis symptoms receive antibiotics. This certainly supports a rapid recovery, but it is still unc
.
Treatment of appendicitis:

Surgery:

Ever since the recognition of the pathophysiological mechanism of appendicitis by Sir Reginald Fitz in 1886, there has
re perforation can occur.
The last decades, the famous Lanz-McBurney incision is increasingly replaced by laparoscopic appendectomy. After
l appendectomy can be done, but the usefulness of this operation remains controversial. Until ten years ago, the use
d appendicitis, associated with septicaemia.
Recently, several studies have shown that early appendicitis can also be primarily treated with antibiotics only.
Antibiotics for early appendicitis:
Several studies have shown that a selected group of patients with acute appendicitis and mild symptoms, first attack
ith antibiotic treatment alone. However, there is a high number of late recurrences up to 40 % for whom surgery at
0:1259-65). Another drawback of non-operative treatment is that US and CT are an uncertain gold standard. The pre
nservative treatment of appendicitis with antibiotics.
In this respect, there is a remarkable analogy with gallbladder stones. Once a gallbladder stone (large arrow) has bee
is wide consensus that cholecystectomy ASAP is indicated.
Similarly, patients with proven symptomatic obstruction of the appendix due to a fecolith (small arrow), should unde
urther studies will have to decide whether the 65 % of patients with obstructive appendicitis without a fecolith, will e
None:

Anal cancer staging:
Monique Maas and Doenja Lambregts
Radiology department of the Netherlands Cancer Institute Amsterdam:
Anal cancer is a rare malignancy with a worldwide
incidence of approximately 1.5 per 100.000.
Almost all anal cancers are
squamous cell carcinomas.
Imaging plays a vital role in the staging and
treatment planning of anal cancer.
The diagnostic work-up consists of
proctoscopy with biopsies, MRI of the pelvis, ultrasound (with fine needle
aspiration) for the inguinal nodes, and CT or FDG-PET for the detection
of further nodal and distant metastasis.
Chemoradiation (CRT) is the
standard treatment for most anal cancers, after which 80-90% of patients
achieve a complete remission.
In patients with residual tumor, additional
surgery is required.
Some patients with small tumors at the perianal skin may
be managed with primary local excision instead of CRT.
Nodal involvement is
common in anal SCC and is usually treated with a radiation boost on the regional
lymph nodes.
Introduction:

Checklist for staging:
This is a checklist for the
structured reporting of anal cancer at baseline staging.
All these items will be discussed in the following chapters. When reporting a restaging or follow-up MRI after chemor
the report should include:
Anatomy:
Anal cancer can be
subdivided into anal canal and anal margin (perianal skin) cancer.
Anal margin
cancers arise from the ±5 cm of perianal skin caudal from the anal margin.
They
are often more superficial and slow-growing tumors, that may be cured with
local excision or local radiation (if T1).
Tumors of the anal canal are often
more advanced (T2+ stage) and are treated with definitive chemoradiotherapy (CTR). The dentate line marks the tran
mucosa.
Tumors above the dentate line often spread to the mesorectal, internal
iliac and obturator lymph nodes, while tumors below this line typically spread to the

inguinal and external iliac nodes.
Staging anal cancer:

T-stage:
T-stage in anal cancer is
primarily based on tumor size with the exception of T4 stage, which is invasion of adjacent organs: In the Tis categor
disease, high-grade Squamous intraepithelial lesion (HSIL) and anal
intraepithelial neoplasia II-III (AIN II-III) are included. Choosing the right plane Note that to determine the T-stage you
the longest possible tumor diameter.
To do so, be sure to evaluate the tumor in
multiple planes and look for the longest tumor dimension. Images
In this example, measuring
the tumor in the axial plane would falsely suggest a T1 tumor.
When measuring the
longest tumor axis in the coronal plane, the tumor stage is T2.
Tumor location:
Describing the tumor location and whether the perianal skin, different layers of the anal sphincter and pelvic floor ar
guide radiation and/or surgical treatment planning. When describing involvement of the internal and external anal s
(e.g. upper half, lower half or full length of the anal canal) as well as the level of circumferential involvement (e.g. fro
he tumor, mention the following: Image
A tumor involves the distal 2/3 of the anal canal.
It invades the internal sphincter, intersphincteric space and external sphincter from ± 12 till 3 o'clock.
There is no involvement of the pelvic floor, rectum or anal margin. Image
Another example showing a tumor that involves the proximal ½ of the anal canal.
It invades the internal sphincter, intershincteric space and external sphincter from 7-10 o'clock.
The tumor invades the puborectalis and levator ani on the right (arrow) and extends just above the level of the anore
N-stage:
Nodal involvement occurs in about 25-45% of patients with anal cancer.
Unlike in rectal cancer where the N-stage is based on the number of suspicious nodes, N-staging in anal cancer is ba
e no widely accepted criteria to characterize anal cancer lymph nodes on MRI.
Some authors advise to adopt the criteria used for rectal cancer also for anal cancer staging. Other reported criteria
will inherently lead to both over- and understaging.
The most accurate nodal staging modality is 18F-FDG-PET-CT, with a sensitivity of 56-99% and specificity of 90-100%
Ultrasound with fine needle aspiration is usually done as an adjunct to MRI and PET-CT, but in some centers it is use
images are of a patient with anal cancer. Images
The MRI shows a clearly enlarged node (1.5 cm short axis diameter) adjacent to the internal iliac vessels, which was s
FDG-PET CT showed pathologic FDG uptake in the node, confirming it as N+. In this case there are two small lymph n
DG-PET showed clearly increased FDG uptake in these small nodes, showing the added benefit of PET over MRI to st
ant metastases in a patient with anal cancer
M-stage:
Approximately 6% of patients with anal cancer present with distant metastases at diagnosis (3,4).
The prognosis is severely impaired by distant metastases with a 5-year median overall survival of only 10-20%. The m
ke common iliac nodes, para-aortic nodes and nodes above the diaphragm, followed by liver and lung metastases.
The recommended staging modality for M-staging in anal cancer is FDG-PET as almost all anal cancers are squamous
ET.
Alternatively, a portal venous phase CT of the chest and abdomen may be performed. Images
Two distant metastases that are clearly FDG-avid on PET: a suspicious nodule in the right lung and a distant para-ao
Restaging and follow-up after treatment:
Tumor (arrow) before treatment with a suspicious mesorectal node. Stage: cT2N1a. As mentioned before, when repo
ould include: The vast majority of anal cancers undergo definitive
chemoradiotherapy (CRT) which leads to a complete remission in ±80-90% of the
patients.
Maximum response rates are achieved after ±6 months at which time final
response evaluation with restaging should be performed. The main goal of restaging is
to identify the ±10% of patients that still have vital residual tumor and
require additional surgical resection.
During restaging the diffusion-weighted
images are particularly helpful to detect residual tumor. Chemoradiation induces fibrosis with low signal on T2W ima
Absence of intermediate
to hyperintense residual signal on T2W images and absence of diffusion

restriction on DWI are signs that are highly predictive for a complete
response. Images
Tumor (arrow) before treatment
with a suspicious mesorectal node.
Stage: cT2N1a.
Continue with the images after treatment... Restaging After treatment the
tumor has decreased in size. There
is no residual intermediate signal mass on the sagittal and axial T2W images. There
is only a small area of hypointense fibrosis
(arrows). The
small dark spot on the ADC map represents 'dark
through' from
fibrosis (arrow).
This can be distinguished
from true diffusion-restriction, since there is no corresponding high signal on
the high b-value diffusion-weighted images. Anal tumor in the middle and lower third of the anal canal before treatm
Pitfall: timing of response:
To assess the final
response to treatment and decide whether or not to operate, imaging is best
performed ±6 months after completion of chemoradiation. If imaging is performed earlier, response
may still be ongoing and presence of residual tumor is highly likely. Some centers perform MRI at 6-10 weeks after cl
These images should be regarded as an interim evaluation and baseline for
further follow-up.
Apart from MRI, clinicians will generally monitor response
by digital rectal examination (DRE) and clinical inspection.
When DRE is not feasible or if clinical
examination results in inconclusive findings, MRI can be used as an adjunct to
further assess the response. Images
Anal tumor in the middle and lower third of the anal canal before treatment.
Continue with the follow up... Residual tumor 6 weeks post chemoradiation. Evaluation after 6 weeks
The
first response evaluation was performed 6 weeks after the last
radiation fraction. ImagesThere is response, but residual tumor is still visible as intermediate
signal tissue on T2W MRI (black arrow) with corresponding diffusion restriction
(white arrow). Continue with the follow up at 6 months... No residual tumor 6 months post chemoradiation. Evaluati
A second response
evaluation was performed at 6 months post-radiation. Images
There is a complete response.
Local recurrence:
Local recurrence is defined as biopsy confirmed reappearance of tumor or locoregional lymph nodes after an initial
tion. Approximately 30% of patients treated with CRT will eventually have local failure (i.e. residual tumor after CRT o
About half of the recurrences occur in the first 2 years after completion of CRT.
Basaloid subtypes, higher stage tumors and HIV positive patients have a higher risk for local recurrence.
Basaloid carcinoma is a distinctive morphologic subtype of squamous cell carcinoma frequently associated with the
recurrence is seen as a new intermediate signal mass on T2W with restricted diffusion on DWI or nodes showing gro
follow up. FDG-PET-CT can be used to confirm or rule out a local recurrence and simultaneously
look for distant metastasis.
Early detection of a local recurrence improves the
chance of successfull salvage surgery, which usually means abdominoperineal resection. Images
This is an anal cancer before chemoradiation.
Continue with the images post treatment... Enable Scroll
Disable Scroll Complete response post-CRT Enable Scroll
Disable Scroll Complete response post-CRT Images post CTR
There is a complete response with only a small thin area of fibrosis at the former tumor location at 1-3 'o clock in the
There was no signs of diffusion restriction (scroll).
The rest of the internal sphincter shows some fuzzy intermediate to high signal, which represents radiation-induced
mages after 2 years... Local recurrence 2 years after completion of CRT Images
There is a local recurrence 2 years after completion of CRT.
Note that the recurrence is larger than the primary tumor.
Extended abdomino-perineal resection after re-irradiation was required to salvage this recurrence.

Imaging protocol:
The recommended MRI protocol mainly consists of high resolution T2W
imaging in multiple planes with a slice thickness of ≤ 3 mm. Diffusion-weighted imaging is mainly crucial in the restag
follow-up setting because it increases the sensitivity of MRI to help detect
areas of vital residual tumor within the fibrotically changed tumor bed. MRI
has a limited performance for N-staging and patients require additional
FDG-PET/CT and/or ultrasound (with FNA) to more accurately assess the lymph
nodes.
Sequence angulation:
High resolution coronal T2W sequences are planned parallel to the anal canal to allow optimal visualization of the
different layers of the anal canal. Transverse sequences are planned perpendicular to the anal canal Note that anal c
occurring at a distance from the primary tumour, i.e. higher up in the rectum
or mesorectal compartment.
Be sure to check for the presence of any
skip lesions on the large FOV images of the pelvis. Image
There is a primary tumor located in the anal canal, presenting with a large skip
lesion in the mesorectum (arrow).
Anal cancer versus rectal cancer.:
The table summarizes the main differences in staging and treatment between anal and rectal cancer. Note that the c
the tumor and not its location.
Anal cancers are typically squamous cell carcinomas, while rectal cancers arise from large bowel mucosa and are typ
l junction into the distal rectum or even be largely situated in the rectum.
Vice versa rectal cancers may extend into or be located for the majority within the anal canal.
When performing anal or rectal cancer staging, the radiologist thus needs to be informed about the underlying tumo
4 disease are different for anal and rectal cancer.
Unlike in rectal cancer, invasion of the external sphincter (*) and pelvic floor muscles (*) is not T4 disease when stagi
ameter of 4.7 cm.
On the axial view the tumor involves the internal sphincter from 4-8 o'clock.
It extends into the intersphincteric plane and invades the levator ani on the right dorsal side (arrow).
In case of anal cancer this is staged as T2 (diameter 2-5 cm), while in case of a rectal cancer, the invasion of the exter
Charity:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click on the image below to watch the video of Medical Action Myanmar and if yo
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Cervical injury:
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Publicationdate 2008-11-24 This review is based on a presentation given by Adam Flanders and adapted for the Radi
present to the emergency department as the result of a motor vehicle accident or fall have a major injury to the cerv
al spine injury. Up to 17% of patients have a missed or delayed diagnosis of cervical spine injury, with a risk of perma
ical spine fractures occur predominantly at two levels. One third of injuries occur at the level of C2, and one half of in
will discuss the most common cervical spine injuries. You can click on some of the images to get a larger image.
Introduction:
Hyperflexion injuriesClick on the image to get a larger view.
Flexion injuries:
The most common fracture mechanism in cervical injuries is hyperflexion. Since the anterior and middle columns re
* Simple wedge fracture is the result of a pure flexion injury. The posterior ligaments remain intact. Anterior wedging
suggests fracture. Increased concavity along with increased density due to bony impaction. Usualy involves the uppe
* Unstable wedge fracture is an unstable flexion injury due to damage to both the anterior column (anterior wedge f

* Unilateral interfacet dislocation is due to both flexion and rotation.
* Bilateral interfacet dislocation is the result of extreme flection. BID is unstable and is associated with a high incide
* Flexion teardrop farcture is the result of extreme flection with axial loading. It is unstable and is associated with a
* Anterior atlantoaxial dislocation Hyperextension injuries
Extension injuries:
Traumatic spondylolisthesis of C2.
* Extension teardrop fracture
* Hyperextension in preexisting spondylosis 'Open mouth fracture'.
Axial compression injuries:

Stability:
Unstable fractures: Non-hemorrhagic and hemorrhagic spinal cord injury
Spinal cord injury:
There are two types of injury to the spinal cord: Effect of spinal cord hemorrhage on motor recovery of the legs at 12
 spinal cord edema and the clinical outcome. The most important factor however is whether there is hemorrhage, si
e chart on the left is showing the motor recovery rate for patients with edema alone (in blue) versus edema plus cor
ly. Central spinal cord injury in a patient with a hyperextension injury and preexisting spondylosis and stenosis. Spin
 with screwdriver On the left images of spinal cord injury after a stab wound with a screwdriver. This resulted in a Br
Hyperflexion injuries:
Hyperflexion sprain without fracture
Hyperflexion Sprain:
Hyperflexion sprain injuries are injuries to the soft tissues of the spine without fracture. On x-rays this can only be su
onstrate subtle injuries to the soft tissues. On the left images of a patient who has been in a car accident and compla
urological symptoms. First study the images on the left. Then continue reading. The findings are: In this patient we ca
ot know if a special treatment is required, since these were isolated MR-findings without evidence of fracture or abn
 soft tissue abnormalities detected only on MRI. Signal changes do not necessarily equate with structural failure. The
up to 25% of all patients with neck injury have signal abnormalities on MR and the significance is indeterminate. Hyp
 44 year old female, who sustained a fall on the ice. She subsequently had a second fall the following morning, where
 examination there was lower extremity paraparesis with some upper extremity weakness on the right. Central cord
udy the images on the left. Then continue reading. The findings are: These CT-findings are very subtle and do not see
ext step. First we show you a coronal and axial CT with also a soft tissue window-setting. There is high density mater
 a traumatic disc herniation. A epidural hematoma should be in the differential, but this finding was limited to just th
e MR. Hyperflexion sprain with spinal cord injury Hyperflexion sprain (3) The MRI explains the neurological status of
 reading. The MR-findings are: Continue with the axial image. Vertebral artery thrombosis: no flow void in the right ve
d in addition to it there is absence of flow void in the right vertebral artery. This indicates thrombosis as a result of d
no fracture, but a severe hyperflexion sprain with acute disc herniation, non-hemorrhagic spinal cord injury and vert
irms the occlusion of the right vertebral artery.
Unilateral interfacet dislocation:
Unilateral interfacet dislocation is due to a hyperflexion injury with rotation. The superior facet on one side slides ov
 anterior subluxation of the upper vertebral body of about 25% of the AP diameter of the body. Simple unilateral fac
ated neurologic defect. MRI plays an important role in the diagnosis in order to see if there is disc extrusion leading t
 who had a rollover motor vehicle accident. First study the images on the left. Then continue reading. The radiograph
 contralateral facetjoint is only distracted. Inverted hamburger sign in unilateral interfacetal dislocation Unilateral int
 joint is normal and the configuration has similarities with the hamburger. On the right side the classic 'inverted ham
nterfacetal dislocation First study the MR-images. Then continue reading. The MRI-findings are:
Bilateral Interfacetal Dislocation:
Bilateral interfacetal dislocation (BID) is the result of extreme hyperflection. There is anterior dislocation of the articu
lex, posterior longitudinal ligament, the disc and usually also the anterior longitudinal ligament. When the dislocation
 one-half of the AP diameter of the vertebral body. Because of its extensive soft tissue damage and dislocated facet j
of cord damage. Bilateral interfacetal dislocation First study the images on the left. Then continue reading. The findin
irm the bilateral dislocation. Near one of the facets there is a small fleck of bone, but there is no major fracture, so th
uble inverted hamburger sign in bilateral facetal dislocation On the axial images the inverted hamburger sign is seen
Disable Scroll Enable Scroll
Disable Scroll Bilateral interfacetal dislocation (2) On the left you can scroll through the 3D-reconstructions. Bilateral
 additional findings. Then continue reading. The MRI-findings are: Continue with the axial image. Notice on the axial i
 is more sensitive to damage. Enable Scroll
Disable Scroll Closed reduction under fluoroscopy. Scroll through the images. Enable Scroll
Disable Scroll Closed reduction under fluoroscopy. Scroll through the images.
--> Reduction under fluoroscopy:
In order to regain normal alignment, progressive weights are used to lengthen the spine until reduction is achieved.

ds the facets start to move, but it finally takes about 110 pounds before the neck is reduced. Because someone is ho
' can be felt in the neck indicating that reduction is achieved. Continue with the MR-images after reduction. Bilateral
old, who was injuried during wrestling. There is 50% anteroposition of C3 on C4 as a result of bilateral interfacetal di
lex. This boy had severe neurologic deficit. Bilateral interfacetal dislocation (6) On the left another bilateral interfacet
is is a very uncommon finding, since the spinal cord is very plastic. Flexion tear drop fracture
Flexion tear drop fracture:
This fracture is the result of a combination of flexion and compression,
which is usually the result of a motor vehicle accident. The teardrop fragment comes from the anteroinferior aspect
body is displaced backward into the spinal canal. On x-rays the facet joints and interspinous distances are usually w
neurologic deficit. It is an unstable fracture associated with complete disruption of ligaments and anterior cord sync
eft images of a 21 year old male who sustained a diving injury, striking his head in a swimming pool. He had immedia
mages. Then continue reading. The findings are: Some would just call this a severe hyperflexion injury, but this entity
dditional findings on the CT-images and then continue reading. The findings are: In fact these vertebral bodies kind o
rdrop) and the larger part posteriorly against the spinal cord. Continue with the MR-images. Flexion tear drop fractu
ntinue reading. The findings are: Flexion tear drop fracture (3) On the left images of a similar case. There is a C5 flexi
s not visualised well and additional imaging is required. The CT-images demonstrate the extreme axial loading. The t
the vertebral body is displaced posteriorly compressing the spinal cord. Continue with the MR-images. T1W- and T2W
t is a hemorrhagic injury, which has a poor outcome. Also notice the posterior ligamentous injury as a result of the h
ge. Central spinal cord injury Notice the central location of the spinal cord injury.
Hyperextension injuries:

Hangman' s fracture:
The Hangman' s fracture is the most common cervical spine fracture. Classically it is an extension-fracture as the har
force. That is why we discuss the hangman' s fracture in the chapter on hyperextension injuries. In some situations h
's fracture is common in diving accidents. Although considered an unstable fracture, it seldom is associated with spi
al is greatest at this level, and the fractured pedicles allow decompression. When associated with unilateral or bilater
's fracture is unstable and has a high rate of neurologic complications. Classification of Hangman' s fractures Hangm
er in a vehicle going about 55 miles per hour . She ran into a tree at about 9 p.m. the previous night with questionab
ion, but was alert and had no neurologic abnormalities on examination. First study the images on the left.
Then continue reading. The findings are: Continue with the CT-images. The CT-images confirm the fracture-lines of th
resulting in a traumatic spondylolysis. In this case there was no neurologic deficit, because the spinal canal is widene
the left images of another patient with a type I Hangman' s fracture. There is a hair-line fracture and there is no disp
Hyperextension with superimposed spondylosis:
On the left images of a 90-year-old male who tripped and fell on his back and the back of his head. He had immediat
st study the images on the left. Then continue reading. The findings are: Continue with the CT-images. On CT we also
dots in the disc space are the result of a vacuum phenomena. The negative pressure resulted in a vacuum phenome
back of C5C6, which could be a herniated disc or just preexisting disc degeneration. In such a patient with spondylos
y can lead to spinal cord injury. Continue with the MR-images. The MR shows a subtle increase in signal intensity of t
rd injury. There is only injury to the central part of the cord and these patients have disproportioned weakness of the
be devastating, although it is uncommon that they are hemorrhagic. Hyperextension with superimposed spondylosis
rextension injury. It is easy to find the injured disc, since it is the one with the high signal (arrows). Notice the prevert
Extension teardrop fracture:
As with flexion teardrop fracture, extension teardrop fracture also manifests with a displaced anteroinferior bony fra
ligament pulls a bony fragment away from the inferior aspect of the vertebra because of the sudden hyperextension
op fracture in which the fragment is produced by compression. This type of fracture is commonly seen in diving acci
associated with the central cord syndrome due to buckling of the ligamenta flava into spinal canal during the hypere
ghly unstable in extension. On the left images of a 70 year old female who fell down ten steps striking her head resu
s. There was no neurologic deficit. Notice the anteroinferior bony fragment of C2. Continue with the CT images. The
ment is a true avulsion, in contrast to the flexion teardrop fracture in which the fragment is produced by compressio
with the MR images. The MR also confirms that this is not a flexion injury, since the soft tissue injury is located anter
extension-teardrop fracture of C2.
Fractures due to axial loading:

Jefferson fracture:
This fracture is caused by a compressive downward force that is transmitted evenly through the occipital condyles to
s process displaces the masses laterally and causes fractures of the anterior and posterior arches, along with possib
racture is characterized by bilateral lateral displacement of the articular masses of C1.
Other injuries:

Odontoid fracture:

Odontoid or dens-fractures are very common. They are seen in elderly, but also frequently in children due to the rela
fracture.
It is stable, since the fracture line is above the transverse ligament.
* Type II: Through the base of the dens.
Most common fracture.
Always unstable and poor healing.
* Type III: Fracture through the body of the axis and sometimes facets.
Can be unstable, but has a better prognosis than type II due to better healing of the fracture which runs through the
On the left the most common type of odontoid fracture, which is type II through the base of the odontoid. These typ
dontoid fracture type II On the left another type II odontoid fracture. Sometimes these fracture-lines can be difficult
ere are fracture mimics like lucent lines as a result of overprojection or a prominent mach line (figure). Odontoid frac
senger in a MVC who was ejected from the automobile. He had multiple injuries including subdural hematoma, hem
e process fracture as well as a left clavicle fracture. There was no neurologic deficit at physiacl examination. First stu
k at the CT-images and then continue reading. Odontoid fracture type III The CT confirm the x-ray findings and show
nstrates: On the left transverse MR-images at the level of the cervical spine and the thoracic spine. Notice that at the
ut it is located posteriorly. This resuted from the T-spine fracture. Continue with the axial images. Type III odontoid fr
of another type III odontoid fracture. Unstable type II odontoid fracture Odontoid fracture (4) On the left images of a
d fracture On the left an unstable type III odontoid fracture. Harris' measurement for AO-DissociationRule of twelves
r line should not exceed 12 mm in an adult.
Atlanto-occipital dislocation:
Atlanto-occipital dislocation is an uncommon injury characterized by complete disruption of all ligaments between o
ccipitoatlantal factes. Anterior translation of the skull on the vertebral column is the most common presentation. De
which causes respiratory arrest. It is reported to occur in 31% of fatal MVAs. It is more common in children due to th
overlooked initially, which can have catastrophic results, since cervical traction can be fatal. Power's ratio is sometim
base and spine, but Harris' measurement for AO-dissociation has a greater sensitivity (figure). On the left images of
found confused and combative at the scene. He was intubated and taken to a hospital, where he was found to be qu
and cervical spine is seen. The axial CT-image demonstrates blood surrounding the brainstem. On the images on th
d the tip of the dens and the posterior arch of the atlas. The subarachnoid space is hyperdense due to the hemorrha
orrhage and the compression on the cord.
Harris classification:

NEXUS criteria:
The NEXUS criteria state that a patient with suspected c-spine injury can be cleared providing the following:
Lateral view:
The lateral view is the most useful view.
Approximately 85-90% of spinal injuries are evident on this view. Systematic approach: Widening of the space betwe
umn spine and its significance in the classification of acute thoracolumbar spinal injuries. by Francis Denis. Spine 198
2. Disorders, diseases and injuries to the spine in current diagnosis & treatment - Orthopedics - fourth edition
3. A schema for the classification of lower cervical spine injuries by C. Argenson, F. de Peretti, A. Ghabris, P. Eude, J. L
4. Unilateral Facet Dislocation in Wheeles' Textbook of Orthopaedics
5. Validity of a Set of Clinical Criteria to Rule Out Injury to the Cervical Spine in Patients with Blunt Trauma by Jerome
r 2
6. Fracture, Cervical Spine in eMedicine by Moira Davenport
None:

Acute Pancreatitis:

2012 Revised Atlanta Classification of Acute Pancreatitis:
Thomas Bollen, Marieke Hazewinkel and Robin Smithuis
Radiology department of the St. Antonius hospital, Nieuwegein, the Medical Centre Alkmaar and the Rijnland hospita
Publicationdate 2015-05-01 The 2012 Revised Atlanta Classification of acute pancreatitis enables standardized repor
research. A standardized template for reporting CT images is given to describe the local complications of acute panc
Introduction:
Temporally, two phases of acute pancreatitis are identified in the Revised Atlanta Classification: Only clinical parame
y the systemic inflammatory response syndrome - SIRS, which can lead to organ failure.
2. Late - after the first week Morphologic criteria based on CT findings combined with clinical parameters determine
ategories based on clinical and morphologic findings: 15-20% of cases. Morphologically, there are two types of acute
Diagnosis of Acute Pancreatitis:
The diagnosis of acute pancreatitis requires two of the following three features: Acute onset of persistent, severe, ep
2. Serum lipase or amylase activity at least three times greater than the upper limit of normal.

3. Characteristic findings of acute pancreatitis on contrast-enhanced CT (CECT) and less commonly MRI or US. The di
minal pain and elevated pancreatic enzymes and CECT is not required, unless there is uncertainty about the diagnos
pigastric pain very suggestive of acute pancreatitis. However the amylase level was within normal levels. A CECT was
diagnosis of mild pancreatitis was made.
Clinical outcome:
Early severity stratification of acute pancreatitis is important to identify patients with the highest morbidity. These pa
re unit or tertiary referral centre. Mild pancreatitis These patients have no organ failure. Most of them have no fluid
y the end of the first week. Moderate severe and severe pancreatitis The clinical condition of the patient is determine
result in a systemic inflammatory response syndrome (SIRS), which increases the risk of organ failure. The presence
tinine□) and cardiovascular failure (blood pressure□). The extent of morphologic changes like necrosis and fluid colle
ilure. Many of these patients however will have necrotizing pancreatitis and the mortality increases when the necros
Atlanta Classification of Fluid Collections:
The 2012 Revised Atlanta Classification discerns 4 types of peripancreatic fluid collections in acute pancreatitis depe
the discrimination between an APFC and ANC may be difficult, especially in the first weeks and the term "indetermin
s may remain sterile or become infected. Infection is rare during the first week. The table summarizes the CT criteria
ancreatitis. Acute Peripancreatic Fluid Collections contain fluid only and are not or only partially encapsulated. They
tly they regress spontaneously.
2. ANC Acute Necrotic Collections contain a mixture of fluid and necrotic material. They are not or only partially enca
itis.
3. PseudocystAfter 4 weeks in interstitial pancreatitis. This fluid collection is encapsulated. Pseudocysts are uncomm
o contain some necrotic material.
4. WONAfter 4 weeks most necrotic collections are fully encapsulated and are called Walled-off Necrosis (WON).
CT severity index:
The CT severity index (CTSI) combines the Balthazar grade (0-4 points) with the extent of pancreatic necrosis (0-6 poi
ring systems based on imaging do not outperform scoring systems based on clinical and biochemical parameters wi
day of admission solely for prediction purposes is not recommended.
Imaging:

CT:
CT is the imaging modality of choice for the diagnosis and staging of acute pancreatitis and its complications.
Ultrasound and ERCP with sphincterotomy and stone extraction play an important role in biliary pancreatitis. Since t
d laboratory findings, an early CT is only recommended when the diagnosis is uncertain, or in case of suspected earl
T may be misleading regarding the morphologic severity of the pancreatitis, because it may underestimate the prese
ncreas on day 1. As the patient's condition worsened, a second CT was performed on day 3. Notice how the greater p
ecrotizing pancreatitis (arrows). The first CT underestimated the severity of the pancreatitis. This patient died on day
Interstitial pancreatitis:
Morphologically there are 2 types of acute pancreatitis - interstitial or oedematous pancreatitis and necrotizing panc
is normal enhancement of the entire pancreatic gland with only mild surrounding fatty infiltration. There are no fluid
yma. CTSI: 2 points. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here another case of interstitial pancreatitis without necrosis. Scroll through the images. The pancreas
). No fluid collections. No pancreatic necrosis. CTSI: 2 points
Necrotizing Pancreatitis:
Necrosis of pancreatic parenchyma or peripancreatic tissues occurs in 10-15 % of patients. It is characterized by a pr
ns, and a high mortality rate. There are 3 subtypes of necrotizing pancreatitis: Necrosis of the pancreatic parenchym
s of peripancreatic tissue can be vary difficult to diagnose, but is suspected when the collection is inhomogeneous, i.
pancreatitis. The body and tail of the pancreas do not enhance. There is normal enhancement of the pancreatic hea
at least two collections. CTSI: 4 + 6 = 10 points.
MRI:
MRI is superior to CT in differentiating between fluid and solid necrotic debris. Here a patient with several homogene
ow homogeneous high signal intensity on a fat-suppressed T2-weighted MRI image, are fully encapsulated and conta
ing pancreatitis with onset 2 months earlier. The CT-image shows a homogeneous peripancreatic collection in the tra
he collection has a low signal intensity (arrow). Most likely this is necrotic fat tissue (i.e. sterile necrosis or walled-off
s. Endoscopic or percutaneous drainage would have little or no effect on its size, but increases the risk of infection.
Peripancreatic Collections:
Spontaneous regression of APFC.
Acute Peripancreatic Fluid Collection - APFC:
Intraabdominal fluid collections and collections of necrotic tissue are common in acute pancreatitis. These collection
ly stage, such a collection does not have a wall or capsule. Preferred locations of fluid collections are: These collectio
zymes which also cause necrosis of the surrounding tissues. This explains why many of these collections harbor solid

regression (figure). The remaining 50% either remain stable or increase and undergo organization and demarcation
e images show spontaneous regression of an acute peripancreatic fluid collection (APFC).
Acute Necrotic Collection - ANC:
Study the image. What are the findings? Then continue reading. The findings are: We can conclude that this is an acu
ontinue reading. What are the findings? The findings are: On day 5 this collection can be diagnosed as probable acut
ut we can assume that in a couple of days this will be a walled-of-necrosis with a complete wall. When peripancreatic
nce of fat necrosis. Because fat does not enhance on CT, the diagnosis of fat necrosis can be difficult. Necrosis can b
if it has direct clinical implications. Pseudocyst
Pseudocyst:
This patient presented with a gastric outlet obstruction 2 months after an episode of acute pancreatitis. There is a ho
ser sac, which abuts the stomach and the pancreas. The patient did not have fever. The collection underwent succes
ase and subsequently resolved along with the patient's symptoms. Therefore, this collection proved to be a true pan
ce or fluid enclosed by a complete wall of fibrous tissue It occurs in interstitial pancreatitis and the absence of necrot
th the pancreatic duct may be present. A pseudocyst requires 4 or more weeks to develop. The differential diagnosis
en a cystic tumor. Most often, they occur in the lesser sac. Most collections that persist after 4 weeks are walled-of-n
pancreatic fluid collections resolve within 4 weeks. Walled-off-necrosis
Walled-off Necrosis - WON:
Based on CT alone it is sometimes impossible to determine whether a collection contains fluid only or a mixture of fl
describe these as 'indeterminate peripancreatic collections'. The images are of a patient with acute pancreatitis. On t
ead in the right anterior pararenal space. At this stage, it is not possible to distinguish between an acute peripancrea
ow-up scan the collection in the right anterior pararenal space increased in size. It has fluid density and a thin enhan
d it may or may not be infected. The patient became septic and a percutaneous drainage was performed. After drain
surgery and the collection was found to consist of necrotic debris, which was not appreciated on CT, hence this was a
as too viscous for successful percutaneous drainage. Walled-off-necrosis (2) These CT-images are of a patient on day
ver. The CT shows a similar collection of fluid density to that of the patient with the pseudocyst, except for its pancre
ated with a thin wall abutting the stomach. During endoscopic debridement this collection contained fluid and necro
ugh the imaging characteristics in this case are similar to the patient with the pseudocyst, this proved to be infected
mogeneous pancreatic and peripancreatic collection, well demarcated with an enhancing wall, on day 25 of an episo
tiple organ failure. Therefore, this collection was suspected to be infected WON and not a pseudocyst. At surgery, the
ted on CT. These cases illustrate that at times CT cannot reliably differentiate between collections that consist of fluid
s with or without infection.
Infected necrosis:
Infected necrosis is: This case is a typical example of infected pancreatic necrosis. The necrosis also involves the peri
tion.
* On day 17 there are gas bubbles in the necrotic collection consistent with infected pancreatic and peripancreatic n
cess is no longer used, since a collection of pus without necrotic tissue is extremely uncommon in acute pancreatitis
ent of the pancreas with surrounding septated heterogeneous acute necrotic collections with fluid- and fat densities
eks later there are gas bubbles in the peripancreatic collection consistent with an infected acute necrotic collection.
mount of necrotic tissue and estimated he had removed over 90% of the pancreas. Continue with the next image. Re
eas. This indicates that during surgery the differentiation between pancreatic necrosis and necrosis of the peripancr
g are summarized in the table. Central gland necrosis with large collections in the left retroperitoneum and lesser sa
Central gland necrosis:
Central gland necrosis is a specific form of necrotizing pancreatitis, representing full thickness necrosis between the
disruption of the pancreatic duct. This leads to persistent collections as the viable pancreatic tail continues to secret
ndoscopic or percutaneous drainage. Definitive treatment may require distal pancreatectomy or long-term endosco
Reporting - PANCODE:
The Pancode system is a checklist for the description of acute pancreatitis and its complications.
Intervention:
The current management of acute pancreatitis is to be conservative for as long as possible. During the first two weel
e should be stabilized in the ICU. Interventions should be delayed for as long as possible. Many collections will remai
llections, which takes about 4 weeks.
FNA and Drainage:
Once the clinical condition of the patient deteriorates and the patient is febrile, fine needle aspiration (FNA) can be u
s. Important remarks concerning FNA: Important remarks concerning Drainage: Peripancreatic collections can be ap
row) or transabdominal (blue arrows) route, but the preferred approach is to stay in the retroperitoneal compartme
s: Videoscopic assisted retroperitoneal debridement (VARD)
Surgical intervention:
In 2013, the IAP/APA evidence-based guideline for the management for acute pancreatitis was published. The follow
through videoscopic assisted retroperitoneal debridement, catheters are left in place
Take home messages:

In these cases MRI can be of additional value.
* Avoid early drainage of collections and avoid introducing infection. by Peter A Banks, Thomas L Bollen, Christos De
G Tsiotos, Santhi Swaroop Vege, Acute Pancreatitis Classification Working Group. Gut 2013;62:102-11
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rch 2012
3. Imaging of Acute Pancreatitis: update of the revised Atlanta Classification by Bollen TL, Radiol Clin North Am 2012;
4. Acute Pancreatitis by Whitcomb N. Engl. J. Med., May 18, 2006; 354(20): 2142 - 2150
5. Staged multidisciplinary step-up management for necrotizing pancreatitis by da Costa DW et al, Br J Surg 2014;101
6. Acute Pancreatitis: Assessment of Severity with Clinical and CT Evaluation by Emil J. Balthazar, MD Radiology 2002;
7. A comparative evaluation of radiologic and clinical scoring systems in the early prediction of severity of acute panc
9.
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9. Update on Acute Pancreatitis: Ultrasound, Computed Tomography, and Magnetic Resonance Imaging Features by
10. MDCT of Acute Mild (Nonnecrotizing) Pancreatitis: Abdominal Complications and Fate of Fluid Collections by Dipt
11. Interventions for necrotizing pancreatitis: summary of a multidisciplinary consensus conference by Freeman ML
12. A step-up approach or open necrosectomy for necrotizing pancreatitis (PANTER trial) by van Santvoort et al. N En
Meniscus special cases:
Robin Smithuis
Radiology department of the Rijnland hospital in Leiderdorp, the Netherlands:
Publicationdate 2010-04-13 In this article we will show some examples of special meniscal pathology in more detail.
the article 'Knee Meniscus - Part 1'. On most images you can click to get an enlarged view, but this does not work on
Flipped meniscus:
Study the image on the left and try to determine what the problem is with this meniscus. Then continue with the nex
art 1' for the basics Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. Then continue reading.. As you already suspected by reading the title of this
a special form of bucket-handle tear. A flipped meniscus occurs when the ruptured fragment of the posterior horn is
o be enlarged. The anterior structure is the anterior horn. Also notice the focal bone marrow edema and the cartilag
4. The anterior structure is the anterior horn.
5. Some irregularity of the posterior part.
6. Posterior part moves caudally.
7. In the intercondylar fossa is the connection between the displaced fragment and the other part of the posterior ho
Disable Scroll Enable Scroll
Disable Scroll On the left another flipped meniscus. Now on the medial side. Part of the anterior horn is flipped post
rly. Most flipped menisci occur on the lateral side. The ACL prevents the meniscal fragment from completely migratin
a flipped meniscus. On a coronal image you will first see an enlarged bulky anterior horn. Posteriorly a very small po
Disable Scroll Enable Scroll
Disable Scroll On the left another case of a flipped lateral meniscus. Scroll through the images. The medial part is the
2. Medial part runs into the intercondylar fossa.
3. The dislocated part is well seen as 'third structure' in the intercondylar fossa.
4. Connection to the remnant of the posterior horn.
5. Connection to the remnant of the posterior horn.
6. Very small remnant of the posterior horn. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Same case sagittal images. Notice how the ruptured part of the meniscus runs anteriorly through the i
rior horn. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the left sagittal PD-images of a flipped meniscus. The whole posterior horn is flipped anteriorly resu
Bucket handle tear:
Enable Scroll
Disable Scroll Bucket handle tear Enable Scroll
Disable Scroll Bucket handle tear First study the images on the left. Then continue reading. The missing inner part is
).
2. The medially displaced part of the torn meniscus, i.e. the bucket handle can be followed in a posterior direction in
3. Continue.
4. Here is the connection between the bucket handle and the posterior horn.
5. Here an anterior slice demonstrating a meniscal cyst.
6. Notice the horizontal high signal.
7. Here we can appreciate the complexity of the meniscal tear with a longitudinal and horizontal component (arrows
he displaced inner fragment resembles the handle of a bucket. The remaining larger peripheral portion of the menis

meniscal tears.
Double PCL sign:
The double posterior cruciate ligament (PCL) sign is a low-signal-intensity band that is parallel and anteroinferior to t
tor of a bucket-handle meniscal tear (3).
Meniscal root tear:
First study the image on the left and try to recognize the meniscal tear. These tears often go unnoticed. Then continu
Disable Scroll Enable Scroll
Disable Scroll A radial tear is present at the posterior root junction of the medial meniscus which extends through th
ng through the defect (red arrows). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Meniscal root tears are often associated with extrusion of the meniscus beyond the margin of the tibia
with tears involving the meniscal root (6). In the case on the left there is a complete radial tear separating the poster
extrusion of the meniscus (image 1/6). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here another medial meniscal root tear. Notice that the posterior horn is not attached to the tibia. Inst
ese tears and think that the posterior horn is normal. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll This is another typical case of a medial meniscal root tear. Notice that there is also a lateral discoid me
Empty meniscus sign:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll When there is a complete radial tear, the two meniscal fragments can be completely separated. This ca
). LEFT: Absent or empty meniscus on sagittal image. RIGHT: Axial image shows complete radial tear leading to a defe
along the length of the tear you will see an absent or empty meniscus. These complete radial tears open up and give
find a displaced meniscal fragment. It is simply separation of the meniscal parts. On the left an illustration of a comp
. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the left coronal PD-images of a patient with a complete radial tear resulting in an empty meniscus s
orn of a meniscus that at first glance might give the impression that it is normal. Continue with the sagittal images. W
ice the empty meniscus sign, where normally the meniscal root attaches (red arrows). This means that we are dealin
p over the tibial spine to insert near the posterior cruciate ligament.
Vacuum phenomenon:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll First scroll through the images on the left. Try to figure out what is going on with this meniscus. Then c
within a discoid meniscus. At closer look you will notice that the horizontal structure has a lower signal intensity than
ed by a vacuum phenomenon. A vacuum phenomenon is caused by negative pressure within the joint due to the po
Continue with the radiograph of the same patient. Vacuum phenomenon on the lateral side.
Discoid Meniscus:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll First scroll through the images on the left. Try to figure out what is going on with this meniscus. Then c
de is a discoid meniscus (blue arrow). The structure on the medial side is again a vacuum phenomenon. On an adjac
Red zone meniscal tear:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll First scroll through the images on the left. Try to figure out what is going on with this meniscus. Then c
ry of the meniscus (red arrow). The outside one-third of the meniscus is called the 'red' zone, because it has a rich bl
because tears in this vascular portion of the meniscus are more likely to heal spontaneously than tears in the avascu
Meniscus within meniscus sign:
Sometimes extensive triangular or wedge-shaped high signal intensity can be encountered that does not reach te su
hin meniscus sign. Since this meniscal abnormality does not reach the meniscal surface, it does not fullfill the criteria
ients and symptoms warranting arthroscopic follow-up had meniscal tears (4). On the left another meniscus with dif
there was no evidence of a tear. Notice severe extrusion of the meniscus beyond the margin of the tibia plateau. Ena
Disable Scroll Enable Scroll
Disable Scroll Also notice the avascular necrosis.
3. Also notice the avascular necrosis.
4. Extrusion of meniscus avascular necrosis.
Meniscal extrusion:
Enable Scroll

Disable Scroll Enable Scroll
Disable Scroll Tears involving the meniscal root (central attachment) are also significantly related to the severity of m
ith major extrusion. With meniscus extrusion, the meniscus is unable to resist hoop stresses and cannot shield the a
this can lead to symptomatic knee osteoarthritis. Tears of the posterior meniscal root can be easily missed because
thorough arthroscopic examination. Detection of meniscal extrusion is important not only because it is associated w
thought to be related to development of osteoarthritis.
Segond fracture and meniscal tear:
A Segond fracture is an avulsion of the lateral capsular ligament. The mechanism of injury is internal rotation and va
agment off the lateral proximal tibia (figure). A Segond fracture has a high association with a tear of the anterior cruc
al menisci (66-70%). On the radiograph you could easily miss the Segond fracture (red arrow). Notice that there is als
the MR-images. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the left three consecutive coronal PD-images: Avulsion of bone fragment of lateral proximal tibia, i.
2. Notice displaced inner fragment of the meniscus.
This indicates that there is also a bucket handle tear.
3. Besides the bucket handle tear (inner blue arrow), there is also a barely visible horizontal tear in the peripheral pa
as better appreciated on other images (not shown). Continue with the sagittal images. A Segond fracture is almost pa
o demonstrated in this patient. On the left an AP-view of another patient. In association with a Segond fracture (red a
iate ligament (blue arrow).
Meniscal cyst:
A meniscal cyst results from extrusion of synovial fluid through a peripherally extended horizontal meniscal tear. Me
sterior horn and lateral meniscal cysts are most commonly located adjacent to the anterior horn or body. On the left
yst are adjacent to the anterior horn as a result of a complex tear. On the left three consecutive images of a small m
arrow). On the left coronal PD-images without fatsat and with fatsat. A large meniscal cyst is seen in relation to a ho
, H. Stanley Lambert and Laurence D. Higgins. AJR 2005; 185:1429-1434
2. Bucket-handle tears of the medial and lateral menisci of the knee: value of MR imaging in detecting displaced frag
of Roentgenology, Vol 165, 621-625
3. The Double Posterior Cruciate Ligament Sign by Marc A. Camacho November 2004 Radiology, 233, 503-504.
4. Grade 2C Signal in the Mensicus on MR Imaging of the Knee by Thomas R. McCauley et al AJR 2002; 179:645-648
5. Lateral Meniscus Root Tear and Meniscus Extrusion with Anterior Cruciate Ligament Tear by Jeffrey M. Brody et al
6. Medial Meniscus Extrusion on Knee MRI: Is Extent Associated with Severity of Degeneration or Type of Tear? by Ro
7. Radial Tear of the Medial Meniscal Root: Reliability and Accuracy of MRI for Diagnosis by So Yeon Lee et al AJR 200
8. MR Imaging of Meniscal Cysts: Incidence, Location, and Clinical Significance by Scot E. Campbell AJR 2001; 177:409
None:

Mediastinal Lymph Node Map:
Robin Smithuis
Radiology department of the Alrijne Hospital in Leiderdorp, the Netherlands:
Publicationdate 2010-06-08 This is an update of the 2007 article, which used the Mountain-Dresler regional lymph no
9 a new Lung cancer lymph node map was proposed by the International Association for the Study of Lung Cancer (I
e MD-ATS maps and refine the definitions of the anatomic boundaries of each of the lymph node stations (2). In this
standing of this IASLC lymph node map.
IASLC lymph node map 2009:
Regional lymph node classification for lung cancer staging adapted from the American Thoracic Society mapping sch
1.Low cervical, supraclavicular and sternal notch nodes From the lower margin of the cricoid to the clavicles and the
s as border between 1R and 1L. Superior Mediastinal Nodes 2-4
2R.Upper Paratracheal 2R nodes extend to the left lateral border of the trachea. From upper border of manubrium t
lic) vein with the trachea.
2L.Upper Paratracheal From the upper border of manubrium to the superior border of aortic arch. 2L nodes are loca
3A.Pre-vascular These nodes are not adjacent to the trachea like the nodes in station 2, but they are anterior to the v
3P.Pre-vertebral Nodes not adjacent to the trachea like the nodes in station 2, but behind the esophagus, which is pr
4R.Lower Paratracheal From the intersection of the caudal margin of innominate (left brachiocephalic) vein with the
rom the right to the left lateral border of the trachea.
4L.Lower Paratracheal From the upper margin of the aortic arch to the upper rim of the left main pulmonary artery.
5. Subaortic These nodes are located in the AP window lateral to the ligamentum arteriosum. These nodes are not lo
e vessels.
6. Para-aortic These are ascending aorta or phrenic nodes lying anterior and lateral to the ascending aorta and the a
7.Subcarinal
8. Paraesophageal Nodes below carina.
9. Pulmonary Ligament Nodes lying within the pulmonary ligaments. Hilar, Lobar and (sub)segmental Nodes 10-14 T

10. Hilar nodes These include nodes adjacent to the main stem bronchus and hilar vessels. On the right they extend
the left from the upper rim of the pulmonary artery to the interlobar region. Enable Scroll
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Axial CT anatomy:
Click on image to enlarge.
Then scroll through the axial CT-images. Images by Dr. Aurelia Fairise of the Institut de Cancérologie de Lorraine in N
Specific Lymph Node Stations:
1. Supraclavicular zone nodes 1. Supraclavicular zone nodes These include low cervical, supraclavicular and sternal n
Upper border: lower margin of cricoid.
Lower border: clavicles and upper border of manubrium. The midline of the trachea serves as border between 1R ar
l border of the trachea.
Upper border: upper border of manubrium.
Lower border: intersection of caudal margin of innominate (left brachiocephalic) vein with the trachea. 2L. Left Uppe
Upper border: upper border of manubrium.
Lower border: superior border of aortic arch. On the left a station 2 node in front of the trachea, i.e. a 2R-node. Ther
A and 3P nodes 3. Prevascular and Prevertabral nodes Station 3 nodes are not adjacent to the trachea like station 2 n
he esophagus, which lies prevertebrally. Station 3 nodes are not accessible with mediastinoscopy. 3P nodes can be a
in the prevascular space. Notice also lower paratracheal nodes on the right, i.e. 4R nodes. 4R. Lower Paratracheal no
Upper border: intersection of caudal margin of innominate (left brachiocephalic) vein with the trachea.
Lower border:lower border of azygos vein. 4R nodes extend to the left lateral border of the trachea. On the left we s
teral to the aortic arch, i.e. station 6 node. 4L. Lower paratracheal nodes 4L. Left Lower Paratracheal 4L nodes are lo
t tracheal border, between a horizontal line drawn tangentially to the upper margin of the aortic arch and a line draw
. These include paratracheal nodes that are located medially to the ligamentum arteriosum. Station 5 (AP-window) n
t an image just above the level of the pulmonary trunk demonstrating lower paratracheal nodes on the left and on th
left an image at the level of the lower trachea just above the carina. To the left of the trachea 4L nodes. Notice that th
but are not located in the AP-window, because they lie medially to the ligamentum arteriosum. The node lateral to t
tic or aorto-pulmonary window nodes are lateral to the ligamentum arteriosum or the aorta or left pulmonary artery
lie within the mediastinal pleural envelope. 6. Para-aortic nodes Para-aortic (ascending aorta or phrenic) nodes are lo
aortic arch from the upper margin to the lower margin of the aortic arch. 7. Subcarinal nodes These nodes are locate
ith the lower lobe bronchi or arteries within the lung. On the right they extend caudally to the lower border of the br
per border of the lower lobe bronchus. On the left a station 7 subcarinal node to the right of the esophagus. . 8 Para
tend caudally to the diafragm. On the left an image below the carina. To the right of the esophagus a station 8 node.
node. On the corresponding CT image the node is not enlarged (blue arrow). The probability that this is a lymph noc
enlarged nodes is higher than in enlarged nodes. 9. Pulmonary ligament nodes Pulmonary ligament nodes are lying
and lower part of the inferior pulmonary vein. The pulmonary ligament is the inferior extension of the mediastinal p
odes are proximal lobar nodes, distal to the mediastinal pleural reflection and nodes adjacent to the intermediate br
since they are not located in the mediastinum.
Axial CT of Lymph Nodes:
Enable Scroll
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Mediastinoscopy and EUS:

Conventional mediastinoscopy:
The following nodal stations can be biopsied by cervical mediastinoscopy: the left and right upper paratracheal node
tation 4L and 4R) and the subcarinal nodes (station 7). Station 1 nodes are located above the suprasternal notch and
Extended mediastinoscopy:
Left upper lobe tumors may metastasize to the subaortic lymph nodes (station 5) and paraaortic nodes (station 6). T
scopy. Extended mediastinoscopy is an alternative for the anterior-second interspace mediastinotomy which is more
rocedure is far less easy and therefore less routinely performed than conventional mediastinoscopy.
EUS-FNA:
Endoscopic Ultrasound with Fine Needle Aspiration can be performed of all the mediastinal nodes that that can be a
the left liver lobe can be visualized. EUS particularly provides access to nodes in the lower mediastinum (station 7,8
3
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Osteolytic - ill defined bone tumors:
Henk Jan van der Woude and Robin Smithuis
Radiology department of the Onze Lieve Vrouwe Gasthuis, Amsterdam and the Rijnland hospital, Leiderdorp, the Ne
Publicationdate 2011-01-01 In the article Bone Tumors - Differential diagnosis we discussed a systematic approach t
. In this article we will discuss the differential diagnosis of ill-defined osteolytic bone tumors in alphabetic order. You
Introduction:
On the left the most common ill-defined bone tumors and tumor-like lesions. An ill-defined zone of transition is seen
mor-like lesions in different age-groups. In the middle column common ill-defined osteolytic lesions. Notice the follo
Chondrosarcoma:
Chondrosarcoma Key facts On the left a partially ill-defined osteolytic lesion with endosteal scalloping. There are clou
aging findings and the size of the lesion favor the diagnosis of a chondrosarcoma. On the left two other lesions that
ot essential in chondrosarcoma. More on Chondrosarcoma On the left a lobulated partially ill-defined lytic lesion of t
t this is a chondroid tumor. The lytic parts with cortical involvement and expansion should raise the suspicion of a hi
Eosinophilic granuloma:
Eosinophilic granuloma with ill-defined borders. Key facts On the left some examples of EG with ill-defined borders.
e left a typical presentation of EG in the skull as an ill-defined osteolytic lesion. More on Eosinophilic granuloma
Ewing's sarcoma:
Ewing's sarcoma in diaphysis of the femur. Notice ill-defined zone of transition (blue arrow) and aggressive type of p
with a Ewing's sarcoma in the femur. Notice the ill-defined osteolysis. There is an aggressive periosteal reaction. On
patient. There is a permeative destruction pattern with irregular cortical destruction. There is an aggressive periostea
On the left an ill-defined lytic lesion of the right iliac bone in a young patient which can easily be overlooked. Final dia
Giant cell tumor:
GCT of the radius with ill-defined margins on the left and a GCT in the tibia with well-defined margins Key facts On th
d margins, destruction of the subchondral bone plate and extension towards the soft tissues. On the right a giant ce
n and non-interrupted cortical bone. More on Giant cell tumor
Lymphoma:
Key facts The plain radiograph on the left shows an ill-defined lytic lesion of the humerus diaphysis. Notice tunneling
r abnormalities within the cortical bone and the circumferential soft tissue mass. Differential diagnosis (depending o
y revealed Non-Hodgkin lymphoma
Metastases:
Metastasis in distal femur Key facts On the left a 60 year old patient with a known malignancy. There is a lesion in th
it was focal osteopenia. The lesion presents as a large ill-defined osteolytic mass extending into the epiphysis and al
of age GCT would be a possible diagnosis. It proved to be a metastasis.
Multiple Myeloma / Plasmacytoma:
Key facts
Osteomyelitis:
Key facts Periosteal reaction and permeative pattern may mimic malignant process: Ewing's sarcoma, osteosarcoma
* In the pediatric age group eosinophilic granuloma may also mimic osteomyelitis.
* Pediatric osteomyelitis: most commonly in central metaphysis, may cross to epiphysis.
* Adult osteomyelitis: most commonly in central metaphysis or diaphysis.
* May be highly permeative with cortical breakthrough, abcesses and fluid along fascia on MR imaging. On the left a
lesion seen on both sides of the physeal plate in the proximal tibia. This is highly suggestive for osteomyelitis. Other
ght coronal T1-weighted MR image reveals a well-defined epi-metaphyseal lesion. There is a dark peripheral zone of
in the metaphysis. On the left an ill-defined osteolytic lesion in the proximal metaphysis of the tibia with extensive re
Osteosarcoma:
Osteosarcoma Key facts of Osteosarcoma On the left a mixed osteolytic and sclerotic lesion in the proximal humerus
teal reaction and a soft tissue mass.
Roadmap to evaluate ovarian cysts.:
Wouter Veldhuis, Robin Smithuis, Oguz Akin and Hedvig Hricak
Department of Radiology of the University Medical Center of Utrecht, of the Rijnland hospital in Leiderdorp, the Neth
g Cancer Center, New York, USA:
Publicationdate 2011-05-15 Ovarian cancer is the second most common of all gynecologic malignancies. It is the lead
ting as a complex cystic mass. The finding of an adnexal cyst causes considerable anxiety in women due to the fear o
in postmenopausal women - are benign. In this article we will focus on specific features of ovarian cysts that are help
map for the diagnostic work-up and management of ovarian cystic masses, based on ultrasound and MRI findings. In
the most common ovarian cystic masses will be presented, as well as several less common cystic lesions.
Diagnostic work-up:

If a cystic pelvic mass is present, the first step is to find out if it is ovarian or non-ovarian in origin.
* Step 2 The next step is to determine if the lesion can be categorized as one of the common, benign ovarian masses
atoma), or is indeterminate.
* Step 3 To aid in selecting the proper work-up, the final step is to determine whether a patient falls into a low-risk ca
ctors) or a high-risk category (i.e. post-menopausal or premenopausal with additional risk factors). Based on these st
US, further evaluation with MRI or excision.
Role of imaging:
Role of Ultrasound For characterization of ovarian masses, ultrasound is often the first-line method of choice, especi
lid lesions. Role of CT CT is useful for the N- and M-staging of proven malignant lesions. Role of MRI For complex lesi
urther evaluation with MRI. Even with MRI it is often not possible to make an accurate diagnosis of neoplastic subtyp
ment of potentially malignant ovarian lesions is prevented. This is not only beneficial to the small number of women
roach to the management of sonographically indeterminate adnexal lesions.
Ovarian or non-ovarian:
If a cystic adnexal mass is present and you suspect an ovarian origin, the first thing to do is try to identify the ovaries
tely identifiable normal ovaries, then most likely you are dealing with an ovarian lesion. If both ovaries are separately
arian cystic lesion, or a lesion that mimics a cystic mass. The next step would be to check if there is uni- or bilateral d
ate malignancy. Also look for secondary findings like ascites, enlarged lymph nodes and peritoneal deposits. The tab
ses. Enable Scroll
Disable Scroll Scroll through the images Enable Scroll
Disable Scroll Scroll through the images A helpful tool to identify the ovaries is to follow the ovarian veins caudally. S
in from where it joins the inferior vena cava, and the left ovarian vein where it joins the left renal vein, until you ident
Ultrasound pattern recognition:
Pattern recognition on ultrasound often allows a fairly confident diagnosis of common cystic ovarian masses. This m
ning the probability that we are dealing with a lesion which falls into the category of a simple cyst, hemorrhagic cyst,
to as a dermoid cyst). Most other cystic lesions are indeterminate and therefore possibly malignant. These therefore
.
Simple cyst:
US findings that allow a confident diagnosis of a simple ovarian cyst are: The US-image shows two simple cysts in the
sels are normal and there are no vascularized septations. These were simple follicular cysts in a premenopausal wom
usually follicular cysts.
They are commonly seen in premenopausal women, but functional cysts also still do occur in postmenopausal wome
A hydrosalpinx may also mimic an ovarian cyst. Cystadenomas can also present as simple cysts, but they usually pre
screening study from 1987 to 2002 including 15,106 women of 50 years or older, 2763 women (18%) were diagnosed
s turned out to be ovarian cancer (4). In women of reproductive age, cysts up to 3 cm are a normal physiologic findin
These simple physiologic cysts do not need to be described in the imaging report and do not require follow-up (1). Cy
certainly benign. Cysts larger than 7 cm may be difficult to assess completely with US and therefore further imaging
ies Functional cysts Hemorrhagic cyst
Hemorrhagic ovarian cyst - HOC:
When a Graafian follicle or follicular cyst bleeds, a complex hemorrhagic ovarian cyst (HOC) is formed. US findings th
e: In premenopausal women short term follow-up is recommended in hemorrhagic cysts > 5 cm. The same follow-up
he characteristics of a HOC
Larger hemorrhagic cysts in the early menopause and any hemorrhagic cyst in the late menopause should be consid
idered. Hemorrhagic cyst with a clot mimicking a neoplasm. Notice absence of flow and good through-transmission (
ffuse low-level echoes, their appearance can be similar to that of endometriomas. In the acute phase a hemorrhagic
solid mass (5). Clot in a hemorrhagic cyst may occasionally mimic a solid nodule in a neoplasm. Clot, however, often
has outwardly convex borders. In both cases there will be no internal flow at Doppler US and there will be good thro
eeks. The ultrasound image shows multiple simple and one complex right ovarian cyst, with diffuse low-level echos a
transmission, also through the complex cyst (blue arrow). On the T1 with fatsat the lesion remains bright, ruling out
, confirming that this is a cystic hemorrhagic lesion, most likely a hemorrhagic ovarian cyst, although your differentia
Endometrioma:
US findings that allow a confident diagnosis of an endometrioma are: In women of any age, probable endometrioma
Until surgically removed, endometriomas require follow-up with ultrasound, for example on a yearly basis. This imag
n with diffuse low-level echoes and two small echogenic foci. These have been postulated to be cholesterol deposits,
tant to differentiate these echogenic foci from true wall nodules. Finding these echogenic foci makes the diagnosis o
Mature cystic teratoma:
US findings that are characteristic of a mature cystic teratoma are: Shown are transvaginal ultrasound images of two
c shadowing from the hyperechoic part of the dermoid cyst (arrow). When misinterpreted as bowel gas, the lesion m
Any other cyst - possible neoplasm:
All other cystic lesions are regarded as possibly neoplastic and therefore possibly malignant. Surgical resection is ne
ing-based staging. Findings indicating possible neoplasm: While benign lesions can be very large, the likelihood that

that a neoplastic lesion is malignant, increases with the size of the lesion.
* Vascularized septations The presence of septations indicates a possible neoplasm. When septations have a thickne
- both increase the likelihood that a neoplasm is malignant.
* Vascularized solid components Vascularized nodularities, papillary projections, or frank solid masses all increase th
* Vascularized thick, irregular wall Lesions with thin walls are more often benign and lesions with thick, irregular wall
making wall thickness a less useful criterion. For example a corpus luteum cyst may also have a thickened, vascularize
* Secondary findings associated with malignant lesions: Large quantities of ascites, lymphadenopathy and peritonea
malignancy. Benign cystic ovarian neoplasms Malignant cystic ovarian neoplasms
Low-risk or High-risk:
Once we have determined a cystic ovarian lesion is either a probable simple cyst, hemorrhagic cyst, endometrioma o
place the patient in a low-risk or high-risk group (table). The final decision to ignore, follow or excise a cystic ovarian
ic ovarian lesions is benign. While the risk of malignancy does increase with age, even in post-menopausal women th
Although complex ovarian cysts in post-menopausal women are also most often benign, they do require further wor
'the Roadmap':
The natural history of incidentally detected pelvic masses with benign US morpgology is not known and therefore th
010 Consensus Guidelines published in (1) and (2) and on the findings in (3) and (4). The mentioned size cut-offs and
ules. Local guidelines may differ based on the clinical scenario and institutional practice preferences. Many of the im
asound, CT and MRI, although of course not every feature is equally detectable on all modalities. Risk factors Age is t
nopausal and post-menopausal women are managed differently. Several other factors (see table) may place a woma
ys, one for lower-risk and one for higher-risk patients.
MRI protocol - which sequences, and why:
MRI protocol There are many possible 'Pelvic/Ovarian mass' protocols. The basic building blocks are simple and are t
nly 1, 2 and 3 (e.g., when the request is to 'rule out an ovarian mass'). Many radiologists prefer a slightly more compr
setting is characterization or staging of a known ovarian lesion, 4 (or CT) and 5 should always be included. The role o
a useful aid in the detection of lymph nodes, tumors and peritoneal deposits.
For the purpose of detection, the DW images are sometimes fused with (superimposed on) anatomical T2W images.
DWI cannot discriminate benign from metastatic lymph nodes. Further differences in protocols all arise as variations
* T2W images in more than 2 planes, or obliquely angled orthogonal to the anatomic structure of interest, are often
MR imaging is a valuable adjunct to US, as it allows identification of blood products within hemorrhagic masses that
s may reveal small amounts of fat, which allows the diagnosis of a mature teratoma ('dermoid'). Contrast-enhanced T
cing mural nodules and/or enhancing solid areas with or without necrosis (3). These MR images show a lesion with h
ontent or fat. On the image with fat-saturation there is suppression of the signal. This means that we are dealing wit
image shows an echogenic lesion. The corresponding lesion has a high signal on the T1-weighted MR image.
This indicates either blood, high protein or fat. On the image with fat-saturation there is no suppression of the signal
n, i.e. most likely a hemorrhagic cyst. by Deborah Levine et al September 2010 Radiology, 256, 943-954.
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Practical approach to Acute Abdomen:
Adriaan van Breda Vriesman and Robin Smithuis
Radiology department of the Rijnland Hospital, Leiderdorp, the Netherlands:
Publicationdate 2005-10-20 The 'acute abdomen' is a clinical condition characterized by severe abdominal pain, requ
ay be challenging, because the differential diagnosis of an acute abdomen includes a wide spectrum of disorders, ra
tions (Table 1). Indicated management may vary from emergency surgery to reassurance of the patient and misdiagn
surgery. Sonography and CT enable an accurate and rapid triage of patients with an acute abdomen. We present pra
eractive cases are presented in the menubar to test your knowledge.
Radiological strategy:
Table 1. Common causes of acute abdomen from life-threatening to self-limiting. Before you perform an examinatio
t the clinician simply 'order' a sonogram or CT, but discuss the patient's age and posture, laboratory results and the r
d on that information and your own degree of confidence with the modalities decide for yourself whether to perform

ntact, enabling assesment of the spot of maximum tenderness and the severity of illness without ionizing radiation.
y. In patients with inconclusive US-results, CT can serve as an adjunct to sonography, and vice versa. We advocate th
Confirm or exclude the most common disease Screen for general signs of pathology You have to be familiar with all
Clinics, laboratory, and plain abdominal film:
The clinical presentation of patients with an acute abdomen is often nonspecific. Both surgical and nonsurgical disea
boratory findings (leucocyte count, erythrocyte sedimentation rate, CRP) are equally nonconclusive. Findings may be
is) and may be abnormal in patients without a surgical disease (like salpingitis). A plain abdominal film has a limited v
not exclude an ileus or other pathology and may falsely reassure the clinician. LEFT: Plain abdominal film in a patien
equent CT shows distended small bowel loops (arrowheads) that are not seen on plain abdominal film because they
eus may not be appreciated on a plain abdominal film if bowel loops are filled with fluid only without intraluminal ai
te an ileus than sonography or CT are usually needed to identify its cause. Thus, a plain abdominal film is seldomly u
eumoperitoneum. For all other indications use sonography or CT.
Confirm or exclude the most common disease:
Many disorders may cause an acute abdomen, but fortunately only a few of these are common and clinically importa
RLQ : Appendicitis:
Pain in the RLQ, regardless of any other symptom or laboratory results, should be considered to be appendicitis unti
nnot rule out the diagnosis of appendicitis unless a good alternative diagnosis is found. If you do not find the appen
he examination indeterminate. Do not call it:' no appendicitis'. Normal appendix : Longitudinal (A) sonogram depicts
e', with a maximum outer diameter of 6 mm, with noninflamed surrounding fat. On an axial view (B) the appendix ca
rst task is to identify the appendix. At sonography and CT the appendix is seen as a blind-ending nonperistaltic tubul
a small bowel loop for the appendix. Secondly determine if the appendix is normal or inflamed. The outer-to-outer d
Although an overlap of appendiceal diameters in normal and inflamed appendices can incidentally be found, a thres
air-containing non-distended appendix (arrowheads), with homogeneous low-density periappendiceal fat. A normal
non-inflamed fat, is compressible and often contains intraluminal gas. Inflamed appendix at sonography. Longitudin
ssible appendix, surrounded bij hyperechoic inflamed fat (arrowheads). Inflamed Appendix An inflamed appendix ha
fat. The presence of a fecolith or hypervascularity on power Doppler strongly supports inflammation. Inflamed appe
h periappendiceal fat-stranding. CT depicts an inflamed appendix as a fluid-filled blind-ending tubular structure surr
ating wall is seen on the enhanced CT. In patients who lack intra-abdominal fat the use of iv. contrast can be helpfull
sonography. A hypoechoic thickened diverticulum is surrounded by hyperechoic inflamed fat (arrows).
LLQ : Diverticulitis:
If the pain is located in the LLQ your main concern is sigmoid diverticulitis. In diverticulitis sonography and CT show d
lammatory changes in the
fat surrounding a diverticulum. Uncomplicated sigmoid diverticulitis. Fat stranding and focal thickening of the coloni
ications of diverticulitis such as abscess formation or perforation, can best be excluded with CT. LEFT: Sigmoid divert
ng fat. The sigmoid wall is thickened. RIGHT: Sigmoid carcinoma with limited fat stranding. An important pitfall is col
pecially when the colon cancer is surrounded by fat stranding due to invasive groth, desmoplastic reaction or inflam
erticulitis from colon cancer and therefore we routinely include colon cancer in the differential diagnosis of sigmoid
RUQ : Cholecystitis:
Cholecystitis occurs when a calculus obstructs the cystic duct. The trapped bile causes inflammation of the gallbladd
preferred imaging method for the evaluation of cholecystitis, also allowing assesment of the compressiblity of the g
e on the non-compressability of the galbladder. Do not rely on measurements. Some galbladders happen to be sma
gallbladder wall. The gallbladder is noncompressible ('hydropic') and causes an impression in the anterior abdomina
s of an enlarged hydropic (meaning non-compressible) gallbladder with a thickened wall in the region of maximum t
lbladder is enlarged with edematous thickening of its wall (arrowhead), and some regional fat-stranding can be foun
reas the obstructing calculus itself may or may not be identified because it is located deep within the galbladder nec
fat, but on sonography this frequently is not seen, while CT sometimes does show fat-stranding. Potential pitfalls ar
ll may lead to thickening of the gallbladder wall without cholecystitis. Therefore be certain that hydropic obstruction
of cholecystitis. Pain in LUQ An acute abdomen with LUQ pain is rare. Its most common cause is gastric pathology in
Screen for general signs of pathology:
After excluding these frequent disorders, search for signs of any other pathology, by systematically screening the wh
, ascites and free air. Inflamed fat at sonography. Extended-view of the ventral abdomen depicting an area of hypere
ompare this to the echogenicity of normal abdominal or subcutaneous fat (green arrows). This patient had an omen
Inflamed fat:
Inflamed fat is hyperechoic, space occupying and noncompressible at sonography. Same patient as above. Unenhan
(arrowheads), in the right-upper quadrant. Compare this to normal low-density subcutaneous fat. Diagnosis: omenta
fat usefully points out where and what the problem is. As a rule, the organ or structure in the centre or nearest to th
ickening of bowel wall in a patient with colitis.](/assets/acute-abdomen-practical-approach/a5097976c20727_US-darr
ient with colitis.
Bowel wall thickening:
Thickening of bowel wall indicates inflammation or tumor, and has an extensive differential diagnosis. Thickening of

all bowel tumors (carcinoid, lymphoma, GIST) are relatively infrequent. In patients with local colonic wall thickening a
distended small bowel loops, but part of the small bowel and the whole colon is nondistended. Therefore this must
easily be identified: intussusception (arrowhead).
Ileus:
Pathologic distention of bowel loops may be caused by obstruction or paralysis. Firstly determine which parts of the
rmal nondistended bowel loops, which, if present, strongly suggest an obstructive cause for the ileus. Enable Scroll
Disable Scroll Scroll through the imagesSmall Bowel Feces Sign: Feces in the dilated small bowel just proximal to the
roll
Disable Scroll Scroll through the imagesSmall Bowel Feces Sign: Feces in the dilated small bowel just proximal to the
el obstruction (SBO) accounts for approximately 4% of all patients presenting with an acute abdomen. The diagnosis
l bowel loops. If obstruction is present, try to identify its cause and location (adhesion, tumor, volvulus, intussuscepti
ases and are the likely cause when a smooth transition from dilated to collapsed small-bowel loops is noted. The 'Sm
at the zone of transition thus facilitating identification of the cause of the obstruction. The SBFS has been defined as
op that simulates the appearance of feces. Scroll through the images on the left to see the small bowel feces sign inc
t any normal bowel loops strongly suggests a paralytic cause. This is usually a response to general peritonitis, wich m
ppendicitis. US only showed a little bit of ascites. A diagnostic puncture (arrow marks needletip) revealed blood. In a
Ascites:
Asymptomatic volunteers do not have a detectable amount of free intraperitoneal fluid, with the exception of an inci
ascites is a nonspecific sign of abdominal pathology, indicating that 'something is wrong'. You may want to perform
stigate whether it is sterile reactive fluid, pus, blood, urine, or bile. Intraperitoneal air in a patient suspected of having
ng on the right.
Free air:
The presence of free intraperitoneal air is proof of bowel perforation, and indicates a surgical emergency. A pneumo
ulcer Perforation of colonic diverticulitis Free air is usually not seen in perforated appendicitis). Always examine the
ominal air (figure).
Differential diagnosis:
A complete list of all possible causes of an acute abdomen is of little use in daily practice, therefore we just provide s
dominal pain US shows enlarged mesenteric lymph nodes in the right lower quadrant, with no other abnormalities
Mesenteric lymphadenitis.:
Mesenteric lymphadenitis is a common mimicker of appendicitis. It is the second most common cause of right lower
iting inflammation of right-sided mesenteric lymph nodes without an identifiable underlying inflammatory process,
n only be made confidently when a normal appendix is found, because adenopathy also frequently occurs with appe
Key finding: Lymphadenopathy with a normal appendix and normal mesenteric fat. Normal appendix (green arrow)
mesenteric lymphadenitis in a child suspected of appendicitis. US typically shows submucosal wall thickening (arrow
surrounding fat.
Bacterial ileocecitis:
Infectious enterocolitis may cause mild symptoms resembling a common viral gastroenteritis, but it may also clinical
cially in bacterial ileocecitis, caused by Yersinia, Campylobacter, or Salmonella. Key finding: ileocecal wall thickening
an inflamed cecal diverticulum (arrowhead) with regional colonic wall thickening.
Right-sided diverticulitis:
Right-sided colonic diverticulitis may clinically mimic appendicitis or cholecystitis, though the patient's history is gene
right-sided colonic diverticula are usually true diverticula, that is, outpouchings of the colonic wall containing all laye
benign self- limiting character of right-sided diverticulitis. Enlarged adnex due to salpingitis
Pelvic inflammatory disease:
Pelvic inflammatory disease is a common mimicker of both of appendicitis and diverticulitis. Transvaginal sonograph
tic of epiploic appendagitis with a right-sided fatty mass surrounded by a hyperattenuating ring.
Epiploic appendagitis.:
Epiploic appendages are small adipose protrusions from the serosal surface of the colon. An epiploic appendage ma
pain that simulates appendicitis when located in the right lower quadrant or diverticulitis when located in the left lo
lamed visceral peritoneal lining surrounding an infarcted fatty epiploic appendage. Left sided epiploic appendagitis i
cteristic hyperattenuating ring sign. Epiploic appendagitis has been reported in approximately 1% of patients clinical
ke a positive diagnosis of this characteristic entity since epiploic appendagitis is a self-limiting disease. Both US and C
. Key finding: inflamed fatty mass adjacent to the colon with characteristic ring sign. Small stone in right ureter (arrow
Urolithiasis:
Urolithiasis often causes flank pain, but an ureteral stone (arrowhead) may occasionally present with clinical signs si
icitis on the other hand may cause hematuria, pyuria and albuminuria in up to 25% of patients because of ureteral in
al fluid collection due to ruptured aneurysm.
Ruptured Aneurysm:
Most abdominal aortic aneurysms rupture into the left retroperitoneum (4). Clinically this may simulate sigmoid dive
djacent structures. However most patient will present with the classic triad of hypotension, a pulsating mass and

back pain. Continuous leakage will lead to rupture into the peritoneal cavity and eventually death. Sonography is a q
specific for the diagnosis of aneurysmal rupture than CT. The absence of sonographic evidence of rupture does not r
nded by fat stranding due to exsudative pancreatitis.
Pancreatitis:
CT depicts fat-stranding (arrowheads) surrounding the primary focus of the inflammation: the pancreas. Conclusion
osis may have serious consequences. We advocate a systematic approach: First focus on the most common diseases
omen for general signs of pathology. A prospective study of ultrasonography in the diagnosis of appendicitis JB Puyla
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None:

Dynamic Rectal examination:
Tjeerd Wiersma
Radiology department of the Rijnstate Hospital, Arnhem, The Netherlands.:
Publicationdate 2006-07-15 Dynamic rectal examination (DRE) is also known as defecography or proctography. DRE
e rectal expulsion of a barium paste that approximates the consistency of feces. DRE provides qualitative and quanti
function, and the effectiveness of the anal sphincter and rectal evacuation. by Tjeerd Wiersma
Dynamic Rectal Examination:
The commode needs to be radiolucent and safely attached to a fluoroscopic table
Indications:
Indications for dynamic rectal examination are: LEFT: Pathology is suspected because of a great distance between re
estion of liquid barium contrast a large enterocele is seen.
Technique:
Two hours prior to the examination the patient ingests 135 ml of liquid barium contrast to opacify the small bowel (f
ration.
The ideal rectal contrast has to simulate stool in weight and consistency.
In our experience, Evacu-Paste? 100 (E-Z-EM Inc., Westbury, NY, USA) is a convenient paste. The barium paste is injec
nsion or until about 250 ml has been instilled. In females the vagina is coated with 30 ml amidotrizoic acid 50% solut
It is applied by means of a syringe with a soft pediatric enema tip. The use of tampons and gauzes soaked in barium
r sufficient filling of the rectum, the patient is asked to sit on a special commode.
The fluoroscopic screening of the rectum and the function of the pelvic musculature and the continence mechanism
The duration of examination is about 15 minutes.
Imaging:
Rest, start of defecation and end of defecation Examinations includes a number of standard images and maneuvers.
out consciously contracting any pelvic muscles and a spot film is taken. The patient then maximally contracts the pel
ular diaphragm and in elevation of the entire pelvic floor a spot film or video is taken. Finally the patient is asked to e
An estimate of the completeness of defecation and measurement of pelvic floor descent can be made. Morphologica
During straining a S-shaped rectum may simulate intussusception in lateral projection. It is important that the patie
nature of defecation is lost when the patient is lying down. Additional oblique or anteroposterior (AP) views should b
teral views (figure). An S-shaped rectum may simulate an intussusception in lateral projection. On the left lateral and
On the left lateral and an AP-view of a patient with an S-shaped rectum which simulates an intussuseption on the la
Recording:
The whole procedure of DRE should be recorded on video or DVD. Dynamic recording of the fluoroscopic images en
the diagnosis of rectocele, enterocele and intussusception, as well as to evaluate the function of the anal sphincter. D
facilitate direct screen measurements of angles. Some patients give a history of various unusual maneuvers (digital
atients to demonstrate the maneuvers during the examination may facilitate the radiological documentation of the
lly can restore the dynamics of rectal evacuation, have been developed speed and completeness of rectal emptying i
Normal findings:
At rest (left), during defecation (middle) and at the end of defecation (right) At rest: distance between vagina and ven
Findings of abnormalities:

Rectocele:
A rectocele can be defined as an anterior or posterior bulge of the rectal wall
beyond the extrapolated line of the wall (Fig. 1). The formation of an anterior rectocele is often apparent during defe
relative weakness of the rectovaginal septum.
At the end of the defecation, residual rectal contents may be left in the rectocele ('trapping').
Significantly more anterior rectoceles were found in female patients and in female control subjects than in males.
Anterior rectoceles may occur in individuals without complaints of the anorectal region
and should therefore particularly in women be considered as a posiible normal phenomenon. Rectocele seen during

sually a feeling of incomplete bowel movement
often requiring digital pressure to the vagina or perineum to facilitate emptying, together with aching
after a bowel movement. Barium trapping in the rectocele is considered to be important in explaining the repeated
sensation of rectal fullness after defecation. In our own series no correlation could be found between the size of the
ore. It has been suggested that rectoceles may be the result of repeated straining secondary
to a preexisting disorder (f.e. spastic pelvic floor syndrome) of defecation rather than to
the rectocele being the primary cause of the obstructive symptoms. This may also explain why rectocele repair is oft
When surgical repair of a rectocele detected at physical examination is considered, preoperative
DRE should be performed to exclude other causes of obstructed defecation (intussusception or enterocele). DRE der
edure e.g. to
correct the intussusception instead of the rectocele. In patients with an anterior rectocele, in whom other causes of
should be considered. In our opinion there are two indications for operating on an anterior rectocele. First: if a patie
cond: in cases of disturbed sexual intercourse. Posterior rectoceles are incidental findings and not related to clinical
ra-anal intussusception, 3 : Extra-anal intussusception (rectal prolapse)
Intussusception:
Intussusception of the rectum is an invagination of the rectal wall, which begins as a circular fold 6 to 8 cm up in the
tal wall folds in towards the rectal lumen. The intussusception can be intra-rectal, intra-anal or finally extra-anal as a
s folding inwards progresses and deepens to form a ring pocket, so that it finally fills the entire ampulla. This may re
. A minimal folding inwards which disappears after the bolus has passed is probably caused by a transient prolapse
most common complaint of the patient with intussusception is: Difficulty in bowel emptying. Pain, blood loss upon d
ften leads to pruritis ani. Upon hard straining the obstructive sensation increases.
In order to empty their bowels many patients have to extract the feces manually, while others have to exert pressure
Enemas may be ineffective. S-shaped rectum which simulates an intussuseption on the lateral view (same case as ab
and difficult to reproduce, while intrarectal intussusception may be overlooked on clinical examination and is seldom
the anal canal it leads to maximal dilatation. These patients often complain of fecal incontinence in between defecat
tying during defecation. A longstanding intussusception may lead to the solitary rectal ulcer syndrome. There is seld
lapse. Lesser grades of prolapse, however, can present a variety of difficulties. Oblique or anteroposterior (AP) views
able image of intra-anal intussusception than the standard lateral view during evacuation.
Enterocele:
An enterocele is a peritoneal sac that has herniated downwards along the ventral rectal wall. As DRE is routinely perf
el are then seen to fill the gap between the vagina and the rectum. Grade 1 is maximally reaching down to the distal
tal lumen. Grade 2 is as grade 1, but reaching down to the perineum. Grade 3 is protruding out of the anal canal to f
fecation there is a rectocele, that is pushed downward by an enterocele . Sometimes the enterocele is identified only
rocele may be pressed into the direction of the introitus vaginae. If there is an associated rectocele, this can be push
Clinically it can be difficult to diagnose an enterocele. Patients with previous pelvic surgery are predisposed to the fo
gina and rectum. In female patients with constipation there is a higher incidence of severe enteroceles in patients wi
omy (9%). Chronically increased intra-abdominal pressure may cause an enterocele with or without a previous pelvic
into a deep pouch of Douglas.
It is less common than an enterocele. Schematic lateral view on the levator ani and external sphincter ani muscles
Spastic pelvic floor syndrome:
On the left a schematic lateral view on the levator ani and external sphincter ani muscles is shown. The puborectal m
ng defecation the puborectal muscle should relax allowing passage of the stool. LEFT: Hypertonic sphincter (during d
-relaxing during defecation). Spastic pelvic floor syndrome denotes a persistent contraction of the pelvic floor muscle
he pelvic floor muscles causing an outlet obstruction. The question arises, however, whether persistent contraction i
ly occurring during the investigation, or whether it really represents a functional disorder of the pelvic floor muscle r
Psychological factors may play a role. The anorectal angle (ARA) normally increases on straining as a result of relaxat
from 20? to 40?. In a small group of patients with impaired evacuation, DRE demonstrated either an unchanged or d
result from a persistent or paradoxical increase of the puborectal muscle impression. This appearance is often quite
e attempts at straining and defecation.
None:

None:

Ultrasound in Acute Abdomen:
Julien Puylaert
Department of Radiology, MCH Westeinde Hospital, The Hague, The Netherlands:
Publicationdate 2007-04-24 Multi-slice CT is increasingly replacing ultrasonography for the evaluation of patients wit
Ultrasound however has specific advantages. This review will focus on: For critical comments and additional remarks
Introduction:
Illustration of a sigmoid diverticulitis

Why perform ultrasonography when you have CT ?:
Multi-slice CT is increasingly replacing ultrasonography (US) for the evaluation of patients with acute abdominal pain
time burden is often less than that of a US examination (1-4). CT is not disturbed by gas and bone, while obesity is ev
can be reviewed by others, even at a distance. With all these advantages, it is not surprising that US is losing field in
dvantages. Visualization of the normal appendix by CT in an obese patient and by US in a lean patient.
Specific advantages of US:
This is only true if the target organ can be approached closely, which requires either a thin patient or the use of grad
Valsalva manoeuvre. Intra-abdominal fat is pressed into the abdominal wall (arrow) through an epigastric hernia. Sp
nd pulsations, and it is also possible to appreciate the effects of respiration, Valsalva maneuver, gravity and compres
Compare the contracted normal ileum (left) with the relaxed, flattened ileum in the same patient a few seconds late
or tissues are soft or rigid. Real time US allows one to observe the effect of compression. On the far left a contracted
seconds later. US guided puncture of intraperitoneal fluid reveals purulent nature of the fluid in a patient with perfo
ge of US over CT is that it allows precise correlation of the US findings with the area of maximum tenderness or with
nd flexibility: It can be done in the Emergency Ward, High Care Units and the Operating Room, and with the present
ywhere. Information provided by the patient may lead to a specific search for a US finding, while, vice versa, certain U
is interactive aspect is perhaps the greatest secret of a successful US examination. If performed in this way, US is mu
oceeds, it is possible to correlate the US findings with the clinical data, the laboratory results, other imaging studies a
long list of possible differential diagnoses will continuously narrow down until a definitive diagnosis is established, o
. The point of maximum tenderness and a possible palpable mass, are correlated with the US findings and in case of
Who does the US examination ?:
Worldwide, there is a large variation of who performs the US examination of the acute abdomen. US is done by tech
inal radiologists, and all sorts of clinicians, urologists, gynecologists and even family doctors. The US examination per
medical background, knowledge of all possible causative conditions (urological, gynecological, gastrointestinal, vascu
imaging guided puncture and other radiological imaging. There is no doubt that the person who meets these condit
ial interest in abdominal US and CT. Additional advantages of concentrating all primary, diagnostic abdominal US exa
ees integrated imaging, constant quality, round-the-clock coverage, continuity, central archiving and accurate and ea
US Technique:
Normal ileum and appendix during compression. Thin habitus of the patient and the application of compression allo
mination in patients with acute abdominal pain requires a specific technique of graded compression. In this way fat
bing influence of bowel gas and reduces the distance from the transducer to the appendix, allowing the use of a high
ue also allows assessing the rigidity of a structure by evaluating its reaction upon compression In order to avoid pain
to the classic palpation of the abdomen. Acutely inflamed appendix in deep pelvic position. The appendix could only
abdomen is examined to exclude disease of gallbladder, pancreas, kidney, aorta, stomach, small and large bowel, ap
er survey of the distal ureters, and of uterus and ovaries in women; however, a full bladder does not allow proper gr
conditions but also for pelvic appendicitis, diverticulitis and Douglas abscesses. The 'mowing-the-lawn' technique. Th
o six vertically oriented, overlapping lanes using a broad based, high frequency probe. We refer to this as 'mowing th
use of thin-liquid US-gel. Segmental colitis in Crohn's disease Bowel pathology is usually conspicuous, because the di
ch contrasts with the surrounding hyperechoic fatty tissue. On the left a patient with segmental colitis caused by Cro
using the 'mowing-the-lawn' technique.
Appendicitis:
The typical appearance of an inflamed appendix is that of a concentrically layered, non-compressible sausage-like st
enderness (Figure). The average maximum diameter is 9 mms with a variation from 7 to 17 mms. In 30% intralumina
after the onset of symptoms, the inflammation progresses to the adjacent fat of the meso-appendix, which becomes
tissue will tend to increase in volume around the appendix: this represents mesentery and omentum, which have m
erforation. Acute appendicitis. The inflamed appendix shows local disturbance of the layerstructure indicating local t
d fat will probably effectively wall-off the imminent perforation. Slowly applied intermittent compression is the best
irregular, asymmetrical contour and loss of the layer structure of the appendix indicate perforation or imminent per
edly increased or absent due to high intraluminal pressure with concomitant ischemic necrosis, however there is alw
ssue . The presence of a generalized, adynamic ileus is suspect for perforated appendicitis, even if the inflamed appe
sition in a patient with clinical signs of cholecystitis. Due to its abnormal position far from McBurney's point (McB), th
This influenced site, size and orientation of the incision and facilitated the appendectomy. A small quantity of free in
on-perforated and perforated appendicitis as well as in many other conditions, both surgical and non-surgical. A larg
represent pus from perforated appendicitis and then is usually accompanied by paralytic ileus. Larger quantities of f
d food particles) and gynecological conditions (puncture usually reveals blood). In most patients with appendicitis inf
the mesenterial root. In case of an abnormal position of the inflamed appendix far from where the usual gridiron-inc
dix on the skin of the patient with a waterproof marker. This may influence site, size and orientation of the incision. S
ith a dilated lumen and a diameter of 11mm. Patient experienced rapidly subsiding symptoms and did not undergo
ndix has decreased in size.
Normal appendix:
The normal appendix presents as a small, easily compressible, concentrically layered, mobile, blind-ending, sausage-

ormal appendix is mobile, may have a collapsed lumen, but also may contain air or some fecal material, and rarely a
nal and there is no hyperechoic, non-compressible inflamed fat around the appendix. Acute appendicitis. Noncompr
compressable ileum. The lumen is dilated and the diameter is 11 by 13 mm. Note the fluid-debris level within the lur
Spontaneous resolving appendicitis:
If the clinical symptoms rapidly subside despite the presence of an unequivocally inflamed appendix on US, one shou
These patients initially have the typical clinical signs of appendicitis, but within 12-48 hours after the onset of pain th
due to relief of obstruction. On US follow up, the appendix usually decreases in size in the course of days. If the pati
is advisable, even if the patient is again completely free of symptoms at that time. Histology in such cases will nevert
agement is opted for, keep in mind that there is a recurrence rate of approximately 40 % (8). Resolution of an appen
other six weeks later.
Appendiceal mass:
Patients, who are admitted with considerable delay may present with a palpable mass and relatively mild peritonitis.
mass of non-compressible fat around the appendix, interspersed with echolucent streaks . These patients are diagn
ly because the surgeon knows that appendectomy in such cases is technically difficult or even impossible (9). On the
n the right lower quadrant. At examination a palpable mass was found. There was no evidence of peritonitis. On the
s consisting of the inflamed appendix, mesentery and omentum. Patient was treated conservatively. Follow up exam
l abnormalities. The patient was completely symptom free. There were no recurrent symptoms and the patient did n
inflamed appendix (arrows). If next to the inflamed appendix, a fluidcollection is found, this is suggestive for an appe
rrounded by inflamed non-compressible hyperechoic tissue representing omentum and mesentery as well as secon
ess from the peritoneal cavity. If an appendiceal abscess is demonstrated and there is no frank peritonitis, percutane
have no fever and only mild pain, it can be even wise to await spontaneous drainage of the abscess to neighboring b
e the inflamed appendix (arrows) lying next to the abscess. Acute appendicitis with a small periappendiceal abscess.
Better off with immediate surgery:
Finally, there are some patients with an appendiceal abscess who are better off with immediate surgery: this goes in
tis, which indicates that the walling-off process is failing. Immediate surgery is also indicated for patients who have a
, in whom appendectomy with evacuation of the abscess is usually technically easy (Figure). On the left a patient with
nitis at physical examination. The sedimentation rate was 48mm/hour. Palpation was unreliable. Subsequent appen
difficulties. Prior to percutaneous drainage, CT is necessary to delineate the extent of the abscess and to determine
d puncture, the combination US plus fluoroscopy has several advantages over CT guided drainage. It is rapid, allows
-side procedure.
Pitfalls in the US diagnosis of appendicitis:
A false positive diagnosis can be made if the normal appendix is mistaken for an inflamed one. Not infrequently the
to lymphoid hyperplasia and in adults due to fecal impaction. Appendiceal compressibility, the absence of a Doppler
tures in deciding if it is normal or inflamed. Mistaking a normal appendix for an inflamed one may also occur if there
carcinoma. In the latter case, the appendiceal lumen is obstructed giving rise to sterile accumulation of mucus in the
The patient often has remarkably mild symptoms and is managed conservatively under the erroneous diagnosis of a
ecognized, this may lead to considerable delay in surgical treatment. The combination of a relatively large appendix
cion of underlying malignancy. Other conditions with secondary thickening of the appendix are perforated peptic ulc
med appendix, demonstrated in the longitudinal (left) and axial (right) plane, has a gas-filled lumen (arrowheads), ma
d fat are the clue to the diagnosis. Pitfalls in the US diagnosis of appendicitis (2) A false negative ultrasound examina
ix. In experienced hands the inflamed appendix can be visualized in 90% of patients with acute appendicitis. General
a lower score in patients with free appendiceal perforation. Also air-filled dilated bowel loops from adynamic ileus m
ifficult to identify the inflamed appendix. Pitfall. Acute appendicitis, but appendix has a diameter of only 6.5mm. How
icating that it is acutely inflamed. Pitfalls in the US diagnosis of appendicitis (3) Another pitfall is demonstration of the
nflamed tip is overlooked, because it is obscured by bowelgas. Rarely, the inflamed appendix has a maximal diamete
the presence of inflamed fat must give the clue. On thr left a patient with acute pain in the right lower quadrant. The
amed fat and an increased Doppler signal indicating that it is acutely inflamed. Pitfall. Secondary thickening of the ile
ut the inflamed appendix (arrow) is overlooked, an erroneus diagnosis of Crohn's disease or infectious ileocolitis can
her pitfall is advanced appendicitis where there is secondary wall thickening of the ileum. Often the ileal thickening is
flamed appendix (Figure). If only the ileum is appreciated and the appendix is overlooked, an erroneous diagnosis of
ileocecitis or Crohn's disease can be made, leading to ill-advised surgical delay. Similarly, if in an adult patient enlarge
uld be cautious to diagnose mesenteric lymphadenitis because these nodes could be secondarily enlarged due to ac
appendicitis, while the inflamed appendix is overlooked. If in a patient with appendicitis only the fecolith in the appe
erlooked, this may lead to an erroneous diagnosis of cecal diverticulitis. Pitfalls in the US diagnosis of appendicitis (5)
cyst is found, this is not necessarily the cause of her symptoms and appendicitis should still be searched for. Finally,
ssible inflamed fat of omentum and mesentery is visualized, and the inflamed appendix is overlooked, this may lead
agitis (10,11). In patients with equivocal US findings, CT scan is indicated. A fortunate circumstance is that these are c
Ileocecal Crohns disease:
Crohn's ileitis with transmural inflammation and abscess formation. Patients with ileocecal Crohn's disease often ha
ay. On the other hand, Crohn's disease may also present with acute, appendicitis-like symptoms and lead to an ill-ad

in establishing the initial diagnosis (12,13). The sensitivity of US for detecting ileocecal Crohn's disease of over 95%. C
ed wall thickening of the terminal ileum with focal disruption of the wall and a small abscess, walled of by hypoechoi
jacent appendix. Note the focal loss of layer structure of the ileal wall and large masses of surrounding inflamed fat (
e ileum, which shows decreased or no peristalsis and is not compressible. Classically, all layers are involved and laye
g echolucent changes in the submucosa. There is inflammation of the fatty mesentery and omentum, recognizable a
cholucent wall bright eccentric foci may indicate deep ulceration. Echolucent streaks within the hyperechoic tissue in
Figure). Cecum and appendix may also show mural thickening. Mesenteric lymph nodes are often markedly enlarged
found which is recognized as a large, moderately well-compressible fatty mass encompassing most of the circumfere
often US signs of prestenotic dilatation, abscess formation, or fistulaformation.

Infectious ileocolitis and Infectious ileocecitis:

Infectious ileocolitis is a bacterial infection of terminal ileum and colon which is characterized by diarrhea and abdor
acter and Salmonella, and Yersinia. The infection is generally limited to the mucosa, is self-limiting and rarely poses c
tious ileocolitis in which the infection is mainly limited to the ileocecal area and is therefore has been coined infectio
ria and the importance of this variant is that its clinial symptoms are dominated by acute right lower abdominal pain
de as the clinical signs of appendicitis and explain why infectious ileocecitis often leads to an unnecessary laparotom
of appendicitis. There is marked mucosal and submucosal wall thickening of ileum and cecum. The symptoms of Yer
d the US features may mimick those of Crohn's disease. The absence of a transmural component, the self-limiting co
he correct diagnosis. The frequency of infectious ileocecitis is fairly high and has a ratio of 1 to 8 compared to appen
ymptoms of appendicitis.

US shows prominent ileocecal valve and to marked mucosal and submucosal wallthickening of ileum and cecum.

Enlarged lymph nodes were found in the radix of the mesentery. The appendix was normal. Appendectomy was can
entually revealed Campylobacter jejuni. Infectious ileocecitis. US reveals mucosal and submucosal wall thickening. Th
appendix is normal (arrow). In infectious ileocecitis US shows fairly characteristic features. There is diffuse thickening
m. The appendix has to be sonographically normal (Figure). Infectious ileocecitis caused by Yersinia, Campylobacter,
ectious ileocecitis, the wall layers are always intact and the muscularis and serosa, are never affected. Also omentum
bowel obstruction, abscess- or fistula-formation. The various micro-organisms have a slightly different pattern of aff
resentation of relative involvement of ileum, cecum and mesenteric nodes in infectious ileocolitis caused by Yersinia

Mesenteric Lymphadenitis:

Mesenteric lymphadenitis. Enlarged mesenteric lymph nodes. Appendix was normal. This is an ill-defined entity, prol
nflamed and enlarged. It is a typical disease of childhood and is only rarely seen in young adults. It mimicks the clinic
ssary appen?dectomy. The US findings are solely enlarged, hypervascular mesenteric lymph nodes. However if these
ssible that these nodes are in fact secondarily enlarged due to acute appendicitis and the inflamed appendix is overl

Cecal carcinoma:

Cecal carcinoma. US reveals asymmetric, hypoechoic, circumferential wall thickening of the cecum (arrowheads) with
node. Patients with cecal carcinoma can present with acute or subacute abdominal symptoms, in several ways. The
involved, the tumour may perforate and the tumour itself may cause direct pain. The often bulky nature of the tumo
makes cecal carcinoma in most cases fairly conspicuous on US. The majority presents as a hypoechoic, solid, well-va
l (Figure). In the proximity enlarged mesenteric lymph nodes can be found, and in most cases there is also some infla
of the scirrhous type, which is less easy to detect. The finding of livermetastases of course strongly supports the diag
l base only rarely causes a full-blown appendicitis, but rather will lead to mucinous dilatation of the appendiceal lum
the underlying tumour and, since there is often a palpable mass and protracted symptoms, these patients are often
icant surgical delay. A clue to the correct diagnosis is the discrepancy between the relatively mild and protracted sym
the appendix and the surrounding tissue. Another helpful sign are markedly enlarged mesenteric lymph nodes (sho
ymptoms and US abnormalities do not resolve within weeks, colonoscopy is indicated.

Sigmoid diverticulitis:

Normal, empty sigmoid. Axial view during relaxation and compression with the transducer shows the colonic anaton
of the muscularis layer. Note the separation of each tenia from the circular muscular layer by a thin, echogenic layer
iverticulitis is often made on clinical grounds. In the classical case the patient presents with localized pain and guardi
r on, elevation of the sedimentation rate. However, the diagnosis is not always clear. On one hand the clinical signs r
ed, as urinary tract infection, renal colic, perforated peptic ulcer, adnexitis or, -in case of diverticulitis in a rightsided l
clinician may think of sigmoid diverticulitis while in fact another condition is present, as sigmoid carcinoma, epiploic
n a ruptured aortic aneurysm. In all of these cases, US may play a role by making the correct diagnosis at an early po
of the sigmoid can reliably be identified in virtually all patients due to its consistent location laterally in the left parac
variable. The lumen can be empty or filled with feces, and the sigmoid can be contracted or relaxed (Figure). Sigmoi
ed diverticula are recognized as strongly reflective, round structures casting an acoustic shadow and localized at the
ticulum, consisting of mucosa only, is not separately visible. A third factor influencing the aspect is compression by th
verticulosis is often markedly thickened and fecolith-containing diverticula can easily be recognized, as large (4-12 m
oustic shadow and localized on the outside of the contour of the contracted colon. If the sigmoid is filled with feces,
diverticulosis in two asymptomatic patients. LEFT: The neck of the diverticulum becomes obstructed. Surrounding in
the imminent perforation. RIGHT: Development of a small paracolic abscess, successfully walled-off by mesentery ar

of the disease. In the earliest stage there is usually local wall thickening of the colon, at first without but later with lo
h there is hyperechoic, non-compressible tissue, which represents the inflamed mesentery and omentum trying to s
entified during gentle, intermittent compression with the transducer, is obligatory for the diagnosis of diverticulitis (1
ural course of sigmoid diverticulitis as it is observed in 80 % of patients. In stage 0 the neck of the diverticulum becor
and an impaired defense system against the bacteria lodging within the fecolith. Surrounding inflamed fat represen
ration. In stage 1 there is development of a small paracolic abscess, successfully walled-off by mesentery and oment
cally weakened. LEFT: Evacuation of pus and residual fecal material through the weakened sigmoid wall into the colo
resolution of the symptoms. In over 80 % of patients, after one or two days, the pus and the fecolith evacuate toward
he level of the original diverticular neck. (Figure) . Correspondingly, the patient's symptoms resolve. Note that the res
a long time after the evacuation, so the patient can be completely symptomfree when there are still considerable US
enign course. On the left the natural, benign course of sigmoid diverticulitis. TOP: US reveals mural thickening of the
aining a fecolith (stage 0). Note the surrounding hyperechoic, non-compressible tissue representing the omentum ar
n the fat, echolucent linear streaks (arrowheads) are visible. MIDDLE: One day later the patient feels slightly better. T
the diverticulum are bulging towards the sigmoid lumen, sign of impending evacuation. BOTTOM: Another two days
e completely evacuated to the sigmoid lumen, leaving an empty diverticulum (curved arrow). Paracolic abscess due t
ticulitis takes a complicated course. Free perforation without any sealing-off by mesentery or omentum, is relatively
ty quickly leads to severe peritonitis rendering laparotomy inevitable. Even in case of a larger diverticular abscess (>
the rule (Figure). On the left a paracolic abscess due to diverticulitis, effectively walled-off by large masses of inflame
entually evacuated completely, and the patient recovered without surgery. Schematic presentation of the natural evo
eloped. In some patients however the abscess may evacuate in a less favourable direction (Figure). In the first place,
ise to more longitudinally oriented abscesses undermining the colonic wall. These abscesses tend to heal badly and
iring elective surgery. In rare cases the abscess breaks through to the peritoneal cavity which may lead to diffuse per
bscess evacuates into bladder or vagina, a fistula may result. On the left a schematic presentation of the natural evo
developed. The most frequent and most favourable pathway is evacuation to the sigmoid lumen. Less favourable is
t, longitudinal, cuff-like abscesses. Even worse is the formation of secondary abscesses (A), and eventual perforation
B), vagina (V) and through the skin will lead to fistulaformation. Colovesical fistula with air-track resulting from sigmo
gmoid diverticulitis. LEFT: From the lumen of the sigmoid an air-track (arrow) can be followed all the way to the bladd
.
From the orificium of the fistula, from time to time the passage of air-bubbles (arrows) could be witnessed. Normal s
Differential diagnosis of diverticulitis:
Finally, US has an important role in the diagnosis of alternative conditions: ureterolithiasis, sigmoid carcinoma, ruptu
piploic appendagitis. On the left a sigmoid carcinoma in 39-year old patient with clinical signs of diverticulitis. LEFT: T
: the colon is thin-walled and well-compressible. RIGHT: Axial US image of the tumour shows asymmetrical, moderate
pressible fat around the tumour, representing a desmoplastic reaction. Epiploic appendagitis in a 48-year old man w
with clinical signs of diverticulitis. br>
US reveals an ovoid, non-compressible, avascular fatty mass (arrowheads) while the adjacent sigmoid has a normal a
The neighboring fat shows hyperemia (arrows). br>
During respiration the mass was seen to be adherent to the parietal peritoneum. br>
The patient's symptoms disappeared within a week without treatment. These findings are typical for epiploic appendo
The mass represents the infarcted epiploic appendagebr>
The patient's symptoms disappeared within a week without treatment.br> Although in lean patients and in women u
lonic carcinoma is often well-possible, it is good practice that in every patient with diverticulitis, colonoscopy is perfo
eous drainage of a large diverticular abscess is indicated in case of persistent spiking fever, however it is only rarely n
ss should always raise the suspicion of underlying malignancy.
Right sided colonic diverticulitis:
Rightsided colonic diverticulitis in many respects differs from sigmoid diverticulitis. Diverticula of the right colon are
all bowel layers. The fecoliths within these diverticula are larger, the diverticular neck is wider and there is no hypert
ndably, right colonic diverticulitis, which can occur at any age, almost invariably has a favourable course and never le
Although relatively rare, it is crucial to make a correct diagnosis, since the clinical symptoms of acute RLQ pain may l
n 40% of patients it even leads to a right hemicolectomy because the surgeon during the operation assumes he is de
ans, the diagnosis in the Western world is not rare: in a recent study one case of right colonic diverticulitis is seen for
0 cases of appendicitis [Oudenhoven]. US, if necessary complemented by CT, has characteristic features and prevent
For proper understan?ding of the US images, it is vital to realize the dynamic sequence of the inflammatory process,
]. A dangerous pitfall is to mistake a fecolith in the base of an inflamed appendix for a case of cecal diverticu?li?tis.
Perforated Peptic Ulcer:
LEFT: In the right upper quadrant wall thickening of the duodenal bulb is found. There are both transmural and extra
nterial and omental fat (fat) attempting -in vain- to wall off the perforation. RIGHT: In the right lower quadrant a large
ng of pneumoperitoneum on a standing chest X-ray in combination with severe acute upper abdominal pain, is stron
follow without additional imaging. In some cases however, symptoms of a perforated ulcer may be atypical and min
ther cases of perforated ulcer free air is not present or not detectable. In all those cases, US and CT may be of help. I

efines the ulcer, demonstrates the free fluid, and can guide puncture of this fluid. On the left a patient with a perfora
ing of the duodenal bulb is seen. There are both transmural and extramural (arrow) gasconfigurations. The inflamed
in- to wall off the perforation.
In the right lower quadrant a large amount of debris-like peritoneal fluid is found (right image). US in the left decubit
nother image of the patient with the perforated duodenal ulcer.
In the left decubitus position free air can be seen to collect between liver and the lateral abdominal wall. In peptic ulc
ll which contains a constant air configuration reaching from the duodenal lumen to the periphery of the wall or even
tion will allow gastric fluid- which is usually present in peptic ulcer disease- to proceed to the duodenum, enabling a
air-track can be found from the ulcer to the peritoneal cavity usually in ventral or cranial direction. Free air is best de
nd right abdominal wall. A lot of free fluid is usually present which contains airbubbles and foodparticles. Puncture r
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Dementia - Role of MRI:
Frederik Barkhof, Marieke Hazewinkel, Maja Binnewijzend and Robin Smithuis
Alzheimer Centre and Image Analysis Centre, Vrije Universiteit Medical Center, Amsterdam and the Alrijne Hospital, L
Publicationdate 2012-01-09 / Update: 2022-03-03 This presentation will focus on the role of MRI in the diagnosis of d
ects: Short overview of neurodegenerative disorders which may be associated with dementia Introduction.
Introduction.:
Coronal image of the hippocampus. The role of neuroimaging in dementia nowadays extends beyond its traditional
port the diagnosis of specific neurodegenerative disorders and sometimes radiological findings are necessary to con
te to the early diagnosis of neurodegenerative diseases such as Alzheimer's disease. Early diagnosis includes recogn
nt (MCI). In addition, early diagnosis allows early treatment using currently available therapies or new therapies in th
gression and is adopted in current trials investigating MCI and AD. The coronal image shows the hippocampus, the m
Assessment of MR in Dementia:
* Lewy = Dementia with Lewy bodies An MR-study of a patient suspected of having dementia must be assessed in a s
omas, tumors and hydrocephalus need to be excluded. Next we should look for signs of specific dementias such as:
or global atrophy, focal atrophy and for vascular disease (i.e. infarcts, white matter lesions, lacunes). When we study
, focal atrophy and for vascular disease (i.e. infarcts, white matter lesions, lacunes). This standardized assessment of
disorder includes: Click on image to enlarge
GCA-scale for Global Cortical Atrophy:
GCA scale is the mean score for cortical atrophy throughout the complete cerebrum: The central sulcus is more post
FLAIR images. In some neurodegenerative disorders the atrophy is asymmetric and occurs in specific regions. A radi
hen assessing atrophy in different regions keep in mind that cranially, the central sulcus lies more posteriorly than y
MTA-scale for Medial Temporal lobe Atrophy:
The MTA-score should be rated on coronal T1-weighted images at a consistent slice position. Select a slice through th
75 years : MTA-score 3 or more is abnormal (i.e. 2 can still be normal at this age) Data from a study with 222 controls
ual rating scale was used to assess temporal lobe atrophy suggest that sensitivities and specificities of 85% can be ob
ting of the width of the choroid fissure, the width of the temporal horn, and the height of the hippocampal formation
more is abnormal. Enable Scroll
Disable Scroll Scroll through the images Enable Scroll
Disable Scroll Scroll through the images Here you can scroll through the images for examples of MTA score 0-4. < 75
abnormal. Medial temporal lobe atrophy in Alzheimer's disease, vascular dementia, dementia with Lewy bodies (DLB
is of Alzheimer disease and is present in the vast majority of patients with AD, while in controls a positive score is alm
od test to discern controls from patients with AD. This test is not completely specific for AD however, as MTA can also
f a patient with mild cognitive impairment (MCI) a possible 'prodromal state of AD' has a negative MTA-score, it is ver

yields high negative predictive value), except in very young subjects, in whom a more posterior pattern of atrophy ca
ing progressive atrophy in familial AD (images kindly provided by Nick Fox). If there is a strong suspicion of Alzheime
if there is any progress of the (medial temporal lobe) atrophy. The images show a follow-up examination at 18 and 3
ing progression of the disease. An alternative approach would be to perform a SPECT- or PET-scan to look for change
changes precede the development of atrophy.

Fazekas scale for WM lesions:

On MR, white matter hyperintensities (WMH) and lacunes - both of which are frequently observed in the elderly - are
-scale provides an overall impression of the presence of WMH in the entire brain. It is best scored on transverse FLAI
s predicts future disability in elderly. Fazekas 1 is considered normal in the elderly. Fazekas 2 and 3 are pathologic, b
however, at high risk for disability. In 600 normally functioning elderly people the Fazekas score predicted disability
In the Fazekas 3 group 25% was disabled within one year (10). Three year follow-up shows that severe white matter c
decline (17). Caps and bands

Normal ageing:

The findings in a normally aging brain can overlap with findings in dementia. As implicated earlier, there may be som
easing prominence of the perivascular (Virchow-Robin) spaces and non-specific fronto-parietal sulcal widening. There
core of 2 for individuals older than 75 years of age may be normal. As the brain ages, there is an increasing depositio
glia, nucleus ruber and pars reticluaris of the substantia nigra. There also may develop a rim of high signal intensity c
and bands (figure). A limited amount of white matter hyperintensities may also occur in the normally ageing brain (F

Strategic infarctions:

Strategic infarctions are infarctions in areas that are crucial for normal cognitive functioning of the brain. These area
t seen on transverse FAIR and T2W sequences. The images show bilateral thalamic infarctions - lesions often associa
ferent patients. Study the images of two different patients. Then continue reading. The image on the far left shows a
tery (PCA), with involvement of the inferior medial temporal lobe which includes the hippocampus. This is a strategic
ult in cognitive dysfunction. The image next to it is a transverse FLAIR image showing another infarct in the PCA-terri
ea. This is another example of a strategic infarction that can result in cognitive dysfunction.

Koedam score for Parietal Atrophy:

In addition to medial temporal lobe atrophy, parietal atrophy also has a positive predictive value in the diagnosis of A
AD (15). This is particularly the case in young patients with AD (presenile AD), who may have normal MTA-scores. The
onal and axial planes. In these planes, widening of the posterior cingulate and parieto-occipital sulci as well as pariet
m scale grade 0-1 Koedam scale grade 0-1 Sagittal T1-, axial FLAIR- and coronal T1-weighted images illustrating the K
ined in different orientations, the highest score must be considered (16). Koedam scale grade 2-3 Koedam scale grad
lustrating the Koedam scale of posterior atrophy. The yellow arrows point to extreme widening of the posterior cingu
or atrophy.

FDG-PET:

In addition to clinical findings, CSF and MRI, PET-imaging is useful in diagnosing AD. In AD FDG-PET can show hypome
ulum. This may help differentiate AD from FTD, which shows frontal hypometabolism on FDG-PET. The images show
AD and FTD. FDG-PET (top row) and axial FLAIR images of a normal subject and of AD and FTD patients. In AD there
ereas in FTD, there is frontal hypometablism (red arrows).

Specific Diseases:

The prevalence of specific forms of dementia is age-dependent. In patients

In patients > 65 years there are more cases of senile AD and vascular dementia. In many older patients with manifes
he demented state. Specimen in end stage AD demonstrating severe global atrophy. Courtesy Webpath (11).

Alzheimers Disease:

AD accounts for 50%-70% of all cases of dementia in the elderly population. Age is a strong risk factor, with the disea
5 and 30% over the age of 85 years. The progression of AD is gradual and the average patient lives 10 years after the
the population, the prevalence of AD is expected to triple over the next 50 years. In end-stage AD there is widesprea
. In imaging we therefore have to try to identify AD in an earlier stage and we have to concentrate on the hippocamp
The role of MRI in the diagnostic process of AD is twofold: Study the image, then continue reading. The findings are
: It is not specific for AD however, since severe GCA occurs in other end-stage disorders as well Presenile AD with no

Presenile AD:

Presenile AD (

Although there usually is some mild hippocampal atrophy, the most striking finding is parietal atrophy with atrophy
be normal.

Mild Cognitive Impairment (MCI):

Mild cognitive impairment is a relatively recent term used to describe people who have some problems with their m
as having problems in two or more cognitive domains. Some of these patients will be in the early stages of Alzheime
em. Finding MTA is a strong risk-factor for progression to dementia. PCA infarction involving the medial temporal lob

Vascular Dementia (VaD):

Vascular dementia (VaD) is thought to be the second most common cause of dementia after Alzheimer's disease. It c
ociation with vascular risk factors. VaD can be characterized by its stepwise deterioration with periods of stability foll

, however, have small vessel disease, which is typified by a more gradual and subtle pattern of deterioration. Control
nesterase inhibitors (drugs that are being used in AD) are also increasingly being used to treat vascular dementia. Th
ng the hippocampus. This type of infarct can result in sudden dementia if located in the dominant hemisphere. It wil
hemisphere. Vascular dementia, no medial temporal lobe atrophy. In most patients with VaD there is diffuse white m
these patients the ventricles may be dilated due to global atrophy and some will also have medial temporal lobe atr
poral lobe was normal.
Strategic infarcts and small vessel disease:
Cognitive dysfunction in VaD can be the result of (2): MTA in a patient with VaD There is an increasing awareness for
ive decline and dementia. Moreover, it seems to amplify the effects of pathologic changes of Alzheimer's disease. On
matter disease is seen as severe WMH (hypointense on T1) in the periventricular regions. In addition to these vascul
VaD and AD, a finding seen in many elderly patients. These findings should be described separately as it may have th
hyperintensities and lacunes are also frequently observed in non-demented elderly and at some level can be regard
AIREN International Work Group has formulated criteria for the history and physical, radiological, (see above) and pa
probable and definite VaD. However considerable interobserver variability exists for the assessment of the radiologi
is mandatory (2). Bilateral medial strategic thalamus infarctions The medial nuclei of the thalamus play an importan
bilateral infarctions in this region can cause dementia. You have to pay special attention to these areas to find these
images you will easily miss these infarctions, because they can be isointense to the surrounding structures (8). A hig
FLAIR in the infratentorial region and in the spinal cord is of limited value as it suppresses not only the signal of wat
phenomenon can also be seen in the detection of Multiple Sclerosis, where FLAIR is of limited value in the infratento
Angiopathy
Cerebral Amyloid Angiopathy (CAA):
Dementia may be the clinical presentation in CAA, a condition in which ?-amyloid is deposited in the vessel walls of th
ut also subarachnoid hemorrhage or lobar hematomas may occur. On MR, the T2* sequence will show multiple micr
sive microhemorrhages, which are usually more centrally located, e.g. in the basal ganglia and thalami). In addition, l
es (Fazekas grade 2 or 3) T2* images in a patient with CAA show multiple peripherally located microbleeds. Cerebral
2 white matter hyprintensities. Cerebral Amyloid Angiopathy T2* images in a patient with CAA microbleeds. Cerebral
ds in a patient with CAA. End stage FTLD with striking atrophy of frontal and temporal lobes. No artophy of parietal a
Frontotemporal Lobar Degeneration (FTLD):
FTLD, formerly called Pick's disease, is a progressive dementia, that accounts for 5-10% of cases of dementia., and oc
linically characterized by behavioral and language disturbances that may precede or overshadow memory deficits. T
important role in the diagnosis as the findings are easy to recognize. Radiological findings are pronounced atrophy o
ophy might be strikingly asymmetric, e.g. in Semantic Dementia, a disease subtype with progressive aphasia and left
e blade' atrophy of left temporal lobe with normal right temporal lobe The images are of a patient with progressive a
rophy of the temporal lobe on the left side with not only atrophy of the hippocampus, but also the temporal poles. T
knife blade atrophy'). There is also some increased signal intensity seen on the FLAIR image, probably due to gliosis.
tients with left-sided temporal atrophy are usually clinically obvious. Right-sided atrophy is usually not as easily recog
es in recognizing faces. Lewy body dementia: normal hippocampus
Dementia with Lewy bodies:
Dementia with Lewy bodies is responsible for approximately 25% of dementias and belongs to the atypical Parkinson
lti-system atrophy (MSA). The clinical manifestations can be similar to that of AD or dementia associated with Parkins
tom complexes: detailed visual hallucinations, Parkinson-like symptoms and fluctuations in alertness and attention.
ewy bodies in various regions of the hippocampal complex, subcortical nuclei and neocortex with a variable number
the treatment of choice for this condition. The role of imaging is limited in Lewy body dementia. Usually the MR of th
important as it enables us to differentiate this disease from Alzheimer';s disease, the main differential diagnosis. Nuc
gic system (so-called DaTscan) PSP with midbrain atrophy
Progressive supranuclear palsy (PSP):
PSP is also one of the atypical parkinsonian syndromes. In PSP there is pronounced atrophy of the midbrain (mesenc
: 'humming bird sign' due to midbrain atrophy Normally the upper border of the midbrain is convex. The atrophy of
in with the typical 'humming bird sign' (figure). 'Hot cross bun sign' in MSA
Multi System Atrophy (MSA):
MSA is also one of the atypical parkinsonian syndromes. MSA is a rare neurological disorder characterized by a comb
omic dysfunction. MSA can be classified as MSA-C, MSA-P or MSA-A. In MSA-C (formerly known as sporadic olivopont
ereas in MSA-P the parkinsonian symptoms dominate (MSA-P was formerly known as striatonigral degeneration). MS
new term for what was formerly known as Shy-Drager syndrome. In MSA there is pronounced cerebellar atrophy and
nd slit-like increased SI lateral to putamen on T2. In contrast to PSP, we don't see the humming bird sign, because th
cross bun sign', which is a result of pontine hyperintensity, is typical for MSA-C. Notice the extreme atrophy of the po
of 2015 with images of 2018. Changes in the neocortex as seen on FLAIR (left) and DWI (right)
Creutzfeldt-Jakob disease (CJD):
CJD is a very rare and incurable neurodegenerative disease, caused by a unique type of infectious agent called a prio
ding to memory loss, personality changes and hallucinations. The disease is characterized by spongiform changes in

replacement by gliosis. The abnormalities can sometimes be detected on FLAIR, but are most conspicuous on DWI s
tion of both. Pulvinar hyperintensity in new variant of CJD. Courtesy Dr. Collie (12) New variant CJD New variant of CJ
fortunately hardly encountered anymore. In this variant the changes are seen in the posterior part of the thalamus,
Corticobasal Degeneration (CBD):
CBD is a rare entity which may present with cognitive dysfunction, usually in combination with Parkinson-like sympto
n. MRI shows asymmetric parietal cortical atrophy, sometimes with associated hyperintensity of the white matter on
arietal atrophy in a patient with CBD.
Huntington Disease:
Huntington disease is a hereditary neurodegenerative disease (autosomal dominant trait, but often de novo mutatio
tosis and psychosis. Imaging shows characteristic atrophy of the caudate nucleus and subsequent enlargement of th
Cerebral Autosomal Dominant Arteriopathy with Subcortical Infarcts and Leukoencehalopathy (CADASIL):
CADASIL is another hereditary disease which may present with a progressive cognitive dysfunction. Other presenting
sturbances. It affects the small vessels of the brain. Confluent white matter hyperintesities in the frontal and especia
arcts and microbleeds are seen on imaging. The FLAIR images show classic findings in CADASIL - confluent white mat
nterior temporal lobes. Traumatic brain injury
Traumatic Brain Injury (TBI):
Long term sequelae of traumatic brain injury such as cerebral contusions and diffuse axonal injury (DAI) may include
2* black dots typical for DAI in a patient with a history of trauma must therefore be taken into consideration when as
ost-traumatic tissue loss with gliosis in both frontal lobes, the left occipital lobe and right temporal lobe. In the book
f MR in dementia (9). Neuroimaging in Dementia
MR protocol:
Protocol that is used in the Alzheimer Centre in Amsterdam Coronal-oblique T1-weighted images are used for the as
obtained in a plane orthogonal to the long axis of the hippocampus; this plane is orientated parallel to the brainstem
by reformatting a sagittal 3D T1 sequence through the entire brain. Additional sagittal reconstructions will enable the
which may be involved in certain neurodegenerative disorders. FLAIR images are used to assess global cortical atrop
T2-weighted images are used to assess infarctions, in particular lacunar infarctions in the thalamus and basal gangli
necessary to detect microbleeds in amyloid angiopathy. These images can also depict calcifications and iron deposit
patients or in rapidly progressive neurodegenerative disorders (DD - vasculitis, CJD). CT with negative scan angle for
ane
CT protocol:
CT can be useful when contraindications prevent MRI or when the only reason for imaging is to rule out surgically tre
scan angle should be parallel to the long axis of the temporal lobe. Use of multi-detector CT will enable coronally ref
axis of the temporal lobe for optimal vizualisation of the hippocampus. Spiral CT of the brain with coronal reconstru
ed images to be reconstructed perpendicular to the long axis of the temporal lobe for optimal vizualisation of the hip
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Ankle fractures - Weber and Lauge-Hansen Classification:
Robin Smithuis
Radiology Department of the Alrijne Hospital, Leiderdorp, the Netherlands:
Publicationdate 2012-08-23 Classification of ankle fractures is important in order to estimate the extent of the injury
ses on the integrity of the fibula and the syndesmosis, which holds the ankle mortise together. The Lauge-Hansen sy
ansen to the Weber system will help you to predict ligamentous injury and instability. This article will help you to cor
not obvious at first sight.
Short overview:
Basically there are three main types of ankle fractures. Weber classified them as: These fractures are identical to the
supination-exorotation and pronation-exorotation. We will first give a short overview of these fractures and then dis
sm as described by Lauge-Hansen and the sequence of events that take place in stages, then you know where to loo
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Weber A:
Occurs below the syndesmosis, which is intact. According to Lauge-Hansen, it is the result of an adduction force on t
bular fracture is transverse, because it is an avulsion or pull-off fracture. The tibial fracture is vertical or oblique, beca
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Weber B:
This is a transsyndesmotic fracture with usually partial - and less commonly, total - rupture of the syndesmosis. Acco
on the supinated foot. Scroll through the images. Notice the oblique or vertical orientation of the push-off fibular fra
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Weber C:
This is a fracture above the level of the syndesmosis. Usually there is a total rupture of the syndesmosis with instabil
of an exorotation force on the pronated foot. Scroll through the images
Exorotation injury:
Weber A fractures are usually not a problem. Weber B and C are more difficult and it is essential to understand the s
injuries. This implies that 75-80% of ankle injuries are exorotation injuries. Weber B starts anterolaterally and the sec
Ligamentous rupture or Avulsion:
Another important thing to remember is, that a ligament can rupture or cause an avulsion fracture at the insertion. E
Weber and Lauge-Hansen summary:
Instability is seen in:
Weber and Lauge-Hansen combined:
How does it work when we combine the Weber classification to the stages of Lauge-Hansen? In daily practice most u
en seems rather difficult at first glance. Combining the simplicity of Weber with the explanation of the trauma mecha
a simple system, but now you really know what is going on. For instance if you see a fracture that is a stage 2 in the L
1 injury and you will study the radiographs with a high suspicion for signs of stage 3 and 4. This can best be demonst
aphs show a fracture of the posterior malleolus. If you would just report this as - a fracture of the posterior malleolu
kle fracture. A posterior malleolus fracture as an isolated finding is very uncommon. When we look at the scheme we
ses is part of a Weber B or a Weber C fracture. A tertius fracture is either Weber B stage 3
or - due to Weber C stage 4 (arrows). We have to re-examine the films to look for additional findings. Since we now k
gs. PE stage 1 On the ankle films there was no sign of an oblique fracture of the lateral malleolus, so we can exclude
C fracture stage 4, i.e. medial rupture or avulsion, high fibular fracture and finally a posterior malleolus fracture. At r
malleolus (red arrow), which is stage 1. Notice also the soft tissue swelling on the medial side (blue arrow) PE stage 3
nd they demonstrate a high fibular fracture, i.e. Weber C stage 3 also known as a Maisonneuve fracture. Weber C fra
l repair. Understanding the fracture mechanism and the stages according to Lauge-Hansen helps you to make the rig
t to make is, that when you understand the sequence of injuries to the ankle, then you know where to look for fractu
Weber A in detail:
We will now discuss the Weber classification and add the stages of the Lauge-Hansen system. Weber A is seen in 20-
is usually no problem. According to Lauge-Hansen the fracture results from an adduction force on the supinated foo
gaments which results in an avulsion fracture. Almost always the avulsion is seen as a horizontal fracture. This is call
e, which is seen as an oblique or vertical fracture. Weber-A stage I
Stage 1:
Weber C is seen in approximately 20% of ankle fractures. It is the most difficult fracture to diagnose and the Lauge-H
, as this will be an enormous help. According to Lauge-Hansen the fracture results from an exorotation force on the
side, which is under maximum tension due to the pronation. It will lead to rupture of the medial collateral ligament c
there will only be a rupture of the medial collateral ligaments or avulsion of the medial malleolus. Lauge Hansen cal
assification, since there is no fibular fracture. In many cases the injury progresses to a higher stage.

Stage 2:
Stage 2 is uncommon and easy to detect. More adduction force results in the medial malleolus being pushed off in a
he ankle is broken in two places. Notice the horizontal orientation of the lateral malleolus fracture and the vertical or
forces must have pushed off the medial malleolus. More on the ring of the ankle and instability
Weber B in detail:
Stage 1: Rupture of anterior tibiofibular ligament - or avulsion fracture (Tilleaux)
Stage 1-2:
Weber B is the most common type of ankle fracture and occurs in about 60 %. According to Lauge-Hansen the fractu
s usually not visible on x-rays. What we normally see is a stage 2 oblique fracture through the syndesmosis and we h
ibular ligament, which is stage 1. According to Lauge Hansen the first injury is on the lateral side, which is under max
ce the foot is in supination, the lateral malleolus is held tightly in place by the lateral collateral ligaments. The lateral
t more rotation of the talus will fracture the fibula in an oblique or spiral fashion because the lateral malleolus is pus
show a Weber B fracture. The oblique course of the fracture is typical for Weber B and results from the exorotation
e malleolar fracture usually starts medially at the level of the talar dome, but can also start a few centimeters above
Stage 3-4:
Stage 3 More posterior displacement of the lateral malleolus fragment by the talus results in tension on the posterio
s. Stage 4 Further posterior movement of the talus will result in extreme tension on the medial side and the deltoid l
the transverse plane. The sequences in a Weber B fracture or Lauge-Hansen supination exorotation injury take plac
arts may again align, which can make it difficult to detect the injuries. Weber B fracture The radiographs show a typic
reading. Do you see what stage this is? This is a Weber B stage 4 injury. Notice that all 4 stages are visible: These ima
an oblique fracture of the fibula. There is an avulsion of the posterior malleolus and an avulsion of the medial malleo
ce the oblique fibular fracture, which is best seen on the lateral view. This is stage 2 and we have to assume, that the
l tertius fragment is seen indicating stage 3. Now you start looking for stage 4 and you will notice the subtle lucency i
the stages of Lauge Hansen this must be a fracture. Here a more subtle case. At first impression there is a Weber B
ertius fracture. The small linear density on the AP-view is enough to diagnose a tertius fracture. The soft tissue swelli
llateral band , i.e. stage 4.
Weber C in detail:

Stage 2-3:
The talus rotates externally and moves laterally because it is free from its medial attachment. Due to the pronation,
move away from the tibia. This causes rupture of the anterior syndesmosis. This is stage 2. Continuous force will twis
ixed to the tibia. Finally the interosseus membrane will rupture up to the point where the fibular shaft fractures. This
s. In many cases it is visible on the radiographs of the ankle, but in some cases the fracture is located high and will o
ype of fracture is also called Maisonneuve fracture. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here we see the different stages in the axial plane. Scroll through the images. Weber C fracture - stage
ion fracture of the medial malleolus and a fibula fracture above the level of the syndesmosis. According to Lauge-Ha
rior syndesmosis (stage 2) must also be ruptured. We do not see a tertius fracture, which would indicate stage 4, but
acture - at least stage 3 Here an example of a Weber C fracture with a proximal fibula fracture. Notice that on the rad
e this as only some soft tissue swelling. In fact this is an unstable ankle fracture, since there also must be a rupture o
broken in two places leading to instability. According to Lauge Hansen we are probably dealing with:
Stage 4:
Finally the posterior syndesmotic ligament ruptures, or there is an avulsion of the posterior malleolus, also known as
ce is only slightly widened, but based on the stages of Lauge Hansen there must be a collateral band rupture.
Interpretation and Reporting:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar
ion Myanmar with a small gift. by John J. Hermans, Annechien Beumer, Ton A. W. de Jong and Gert-Jan Kleinrensink. J
2. AO-foundation ankle fractures
3. Introduction to Lauge Hansen & Danis Weber Classifications Ankle Fracture Animation on YouTube by Dr Glass.
None:

None:

How to Differentiate Carotid Obstructions:
Adriaan van Es
Leiden University Medical Centre in Leiden, the Netherlands:
Publicationdate 1-2-2023 In patients with an acute stroke and
an intracranial large vessel occlusion, we need to know if there is carotid
pathology and if so what kind of pathology we are dealing with. This is important for procedural

planning and the technical execution of endovascular treatment. Furthermore, carotid artery pathology determines secondary profylaxis with either carotid endarterectomy, stenting or anti-platelet therapy. The most common carotid obstruction is caused by atherosclerosis.
In this article we will discuss how to differentiate this type of carotid obstruction from an obstruction caused by a carotid dissection or a pseudo-occlusion Other pathology that we will discuss is the floating thrombus, the carotid web and the isolated internal carotid artery.
An isolated internal carotid artery is an unfavourable configuration of the circle of Willis which can lead to severe ischemia in case of a ICA occlusion.
A carotid web is an entity that is increasingly recognized as an important cause for ischemic stroke in especially young females.
Overview:
AtherosclerosisAtherosclerotic plaques are mostly located at the level of the bulbus. Atherosclerosis is usually bilateral and frequently calcifications can be seen. Subtotal stenosisIn a high-grade atherosclerotic stenosis the flow through the internal carotid is severely decreased and results in a collapse and consequently a small caliber of the vessel distal to the occlusion. OcclusionIn a total occlusion the contrast has a { or curly bracket-like configuration. Dissectio and the contrast in the proximal ICA has a flame-shaped configuration. The total diameter of the ACI is widened due to the formation of a mural hematoma. The narrowed eccentric true lumen is surrounded by a crescent-shaped mural on transversal imaging. The compressed true lumen can be occluded in case of severe compression. Pseudo-occlusionThis simulates an occlusio of the lower cervical part of the internal carotid, but is actually the result of a stop at the carotid T-top. Contrast that tries to enter the internal carotid will give a waterpaint appearance due to this outflow obstruction. Carotid webThis is a thin shelf-like luminal protrusion of the intimal fibrous tissue that extends from the posterior aspect of the proximal internal carotid artery bulb into the lum
The carotid web is increasingly being associated with ischemic stroke in young individuals, especially females. Study showing that differentiation between carotid dissection and pseudo-occlusion i sus pseudo-obstruction. In a study in which the CTA-findings were compared to tDSA (golden standard for carotid lesions), the results showed that there was a high accuracy in diagnosing atherosclerotic occlusions and high grade stenoses of the internal carotid artery. Only one atherosclerotic stenosis was misdiagnosed as a pseudo-occlusion. On the other hand pseudo-occlusions were misdiagnosed as carotid dissection and dissections were misdiagnosed as pseudo-occlusions quite frequently (red circles). In the chapters below we will discuss how to differentiate dissection from pseudo-occlusion. Tandem occlusions are intracranial occlusions combined with a severe (>70%) stenosis or occlusion of the ICA.
They are found in up to 30% of all patients presenting with a large vessel occlusion.
The accompanying ICA pathology is not a contra-indication for endovascular therapy for the intracranial occlusion, regardless of the underlying ethiology of the ICA stenosis/occlusion. However identifying caro execution of the endovascular procedure.
Atherosclerosis:
Typical findings in an atherosclerotic stenosis or occlusion are: These patients are usually older and have cardiovascular risk factors.
ICA stenosis measurement:
The illustration shows the formula for measuring the degree of stenosis according to the NASCET (North American S is (a) should be measured perpendicular to the longitudinal axis of the vessel (green line) and not in a pure axial plan f stenosis.
It is compared to the diameter of the normal vessel at about 6 cm distal to the stenosis (b).
In the formula the degree of stenosis is calculated. Calcifications are common in atherosclerotic

stenosis and CTA has a high sensitivity in detecting these calcified
structures. Sometimes a bias in the exact
evaluation of stenosis degree may be caused by the high attenuation values of
the calcified plaques.
This might lead to an overestimation of the degree of
stenosis.
Furthermore, heavily calcified plaques can be a challenge for the
interventional neuroradiologist as the stenosis needs to passed with a large
bored guiding catheter or long sheath (at least 6 Fr).
Near occlusion:
In a severe stenosis or near occlusion the diameter of the ACI above the level of the stenosis is diminished and less t
CA. In a total occlusion the contrast has a { or curly bracket-like configuration, which is unlike an occlusion in a dissec
ged view. Small distal caliber of the distal ICA and a drop in systolic peak velocity. Near occlusion (2) In this case the c
There is a severe stenosis with a partly calcified plaque at the level of the bulbus (2).
The ICA above the stenosis shows a small caliber (3). See also the arrow in the sagittal reconstruction. The criteria fo
lly increases in relation to the severity of a stenosis, but when there is a near-occlusion the systolic peak velocity will
ntinue with the sagittal images... Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll You can scroll through the sagittal images. Notice the calcified plaque at the level of the bulbus and th
iber of the ECA. TreatmentTreatment strategy for near occlusion
(NO) is still controversial. In the analyses conducted in randomized controlled
trials such as the North American Symptomatic Carotid Endarterectomy Trial
(NASCET) and the European Carotid Surgery Trial (ECST), it was reported that
the risk of stroke was low with medical treatment, and surgical therapy was not
beneficial for internal carotid NO.However, an 11%–33% risk of ipsilateral
stroke within the first year has also been reported in medically treated
patients. Furthermore, other authors have
reported a significantly lower risk of future stroke after Carotid endarterectomy or Carotid artery stenting in these
patients. Seeking safe interventional
procedures could, therefore, be worthwhile especially with the current improvements
in carotid stenting technique .
Occlusion:
In a total atherosclerotic occlusion the contrast has a { or curly bracket-like configuration.
The stop will be at the level of the bulbus.
Carotid Dissection:
A carotid dissection is the result of
a tear in the intima of the vessel wall. As blood enters between the layers of
the vessel wall an intramural hematoma is created. This intramural hematoma results in the following: Dissections c
ischemic strokes in young people.
Patients sometimes present with pain in the neck and may have a history of a previous trauma. On CTA a dissection
following findings: Flame-shaped ICA These images show the typical flame-shaped presentation of a carotid dissecti
reconstruction you can follow the contours of the dilated ICA above the level where the contrast stops.
Also notice how similar the images are, when you compare the CTA with the DSA. String sign In most cases a dissecti
present with a flame-shaped appearance like in A, but when the lumen is less
compressed and still partially patent you
may get the "string sign" as in B. Look below the skull base When you consider the possibility of a dissection, t is imp
in this case. On the left side there is a normal ICA and ECA (the high density structure in between them is the styloid
On the right side we see a normal ECA and medial to the jugular vein is the dilated ICA (circle).
The lumen does not fill with contrast.
The combination of an occlusion in an enlarged and dilated ICA means that we are dealing with a dissection. A disse
dissection. In A we see the compressed lumen in
an eccentric position (green arrow). The diameter of the ICA is enlarged
by the intramural hematoma (red arrowheads). When we follow the ICA cranially, the
dissection continues up to image E (arrowheads). At the level of the skull base, where
the ICA enters the carotid canal (vertical petrous segment) , the dissection
stops and the ICA has a normal appearance (yellow arrow). Hyperdense thrombi A typical finding in dissection are
hyperdense thrombi as in these two patients. Whenever you see these kind of extremely
hyperdense thrombi, think of dissection and scroll down to just below the skull
base.
These thrombi are almost completely composed of erythrocytes. Dissection on DSA All the findings that we discusse

a is for a large part lysed through the iv-treatment of recombinant tissue plasminogen activator (rt-PA, alteplase) pric
. Again
you can seen the intimal flap stopping at the level of the skull base.
Pseudo-Occlusion:
Pseudo-occlusion of the cervical internal carotid artery refers to an isolated occlusion of the distal intracranial ICA th
pseudo-occlusion it looks as if there is a total occlusion in the ICA just above the level of the bulbus.
The contrast that enters the ICA has difficulty to move up further cranially, because of the stagnant blood within the
The contrast will only slowly penetrate this stagnant blood column and this results in a waterpaint appearance. On C
diminishing contrast density in the ACI with a water paint appearance. The
problem is the outflow obstruction at the level of the carotid T-top. A
pseudo-occlusion is never seen in combination with a more distal occlusion.
For
example, in case of a M2 occlusion there will be sufficient outflow of the
distal ICA through the other patent M2
division and the ACA. Two cases of a carotid pseudo-occlusion. In the first case (left) the contrast
stop is rather abrupt, although a small zone of diminishing contrast density can
be seen.
In this case the differentiation between a pseudo-occlusion and a dissection or atherosclerotic occlusion
can be difficult.
However, we do not see the typical flame shape
configuration of the bulbus as seen in a dissection and we see no signs of
atherosclerosis (no plaque or calcifications). In the second case the gradually
dimishing contrast density is cleary seen over a longer course (arrowheads).
This
is clearly a carotid pseudo-occlusion. Continue with the DSA images... Pseudo-occlusion with DSA The DSA gives us c
angiography, first there was a typical waterpaint appearance of the contrast
in the ICA, which simulated a proximal occlusion in the ICA. However the catheter could easily be advanced into
the distal ICA. After a more
forceful contrast injection there is a typical carotid-top occlusion on the
lateral view (just above the level of the ophthalmic artery.
There is no contrast filling
of the intracerebral vessels.
Floating Thrombus:
On the saggital view there is a longitudinal filling defect
in the proximal internal carotid artery (arrowheads).
This filling defect is a
floating thrombus attached to a atherosclerotic plaque located at the carotid
bulb (white arrow). In the axial plane this floatig thrombus causes a central
filling defect in the ICA also now as a “donut sign” (arrowhead). In case of an
accompanying intracranial occlusion of a large vessel endovascular therapy is
initiated to open this intracranial occlusion.
An isolated floating thrombus
(no large vessel occlusion) is treated with heparine or
anti-platelet therapy .
Carotid Web:
A carotid web is a shelf-like lesion along the posterior wall of the internal carotid artery bulb and an under-recognize
Several studies suggest that patients with a carotid web have a high risk of recurrent stroke. In the MR CLEAN study
entified.
In this study 1 out of every 6 patients with a symptomatic carotid web had a recurrent stroke within 2 years, suggesti
tection for patients with a carotid web. On the saggital view of the
CTA the shelf-like protusion on the dorsal wall of the ICA bulbus is seen. This
is the typical configuration location for a carotid web. However, for the
definite diagnosis of a carotid web a ridge connecting the lateral and medial
wall of the internal carotid artery must be seen in the axial view (arrow right
image). Carotid webs can differ in size.
In this case the
carotid web is much smaller than in te previous example.
However, the imaging
criteria for the diagnosis of a carotid web still apply.
On the sagittal images

a self-like protrusion is seen on the dorsal aspect of the internal carotid
artery (arrow left image).
On the axial images the ridge of the carotid web
is seen connecting the lateral and medial wall of the internal carotid artery (arrow). If you only look at the axial image
you may miss a web. The red arrow points at the ICA and
ECA, but no web is seen.. Only with by angulating the axial
plane perpendicular to the longitudinal axis of the ICA (green line and green
arrow) you will notice the web (ridge
connecting the lateral and medial wall of the ICA.
Of course the sagittal
reconstructions are superior for detecting a web. Correlation carotid web and cerebral ischemia These DSA images c
the mechanism by which carotid webs cause cerebral infarctions.
On the first
angiographic images you might first a stenosis
(white arrow left image).
On the next image the web is clearly delineated (yellow arrow). On in the late arterial phase view t stasis of contrast
It is clear, that in this region, due to
turbulence and stasis thrombi can develop and can cause cerebral emboli.
Isolated Carotid:
An isolated carotid means that the
ICA supplies blood to the ipsilateral anterior and middle cerebral artery, but
that there is no connection to the contralateral side or posterior circulation,
because the anterior (Acom) and posterior (Pcom) communicating artery are
missing as an anatomic variant. This is one of the many variants of
the circle of Willis. Patent circle of Willis Let us first describe the most common
situation. In 90% of patients the circle of
Willis is patent. When these patients present with an
acute stroke as a result of a dissection, they usually have an embolus in the
middle cerebral artery. In those cases it is sufficient to
treat the intracranial occlusion and the dissected carotid artery can be left
untreated. The collateral circulation over the
patent circle of Willis will take over the blood flow to the middle cerebral
artery. Non-patent circle of Willis In 10% of cases the circle of Willis
is insufficient. In this case both the anterior and
posterior communicans artery are absent. If there is an occlusion of the ACI,
then the patient is at risk for a massive stroke in both the anterior and
middle cerebral artery territory, since there is no collateral flow from the
contralateral ICA. We will demonstrate this scenario in
the following case... Case A 35-year-old woman presented at the ER with speech difficulties and a paresis of the right
On the CECT there was normal enhancement of the intracerebral vessels, which means no intracerebral occlusion. W
n partial recovery. One hour later however there was a deterioration with hemiparalysis on the right and aphasia.
The NIHSS was 27. Subsequently she was transported to the intervention center.
Continue with the CTA of the neck... The CTA of the neck shows the typical
flame shape of the proximal ICA indicating a dissection. Continue with the axial slices... The axial image shows a dilat
there is a 35-year old women with a massive stroke (NIHSS = 27), a carotid occlusion as a result of a dissection, but n
The DSA of the left ICA confirmed the
dissection (arrowheads) by demonstrating the flame shaped configuration of the proximal
ICA . Subsequently a DSA of the right ICA
and the left vertebral artery was performed.
The angiography of the right ICA showed
an absent Acom as not contrast crossed from right to left. In addition,
contrast injection in the left vertebral artery showed an absence of a Pcom. This was proof of the diagnosis
"Isolated carotid artery". Poor perfusion in the anterior and middle cerebral artery territory (all penumbra, no infarct
or the contrast
filling of the left middle cerebral
artery as the left ACI is occluded and there is no collateral flow through the
circle of Willis? The explanation is, that there are
small collaterals between the external carotid artery (ECA) and the ICA. This is enough to to fill the ACM
with contrast , but this is not sufficient for adequate perfusion of the left
hemisfere.

This is clearly demonstrated on the perfusion images. During the interventional procedure
the flow was restored due to repositioning of the intimal flap caused by the
catheter manipulation. Carotid stent placement was considered but not
performed.
The patient was treated with Fraxiparine After 24 hours there was a NIHSS: 2
with only a mild aphasia, after 3 months the NIHSS was down to 0. Follow-up MRI after one month showed
a small left frontal infarction (white arrow). The left ICA was patent and showed a remaining
of the intramural hematoma with high signal on the T1W-image (arrowhead). Valeria Guglielmi et al. JAMA Neurol 20
None:

Cervical Lymph Node Map:

modified from Robbins:
Aurelia Fairise and Robin Smithuis
Institut de Cancérologie de Lorraine in Nancy, France and the Alrijne hospital in Leiderdorp, the Netherlands:
Publicationdate 2022-07-11 This article is based on the nomenclature proposed by the American Head and Neck Soc
10 node groups are defined with a concise description of their main anatomic boundaries, the normal structures jux
ring metastases in those levels [1].
Overview:
In this cervical lymph node map the levels were extended to 10. Some of these are being divided into sub-levels to co
Borders:
Important landmarks are:
Axial CT:
Enable Scroll
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Disable Scroll Axial CT slices in correlation to overview illustration. Enable Scroll
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Disable Scroll Axial CT slices in more detail.
Enlarge images by clicking on them.
Levels:

I - Submental and submandibular:
Nodes in level I are at risk of developing metastases from cancers of the oral cavity, anterior nasal cavity and the soft
Scroll
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is a median region located between the anterior belly of the digastric muscles, which contains the submental nodes.
contains the submandibular nodes located in the space between the inner side of the mandible laterally and the dig
submandibular gland posteriorly.
II - Upper jugular:
Level II receives lymphatics from the face, the parotid gland, and the submandibular, submental and retropharyngea
Level II also directly receives the collecting lymphatics from the nasal cavity, the pharynx, the larynx, the external aud
ibular glands [1]. Level II can be divided into level IIa and level IIb by drawing a line at the posterior edge of the interr
Disable Scroll Enable Scroll
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alivary glands. Level IIb is more likely associated with primary tumors of the oropharynx or nasopharynx, and less fre
1].
III - Mid jugular:
Level III receives efferent lymphatics from levels II and V, and some efferent lymphatics from the retropharyngeal, pr
It collects the lymphatics from the base of the tongue, tonsils, larynx, hypopharynx and thyroid gland. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The inferior border of the cricoid is the border between level III and IVA. Nodes in level III are at risk of
sopharynx, oropharynx, hypopharynx and larynx.
IV - Lower jugular and medial supraclavicular:
The border between level IVa and IVb is set arbitrarily 2 cm cranial to the sterno-clavicular joint. Enable Scroll
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These nodes are at risk for harboring metastases from cancers of the hypopharynx, larynx, thyroid and cervical esop
Rarely metastases from the anterior oral cavity may manifest in this location with minimal or no proximal nodal dise
om cancers of the hypopharynx, subglottic larynx, trachea, thyroid and cervical esophagus.

V - Posterior triangle and Supraclavicular:
Level V contains the nodes of the posterior triangle group located posteriorly to the sternocleidomastoid muscle aro
se cervical vessels. Nodes in level V are most often associated with primary cancers of the nasopharynx, the oropha
roid gland. Enable Scroll
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Disable Scroll Level Vc - Supraclavicular This level contains the lateral supraclavicular nodes located in the continuati
e cervical transverse vessels down to a limit set arbitrarily 2 cm cranial to the sternal manubrium.
It corresponds partly to the area known as the supraclavicular fossa. Level Vc receives efferent lymphatics from the p
associated with nasopharyngeal tumors [1]. Transverse cervical artery
Scroll through the images for the anatomy of the transverse cervical artery.
VI - Anterior cervical:
This level contains the superficial anterior jugular nodes (level VIa) and the deeper prelaryngeal, pretracheal, paratra
Scroll
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This level contains the superficially located anterior jugular nodes. Level VIbThis level is contained between the medi
The nodes in this area are: Delphian lymph node The Delphian lymph node derived its name from the oracle of Delp
is a pretracheal node in level VIa located anterior to the cricoid and in between the cricothyroid muscles. Enable Scr
Disable Scroll Enable Scroll
Disable Scroll The recurrent laryngeal nerves branch off the vagus, the left at the aortic arch, and the right at the righ
ssed by subaortic lymph node metastases in the aorto-pulmonary window as seen in patients with lung cancer.
VII - Retropharyngeal and retrostyloid:
Retropharyngeal nodes receive lymphatics from the mucosa of the nasopharynx, the Eustachian tube and the soft pa
the nasopharynx, the posterior pharyngeal wall and the oropharynx (mainly the tonsillar fossa and the soft palate).
ryngeal space, extending cranially from the upper edge of the first cervical vertebrae (massa lateralis) to the cranial e
ace is bounded anteriorly by the pharyngeal constrictor muscles and posteriorly by the longus capitis and longus col
Laterally, the retropharyngeal nodes are limited by the medial edge of the internal carotid artery. Retropharyngeal n
ynx, the Eustachian tube and the soft palate.
These nodes are at risk of harboring metastases from cancers of the nasopharynx, the posterior pharyngeal wall and
evel VIIb - retrostyloid The retro-styloid nodes are the cranial continuation of the level II nodes.
They are located in the fatty space around the jugulo-carotid vessels up to the base of skull at the jugular foramen. E
Disable Scroll Click to enlarge Enable Scroll
Disable Scroll Click to enlarge The retro-styloid space is delineated by the internal carotid artery medially, by the stylo
tebral body of C1 and the base of skull posteriorly and by the pre-styloid para-pharyngeal space anteriorly.
VIII - Parotid:
This level contains the parotid node group, which includes the subcutaneous pre-auricular nodes, the superficial and
tend from the zygomatic arch and the external auditory canal down to the mandible. They extend from the subcutan
osterior edge of the masseter and the pterygoid muscles anteriorly to the anterior edge of the sternocleidomastoid
[1]. Enable Scroll
Disable Scroll Click to enlarge Enable Scroll
Disable Scroll Click to enlarge The parotid group receive lymphatic from the frontal and temporal skin, the eyelids, th
tympanum, the nasal cavities, the root of the nose, the nasopharynx, and the Eustachian tube. They are at risk of ha
orbit, external auditory canal, nasal cavities and parotid gland.
IX - Buccofacial:
Level IX contains the malar and bucco-facial node group, which includes inconsistent superficial lymph nodes aroun
le.
These nodes extend from the caudal edge of the orbit (cranially) down to the caudal edge of the mandible (caudally)
medially) in the sub-cutaneous tissue, from the anterior edge of the masseter muscle and the Bichat's fat pad (poste
Scroll
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Disable Scroll The bucco-facial nodes receive efferent vessels from the nose, the eyelids, and the cheek. They are at
ce, the nose, the maxillary sinus (infiltrating the soft tissue of the cheek) and the buccal mucosa.
X - Retroauricular and occipital:
Level Xa contains the retroauricular (also called mastoid) and subauricular nodes, which includes superficial nodes ly
l auditory canal cranially to the tip of the mastoid caudally. Level Xb contains the occipital lymph nodes, which are th
up to the cranial protuberance. They lie from the posterior edge of the sternocleidomastoid muscle to the anterior (l
Disable Scroll Enable Scroll
Disable Scroll Lymph node metastases in level X are from skin cancers of the retro-auricular area (Xa) and skin cance
ore information about Medical Action Myanmar, a medical organization run by Nini Tun and Frank Smithuis, who ha
C CTG, NCRI, RTOG, TROG consensus guidelines. by V Grégoire et al. Radiother Oncol 2014 ;110:172–81.

2. Integrating radiological criteria into the classification of cervical lymph node disease. by Robbins KT. Arch Otolaryn
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TW. Radiographics. 2014 Oct;34(6):1680-91.
Hip pathology in Children:

Imaging findings:
Joosje Bomer and Herma Holscher
Juliana Children's hospital, the Hague, the Netherlands:
Publicationdate 2015-08-11 In this review we will discuss the most common imaging findings in children with hip pai
Introduction:

Differential diagnosis:
Children with hip pathology may present with hip pain or a limp. The differential diagnosis can be narrowed down ac
difficulty localizing or communicating the location of their pain; and sometimes children who initially seem to have a
foot.
Imaging:
In children from 2 to 10 years old with symptoms less than 5 days, and in the absence of high fever or elevated inflar
cases the diagnosis is usually transient synovitis, which is a spontaneously resolving condition. Sometimes the refer
ce of a joint effusion. In all other cases x-ray imaging should be performed. The diagram shows a practical approach
important to realize that early in the course of Perthes disease, juvenile idiopathic arthritis, osteomyelitis and septic
young children may have difficulty communicating the problem, it may be necessary to image the entire extremity. In
ral (or Lauenstein) view only. In case of suspected pathology on the frog-leg lateral view, an additional AP radiograph
. Children with cerebral palsy are at an increased risk for hip dislocation, and in these cases an AP-view is recommen
uate frog-leg lateral view is not possible. Lead Shielding The reduction of gonadal radiation exposure with lead shield
owing reasons: Note: as this is a relatively new insight, some of the images in this article do still include lead shieldin
Pathology:
Transient synovitis. The left hip shows a joint effusion (arrow) in the anterior recess which causes separation of the la
Transient synovitis:
Transient synovitis - also known as coxitis fugax - is an aseptic inflammation of the hip, presumably of postviral etiolo
ustained a low grade respiratory tract infection. The condition is self-limiting and treated with rest and analgesics. It
under the age of ten years. Imaging is not strictly necessary, but an ultrasound is often requested to confirm the pre
here are other differential diagnostic considerations. Do not suggest the presence of an effusion on radiographs, as
nsider the possibility of septic arthritis in a sick child! The appearance of the effusion on ultrasound is not helpful for
Perthes disease:
Perthes disease, also known as Legg-Calvé-Perthes disease, is an idiopathic avascular necrosis of the proximal femor
5 and 8 years of age, but may range from the ages 3-12. It can occur bilaterally, but it is usually asymmetric. Early rad
ral head. Sclerosis and subchondral fractures may develop, features best appreciated on the frog-leg lateral view. Th
d boy. The findings are: Early on in the disease radiographs may be negative, but MRI will show edema in the femora
Sometimes a radiographically occult fracture can be detected on MRI as a double rim sign on T2-weighted images w
rtrophic on the affected side. The images show right-sided Perthes disease in a nine-year old girl. There is loss of T1
reatment is symptomatic. Depending on whether or not there is spontaneous revascularization, the disease may or
of the femoral head will occur. Metaphyseal lucencies can be seen. In the healing phase, Perthes disease can lead to
xa magna deformity. Surgical reconstruction (Salter osteotomy) may be required to prevent early osteoarthritis. The
ease includes: Secondary avascular necrosis Perthes disease has to be differentiated from avascular necrosis with a
Causes of avascular necrosis include: The x-ray is of a 15-year old with acute lymphatic leukemia who was treated wi
isease, but based on the clinical information, this is secondary avascular necrosis. Meyer's dysplasia This is an uncon
tion and fragmentation, most often occurring bilaterally. Radiographically it cannot be differentiated from Perthes di
time and is symmetric. It generally occurs in a younger population (2-4 years old). The condition itself is asymptomat
splasia Multiple epiphyseal dysplasia can mimick Perthes disease as it may manifest primarily in the hips. It is a rare
ng gait, pain, fatigue and short stature. Contrary to Perthes disease, the abnormalities are usually symmetric. The kn
ossification is abnormal and results in small, fragmented epiphyses with alignment abnormalities. Radiographs of all
velop premature osteoarthritis. The treatment is symptomatic. Slipped epiphysis in a thirteen-year old boy. AP radio
overlooked. The frog-leg lateral view shows a medio-posterior slippage of the left femoral epiphysis.
Slipped Capital Femoral Eiphysis:
Slipped Capital Femoral Epiphysis (SCFE) or femoral epiphysiolysis is an idiopathic Salter-Harris type I fracture of the
and in obese children. The typical age at presentation is between 12-15 years. SCFE may occur bilaterally in up to on
er extent medially. It is therefore best appreciated on the frog-leg lateral view. SCFE is treated with surgical fixation t
ral epiphysis is a potential complication. JIA: Effusion of the right hip in JIA. The synovium is thickened and loads Gad
ller
Juvenile Idiopathic Arthritis:

Juvenile Idiopathic Arthritis (JIA) is a clinical diagnosis and is currently divided into six different subtypes. In most case
inly affected, including the hips. JIA begins with a tenosynovitis and only later shows bone edema, periostitis, osteop
on, cartilage loss and erosions are not a frequent finding in JIA. X-rays are usually negative early on in the disease. Ty
htly larger epiphysis, or accelerated bone maturation. Since JIA is treated aggressively early on, radiographic bony ch
ned synovium and sometimes hyperemia. MRI will also demonstrate the joint effusion and synovial thickening, but c
dality for the assessment of resulting growth disturbances.
Osteomyelitis:
Osteomyelitis is a relatively common severe condition in children, occurring most frequently in children under the ag
er non-specific, and infants may present only with a fever and failure to thrive. Most cases are hematogenous, and m
aureus is the most common pathogen. 5 week old, sick infant with severe osteomyelitis of the left hip. MRI with Gad
steal reaction. Most radiographs will not show abnormalities in the early stages of the disease, but after 7-10 days th
can be helpful in the diagnosis in cases with subperiosteal abscess formation. In suspected osteomyelitis, MRI is the
the location may be uncertain, bone scintigraphy can be useful. Both MRI and bone scintigraphy show abnormalities
an area of T2 increased signal in the metaphysis with enhancement and surrounding edema in the soft tissues, and
closed growth plates, the growth plate does not act as a barrier and infection may spread to the epiphysis and joint.
steal reaction is present and there is accelerated bone maturation. In osteomyelitis bone scintigraphy will show an a
biotics and has a good prognosis if detected promptly. Brodie's abscess A subtype of osteomyelitis which is typically
yelitis with intraosseous abscess formation. The only complaint can be pain. Fever and inflammatory markers may b
ones, but may be located in the epiphysis in young children. On x-ray there is a sharp defined oval lytic lesion with o
long axis of the bone (see figure). On MRI the lesion is hyperintense on T2WI. There is joint effusion and only minima
a limp and fever at presentation. Ultrasound was difficult because the boy was unable to stretch his leg, but the left
evacuated in the operating theater.
Septic arthritis:
Septic arthritis is a surgical emergency. The inflammation of a joint in septic arthritis is bacterial and, as in osteomye
rthritis can have a rapidly deteriorating course with destruction of the joint. Affected children are ill, with fever and s
s previously mentioned, the echogenicity is not of diagnostic value). The synovium may be thickened, but this is a no
ch as JIA. The clinical profile, laboratory findings and the presence of a joint effusion are suggestive of septic arthritis
rgical debridement should take place as soon as possible. Radiographs are not sensitive to joint effusion and are not
quired for follow-up purposes. Joint space narrowing and osteolysis will become visible in later stages of the disease
tect possible concomitant osteomyelitis. *NOTE: Absence of joint effusion excludes septic arthritis.*
Avulsion injuries:
Avulsion injuries of the pelvis are a frequent cause of hip pain in adolescents involved in sports. Because at this age t
muscle contraction can result in apophyseal avulsion fractures. Avulsion injuries can be acute or chronic. Typical avu
tion of the rectus femoris tendon. Typical avulsion injury of the right ischial aphophysis. Osteoid osteoma
Bone tumors and tumor-like lesions:
There are many bone tumors and tumor-like lesions that may cause pain in the hip or upper leg. We will not discuss
d, since it is a relatively common tumor, and the cortex of the femoral neck a common location. Osteoid osteoma is a
ere bone pain, occurring mainly at night. X-ray imaging shows a small oval lytic lesion which may be obscured by the
philic granuloma Other bone tumors and tumor-like lesions such as eosinophilic granuloma may also be the underly
bular Toddler's fracture.
Knee and foot:
As mentioned previously, young children may have difficulty communicating the cause of their pain or limp. In such c
ity. A toddler's fracture (image) may be one of the possible underlying causes. Corner fractures in a case of child abu
on of non-accidental injury (NAI)
See section on child abuse. In 524 children analyzed for hip pain we found three cases of mesenteric adenitis. In som
f value. by Bomer J, Klerx-Melis F, Holscher HC. Eur Radiol 2014 24(3):703-8.
4. Gonad shielding in paediatric pelvic radiography: disadvantages prevail over benefit (2012) Frantzen MJ, Robben S
maging 3(1):23-32
5. Establishment of Normative MRI Standards for the Paediatric Skeleton to better outline Pathology - focussed on Ju
Elbow fractures in Children.:
Robin Smithuis
Radiology department, Rijnland Hospital Leiderdorp, the Netherlands.:
Publicationdate 2008-12-01 Elbow fractures are the most common fractures in children. The assessment of the elbow
leton and the subtility of some of these fractures. In this review important signs of fractures and dislocations of the e
try one of the cases in the menubar. You can test your knowledge on pediatric elbow fractures with these interactive
This does not work for the iPhone application If you want to use images in a presentation, please mention the Radio
Fracture mechanism:
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Hyperextension:
Injury to the elbow joint is usely the result of hyperextension or extreme valgus due to a fall on the outstretched arm
ion leads to a supracondylar fracture. The hemarthros will result in a displacement of the anterior fat pad upwards a
Disable Scroll Scroll through the images. Enable Scroll
Disable Scroll Scroll through the images.
Extreme valgus:
The other important fracture mechanism is extreme valgus of the elbow. The normal elbow already has a valgus pos
o extreme valgus. On the lateral side this can result in a dislocation or a fracture of the radius with or without involve
the humerus, the extreme valgus will result in a fracture of the lateral condyle. On the medial side the valgus force ca
dial epicondyl becomes trapped within the joint. Because of the valgus position of the normal elbow an avulsion of t
Radiological Interpretation:

Methodical review:
When looking at radiographs of the elbow after trauma a methodical review of the radiographs is needed . You shou
f joint effusion? After trauma this almost always indicates the presence of hemarthros due to a fracture (either visibl
n children dislocations are frequent and can be very subtle. Are the ossification centres normal? Is the piece of bone
s ossification centre in the normal position. . Look especially for the position of the radial epiphysis and the medial e
fractures in children are very subtle.
So you need to be familiar with the typical picture of these fractures. . Normal anterior fat pad.
Fat Pad Sign and Joint effusion:
Normally on a lateral view of the elbow flexed in 90? a fat pad is seen on the anterior aspect of the joint . This is norm
no fat pad is seen since the posterior fat is located within the deep intercondylar fossa. Positive fat pad sign both ant
tion of the joint will cause the anterior fat pad to become elevated and the posterior fat pad to become visible. An el
ue lateral radiograph of an elbow flexed at 90? is described as a positive fat pad sign (figure). Hemarthros results in a
displacement the posterior fat. Positive Anterior Fat Pad sign. On digital radiographs you may need to adjust the win
on the X-rays. Positive fat pad sign (2)
Any elbow joint distention either hemorrhagic, inflammatory or traumatic gives rise to a positive fat pad sign. If a pos
ra-articular injury is unlikely. A visible fat pad sign without the demonstration of a fracture should be regarded as an
isplaced fracture with 2 weeks splinting. Skaggs et al repeated x-rays after three weeks in patients with a positive pos
nce of fracture in 75%. They concluded that in trauma displacement of the posterior fat pad is virtually pathognomon
t pad alone however can occur due to minimal joint effusion and is less specific for fracture. Notice that the elbow is
hapter on positioning.
Alignment:
There are two important lines which help in the diagnosis of dislocation and fracture . These are the Radiocapitellar l
A line drawn through the centre of the radial neck should pass throught the centre of the capitellum, whatever the p
capitellum (figure). In dislocation of the radius this line will not pass through the centre of the capitellum. On the left
of the capitellum on every radiogragh even though C and D are not well positioned. Notice supracondylar fracture in
ght lower image shows an obvious dislocation of the radius. Radiographs of elbows at different ages. The Anterior H
rior humeral line. A line drawn on a lateral view along the anterior surface of the humerus should pass through the m
Humeral line . In cases of a supracondylar fracture the anterior humeral line usually passes through the anterior thi
of the capitellum or in front of the capitellum due to posterior bending of the distal humeral fragment. On the left th
he capitellum. This indicates that the condyles are displaced dorsally (i.e. supracondylar fracture). First study the ima
line ends above the capitellum. This means that the radius is dislocated. Did you also notice the olecranon fracture?
e ulna carefully. The order of appearance of the ossification centres is specified in the mnemonic C-R-I-T-O-E.
Ossification centres:
There are 6 ossification centres around the elbow joint.
They appear and fuse to the adjacent bones at different ages. It is important to know the sequence of appearance s
s order of appearance is specified in the mnemonic C-R-I-T-O-E
(Capitellum - Radius - Internal or medial epicondyle - Trochlea - Olecranon - External or lateral epicondyle). The ages
e and differ between individuals. It is not important to know these ages, but as a general guide you could remember
fferent children. The Trochlea has two or more ossification centres which can give the trochlea a fragmented appear
joint On a lateral view the trochlea ossifications may project into the joint. They should not be mistaken for loose int
Radiography:
Shoulder higher than elbow. Radius and Capitellum project on to the ulna.
Common errors in positioning:
Error 1: Shoulder higher than elbow For a true lateral view the shoulder should be at the level of the elbow. If the sho
l project on the ulna. The solution is either to lift the examination table which will lift the elbow or to lower the shoul
t endorotation of the humerus due to a low position of the wrist. RIGHT: More endorotation due to malpositioning. E
wrist positioning' leading to rotation of the humerus. The low position of the wrist leads to endorotation of the hume
will move anteriorly, while a medial structure like the medial epicondyle will move posteriorly. The wrist should be hi

on of the elbow. The hand should be with the 'thumb up'.
Elbow fractures:

Supracondylar fractures:
These fractures account for more than 60% of all elbow fractures in children (see Table). More than 95% of supracon
retched hand.
The elbow becomes locked in hyperextension.
The olecranon is pushed into the olecranon fossa causing the anterior humeral cortex to bend and eventually break.
If the force continues both the anterior and posterior cortex will fracture. Supracondylar fractures. In A the anterior l
lum and in B even more anteriorly. Notice positive posterior fat pad sign in both cases Supracondylar fractures (2)
If there is only minimal or no displacement these fractures can be occult on radiographs.
The only sign will be a positive fat pad sign.
Usually there is some displacement and the anterior humeral line will not pass through the centre of the capitellum
(figure). Supracondylar fractures (3)
Supracondylar fractures are classified according to Gartland.
Gartland Type I fractures are often difficult to see on X-rays since there is only minimal displacement.
Most of these fractures consist of greenstick or torus fractures. The only clue to the diagnosis may be a positive fat p
These patients are treated with casting. In Gartland type II fractures there is displacement but the posterior cortex is
There may be some rotation. These fractures require closed reduction and some need percutaneous fixation if a lon
fracture Gartland type III fractures are completely dislocated and are at risk for malunion and neurovascular compli
ry open means. Stabilisation is maintained with either two lateral pins or medial lateral cross pin technique. Gartland
eduction there is inadequate correction of medial collaps. After two months there is malunion with cubitus varus de
Malunion will result in the classic 'gunstock' deformity due to rotation or inadequate correction of medial collaps. Po
ated with injurie to the neurovascular bundle which is displaced over the medial metaphyseal spike. Nerve injurie alm
ascular injurie usually results in a pulseless but pink hand.
Conservative management and vascular intervention have the same outcome.
A pulseless and white hand after reduction needs exploration. Flexion-type supracondylar fracture caused by direkt
mmon (5% of all supracondylar fractures).
They are caused by direct impact on the flexed elbow.
Ulnar nerve injury is more common.
Compared to extension types, they are more likely to be unstable, so more likely to require fixation.
Lateral Condyle fractures:
This fracture is the second most common distal humerus fracture in children. They occur between the ages of 4 and
e extended elbow. They tend to be unstable and become displaced because of the pull of the forearm extensors. Sin
cause the fracture is bathed in synovial fluid. Lateral condyle fractures are classified according to Milch. They are Salt
actures that travel from the lateral humeral metaphysis above the epiphysis and exit through the lateral crista of the
teral Condyle fractures (2) The problem with the Milch-classification is the fact that the fracture fragments are prima
not visible on radiographs, so the radiographic interpretation concerning classification is difficult.
Treatment strategies are therefore based on the amount of displacement (see Table). Undisplaced fractures are trea
These fractures must be carefully monitored as they have a tendency to displace. At follow up both AP and Oblique v
Once displaced fractures consolidate in a malunited position, treatment is difficult and fraught with complications.
For this reason surgical reductions is recommended within the first 48 hours. Open reduction is indicated for all disp
ral Condyle fractures (3) .
The diagnosis of a lateral condyle fracture can be challenging. Fracture lines are sometimes barely visible (figure). Re
econd most common elbow-fracture in children and because you know where to look for will help you Lateral condy
. The detatched fragment however is larger than it appears on the radiograph. The fracture extents into the lateral ri
e fractures (4) . Since most of the structures involved are cartilageneous, it is very difficult to know the exact extent o
dyle fracture. Humeroulnar joint is stable. Sometimes the fracture runs through the ossified part of the capitellum. In
condyle fracture extending through the ossified part of the capitellum. This is a Milch I fracture. The elbow is stable.
There is too much displacement so osteosynthesis has to be performed. MR of lateral condyle fracture. Milch II and u
rtilaginous fracture. Fracture-fragment surrounded by synovial fluid. (Courtesy of Lynne Steinbach, M.D. Univ. of Cali
l extent of the cartilaginous component of the fracture. The case on the left shows a fracture extending into the unos
ilage is so far medial that the ulna is only supported on the medial side. This means that the elbowjoint is unstable. L
ement and probably stable. RIGHT a different case. Oblique view gives nice impression of fracture. Blue arrow indica
yle fractures (5)
In lateral condyle fractures the actual fracture line can be very subtle since the metaphyseal flake of bone may be mi
n be helpfull, but usually these are not routinely performed (figure). Two cases of overprojection of the capitellum on
cture on the right Lateral Condyle fractures (6) . Overprojection of the capitellum on the humeral metaphysis may sim
ures (7) . On the left a couple of examples of lateral condyle fractures. Capitellum fracture While fractures of the late
, isolated fractures of the capitellum are seen in children above the age of 12. Capitellum fractures are uncommon. T

on the X-rays (arrow). Normal medial epicondyle projecting posteriorly. Notice radial head dislocation and olecranon
Medial Epicondyle avulsion:
The medial epicondyle is an apophysis since it does not contribute to the longitudinal growth of the humerus.
It is located on the dorsal side of the elbow. On a lateral view especially if the arm is endorotated it can project so far
However avulsions are located more distally and anteriorly. Since the medial epicondyle is an extra-articular structur
ive fat pad sign. Avulsion of medial epicondyle. Medial Epicondyle avulsion (2). 80% of avulsion fractures occur in boy
ute valgus stress due to a fall on the outstretched hand or sometimes due to armwrestling. Chronic injuries do occur
es these stressfractures on the medial side is the same mechanism that causes a osteochondritis of the capitellum d
interposed medial epicondyle. Medial Epicondyle avulsion (3). There is a 50% incidence of associated elbow dislocati
When the elbow is dislocated and the medial epicondyle is avulsed,
it may become interposed between the articular surface of the humerus and the olecranon (figure). In every disloca
. Same case as above. After reduction the epicondyle returned to its normal position (not good visible due to cast) ar
may return to it's original position or remain trapped in the joint.
This may severely damage the articular surface. So post-reduction films should be studied carefully. Medial Epicondy
mporarily open.
The avulsed fragment may become entrapped in the joint even when there is no dislocation of the elbow. On AP-view
iew shows the fragment to be trapped within the joint. Medial Epicondyle avulsion (5).
An avulsed fragment that is located within the joint can give diagnostic problems. On an AP-view this fragment may l
avulsed fragment may simulate a trochlear ossification centre. Another example of a dislocated elbow with avulsion
cted into the joint. Medial Epicondyle avulsion (6). Treatment Non-displaced fractures are treated with 1-2 weeks cas
There is disagreement about the amount of displacement of the medial epicondyle that requires operative fixation.
ent of medial epicondyle fractures with 5-15mm displacement. Avulsion of the medial epicondyle. The amount of sof
located. Medial Epicondyle avulsion (7). If the history or the radiographs suggest that the elbow was or is dislocated,
need for early motion. Click on the image to enlarge Medial Epicondyle avulsion (8).
Study the images. You can click on the image to enlarge. There are three findings, that you should comment on. Click
e to enlarge The MR shows the small medial epicondyle with tendon attachement trapped within the joint. The avuls
fixated with K-wires. Subtle radial neck fracture seen only on AP-view.
Proximal fractures of the Radius:
In adults fractures usually involve the articular surface of the radial head.
In children however it's the radial neck that fractures because the metaphyseal bone is weak due to constant remod
Usually it is a Salter Harris II fracture. If there is no displacement it can be difficult to make the diagnosis (figure). Rad
ions projecting in between humerus and ulna simulating intra-articular fragments. If there is less than 30? tilt of the r
It is important to realize that there is normally some angulation of the radial head (up to 15?). If there is more than 3
on radiograph in cast shows unsuccesfull reduction. K-wire insertion is performed Whenever closed reduction is uns
nd supinate up to 60?, a K-wire is inserted to maintain reduction. The radial epiphysis is slipped (arrows). The radioca
dislocation and there is a fracture of the olecranon Radial neck fractures aswell as radial head dislocations are in 50
The most common is a fracture of the olecranon. When the radial epiphysis is yet very small a slipped radial epiphys
r If these fractures are not recognized or reduction is unsuccesfull radial head overgrowth can be the result. A short
s contributes to the length growth of the radius. LEFT: an obvious radial dislocation. No fracture of the ulna (Montegg
ed olecranonfracture is seen on carefull inspection
Dislocations of the Radial head:
Dislocations of the radial head can be very obvious.
It is however not uncommon that these dislocations are subtle and easily overlooked. In all cases one should look fo
In the original discription of Monteggia there is a radial dislocation in combination with a proximal ulnar shaft fractu
However fractures anywhere along the ulna have been reported.
Especially associated fractures of the olecranon are very common (figure). Radius Pulled Elbow (Nursemaid's elbow)
lly and the ligament slips over the radial head and becomes trapped within the joint. The X-ray is normal. The conditi
s during positioning for a true lateral view (which is with the forearm in supination). Olecranon fracture indicated by
Olecranon fractures:
Olecranon fractures in children are less common than in adults. As discussed above they are associated with radial r
ion centres in a patient with a tilted radial neck fracture. Olecranon fractures (2) Do not mistake the apophysis or its
The apophysis has undulating faintly sclerotic margins.
The growth plate usually has a different oblique course compared to a fracture-line. Olecranon fractures (3) On the l
le some of these fractures are.
Conclusion:
Whenever you study a radiograph of the elbow of a child, always look for: Position of the medial epicondyle. Elbow a
onin, MD, in Radiology of Skeletal traumaThird edition Editor Lee F. Rogers MD
2. Elbow injuries in children in www.orthotheers A site developed for Postgraduate Orthopaedic Trainees preparing f
3. Pediatric Elbow fractures in Wheeless on line textbook on Orthopaedics A site with detailed information on fractur
Acute Abdomen in Gynaecology - Ultrasound:

Julien Puylaert
Amsterdam UMC and Haaglanden MC, The Hague:
Publicationdate 01-01-2022 This is a pictorial essay
of the various gynaecological conditions
that may cause acute abdominal pain, as far as they are encountered in daily radiological
practice. Conditions which present
during a known pregnancy like
miscarriage, early ectopic pregnancy, uterine rupture and placental abruption, as well as puerperal endometritis,
are not included as they belong to the professional terrain
of the gynaecologist.
These conditions are rarely seen in the daily radiological practice of acute
abdomen. For critical
comments and additional remarks: j.puylaert@gmail.com
Introduction:
This table summarizes the gynaecological diseases that may present
with acute abdominal pain. It is divided into pathology in:
Normal US anatomy:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Uterus and ovaries are best visualized with the bladder
half-full. A very full bladder is unpleasant
for the patient, hampers adequate compression and pushes organs away from the ventral
abdominal wall, excluding the use of high frequency probes. In the sagittal view the uterus, cervix, vagina, anorectum
and urethra (u.) can be identified, as well as the collapsed anterior and
posterior fornix of the vagina. Studying a uterus, which is in retroflexion, requires more
bladder filling. Transverse view allows visualization of both uterus
and ovaries. The uterus itself may also provide
an acoustic window to visualize the ovaries. With the uterus in anteflexion, the ovaries are quite
ventrally localized and can often be visualized using the right and left iliac vessels as an acoustic window (figure).
Dominant follicle:
In women of the fertile age the normal inactive
ovaries show moderate vascularization (left image). During the pre-ovulatory phase the dominant follicle
can be identified by its “ring-of-fire” (right image).
Luteal body:
After the ovulation the dominant follicle becomes smaller
(left) and in the absence of pregnancy, turns into a crenulated luteal body (right). Transvaginal ultrasound (TVUS) has
visualizing the uterus and ovaries. It can also be used for non-gynaecological
conditions such as appendicitis, diverticulitis, etc. The use of transvaginal ultrasound will be dealt with in a
different article: TVUS for non-gynaecological conditions.
Acute gynaecological conditions in pregnancy:

Ectopic pregnancy:

In:
this young woman, US demonstrated a large quantity of clotted (C.) and liquified
blood (*) around the uterus, suspect for ectopic pregnancy. However, β-HCG levels in both urine and serum were ex
low. US
guided puncture in the liquified part confirmed blood. (bl. = bladder) Laparoscopy
revealed severe bleeding from a luteal body, which was successfully coagulated. ischemic myoma in pregnancy
Ischemic myoma:
During
pregnancy a myoma may increase in size and outgrow its vascularization. case 1 This 25
year old pregnant woman presented with a palpable, painful mass in the
RLQ, suspect for an “appendiceal mass”. US revealed
a hypoechoic, inhomogeneous, hypovascular round solid mass arising from the myometrium,
and “bulging” into the abdominal wall during compression. The
diagnosis was an ischemic myoma.
She was successfully treated
with analgesics.
Labor inhibitors were not

necessary. Necrotic myoma in pregnancy case 2 Here another case of an ischemic myoma.
The extrinsic location in this case suggests that this is a
pedunculated myoma (arrowheads). This patient was successfully treated with analgesics and labor inhibitors. Torsio
Torsion of enlarged adnex:
case 1 Young
female with acute onset of RLQ pain. US
reveals a large mass filled with hypoechoic sebum, harbouring a hyperechoic hairball
(arrow) surrounded by multiple tiny linear
hair reflections. CT confirms
a dermoid cyst containing a hairball
(arrow) and surrounded by fat stranding, caused by venous congestion.
At surgery
torsion of a dermoid cyst was confirmed. Torsion of hydrosalpinx. case 2 A 40
year old lady presented with acute RLQ pain.
CT revealed a dilated, fluid-filled
salpinx. Additional
US showed that the salpinx was under tense pressure and “bulged” into the
abdominal wall during compression (arrows). An
ischemic, twisted hydrosalpinx was found and laparoscopically removed. Torsion of large dermoid cyst, missed by gy
with acute lower abdominal pain, TVUS was negative.
Subsequent transabdominal US showed a large dermoid (arrowheads) in a fairly high location.
CT confirmed the diagnosis.
At surgery a twisted dermoid cyst was found. Endometriosis: chocolate cysts and “kissing ovaries”.
Acute conditions in non-Pregnant women:
Persistent haemorrhagic cyst.
Persistent or hemorrhagic cyst.:
In young
women with acute abdominal pain, an enlarged
cystic adnex with or without some free fluid, is a frequent finding. In most cases, this is
a functional cyst, which has ruptured or has been bleeding.
Lab findings are
usually normal with a low CRP and the US
abnormalities disappear within days or weeks. case 1
In this young woman a large partly cystic mass was found with a solid, avascular component (clot).
CRP remained low and the pain was gone in two days.
Follow up US after 6 weeks showed complete normalization. It is important to realize that these US findings may
also be completely asymptomatic. Persistent haemorrhagic cyst. case 2
In this young woman with two days of RLQ pain and a
CRP of 2, a right-sided, thin-walled ovarian cyst was found at US. TVUS shows the typical, very thin, lace-like septation
and also the residual normal, follicle-containing ovary “squeezed” to the side
by the haemorrhagic cyst.
Complete resolution after 6 weeks. Ruptured follicle. (ut = uterus) case 3
These images are of a woman of 17 years old with acute, severe RLQ pain. CRP 1. US reveals an ill-defined thick-wall
right ovarian cyst and free fluid (*) in Douglas pouch. TVUS confirms the fluid and a partially collapsed,
easily compressible cyst in the right ovary.
The left ovary is normal (right lower
image). The pain gradually decreased and lab-findings remained normal.
Within one week there was complete
normalization of the US findings. The most likely diagnosis: ruptured
functional cyst. ov-cyst-funct.jpg) Enable Scroll
Disable Scroll Well-compressible, haemorrhagic cyst ov-cyst-funct.jpg) Enable Scroll
Disable Scroll Well-compressible, haemorrhagic cyst case 4
This functional, hemorrhagic cyst was a coincidental
finding and could easily be compressed against the promontory (p). Complete resolution of the abnormalities
within two weeks. funct-cyste-zeker-coll.jpg) Haemorrhagic cyst with clot. case 5
Persistent haemorrhagic cysts often contain solid,
avascular, inhomogeneous masses representing clots. Retractility of such clots often results in concave
contours (arrowheads). Pitfall: asymptomatic right ovarian cyst in woman with appendicitis. (V= iliac vein) case 6
In this young woman a conspicuous hemorrhagic right
ovarian cyst (arrowheads) was visualized and initially held responsible

for her RLQ symptoms. Further examination however revealed an acute appendicitis
(arrow).
The cyst was an asymptomatic coincidental finding.
PID:
Pelvic Inflammatory Disease (PID) is the common denominator
for all ascending infections of cervix, endometrium, ovary and Fallopian tubes and its extension into the peritoneal c
organisms, but often cultures remain negative, and then the diagnosis is based
on clinical findings and a good effect of antibiotics. PID is often diagnosed and treated on clinical grounds,
however US is often performed to diagnose and stage PID and to exclude alternative
conditions as appendicitis. PID due to Chlamydia infection PID case 1 A 32 year old woman was treated for suspecte
antibiotics by the family-doctor. Now submitted with clinically suspected
appendicitis and CRP 190 and WBC 9. US was normal, but of moderate quality due to obesity.
CT showed an 8 mm, but otherwise normal looking appendix (arrow) and bilateral fatty
stranding of the peritoneal fat (arrowheads). The appendix looked “too normal” for a CRP of 190, so
the most likely diagnosis was PID and antibiotics were started. Two days later
the PCR for Chlamydia was positive. PID in the LLQ PID case 2 A young woman with severe pain in the LLQ and a CRP
530 and a WBC of 22. The only abnormal US finding was some hyperechoic preperitoneal
fat in the LLQ.
CT confirms the US findings.
Normal appendix and
adnexa (not shown here). The most likely diagnosis was PID.
There was good reaction on antibiotics and no microorganism was found. Early PID. PID case 3 Young woman with a
US showed subtle hyperemia of both tubes and ovaries,
surrounded by hyperechoic, moderately compressible, fatty tissue (*).
This
represents slightly inflamed peritoneal, mesenterial and omental fatty tissue. CT confirmed a normal appendix (arro
hyperdensity of the peritoneal, mesenterial and omental fat (*). She quickly
recovered with antibiotics. Cultures and PCR remained negative. gonorr-pid-ov-ut-gb-paral-ileus-coll-2.jpg/a7d94aba
PID case 4 These images are of a very ill, painful young woman with generalized peritonitis
and a CRP of 250, clinically suspect for perforated appendicitis. US showed aperistaltic small bowel (b.).
The appendix
was not visualized. TVUS showed a normal uterus and normal ovaries
(arrowheads), which were surrounded by hyperechoic tissue (*). CT confirmed the paralytic ileus and showed a norm
appendix (arrow). PCR was positive for gonorrhoea. Early PID with secondary thickened appendix. (ut. = uterus, b = s
e 5 Young woman presented with RLQ pain and a CRP of 70,
suspect for appendicitis. US showed some turbid fluid in Douglas pouch (*).
At
the spot of maximum tenderness a compressible appendix (arrow) was seen, surrounded
by a little hyperechoic fat. TVUS shows that the free fluid is turbid, in view of
the high CRP probably pus.
The ovaries had a normal aspect, but were surrounded
by hyperechoic, inflamed fat. Diagnosis:
Early PID with minimal secondary reaction
of peritoneum and appendix.
One day later the PCR for Chlamydia was positive. PID with secondarily thickened appendix. PID case 6 A 29-year old
TVUS showed turbid fluid (*) in Douglas pouch, in combination with a CRP of
230, indicating pus. The appendix (arrow) was small, but surrounded by
hyperechoic fat. In view of the high CRP, it was decided that this was a case
of PID with mild (secondary) inflammation of the appendix, rather than a case
of appendicitis. The patient was not operated, and responded well on
antibiotics. Key to avoid an unnecessary appendectomy in these
cases, is to note the discrepancy between the relatively mild inflammation of the
appendix and the high CRP. Confusing peri-appendicitis in PID, leading to unnecessary appendectomy. PID case 7 Ill
17.
The next day CRP was 400. US showed a 8 mm appendix (arrows) and diffuse hyperechoic
fat in between hypoechoic tissue.
The ovaries were not well visualized. CT confirmed a 9 mm appendix (arrows) and diffuse fat
stranding of the ventral fatty tissue (*).
Normal size and aspect of the ovaries
(not shown here). At diagnostic laparoscopy a purulent peritonitis was

found and an abnormal appendix with fibrinous exudate was removed.
The pathological
specimen showed only peri-appendicitis, not primary appendicitis. The day after the operation the PCR of the cervix
positive for Chlamydia. Pitfall: Omental infarction mimicking PID.
Omental infarction mimicking PID:
A young woman presented with isolated pain in the RUQ and an elevated
CRP. The only abnormality at US and CT was a cake-like, rather
outlined area of fat stranding adjacent to the ventral abdominal wall in the RUQ,
just above the level of
the umbilicus. The shape and typical location strongly plead for segmental omental
infarction rather than PID. Pitfall: Familial Mediterranean Fever (FMF) mimicking PID.
Familial Mediterranean Fever:
A 27-year old woman had a history of two episodes of
severe LLQ respectively RLQ pain, with a high CRP. She had no fever. US was normal, but CT showed diffuse fatty pre
stranding (*).
Both times she was diagnosed with PID and treated with antibiotics.
Symptoms
disappeared, and cultures remained negative. In view of her Turkish background, the third time the
diagnosis of Familial Mediterranean Fever was suggested, and eventually genetically proved.
She had no relatives
with FMF, but her parents were cousins. No more attacks after colchicin. fitz-hugh-curtis-coll2.jpg/355e8a09daed4df4
ening of the appendix.
Fitz-Hugh-Curtis:
case 1 Young,
ill lady with severe RUQ pain and an elevated CRP, clinically suspect for cholecystitis
or perforated appendicitis. US
shows a relatively high localization of an 8 mm appendix, which is well-compressible
(arrowheads), surrounded by some hyperechoic fat and clearly not responsible for
her clinical symptoms and lab findings. Higher
up there is some free fluid and hyperechoic fat (arrows) around the tip of the
right liver lobe. No other abnormalities were found, especially normal aspect
of uterus and ovaries. PCR
tests of cervix and urethra, one day later were positive for Chlamydia. Diagnosis: Fitz-Hugh-Curtis (FHC). FHC is also r
of “PID in the RUQ”, where the infection from the right Fallopian tube spreads directly
to the perihepatic space. Late
sequelae of FHC are the well-known “violin string” adhesions between liver and
abdominal wall at laparoscopy. Fitz-Hugh-Curtis (FHC) case 2 A
29-year old woman presents with progressive pain in the RUQ during a week,
radiating to her right shoulder. The family doctor determined her CRP, which
was 145. US
showed a little perihepatic fluid (arrows) and some fatty infiltration right of
the umbilicus (**). CT confirms
the US findings. CA-125 was elevated (200). The differential diagnosis was FHC,
tuberculous peritonitis or malignant peritonitis. US guided omental biopsy
revealed no malignancy. Two
days later PCR of cervix and urethra was positive for Chlamydia. Complete cure
after antibiotics. Fitz-Hugh-Curtis in patient with coincidental gallstones. case 3 Twenty
year old woman with severe RUQ pain and a high CRP, suspect for acute
cholecystitis. US showed
a compressible, thin-walled gallbladder with multiple stones. This aspect is not
compatible with cholecystitis and does not explain the severe pain and the high
CRP. There was hyperechoic fat between the abdominal wall and the right liver
lobe (arrowheads). CT
confirmed some perihepatic fat stranding (arrowheads) and (secondary) enhancement
of the subcapsular liver parenchyma (arrows), confirming the diagnosis of FHC. One
day later the PCR was positive for Chlamydia. pid-coll.jpg/44d80986fc45369eced905f3ace3cba7.jpg) PID: Right sided
Oophoritis:
case 1 Ill,
young woman with RLQ pain and a CRP of 160.
TVUS shows a hyperemic,

swollen right ovary, with irregularly defined, thick-walled follicles, filled
with debris-like material (pus), surrounded by hyperechoic fat (*). PCR was
positive for Chlamydia the next day. Right-sided oophoritis. case 2 Young woman with acute pain RLQ and a CRP of 7
TVUS
shows an irregularly enlarged, inhomogeneous
right ovary with blurred follicles and surrounded by hyperechoic fat (*). The left ovary is slightly hyperaemic, but oth
normal.
There is turbid fluid (f.) in Douglas pouch, representing pus (CRP 75). toa-ecoli-ziek-coll-eng.jpg/e2f13b033254bbb5c0
Tubo-ovarian abscess:
TOA case 1 Young,
very ill woman with acute LLQ pain and a CRP of 260. Left of the uterus a massively
enlarged (6 x 7 x 8 cm) ovary is found.
The individual follicles are enlarged, ill-defined
and filled with turbid fluid (pus).
Note the hyperechoic halo around this inflamed
mass. Since
there is no apparent involvement of the Fallopian tube, strictly speaking this
is an oophoritis. Nevertheless, usually the term of tubo-ovarian abscess is used. Bilateral tubo-ovarian abscesses wi
woman presenting with severe acute abdominal pain clinically suspect for perforated
appendicitis.
Lab-findings at admission: WBC 10.6 - CRP 6 Two days later: WBC 19.7 - CRP 459 US showed a large inhomogeneous
right of the uterus, suspect for tubo-ovarian abscess (TOA). There
was also a paralytic ileus with secondary wall thickening of small bowel (b.) and
hyperechoic preperitoneal and mesenterial fat.
Puncture of a little ascites yielded
2 cc of yellow, turbid fluid. CT
confirmed the US findings but additionally demonstrated a pyosalpinx (p.)
within the tubo-ovarian mass on the right side. Antibiotics are started intravenously. Two
days later PCR of both cervical and urethral probes as well as the punctured
fluid were positive for Chlamydia.
Rapid recovery with only antibiotics. Tubo-ovarian abscess (TOA) containing gas. TOA case 3 Large
left sided TOA with air-configurations.
This is a rare finding in TOA, successful
treatment with only antibiotics. Bilateral infected endometriotic cysts. TOA case 4 (infected endometriotic cysts) The
is. CRP 185, WBC 17. US shows a normal compressible appendix, thereby excluding appendicitis.
Large, thick-walled, septated cystic structures, filled with debris-like material, were found on both sides of the uterus

This is somewhat suspect for bilateral infected endometrotic cysts. The patient was treated with antibiotics and lapa
There was a protracted course, but eventually regression of the abnormalities. An MRI six months later, demonstrate
the rectum, thereby confirming the diagnosis of endometriosis. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll case 5 - Actinomycosis A
52-year old woman presented with RLQ pain
for two weeks. US and
subsequent CT, showed a large, right sided iliopsoas abscess (absc.), in continuity
with a TOA, causing hydronephrosis with cortical loss and a dilated ureter (u.). There was an IUD in the uterus, the CI
IUD, that had been in place for 30 years, was removed. The abscess was punctured
and later drained percutaneously.
Gram
stain of the pus showed gram-positive rods, suggestive of actinomycosis, and
i.v. penicillin was started.
Cultures grew Actinomyces israelii 20 days later. Eventually
there was a complete cure without residual abnormalities. Pyosalpinx
Pyosalpinx:
case 1 these images are of a young
woman with pain in the RLQ for two days and CRP 170 and WBC 14. US respectively
TVUS shows tortuous, thick-walled tubular
structure right of the uterus (ut.), in combination with the CRP, typical for a
pus-filled Fallopian tube (pyosalpinx). This
patient was successfully treated with antibiotics but had recurrent episodes.

For this reason she underwent
a tubectomy three years later. Pyosalpinx case 2 Young
lady with pain RLQ since three days. CRP 100 and WBC 23, suspect for appendicitis. US shows
turbid peritoneal fluid and a dilated, thick-walled Fallopian tube, filled with debris. Complete cure after antibiotics. P
woman with acute pain RLQ and a CRP 180,
suspect for appendicitis. US
confirms a IUD in the uterus and a large, right-sided pyosalpinx. Complete
recovery after antibiotics and removal of the IUD.
Endometriosis:

Endometriosis is endometrium outside the uterus.There are three main types of endometriosis, based on where it is
case 1
Young
woman with chronic lower abdominal pain and normal lab findings. US
demonstrates two large, thick walled ovarian cysts with homogeneous sludge-like
("chocolate") contents behind the uterus. The cysts are fixed to each other ("kissing
ovaries") and to the uterus. Endometriotic cyst. case 2 Patient
with chronic lower abdominal pain and normal lab. US
shows 5 cm, thick-walled cyst with triangular demarcation from the uterus,
indicating adhesions. At
TVUS the cyst adhered completely to the uterus and during compression with the
vaginal probe, it was not possible to separate the cyst from the uterus.
Enlarged cystic adnex:
In the
majority of women with acute abdominal pain and an enlarged, cystic adnex, the final diagnosis will be an ordinary h
persistent or ruptured functional cyst.
There will be no other therapy than pain medication
and reassurance. There
are however several other pathological adnex-conditions that do have therapeutic
consequences, and thus should be excluded like endometriotic cyst, dermoid cyst,
a benign or malignant tumor, hydrosalpinx or a tubo-ovarian abscess (see Table). Next
to clinical features and lab findings, US has an important role to differentiate
these conditions from a functional cyst. Therefore in case of relatively mild
symptoms and conservative treatment, a cystic adnex is generally followed up by
US after six weeks.
If completely disappeared by then, it must have been a
case of a hemorrhagic, persistent or ruptured functional cyst. Ruptured endometriotic cyst case 3 Young
female with peracute pain in the lower abdomen since 4 hours. WBC 20, CRP 17. US
shows large, thick-walled, partly cystic mass right of the uterus and some turbid free
fluid (*). TVUS
shows that the endometriotic cyst is filled with homogeneous, hyperechoic fluid
(old blood) and is easily compressible (as expected after rupture). Ruptured benign mucinous cystadenoma.
Ruptured cystadenoma.:
case 1 An elderly
lady presented with peracute RLQ pain and leucocytosis. US
and subsequent CT showed a collapsed, multicystic tumour with thick-walled,
hypervascular septa and free fluid (*).
The bladder (b.) was empty. Surgery
revealed a ruptured cystadenoma, which was benign at histology. Ruptured mucinous cystadenoma. (ut. = uterus) ca
n and bloating.
US revealed a very large cystic,
septated mass of 15 x 18 x 20 cm.
There was no ascites. She was planned for
laparotomy within one week. Three
days later she presented at the hospital with acute pain.
US showed a collapsed
cyst with massive intra-peritoneal fluid. At laparotomy a ruptured, benign, mucinous
cystadenoma was removed.
Twelve years later she is still doing fine. Ruptured dermoid cyst case 3 This young
woman presented with acute lower abdominal pain.

US
showed a right sided hyperechoic mass and a lot of free fluid (not shown here). CT
confirmed a small dermoid cyst and hyperdense ascites, probably blood. Operation
revealed a ruptured dermoid cyst, the free fluid is a mixture of blood and
sebum.
Post Partum:
ovthromboseleekapp-coll.jpg/c4dc923192c25ce0cd38721399b1dba5.jpg) Right ovarian vein thrombosis (*). a and v =
Ovarian vein thrombosis:
case 1 Four days after delivery this young woman developed
pain in the RLQ and a CRP of 125.
At the spot of maximum pain an ill-defined, solid,
tubular, hypoechoic structure (*) was seen, surrounded by hyperechoic, non-compressible,
inflamed fat (arrowheads). CT confirmed an ovarian vein thrombosis. The surrounding
fat-stranding suggested a concomitant, phlebitis-component. Complete recovery with antibiotics and anticoagulant
ic myomectomy. case 2 This patient presented with RLQ pain 5 days after the procedure.
US demonstrated a thrombus in the right ovarian vein, there was no clear phlebitis
component. CT confirmed a thrombus in the right ovarian vein, without
any fat stranding.
CRP remained low.
Complete cure with only anticoagulant therapy.
Epilogue:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar
ion Myanmar with a small gift.
None:

None:

Appendicitis and Mimics:

Alternative nonsurgical diagnoses at sonography and CT:
Adriaan van Breda Vriesman M.D. and Julien Puylaert M.D.
Radiology Department, Rijnland Hospital, Leiderdorp and Medical Centre Haaglanden, the Hague, the Netherlands:
Publicationdate 2005-08-14 Introduction In this overview we focus on nonsurgical appendicitis-mimicking diseases. A
stful in-hospital observation. For critical comments and additional remarks: j.puylaert@gmail.com
the Appendix:
Appendicitis with periappendical fat infiltration.Click on the image to enlarge
Normal Appendix:
Sonography and CT allow direct visualization of the normal or inflamed appendix. The normal appendix can be ident
. Fig. 1.- 34-year-old healthy volunteer with a normal appendix. A and B, longitudinal (A) and transverse (B) sonogram
he 7 mm cut-off point, surrounded by normal noninflamed fat. At sonography the normal appendix is less frequently
operator dependency of sonography. One of the most important imaging criteria in the evaluation of appendicitis is
ceal diameters in normal and inflamed appendices has been reported, a threshold value of 6-7 mm is most common
. Unenhanced CT shows an air-filled nondistended appendix (arrowhead) with homogeneous periappendiceal fat wit
mm, is surrounded by homogeneous non-inflamed fat, and often contains intraluminal gas [2] (Fig. 2). Fig. 3. A 19 ye
gram show an enlarged appendix (arrows) surrounded by hyperechoic inflamed fat (arrowheads).
Appendicitis:
An inflamed appendix has a diameter larger than 6 mm, and is usually surrounded by hyperechoic inflamed fat at sc
include the presence of an appendicolith, cecal apical thickening Fig. 3b. Power Doppler sonography shows hypervas
dicitis is hypervascularity of the appendix wall on color Doppler sonography [1] (Fig. 3b). Fig. 4.- 43-year-old man with
istended appendix (arrow) with periappendiceal fat-stranding. At CT the inflamed appendix is surrounded by fat-stra
Gastrointestinal nonsurgical mimics of Appendicitis:
Fig. 5. A 14 year old boy with mesenteric adenitis. Sonogram of the right lower quadrant shows a cluster of enlarged
t shown) and no other abnormalities were found.
Mesenteric adenitis:
Mesenteric adenitis has been reported to be the second most common cause of right lower quadrant pain after app
with a clinical suspicion of appendicitis [3]. It is defined as a benign self-limiting inflammation of right-sided mesente
atory process, occurring more often in children than in adults. Sonography and CT show clustered adenopathy (Fig. 5
nography shows moderate mural thickening of the terminal ileum and cecum, surrounded by normal noninflamed f
Bacterial ileocecitis:

Because adenopathy also frequently occurs with appendicitis, the normal appendix must be confidently visualized o
s. Infectious enterocolitis may cause mild symptoms resembling a common viral gastroenteritis, but it may also clinic
4]. This latter presentation may occur in bacterial ileocecitis, caused by Yersinia, Campylobacter, or Salmonella. Imag
cum without inflammation of the surrounding fat (Fig. 6), and moderate mesenteric adenopathy. Fig. 7.- 29-year-old
quadrant reveals a hyperechoic inflamed fatty mass (arrowheads) adjacent to the colon (arrow), at the spot of maxi
aracteristic hyperattenuating ring (arrow) corresponding to thickened visceral peritoneal lining.
Epiploic appendagitis:
Epiploic appendages are small adipose protrusions from the serosal surface of the colon. An epiploic appendage ma
l pain that simulates appendicitis when located in the right lower quadrant. Epiploic appendagitis is a self-limiting dis
clinically suspected of having appendicitis [5]. Sonography and CT depict an inflamed fatty mass adjacent to the colo
thickenend visceral peritoneal lining on CT [5]. Fig. 8.- 41-year-old man with omental infarction. A, Sonography of the
itoneal fat (arrowheads). B, Unenhanced CT depicts the lesion as a cake-like area of dense inflamed omental fat (arro
rattenuating ring.
Omental infarction:
Omental infarction has a pathophysiology and clinical presentation similar to that of epiploic appendagitis, with the i
um. Imaging shows a cakelike inflamed fatty mass (Fig. 8), larger than in epiploic appendagitis and lacking a hyperatt
t lower quadrant pain. Unenhanced CT shows an ovoid inflamed fatty mass (arrowhead) with normal regional bowel
, but the lesion does not contain a hyperattenuating ring. In this case, it is difficult to discriminate between epiploic a
t may be difficult to distinguish epiploic appendagitis from omental infarction (Fig. 9), however, this distinction has n
history [5]. Fig. 10.- 51-year-old man with right-sided colonic diverticulitis. A, Unenhanced CT shows extensive with fa
pendix (arrow). B, Sonography reveals the cause of the inflammation by depicting an inflamed cecal diverticulum (ar
Right-sided colonic diverticulitis:
Right-sided colonic diverticulitis may clinically mimic appendicitis or cholecystitis, though the patient's history is gene
right-sided colonic diverticula are usually true diverticula, that is, outpouchings of the colonic wall containing all laye
benign self- limiting character of right-sided diverticulitis [6]. Sonography and CT findings consist of inflammatory ch
colonic wall, at the level of an inflamed diverticulum (Fig. 10). Fig. 11.- 28-year-old man with acute ileocecal Crohn dis
f the terminal ileum (arrows) in longitudinal (A) and transverse (B) section, with hyperechoic inflammatory changes o
rms the wall thickening and luminal narrowing of the terminal and pre-terminal ileum (arrowheads), with regional fa
Crohn disease:
Crohn disease often causes long-standing symptoms, but up to one third of patients with ileocecal Crohn disease pr
appendicitis [7]. In the acute active phase of ileocecal Crohn disease, imaging shows transmural bowel wall thickenin
flammatory changes of the surrounding fat (Fig. 11). Uncomplicated Crohn disease can initially be treated with anti-i
Other nonsurgical mimics of appendicitis:
Fig. 12.- 39-year-old woman with pelvic inflammatory disease.A, Endovaginal sonography shows an inhomogeneousl
enlargement of the ovaries (B, arrows) with ill-defined contours of the ovaries and uterus, and some free pelvic fluid
Gynecologic conditions:
Gynecologic conditions such as pelvic inflammatory disease or a hemorrhagic functional ovarian cyst can cause acut
y disease the imaging findings vary according to the severity of the disease, and may be normal in early conditions. I
internal genital organs with indistinct contours, and free pelvic fluid (Fig.
12). In absence of a drainable tubo-ovarian abscess, treatment is medically with antibiotics. An hemorrhagic ovarian
tenuation adnexal mass at unenhanced CT, and does not require any treatment. Fig. 13. 77-year-old man with a righ
rrow) within the distal ureteral lumen.
Urolithiasis:
Urolithiasis may present with right lower quadrant pain when obstruction is caused by a distal ureteral stone. Unenh
than sonography, Fig. 14. 40-year-old woman with a ureteral stone.A and B, Sonography shows right-sided hydronep
er at the level of the iliac vessels. Ultrasound may show both hydronephrosis and hydroureter as signs of obstructio
atoma.A, Sonography depicts a small painfull lesion (arrow) within the sheath of the rectus abdominis muscle in the
Unenhanced CT depicts the lesion as a partly hyperdense mass (arrow) within the rectus sheath.
Rectus sheath hematoma:
A rectus sheath hematoma may be easy to diagnose in patients presenting with a painful palpable mass under antic
masquerade as appendicitis and also occur in patients without anticoagulantia [8]. Sonography and CT show a hem
15). No treatment is required other than adjusting any anticoagulant therapy.
Conclusion:
A broad spectrum of nonsurgical diseases may clinically present as appendicitis in patients without appendicitis. The
of these alternative disorders, as a correct imaging diagnosis prevents an unwarranted operation and unnecessary h
None:

CT in Abdominal Trauma:
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Publicationdate 2007-08-02 / update 2022-07-07 This review is based on a presentation given by Stephen Ledbetter a
en Ledbetter is director of the emergency radiology department of the Brigham and Women's Hospital in Boston, wh
w will focus on the role of CT in the evaluation of patients with traumatic abdominal injuries. Some of the cases will b
Introduction:
Click to enlarge Trauma is the leading cause of death under the age of forty. Of all traumatic deaths, abdominal trau
trauma are the following: Nowadays there is a trend towards non-operative management of blunt abdominal traum
ll renal injurys are managed non-operatively, because patients proved to have better outcomes on the long term rela
t trauma not only initially, but also for follow up, when patients are treated non-operatively. CT is also used to clear p
as a very high negative predictive value and can rule out injury. These patients do not have to be admitted for obser
The sensitivity and specificity of CT in blunt abdominal injury is 96 to 100% and 94 to 100%, respectively. CT is also in
was evaluated operatively, but the CT-results should be interpreted with caution as the sensitivity and specificity in p
1.3% to 100% and 81 to 84%, respectively).
In haemodynamically unstable patients there is already an indication for surgery and you may wanna skip the CT, ur
.
CT Protocol:

Multiphase CT:
In the original article in 2007 the standard method of scanning was the venous phase at 70 seconds post injection ar
ater if injury was detected on the initial scan. Nowadays the importance of the arterial scan is recognized.
Here we present the protocol and indications as advised by the radiological society of the Netherlands. A multi-phas
exclusion of vascular injury or active intra-abdominal hemorrhage.
In addition, the scan in the arterial phase can serve as a “roadmap” for the interventional radiologist or the vascular s
(arterial phase and venous phase combined in one scan). The disadvantage of such scans is that it can be more diffic
ral phase difference and the potentially reduced visibility of arteries compared to the pure arterial scan.
The advantage of such a scan is the lower radiation dose.
Secretory CT:
For the detection of lesions of the collecting system of the kidneys, ureteral and bladder lesions, venous phase CT is
secretion phase after 7 to 10 minutes. In the table the indication for an additional scan in the excretory phase are lis
an lesions, but did not proof to increase the sensitivity of CT abdomen without oral contrast and is therefore not ind
Spleen:
Click to enlarge The spleen is the most commonly injured solid organ (25%). The finding of contrast extravasation ha
active bleeding, there will be failure of non-operative management in 80% of the cases. In these patients the need fo
without extravasation. The table shows the CT findings in the spleen injury scale. Vascular injury is defined as a pseu
llection of vascular contrast that decreases in attenuation with delayed imaging. Active bleeding from a vascular inju
ses in size or attenuation in delayed phase. Vascular thrombosis can lead to organ infarction. The spleen injury grad
peration or on pathologic specimen. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Case 1 Scroll through the images and determine the degree of splenic injury. Then continue. The findir
ions.
2. Ribfracture and subcutaneous emphysema due to pneumothorax.
3. No contrast blush or hemoperitoneum Because of the absence of hemoperitoneum or active bleeding, this patien
oll
Disable Scroll Splenic injury. Scroll through the images and describe the findings Enable Scroll
Disable Scroll Splenic injury. Scroll through the images and describe the findings Case 2 Scroll through the images ar
lowing: Depending on the clinical condition this patient will be managed non-operatively, because there is no active l
Contrast blush:
A contrast blush is defined as an area of high density with density measurements within ten HU (Houndsfield Units)
is is: How can these entities be differentiated? Enable Scroll
Disable Scroll Splenic injury. Scroll through the images and describe the findings Enable Scroll
Disable Scroll Splenic injury. Scroll through the images and describe the findings Case 3
Images of a 22-year old male who presented 3 hours after a snowboarding accident with LUQ and left shoulder pain
The findings are the following: So in this case there is a chance of failure of non-operative management. Case 4
There are lacerations and also active bleeding with a contrast blush with the density within the range of the density
l probably need surgery.
Liver:
Liver laceration with active bleeding In trauma the liver is the second most commonly involved solid organ in the abd
ause of death. This is due to the fact that there are many major vessels in the liver, like the IVC, hepatic veins, hepati
cially if you are doing ultrasound, that the posterior segment of the right liver lobe is the most frequently injured par
o retroperitoneal bleeding rather than bleeding into the peritoneal cavity. Liver injury. The arrows indicate different t
tient with liver injury. Describe the findings. Then continue. The findings are:

Liver injury scale:
The AAST (American Association for the Surgery of Trauma) liver injury scale was revised in 2018. First look at the ima
T findings in this case? The findings are the following: First look at the images on the left of a patient with liver injury.
the following: So despite the fact that there is a contrast extravasation, this patient will be treated non-operatively a
the peritoneal cavity. Contrast extravasation is of great importance especially if it is associated with hemoperitoneu
on. Lacerations can be stellate, like the example on the left or branching like the one on the right. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll First look at the images on the left of a patient with liver injury. Questions: There is i.v. contrast and im
ontrast filling of the stomach. The contrast surrounding the liver could be a result of stomach or bowel perforation, b
unlikely. So the extravasation was thought to be a result of active bleeding and since there is a great amount of cont
. At the OR an avulsed right hepatic vein was found. This diagnosis has a 90-100% mortality and this patient died in th
Kidney:
Enable Scroll
Disable Scroll Scroll through the images by clicking on the arrows.Portal, delayed and excretory phase in a 21-year ol
ion or movement in lower extremities. Gun shot wound entry in right upper quadrant. No hematuria. The white obje
le Scroll
Disable Scroll Scroll through the images by clicking on the arrows.Portal, delayed and excretory phase in a 21-year ol
ion or movement in lower extremities. Gun shot wound entry in right upper quadrant. No hematuria. The white obje
trating injury Look at the images on the left and try to answer the following questions: Answers: Findings: There is als
+ In the delayed phase there is more extravasation, although it is not clear whether that is due to the active bleeding
+ In the extretory phase it is clear that there is violation of the collecting system The next question is, whether the pr
see if there is bowelperforation, because there is a penetrating trauma? In this case the answer is no, do not give this
reached the treshold for this patient to go to the OR. There are 3 reasons for this patient to go to surgery: If rectal co
t pose the problem that it would have been unclear, whether the contrast deposition was due to active bleeding or b
ontrast should only have been given if there were no other findings in need of surgery. Although this patient had sev
in penetrating trauma and does not rule out renal injury. In blunt trauma however the abcense of hematuria does r
ther patient with a penetrating injury due to a knife stab in the flank. The CT demonstrates nicely, that the injury is lir
oma. There is no sign of peritoneal violation and on delayed images (not shown) there was no extravasation of the co
nt injury In 90% of cases there will be renal injury due to blunt trauma. Unlike in injury to the spleen and the liver, in
m. Renal injury scale according to the Organ Injury Scale of the American Association of Surgery of Trauma (AAST) Th
agement of the patient. However unlike the grading for spleen and liver injury it is not that simple to remember. In g
on or subcapsular hematoma. Grade II and III injuries are either less or greater than 1 cm lacerations, but with no inj
ting system or large lacerations> Grade V is a shattered or devascularized kidney. First look at the images on the left
the CT grade of injury? The answer is, that like all grading systems, this system also has its limitations. What we see o
is not a contusion, because it is sharply demarcated. This is an post traumatic segmental infarction. On the left a typ
ry. Some final remarks on renal injury: Click to enlarge
Categories of Renal Injuries:
Michael Federle placed renal injuries into four categories:
Bladder:
On the left a 65-year old male struck by a car traveling at moderate speed. Loss of consciousness for 2 minutes. A fo
shows a moderately displaced fracture of the pubic bone with bony spicules in the bladder region. So the question i
will it affect our protocol? First this patient is at risk for arterial injury with pelvic hematoma, rectal, vaginal injury and
d after the routine CT. On the left the images of the routine trauma-CT. What are the findings? There is a displaced p
re is fluid in the prevesicle space (space of Rezius). If there is a pelvic fracture the chance of a bladder rupture is 10%
pelvic fracture. First it was thought that the rupture was caused by the pelvic fracture itself, but now we know that or
f the bone spicule. Two third of rupture occur at the opposite site, meaning that shearing forces play a significant rol
m images. There is contrast in the bladder surrounding the foley catheter and there is extravasation of contrast in th
o as the 'molar tooth sign' indicating extraperitoneal bladder rupture. On the left a sagittal and coronal reconstructio
lic gutter, so there is no intraperitoneal extention. The sensitivity and specificity of CT Cystography is very high. For e
for intraperitoneal rupture it is 92% and 100%. The most important factor is that you have to have good distention o
CT Cystography:
First we drain the bladder, because we want to get rid of the urine and contrast that was excreted by the kidneys. Th
r rectal contrast (i.e. 50 cc contrast in 1L saline). We instill the contrast retrograde through the foley catheter until on
ustrate why you do not administer contrast in the bladder at the same time as the administration of iv. contrast. The
ditional CT-cystogram? The answer to the first question is that if you would have administered contrast to the bladde
hether the contrast that is seen is due to a bladder rupture or to active bleeding. Since no contrast was instilled in th
condly because of the enormous extravasation, this patient is in need of immediate embolisation without further de
Pancreas:
Concerning pancreatic injury the following remarks can be made: On the left an unrestrained driver who had a car a
abdomen. First look at the images on the left and then continue. All the intraperitoneal organs were normal and the

ypodense area in the pancreatic tail and some fluid behind the pancreas, best seen anteriorly to the left kidney. So t
ury. The reason that he was not more definitive was that, an isolated pancreatic injury is exceptionally rare, since the
horax. During follow up this patient experienced more pain and on a follow up scan (not shown) there was impressiv
isolated pancreatic injury. The case above is an exceptional case. When the pancreas is involved in a trauma, it is alr
Disable Scroll Enable Scroll
Disable Scroll The more common presentation of pancreatic injury is what is seen on the left. Scroll through the imag
eft sided package injury. There is pancreatic tail injury and also splenic injury, renal injury and pneumoperitoneum. F
another common presentation of pancreatic injury. Look at the images and describe the findings. Then continue. Th
ssing the major vessels associated with a transsection of the pancreas at the junction of the head and the body. The
liver and the pancreas against the spine. Sometimes this kind of injury also involves the duodenum.
Diafragmatic injury:
On the left a chest film of a 79-year old restrained driver who had a car accident. Initially unresponsive at the scene.
of tubes. Look at the image on the left and describe the findings. Then continue. The first thing you'll notice is that th
. Nasogastric tube comes down and coils in the stomach. The superior mediastinum looks widened and indistinct, sc
an indistinct diafragmatic border and an opacity. This could be a lot of things like hematothorax, lung contusion, diaf
we are conceirned about possible aortic injury, pulmonary contusion and injury to the diaphragm, spleenic and left
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images on the left. What contrast is on board adn wh at are the findings? There is i.v
nasogastric tube we will notice that there is no contrast in the stomach. The most important finding in this case is th
be of the lung and lateral to it an amount of fat. This is very suggestive of diafragmatic rupture. What can we do to g
tube is in place, we can administer contrast to the stomach. The images on the left prove that the structure is the sto
n the stomach compatible with the 'collar sign'. These findings are specific for diafragmatic rupture.
CT 'collar' sign:
On the left the coronal reconstruction of the same patient demonstrating the 'collar sign', where the stomach passes
signs of diafragmatic injury are present. Non-specific signs are discontinuity or thickening of the diafragm or the 'dep
diafragmatic rupture
'Dependent viscera' sign:
On the left a demonstration of the 'dependent viscera' sign. On the left side there clearly is a diafragmatic rupture wi
spleen lie against the posterior thoracic wall, which is abnormal. This is unlike on the right side where the liver is aw
Chest film in a patient with right-sided injury. On the left a patient with a right-sided injury. On the chest film it looks
ybe there is a subpulmonic pleural fluid collection. There also could be a baseline diafragmatic paralysis. Now contin
c rupture Describe the findings on the left and then continue. The axial image demonstrates that the opacity on the
there is this unusual shape (yellow arrow). There is discontinuity of the crus which is a non-specific sign (small blue a
on the posterior side due to blood in the thorax. On the sagittal MPR there is indentation of the liver and the 'collar' s
concerning diafragmatic rupture.
Aortic injury:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll On the left an unrestrained 22 y.o. male involved in a high-speed motor vehicle accident. He was ejecte
bated with diminished femoral pulses. Scroll through the images on the left and describe the findings. The findings a
level of the diafragm A unilateral renal infarct can be the result of a localized injury. However when there are multip
The most common location after injury for these emboli is in the thoracic aorta at the isthmus, because the aorta is
ic dissection of the aorta at the level of the diaphragm. This is the second most common location for injury to the ao
Bowel injury:
Enable Scroll
Disable Scroll Multiple injuries due to 40 feet fall. Enable Scroll
Disable Scroll Multiple injuries due to 40 feet fall. On the left images of a 44 y.o. male who jumped 40 feet from build
tment for depression BP 90/54. Pale, diaphoretic, confused. No head injury. Ecchymoses around chest and abdomen
Distended abdomen. Pelvis grossly unstable.
Gross hematuria. Scroll through the images on the left and describe the findings. The findings are: The questions in
marks have to be made: In fact the most common findings in small bowel injury are non-specific findings like thicken
he patient that we discussed the diffuse wall thickening was only a result of hypoperfusion or 'shock' bowel due to th
lts in focal thickening and is mostly a non-transmural injury. It is very uncommon to identify findings that are specific
el content. More commonly you will find a combination of intraperitoneal fluid and mesenteric stranding, focal bowe
injury. by Akira Kawashima, MD, Carl M. Sandler, MD, Frank M. Corl, MS, O. Clark West, MD, Eric P. Tamm, MD, Elliot
1:557-574
2. PDF format: American College of Radiology, ACR Appropriateness Criteria? for Blunt Abdominal Trauma This revie
ed trend is noted for detection of specific findings that do predict the need for therapeutic surgery or for angiograph
is needed for an injured patient. This trend in imaging parallels a strong trend in trauma therapy toward nonoperativ
hen hemoperitoneum is present.

3. Optimization of Selection for Nonoperative Management of Blunt Splenic Injury: Comparison of MDCT Grading Sys
US of the GI tract - Normal Anatomy:
Julien Puylaert
Medical center Haaglanden in the Hague and Academical Medical Center in Amsterdam, the Netherlands:
Publicationdate 3-4-2020 Press ctrl+for larger images and text on a PC or □+ on a Mac.
Most images can be enlarged by clicking on them. For critical comments and additional remarks: j.puylaert@gmail.c
Normal anatomy:
Courtesy: Dr. Netter
Histology of the GI tract:
From inside to outside the layers of the small bowel are the mucosa (M.), the submucosa (S.M.), the circular muscle l
(S.)
US fingerprint of the normal GI tract:
The classic five-layer-US-structure of the bowel wall is easiest apprehended by studying the wall of the fluid filled st
er-hypo-hyper-hypo-hyper-echoic or white-black-white-black-white. The US architecture of the wall is essentially the
rficial mucosa is brightly hyperechoic, due to mucus and very tiny air-particles caught between the small intestinal vi
perechoic feces, as in this US image of the colon. The outer white serosa can only be identified when there is ascites.
deep mucosa, submucosa and muscularis (black-white-black) are always visible. In this patient with severe coprosta
th a 12 MHz probe. Deep Mucosa The deep mucosa is hypoechoic and has a variable thickness. It represents the pac
osae. Especially in the terminal ileum of children and young adults, prominent echolucent lymphoid tissue is found i
ressively large and asymmetrical. Submucosa The submucosa contains vessels, nerves and fat and is hyperechoic du
e colitis, prominent vessels (arrows) in the submucosa are visualized and proven with color Doppler in the right imag
is, and during contraction, the submucosa can be seen to follow the mucosal folds (left upper). After drinking water,
r). This loose connection also explains why gastroscopical biopsies can be taken unpunished, especially when the sul
e muscularis is hypoechoic due to muscular tissue and as outer black layer is easy to identify. It consists of two layer
muscle layer, which cooperate to produce peristaltic movements. These two muscular layers are separated by a thin
rbach plexus. This thin layer (arrowheads) is hyperechoic on US and can be seen in the small bowel of lean patients.
of the Auerbach plexus, underlines the high resolution of US compared to CT and MRI. (M= muscularis, BV= Bloodve
is different from that of the small bowel. The longitudinal muscle layer is limited to three longitudinally oriented ban
hin patients, these three teniae (arrowheads), can often be identified by US as a local thickening of the muscular laye
e. In this longitudinal view only one tenia coli (arrowheads) is identified. Serosa The serosa or visceral peritoneum is
ends with the hyperechoic fatty tissue of mesentery and omentum, surrounding the bowel. If there is intraperitonea
ed, as in these ileal loops.
Stomach:
In most patients referred for US, the stomach is empty, either because they have been asked not to drink too much
with their acute abdominal problem. If the stomach is fluid-filled and the patient denies previous drinking, this is a r
paresis or hypersecretion with stasis due to active peptic ulcer disease. Antrum and duodenal bulb are the parts of t
local thickening of the muscularis distally to the antrum. The wall of the duodenal bulb is thinner than that of the sto
the antrum and duodenal area, by turning patients on their right side: air rises to the gastric fundus, and fluid enters
lts with peptic ulcer disease. The left image shows a gastric ulcer (arrow). Note the loss of layer structure in the vent
ing the omentum and mesentery, trying to wall-off the imminent perforation from this deep penetrating gastric ulce
e fluid-filled duodenal bulb. Descending and horizontal duodenum are rarely accessible for US. When specifically loo
% of the normal population, can be identified. They present as a (curvi)linear reflection within the pancreatic head.
than normal patients. Enable Scroll
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Small bowel:
The normal small bowel is easily visualized by US and is recognized by continuous and vivid peristalsis, even if the lu
yperechoic border within the bright submucosa. These represent normal 0.4 – 0.5 mm vessels. Note also the thin hy
ssue separating the longitudinal and circular muscle layer, containing the Auerbach plexus. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Normal small bowel in the longitudinal plane.
Jejunum:
The jejunum (left image) is mainly located in the LUQ, and contains more Kerckring's folds (valvulae conniventes) tha
suring bowel wall thickness with US is difficult because thickness changes with peristaltic movements. In this individu
in the axial plane during light compression (left under) vary considerably, but during moderate compression (right u
n hyperechoic serosa is rarely discernible, bowel wall thickness is measured from the outer contour of the ventral m
n of course, divided by two. Normally, single small bowel wall thickness during compression is about 1.5 - 2.5 mm. M
comparable to what surgeons do with their fingers during laparotomy to decide whether small bowel is abnormal. I
e well compressible during relaxation. Compare a normal terminal ileum (left) and a Crohn's ileum (right), without co
te the same cm-scale in all four US-images. Single wall thickness in the normal individual is 1.5 mm, in the Crohn pati

Terminal ileum:
The terminal ileum can often be identified separately due to its specific location and course from the pelvis toward th
inal ileum into the cecum can only be seen in thin patients with an empty cecum. The location of the ileocecal valve r
cus. Note the lymphoid hyperplasia of the Peyer's patches in the terminal ileum. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll More frequently the terminal ileum can be followed until it disappears into the feces-filled cecum. Thes
and young adults with large Peyer's patches presenting as asymmetrical, hypoechoic thickening of the deep mucosa
n young patients both mesenteric lymph nodes and Peyer's patches are –also in absolute dimensions- much larger th
results in prominent Peyer's patches in the terminal ileum and enlarged mesenteric lymph nodes (left under), but als
that the –sometimes polyp-like- protrusions (right upper), may act as lead-point in the classic ileocecal intussusceptio
Intussusception:
Here the US image in a 2 year-old child with intermittent ileocecal intussusception, examined in between attacks. The
m. Classic US image of ileocecal intussusceptions in two different children. In both, the intussuscepted ileum is asym
perechoic fatty mesentery, attached to the ileum and following the ileum, when pulled in. Within the mesentery US s
re enlarged as part of the general lymphoid hyperplasia and are not localised in the ileal lumen. Therefore it is not th
ix (arrow) is pulled in also. Note the multi-layered aspect of the ventral wall of the intussusception complex, represe
issue in the terminal ileum is most impressive in the young child, it may be found until the age of 20 years. In this you
there are still prominent Peyer's patches (p.) in the deep mucosa of the terminal ileum. During US examination, it is n
eption. Apart from lack of symptoms, these can be discriminated by US from the real symptomatic intussusception,
no lead point. These transient intussusceptions may be associated with celiac disease and it is important to exclude
Omentum, mesentery and lymph nodes:
The normal omentum is usually not separately visible. When it is thickened e.g. in malignant or, more rarely, in tuber
if there is concomitant ascites. US can also visualize the omentum (arrowheads) in segmental omental infarction, in
n. The small bowel is attached to the mesentery which is folded like a fan. The mesentery contains a variable amoun
ct, especially when compressed during US. The normal mesentery (arrows) in thin patients is only visible when there
d can be visualized as a well-compressible, flat, multi-layered structure. In one plane this may simulate a thickened b
s (right image), it is immediately recognized as a flat structure (arrows). Click image for animation. At the edge of the
can be visualized. Click image for animation.
Epiploic appendages:
Next to mesentery and omentum, also the properitoneal fat is part of the intra-abdominal fatty tissue, as are the epi
te arrowheads) , prone to hemorrhagic infarction (epiploic appendagitis). Normal epiploic appendages are only visibl
nteric lymph nodes can be visualized, predominantly in the region right of the umbilicus. During graded compressio
iliac vessels. The dimensions of the normal mesenteric lymph node are variable, in this case the dimensions in three
diameters may even be larger, the shortest axial diameter in adults should not exceed 5 mm. In case of enlarged me
meter that increases. Therefore, to decide whether a node is normal or abnormal, measuring the shortest axial diam
lymph node, is that of an almond versus an olive. In children, especially those of 5 to 10 years old, the mesenteric ly
ameters up to 10 mm. These large mesenteric lymph nodes in children, may be associated with viral infections, but c
es have a relatively hyperechoic center and a lobulated, echolucent peripheral zone, representing the germinal cente
Appendix:
An experienced sonographer can identify the entire normal appendix -including the blind end- in about 30 % of adu
ormal appendix, excludes appendicitis. The normal appendix has the same layers as in normal bowel wall. In this you
to a little intraperitoneal fluid. Note the empty lumen and the normal triangle-shaped hyperechoic meso-appendix. E
Disable Scroll Enable Scroll
Disable Scroll To compress the appendix, a rather firm underground is mandatory like iliac artery, psoas muscle or v
from small bowel by its location, its size, its absence of peristalsis, its attachment to the cecal pole (c.p.) and its blind
Disable Scroll Enable Scroll
Disable Scroll The blind end of the normal appendix is firmly demonstrated using a "mini-clip". The US diameter of th
mpression from outer contour of the ventral muscularis to the outer contour of the dorsal muscularis. Thus measure
is inflamed appendix (right) 8.5 mm. In many textbooks a cut-off value of 6 mm is reported, however this is not a reli
rge study and found that the diameter of the normal appendix was 6 mm or larger in 27 % of cases, with a range of
special chapter on appendicitis. CT measurements overestimate the appendix diameter compared to US. In the litera
3 to14 mm). The explanation for this discrepancy may be that on CT: The left panel here shows a CT of a normal, fec
a comparable normal appendix in a different patient measuring 7.5 mm, the right panel shows that same appendix
meter of the normal appendix is 6 mms or less in 73 % of cases. Here you see the normal appendix during compres
(Note the same cm-scale). In the lower five, the lumen is filled with fecal material of various reflectivity, which make
nating feature indicating appendicitis is inflamed fat, followed by diameter, non-compressibility, hyperemia and a fix
nced appendicitis, as fluid collections and loss of layer structure, but in these cases it is clear that the appendix is infl
hich case the appendix is easily compressible. Not rarely, the blind ending tip (arrowheads) of the normal appendix
normal appendix has no fixed position and during the US examination may appear in different places in the abdomi
rrows) are close to each other, in contrast to the inflamed appendix that becomes more rigid and stretches to some

ith an acoustic shadow are found, indicating inspissated feces. As they are small and not calcified on CT, they are no
images in this 15 year old boy show a normal compressible appendix with a large fecolith (arrows), producing a harc
US examination, but he recalled four, one-day-lasting, self-limiting episodes of severe RLQ pain over the past nine n
ndectomy he had no more attacks. In children, the deep mucosa may show remarkable hypoechoic thickening due t
ible. This is a common finding in healthy kids, but in case of very prominent hyperplasia, a viral infection may be pres
Colon:
Longitudinal (left) and transverse (right) image of the empty sigmoid in a lean patient. In the transverse image three
sent the three teniae coli (arrowheads). Normal colon filled with feces (left), during contraction (middle) and during r
s during compression is 3-4 mms. Acoustic shadowing of the feces prevents US visualization of the posterior wall (le
contents, scarce peristalsis and a thick outer muscle layer with three tenia coli. The muscularis of the sigmoid may c
anent thickening of the muscularis is associated with the development of diverticula (arrows). Sigmoid diverticulosis
isualized when the colon is contracted. They present as bright reflective structures with an acoustic shadow on the o
scularis in these four patients. Detailed US image of sigmoid diverticulum in very lean 61-year old patient. There is a
h in the diverticulum (arrows). Note the very thin wall of the diverticulum, consisting of herniated (sub)mucosa cover
, invariably occurs at a weak spot where the vessels penetrate the circular muscle layer, immediately next to the teni
y color Doppler in another very lean patient (left under) and illustrated in the Netter image right under. Undigested v
ithin the colonic lumen. These can be differentiated from colonic polyps by their edgy contours, lack of vascularity, th
uring follow-up. Incidental finding of a round echolucent structure in the sigmoid lumen. This proved to be a vascula
gy confirmed a polypoid, tubulovillous adenoma. Colonoscopy found also three other adenomas, not detected by US
Coronary anatomy and anomalies:
Robin Smithuis and Tineke Willems
Radiology department of the Rijnland Hospital Leiderdorp and the University Medical Centre Groningen, the Netherl
Publicationdate 2008-10-14 In this article we describe the anatomy of the coronary arteries of the heart and some of
an update of an article that appeared earlier in the Radiology Assistant.
Overview:
RCA, LAD and Cx in the anterior projection On the left an overview of the coronary arteries in the anterior projection
he left an overview of the coronary arteries in the right anterior oblique projection. RCA, LAD and Cx in the lateral pr
the lateral projection. Read more about coronary anatomy inIntroduction to cardiothoracic imaging
Left Coronary Artery (LCA):
Left coronary (LC), right coronary (RC) and posterior non-coronary (NC) cusp The left coronary artery (LCA) is also kno
p. The aortic valve has three leaflets, each having a cusp or cup-like configuration. These are known as the left coron
n-coronary cusp (N). Just above the aortic valves there are anatomic dilations of the ascending aorta, also known as t
The left aortic sinus gives rise to the left coronary artery. The right aortic sinus which lies anteriorly, gives rise to the
ned on the right side. LCA divides into LAD and Cx The LCA divides almost immediately into the circumflex artery (Cx
CT-image. The LCA travels between the right ventricle outflow tract anteriorly and the left atrium posteriorly and div
main artery dividing into On volume rendered images the left atrial appendage needs to be removed to get a good l
e LAD and the Cx, known as the ramus intermedius or intermediate branch. This intermediate branche behaves as a
Left Anterior Descending (LAD):
CT image of the LAD in RAO projection The LAD travels in the anterior interventricular groove and continues up to th
ptum with septal branches and the anterior wall of the left ventricle with diagonal branches. The LAD supplies most
branches arise from the LAD. The diagonal branches come off the LAD and run laterally to supply the antero-lateral w
e boundary between the proximal and mid portion of the LAD (2). There can be one or more diagonal branches: D1,
Circumflex (Cx):
Circumflex and LAD seen in Lateral projection The Cx lies in the left AV groove between the left atrium and left ventri
entricle. These vessels are known as obtuse marginals (M1, M2...), because they supply the lateral margin of the left v
e Cx ends as an obtuse marginal branch, but 10% of patients have a left dominant circulation in which the Cx also su
branches arise from the Cx and supply the lateral Margin of the left ventricle.
Right Coronary Artery (RCA):
RCA, LAD and LCx in Anterior projection The right coronary artery arises from the anterior sinus of Valsalva and cour
ight artium and right ventricle to the inferior part of the septum. In 50-60% the first branch of the RCA is the small co
In 20-30% the conus branch arises directly from the aorta. In 60% a sinus node artery arises as second branch of the
from the Cx). The next branches are some diagonals that run anteriorly to supply the anterior wall of the right ventr
ute angle and runs along the margin of the right ventricle above the diaphragm. The RCA continues in the AV groove
s the posterior descending artery (PDA) is a branch of the RCA (right dominant circulation). The PDA supplies the infe
. LEFT: RCA comes off the right sinus of ValsalvaRIGHT: Conus artery comes off directly from the aorta On the image
A comes off the right cusp and will provide the conus branch at a lower level (not shown). On the image next to it, we
e large acute marginal branch (AM) supplies the lateral wall of the right ventricle. In this case there is a right dominan
) comes off the RCA.
Coronary Anomalies:
Coronary anomalies are uncommon with a prevalence of 1%. Early detection and evaluation of coronary artery anom

ial ischemia and sudden death (3). With the increased use of cardiac-CT, we will see these anomalies more frequently
origin, the course and termination (Table). The illustration in the left upper corner is the most common and clinically
from the right sinus of Valsalva and the LCA courses between the aorta and pulmonary artery. This interarterial cour
n myocardial ischemia. The other anomalies in the figure on the left are not hemodynamically significant.
Interarterial LCA:
On the left images of a patient with an anomalous origin of the LCA from the right sinus of Valsalva and coursing bet
observed in these patients.
ALCAPA:
On the left images of a patient with an anomalous origin of the LCA from the pulmonary artery, also known as ALCAP
by relatively desaturated blood under low pressure, leading to myocardial ischemia. ALCAPA is a rare, congenital car
nital heart diseases. Approximately 85% of patients present with clinical symptoms of CHF within the first 1-2 month
Myocardial bridging:
Myocardial bridging is most commonly observed of the LAD (figure). The depth of the vessel under the myocardium
s debate, whether some of these myocardial bridges are hemodynamically significant. Left to right shunt: septal bran
Fistula:
On the image on the left we see a large LAD giving rise to a large septal branch that terminates in the right ventricle (
2. Cardiology Site by M. Abdulla This site includes instructional movies, 3-D animation, panoramic views, online quiz,
d interactive echocardiograms.
3. Visualization of Anomalous Coronary Arteries on Dual Source Computed Tomography by G.J. de Jonge et al Europe
None:

None:

US of the GI tract - Technique:
Julien Puylaert
Medical center Haaglanden in the Hague and Academical Medical Center in Amsterdam, the Netherlands:
Publicationdate 3-4-2020 The GI tract is the most challenging part of the abdomen to examine by US.
Although technically demanding, its results have great clinical implications in early triage of bowel diseases and in th
This is the first of a series on US of the GI tract. Press ctrl+for larger images and text on a PC or + on a Mac.
This can be helpful for scroll-images.
Single images can be enlarged by clicking on them. For critical comments and additional remarks: j.puylaert@gmail.c
Examination technique:
Thickening of mucosa and submucosa in Clostridium colitis Modern ultrasound machines provide high resolution im
mucosa and submucosa in Clostridium colitis. However nowadays cheap ultrasound systems consisting of a 1200 eu
d quality (see next image). We expect that more doctors and health workers will use ultrasound in their daily practice
Knowledge of technique, normal anatomy and pathology of the GI tract will be important for patient management. U
US machines and probes:
In this lean person, the normal terminal ileum and the normal, compressed appendix (arrow) are visualized on a tab
ogram with patients of varying habitus, still three probes is the minimum. The cm's indicate the range where image r
l, the middle and small probe are the workhorses in US of the GI tract. Choice of the probe is based on the depth wh
fluid-filled stomach in this obese patient (left), is best studied with the middle-transducer, the normal ileum and appe
e-sets for specific abdominal organs can be helpful, but we use only two abdominal pre-sets per probe: normal and
The "over-processed" US image:
The processed US image: speckle-noise-reduction Compare the native US images (left) of the pancreatic region with
mages the vessels have a sharper delineation with a completely anechoic lumen. However, also unrealistic reflection
s in the area dorsal from the pancreatic tail (right upper image) and note the bizarre contour of the stomach and the
US examination of bowel:
US of the GI tract has been quite unpopular in the past because of the interference of gas and other bowel contents
s often conspicuous, due to local wall thickening and an empty lumen, e.g. in this patient with segmental Crohn's coli
is best done using the so-called "mowing-the-lawn" technique. This technique requires graded compression, a high-f
, overlapping lanes are necessary, not to miss any pathology. Most commercially available US gels are quite viscous.
one third of hot tap water. Better skin contact prevents disturbing air-artifacts (arrowheads). It is time-efficient to pu
normal habitus, one large dose (~25 cc) of diluted US gel is sufficient for the entire examination. A small reservoir in
liberal use of US gel has great advantages.
There are however two drawbacks: things may get quite messy and hygiene may be endangered. This requires "US g
le getting sticky, you can put it around your neck or place it on the patient's chest when studying the left flank. US ge
back. Proper cleaning of the probes after each patient speaks for itself. Ask the manufacturer what to use as cleanin
hand free of US gel: the combination of rather forceful compression with subtle rotational movements requires a dry
Graded compression:
Advantages compression Compression should be graded and gentle Graded compression is remarkably well tolerate

elations are altered by graded compression.
During compression, the ventral wall of the bowel is compressed against the dorsal wall, eliminating the disturbing e
onstrates a retrocecal, inflamed appendix (arrowheads) with an obstructing fecolith (arrow). By graded compression
pendix is visualized close to the abdominal wall (note cm-scale). CT shows contracted colon (arrow) in obese patient
visualized with a 12 MHz probe. During moderate compression (right), the relaxed colon can even be seen flattened
ith inactive ulcerative colitis. The sigmoid lies 9 cms from the skin. During compression (arrowheads) this distance wa
obe. Click on image for animation To visualize a tubular structure (e.g. the inflamed appendix) in two perpendicular p
in the middle of the US image. This allows to keep the structure visible, while rotating the probe 90 degrees (click on
in keeping a small tubular structure in sight. The rather ovoid than round shape of most probe-handles is not very h
th compression. Try to develop a grip that allows you to rotate the probe from your wrist, and not from your arm or
Preparation of the patient:
A half-full bladder allows optimal examination of the bladder and distal ureters and uterus and ovaries in women (im
In patients with acute abdominal pain, preparation is not an issue: most of the patients have not eaten or have vomi
ical condition is ruled out.
MRI traumatic changes:
Mini Pathria and Jennifer Bradshaw
Department of Radiology of the University of California School of Medicine, San Diego, USA and the Medical Centre A
Publicationdate 2009-10-01 This article is based on a presentation given by Mini Pathria and was adapted for the Rad
MR features of various muscle injuries. In part II we will discuss non-traumatic muscle changes.
Introduction:
Dr. Pathria is a Professor of Clinical Radiology at the University of California, San Diego . Dr. Pathria's specific areas o
ology, and musculoskeletal MR imaging. She is the author of the book MRI of the Musculoskeletal System. Normal m
feathery fat planes and low signal on all sequences When looking at muscle on MR there are a few rules to keep in m
the four basic patterns of abnormality is present: On the left an example of a lipoma creating a mass effect in the an
Muscle injury:
The most common muscle injury is muscle strain (1). It is an injury to the musculotendinous junction. Typical for mus
(1). More severe muscle strains contain fluid collections such as hematomas and may contain grossly interrupted m
dition to muscle edema. Muscle contusions are caused by a direct blow. MR images reveal interstitial hemorrhage as
tain hematomas and thus reveal a masslike lesion in addition to the edema. Abnormal Signal Intensity in Skeletal Mu
, MD et al October 2000 RadioGraphics, 20, S295-S315
Muscle Strain:
The musculo-tendinous junction extends deeply into the muscle Muscle strain is an injury to the musculotendinous j
tendon, and the shape of it varies in different muscles. In many muscles, the tendon extends deeply into the muscle
s especially important in a trauma setting, because it is often involved. The epimysium is the fibrous tissue that lies a
fuses with the tendon. This is also an important area to consider because when there is a tear in the muscle, fluid ten
ema in muscle strain will depend on the architecture and shape of the musculotendinous junction involved. The ima
he musculotendinous junction in an atrophic muscle. Complete tear of the rectus femoris with edema at the muscul
surrounding the musculotendinous junction in a feather-like arrangement. This is a complete tear to the rectus fem
on the left the rectus femoris, which can show a variety of edema patterns depending on where (anatomically)
the injury took place. The blue arrow demonstrates the tendon of the indirect head, which comes from the hip, it has
on this axial image. Along the posterior portion of the muscle (yellow arrows), there is a flat area of tendon originatin
the tendons it means that there are different patterns of edema possible
depending on the tendon injured. Therefore this is a pattern of edema corresponding to an injury arising from the k
ry is usually very concise. The muscles that are most prone to strain are the long fusiform muscles that cross 2 articu
edial gastrocnemius. Strain involving the upper extremity is slightly less common and then usually involves the bicep
yotendinous juntion because that is where the tearing takes place. There is edema around the tendon and sometime
attern of muscle strain (left) and epimysial strain pattern (right) There are 2 patterns found with muscle strain. By far
occurs roughly 97% of the time. Depending on the severity of the strain, there might also be fluid collections. The re
ormalities found at the periphery of the muscle. Epimysial strain pattern of an acute muscle strain of the supraspina
lifter with an epimysial strain pattern. The tendon tears at the myotendinous junction, and the fluid leaks around the
fuse this with a degenerative or impingement-type tear. Strain of the subscapularis muscle On the left a strain with p
gent muscle (like for example the pectoral muscle) with multiple tendons. Edema will have a multipennate distributio
multiple tendons. Two different types of musculotendinous junction strain On the far left a complete tear of the indi
ates in the hip. The image next to it, which was also shown above, shows a completely different finding. There is ede
a. The other tendon is completely normal (blue arrow).
Grading muscle strain:
Clinically the severity of a muscle injury is graded from 1-3. Trying to grade a muscle injury by the signal intensity is t
et still be high grade injuries according to the clinical classification. On the left an example of a tear in the left pectora
scle with a small amount of fat filling it up. The gradient echo demonstrates focal fluid accumulation and some incre
ever, when asked to fully contract the pectoral muscles there is an obvious asymmetry due to a complete tear in the

complete loss of function of the muscle.
Low grade muscle strain:
On the left a low grade injury of the flexor hallucis longus. There is normal muscle architecture on the T1-weighted in
njury will heal completely within a couple of weeks. This example shows edema with an epimysial pattern which is co
not only at the architecture but also at the length of the muscle. Studies have shown that the length of the muscle st
longer lesions requiring more time to recover. (Reference article by Dr. Connell DA et al, AJR 2004, 83: 975-984). So th
to heal. On the left a patient with 2 grades of injury to the gastrocnemius. There is a low grade injury to the lateral h
Moderate grade muscle strain:
On the left the same patient. There is also a moderate grade injury to the medial head. Note the fluid accumulations
derate grade injury to the rectus femoris muscle On the left an injured rectus femoris muscle. The images demonstr
uid collection (arrow). Notice the edema at the bipennate musculotendinous junction.
High grade muscle strain:
On the left an example of a high grade injury. There is a complete tear of the tendon or myotendinous junction of th
scle. On the left a complete tear of the left hamstring at the musculotendinous junction. Tthe tendons are avulsed ar
n epimysial pattern of edema On the left a different patient with also a complete hamstring rupture. There is an epim
A hamstring syndrome may occur. This is a painful condition caused by post-traumatic scar formation around the sc
Chronic changes of muscle strain:
On the left images of a patient who had a prior muscle strain. There are typical chronic changes such as focal tendon
w arrow). On the left images of a patient who had an injury to the long head of the biceps femoris muscle. There are
row) and severe muscle atrophy.
Contusion:
Muscle contusion with edema of the skin, muscle and bone marrow (arrows) Muscle contusions are caused by a dire
t the typical myotendinous junction localization seen in the latter. Typically, there is also skin edema and sometimes,
requently due to interstitial hemorrhage as well as edema. More severe contusions may contain hematomas and thu
the superficial muscles. Muscle contusion On the left images of a patient who has a mass-like swelling of the fore-foo
oor on foot' was specific.
Hemorrhage:
Muscle hematoma and parenchymal hemorrhage Hemorrhage can present as a discrete hematoma or as parenchym
ntensity of a hematoma on T1W- and T2W-images depends on the stage of the hematoma (Table). Hyperacute hema
s a hyperacute hematoma. Low signal intensity on T1W and high signal on T2W. Acute hematoma On the left an acut
ntensity in T2WI in the acute period is due to the high concentration of intracellular deoxyhemoglobin. Early subacut
early subacute hematoma. On the far left a T1-weighted image. The hyperintensity at the periphery of the hematom
t for months. The image on the right shows the same hyperintensity on a T2-weighted image. Late subacute hemato
layering. Chronic tennis leg On the left images of two different patients with a chronic hematoma in the calf. On the
urrounding the hematoma. On the right a T2-weighted image of a similar case. Notice that the hemosiderin is also da
Morel-Lavallee:
On the left a chronic hematoma known as Morel-Lavallee lesion. A Morel-Lavallee lesion is the result of separation o
is filled with fluid and debris. These lesions are found around the thigh and have a well-defined oval or fusiform shap
ding Morel-Lavallee Lesions of the Trochanteric Region and Proximal Thigh: MRI Features in Five Patients by J. M. Me
rcinoma A hematoma can look like a tumor and vice versa. On the left a metastasis of a renal cell carcinoma. When i
e with the post-Gad image. Metastasis of a renal cell carcinoma with central necrosis The majority of the lesion enha
ement as a result of necrosis. Hematomas can show some enhancement, but only at edge.
Myositis ossificans:
Myositis ossificans Severe blunt trauma causing an intra-muscular hematoma may result in delayed ossification in th
as a variable appearance depending on the maturity: Myositis ossificans On MRI myositis ossificans can be difficult to
ossification not attached to bone is seen. Myositis ossificans On the left another case of myositis ossificans with bon
Compartment syndrome:
Post fasciotomy for post fracture compartment syndrome Compartment syndrome is a limb-threatening and life-thr
pressure in a closed anatomic space. A fasciotomy procedure with incision in the skin and the muscle fascia is neces
pillaries. Compartment syndrome progresses to rhabdomyolysis if untreated. Necrosis of tissue may begin at interst
xtbook of Orthopaedics Muscle necrosis, post IV gadolinium In the lower leg there are four compartments: the anter
compartment. On the left T1W-images of a patient one month post trauma. On the post-Gadolinium image the necr
partment is normal. Chronic lateral compartment syndrome On the left a T2W-image of a patient with a chronic later
syndrome On the left a compartment syndrome in the upper leg which progressed to rhabdomyolysis. Rhabdomyoly
ic intracellular contents from the myocytes into the circulatory system and can lead to kidney failure. Calcific myonec
Calcific myonecrosis:
Calcific myonecrosis is a rare post- traumatic entity characterized by latent formation of a dystrophic calcified mass o
onecrosis an entire single muscle is replaced by a fusiform mass with central liquefaction and peripheral calcification
al features that suggest an enlarging soft-tissue neoplasm or infection. Calcific Myonecrosis of the Calf Manifesting a
Janzen et al AJR 1993;160:1072-1074 Calcific Myonecrosis: Keys to Recognition and Management by Helena M. O. Dw

Laceration:
Laceration of right pectineus muscle with atrophy and scar tissue On the left a patient who met up with the wrong e
r with another woman and he was rewarded with a stab into the groin. This resulted in a laceration of his right pecti
since these patients usually go directly to the ER or OR for surgical exploration, but this case nicely demonstrates the
Delayed onset muscle soreness:
Delayed onset muscle soreness of gasctrocnemius Delayed onset muscle soreness (DOMS) develops 1-2 days follow
on the ski slopes). DOMS is a type of overuse injury that does not become symptomatic until hours or days after the
which usually is immediately painful. The MR findings show diffuse muscle edema that does not localize to the myot
who had gone for a run for the first time in quite a while. The muscle is irritated as illustrated by edema in the gastro
ents are not always aware of when or how the injury was actually caused. On the left a navy recruit with delayed ons
us brachialis muscle. These abnormalities can last for weeks.
Fascial hernia:
A fascial tear presents as a mass, the signal is usually normal (rather like an accessory muscle). The muscle herniates
n. It is an intermittent mass and can be missed on MR if it is only visible during contraction. A fascial tear is a typical s
). This type of muscle injury is well evaluated with ultrasound, because it is an dynamic examination. David A. May et
2. Longitudinal Study Comparing Sonographic and MRI Assessments of Acute and Healing Hamstring Injuries Connel
3. Long-Standing Morel-Lavall?e Lesions of the Trochanteric Region and Proximal Thigh: MRI Features in Five Patients
4. Calcific Myonecrosis: Keys to Recognition and Management by Helena M. O. Dwyer et al, AJR 2006; 187:W67-W76
5. Calcific Myonecrosis of the Calf Manifesting as an Enlarging Soft-Tissue Mass: Imaging Features by Dennis L. Janze
None:

TNM classification 8th edition:
Onno Mets and Robin Smithuis
Department of Radiology of the Academical Medical Centre, Amsterdam and the Alrijne Hospital, Leiderdorp, the Ne
Publicationdate 2017-12-09 This is a summary of the 8th Edition of TNM in Lung Cancer, which is the standard of nor
ued by the IASLC (International Association for the Study of Lung Cancer) and replaces the TNM 7th edition.
TNM-8:
TNM-staging 8th edition. Changes to 7th edition in red. The 8th edition of the TNM classification for non-small lung c
e three components that describe the anatomic extent of the tumor: T for the extent of the primary tumor, N for lym
n is performed using CT, the N- and M-classification using CT and PET-CT. It can be used in the pre-operative imaging
e for definitive pathological staging pTNM, re-staging after therapy yTNM and staging of a recurrence rTNM. Differen
What is new in the TNM 8th edition:
In the new TNM 8th edition the size went down for several T-categories, and some new pathology based categories w
rathoracic metastatic disease. Size of a solid lesion is defined as maximum diameter in any of the three orthogonal p
fined by the diameter of the solid component and not the diameter of the complete groundglass lesion. Stages of lu
Non-small lung cancer stages:
Subsets of T, N and M categories are grouped into certain stages, because these patients share similar prognosis [1].
7-92%. On the other end of the spectrum is any M1c disease (stage IVB) that has a 5-year survival of 0%. Lungcancer
l reconstructions; lobectomy is no longer possible. Lobectomy is generally not possible if there is: These are specific i
tions are necessary to best demonstrate the relation with surrounding structures. In case of indeterminate invasion,
enefit of doubt is given, depending on the individual case and co-morbidity.
T-classification:

T0:

Tis:
This can only be diagnosed after resection of the tumor. T1 tumor – A typical T1 tumor in the left lower lobe, comple
T1:
Tumor size ≤3cm T1a(mi) is pathology proven 'minimally invasive', irrespective of size. T1a(ss) is a superficial spreadi
tumor - A typical T2 tumor with atelectasis/pneumonitis of the left lower lobe up to the hilum, due to involvement o
T2:
T2a= >3 to 4cm T2b= >4 to 5cm T3 tumor - A typical T3 tumor in the right upper lobe with invasion of the chest wall.
T3:
T4 tumor – A typical T4 tumor in the right upper lobe with invasion of the mediastinum.
T4:

Pancoast tumor:
Enable Scroll
Disable Scroll Pancoast tumor. Scroll through the images Enable Scroll
Disable Scroll Pancoast tumor. Scroll through the images A Pancoast tumor is a tumor of the superior pulmonary sul

orner's syndrome and destruction of bone due to chest wall invasion. MR is superior to CT for local staging. Pancoas
euwegein, The Netherlands) An operable T3 Pancoast tumor on a sagittal contrast-enhanced T1-weighted image. The
involved (green arrow). A = subclavian artery, ASM = anterior scalene muscle. (Courtesy of Wouter van Es, MD. St. An
rtesy of Wouter van Es, MD. St. Antonius Hospital Nieuwegein, The Netherlands) Here an inoperable T4 Pancoast tum
on of brachial plexus (white arrow) and encasement of the subclavian artery (A). ASM = anterior scalene muscle.
N - Staging:
Adapted from the American Thoracic Society mapping scheme
Regional Lymph Node Classification System:
Lymph node staging is done according to the American Thoracic Society mapping scheme. Supraclavicular nodes Sup
inal nodes Inferior Mediastinal nodes Pulmonary nodes The boundary between level 10 and level 4 is on the right the
of the pulmonary artery (N1 vs. N2). There is an important separation to be made between level 1 and level 2/3 node
s the clavicles bilaterally and, in the midline, the upper border of the manubrium. The boundary between level 4R an
mic midline. Paracardial, internal mammarian, diaphragmatic, axillary and intercostal lymph nodes are not described
t is proposed to regard these non-regional nodes as metastastic disease [2]. CT is unrealiable in staging lymph nodes
chosen. PET-CT is much more reliable in determining the N-status. False-positives occur in patients with sarcoid, tub
edictive value, PET scanning should be performed in all patients considered for surgery. T2 tumor (> 3cm) in the righ
N1 - Nodes:
N1-nodes are ipsilateral nodes within the lung up to hilar nodes. N1 alters the prognosis but not the management. N
N2 - Nodes:
N2-nodes represent ipsilateral mediastinal or subcarinal lymphadenopathy. There is only a subset of patients with N
-after a negative mediastinoscopy- are found to have microscopic metastatic disease at the time of thoracotomy. Th
sease. N3-stage disease.
N3 - Nodes:
N3-nodes represent contralateral mediastinal or contralateral hilar lymphadenopathy or any scalene or supraclavicu
e N-stages are: N1Ipsilateral peribronchial and/or hilar lymph nodes 10R-14R N2Ipsilateral mediastinal and/or subca
stinal and/or hilar, as well as any supraclavicular lymph nodes 1, 2L, 3aL, 4L, 5, 6, 8L, 9L, 10L-14L For a tumor in the le
or hilar lymph nodes 10L-14L N2Ipsilateral mediastinal and/or subcarinal lymph nodes 2L, 3aL, 4L, 5, 6, 7, 8L, 9L N3C
cular lymph nodes 1, 2R, 3aR, 3pR, 4R, 8R, 9R, 10-14R
M-Staging:
Almost every organ may be involved in metastatic disease. Common are adrenal, nodal, brain, bone and liver involve
metastases, their location and multiplicity. A distinction is made between regional metastatic disease (M1a) and solit
tant metastases The Eighth Edition Lung Cancer Stage Classiï¬cation. Detterbeck et al CHEST (2017); 151(1):193-203
2. Proposals for Revision of the TNM Stage Groupings in the Forthcoming (Eighth) Edition of the TNM Classification fo
3. International Association for the Study of Lung Cancer (IASLC) Lymph Node Map: Radiologic Review with CT Illustra
4. The Revised TNM Staging System for Lung Cancer by Ramon Rami-Porta et al Ann Thorac Cardiovasc Surg 2009; 15
5. New Guidelines for the Classification and Staging of Lung Cancer: TNM Descriptor and Classification Changes in th
None:

Cardiovascular Pearls on Chest CT:
Onno Mets[1] and Robin Smithuis[2]
[1]Radiology department of the University Medical Center Amsterdam and [2]Alrijne hospital in Leiden, the Netherlands
Publicationdate 2023-12-31 The primary focus of chest-CT is often on the pulmonary
parenchyma and associated pathology. However, beyond the pulmonary domain, chest CT also provides
valuable insights into the cardiovascular system, although it is frequently
beyond the scope of imaging indication. Due to the wealth of information on non-cardiac chest CT
scans, there is a risk of oversight for those not specifically trained in or
focused on cardiovascular
radiology. In this article we provide a systematic diagnostic approach
to the heart and vessels, and we will discuss the following helpful tools: 'Go with the
flow' - a more systematic approach to study the cardiovascular structures as blood flows
towards the right
atrium and eventually leaves the left
ventricle. Introduction
Introduction:

Five Corner approach:
Detecting vascular anomalies on non-cardiac chest CT scans can be
challenging, especially when they are not suspected and therefore not the primary focus of the examination.
By just checking five corners it is possible to detect the vast majority of vascular variants:
Go with the flow:

An easy way to study the cardiovascular structures is to use the ‘go-with-the-flow’ method.
This evaluates
the structures transferring the blood as it enters through
the caval veins, through the right side of the
heart into the pulmonary arteries, that carry the blood to the lungs.
Then the blood travels back
through the pulmonary veins into the left atrium and ventricle to enter the aorta and major branches including the
SVC and IVC:

Azygos continuation of the inferior vena cava:
In this variant there is absence of the infrahepatic portion of the IVC with the infrarenal and renal segments drainin
The supra-hepatic segment of the IVC is present but drains only blood from the hepatic veins into the right atrium. A
idental finding in asymptomatic patients, although it might be associated with other cardiovascular abnormalities, as
The importance of not overlooking this condition lies mainly in its relevance for surgical planning as well as endovas
from inferior. ImagesAzygos continuation of the IVC showing the characteristic ‘double aorta’ configuration at the lev
all the way towards the connection to the SVC. Enable Scroll
Disable Scroll Enable Scroll
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Persistent left superior vena cava:
This is the most common thoracic venous anomaly and may be seen either
in isolation or as component of more
complex congenital pathology. The vein begins at the confluens of the left
subclavian and internal jugular vein, passes through the left side of the
mediastinum adjacent to the arcus aorta, and typically drains into the
right atrium via the coronary sinus. For a vessel in this location, lateral to the
aortic arch, there is a differential diagnosis of four:
Levo-atrial cardinal vein:
A rare vascular anomaly that some consider a left-sided
SVC connecting to the left atrium is the levo-atrial cardinal vein (LACV).
However, one may argue its behavior is more on the anomalous pulmonary venous return spectrum. Although
in levo-atrial cardinal vein, the pulmonary veins drain normally into the left atrium, there
is an anomalous venous connection between the left atrium and
left brachiocephalic vein, creating a left-to-right shunt. Due to its location a levo-atrial cardinal vein may easily be mis
a left-sided superior caval vein, however,
a left SVC should connect to the coronary
sinus and right atrium and just
represents a venous variant and not a cardiovascular shunt. Simply check the drainage site to differentiate these two
Left superior intercostal vein - Aortic nipple:
A mimicker of a
vascular variant lateral to the aortic arch is the left superior
intercostal vein. This is a normal venous structure considered part of the hemi-azygos system, and is sometimes mo
Due to
its location it may suggest an anomalous pulmonary venous return, left-sided SVC or levo-atrial cardinal vein, howev
will help separate this
normal venous structure from the above mentioned differential diagnoses of vascular
anomalies. Images
Prominent
left superior intercostal vein, sometimes referred to as ‘aortic
nipple’.
Notice te resemblence to the levo-artial cardinal vein (on the axial view).
Right side of the heart:

Tricuspid valve:
The majority of cases of right-sided infective endocarditis involve the tricuspid valve and are associated with intraver
with hemodialysis catheters, pacemakers, and defibrillator leads are also at increased risk for tricuspid valve infectiv
Massive infectious vegetations on the tricuspid valve in an intravenous heroin user with S. Aureus endocarditis.
Right heart dilatation:
The right atrium generally dilates due to
tricuspid valvular disease, which may be primary or secondary to right
ventricular pathology. The right ventricle can be dilated due to various

reasons, either in acute setting or more chronically.
In the acute setting
massive thrombo-embolic disease may lead to outflow obstruction and ballooning
of the right ventricle, which is inversely related to morbidity and mortality. More chronically, RV dilation can be seen
pulmonary hypertension due to various etiologies, including chronic thrombo-embolic disease.
Adaptation and remodelling of the right ventricle shows a spectrum of dilation, hypertrophy and eventually failure.
Right heart failure will lead to ascites and body edema, in contrast to left heart failure which leads to congestion with
Central wall-adhering thrombus in a patient with chronic thrombo-embolic disease with right heart dilation, consiste
Pulmonary Arteries:
Dilatation of the main pulmonary artery (MPA) may reflect
primary or secondary pulmonary hypertension. As in aortic dimensions, size may differ between patients
based on multiple factors, such as sex, age, BSA, etc.
In the general population with a low risk of pulmonary hypertension, main pulmonary artery diameter > 34 mm, or a
MPA-to-Aorta ratio >1.1, should be reported as dilated. In high risk populations with predisposing factors such as
left heart disease, COPD, systemic sclerosis etc. the threshold lowers to >
30 mm, or an MPA-to-Aorta ratio > 0.9. When a dilation of the pulmonary artery is seen this should trigger the search
of non-cardiac chest CT.
This can help in recommending additional imaging modalities, as well as referral to the correct clinician. Dilation may
congestion due to left heart disease, fibrotic and other severe lung disease, or due to a left-to-right-shunt in a vascu
cardiovascular left-to-right shunt (ie. PAPVR).
Pulmonary Veins:

Anomalous pulmonary venous return:
This figure is shown before. By checking these five corners it is possible to detect the vast majority of vascular varian
malies (in bold): Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Anomalous pulmonary venous return (2)Normally the oxygenated blood runs from all lung lobes to th
left atrium through several pulmonary veins.
Although number and size of pulmonary veins may vary between patients, site of drainage should not.
In abnormal pulmonary venous return there is drainage into
the systemic circulation rather than into the left atrium, creating a
left-to-right shunt. Drainage can either be supracardiac (eg. caval
vein), cardiac (eg. right atrium), infracardiac (eg. IVC) or mixed (ie.
combination of the above). In adults there is most often a partial anomalous return (PAPVR) as
compared to total anomalous pulmonary venous return (TAPVR), which is a severe
congenital abnormality that is not incidentally found on chest CT later in life. The impact
the anomaly has on the right
side of the heart, as well as presence of symptoms such as dyspnea, depend on the shunt
fraction. If small, a PAPVR may prove to be a clinically
irrelevant finding. In PAPVR most often the left upper lobe drains into the left
brachiocephalic vein.The next most common anomaly is the right upper lobe draining into the
superior caval vein.
A right-sided PAPVR has a strong association with a sinus venosus defect
(approx. 40%), wich is an atrial septal defect at the location of the
cavo-atrial junction. One should thus check for the presence of this type of
ASD when a right PAPVR is seen. ImagesThis patient was scheduled
for right upper lobe lobectomy for lung cancer and the vascular anomaly was
initially missed on CT imaging.
The peroperative
implications of such an anomaly underline the importance of not overlooking
such variants. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. ImagesIncidental left-sided PAPVR with supracardiac drainage of blood from
Scimitar vein:
A scimitar vein is a PAPVR of the right lung draining infracardially, most often into the IVC. ImagesPAPVR of the right
s a Scimitar vein, due to its resemblance to a certain type of sword.
Left Atrium and Appendage:

Dilatation of Left Atrium:
Left

atrial dilation is a very common finding and most often related to atrial fibrillation
and mitral valvular heart disease.
Dilation of the left atrium may coincide
with arrhythmias and cloth formation, increasing the risk for embolic events. Enable Scroll
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Thrombus:
The most common intracardiac mass is a thrombus, which is often
located in the left atrial appendage (LAA), predominantly in patients with atrial
fibrillation and significant dilation.
Nevertheless, thrombus may also be seen in the right atrium in relation to a
central venous catheter or in a left ventricle apical aneurysm after prior
myocardial infarction. Scroll through the images of a patient with atrial fibrillation.
What are the findings? Images
The left atrium is dilated.
There is a thrombus in the left atrial appendage (arrow) extending towards the left atrium (arrowhead). In the left at
ombus or incomplete opacification due to slow-flow, especially in early contrast phase imaging.
This might be solved with CT in a later contrast phase or acquisition in the prone position.Transesophageal cardiac u
Slow-flow artefact in the
left atrial appendage, with inital incomplete opacification of the LAA but
complete filling in a later contrast phase.
Myxoma:
A myxoma is a relatively rare benign tumor, but one of the commonest primary cardiac masses.
It usually originates in the atrium, mostly on the left side.
It is often pedunculated and attached to the interatrial septum.
They are heterogeneously low attenuating and calcification may be seen.
Depending on the size it may lead to valvular obstruction, prolapse and systemic embolic events. Image
Incidental left-atrial myxoma.
Cor triatriatum:
In cor triatriatum the atrium is divided into two compartments by a fibromuscular membrane.
The membrane is more commonly seen in the left atrium.
The severity of clinical symptoms depends on the size of the fenestration in the membrane.
Less severe cases may go undetected for a long time. Image
Incidental cor triatriatum sinistra with delayedopacification of the right compartment of the left atrium.
This was initially misinterpreted as a thrombus. Continue with the MR... Here the MR of the same case Images
Delayed filling of the right compartment of the left atrium in a cor triatriatum sinistra. ImagesLess severe septation c
triatriatum, showing only a string-like structure that is also known as ‘left
atrial band’
Left Ventricle:

Dilatation:
The
left ventricle can be dilated due to various reasons, but most commonly due to
dilated cardiomyopathy, or post-infarction ischemic cardiomyopathy.
Decreased
systolic function of the left ventricle will lead to congestion, with left
atrial dilation, pulmonary edema and pleural effusions. In the chronic situation, left heart disease and longstanding c
f the heart, and eventually
cause pulmonary hypertension. This image is of a female trauma patient, who presented with an intracranial hemor
Incidentally found severely dilated left ventricle.
The transverse LV diameter is > 70 mm.
Hypertrophy:
Myocardial dimensions are influenced by the time of acquisition,
as in systole the myocardium will appear thicker than in diastole. Nevertheless myocardial
hypertrophy should be suggested when thickness exceeds 20-25 mm.
Left
ventricular hypertrophy may either be concentric of asymmetrical: Multiplanar
reconstructions can help to asses morphology of the myocardial hypertrophy, and
suggest possible underlying etiology. ImageConcentric left ventricular hypertrophy in chronic
hypertensionmeasuring up to 26 mm at the basal septum.

This is abnormal even in systole.
Myocardial infarction:
A prior myocardial infarction may go undetected and signs of
such an event can incidentally be found on non-cardiac
chest CT. Typically CT shows myocardial thinning with or without fatty
replacement, which is seen as a hypodense subendocardial line. Image
Subendocardial fibro-fatty replacement after a prior infarction in the LAD territory. In the acute phase of a myocardi
ed chest CT as hypodense attenuation in a coronary territory.
This may present in scenarios where the patient's initial presentation is related to trauma – such as a traffic accident
itially overlooked.
This scenario underscores the importance of a thorough evaluation of cardiovascular abnormalities in the early dete
tory of 45 year old trauma patient, who presented after a fall from the stairs during heavy lifting.
A sharper window setting helps to assess the myocardial attenuation differences.
Aneurysm of the left ventricle:
Aneurysmatic dilation of the left ventricular may develop
post-infarction, and sometimes shows wall
calcification. Check for signs of an intracardiac thrombus in these cases,
as this can result in systemic emboli. Image Post myocardial infarction in LAD territory with apical
aneurysm formation, wall calcification and a large intraventricular thrombus.
Cardiac masses:
Secondary malignancy due to metastatic spread is much more common than a primary cardiac tumor.
The ratio is estimated up to 30:1. ImageThickened nodular appearance of the heart apex (arrow) and a large pericar
This was a metastatic disease from an ENT carcinoma. Cardiac lymphoma ImagePrimary cardiac lymphoma
with involvement of the AV groove and right ventricle wall.
Aorta:

Aortic dilatation:
The suggested cut-off values for defining an aortic aneurysm are 50 mm for the ascending and 40 mm for the descen
respectively.
Values between normal and aneurysmatic should be considered dilated.
However, aortic size varies among patients, and individual values differ based on factors like age, sex, and body surf
Also, acknowledging the potential challenges in measurement accuracy due to factors like movement in non-ECG trig
Nevertheless, taking into consideration the above mentioned margins of error it is important not to miss a significan
larly in patients with a proximal aorta size exceeding 55 mm.
The threshold of determining the need for surgical intervention is lower in patients with known connective-tissue dis
dilation of aortic sinus and ascending
aorta. When a dilated proximal aorta is seen, this should trigger
more thorough evaluation of possibly associated
abnormalities such as aortic valve stenosis
or bicuspid aortic valve. Image
Bicuspid aortic valve. From reference 1
Aortic valve calcification:
Aortic valve calcification is most often caused by calcific
degeneration and is therefore increasingly seen in older patients. In younger
patients a bicuspid aortic valve should be high in the differential diagnosis. The extent of aortic valve calcifications co
severity of aortic stenosis. It is recommended to visually quantify aortic valve calcification as mild, moderate and
severe (figure). A recommendation can be included in the radiology report (see Figure). If aortic valve calcification is i
nding aorta. Calcification may also occur elsewhere in the heart, including at the mitral valve or annulus, and in the p
clinical significance and require no recommendation in the report impression.
Papillary fibroelastoma of the Aortic valve:
Non-ECG gated chest CT does not visualize the cardiac valves well, however, sometimes abnormalities can be seen.
As discussed above, main valvular incidental findings will be aortic valve and mitral calcification. A rare finding is a pa
ary tumor in relation to the cardiac valves, mainly in relation to the aortic or mitral valve. The typical CT finding of a P
to the heart valve. Most often it is an asymptomatic incidental finding, although a
papillary fibroelastoma can be complicated by systemic embolic events. Right Aortic Arch with an aberrant left subcl
Aortic arch and branch variants:
Anomalies of the aorta and branches are discussed in the article 'Vascular Anomalies of Aorta, Pulmonary and Syste
Aortic diverticulum:
An aortic diverticulum is usually seen at the site of the isthmus where the ductal remnant or ligamentum arteriosum
Because this is also the location where the majority of traumatic aortic injuries is seen, it is sometimes mistaken for a

A diverticulum shows more obtuse angles, often a more beak-like appearance and calcification may be present. Con
no surrounding infiltration or fluid. Just distal to the level of the isthmus the aorta may show a more diffuse bulging,
lly irrelevant variant. ImagesExamples of an aortic diverticulum (left), an aortic splindle (middle), and traumatic aortic
Aortic branches including coronaries:

Aberrant right subclavian artery:
Also known as Lusoria artery, this is the most common aortic arch anomaly. Instead of being the first branch, the rig
tery as the fourth branch. It then runs back towards the right side, its course variable in relation to the esophagus ar
esophagus, but sometimes between the trachea and esophagus, or rarely even anterior to the trachea. Normally asy
phagia. ImagesAberrant right subclavian artery with a retro-esophageal course. Here a dilated aberrant right suclavia
Notice the take off from the aorta behind the trachea and esophagus.
The dilatation results in swallowing problems due to obstruction of the esophagus.
Hypertrophy of bronchial arteries:
The bronchial arteries deliver oxygenated blood under
systemic pressure to the supporting structures of the lung, including the
pulmonary arteries. Although variation occurs, they
origin from the descending aorta mostly at the level of the fifth thoracic
vertebra.
Bronchial arteries are small and often not easily depicted. When enlarged and sufficiently opacified they may be see
Bronchial artery hypertrophy can be seen for
example in severe parenchymal disease and chronic thrombo-embolic
pulmonary hypertension. ImagesHypertrophy of the bronchial artery up to 4 mm in diameter (arrows) with a small a
Persistent ductus arteriosus:
The ductus arteriosus runs between the inferior aortic arch
at the level of the isthmus and the proximal left pulmonary artery. Before birth it allows blood to bypass the non-ver
lungs in a physiologic right-to-left shunt. The ductus normally closes in the early postnatal period. Contrarily to the p
after birth results in a left-to-right shunt with blood flowing from the
high-pressure systemic circulation into the low-pressure pulmonary artery.
This
leads to lung overcirculation and left heart volume overload. The severity of the condition depends on the size of the
iated with
other cardiac anomalies. ImagesIncidental patent ductus arteriosus (PDA) with a jet of less opacified blood (arrows) i
Arch vessels:
The arch
vessels can easily be assessed for proximal obstruction on contrast-enhanced CT
imaging.
Depending on which vessel is compromised this may have clinical
implications regarding perfusion of the brain (ie. carotids) or the upper
extremities (ie. subclavian arteries). Image Severe atherosclerosis in the proximal left
subclavian artery.
Proximal subclavian occlusion or severe flow obstruction may
explain a left-to-right difference in blood pressure, and is important
information for example to prevent a clinical suspicion for aortic dissection later in life. Enable Scroll
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Sequestration:
In pulmonary sequestration there is a systemic arterial
supply of the involved segment of the lung. This lung segment is not aerated and has per
definition no normal connection to the bronchial tree and pulmonary
arterial system. ImagesSystemic arterial supply to the left lower lobe in pulmonary sequestration. Sometimes part of
systemic artery, either solely (ie. isolated) or in conjunction with normal pulmonary arterial supply (ie. dual
supply), while the bronchial anatomy and aeration of the involved lung segment is normal.
This
condition is named anomalous systemic arterial supply of the normal lung. This is often an asymptomatic finding, bu
patients can develop focal hypertension with signs of congestion and
haemoptysis.
This may require surgical or endovascular intervention. ImagesIncidental anomalous systemic arterial supply of the r
nary sequastration. Note the subtle signs of congestion in the involved segment of the right lower lobe.
Aberrant coronary arteries:
Large variation in origin and course of the coronary arteries exists.

Most are benign variants, but a proximal interarterial and intramural course (mostly RCA from left coronary cusp) is
sudden cardiac death.
Within study limitations of non-cardiac chest CT one can check origin and proximal course of the coronaries to detec
Benign course of an aberrant LAD originating from the right coronary artery (RCA), running anterior to the RVOT. Mo
'Coronary anatomy and anomalies' by Tineke Willems and Robin Smithuis From reference 1
Coronary calcifications:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. Williams MC et al. Br J Radiol (2021). doi: 10.1259/bjr.20200894.
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None:

Normal Values in Pediatric Ultrasound:
Simon Robben, Rick van Rijn and Robin Smithuis
Radiology Departement of the Maastricht University Hospital, Academical Medical Centre in Amsterdam and the Alri
Publicationdate 2018-02-09 This is an overview of normal values of ultrasound examinations in neonates and childre
Adrenal:
Adapted from reference 21 Material and methods Ultrasonographic study of 92 infants. Sagittal measurement of the
L) of the gland is defined as the maximum cephalocaudal dimension (either coronal or sagital plane). The width is de
Appendix:
Adapted from reference 14 Materials and method In this ultrasonographic study 146 consecutive patients (62 boys a
. Children with cystic fibrosis, acute abdominal pain, with previous appendectomy and below the age of 2 years (beca
n 120 children the appendix was visualized. Ultrasonographic anteroposterior measurement of the appendix. Casue
Bladder:
Adapted from reference 17
Bladder volume:
Material and methodA total of 3376 children were recruited in this ultrasonographic study. The total number of patie
because not all age-subgroups were included in the table. The bladder volume was calculated first by measuring the
n, which was obtained from the neck to the fundus of the bladder. Depth (D) was measured, perpendicular to the firs
anterior to posterior mucosal surface of the bladder. The width (W) was taken perpendicular to D at its mid-point. Bl
data in this study using the equation for an ellipsoïd: L×D×W (in centimetres) x 0.523. Adapted from reference 17
Bladder wall thickness:
Materials and method: A total of 3376 children were recruited. Bladder wall thickness was only measured when the r
ladder wall thickening: The bladder wall thickness was measured from a zoomed image of the transverse plane of th
laterally (figure). The mean was taken for these three measurements. The bladder wall thickness depends on the deg
er wall thickness is expressed as the bladder volume wall thickness index (BVWI).
Bowel:
Adapted from reference 13 Materials and method The study population consisted of 128 patients (57 male and 71 fe
y data pertaining to this selection is presented). Bowel wall thickness was measured on transverse sections and com
d muscularis propria. Ultrasonographic measurement of wall thickness of terminal ileum in a 12-year-old boy with cy
reference 13 In the same study the wall thickness of the colon was measured. Causes of colon wall thickening:
Common Bile Duct:
Adapted from reference 8 Materials and method One hundred and seventy-three consecutive children, referred for
e included in this study (100 boys and 73 girls), age range 1 day - 13 years (median age 5.0 years). The diameter of th
trasonographic image of common bile duct and surrounding anatomy
Galbladder:
Adapted from reference 10 Materials and method Ultrasonographic gallbladder volume assessment (length x width
and mean birth weight 1556 ± 441 g) and 46 term infants (mean GA 38.3 ± 1.2 weeks 3253 ± 440 g). Data were collec
ys at 3-h and 6-h fastening following regular milk feeding. Causes of small gallbladder:
Hip:
Adapted from reference 22
Anterior recess:

Materials and method Ultrasonographic study of 58 healthy children and 105 children with unilateral transient synov
supine position with hips in neutral position. Adapted from reference 22 The children are examined in the supine po
was measured, including both of its components (the anterior and posterior layer). Also the anterior contour of the j
correlation between age and thickness of the anterior joint capsule. A difference >2mm or an effusion >2mm is cons
Shape of the border of the anterior joint capsule:
The anterior contour of the joint capsule can be evaluated. Ultrasonographic measurement of the anterior joint caps
Causes of hip joint effusion: Adapted from reference 23
Graf's classification:
Mature centred hip joint. Well developed acetabular roof. Angular or slightly blunt bony rim.
* Type II: Centred joint. Deficiently developed acetabular roof Rounded bony rim
* Type III: Decentred joint. Poorly developed acetabular roof. Flattened bony rim. Click here for article on Developme
he hip joint in the coronal plane (a). Measurement of α angle (b)
Kidney:
Adapted from reference 6
Preterm and Term babies:
Material and methods US study in 261 healthy newborn infants. Craniocaudal dimension of the kidneys was determi
f a neonatal kidney. Note the increased echogenicity of the renal parenchyma compared to liver parenchyma. This is
Children:
Materials and method These ultrasonography studies comprised of 512 healthy children - 238 boys and 274 girls - w
remature infants with gestational ages from 25-35 weeks. None of the children had a problem that could affect splee
d for age. Causes of splenomegaly: The measurement of spleen length is the optically maximal distance -ideally at th
omedial and the most inferolateral points (figure).
Kidney volume:
Material and method A total of 3376 children were recruited in this ultrasonographic study. Kidney volume was calcu
3. In this study, the total renal volume was obtained by adding together both kidney volumes but without mentioning
the table were obtained by dividing the total renal volume by two. Ultrasonographic measurement of the length, wid
psoid formula as Length x Width x Depth x 0.523. Adapted from reference 18
Thickness of the wall of the collecting system:
Material and MethodsUltrasonographic study of 48 renal collecting systems in 24 healthy children (age range 3 days
idneys and its wall thickness varied between 0 (not visible) and 0.8 mm. Thickening of the wall ≥ 1mm is be considere
Liver:
Craniocaudal dimension of the liver on the midclavicular line was measured with ultrasonography (figure). Causes of
Newborns:
Material and methods US study in 261 healthy newborn infants. Craniocaudal dimension of the liver on the midclavi
ce 7
Doppler values:
Materials and MethodOne-hundred ultrasound examinations performed in 100 healthy children aged 0–17.9 years (
erence values for the hepatic hilum portal vein peak systolic velocity, hepatic artery peak systolic velocity, and hepati
ence). Portal vein peak systolic velocity is not age-dependent, whereas hepatic artery peak systolic velocity and hepa
Mesenteric lymph nodes:
Adapted from reference 15 Materials and method In this retrospective study in 61 children (36 boys and 25 girls, me
t abdominal CT examination for evaluation of suspected or known renal stones abdominal lymph node size was eval
rasonography. Enlarged mesenteric lymph nodes (short axis > 5 mm) were found in 33 (54%) of the 61 children. The
ght lower quadrant (88%). Based on their findings the authors state that: using a short-axis diameter of >8 mm migh
in children. False-positive rate for enlarged mesenteric lymph nodes with varying lymph node threshold size is seen
Ovary:
Adapted from reference 20 Material and Method Ultrasonographic measurement of uterine and ovarian volume was
me is calculated using the formula:
Pancreas:
Adapted from reference 12 Materials and method Two hundred and seventy-three patients (differentiation in sex no
y. The maximum anteroposterior (AP) diameters of the head, body and tail of the pancreas were measured on transv
45 (53%) and high in 101 (37%). The maximum anteroposterior (AP) diameters of the head, body and tail of the panc
nt of the pancreas:
Portal vein:
Adapted from reference 9 Materials and method One hundred and fifty children aged 0-16 years, without clinical evi
inal ultrasound were included in the study. Measurement of portal vein diameter The portal vein is visualized in the l
r hilum. The greatest anteroposterior diameter is measured at the site where the hepatic artery crosses the portal ve
Spleen:
Adapted from reference 6
Preterm and term babies:

Material and methods US study in 261 healthy newborn infants. Craniocaudal dimension of the spleen was determin
Subarachnoid space:
Adapted from reference 5 The subarachnoid space was assessed using ultrasonography in 278 full-term healthy Chi
l of the foramen of Monro (figures) The mean values in the table were calculated from the equations given in the arti
he article. Ultrasonographic coronal representation of the subarchnoid space at the level of the foramen of Monro. C
Testicle:
Adapted from reference 19 Materials and method A total of 344 boys from different ethnic backgrounds were studie
nd left testicle. Causes of enlargement of the testis: Testicular volume was calculated using the formula:
Thymus:
Adapted from reference 22 Materials and method Mediastinal ultrasonography was performed in 151 infants (79 bo
ffecting their thymic size. Causes of enlarged thymus: The maximum transverse diameter, right lobe anteroposterior
the longest craniocaudal dimension (length) is assessed. The thymic index was calculated by multiplying the transver
Thyroid:
Adapted from reference 1-3 Material and methods US study in 100 English newborn infants in the first week of life, a
09 children, aged 6-15 years 1 and a subset of German children from a study of 252 children aged 2-4 years 2 [1-3]. T
volume of the isthmus was not included. Causes of enlargement of thyroid gland: The volume of a thyroid lobe is cal
0,52).
Uterus:
Adapted from reference 20 Material and Method Ultrasonographic measurement of uterine and ovarian volume was
volume was calculated using the formula:
Ventricles:
Adapted from reference 4 Adapted from an ultrasonographic study of 1483 neonates, gestational age range 25-42 w
l asphyxia, infection of the central nervous system, intracranial hemorrhages of craniospinal malformation were excl
ventriculo-hemspheric ratio is measured on the coronal view at the level of the foramen of Monro.
None:

None:

Elbow fractures in Children:
Robin Smithuis
Radiology department, Rijnland Hospital Leiderdorp, the Netherlands.:
Publicationdate 2008-12-01 Elbow fractures are the most common fractures in children. The assessment of the elbow
leton and the subtility of some of these fractures. In this review important signs of fractures and dislocations of the e
try one of the cases in the menubar. You can test your knowledge on pediatric elbow fractures with these interactive
This does not work for the iPhone application If you want to use images in a presentation, please mention the Radio
Fracture mechanism:
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Hyperextension:
Injury to the elbow joint is usely the result of hyperextension or extreme valgus due to a fall on the outstretched arm
ion leads to a supracondylar fracture. The hemarthros will result in a displacement of the anterior fat pad upwards a
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Disable Scroll Scroll through the images.
Extreme valgus:
The other important fracture mechanism is extreme valgus of the elbow. The normal elbow already has a valgus pos
o extreme valgus. On the lateral side this can result in a dislocation or a fracture of the radius with or without involve
the humerus, the extreme valgus will result in a fracture of the lateral condyle. On the medial side the valgus force ca
dial epicondyl becomes trapped within the joint. Because of the valgus position of the normal elbow an avulsion of t
Radiological Interpretation:

Methodical review:
When looking at radiographs of the elbow after trauma a methodical review of the radiographs is needed . You shou
f joint effusion? After trauma this almost always indicates the presence of hemarthros due to a fracture (either visibl
n children dislocations are frequent and can be very subtle. Are the ossification centres normal? Is the piece of bone
s ossification centre in the normal position. . Look especially for the position of the radial epiphysis and the medial e
fractures in children are very subtle.
So you need to be familiar with the typical picture of these fractures. . Normal anterior fat pad.
Fat Pad Sign and Joint effusion:
Normally on a lateral view of the elbow flexed in 90? a fat pad is seen on the anterior aspect of the joint . This is norm

no fat pad is seen since the posterior fat is located within the deep intercondylar fossa. Positive fat pad sign both ant
tion of the joint will cause the anterior fat pad to become elevated and the posterior fat pad to become visible. An el
ue lateral radiograph of an elbow flexed at 90? is described as a positive fat pad sign (figure). Hemarthros results in a
displacement the posterior fat. Positive Anterior Fat Pad sign. On digital radiographs you may need to adjust the win
on the X-rays. Positive fat pad sign (2)
Any elbow joint distention either hemorrhagic, inflammatory or traumatic gives rise to a positive fat pad sign. If a pos
ra-articular injury is unlikely. A visible fat pad sign without the demonstration of a fracture should be regarded as an
isplaced fracture with 2 weeks splinting. Skaggs et al repeated x-rays after three weeks in patients with a positive pos
nce of fracture in 75%. They concluded that in trauma displacement of the posterior fat pad is virtually pathognomon
t pad alone however can occur due to minimal joint effusion and is less specific for fracture. Notice that the elbow is
hapter on positioning.
Alignment:
There are two important lines which help in the diagnosis of dislocation and fracture . These are the Radiocapitellar l
A line drawn through the centre of the radial neck should pass throught the centre of the capitellum, whatever the p
capitellum (figure). In dislocation of the radius this line will not pass through the centre of the capitellum. On the left
of the capitellum on every radiogragh even though C and D are not well positioned. Notice supracondylar fracture in
ght lower image shows an obvious dislocation of the radius. Radiographs of elbows at different ages. The Anterior H
rior humeral line. A line drawn on a lateral view along the anterior surface of the humerus should pass through the m
Humeral line . In cases of a supracondylar fracture the anterior humeral line usually passes through the anterior thi
of the capitellum or in front of the capitellum due to posterior bending of the distal humeral fragment. On the left th
he capitellum. This indicates that the condyles are displaced dorsally (i.e. supracondylar fracture). First study the ima
line ends above the capitellum. This means that the radius is dislocated. Did you also notice the olecranon fracture?
e ulna carefully. The order of appearance of the ossification centres is specified in the mnemonic C-R-I-T-O-E.
Ossification centres:
There are 6 ossification centres around the elbow joint.
They appear and fuse to the adjacent bones at different ages. It is important to know the sequence of appearance s
s order of appearance is specified in the mnemonic C-R-I-T-O-E
(Capitellum - Radius - Internal or medial epicondyle - Trochlea - Olecranon - External or lateral epicondyle). The ages
e and differ between individuals. It is not important to know these ages, but as a general guide you could remember
fferent children. The Trochlea has two or more ossification centres which can give the trochlea a fragmented appear
joint On a lateral view the trochlea ossifications may project into the joint. They should not be mistaken for loose int
Radiography:
Shoulder higher than elbow. Radius and Capitellum project on to the ulna.
Common errors in positioning:
Error 1: Shoulder higher than elbow For a true lateral view the shoulder should be at the level of the elbow. If the sho
l project on the ulna. The solution is either to lift the examination table which will lift the elbow or to lower the shoul
t endorotation of the humerus due to a low position of the wrist. RIGHT: More endorotation due to malpositioning. E
wrist positioning' leading to rotation of the humerus. The low position of the wrist leads to endorotation of the hume
will move anteriorly, while a medial structure like the medial epicondyle will move posteriorly. The wrist should be hi
on of the elbow. The hand should be with the 'thumb up'.
Elbow fractures:

Supracondylar fractures:
These fractures account for more than 60% of all elbow fractures in children (see Table). More than 95% of supracon
retched hand.
The elbow becomes locked in hyperextension.
The olecranon is pushed into the olecranon fossa causing the anterior humeral cortex to bend and eventually break.
If the force continues both the anterior and posterior cortex will fracture. Supracondylar fractures. In A the anterior l
lum and in B even more anteriorly. Notice positive posterior fat pad sign in both cases Supracondylar fractures (2)
If there is only minimal or no displacement these fractures can be occult on radiographs.
The only sign will be a positive fat pad sign.
Usually there is some displacement and the anterior humeral line will not pass through the centre of the capitellum
(figure). Supracondylar fractures (3)
Supracondylar fractures are classified according to Gartland.
Gartland Type I fractures are often difficult to see on X-rays since there is only minimal displacement.
Most of these fractures consist of greenstick or torus fractures. The only clue to the diagnosis may be a positive fat p
These patients are treated with casting. In Gartland type II fractures there is displacement but the posterior cortex is
There may be some rotation. These fractures require closed reduction and some need percutaneous fixation if a lon
fracture Gartland type III fractures are completely dislocated and are at risk for malunion and neurovascular compli
ry open means. Stabilisation is maintained with either two lateral pins or medial lateral cross pin technique. Gartland

eduction there is inadequate correction of medial collaps. After two months there is malunion with cubitus varus de
Malunion will result in the classic 'gunstock' deformity due to rotation or inadequate correction of medial collaps. Po
ated with injurie to the neurovascular bundle which is displaced over the medial metaphyseal spike. Nerve injurie al
ascular injurie usually results in a pulseless but pink hand.
Conservative management and vascular intervention have the same outcome.
A pulseless and white hand after reduction needs exploration. Flexion-type supracondylar fracture caused by direkt
mmon (5% of all supracondylar fractures).
They are caused by direct impact on the flexed elbow.
Ulnar nerve injury is more common.
Compared to extension types, they are more likely to be unstable, so more likely to require fixation.
Lateral Condyle fractures:
This fracture is the second most common distal humerus fracture in children. They occur between the ages of 4 and
e extended elbow. They tend to be unstable and become displaced because of the pull of the forearm extensors. Sin
cause the fracture is bathed in synovial fluid. Lateral condyle fractures are classified according to Milch. They are Salt
actures that travel from the lateral humeral metaphysis above the epiphysis and exit through the lateral crista of the
teral Condyle fractures (2) The problem with the Milch-classification is the fact that the fracture fragments are prima
not visible on radiographs, so the radiographic interpretation concerning classification is difficult.
Treatment strategies are therefore based on the amount of displacement (see Table). Undisplaced fractures are trea
These fractures must be carefully monitored as they have a tendency to displace. At follow up both AP and Oblique v
Once displaced fractures consolidate in a malunited position, treatment is difficult and fraught with complications.
For this reason surgical reductions is recommended within the first 48 hours. Open reduction is indicated for all disp
ral Condyle fractures (3) .
The diagnosis of a lateral condyle fracture can be challenging. Fracture lines are sometimes barely visible (figure). Re
econd most common elbow-fracture in children and because you know where to look for will help you Lateral condy
. The detatched fragment however is larger than it appears on the radiograph. The fracture extents into the lateral ri
e fractures (4) . Since most of the structures involved are cartilageneous, it is very difficult to know the exact extent o
dyle fracture. Humeroulnar joint is stable. Sometimes the fracture runs through the ossified part of the capitellum. In
condyle fracture extending through the ossified part of the capitellum. This is a Milch I fracture. The elbow is stable.
There is too much displacement so osteosynthesis has to be performed. MR of lateral condyle fracture. Milch II and u
rtilaginous fracture. Fracture-fragment surrounded by synovial fluid. (Courtesy of Lynne Steinbach, M.D. Univ. of Cali
l extent of the cartilaginous component of the fracture. The case on the left shows a fracture extending into the unos
ilage is so far medial that the ulna is only supported on the medial side. This means that the elbowjoint is unstable. L
ement and probably stable. RIGHT a different case. Oblique view gives nice impression of fracture. Blue arrow indica
yle fractures (5)
In lateral condyle fractures the actual fracture line can be very subtle since the metaphyseal flake of bone may be mi
n be helpfull, but usually these are not routinely performed (figure). Two cases of overprojection of the capitellum on
cture on the right Lateral Condyle fractures (6) . Overprojection of the capitellum on the humeral metaphysis may sim
ures (7) . On the left a couple of examples of lateral condyle fractures. Capitellum fracture While fractures of the late
, isolated fractures of the capitellum are seen in children above the age of 12. Capitellum fractures are uncommon. T
on the X-rays (arrow). Normal medial epicondyle projecting posteriorly. Notice radial head dislocation and olecranon
Medial Epicondyle avulsion:
The medial epicondyle is an apophysis since it does not contribute to the longitudinal growth of the humerus.
It is located on the dorsal side of the elbow. On a lateral view especially if the arm is endorotated it can project so far
However avulsions are located more distally and anteriorly. Since the medial epicondyle is an extra-articular structur
ive fat pad sign. Avulsion of medial epicondyle. Medial Epicondyle avulsion (2). 80% of avulsion fractures occur in boy
ute valgus stress due to a fall on the outstretched hand or sometimes due to armwrestling. Chronic injuries do occur
es these stressfractures on the medial side is the same mechanism that causes a osteochondritis of the capitellum d
interposed medial epicondyle. Medial Epicondyle avulsion (3). There is a 50% incidence of associated elbow dislocati
When the elbow is dislocated and the medial epicondyle is avulsed,
it may become interposed between the articular surface of the humerus and the olecranon (figure). In every dislocat
. Same case as above. After reduction the epicondyle returned to its normal position (not good visible due to cast) ar
may return to it's original position or remain trapped in the joint.
This may severely damage the articular surface. So post-reduction films should be studied carefully. Medial Epicondy
mporarily open.
The avulsed fragment may become entrapped in the joint even when there is no dislocation of the elbow. On AP-view
iew shows the fragment to be trapped within the joint. Medial Epicondyle avulsion (5).
An avulsed fragment that is located within the joint can give diagnostic problems. On an AP-view this fragment may l
avulsed fragment may simulate a trochlear ossification centre. Another example of a dislocated elbow with avulsion
cted into the joint. Medial Epicondyle avulsion (6). Treatment Non-displaced fractures are treated with 1-2 weeks cas
There is disagreement about the amount of displacement of the medial epicondyle that requires operative fixation. T

ent of medial epicondyle fractures with 5-15mm displacement. Avulsion of the medial epicondyle. The amount of sof
located. Medial Epicondyle avulsion (7). If the history or the radiographs suggest that the elbow was or is dislocated,
need for early motion. Click on the image to enlarge Medial Epicondyle avulsion (8).
Study the images. You can click on the image to enlarge. There are three findings, that you should comment on. Click
e to enlarge The MR shows the small medial epicondyle with tendon attachement trapped within the joint. The avuls
fixated with K-wires. Subtle radial neck fracture seen only on AP-view.
Proximal fractures of the Radius:
In adults fractures usually involve the articular surface of the radial head.
In children however it's the radial neck that fractures because the metaphyseal bone is weak due to constant remoc
Usually it is a Salter Harris II fracture. If there is no displacement it can be difficult to make the diagnosis (figure). Rad
ions projecting in between humerus and ulna simulating intra-articular fragments. If there is less than 30? tilt of the r
It is important to realize that there is normally some angulation of the radial head (up to 15?). If there is more than 3
on radiograph in cast shows unsuccesfull reduction. K-wire insertion is performed Whenever closed reduction is uns
nd supinate up to 60?, a K-wire is inserted to maintain reduction. The radial epiphysis is slipped (arrows). The radioca
dislocation and there is a fracture of the olecranon Radial neck fractures aswell as radial head dislocations are in 50
The most common is a fracture of the olecranon. When the radial epiphysis is yet very small a slipped radial epiphys
r If these fractures are not recognized or reduction is unsuccesfull radial head overgrowth can be the result. A short
s contributes to the length growth of the radius. LEFT: an obvious radial dislocation. No fracture of the ulna (Montegg
ed olecranonfracture is seen on carefull inspection
Dislocations of the Radial head:
Dislocations of the radial head can be very obvious.
It is however not uncommon that these dislocations are subtle and easily overlooked. In all cases one should look fo
In the original discription of Monteggia there is a radial dislocation in combination with a proximal ulnar shaft fractu
However fractures anywhere along the ulna have been reported.
Especially associated fractures of the olecranon are very common (figure). Radius Pulled Elbow (Nursemaid's elbow)
lly and the ligament slips over the radial head and becomes trapped within the joint. The X-ray is normal. The conditi
s during positioning for a true lateral view (which is with the forearm in supination). Olecranon fracture indicated by
Olecranon fractures:
Olecranon fractures in children are less common than in adults. As discussed above they are associated with radial r
ion centres in a patient with a tilted radial neck fracture. Olecranon fractures (2) Do not mistake the apophysis or its
The apophysis has undulating faintly sclerotic margins.
The growth plate usually has a different oblique course compared to a fracture-line. Olecranon fractures (3) On the l
le some of these fractures are.
Conclusion:
Whenever you study a radiograph of the elbow of a child, always look for: Position of the medial epicondyle. Elbow a
onin, MD, in Radiology of Skeletal traumaThird edition Editor Lee F. Rogers MD
2. Elbow injuries in children in www.orthotheers A site developed for Postgraduate Orthopaedic Trainees preparing f
3. Pediatric Elbow fractures in Wheeless on line textbook on Orthopaedics A site with detailed information on fractur
None:

Fractures:
Robin Smithuis
Radiology department of the Rijnland Hospital in Leiderdorp, the Netherlands:
Publicationdate 2008-01-12 Fractures of the distal radius account for one-sixth of all fractures seen in the emergency
he factors that alter clinical decision making and patient treatment. In this review we will discuss: Complications Imag
Imaging:
PA view: wrist and elbow at shoulder heightLateral view: shoulder, elbow and wrist in sagittal plane
Positioning:
PA view should be taken with the wrist and elbow at shoulder height. This means that the wrist, elbow and shoulder
Only in this position, the radius and the ulna are parallel. Lowering the arm makes the radius cross the ulna and bec
length of the radius. Lateral view is taken with the elbow adducted to the side. Shoulder, elbow and wrist are again in
e the lateral view exactly perpendicular to the PA view. On a correctly positioned PA view the extensor carpi ulnaris t
endon groove should be at the level of or radial to the base of the ulnar styloid. True lateral: The palmar cortex of pis
and capitate. A true lateral view is defined by the relationship between the pisiforme, capitate and scaphoid bones.
one should overlie the central third of the interval between the palmar cortices of the distal scaphoid pole and the ca
radius, as measured on the lateral view, increases with supination and decreases with pronation of the wrist (5). A ch
eral radiographs is not uncommon during clinical follow-up and results in 5 degrees change in apparent tilt. CT shou
detail about radiocarpal articular step-off and gap displacement. On the left a patient with a communitive intraarticu
r rim of the radius together with the carpus (i.e. a volar Barton's). There is an axial CT image with 3D-, coronal and sa
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t. Magnetic resonance (MR) imaging is of benefit when concomitant injuries of ligaments and triangular fibrocartilage
not demonstrated on routine radiographs. On the left a fracture of the ulnar styloid process not visible on standard
Measurements:
Radial length or height Radial length is measured on the PA radiograph as the distance between one line perpendicu
f the radial styloid. A second line intersects distal articular surface of ulnar head. This measurement averages 10-13 m
the angle between one line connecting the radial styloid tip and the ulnar aspect of the distal radius and a second lin
dial inclination ranges between 21 and 25 degrees . Loss of radial inclination will increase the load across the lunate.
The radial tilt represents the angle between a line along the distal radial articular surface and the line perpendicular
The normal volar tilt averages 11 degrees and has a range of 2-20 degrees .
Radiological Interpretation:
Table 1: Description of fracture characteristics There are many ways to describe distal radial fractures and there are
requently eponyms like Colles' and Barton's are used. When these epomyms are used, an accurate description of the
. In addition it should also be noted if there is osteoporosis or additional findings such as ligamentous injuries. We w
Location:
One of the most important characteristics is whether a fracture is extraarticular or intraarticular. Extraarticular fractu
ve. Intraarticular fractures either involve the radiocarpal joint, distal radioulnar joint, or both. Extraarticular fracture
Configuration:
Always mention whether the fracture is transverse (good prognosis), oblique or comminuted (multifragmented). Wh
mid axial line, it can be unstable. On the left a patient with an extraarticular distal radius fracture. Notice the oblique
ation frequently show loss of reduction at follow up and need surgical treatment. On the left a sagittal reconstruction
his is a volar Barton's type fracture. Even in a cast the volar fragment will show progressive displacement at follow-up
n place.
Displacement:
Fractures are either displaced or nondisplaced. A fracture with an offset of 2 mm or more in any plane or 2 mm offse
cement can be dorsal, volar, radial or proximal. Axial shortening, radial inclination and radio-ulnar displacement can
t and dorsal or palmar displacement can be measured on the routine lateral X-ray. Fragment displacement and rotat
Instability:
Instability is defined as a high risk of secondary displacement after initial adequate reduction. Radiographic signs tha
uted configuration (as mentioned above). These signs are listed in the table on the left. Although the initial x-ray afte
at follow up. Articular incongruity is the most important factor in the development of posttraumatic osteoarthritis o
ar neck
Ulna and Distal radioulnar joint (DRUJ):
Assessment of a wrist fracture must also include a description of the distal ulna and distal radioulnar joint (9). The di
Type I: stable Avulsion fractures of the tip of the ulnar styloid and stable fractures of the ulnar neck have a good prog
nt and stable. Extraarticular unstable fractures however, require plate fixation. Tear of the TFCC or avulsion of the ba
n or dislocation of the ulnar head as a result of avulsion of the base of the ulnar styloid or tear of the TFCC and/or ca
sed or operative treatment to avoid chronic instability and arthosis. Intraarticular fracture of sigmoid notch or ulnar
Type III: potentially unstable Intraarticular fractures of the sigmoid notch and intraarticular fractures of the ulnar he
DRUJ. Subluxation is possible.
Common Fracture Eponyms:

Colles' fracture:
A Colles' fracture is a fracture of the distal metaphysis of the radius with dorsal angulation and displacement leading
frequently with advancing age and in women with osteoporosis. In many cases a Colles' fracture is an extraarticular,
So look for signs of instability in all Colles' fractures, especially: On the left a detailed AP view of the same patient as
lateral view, notice the following: Just calling this fracture a Colles' fracture would be insufficient. All the characteristi
vey the full extent of the injury, possible complications and treatment.
Smith's fracture:
Smith's fractures occur in younger patients and are the result of high energy trauma on the volar flexed wrist. Volar
e left an extraarticular Smith's fracture with palmar and radial angulation and displacement. There is also an avulsion
Barton's fracture:
Volar-type Barton's is a fracture-dislocation of the volar rim of the radius. This type is the most common. Dorsal-type
adius. Dislocation of the radiocarpal joint is the hallmark of Barton's fractures. These are shear type fractures of the
he distal radial fragment and the carpus. These fractures have a great tendency for redislocation and malunion. They
rton's fracture. The radiographic findings are the following: On the left a dorsal-type Barton's fracture. The radiograp
Die-punch fracture:
A die-punch fracture is a depression fracture of the lunate fossa of the distal radius. It is the result of a transverse loa
ry subtle. In many cases there is also a subtle proximal displacement of lunate, seen as a break in carpal arc I. (see th
the left a typical die-punch fracture. The blue arrow indicates the depressed fragment of the lunate fossa. Notice the

ure of the radial styloid process. There is no disruption of carpal arc I. Notice that you can easily overlook such a frac
re as above.
Chauffeur's fracture:
An isolated fracture of the radial styloid process is also called a Hutchinson's or chauffeur's fracture. Displacement o
the scapholunate ligament. In most cases a fracture of the radial styloid process is part of a comminutive intraarticu
process fracture is usually associated with radial fractures and rarely isolated. An isolated fracture of the tip is clinica
ually associated with TFC tears and can be associated with instability of the distal radioulnar joint (DRUJ). On the left
blue arrow) in a patient with a volar Barton's fracture. Notice the depression of the volar rim.
Fractures in Children:

Torus fracture:
Torus fractures, or buckle fractures, are extremely common injuries in children. Because children have softer bones,
the Latin word 'Tori' meaning swelling or protuberance. These injuries tend to heal much more quickly than the simi
Green stick fracture:
These are partial fractures, since only one part of the bone is broken and the other side is bent. The name is derived
ften the greenstick fracture must be bent back into the proper position. Greenstick fractures can take a long time to
ing parts of bone.
Epiphysiolysis fracture:
These are usually Salter Harris type II epiphysiolysis fractures. Restorage of the anatomical situation is necessary to p
osed reduction. In many cases they need percutaneous pinning.
Classification systems:

Muller AO-classification:
The Muller AO-classification is adapted by the Orthopaedic Trauma Association. In reference (6) a link is provided to
ractures. A = extra-articular fracture B = partial articular fracture C = complete articular fracture of radius
Fernandez Classification:
This classification is popular, since it addresses the mechanism of injury and the consequent treatment options. Inst
r initial adequate reduction. Associated traumatic lesions are ligamentous rupture, nerve compression and compartm
Type 3 : Compression fracture Type 4 : Avulsion fracture Fernandez classification. Modified and reprinted with permi
Treatment:
The treatment decision of a distal radius fracture is complex and depends on the type of the fracture, the age and ac
eme a stable, undisplaced extra-articular fracture has an excellent prognosis. At the other an unstable, displaced intr
nosis. If the alignment of the bones is not acceptable, they need to be reduced by closed or open reduction.
Indications for Reduction in Distal Radius Fractures:
Many authors suggest that distal radial fractures be reduced anatomically, but the real question is 'what is acceptabl
some of the recommendations of the International Distal Radius Fracture Study Group are presented in the table or
ongoing debate (5). Good alignment after closed recuction for extraarticular Colles fracture
Closed Reduction:
The initial treatment for most radius fractures is closed reduction and plaster immobilization. A displaced fracture is
is placed under traction to unlock the fragments. The deformity is then reduced with appropriate closed reduction, c
such a way that the risk of re-displacement is minimized. X-rays are taken to ensure that the reduction was successfu
st. Unsuccesful reduction. Guidelines for non-acceptable reduction are (8): On the left a control radiograph made aft
dorsal tilt > 10 degrees , loss of inclination and radial shortening.
Surgical treatment:
Although in most cases closed reduction is attempted, surgical intervention is required when there is failure to obtai
are considered to be unstable and require surgical fixation. Many techniques of fixation are now available, including
, and internal fixation with customized implants, including the Distal Volar Radius (DVR) system. Surgical fixation allow
reater function is possible. On the left a post-operative image of a Salter-Harris II fracture, which is held in place with
th a die-punch fracture, nicely shown on an oblique radiograph. The fracture fragment of the lunate fossa was replac
res are rarely successfully treated with closed reduction due to the shearing nature of the injury. A volar buttress pla
ne make external fixation the preferred surgical treatment option. On the left an intraarticular fracture of the distal r
ate. External fixation was used to lengthen the radius. On the left a patient with a dorsal Barton's fracture (shown be
s better, but this still is an unstable situation. Volar plates were used with screws to lock the dorsal rim. The volar app
l result after one of the plates has been removed.
Complications:

Malunion:
Non-union is uncommon in distal radial fractures, since there is excellent vascularisation of this region. Malunion ho
ing, angulation and incongruity of the articular surface. This results in malfunction and early osteoarthritis. More tha
factor in the development of posttraumatic osteoarthritis of the wrist. On the left a patient with malunion. The radia

he loss of radiocarpal joint space indicating osteoarthritis. Malunion Closed reduction is frequently unsuccessful whe
mminutive. On the left a patient with an intraarticular fracture with dorsal tilt (i.e. intraarticular Colles' fracture). On t
me dorsal tilt. After closed reduction and at follow up after one week, there is an acceptable tilt. Finally at 6 weeks fo
shortening and loss of inclination. The ulna abutts the lunate. The final result will be malfunction, radiocarpal and di
ment relate to the potential for compression of the swollen arm causing compartment syndrome or carpal tunnel sy
mmon complications. Complications associated with plating include tendon irritation or rupture and the need for pla
hritis. There is also scapholunate dissociation as a result of associated ligamentous rupture with volar tilt of lunate ir
her patient after unsuccessful treatment. There is loss of radial inclination and radial shortening, dorsal tilt and an ar
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None:

None:

None:

Fleischner 2017 guideline:
by Onno Mets and Robin Smithuis
the Academical Medical Centre, Amsterdam and the Alrijne Hospital, Leiderdorp, the Netherlands:
Publicationdate 2017-07-01 Pulmonary nodules are frequently encountered incidentally on chest CT. The role of the
sions, and advise on follow-up imaging or additional invasive imaging techniques. This article summarizes the basics
gement recommendations of the Fleischner Society.
Introduction:
In 2017 the updated Fleischner Society guideline was published[1]. These replace the recommendations for solid (20
ines should reduce the number of unnecessary follow-up examinations and provide clear management decisions. N
mm, since a small solid nodule may appear to have groundglass density on a thick slice due to partial-volume effect.
Fleischner Guideline 2017:

Solid nodules:
Solid pulmonary nodules can represent various etiologies: Perifissural nodules are a separate entity, since they usua
eed no follow up. They are discussed in the last chapter. In another article we presented some features that can help
re) Unfortunately, there is considerable overlap and often no definitive answer can be given based on imaging morp
Subsolid nodules:
Most subsolid nodules are transient and the result of infection or hemorrhage. However, persistent subsolid nodule
reliable distinction can be made radiologically, although studies suggest that larger size and a solid component are a
ns, persistent subsolid nodules have a much slower growth rate, but carry a much higher risk of malignancy. In a stu
pure groundglass SSNs in 18% and solid nodules only in 7% [4]. Subsolid nodules in the adenocarcinomatous spectru
inology should no longer be used. A new pathology-based classification for adenocarcinoma was introduced in 2011
subsolid nodule Transient subsolid nodules usually represent infection or alveolar hemorrhage. To differentiate bet
ld be obtained. Previously, it was recommended to repeat imaging after 3 months, however, this interval has been in
follow-up period for persistent subsolid nodules has been increased to 5 years. The images show a 7 mm pure grou
s proved to be a transient subsolid nodule. Persistent malignant subsolid nodule These images show a pure groundg
ed growth in a two year interval and proved to be malignant after resection.
Risk factors:
Defining high- or low-risk is currently more difficult than it was in the old guideline. Previously a high-risk subject was
f lung cancer in a first-degree relative or exposure to asbestos, radon or uranium. Now, it is aimed for to separate hig
ers than subject characteristics alone (See Table). Since these risk factors are numerous and have different effects on
gories concerning the probability of malignancy 8.
Notes:
The guideline recommends follow-up for nodules with an estimated lung cancer risk of around 1% or greater, which
or an incidentally found pulmonary nodule in the lower lobe of a relatively young patient compared to a nodule in th

known or suspected malignancy. For this reason the Fleischner guideline for the management of pulmonary nodules
than 35 years, immunocompromised patients or patients with cancer [1].
Pulmonary Nodule Measurements:
A lesion which measures 8 x 5 mm has an average of (8 + 5) : 2 = 6.5 mm - rounded up to 7 mm In the Fleischner guid
easurements or 3D nodule volumetry. Manual 2D caliper measurements should be based on the average of the long
e same transverse, coronal or sagittal reconstructed image, whichever plane reveals the greatest dimensions [1]. Thi
e averaged diameters in the axial plane only [2]. Manual 2D caliper measurements should be rounded to the nearest
ule as well as the solid component dimensions should be measured separately, both using the abovementioned ave
Perifissural nodules:
Perifissural nodules are a separate entity, and likely represent intrapulmonary lymph nodes. Morphologically these a
or rounded, lentiform or triangular in shape. Their location is within 15 mm of the fissure or the pleura. They may or
ferentiates between a typical and atypical PFN (see Figure). PFNs can show significant growth rates on serial imaging
al sign of malignancy, but merely a result of their presumed lymphatic origin. Typical PFNs. Images from Ref [Hoop].
cal and atypical PFNs were found to be malignant in a 5.5 year follow-up [5]. This confirmed prior results of Ahn et al
ated to clinical subjects, which has recently been supported by a study using routine-care clinical CT imaging [7]. The
les have a perifissural or other juxtapleural location and a morphology consistent with an intrapulmonary lymph noc
exceeds 6 mm. Non-PFN nodules. Courtesy of M. Prokop Perifissurally located nodules that do not conform to the m
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dental perifissural nodules on routine chest computed tomography: lung cancer or not?
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Vascular territories of the Brain:
Robin Smithuis
Radiology department of the Alrijne Hospital in Leiderdorp, the Netherlands:
Publicationdate 2008-11-24 Knowledge of the vascular territories is important, because it enables you to recognize in
venous infarctions. It also helps you to differentiate infarction from other pathology.
Cerebral Arterial Territory:
Vascular territories of the cerebral arteries (adapted and modified with permission from M. Savoiardo (1) The PICA te
nd is in equilibrium with the territory of the AICA in purple, which is on the lateral side (1). The larger the PICA territo
* Superior Cerebellar Artery (SCA in grey) The SCA territory is in the superior and tentorial surface of the cerebellum.
* Branches from vertebral and basilar artery These branches supply the medulla oblongata (in blue) and the pons (in
* Anterior Choroideal artery (AchA in blue)) The territory of the AChA is part of the hippocampus, the posterior limb
to the posterior part of the cella media.
* Lenticulo-striate arteries The lateral LSA' s (in orange) are deep penetrating arteries of the middle cerebral artery (M
e medial LSA' s (indicated in dark red) arise from the anterior cerebral artery (usually the A1-segment). Heubner's art
supplies the anteromedial part of the head of the caudate and anteroinferior internal capsule.
* Anterior cerebral artery (ACA in red) The ACA supplies the medial part of the frontal and the parietal lobe and the a
rnal capsule.
* Middle cerebral artery (MCA in yellow) The cortical branches of the MCA supply the lateral surface of the hemisphe
be (anterior cerebral artery), and the inferior part of the temporal lobe (posterior cerebral artery).
The deep penetrating LSA-branches are discussed above.
* Posterior cerebral artery (PCA in green) P1 extends from origin of the PCA to the posterior communicating artery, c
g arteries branch off the P1 segment and supply blood to the midbrain and thalamus. Cortical branches of the PCA s
isual cortex, and splenium of the corpus callosum. On the left a detail to illustrate the vascular supply to the basal ga
PICA:
On the left CT-images of a left-sided PICA-infarction. Notice the posterior extention. The infarction was the result of a
ded PICA-infarction. In unilateral infarcts there is always a sharp delineation in the midline because the superior verm
urse. This sharp delineation may not be evident until the late phase of infarction. In the early phase, edema may cros
t pontine level are usually paramedian and sharply defined because the branches of the basilar arery have a sagittal
ly observed because these patients do not survive long enough to be studied, but sometimes small bilateral infarcts
SCA:
On the left MR-image of a cerebellar infarction in the region of the superior cerebellar artery and also in the brainste
idline. ACA infarction
ACA:

Anterior cerebral artery: Infarction of right hippocampal region (courtesy Frederik Barkhof)
Anterior choroidal artery:
The anterior choroidal artery originates from the internal carotid artery. Rarely it arises from the middle cerebral art
es part of the hippocampus, the posterior limb of the internal capsule and extends upwards to an area lateral to the
lved in AChA infarcts. The posterior limb of the internal capsule also receives blood from the lateral lenticulostriate a
al region. Part of the territory of the anterior choroidal artery and the PCA are involved. MCA infarction. Involvement
rteries
Middle cerebral artery:
The MCA has cortical branches and deep penetrating branches, which are called the lateral lenticulo-striate arteries.
ries of the MCA is indicated with a different color from the rest of the territory of the MCA because it is a well-define
ed or spared in infarcts separately from the main cortical territory of the MCA. On the left a T2W-image of a patient w
ry (MCA). Notice that the lateral lenticulo-striate perforating arteries of the MCA are also involved (orange arrow).
Lenticulostriate arteries:
Medial lenticulostriate arteries They are branches of the A1-segment of the anterior cerebral artery. They supply the
he anterior limb of the internal capsule together with the recurrent artery of Huebner, which also is a branch of the a
y are branches of the horizontal M1-segment of the middle cerebral artery. They supply the superior part of the hea
and putamen. They also supply the anterior limb of the internal capsule and parts of the posterior limb of the interr
artery. CT and T2W-gradient echo image of a hemorrhagic infarction limited to the territory of the lateral lenticulo-st
in the area of the deep perforating lenticulostriate branches of the MCA. MCA infarction with luxury perfusion On th
territory of the middle cerebral artery (MCA). There is extensive gyral enhancement (luxury perfusion). Sometimes th
nt. PCA infarction
Posterior cerebral artery (PCA):
Deep or proximal PCA strokes cause ischemia in the thalamus and/or midbrain, as well as in the cortex. Superficial o
the left a patient with acute vision loss in the right half of the visual field. The CT demonstrates an infarction in the c
infarction Only about 5% of ischemic strokes involve the PCA or its branches (3). On the left CT-images of a patient w
Notice the loss of gray/white matter differentiation in the regio of the left occipital lobe.
Variations in Arterial Territories:
Images courtesy Jeroen Hendrikse (9) Variations in perfusion territories in the brain can be visualized with selective a
fusion territories is important in specific patient groups with cerebrovascular disease, such as acute stroke, large art
as it provides valuable hemodynamic information. On the left the time-of-flight MR angiography-images of brain-fee
sion territory imaging of the left and right internal carotid artery and the vertebrobasilar artery. Normal perfusion te
esy Jeroen Hendrikse (9) On the left a patient with a lacunar infarction on the left with normal perfusion territories. C
d by the right ICA Images courtesy Jeroen Hendrikse (9) On the left a patient with a watershed infarct in the left hemi
(arrow). Notice that there is a variation in the brain perfusion since the left frontal lobe is supplied by the right interr
On the left another variation in the brain perfusion in a patient with multiple infarctions as demonstrated on the diff
occipital lobe which happens to be perfused by the left internal carotid artery (arrow). Notice that there is no contrib
Watershed Infarcts:
Watershed infarcts occur at the border zones between major cerebral arterial territories as a result of hypoperfusion
the deep white matter of the centrum semiovale and corona radiata at the border zone between lenticulostriate per
t the border zone of deep white matter branches of the MCA and the ACA. Deep watershed infarction in a patient wit
ee consecutive CT-images of a patient with an occlusion of the right internal carotid artery. The hypoperfusion in the
arctions. This pattern of deep watershed infarction is quite common and should urge you to examine the carotids. S
n internal border zone infarctions, lacunar infarctions and MS. Borderzone infarcts due to occlusion of the internal c
s in the right hemisphere in the deep borderzone (blue arrowheads) and also in the cortical borderzone between the
n the right carotid (red arrow) as a result of occlusion. In patients with abnormalities that may indicate borderzone in
for abnormal signal. On the left another example of small infarctions in the deep borderzone and in the cortical bor
e. On the left an example of infarctions in the deep borderzone and in the cortical borderzone between the ACA- and
is the result of an occlusion. This combination of findings is so common, that once you know the pattern, you will se
Lacunar Infarcts:
Lacunar infarcts are small infarcts in the deeper parts of the brain (basal ganglia, thalamus, white matter) and in the
gle deep penetrating artery. Lacunar infarcts account for 25% of all ischemic strokes. Atherosclerosis is the most con
ts with clinical and radiologically defined lacunes had a potential cardiac cause for their strokes. On the left a T2W- a
the FLAIR image the infarct is hardly seen. There is only a small area of subtle hyperintensity. Lacunes may be confu
how-Robin spaces (VRS). The VRS are extensions of the subarachnoid space that accompany vessels entering the bra
arteries in the substantia perforata and can be seen on transverse MRI slices around the anterior commisure, even i
f the anterior commisure (blue arrows). On the CT there is a hypodense area in the right hemisphere, which follows t
ical for widened VRS.
PRES:
PRES (courtesy Madja Turnher) PRES is short for Posterior Reversible Encephalopathy Syndrome. It is also known as
cally consists of potentially reversible vasogenic edema in the posterior circulation territories, but anterior circulation

n described including hypertension, eclampsia and preeclampsia, immunosuppressive medications such as cyclospo
ated to a hyperperfusion state, with blood-brain-barrier breakthrough, extravasation of fluid potentially containing b
dema. The typical imaging findings of PRES are most apparent as hyperintensity on FLAIR images in the parietooccip
ess commonly, the brainstem, basal ganglia, and cerebellum are involved. On the left images of a patient with revers
e posterior circulation as well as in the basal ganglia. Continue. Four days later most of the abnormalities have disap
Cerebral Venous territory:
There is great variation in the territories of venous drainage. The illustrations on the left should be regarded as a rou
Cerebral venous thrombosis:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
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Abdominal wall hernias:
Marc Engelbrecht, Simba Timmer, Erwin van Geffen and Robin Smithuis
Radiology department of the Amsterdam Medical Center, Department of Surgery Jeroen Bosch hospital and the Alrij
Abdominal hernias are usually a clinical diagnosis and have been considered a simple
problem to be repaired.
However, long-term follow-up of patients has shown
disappointing results, both in terms of complications and recurrence (1).
Due
to increased complex abdominal wall surgery, pre-operative CT planning with
abdominal wall mapping has gained increasing attention.
In this article we will
adress the key imaging features of complex abdominal wall hernias.
Introduction:

Structured Radiology Report:
What the surgeon needs to know is: In the table you will find the most important items, that need to be addressed in
All these subjects will be discussed in this order in the next chapters.
Abdominal wall musculature:
Important muscular structures that surround the abdominal
organs are shown in this figure. The linea alba is a line
formed by the aponeuroses of the right and left rectus muscle and connects both
muscles in the midline.
As the linea alba is an avascular area, it is
frequently used as point of entrance for open abdominal surgery. The linea semilunaris is a curved tendinous line th
abdominis muscle on both sides.
Here, the anterior and posterior rectus sheaths
connect with the three lateral abdominal wall muscles: the external oblique,
the internal oblique and the transverse abdominal. This illustration demonstrates how the anterior and posterior rec
sheath are formed by the aponeuroses of the external oblique, internal
oblique and transverse abdominal muscles.
Because abdominal
wall hernias are defects of the fascia of the abdominal wall, these fascia layers need to be brought
together during surgery.
Therefore, the rectus sheaths play an important role
in surgical hernia repair.
Type of abdominal wall defect:

Primary hernia:
Abdominal wall hernias can be divided into primary hernias, that are not related to incisions and incisional hernias. P
ain weak spots in the abdominal wall.

In the midline are the umbilical and epigastric hernia and lateral are the Spigelian and lumbar hernia.
The Spigelian hernia is an uncommon hernia at a weak spot between the oblique abdominal muscles and the rectus
Primary lumbar hernias are uncommon and are also located lateral but more posteriorly, where there is a weak spo
hey can be divided into
superior and inferior lumbar hernias (Greenfellt-Lesshaft and Petit).
Incisional hernia:
Incisional hernias are the most common and can be located anywhere, where there has been an incision, drain oper
Most incision hernias are located in the midline.
Incisional hernias in the lumbar region can be seen after nephrectomy, hepatopancreatobiliary, or aortic-surgery. Ex
Rectus diastasis:
Rectus diastasis is a widening between the left and
right rectus muscle with protrusion of visceral fat or bowel (figure).
The difference with a hernia is that in diastasis there is no fascia defect.
A gap of 2,0 cm between left and right rectus muscle is considered diastasis.
Besides transverse width, craniocaudal length of the diastasis should be measured as well. Rectus
diastasis in men is often caused by increased visceral fat and in women due to
pregnancy.
Abdominal wall hernias may coexist with diastasis.
Diastasis is important to mention as hernia recurrence is more likely in the presence of rectus diastasis.
Location and size of the defect:
The number of defects and the location of the defect should
be reported.
As mentioned before, hernias are classified as midline as long as they are located
within the lateral borders of the rectus sheath (e.g. the linea semilunaris). Lateral
hernias are located lateral to the linea semilunaris. A description of the size of the abdominal wall
defect is needed for pre-operative planning.
The size consists of width and
height. Here a schematic illustration of the measurements
of the defect in two axes: longitudinal and transverse (see Figure).
For
midline hernias cranio-caudal location can be described by the distance to the
xiphoid or symphysis pubis.
For lateral hernias, cranio-caudal location
can be described by distance to the costal margin or iliac crest. When multiple defects are present, the combined len
defects should be reported because multiple defects are normally treated as one
functional defect (like Swiss Cheese).
However if hernias are located
relatively far away, they can be described as separate hernias. Here an example of the measurement of the defect
size.
The hernia width is the maximum distance in between the rectus muscles,
measured on the axial view at which this distance is largest.
The defect height
is the maximum cranio-caudal distance, measured in the sagittal plane. Measurement of multiple hernias This patien
There is a midline hernia (yellow arrowheads) and a lateral hernia (white arrowheads).
in this case the total combined length and total width are measured.
Rectus to Defect Ratio:
The Rectus to Defect Ratio (RDR) is the ratio of
the sum of the width of the left and right rectus compared to the hernia width. Another name for this equation, ofte
do Carbonell who first published this. The RDR is a practical and reliable tool to predict
the ability to close the abdominal wall defect during routine hernia repair
without the need to perform an additional component separation technique (CST). Component separation technique
transsected from the others.
These techniques 'loosen' the remaining abdominal wall, but are associated with a higher risks of postoperative com
pair will be able to close the abdominal wall defect in 90% of cases.
If the RDR is < 1.5, in more than 52% of the repairs, additional component separation technique is required. Image
In this
patient the Rectus to Defect Ratio: (49 mm + 43 mm) / 157 mm = 0.58. This ratio predicts
that hernia closure will probably not be possible without performing a component separation technique. Image
In a different patient, the Rectus to Defect Ratio
is: (73 mm + 81 mm) / 51 mm = 3. Contrary to the previous case, hernia closure will be possible without performing a

Loss of Domain:
Loss of domain is a ratio that describes the amount
of peritoneal content that is located in the hernia sac.
This ratio is used to
predict the risk of peri-operative complications as well as the need for preoperative
botulinum injections and/or component separation technique. This ratio is calculated by dividing
the hernia sac volume (HSV) by the total peritoneal volume (TPV).
The total
peritoneal volume consist of the hernia sac volume plus the
abdominal cavity volume (ACV).
For more information on preoperative botox
injections: see treatment. The specific volumes can be obtained through volume
rendering or with a simplified method to
estimate the volumes, i.e. the height, width and depth of the hernia and abdomen
are multiplied by 0.52 (the formula of an ellipse). The height of the abdomen is measured from the
upper edge of the liver to the symphysis, the width is measured in between the
transversus abdominal muscles on both sides.
The depth is measured from the
anterior side of the vertebral column to the anterior abdominal wall.
If the anterior abdominal wall is no longer present, due to a large ventral hernia, extrapolation of the remnant anteri
red.
The
height, width, and depth of the hernia are measured within the hernia sac.
For
more information on Loss of Domain measurments see ref 6. If the loss of domain is larger than 20 %, there is a high
sult in increased
abdominal cavity pressure with complications such as respiratory failure and
hernia recurrence (ref 7 and ref 8). ImageIn this patient the loss of domain is > 20% and additional strategies will be
In this patient with a large hernia, the measurements are as follows: The loss of domain in this case is the volume of
avity:
3.1: 8.9 = 35%. This is far
greater than 20% and means that there is a high risk of
complications during and after a simple abdominal wall repair. In this patient with a hernia, the measurements are a
Complications:

Incarceration:
The most
serious and acute complication is an incarcerated hernia.
An incarcerating
hernia can be diagnosed by looking at two separate features, namely small
bowel obstruction and signs of impending strangulation. Actually these are all signs of closed loop obstruction, whic
You will find more information about closed loop obstruction here. These images are of a 78 year old morbid obese
hen compare to the next images, who were taken one month later, when she presented with a painfully swolen herr
contains bowel, strangulation in abdominal wall hernias occurs as a result of closed loop obstruction with venous in
This patient has a hernia that contains small bowel.
The defect is rather small and there is a stenosis at the point where the bowel enters the hernia sac (yellow arrow) a
These two stenosis are proof of a closed loop obstruction.
There is dilatation of the bowel and fat infiltration as a result of ischemia resulting from venous obstruction. Continu
ded videos. The video better demonstrates the two stenoses. Sorry, your browser doesn't support embedded videos
ia sac.
The white arrow indicates the first obstruction, where the bowel enters the closed loop.
The yellow arrow indicates the exit.
In this case the closed loop is caused by adhesions within the hernia sack. Notice the fat infiltration and the dilated lo
These are all signs of bowel ischemia. Immediate laparotomy was performed.
The bowel within the hernia sac was ischemic and had a purple color, but after cleavage of the adhesions, the color c
Mesh infection:
A common complication
of abdominal wall surgery is the development of a fluid collection.
It is
important to differentiate sterile collections like hematoma and seroma from an abscess Image

This patient had abdominal wall hernia surgery with bilateral component separation surgery.
There is a large fluid collection with air bubbles as a result of infection. Infected mesh ImageFluid collection with air c
abdominal wall (blue arrow). This is an infected mesh.
Mesh ingrowth in bowel:
This is an uncommon complication. Image
A calcified mesh has migrated into
the bowel (black arrow).
Adhesions:
The presence of viscera inside the hernia sac is associated with greater difficulty in dissecting it and greater risk of ar
at. Image
There is a midline hernia with bowel content.
There are adhesions between the bowel and the thickened skin (arrow). In this patient there are also adhesions conn
r (blue arrow) Sorry, your browser doesn't support embedded videos. In this patient the hernia sac contains small bo
Entero-atmospheric fistula:
In this patient leakage of oral contrast is seen arrow heads
and white arrow.
Treatment:
Examples of the many positions of meshes The only treatment option for abdominal wall hernia is surgery.
The aim is to close the abdominal cavity by re-approximating the fascial edges of the rectus muscles.
Attention should be paid that this is done without too much tension on the midline repair. A mesh is almost always u
recurrent hernia. A mesh can be placed in many positions, but preferably located posterior to the rectus muscle.
This is called a retrorectus repair as originally described by Rives, Stoppa and Wantz.
An intra-peritoneal positioned mesh, which can be placed by open or laparoscopic repair, has a greater chance of bo
air
Rives-Stoppa repair:
In the Rives-Stoppa repair the skin is
incised and the hernia sac is opened. The bowel is put to the side and
protected by gauze. On both sides the posterior rectus sheath is transsected
from the rectus muscle, creating the retromuscular space. This
space is dissected laterally, just up to the linea semilunaris.
Then, the
posterior rectus sheaths from both sides are sutured together in the midline.
On this posterior layer, a mesh is positioned.
Then, the rectus muscles are
brought together, and the anterior rectus sheaths from both sides are sutured
in the midline.
Component separation:
The above-described
surgical repair is quite straightforward and can be used for small and medium
sized hernias.
For large hernias or hernias with large loss of domain,
it will not be possible to medialize the rectus muscles without too much tension. Component separation techniques
medialization of the rectus muscles, by transection one of the lateral
abdominal wall muscles from the other two. In the Ramirez technique
(also known as the open anterior CST), after mobilization of the skin and subcutaneous tissue up to the semilunar lin
the external oblique is
dissected from the internal oblique.
It
provides about 10cm of medialization, but is associated with a high risk
of postoperative wound complications, because of the skin mobilization. Images
Transversus Abdominus Release (oTAR):
The open posterior Components Separation or Transversus Abdominus Release (oTAR) is now the preferred treatme
The first step in TAR is entry into the retrorectus space from the posterior side and dissection is proceeded laterally t
orectus space.
Next the posterior rectus sheath is longitudinally divided as laterally as possible, taking care to avoid the subcostal n
versus Abdominus are divided with electrocautery.
By dividing the transversus abdominis muscle from the oblique internal muscles, it becomes possible to approximat
developed to as far as the lateral border of the psoas muscle.
The dissection is repeated on the opposite site and may be carried superiorly to the central tendon of the diaphragm
developed inferiorly to the retropubic space.

Then the posterior rectus sheaths are approximated to one another and a sublay mesh is placed into the retromusc
inus Release(rTAR)Most TAR procedures are currently performed by a Robot Assisted procedure. This has the advan
of wound related complications, less morbidity and decreased length of stay in the hospital. By dividing the transve
l become possible to approximate both the posterior rectus sheathsRecent systematic review in Hernia.
Botox injections:
Component separation technique can be very effective, but is invasive and permanent.
Botuline (Botox) injection in the muscles of the lateral abdominal wall is a
non-invasive pretreatment, and its use has become very popular in the
last couple of years. Injections 4 - 6 weeks before surgery results in thinning
and elongation of the muscles and can preclude the need to
perform CST in large hernias. Image
Thinning and elongation of the oblique muscles after Botox injection..
CT protocol:
For primary and small hernias ultrasound imaging can suffice.
For all other type of hernias CT imaging is preferred.
I.v. contrast is not always necessary, but can be helpful in complicated cases.
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Acute Aortic Syndrome:

Aortic Dissection, Intramural Hematoma and Penetrating Ulcer:
Ferco Berger, Robin Smithuis, Otto van Delden
From the Radiology Department of the Academical Medical Centre, Amsterdam and the Rijnland Hospital, Leiderdor
Publicationdate 2006-04-10 The term Acute Aortic Syndrome (AAS) is used to describe three closely related emergen
ntramural Hematoma (IMH) and Penetrating Atherosclerotic Ulcer (PAU). Clinically these conditions are indistinguish
gnosis, differentiation and staging. This review will discuss the imaging features and important pitfalls. *by Ferco Ber
of the Academical Medical Centre, Amsterdam and the Rijnland Hospital, Leiderdorp, the Netherlands.*
Imaging Protocol:
Image protocol will be based on the type of scanner that is available. Our imaging protocol is based on a 4 slice helic
AS, we use 4x2,5 mm collimation technique
with 5 mm axial reconstructions and coronal, sagittal and oblique MPRs. A non-enhanced scan of the thoracic aorta i
is followed by a contrast-enhanced scan of the aorta in the arterial phase with bolus triggering and in the venous ph
rterial and venous phase can be helpful in differentiating true and false lumen. The iliac tract is included for evaluati
the arch are visualized to evaluate the extend of dissection and awareness of possible neurological complications. Ty
: not visible on left arm injection.RIGHT: Same patient with right arm injection. Important reduction of artifacts and th
d that placing ROIs can be difficult with dissected lumina (should be just distal to the aortic arch).) Have the technicia
Classification of Acute Aortic Syndrome:
Typical Aortic Dissection, Intramural Hematoma and Penetrating Aortic Ulcer. Classic Aortic Dissection (AD), Intramu
e distinct entities, but closely related. This is reflected upon in their identical therapeutical strategies. The main goal f
causing the clinical problem, but more importantly to differentiate between type A and B!
Stanford classification:
The Acute Aortic Syndrome (AAS) is classified according to Stanford.
Stanford Type A lesions involve the ascending aorta and aortic arch and may or may not involve the descending aort
Stanford Type B lesions involve the thoracic aorta distal to the left subclavian artery. The Stanford classification has n
and descending aorta: type II= only ascending aorta: type III= only descending aorta). Treatment options for the 2 su
Stanford type A will be treated with surgery or endovascular therapy. Stanford Type B will be treated medically.
Aortic Dissection (AD):
Classic Aortic Dissection Classic Aortic Dissection is the most common entity causing an acute aortic syndrome (70%)

ortic arch.RIGHT: Type B dissection. Entry point distal to left subclavian artery. Management decisions are based on t
tes entry. False lumen is indicated by yellow arrows and is seen spiraling around the true lumen.
Imaging features:

Dissection into brachiocephalic arteries:
Carefully sort out which branches of the aortic arch are involved. Make sure from which lumina they arise. Left: Cont
, significantly contributing to organ perfusion.Right: : SMA and renal artery involvement, illustrating possible cause of
Dissection into abdominal arteries:
The celiac trunc, SMA and right renal artery flow usually originates from the true lumen. Left renal artery flow mostly
gans can be due to 2 mechanisms: 1) static = continuing dissection in the feeding artery (usually treated by stenting)
curtain (usually treated with fenestration). This may be hard to discern, MPR's can be helpfull. Look for the re-entry
ation about tortuisity and calcifications of the iliac tract if endovascular procedures are being considered. LEFT: Disse
organs are compromised and there is sufficient perfusion, dissection can be left alone. This may persist for a long tir
he left with follow-up of 2 years. Some dissections remained unchanged during a follow up of more than 5 years. Lef
aorta. Even small amounts are proving rupture, though hematoma can be extensive such as in this case.Right: Mass
stinum and pleural cavity, no pericaldial hematoma.
Rupture into pericardium and thoracic cavity:
Even the slightest amount of fluid in pericardium, mediastinum or pleural cavity is suggestive of rupture of the disse
e of extensive hematoma in above mentioned locations. Note extreme hematothorax and hematomediastinum, cau
en aorta. No pericardial effusion visible. Type B aortic dissection in a non-operable patient. At 5 days flow reappeare
formed. The case on the left is a patient who presented with a fully thrombosed false lumen. 5 days after initial pres
the earlier episode. Re-examination showed recurrence of flow in the false lumen, locally contained, but with alarmi
cal or endovascular repair for various reasons and was treated consevatively. LEFT: Dissection with a thrombosed fa
intimal calcifications.
Aneurysm with thrombus versus thrombosed dissection:
It can be difficult to differentiate an aneurysm with thrombus from a dissection with a thrombosed false lumen. If th
e lumen displaces the intimal calcifications.
Intramural Hematoma:
Intramural Hematoma is a result of ruptured vasa vasorum Brief facts: Classic example of IMH. Hyperdense hemato
inician needs to know Predictors of mortality: Ascending Aorta > 5 cm ? IMH thickness > 2 cm Pericardial effusion (to
, hyperdense on a NECT. Same case. CECT of Intramural hematoma type B. Same case contrast enhanced CT. Note th
elping to differentiate both. Essentially, this is not important, therapeutical decision will be made by whether this IMH
o pericardial effusion. IMH thickness stays below 2 cm, making regression of this Type B IMH likely (up to 80%).
Penetrating Atherosclerotic Ulcer:
PAU is defined as an ulceration of an atheromatous plaque that has eroded the inner elastic layer of the aortic wall.
ia. Brief facts: Typical illustration of PAU, focal outpouchings of contrast, separating extensive intimal calcifications W
Complications:
The complications of a Penetrating Atherosclerotic Ulcer include: However most patients have a poor prognosis beca
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LI-RADS:

Liver Imaging Reporting And Data System:
Frederieke Elsinger*, Christopher Lunt, Alison Harris and Silvia Chang
Luzerner Kantonsspital* and Vancouver General Hospital:
Publicationdate 26-3-2020 The Liver Imaging Reporting and Data System (LI-RADS) is a classification system for liver l
ic HBV without cirrhosis, because these patients have an increased risk of hepatocellular carcinoma (HCC). The LI-RA
ypical CT and MR-findings in HCC. LI-RADS is not meant to be used in patients <18 years or patients with cirrhosis du
ecause these patients have a lower chance of developing HCC. Press ctrl+for larger images and text on a PC or □+ on
Single images can be enlarged by clicking on them.
Introduction:

LI-RADS major features:
There are five major features which are typically seen in HCC in patients with livercirrhosis and chronic hepatitis B vi
ripheral washout or threshold growth is L5.
LI-RADS categories:
Non enhancing lesions in a cirrhotic liver, compatible with cysts, LR-1
Mass versus Pseudolesion:
LI-RADS uses the term 'observations' to describe focal abnormalities which are distinct from the background liver pa
It is preferred not to use the word 'lesion' or 'nodule' as some of these abnormalities do not represent true lesions bu
eudomass or an artifact.
When to use LI-RADS:
LI-RADS can only be used in patients with cirrhosis and chronic HBV infection. LI-RADS should not be used in patients
In these patients the formation of benign hyperplastic nodules may resemble HCC on imaging and cause false positi
Major features:
Typical HCC with APHE and washout.
Arterial Phase non-rim Hyperenhancement (APHE):
Here an image in the late arterial phase in a patient with cirrhosis.
There is an observation with non-rim hyperenhancement (yellow arrow).
In a late phase there is washout.
These are typical features of HCC. The other lesion (green arrow) is a treated lesion, which we will discuss later. Typic
Washout - Capsule:
This is another patient with an enhancing lesion and washout.
Note also the enhancing capsule on the delayed phase. A capsule is one of the major features of HCC and can be co
A capsule should always be included within the measurement of the lesion. LEFT: Hyperenhancing observation detec
Size - Threshold growth:
Size also determines in which category a lesion is placed.
The bigger the lesion, the higher the chance that it is a HCC. An observation should be measured in the phase, seque
Measurement on the arterial phase and DWI sequence should be avoided as size could be overestimated due to sur
. Threshold growth is also an important finding.
It is defined as more than 50% growth in less than 6 months The images show an observation in segment 5 of the liv
The lesion has grown from 8 mm to 21 mm in 3 months, which means that there is threshold growth.
LI-RADS 1 - definitely benign:
Observations in this category are definitely benign. Examples of LR-1 lesions are definite: The images show lesions th
delayed phase. Typical haemangioma in a patient with livercirrhosis.
LI-RADS 2 - probably benign:
LR-2 observations are probably benign.
Of all LR-2 lesions about 16% are HCC and 18% are malignant. Examples of LR-2 lesions are probable: Distinct nodule
ignant features) can be categorized as LR-2. Examples are nodules which are T1 hyperintense, T2 hypointense, sidero
on with enhancement that follows the bloodpool, which is typical for a hemangioma. Continue with the MR of this pa
on follows the enhancement of the blood pool.
LI-RADS 3 - intermediate probability:
LR-3 observations vary from benign lesions to dysplastic nodules to HCC.
Many LR-3s are vascular pseudolesions.
Of all LR-3 lesions approximately 37% are HCC and 39% are malignant (1). Lesions that are placed in category LI-RAD
How would you score LI-RADS. The findings are: The lesion was classified as LI-RADS 3. LI-RADS 3 Here another small
, capsule or threshold growth. This was also classified as LI-RADS 3. LI-RADS 3 Arterial, PV and delayed phase images
In segment 5 there is a subcapsular observation of intense arterial enhancement without washout in the PV or delay
posterior in segment 7 measuring 9 mm.
LI-RADS 4 - probably HCC:
Of all LR-4 observations about 74% are HCC and 81% are malignant (1). The categorizing of an observation as LR-4 de
nt of additional major features (see LIRADS table). Here a very small lesion which measures less than 10 mm with no
-RADS 4.
LI-RADS 5 - definitely HCC:
Study the MR-images.
What are the major findings and what are additional findings?
How would you score LI-RADS. Major features - which makes this a LR-5 lesion: Ancillary features - which we will disc
This is a LR-5 lesion. Of all LR-5 lesions 95% are HCC and 98% are malignant.
In patients with concurrent extra-hepatic malignancy the positive predictive value of LR-5 for HCC drops, especially if
When in doubt, categorizing a lesion as LR-M might be more appropriate in this group of patients. LR-5 The images s
picious of HCC: LR-5. Note that the arterial enhancement is faint because the patient is scanned in the early arterial p

peak enhancement. Additional small lesions can therefore be easily missed. LR-tumor in vein
LR-TIV - tumor in vein:
The classification LR-TIV should be applied when there is unequivocal soft tissue within a vein, regardless if an associ
Almost always the venous invasion by tumor is related to a HCC.
LR-TIV is a contraindication to liver transplantation.
Malignancies other than HCC may also invade the portal venous system. Additional clues of possible venous invasion
ke arterially enhancing lesion in segment V with washout.
A linear area of hypoenhancement is seen extending from the mass which is suspicious of tumor in vein (yellow arro
Since we are not absolutely sure that it is a tumor thrombus, we cannot categorize this as LR-TIV. A follow up CT was
ar involvement of the anterior right portal vein (white arrow).
Now we are sure of tumor invasion in the portal vein.
LR-M - malignant:
The category of LR-M should be applied to malignant appearing lesions that do not have the typical characteristics o
on as LR-M does not mean the diagnosis of HCC is excluded.
Of all LR-M lesions 2/3 are non-HCC malignancies like intrahepatic cholangiocarcinomas (CCA) or combined HCC-CCA
This small percentage of benign malignant appearing lesions usually represent sclerosing hemangiomas or abscesse
markers such as AFP and CA19-9 can be helpful to refine the differential diagnosis. Cholangiocarcinoma LR-M The im
a patient with chronic hepatitis.
In the portal venous phase there is progressive peripheral enhancement. Pathology diagnosis confirmed this was no
a large, heterogeneous enhancing lesion in segment II. There is peripheral enhancement in the portal venous phase
iction. This lesion was resected and pathology showed a mixed HCC-iCCA.
Ancillary features:
Ancillary features are findings that are helpful for detection improvement, increase in confidence for favoring the dia
to category adjustment.
These features are not obligatory and can be used at the radiologist's discretion.
In case of category adjustment, observations can only be upgraded or downgraded one category.
However you are not allowed to upgrade from LR-4 to LR-5, because these ancillary features lack sufficient specificity
Features favoring HCC:
Non-enhancing capsuleis a feature of a capsule surrounding an observation not appearing as an enhancing rim. Noc
ng characteristics
Mosaic structureis randomly distributed compartments or nodules within an observation, usually with different imag
Blood products in mass isintralesional or perilesional hemorrhage in the absence of biopsy or trauma.
Fat in mass isexcess of fat within the whole or part of the mass, more than in adjacent liver. Can be large extracellula
Nodule in nodule:
The images show a fat containing lesion with arterial hyperenhancement.
Within this lesion there is a nodule (arrow) with wash out and a capsule. The lesion was classified as LR-5.
Mosaic architecture:
The image shows an observation with hyperenhancement in the late arterial phase in a patient with cirrhosis.
Notice the mosaic architecture. IP and OOP image
Blood products in mass:
Study the MR-images.
What are the findings? The findings are high signal in a mass in segment II both on an in-phase image as well as on th
ge and in the absence of biopsy or trauma, is a feature that favors the diagnosis of HCC. HCC classified as LI-RADS 5.
Fat in mass:
Excess of fat in the whole or part of a mass is an ancillary finding that favors the diagnosis of HCC. Same image as sh
What are the findings? The findings are: This was classified as LI-RADS 5. Study the MR-images. What are the findings
dings on the images shown above, the lesion is classified as LI-RADS 5 because it is larger that 20mm and shows hyp
avoring HCC are intracellular fat on IP/OOP imaging and diffusion restriction.
Now we can not go any higher than LI-RADS 5, but the additional features will give us extra confidence in the diagnos
Diffusion restriction:
In this patient with cirrhosis the MR-images show an arterially enhancing observation (< 2 cm) in the right lobe (arrow
As there is no washout or any other major feature observed this should be classified as a LR-3 lesion.
However due to the ancillary finding of diffusion restriction this observation can be upgraded to a LR-4. This is a diffi
non-HCC tumors. If there is doubt between the diagnosis of possible HCC and another type of malignancy a diagnost
Favoring non-HCC Malignancy:
The table shows an overview of ancillary features favoring not HCC specific malignancy.
Features favoring benignity:
The table shows an overview of benign ancillary features. Siderotic nodules The images are of a patient with liver cirr
On the T2W-images there are multiple small nodules which are of low signal on the T2-weighted images.
This is due to the T2 shortening of iron.

This feature favors benignity. There is no contrast enhancement of the lesions.
Management:

LRTR - LI-RADS treatment response:
Evaluation of treatment response A different algorithm was created for the categorization of treated lesions.
Examples of locoregional therapies are radiofrequency ablation, percutaneous ethanol ablation, cryoablation, micro
irubicin-eluted bead chemoembolization, transarterial radioembolization and external beam radiotherapy. These les
or viable.
Treatment related parenchymal perfusional changes may mimic or obscure residual tumor, potentially leading to fal
If there is any uncertainty between two categories, the one reflecting lower certainty should be applied. LI-RADS doe
ation shows no residual major or ancillary features or has completely disappeared it can be characterized as non-via
treatment and there are no signs of residual malignancy, a lesion can be considered as non viable. The images show
ic vein without residual areas of arterial enhancement or washout.
This was classified as LRTR non viable. LRTR non-viable The image in the late arterial phase show normal post treatm
ver parenchyma due to hyperemia after DEB-TACE (arrow). DEB TACE is drug-eluting bead transarterial chemoembo
ospheres to release chemotherapeutic agents within a target lesion with controlled pharmacokinetics.
DEB-TACE nowadays represents one of the most used treatments for unresectable hepatocellular carcinoma. LRTR r
There is mild perilesional enhancement noted on the follow-up scan, which is a normal post-treatment finding. LRTR
ic expected enhancement and otherwise not meeting criteria for probably or definitely viable.
For some treatments early post-treatment enhancement patterns may not reliably differentiate viable from non viab
ost-treatment period may be LRTR equivocal. Area of arterial enhancement without washout in a segment 5 ablation
mor only the largest continuous area of enhancement or washout should be measured (not traversing non enhancin
If residual enhancement within a lesion is nodular, the largest nodule should be reported. LRTR viable If a new tumo
assigned a new non-treated LIRADS category. If a new observation is noted at the surgical margin it should be assign
onal images shows a large lesion treated with TACE with residual areas of mild arterial enhancement and washout d
ble. Continue with the axial image ... Note there is irregularity of the peritoneal fat anteriorly due to capsular rupture
able tumor at the resection margin.
Note the area of arterial enhancement and washout adjacent to the surgical clips (arrows).
This is LRTR-viable.
Summary:

Hypervascular metastases:
Hypervascular metastases are sometimes difficult to differentiate from HCC because of their similar arterial enhance
Screening for HCC risk factors and patient history of primary tumors which can give hypervascular metastases (RCC,
osarcoma) can be helpful in those cases.
Also absence of the typical HCC imaging characteristics should raise suspicion of another type of malignancy. These
I-RADS.
There are multiple heterogenous lesions with mild peripheral enhancement in the arterial phase.
Some lesions are mildly hypodense compared to adjacent liver parenchyma on the portal phase and larger lesions h
Multiplicity and targetoid enhancement pattern are not typical for HCC and suggestive of metastatic disease. This pa
ges are of a patient with a steatotic liver.
Although some of these patient have a mildly greater chance of developing HCC, we cannot use LI-RADS. There are
venous phase. This is another example of hypervascular metastases.
This patient was known to have a neuroendocrine tumor of the pancreas.
Protocols:
Early aterial phase (left). Late arterial phase (right). CT protocol Required images for CT are late-arterial, portal venou
Precontrast images are recommended after locoregional treatment. Late arterial phase
This phase refers to the hepatic arterial phase in which the hepatic artery and branches are fully enhanced and the h
rongly in the late arterial phase showing early enhancement of the portal vein and is therefore preferred over the ea
enhancement of the HCC. Notice poor enhancement of liver and portal vein (white arrow) in the early arterial phase
al vein (green arrow) in the late arterial phase. Portal venous phase Portal venous phaseThere is complete enhancem
In this phase the normal liver parenchyma is usually at its peak of enhancement.
Hypovascular lesions like most metastases are best detected in this phase, but hypervascular lesions are poorly seen
he liver parenchyma and the hypervascular lesion. Delayed phase Delayed phase Portal and hepatic veins are enhan
Liver parenchyma is enhanced but also less than in PV phase.
This phase is typically acquired 2-5 min after injection. This phase is helpful in detecting wash out of HCC and in dete
metastases like sometimes seen in breast cancer. Hepatobiliary phase study: diffuse uptake of contrast by normal liv
rast excreted within the bile ducts. MRI protocol The required sequences for MRI are: Transitional phaseThis phase is
lular phase but before the hepatobiliary phase.
Liver vessels and hepatic parenchyma are of similar intensity. Typically acquired 2-5 min after injection. Hepatobiliary

Liver parenchyma is hyperintense to the hepatic vessels. There is excretion of contrast in the biliary system.
Typically acquired about 20 min after injection of gadoxetate or 1-3 hours after gadobenate.
Neonatal Brain US:
Erik Beek and Floris Groenendaal
Department of Radiology and Neonatology of the Wilhelmina Children's Hospital and the University Medical Centre
Publicationdate 2006-04-01 Cranial sonography (US) is the most widely used neuroimaging procedure in premature
ce clinical examination and symptoms are often nonspecific. It gives information about immediate and long term pr
Introduction:
Use both the sector and linear transducer and examine the greater fontanel and if necessary also the lesser and sph
ch makes it ideal for premature infants. Try to get all the information you can. Do not limit yourself to only one trans
e fontanel is used as acoustic window. The small fontanel however is a good window to the occipital lobes. This can b
areas. Disadvantages of US are:
Peri Ventricular Leukomalacia (PVL):
PVL is also known as Hypoxic-Ischemic Encephalopathy (HIE) of the preterm. It is a white matter disease that affects
is a watershed zone between deep and superficial vessels. Until recently ischemia was thought to be the single cause
n additional role. PVL presents as areas of increased periventricular echogenicity. Normally the echogenicity of the p
y of the choroid plexus. PVL occurs most commonly in premature infants born at less than 33 weeks gestation (38%
s important because a significant percentage of surviving premature infants with PVL develop cerebral palsy, intellec
with PVL or grade III hemmorrhage develop cerebral palsy.
Grading PVL:
PVL is graded according to the signs as listed in the Table on the left. Regular sonographic examination is mandatory
ecially in prematures
Cranial ultrasonographic findings may be normal in patients who go on to develop clinical and delayed imaging findi
until discharge
?nd at the age of 40 weeks. Sagittal image of a child with PVL grade 1 PVL grade 1 PVL is diagnosed as grade 1 if there
ny cyst formation persisting for more than 7 days. Increased periventricular echogenicity is however a nonspecific fi
r halo or normal hyperechoic 'blush' posterosuperior to the ventricular trigones. Suspect PVL if the echogenicity is as
d plexus. The abnormal periventricular echotexture of PVL usually disappears at 2-3 weeks. PVL can be differentiated
agittal image of a child with PVL grade 2. PVL grade 2 The images on the left demonstrate a PVL grade 2 with small p
f cyst formation. 2% of the preterm neonates born before 32 weeks develop cystic PVL. The severity of PVL is related
identified on cranial ultrasounds on the first day of life, indicating that the adverse event was at least 2 weeks prena
e in the detection of cystic WM injury (PVL grade II or more), but has significant limitations in the demonstration of n
cranial US is important, because noncystic WM injury is considerably more common than cystic WM injury. Sagittal i
sed as grade 3 if there are areas of increased periventricular echogenicity, that develop into extensive periventricula
nd transverse images demonstrating PVL grade 4 PVL grade 4 PVL is diagnosed as grade 4 if there are areas of increa
ng into extensive subcortical cysts. PVL grade 4 is seen mostly in fullterm neonates as opposed to PVL grade 1-3, whi
Flaring persisting beyond the first week of life is by definition PVL garde 1.
Flaring:
Transverse and sagittal images demonstrating flaring in a premature infant. The term flaring is used to describe the
premature infants in the first week of life. During this first week it is not sure if this is a normal variant or a sign of PV
life is by definition PVL grade 1. LEFT: Initial examination shows flaring.RIGHT: Follow up one week later shows norm
tiate flaring from PVL grade I. The case on the left shows a premature infant with flaring. At follow up no cyst formati
r white matter was seen.
Germinal Matrix Hemorrhage:
Germinal matrix hemorrhage (GMH) is also known as periventricular hemorrhage or preterm caudothalamic hemorr
also stress sensitive germinal matrix, which is located in the caudothalamic groove. This is the subependymal region
tomatic or demonstrate subtle signs that are easily overlooked. These hemorhages are subsequently found on surve
al US of subependymal hemorrhage located in the groove between the thalamus and the nucleus caudatus. Grade 1
to the caudothalamic groove. It is staged as grade 1 hemorrhage. In the acute phase these bleedings are hyperecho
l US of a grade 2 hemorrhage Grade 2 intracranial hemorrhage On the left a grade 2 intracranial hemorrhage. On th
ventricles are filled with blood, but there is no ventricular dilatation. On the left the same patient after 3 days. The v
y hydrocephalus occuring several days after a grade 2 bleed should not be mislabeled as grade 3 hemorrhage. LEFT:
ttal image, yellow arrow indicating venous infarction. Grade 3 intracranial hemorrhage On the left a grade 3 intracra
e wedge shaped hyperechoic area on the laterosuperior side of the ventricle. This represents a small venous infarcti
on. Same patient as above. Two weeks later the venous infarction has developed into a hypoechoic area with cyst fo
rhage Originally these grade 4 hemorrhages were thought to result from subependymal bleeding into the adjacent b
s hemorrhagic infartions, which are the result of compression of the outflow of the veins by the subependymal hem
ymal bleeding but also a large area with increased echogenicity in the brain parenchyma lateral to the ventricle. This
ctions resolve with cyst formation. These cysts can merge with the lateral ventricle, finally resulting into a porenceph
orrhage at a later stage with extensive cyst formation. Grade 1 and 2 bleeds generally have a good prognosis. Grade

rade 3 hemorrhages is usually good when no parenchymal injury has occurred. Hydrocephalus is a common complic
isms by which hydrocephalus develop include:
Normal Variants:
Common variants are listed in the Table on the left. LEFT: Coronal image. Cavum septi pellucidi is seen in between th
vum vergae.
Cavum septi pellucidi, cavum vergae and cavum of the velum interpositum:
Well known variants are the cavum of the septum pellucidum and the cavum vergae. The more premature the baby,
adulthood. A less frequently seen variant is the cavum of the velum interpositum. This presents as a cyst-like structu
met. It can easily be confused with a subarachnoid cyst or a cyst of the pineal gland.
Choroid plexus cyst:
In postnatal US these cysts of the chorio?d plexus are often incidental findings without clinical consequences. Choroi
s. At prenatal US these cysts can be predictive of trisomy 18. About half of babies with Trisomy 18 show a CPC on ult
ormalities on the ultrasound, especially in the heart, hand, and feet. An exeption must be made for cysts that arise c
ear spontaneously, follow up US is necessary to ensure disappearance. Some may produce symptoms of raised intra
low.
Benign macrocrania:
Benign macrocrania is also known as extraventricular obstructive hydrocephalus. This is seen in children between 6
ntile. After the age of 2 years the head size normalizes. Often the mother or father of the child had large heads at tha
condition, although some state that these children have a slight developmental delay. LEFT: Normal subarachnoid s
large head are presented for US, examine the superficial subarachnoid space and the ventricles.
The normal subarachnoid space measures less then 3 mm. The ventricles are often slightly enlarged. These promine
not be interpreted as cerebral atrophia, as in atrophia there is a small head circumpherence.
Mineralizing vasculopathy:
Mineralizing vasculopathy can be seen in the thalamostriatal and lenticulostriatal arteries and is caused by calcificati
and nonspecific clinical conditions may result in this sonographic finding. In the Wilhelmina Children's Hospital thes
y the only test that is done is a urine-test for CMV. Germinolytic cysts Are located at the caudothalamic groove. They
e and these children have no neurological sequelae. The etiology is not known. Pseudocyst These are also called coa
have no neurological sequelae 1+2 = germinolytic cysts and pseudocysts, 3 = cystic periventricular leukomalacia, 4 =
Cysts:
If cysts are seen around the lateral ventricles, it is important to determine their position in regard to the upper part o
Ventricular measurement:
Measurement of the ventricular system should be done in an easy reproducible sonographic plane. Use a coronal se
n of Monro. You will see 3 echogenic dots representing the choroid plexus in the lateral ventricles and in the roof of
image of the Sylvian fissure on both sides and the hippocampus (green and orange arrows).
Levene index:
Up to 40 weeks of gestational age the Levene-index should be used and after 40 weeks the ventricular index. The Le
l wall of the anterior horn in the coronal plane at the level of the third ventricle. This is performed for the left and rig
nce curve and are quite usefull for further follow-up. LEFT: Standard measurement of the ventricular index.RIGHT: Th
erestimates the severity of the ventricular widening.
Ventricular index:
After 40 weeks the ventricular index or frontal horn ratio should be used, i.e. the ratio of the distance between the la
en using this ratio you have to realise, that when the ventricular system widens, the frontal horns tend to enlarge in
nsion. Measurement of the falx to the most lateral point of the lateral ventricle. Real-time ultrasound was used to ma
lateral ventricle to the falx (the ventricular index) in 273 infants of varying gestational ages (5). The measurement per
rrelated closely with an actual measurement made in coronal plane in 50 infants. A cross-sectional centile chart was
weeks' postmenstrual age. A further chart showing the rate of change of the ventricular index allowed growth of the
charts permits early detection of hydrocephalus or dilated ventricles secondary to cerebral atrophy. A more realiable
a- or volume-measurement. This however is more time consuming. So although ventricular index has shortcomming
images by eye is reliable, provided, that standard planes are used. by Paul Govaert, Gent University Hospital and Lin
of Frank van Bel, Erik Beek, Dirk Voet, An Bael, Linde Goossens
2. Parenchymal Brain Injury in the Preterm Infant: Comparison of Cranial Ultrasound, MRI and Neurodevelopmental
k, Paula Eken, Ingrid C. van Haastert, Linda S. de Vries.
3. Periventricular Leukomalacia in eMedicine, Author: Terence Zach, MD,
4. Periventricular Hemorrhage-Intraventricular Hemorrhage in eMedicine, Author: David J Annibale, MD
5. Levene MI., Measurement of the growth of the lateral ventricles in preterm infants with real-time ultrasound. Arch
None:

Cartilage tumors:

with special attention to Atypical Cartilaginous Tumors:

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Publicationdate 29-08-2023 Cartilage or chondroid tumors are a heterogeneous group of bone tumors that all share a chondroid matrix.
They range from benign enchondromas to highly malignant chondrosarcomas.
Low-grade chondrosarcomas of the long bones have been classified as an intermediate group and are now called atypical cartilaginous tumor (ACT), because these tumors rarely metastasize and have a better clinical outcome compared to the same tumor in the axial skeleton. The recommended treatment of ACT has changed over the years from resection to curettage and even "watchful waiting" with MRI follow-up [1].
Due to these changes in management, imaging plays a major role in the diagnosis and follow up of ACT. In this article we will discuss: Follow up of ACT. Introduction
Introduction:
Cartilage tumors share the characteristic production of a chondroid matrix with frequently typical matrix calcificatio
They vary in severity from benign enchondromas and locally aggressive atypical cartilaginous tumors (ACT) to malign
About 10% of chondrosarcomas are dedifferentiated, which is a highly malignant variant of chondrosarcoma. Atypic
have been classified as intermediate grade chondroid tumors by the World Health Organization in 2013. “Intermediate” means that these tumors may behave locally aggressive but rarely metastasize (< 2%). Since 2020 intermediate lesions in the appendicular skeleton are called ACT, while the same lesi
located in the axial skeleton are called chondrosarcoma grade I (CS-I) because they have a poorer outcome. The ter
axial skeleton, meaning the spine, pelvis, ribs, sternum, scapula and skull base. Task of the radiologist
Enchondromas are benign and do not need follow up.
High grade chondrosarcomas are treated with wide resection, since they are insensitive to chemotherapy and radiat
For ACTs watchful waiting with MRI follow up is replacing surgical intervention in many centers.
Given these developments, the most important task for the musculoskeletal radiologist is to differentiate ACTs from high grade chondrosarcomas.
Terminology in Chondroid tumors:
This figure demonstrates examples to explain the terminology used to describe chondroid tumors. In some examples there can be more than one typical finding.
How to diagnose a Chondroid tumor:

X-ray:
On radiographs, chondroid tumors show foci of nodular, popcorn-like matrix mineralization. These calcifications may be present within the entire spectrum o
chondroid tumors. Often the tumor size is underestimated on a radiograph, as frequently only the mineralized part of the tumor is visible. In the phalanges, enchondromas may present as purely osteolytic tumors, not necessarily containing matrix calcifications. Image
There is a small area of 1.5 cm with popcorn calcifications in the distal metaphysis of the femur without extension to
This is an enchondroma. Images
The radiograph demonstrates an osteolytic lesion in the distal femur containing typical popcorn calcifications and showing anterior cortical scalloping (arrowhead). On the sagittal MRI we can appreciate that the tumor is larger than the area of calcifications on the radiograph, measuring 8 cm.
The tumor is hyperintense on T2 STIR and contains multiple foci of low signal intensity, corresponding to the chondroid matrix calcifications on the radiograph. Conclusion
Since there is no periosteal reaction or soft tissue mass, these findings fit with the diagnosis of ACT.

The patient remains in follow-up.
CT:
CT is not part of the routine imaging work-up in chondroid tumors,
however it may aid in the detection of subtle matrix mineralization in case
there is doubt about the diagnosis. CT can also be helpful in axial
lesions where radiographs are not sufficient - such as the skull base or pelvis
- to quantify bone destruction and the extent of the tumor. If there is doubt about cortical
destruction in an expansile lesion on MR, CT will usually clearly demonstrate
the presence or absence of a cortex.
Finally,
CT is useful to assess pathological fractures and for example to assess whether
these extend into a joint. Images MRI cor T1W-image shows an eccentric,
slightly expansile lesion in the caput and collum of the right femur. It is difficult to appreciate whether
the medial cortex is only thinned or destructed. Therefore an unenhanced CT was done
in addition. Unenhanced CT demonstrates a lytic
lesion containing chondroid matrix calcifications. There is cortical scalloping
medially, but no cortical destruction. Curettage was performed to exclude a clear cell chondrosarcoma. This is
a rare subtype of chondrosarcoma which occurs in the epiphysis of long bones in
young adults. Pathology diagnosis: ACT.
MR:
On fluid sensitive sequences - preferably T2W with fat suppression - cartilage nodules are hyperintense and groupe
After gadolinium contrast administration, cartilage tumors enhance with a typical septonodular enhancement.
This feature is helpful in distinguishing cartilage tumors from other bone tumors.
Calcifications can be visible on MRI and show low signal intensity on all sequences. Unfortunately, diffusion weighte
imaging has been shown not to be of use in differentiating low grade from high
grade cartilage tumors. Interspersed fatChondroid nodules may have
fatty marrow between them, also called interspersed or entrapped fat. This is best assessed on
T1-weighted images and is present in lesions at the benign side of the
spectrum, so in ACTs. For example, during follow
up of ACTs, the amount of interspersed fat and calcifications may increase,
which can be interpreted as “maturation” of a lesion.
This may
even cause decrease in size of the tumor over time. Both fatty maturation and
increased calcification of a chondroid tumor over time are signs of benignity. ScallopingCartilage tumors may cause
of the cortex, which appears as sharp osteolysis extending from the marrow
cavity. The Birmingham group proposed the
BACTIP criteria for MRI assessment of chondroid tumors and guidance towards referral to a
tertiary center or end of follow up. BACTIP defined scalloping as
localized if less than 10% of the lesion circumference was involved, measured
on an axial slice with the largest tumor diameter. Whereas scalloping of more than 10%
of the lesion circumference was defined as extensive. Relevance of the depth of cortical
scalloping remains unclear. Image
The axial T1 SPIR post contrast shows cortical scalloping anteriorly over approximately 43/360 degrees.
This means scalloping of 12% of the tumor circumference (extensive).
Also note more subtle posterior cortical scalloping (arrowhead).
This tumor shows septonodular, peripheral enhancement.
Note the low signal intensity foci in keeping with calcifications. Figure courtesy of Wouter Stomp MR perfusion
Perfusion or dynamic contrast
enhanced MRI is a functional imaging technique in which early enhancement of
the tumor is monitored after an intravenous gadolinium bolus injection.
In cartilage tumors, perfusion has been used to differentiate
enchondroma from chondrosarcomas. A cut off of 10 seconds is used for
fast versus slow enhancement. However, overlap in early enhancement patterns of
chondroid tumors may occur, for example: fast enhancing enchondromas exist,
but also slow enhancing ACTs. Images
There is a tumor of less than 2 cm in the distal femur metaphysis.
The lesion is hyperintense on T2, iso-intense on T1 and shows septonodular enhancement. There is no relation with
r shows slow enhancement, starting approximately 20 seconds post arterial enhancement.
This is an enchondroma and needs no follow up. Read more on MR perfusion here
PET-CT:

As for 18F-FDG-PET-CT, SUVmax was shown to correlate with
histologic grade in chondroid tumors.
SUVmax < 2 supports the diagnosis of a benign
tumor, while SUVmax > 4.5 is suggestive of higher grade
chondrosarcoma.
However, as the majority of ACT/grade
I lesions ends up in an intermediate category with overlapping values (SUVmax 2- 4.5), PET CT is not recommended
to differentiate cartilage tumors. Whole body PET CT may be useful in detecting metastases in
dedifferentiated chondrosarcoma. Image
Dedifferentiated chondrosarcoma in the right femur (arrowhead) with multiple metastases.
Enchondroma:
Enchondromas are considered a “cartilage rest”.
Hence the close relation to the epiphyseal growth plate, often within 2 cm.
Enchondromas are mostly found in the proximal humerus, distal femur or proximal tibia metaphyses.
These benign lesions occur as incidental findings in 3% of all knee MRIs and need no follow up.
Enchondromas may slowly grow over time or even regress in size.
Growth itself is not a sign that the lesion has become malignant. Enchondromas are typically smaller than 5 cm and
Variable size cut offs are proposed to differentiate enchondroma from ACT and chondrosarcomas.
In the BACTIP-criteria a cut off of 4 cm is used to decide whether a lesion should be followed up or not. In our institu
cm as a cut off, however keep in mind that there is no definitive size cutoff
value and you should always rule out aggressive features, since there can be
high grade chondrosarcomas smaller than 5 cm that grow through the cortex and
have an accompanying soft tissue mass. Images courtesy of Wouter Stomp Typical
enchondroma
The images show two small lesions adjacent to the physis in the distal femur metaphysis, representing small cartilag
relation to the cortex or perilesional bone marrow edema.
No follow up is
needed.
Enchondroma versus ACT:
Over time, treatment of ACT has
shifted towards the conservative side, i.e. watchful waiting or “wait and scan” by
MRI instead of curettage. This has implications for
radiologists too, as the main task is now to decide which lesions we want to
follow up. In our tertiary referral centre, we
follow up lesions that extend up to the cortex. This means that independent of size,
we consider possible growth through the cortex in the future an indication for follow up.
See the table with our follow op schedule for ACT below. Case
First look at the images.
What are the findings?
Then continue reading. Images X-ray: An area of chondroid calcifications is present in the distal femur
diaphysis without cortical scalloping. MRI: Sag T1W-image shows the multinodular
cartilage tumor without contact with the anterior or posterior cortex. The
lesion measures 38 mm. The axial T1 shows no cortical
scalloping. Conclusion Enchondroma. PearlFor lesions < 5 cm, as long as the cartilage lesion does not reach the cort
and there is no surrounding bone marrow oedema or periostitis, we consider it
an enchondroma. No follow up is needed. Case First look at the images. What are the findings? Then continue readi
popcorn calcifications in the distal diaphysis. The MR-images show a 4.6 cm lesion in the distal femur diaphysis with
cortex (wall- to-wall filling). Note that the lesion appears smaller
on the radiograph due to limited calcifications. The calcifications and septonodular enhancement confirm the
chondroid nature of the tumor. No cortical scalloping is present on
the axial T1W-image. ConclusionThe lesion is quite large for the
diagnosis enchondroma.
As mentioned before we use a cutoff
of 5 cm. There is wall-to-wall filling, but no scalloping. No aggressive
features are present (such as periosteal reaction, bone marrow oedema). It was diagnosed as ACT and follow up
was performed by wait-and-scan. After 5 years of follow up, the
craniocaudal diameter increased 6 mm. There were no other worrisome
features and the patient remained in follow up. CaseFirst look at the images.
What are the findings?
Then continue reading. Images X-rays:there is an area with chondroid

matrix calcifications and some osteolysis of less than 2 cm adjacent to the
closed physis in the distal femur. No relation with the cortex was seen.
MRI was done to assess the true size and decide whether the lesion needed follow-up. MRI: on the sagittal T1W-imag
lesion measures maximum 2.8 cm and there is a close relation to the posterior
cortex at the intercondylar notch. Conclusion Because of the extent to the posterior cortex,
the lesion was called ACT and remained in follow up.
Atypical Cartilaginous Tumor:
ACTs are intermediate grade chondroid tumors.
They are often larger than
5 cm, extend up to the cortex and show cortical scalloping.
They may have
interspersed fatty marrow.
On MR perfusion, fast enhancement (within 10
seconds) can be present. Keep in mind that growth itself does not imply malignant transformation,
and some of these lesions regress in size over time.
ACTs do not show
periostitis unless there is a fracture.
No cortex destruction or soft tissue
mass is allowed for the diagnosis ACT.
In that case we should call it a chondrosarcoma of higher
grade. This case was shown before. Looking back to the previous
MRI performed 5 years before, 6 mm growth occurred in the craniocaudal
dimension.
Also note some expansion
of the lesion anteriorly (yellow arrows).
No cortical thinning,
bone marrow oedema or periostitis are present. This lesion is an
ACT and remains in follow-up.
ACT versus high grade CS:
Differentiation between ACT and high grade CS is the most important task for a radiologist, as the high grade tumors
re centers treat ACTs with watchful waiting and no operation.
Actively look for features such as perilesional bone marrow oedema, periosteal reaction, cortical destruction and a s
y be seen in ACT but is more common in high grade CS.
Mucoid components are a sign of higher grade and are also present for example in dedifferentiated CS.
Fast dynamic contrast enhancement, cortical scalloping and matrix calcifications can be present in both ACTs and hig
Size matters but is not a key feature to differentiate ACT from high grade CS.
In case of a pathological fracture in ACT, surrounding oedema and periostitis may be present. Always correlate the in
up MRI after 3-6 months to assure that these findings resolve. We will now show you some cases, where you have to
 images and decide whether you are dealing with an ACT or CS.
Then continue reading. Images
There is a lesion measuring
more than 20 cm in the diaphysis of the femur.
Note the popcorn matrix
calcifications.
There
is one focal nodule (within the yellow circle) causing cortical scalloping and
there is mild extension of the marrow cavity. Continue with the MR... First look at the images.
Then continue reading. Images
MR-images show interspersed fat between the cartilage nodules.
It has a high signal on the sagittal T1W-image and low signal on the fat suppressed image (arrows).
There is one focal nodule causing cortical scalloping (<10%) and there is mild extension of the marrow cavity. Conclu
stable during follow up. CaseFirst look at the images and decide whether you are dealing with an ACT or CS.
Then continue reading. Images
There is a well defined
osteolytic lesion >10 cm in the proximal femur diaphysis with popcorn i.e.
chondroid matrix calcifications.
There is expansion of the bone, however no frank cortical scalloping or periostitis. Conclusion
Based on the radiograph alone, this tumor could be an ACT or a chondrosarcoma of higher grade. The next step is to
First look at the images.
Then continue reading. Images

MRI confirms the chondroid nature of the tumor with hyperintense
cartilage nodules on T2 DIXON that show septonodular enhancement after
contrast.
However, there is also marked bone marrow oedema proximally (black arrow) and a periosteal reaction with enhanc
These features are very suspicious for the diagnosis of a high
grade chondrosarcoma. Images
Axial T1 weighted image confirms deep
anterior cortical scalloping over approximately 1/3 of the cortex, i.e. extensive scalloping (> 10% of tumor circumfere
was performed.
Final diagnosis: chondrosarcoma grade II Case
First look at the images.
Then continue reading. Images
Radiograph shows small areas of chondroid matrix mineralization.
COR T2W FS illustrates how the size of the lesion is underestimated on plain film.
Note the hyperintense cartilage nodules in combination with low SI areas in keeping with the calcifications on X ray.
After contrast typical rings-and-arcs enhancement is seen. Conclusion
Due to the size of 5.7 cm and the extent to the cortex, this was called an ACT and the lesion will be followed up with
First look at the images.
Then continue reading. Images
The radiograph shows an expansile multilocular osteolytic lesion in the proximal radius metaphysis.
Some small specs of calcification are visible within the lesion.
The tumor is hyperintense on T2 DIXON and there are areas of cortex destruction.
After contrast, typical septonodular enhancement is present and areas of mucoid without enhancement, also in the
Around the tumor we see soft tissue oedema.
These findings help us to make the diagnosis of a high grade chondrosarcoma. Pathology after wide resection came
MRI follow-up guidance for ACT:
In our centre, ACTs are followed up by MRI as shown in the table [1].
This may provide some clinical guidance, however solid long term (>10 years follow up) data is needed to further def
me with a burden of costs and may cause worry for the patient. If aggressive features occur during follow-up that ar
worrisome for chondrosarcoma, the patient is discussed in the multidisciplinary
tumor board and surgical treatment may be considered.
Chondrosarcoma:
Chondrosarcomas are on average more than 10 cm
at presentation, show cortical destruction and often have an accompanying soft
tissue mass.
However, smaller chondrosarcomas of high grade occur, therefore
size is not the best criterium. Periostitis on MRI is shown as a
T2 hyperintense rim surrounding the cortex, enhancing after contrast.
A mucoid
component may be present within the marrow cavity or in the soft tissue mass.
These
lesions are high grade meaning they are at risk to metastasize (primarily to
the lungs). Treatment is wide resection and in addition to
the MRI, a CT may be done for preoperative planning, as radical resection is
the only good treatment option. Case
First look at the images.
Then continue reading. Images
There is an osteolytic, expansile
lesion in the right proximal femur diaphysis.
Adjacent subtle cortical
thickening is present without periosteal reaction.
No frank chondroid matrix is
appreciated on this radiograph. Conclusion
The differential diagnosis would include chondrosarcoma,
fibrous dysplasia, lymphoma, metastasis and plasmacytoma. An unenhanced CT could help in
detection of subtle chondroid matrix calcifications in this case. However, we
went straight for MRI.
Continue with the MRI... First look at the images.
Then continue reading. Images
T1W-image shows marrow replacement.

T2W-image shows periosteal reaction
and perilesional bone marrow edema.
The tumor itself is hyperintense and
nodular.
T1W FS post Gd-image shows rings-and-arcs
enhancement pattern. Conclusion
All these findings are in keeping
with a chondroid tumor, and very suspicious of a chondrosarcoma of grade II or
higher. In our tertiary referral center for
bone sarcomas we perform no biopsy in these chondroid tumors, as this may cause
sampling error due to heterogeneity within the tumor.
You may erroneously biopsy the
friendlier part of the tumor and underestimate the grade. Chondroid tumors are known for their
seeding along the biopsy tract. Continue with the postoperative
X-rays….. Treatment consisted of en bloc resection of the proximal femur and reconstruction with an endoprosthesis
grade II and III cannot be differentiated based on imaging.
This is a diagnosis made on histopathology.
Therefore, we refer to such lesions as “grade II or higher” in our radiology report. CaseFirst look at the images.
Then continue reading. Images
Radiographs demonstrate an
aggressive expansile osteolytic lesion in the proximal femur diaphysis of a 30-year-old patient.
There
is extensive cortical scalloping and a spiculated, hair-on-end periosteal
reaction.
Note the pathological fracture of the trochanter minor.
There is subtle mineralization in the soft
tissues medially (arrow). ConclusionAll these findings are pointing
towards a malignant bone tumor.
In the differential diagnosis (taking
into account the age and diaphyseal location) we would include a Ewing sarcoma,
but also a high grade chondrosarcoma.
Although Langerhans cell
histiocytosis may also present in the diaphysis of a long bone in this age
group, this tumor is very large and the periosteal reaction is too
aggressive. Continue with the MRI… First look at the images.
Is this a chondroid tumor or something else?
What is the best
treatment, follow up or resection? ImagesMRI confirms the T2
hyperintense multinodular aspect of a chondroid tumor.
There is a large soft
tissue mass present anteromedially. There is marked periostitis on MRI, bone
marrow oedema proximally and surrounding oedema in the soft tissues.
Note the septonodular
enhancement pattern.
There is no enhancement
cranially in the tumor and in the soft tissue mass. This is regarded as a mucoid
component. Conclusion
Based on the MRI findings, we should make the diagnosis of a chondrosarcoma grade II or higher.
Treatment was wide resection. Pathology diagnosis: Chondrosarcoma grade III A mucoid component is one feature o
ogist.
The pathologist also assesses cellularity, nuclear atypia and mitoses in the tumor, which are higher than in ACT or gr
in the axial skeleton. We have to shift gears as there is a different approach than for lesions in the appendicular skel
First look at the images.
Then continue reading. Images
Axial CT shows an expansile
osteolytic tumor in the corpus of the sternum.
There are multiple foci of cortical
destruction.
Popcorn calcifications are present centrally.
MRI confirms the chondroid nature of

this tumor with hyperintense signal on the STIR-image and septonodular contrast
enhancement. ConclusionAlthough there is no soft
tissue component, due to the expansion and multiple foci of cortex destruction this tumor should be called a chondr
is the correct treatment. Pathology showed a grade II
chondrosarcoma. In the axial skeleton chondroid tumors have a worse outcome.
This implies, that they are resected even if they are grade I as opposed to the same tumor in the appendicular skelet
Do not call axial tumors enchondromas if they show cortical scalloping or cortical destruction, as this would lead to u
Then continue reading. Images
On the radiograph, there is a permeative osteolytic lesion with aggressive periosteal reaction, cortical scalloping and
Axial T2 DIXON shows multiple soft tissue masses along the humerus.
The post contrast sequence demonstrates septonodular enhancement, aggressive periostitis and mucoid areas with
the soft tissue mass medially. Conclusion
High grade CS.
Dedifferentiated chondrosarcoma:
First look at the images of a 79-year-old patient with a bone tumor.
Then continue reading. Images
Radiographsshow a large tumor in the femoral diaphysis with typical popcorn calcifications distally and a
more osteolytic component proximally. Detailed magnified window of the
lateral view shows cortical permeation by the tumor and a high risk for a
pathological fracture. The caudal part of the tumor appears
like an ACT with focal cortical scalloping, while the cranial part looks like a high grade CS. ConclusionThis is the typica
presentation of a dedifferentiated chondrosarcoma, with one part behaving like a
low to intermediate grade cartilage tumor with abrupt transition to a
high-grade (sometimes non-cartilaginous) sarcomatous component. This subtype
usually presents in older adults.
Overall survival of a dedifferentiated
chondrosarcoma is poor as compared to chondrosarcomas grade II and III, as
patients often present with pulmonary and bone metastases at the time of
diagnosis. Continue with the next images... ImagesNote the cortical defect on the axial
T2 DIXON and the surrounding soft tissue mass.
Part of the tumor does not enhance
and this area of mucoid indicates a high grade chondrosarcoma. As on the radiographs, this
case is a typical dedifferentiated
chondrosarcoma, where the lower part behaves
like an ACT and the proximal part as a high grade sarcoma.
Frequently they present as a large tumor in an elderly patient. Perfusion images demonstrate
heterogeneous enhancement within this dedifferentiated chondrosarcoma.
The mucoid part (blue line)
shows no enhancement. Continue with the PET-CT... We discussed before that 18F-FDG PET-CT is not recommended
chondrosarcoma to differentiate between ACT and high grade tumors. However, in dedifferentiated
chondrosarcoma, PET CT combined with a diagnostic CT of the chest may be
performed to look for metastatic disease. The dedifferentiated chondrosarcoma in
the right femur shows high FDG captation and the whole body image demonstrates multiple bone metastases in the
right and in the sternum. Para-iliac lymph node metastases are
present bilaterally. As chondrosarcomas are insensitive to radiotherapy and chemotherapy, the
patient received palliative care, including nailing of the right femur to
prevent a fracture. Unfortunately, he developed a pathological fracture in the left femur
which was subsequently treated. Coronal CT image of the chest demonstrates the soft tissue mass around
a metastasis in the left clavicle.
No pulmonary metastases were found. The prognosis of dedifferentiated chondrosarcoma is poor with a 5-year
overall survival of about 18%.
Osteochondromas:
Osteochondromas
are peripheral chondroid tumors, meaning they are not located in the medullary
cavity.
Two morphological subtypes exist: sessile (broad based) or pedunculated
lesions (with a stalk) covered by a cartilage cap. The
stalk of an osteochondroma is continuous with the marrow cavity, originates
from the metaphysis and points away from the joint.
The cartilage

cap thickness should be less than 2 cm in patients with closed physes according
to the WHO criteria defined in 2020.
If the cap measures more than 2 cm, this
is worrisome for ACT or even chondrosarcoma, and these lesions are resected. In
children, the cartilage cap of an osteochondroma may be thicker than 2 cm as
their skeleton is still developing. This radiograph is of a 17-year-old patient
presenting with pain in the shoulder since 2
months. Image
There is a pedunculated lesion originating from the proximal
humerus metaphysis.
The stalk shows continuity of the bone marrow and an
overlying cap containing chondroid matrix calcifications.
These findings are typical for an
osteochondroma. On the radiograph, the mineralized
and thereby visible part of the cartilage cap is large, which is why a MRI was
performed to adequately measure the thickness of the cap. Continue with the MR-images... The thickness of the cart
sequence. ImageAxial T2W-image with fatsat
shows the osteochondroma on the posterior aspect of the left proximal humerus
with a cartilage cap thickness of 22 mm. In lesions
with a cartilage cap > 2 cm, resection is performed to exclude a
chondrosarcoma. The tumor was removed and
pathology was in keeping with a peripheral ACT. Image
Radiographs show an expansile lesion
with cartilage matrix mineralization originating from the right femur at the
level of the lesser trochanter.
The cartilage cap seems well demarcated and
matured. MRI was performed to assess the cartilage
thickness of the cap. Continue with the MRI... T2W-image with fat saturation demonstrates a thin overlying
cartilage cap of only 3 millimeters.
The rest of the lesion is matured, which means that it contains bone marrow with suppressed signal on the fat satura
te bony maturation
of the cartilage cap on the unenhanced CT.
The rim of the lesion is well defined. This lesion was called an
osteochondroma as there are no signs of malignancy, it is not suspicious of ACT
or chondrosarcoma. Sometimes these osteochondromas are
resected due to mechanical complaints or after a fracture, and they may give
rise to an overlying bursa.
Differential diagnosis of Chondroid tumors:
The
differential diagnosis of chondroid tumors depends on the age, location and whether
there are single or multiple lesions.
Several examples of differential diagnoses are given in the table. Bone infarctions and polyostotic fibrous dysplasia a
This means that these lesions have such a typical appearance that they can be characterized based on radiographs a
However if there is only a single lesion and the diagnosis of fibrous dysplasia is uncertain, CT guided biopsy may be p
one tumors such as Ewing sarcoma and osteosarcoma may enter the differential diagnosis.
Especially the rare subtype osteolytic osteosarcoma or chondroblastic osteosarcoma can be difficult to distinguish fr
In case of doubt, a biopsy for pathology diagnosis needs to be obtained, as there are important consequences for tre
In patients over 50 years of age, the differential diagnosis includes metastasis and plasmacytoma. Bone infarctions E
The most common differential diagnosis for matrix mineralization in the metaphysis of a long bone is a bone infarcti
in cartilage tumors.
In addition, bone infarctions are often multifocal and may occur bilaterally. ImageRadiograph demonstrates multiple
bia, centered on the metaphysis.
This image is typical for bone infarctions and occurred due to longstanding steroid use in a patient with SLE.
Note the absence of stippled chondroid calcifications. Polyostotic fibrous dysplasia Fibrous dysplasia
In the differential diagnosis we can consider fibrous dysplasia, which often contains a cartilage component.
In most cases the ground glass appearance on radiographs helps to differentiate. First look at the images of a 23-yea
hen continue reading. HipThere is expansion of the proximal femur with widening of the metaphysis and a ground g
. Note the secondary osteoarthritis of the hip.
WristThe distal radius shows the same appearance with a changed bone structure due to ground glass osteolytic les
ted. Conclusion

The multiple bone involvement together with the age, history of pubertas praecox and the radiographical appearanc
No biopsy should be done. This patient is known with polyostotic fibrous dysplasia as a part of the McCune Albright
Radiograph of the right humerus in a 26 year old patient shows a large lesion filling the medullary cavity of the proxi
ndglass appearance and more sclerotic components distally.
There are no periosteal reaction or other aggressive features.
Given the age and this appearance, FD would be a likely diagnosis.
MRI was performed for further characterisation in this case. Coronal T1 and STIR images demonstrate cystic compor
se on STIR (arrows). These are typical for FD.
In between the cystic areas there is fat, which is hyperintense on T1W and signal is suppressed on STIR (asterix).
Note the distal part of the lesion contains very low signal intensity corresponding to the sclerosis on X-ray. FD can ap
to cystic areas or sclerosis.
No biopsy is needed as these findings are in keeping with mono-ostotic FD. Langerhans cell histiocytosis Langerhans
In the ribs Langerhans cell histiocytosis may mimic a chondroid tumor. Images ConclusionThe differential diagnosis
l skeleton), Langerhans cell histiocytosis (typical location, young patient), and in patients over 50 years think of multip
A biopsy was performed under CT guidance and LCH was the final diagnosis.
The lesion was followed up and resolved without treatment. In case of highly aggressive tumors (high grade CS), othe
enter the differential diagnosis.
Especially in the more rare osteolytic osteosarcoma cases this can be difficult to distinguish from chondroid tumors.
In patients over 50 years of age, a metastasis can be a mimicker of a chondroid tumor.
WHO classification of chondroid tumors:
In the 2013 WHO classification,
the term atypical cartilaginous tumor (ACT) was introduced as a synonym for
chondrosarcoma grade 1 (CS1) and classified as intermediate (locally
aggressive) to reflect
the clinical behavior of these well-differentiated low-grade lesions. The argument was that such lesions,
especially in the long bones, behave in a locally aggressive manner and do not
metastasize. Therefore, they should not be classified as having full malignant potential
(1). In the 2020 WHO edition the term ACT
is only reserved for low-grade chondrosarcomas located within the long bones of
the appendicular skeleton. The term “CS1”should be reserved for tumors of the
axial skeleton, including the pelvis, ribs, scapula and skull base (flat
bones), reflecting
the poorer clinical outcome of these tumors at these sites. Primary central ACTs arise in the medulla of long bones w
precursor.
Secondary central ACTs arise centrally in bone in association with a
preexisting enchondroma.
Peripheral ACTs in long bones arise secondary within the cartilaginous
cap of a preexisting osteochondroma.
The WHO 2020 defined a cut-off of 2 cm
for the cartilage cap thickness. Other changes in the 2020 WHO classification
are:
MR perfusion:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar
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malignant chondroid neoplasms: a systematic review of the literature. Skeletal Radiol. 2017. doi: 10.1007/s00256-01
None:

Staging and Treatment of Breast Cancer:
Robin Smithuis, Janneke de Bes and Anneke Zeillemaker
Department of Radiology and Surgery of the Alrijne hospital, Leiderdorp in the Netherlands:
Publicationdate 2016-08-29 Imaging plays a major role in the detection and staging of breast cancer and monitoring
ncer, it is important to be familiar with the staging classification and be aware of the available surgical, radiotherape
relevant information and so optimize patient care This article is an overview of breast cancer staging and treatment.
s, and that new targeted therapies are currently being developed.
Overview:
Click to enlarge
Staging and treatment overview 1:
This is a schematic illustration of the staging and treatment in a patient with breast cancer. This results in a pTNM-st
is referred to as the ypTNMstage.
4. Based on the pTNM- or ypTNM-stage, further treatment with adjuvant chemotherapy, radiotherapy and hormona
very image can be clicked to enlarge.
Staging and treatment overview 2:
This table demonstrates the staging and treatment of breastcancer in a more schematic way. cTNM Breast cancer is
the breast (T), regional lymph nodes (N) and systemic disease, i.e. distant metastases (M). Systemic disease (or stage
possible diagnoses of DCIS, localized cancer, locoregionally advanced cancer and cancer with distant metastases. Th
One might think that this staging is largely based on the findings of physical examination, but it is mostly based on t
emotherapy Neoadjuvant chemotherapy (from neo: before and adjuvare: to aid) is given to patients with locoregiona
n patients with localized cancer in whom there is an indication for adjuvant therapy (see table under adjuvant therap
ter surgery (adjuvant). Sentinel Node In patients who have no detectable axillary lymph node metastases with ultraso
e is performed in order to acquire information about the lymph node status of the axilla. Breast Conserving Therapy
d cosmetic result. Surgery is always followed by radiotherapy. Good cosmetic result depends on the size of the tumo
ger tumors with BCT by applying plastic- and reconstructive surgery with fat grafting and flap-procedures. If BCT is n
med. Radiotherapy Treatment is planned on the final stage and tumor characteristics. Adjuvant systemic chemother
rimary locoregional treatment. These are aimed at eliminating any distant occult metastases which may be present,
erapy and/or herceptin and/or hormonal therapy. The choice of therapy depends on:
DCIS:
There are multiple fine, linear calcifications in a large segment of the breast. These are suspicious calcifications and a
a in situ is the most common non-invasive breast cancer. In situ means 'in place' and refers to the fact that the cance
rrounding tissue. DCIS can progress to become invasive cancer, but likelihood estimates vary. 80% of DCIS is diagnos
re), followed by vacuum-assisted biopsy. Very few cases of DCIS present as a palpable mass. The problem with DCIS
cases with high-grade DCIS in some institutions, to better delineate the spread of the tumor and to assess if there ar
he patient is still unclear. Treatment of DCIS consists of breast conserving therapy (BCT) or mastectomy depending o
course, on patient preference. BCT consists of microscopically complete tumor excision and radiotherapy. A radiatio
nel node procedure should be considered in patients likely to have additional invasive carcinoma (see table). Specim
ion. After breast conserving surgery, these patients are treated with radiotherapy. If there is focal invasion of the res
an focal invasion (> 4mm) then a re-resection or mastectomy will be performed. Click to enlarge Study the images ar
Because of the large area with calcifications, a mastectomy was planned. A sentinel node procedure was also perfor
my is planned, an SN-procedure is routinely included, because it cannot be performed afterwards. Pathology showe
ere are two groups of suspicious calcifications which are about 5 cm apart. First the larger group was biopsied. The i
ler cluster would probably also be benign. However, the larger group of calcifications turned out to be DCIS grade 2.
tions, and this also turned out to be DCIS grade 2. A mastectomy with a sentinel node procedure was planned. The t
treatment.
Localized breast cancer:
Localized or early stage breast cancer includes: Axilla The axilla is initially examined with ultrasound. When patholog
lts are positive (N+), usually a PET-CT is performed to exclude more advanced disease. When no suspicious lymph no
procedure. BCT in Localized breast cancer When breast conserving surgery is performed, there is always a risk of lea
ns are tumor-free. This is the main reason why in BCT, surgery is always combined with radiotherapy. The risk of loca
S component. Depending on the receptor status of the tumor, most patients with localized cancer will also receive ad

tients younger than 70 years with small, low-grade tumors do not need chemotherapy (see table). No further investig
e of finding metastatic disease is very low.
Locoregional advanced cancer:
Locally advanced breast cancer includes: Treatment In the past these tumors were synonymous with inoperable bre
therapy. These patients are first treated with neoadjuvant chemo- and/or hormonal therapy. If there is a good respo
times even breast-conserving surgery is possible. Before neoadjuvant therapy is given, a clip is placed in the tumor. S
found. There is current debate whether these patients still need surgery, but currently, most of these patients are tr
adiotherapy).
Surgery and other procedures:
FNA of axillary lymph nodesThe criteria for performing Ultrasound guided FNA or biopsy of an axillary lymph node a
Wire localisation:
DCIS and many small tumors are not palpable. In these cases, the radiologist places a hook wire in the area that nee
of DCIS, either US-guided or stereotactically. With US, the position of the tumor is marked on the skin, while the pati
exact depth of the tumor beneath the skin is also noted. The figure shows the tract of the wire (yellow arrows) towa
ark the exact position of the tumor. The curved arrow indicates the entrance of the wire into the breast.
Sentinel node:
The sentinel node procedure (SLN) has become the standard method for staging the axilla in breast cancer patients
rate staging information while avoiding the morbidity of a complete axillary lymph node dissection. A radiopharmac
hese tracers flow through the lymph ducts to the lymph nodes. The first lymph node(s) to receive the tracers are rem
three SLNs does not increase the accuracy of finding a positive node.
BCT:
Breast Conserving Treatment (BCT) is also known as lumpectomy or wide excision. A locoregional excision of the tum
ging, followed by radiotherapy of the breast with or without a boost. MRI-compatible clips should be placed in the tu
e-excision is indicated if there is more than a focal tumor-positive resection margin (see pathology). Resection margi
* Focal non-radical Less than 4mm of the resection margin contains tumor.
* More than focal More than 4mm of the margin is involved. Invasive cancerRe-excision is indicated if there is a more
important risk factor for local recurrence. When the resection margin is only focally involved, adjusting the radiation
eatment is more aggressive in DCIS, since re-excision or mastectomy is advocated in any involvement of the resectio
Mastectomy:
Simple MastectomyRemoval of the whole breast. Some of the axillary lymph nodes (level I) may also be removed. Mo
h nodes, and the fascia of the chest wall muscles is removed. The pectoralis muscle is not removed. Nipple sparing m
e nipple can be spared if: DIEP flap
Oncoplastic surgery:
Direct reconstructionDirect breast reconstruction using implants. DIEP-flapThe deep inferior epigastric artery perfor
neous fat are taken from the abdomen to recreate the breast. SGAP flapThe superior gluteal artery perforator (SGAP
ssue. This is usually done if patients do not have adequate skin and tissue in their abdomens or have had previous a
remains attached to its original site, retaining its blood supply. The flap, consisting of the skin, fat, and muscle with it
.
Axillary Lymph Node Dissection:
In Axillary Lymph Node Dissection (ALND) the axillary lymph nodes are removed. There are three levels of axillary lym
r muscle. Level II is at the level of the pectoralis minor. Level III is above the pectoralis minor. In ALND levels I and II a
performing a sentinel node dissection or by downstaging the axilla with neoadjuvant therapy. ALND is performed wh
possible. Sorry, your browser doesn't support embedded videos.
MARI procedure:
The MARI procedure is a new minimal invasive method to assess the pathological response of an axillary lymph node
axillary lymph node is marked with a radioactive iodine (I) seed. This marked lymph node is the so-called MARI-node
ed using a γ-detection probe. If the node has become tumor-negative and the sentinel node is also negative, no addi
illa-conserving surgery in patients who respond well to neoadjuvant treatment.
Pathology:

pTNM-stage:
Following surgery, the surgical specimens of the tumor, the sentinel node or axillary nodes after dissection are analy
he pTNM may differ from the cTNM-stage, and sometimes the original treatment plan has to be adjusted. For examp
ion or adjustment of radiotherapy may be necessary. For a proper pathological pT-classification there can be no gros
microscopic tumor in the margins. The tumor size includes only the invasive component. If there is a large in situ co
), the tumor is measured 0,5 cm and coded pT1a. The analysis of the surgical specimen of the tumor, the sentinel no
n a pTNM or ypTNM-stage. Other tumor characteristics such as tumor-grade, hormone receptors, lymphangio-invasi
determine the risk of local recurrence and systemic disease.
pN-stage:
ypN-stage In patients who have received neoadjuvant chemotherapy, the lymph node status will be affected. For this

node procedure is performed after neoadjuvant therapy and 3 positive nodes are found at pathology, this will result
other important prognostic factor in the staging of a tumor. A high-grade tumor is more likely to spread, necessitatin
ding to the modified Bloom and Richardson guidelines and is based on the total score of tubule formation, nuclear p
Gene expression:
The prognosis and treatment of patients with breast cancer depends on many factors: Analysis of the DNA of the tur
s of breast cancer that have distinct clinical outcomes and different responses to chemotherapy. It can help to select
ene expression is a process in which a gene gets turned on in a cell to make RNA and proteins. Some of these protei
u This protein is produced in abnormally high amounts in about 20% of breast tumors. Breast cancers that overprod
astuzumab (Herceptin) targets the HER2 protein specifically, and in conjunction with adjuvant chemotherapy, can lov
rapy alone. Whenever breast cancer recurs or spreads, the cancer cells should be retested for HER2 as well as for ho
er in up to 20 to 30 percent of cases (8). Mammaprint On the basis of patterns of gene expression, breast cancer ma
of these profiles is the MammaPrint®, which tests for 70 different tumor genes and divides patients into a high- and
herapy or not.
Systemic Therapy:
* Some advocate chemotherapy in all HER2+ patients younger than 35 years
Adjuvant systemic therapy:
Adjuvant systemic chemotherapy and endocrine therapy are administered as complements to primary locoregional
ch may be present, but cannot be detected yet). Adjuvant therapy can consist of chemotherapy, herceptin and/or ho
re HER2/neu positive and hormonal therapy is given to patients who have estrogen or progesteron receptors (ER+ or
apy ois given in trying to stabalize the disease.
Neoadjuvant therapy:
Neoadjuvant chemotherapy or primary systemic treatment used to be given exclusively to patients with locally adva
r (T3N0). Current policy is that more and more patients with early cancer, who have an indication for chemotherapy,
djuvant therapy post-surgery. Advantages of this policy is that neoadjuvant therapy allows for monitoring of the resp
ted when there is no adequate response. Another advantage is that the size of the lumpectomy can be reduced, and
herwise have been treated with mastectomy. Even in clinical complete remission, a combination of surgery and radio
s for starting neoadjuvant therapy Breast diagnostics Regional diagnostics Screening for distant metastasis
Neoadjuvant chemotherapy:
The response rate to neoadjuvant chemotherapy is 80-90%. The risk of progression is less than 5-10%. There is no cl
IST > 20% increase in diameter during chemotherapy.
Neoadjuvant hormonal therapy:
There are no randomized studies available comparing neoadjuvant hormonal therapy with the same treatment post
rs to make downstaging possible for hormone receptor-positive tumors, with an improved chance of radical surgery
Neoadjuvant trastuzumab:
The addition of trastuzumab to neoadjuvant chemotherapy increases the percentage of pathological complete respo
Radiotherapy:
Radiotherapy of the breast Radiotherapy forms an integral part of breast conserving treatment in breast cancer. Mo
hole breast is irradiated with an optional boost dose to the tumor bed. Patients with a small and low grade DCIS hav
justified (15). Radiotherapy of the chest wall Indications for radiotherapy of the chest wall following mastectomy are
lternative to axillary lymph node surgery and has a less risk of lymphedema. There is a lot of discussion concerning t
are not evidence-based. Approaches differ between countries and between institutions. In the Duthc Breast Cancer
ot recommended.
2. Micrometastases in the SN: Radiotherapy is only recommended in case of additional risk factors.
3. Macrometastases: Radiotherapy is indicated. In cases with a large axillary tumor load an axillary lymph node disse
ther countries and are also not evidence-based, but expert opinions. You must reach a consensus for radiotherapy i
Special types of breast cancer:

Triple negative breast cancer:
Approximately 15-20% of breast cancers are so-called triple negative and characterized by the absence of ER-, PR- an
ge, are high-grade, and on presentation often substantial in size with metastases to the axillary lymph nodes. Triple
and frequent brain metastases. Studies have found that these tumors respond better to standard neoadjuvant chem
s.
Inflammatory carcinoma:
Inflammatory carcinoma or mastitis carcinomatosa is a separate category of breast cancer and accounts for 1-5% of
orange and swelling of the breast, therefore it is mainly a clinical diagnosis. It is a rare and very aggressive disease in
TNM classification is T4D (stage III). Dimpling of the skin and nipple retraction is not the same as inflammatory breas
assification.
Paget disease of the nipple:
The diagnosis of Paget disease of the nipple can only be made if there is no disease in the underlying breast parench
isease are categorized based on the size and characteristics of the parenchymal disease, although the presence of P

Lobular carcinoma:
Invasive lobular carcinoma is the second most common type of breast cancer after invasive ductal carcinoma (17). In
ammography, because instead of forming a lump, the cancer cells typically spread to the surrounding connective tiss
Additional Imaging:

PET-CT:
When to use PET-CT PET-CT is recommended in patients with locoregional disease to search for distant metastases.
distant metastases and locoregional recurrence than conventional imaging. The sensitivity of PET-CT however is too
does not play a role in staging of a clinically negative axilla and cannot replace the SN-procedure. However, when axi
e procedure, and the PET-CT shows uptake in lymph nodes, then all these nodes are regarded as positive, because th
ith advanced breast cancer. The US of the breast showed an 18mm echopoor lesion with irregular margins and micr
hilum. FNA was performed, and both the tumor and the lymph node were positive for adenocarcinoma. The lesion w
-CT image a level II node is positive just underneath the pectoralis minor (yellow arrow). Multiple axillary nodes were
ong the neck and shoulder muscles on both sides (circle). This patient was planned for neoadjuvant therapy and biop
receptors and HER-2-neu-amplification. Here another PET-CT example. On the mammogram, there is a tumor with s
he tumor - click on image to enlarge. This means that the infiltrating tumor developed within an area of ductal carcin
he skin, i.e. T4b (red arrow). Continue... On this ultrasound image, there is another satellite nodule within the skin (ye
arrow). Fine needle aspiration demonstrated metastases within these nodes. This tumor was staged as T4bN+. This
e patients are at risk for systemic disease and additional imaging was performed. Continue... Here we see the PET-CT
spread to the skin are demonstrated (red arrows). There are multiple metastases in both lungs - a metastasis in the r
asis in the left lung. In addition, there were also bone- and liver metastases and multiple axillary lymph nodes were s
T4bN3M1.
MRI:
MRI is found to be better at indicating the size of DCIS and invasive cancer and is also better in detecting multifocal c
e role of preoperative MRI in patients with breast cancer, because overestimation occurs due to the presence of enh
operative MRI, since it has not resulted in a better outcome or significantly lower percentage of reoperations. It is on
ze in patients who would like to be eligible for BCT. MRI however plays an important role in diagnostic problem solvi
the right breast is easily detected with BSGI, while hardly visible on the mammogram.
BSGI:
Breast-specific gamma imaging (BSGI) is an adjunct modality for breast imaging which, like MRI, uses a physiologic ap
ecificity are comparable to MRI, and are much higher than for mammography - especially in dense breast tissue. The
e for screening, but it is an excellent tool for problem-solving. Just like MRI, it is good at detecting multifocal or contra
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None:

None:

Transvaginal Ultrasound for Non-Gynaecological Conditions:

including Deep Infiltrating Endometriosis:
Julien Puylaert
Amsterdam UMC and Haaglanden MC, The Hague:
This is an overview of the use of Transvaginal Ultrasound (TVUS) for the diagnosis of various non-gynaecological conditions as they appear in the pelvic cavity. This pictorial essay is for gynaecologists who want to look beyond pathology of uterus and ovaries, and diagnose non-gynaecological conditions. Also included here is Deep Infiltrating Endometriosis (DIE). Although the latter is obviously a gynaecological disorder, its diagnosis requires thorough

knowledge of TVUS aspect of colon, ileum and bladder. This pictorial essay is also for radiologists who like to master the TVUS technique as an adjunct for their transabdominal US examination, diagnosing both gynaecological and non-gynaecological conditions.
See also 'US of acute gynaecological conditions' For critical comments and additional remarks: j.puylaert@gmail.com
Introduction:
Pelvic anatomy TVUS is traditionally performed by gynaecologists and obstetric sonographers and their scope is generally focussed on the uterus, ovaries and Fallopian tubes. However, there are more organs within the female pelvis in reach of the transvaginal probe such as the bladder, urethra, distal ureters, sigmoid, anorectum and the appendix.
Also the virtual spaces of the peritoneal cavity as cavum Retzii and Douglas pouch can be inspected. Due to the high mobility of the vaginal top, pathology of these organs and regions can be studied by TVUS with a high frequency probe, resulting in exceptionally detailed images. Enable Scroll
Disable Scroll Normal US anatomy Enable Scroll
Disable Scroll Normal US anatomy Uterus and ovaries are best visualized with a half-full bladder. A very full bladder is unpleasant for the patient, hinders adequate compression and pushes organs away from the ventral abdominal wall, out of reach for transabdominal US. In the sagittal view, uterus, cervix, vagina and urethra (u.) can be identified, as well as the collapsed anterior and posterior fornix of the vagina. Studying the uterus in retroflexion, usually requires more bladder filling. Normal US anatomy Sagittal view of the normal uterus w fluid, outlining the portio as well as the anterior (*) and the posterior fornix (*). Enable Scroll
Disable Scroll Normal uterus in relation to her surroundings. Enable Scroll
Disable Scroll Normal uterus in relation to her surroundings. It is important to understand also the anatomy outside the uterus.
A little fluid in Douglas' pouch and a small Nabothian cyst (n.) may be easy to identify, but what are the structures marked with a question mark? Note the full bladder displacing the uterus posteriorly.. Probe orientation in TVUS It is important to realize that the orienta endovaginal probe is different from that of the abdominal probe. The right panel shows the anteflexed uterus visualized with the endovaginal probe in the anterior fornix of the vagina. This position of the uterus corresponds with the image during transabdominal US. Probe orientation in TVUS Most sonographers, however, look at the TVUS image r panel. This is not necessarily a problem, as long as one realizes the different presentation of the anatomy, including gravity effects. Note the horizon in relation to the TVUS image. Fluid-debris-level in endometriotic cyst For instance, in this patient with an endometrioti the fluid-debris-level is vertically oriented, and could therefore be misinterpreted. This could be overcome by clockw image). The importance of orientation in pattern recognition. However, liberal switching of US image orientation doe not favour good pattern recognition. For this reason, it is best to stick to one and the same orientation. For example, many radiologists reading a CT colonography, made with the patient in prone position, will switch to the familiar CT image in "supine" position, especially when searching for extra-colonic pathology. Likewise, although the image information of the two Mr. Bean portraits is identical, the comedian is much easier recognized on the picture hanging normal than on the one hanging upside-down.
TVUS for Urological Pathology:
Enable Scroll
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Ureteral stones:
In pregnant patients with suspected ureterolithiasis, CT is contra-indicated. If distal ureteric stones cannot be visuali man, the normal distal ureter (arrowheads) was visualized including a ureteric "jet-phenomenon" using Doppler. Not shows distal ureteric stone in pregnant patient with acute LLQ pain. US confirmed an intact pregnancy and showed a The bladder was empty and no obstructing stone could be visualized. Additional TVUS demonstrated a distal stone (a ic wall after stone passage. A 58 year old woman had a left sided colicky attack, followed by a burning sensation duri blood clots in the urine, but did not notice any stones. CT showed no stones. The sediment showed atypical urotheli ght ureter (arrowheads). The combination of these findings, raised the possibility of urothelial malignancy. Seven day sediment was normal again and follow up TVUS showed complete normalization of the distal ureter (arrowheads). Th y effects of transient ureteric wall thickening and of abnormal urothelial cells in the sediment. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Pathology of the urethra, distal vagina and anal sphincter can be studied with the transvaginal probe p

Normal US anatomy with probe in vulvar position Urethral diverticulum demonstrated by TVUS.
Urethral diverticulum:
Recurrent lower urinary tract infections may be caused by intermittent obstruction / infection of an urethral diverticu
ion) detected a large, inflamed urethral diverticulum (*) right and anterior of the urethra (U.) (V. and S. = vagina and s
ant bladder polyp: coincidental finding by gynaecologist.
Bladder carcinoma:
During routine TVUS, the gynaecologist detected a solid, well-vascularized, moderately well-defined mass with a dian
There was no history of hematuria or micturition problems. Cystoscopic surgery revealed a grade 1 transitional cell c
TVUS for Intestinal Pathology:
Enable Scroll
Disable Scroll Normal sigmoid at TVUS. Enable Scroll
Disable Scroll Normal sigmoid at TVUS.
Diverticulitis:
TVUS anatomy of the normal and well-compressible sigmoid
in longitudinal and axial view. At the end, in the transverse view, the sigmoid
is easily compressed with the probe (arrowheads) against the sacrum. Uncomplicated course of sigmoid diverticulitis
pain. TVUS demonstrated local wall thickening of the sigmoid
and a diverticulum harbouring a fecolith (arrow), which was surrounded by inflamed
fat (*), representing mesentery and omentum, effectively walling-off the imminent
perforation. The next day, she felt much better and follow up TVUS showed
a hypoechoic, oedematously thickened, empty diverticulum (arrowhead).
The fecolith
apparently did evacuate to the sigmoid lumen. Paracolic diverticular abscess detected with TVUS A 37-year old woma
The gynaecologist consulted the radiologist, who recognized it as small paracolic abscess, probably of diverticular or
cts small sigmoid CA in patient with massive colonic obstruction. A 66-year old woman presented with progressive bl
and constipation. CT showed massive colonic dilatation, but pelvic CT (not
shown here) was of low quality due to two hip prostheses. US confirmed multiple, strongly dilated, air-filled
large bowel loops, but was otherwise non-diagnostic. TVUS demonstrated a small, stenosing sigmoid carcinoma
with concomitant desmoid reaction (*) in the surrounding fat. Adenomatous polyp in the sigmoid, detected by TVUS.
Adenomatous polyp:
A colonic polyp (arrow) was seen both on CT and at
colonoscopy, however due to adhesion-related kinking, the polyp was out of
reach for biopsy.
Surgeons wanted more proof before proceeding to laparoscopic
resection. TVUS showed an ovoid, solid, well-defined, inhomogeneous,
hypervascular, intraluminal mass (arrows) with a diameter of 1.5 cm.
Segment
resection was done, histology showed a malignant adenomatous polyp. Enable Scroll
Disable Scroll Rectal cancer in longstanding ulcerative colitis, detected by TVUS. Enable Scroll
Disable Scroll Rectal cancer in longstanding ulcerative colitis, detected by TVUS.
Rectal cancer:
A 39-year old woman with known ulcerative colitis for 20
years, presents with blood in the stool. TVUS confirms thickening of the hyperechoic submucosa
(arrowheads) compatible with longstanding inactive colitis. Also a hypoechoic carcinoma (CA) in the ventral rectal
wall is detected. Note the focal obliteration of the layer structure and the
desmoplastic reaction at the serosal side (*). Early acute appendicitis in pregnant patient, shown by TVUS.
Appendicitis:
A young, early pregnant woman presented with acute deep
pelvic pain. US demonstrated enlarged mesenteric lymph nodes (ln) and
an intact intra-uterine pregnancy.
The appendix was not visualized. (ivc =
inferior vena cava, a = iliac artery). TVUS easily demonstrated a 12-mm, inflamed appendix harbouring
a large fecolith (arrowhead).
The appendix was in pelvic position and surrounded
by free fluid.
There was no perforation
at surgery. TVUS detects inflamed appendix in deep pelvic location. In this obese, 3 weeks pregnant woman, transab
visualized an dubiously abnormal appendix (?). TVUS showed a dilated, pus filled, inflamed appendix
in deep pelvic location. Abscess in Crohn’s disease.
Crohn’s disease:

A young, 4 weeks pregnant woman presented with 6 days of
RLQ pain and a CRP of 120. US demonstrated wall thickening of the terminal ileum
with echolucent changes in the submucosa, suspect for Crohn's disease. Complementary TVUS detected an abscess
by mesenterial and omental fat (*). Spontaneous evacuation of postoperative Douglas abscess to rectum. Young wo
after surgery for perforated appendicitis. CT shows a bilobar puscollection, close to the thick-walled,
empty rectum (R.). TVUS confirms the abscess, and demonstrates an echolucent
tract (*) from the abscess towards the rectal lumen (R.) with focal blurring of the layer structure of
the oedematous rectal wall.
These TVUS findings, in combination with the improving
symptoms of the patient, are signs of impending spontaneous evacuation. Three days later the thick-walled abscess
empty.
The patient recovered without surgical or radiological drainage. Malignant peritonitis detected by TVUS. Elderly lady
US only some ascites. TVUS demonstrates slightly hyperechoic ascites and
multiple, vascularized tumour deposits on the peritoneum, strongly suspect for
malignant peritonitis.
TVUS for Deep Infiltrating Endometriosis:
Deep Infiltrating Endometriosis (DIE) DIE is a potentially devastating, gynaecological
condition.
By repeated episodes of bleeding, resorption and the resulting formation
of scar tissue, the endometriotic implants may cause pain, dyspareunia and subfertility. DIE, if localized in Douglas p
vesico-uterine recess, may aggressively invade the rectum, bladder and ureters,
with all its sequelae, as colonic obstruction, micturition problems and hydronephrosis. In prominent, longstanding D
scar tissue of DIE (*), may cause narrowing, and eventually total obstruction, of
the colonic lumen. In this young lady with unexplained chronic abdominal
symptoms for many years, CT and subsequent MRI demonstrated extensive endometriosis. In addition there are lar
("kissing ovaries"), bilateral hydronephrosis and complete
obstruction of the colon, due to ingrowth of endometriosis in the ureters and the rectum.
Background:
There are many reasons for diagnostic delay in
DIE.
The symptoms of DIE are chronic, atypical and often non-cyclical.
Gynaecological
TVUS often shows a normal uterus and normal ovaries.
The lab findings are usually
normal and colonoscopy in DIE is often inconclusive Even laparoscopy can be non-diagnostic
because DIE may hide under adhesions. MRI of DIE (*) yields pathognomonic images, but is
only performed when there is clinical suspicion of endometriosis. TVUS provides a unique opportunity to make the d
of DIE in patients who undergo routine examination for aspecific symptoms.
DIE of the rectum:
The images are of a patient with DIE and a normal aspect of uterus and
ovaries. DIE has typical, almost pathognomonic TVUS features.
Although
obviously a gynaecological condition, it is not infrequently overlooked by
gynaecologists during TVUS. The reason is that the majority of
patients with DIE (*), lack the typical endometriotic cysts and have, as in the
patient here, a normal uterus and ovaries (L. OV. and R. OV.). Furthermore, the
TVUS diagnosis of DIE requires thorough knowledge of the US image of normal and
pathological bowel and bladder, which knowledge may be absent in gynaecologists. (See also: "US of the GI tract: no
our
different patients. DIE implants (*) in Douglas pouch, are asymmetrically
localized, solid, hypoechoic, poorly vascularized masses, which are continuous
with the outer hypoechoic muscularis layer of the colon. The overlying hyperechoic submucosa, and also the colonic
This explains also why blood in the stool is quite rare in DIE. The outer contour of these hypoechoic masses is mostly
firmly adherent to uterus and/or cervix. Often there is spiculation or "tethering"
visible on the outer margins. Sorry, your browser doesn't support embedded videos. Adherence to the uterus and ce
. Whereas the normal sigmoid and rectum can easily be pushed away from the uterus with the probe ("sliding phenc
e of the probe into the posterior fornix. In this videoclip, the transvaginal probe is gently
moved to-and-fro. The implant (*) has developed firm adhesions between uterus
and colon, which prevent entering of the probe deeper in the direction of the
sacrum. In the normal situation, uterus and colon can be easily be pushed aside. TVUS image of DIE with operative s

sigmoid wall, clearly overlies the large DIE implant (*). Note also the completely
normal dorsal sigmoid wall. The resected specimen shows that the (sub)mucosa
(arrows) is intact and overlies the DIE (*). As expected, also this patient had
no history of rectal bloodloss. Image orientation in TVUS and MRI For a proper understanding of the TVUS image of D
and especially the correlation with the MRI images, it is important to realize the
different orientations used in both image modalities. In the upper three rows, the “MRI-orientation”
prevails, and the upper-right TVUS image is therefore is 1. flipped
horizontally (mirror view) and 2. rotated anti-clockwise about 120 degrees. Although one might argue that this flippe
image corresponds better to the sagittal MRI, pattern recognition benefits from
using the “classic” TVUS view, as shown in the bottom image.
Differentiating DIE from carcinoma:
Differentiating rectal cancer from DIE of the rectum. Both conditions appear as solid, moderately defined, rather
hypoechoic, asymmetrically localized masses arising from the rectum with a
tendency to narrow the lumen. TVUS may be key to discriminate the two. In DIE the hypoechoic mass is hypovascula
at the outer contour of the rectum and is continuous with the hypoechoic muscularis.
The submucosa and mucosa of the colon are intact. In rectal CA, the hypoechoic mass is hypervascular and
the mass originates from the mucosa, with focal loss of layer structure as a
consequence of transmural tumour growth. Longstanding actinomycosis mimicking DIE.
Differentiating DIE from actinomycosis:
A 43-year old woman with longstanding lower pelvic
pain. During routine US (not shown here) an ill-understood asymmetrical rectal
wall thickening with inflammation of the surrounding fat was found. A CT was advised. Images
CT and subsequent MRI confirmed the US findings and also
showed extension of the abnormalities to the pararectal fascia and cervix.
Within the mass (*) small areas of necrosis or fluid were seen.
CRP was 2.
TVUS showed oedematous. thickening of an otherwise
normal rectum, and an atypical hypoechoic mass (*) right posteriorly,
surrounded by hyperechoic, non-compressible fat.
The mass felt very hard at toucher.
An atypical form of DIE was suggested. Eventually, deep EUS guided colonoscopic biopsies showed
a fibrosing, low-grade infection, and no features of endometriosis or
malignancy. The diagnosis of actinomycosis was suggested. After six months of
intravenous penicillin (port-a-cath), only minimal residual abnormalities
remained. The patient was pain free. Fifteen years earlier an IUD had been
removed. The low CRP was compatible with
longstanding, low grade infection. No bacteriological proof was obtained.
Bladder endometriosis:
Coincidental finding of “bladder polyp” (arrow) on CT
scan in young female. Confirmation of a flat polypoid structure (arrow) by
abdominal US. Cystoscopy was completely normal, indicating that the
mass is covered by normal bladder mucosa.. TVUS demonstrates
that the mass in fact is an endometriotic implant and shows blurring of the
hyperechoic contour (*) of the uterus, indicating local ingrowth.
TVUS also
demonstrated DIE in Douglas pouch (not shown here). A 45-year old woman with a long history of painful
micturition. Cystoscopy was negative. CT shows a plaque-like, irregularly defined mass
(arrow). TVUS confirms a large endometriotic implant (arrow) in
the prevesical space (cavum Retzii). Note again the ill-defined border with the
uterus. Enable Scroll
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Ileum endometriosis:
A 32-year old woman with a long history of chronic
abdominal pain. US revealed a poorly vascularized hypoechoic mass
between ileum and cecum (DIE). The mass was continuous with the muscularis, and
spared the (sub)mucosa of ileum and cecum.
Although there was no local pain on pressure, an endometriotic implant was
suggested. Subsequent MRI revealed extensive DIE affecting not
only the ileocecal region, but also Douglas pouch and the cavum Retzii. A 34-year old woman with known extensive p

presented with subacute pain in the RLQ. A large polylobular mass was found on CT. The corresponding abdominal
be multiple coalescent DIE implants, leaving the hyperechoic submucosa of the
ileum intact. (a and v = iliac artery and vein)
Appendix endometriosis:
Enlarged, hyperattenuating tip of the appendix on CT
scan in 43-year old woman, with previous extirpation of uterus and adnexa for DIE. TVUS revealed a solid, moderate
mass (*) in close contact with a thin appendix (arrow), suspect for endometriosis.
However malignancy could not be excluded. Appendectomy revealed a longitudinally oriented endometriotic
implant on the appendix tip. A 26-year old woman presents with recurrent subacute pain RLQ. US shows an -at that
cularized mass, in the region of the cecum. Malignancy was suggested. At surgery a “tumour mass” was found origin
s could be stapled-off safely, and turned out to be the appendix, intussuscepted into the cecum due to extensive enc
Epilogue:
The author thanks his fellow radiologists for their valuable help in collecting all the educational material. A special th
he manuscript. Finally, for all those interested in DIE, I strongly recommend the excellent youtube-lecture of gynaeco
None:

Lumbar Disc Herniation:

and other causes of nerve compression:
Robin Smithuis
Radiology department of the Rijnland hospital in Leiderdorp, the Netherlands:
Publicationdate 2014-12-14 In this article a systematic approach to patients with nerve root compression in the lumb
hrosis, synovial cysts, spondylolisthesis and epidural lipomatosis. The images can be enlarged by clicking on them.
Systematic approach:

Four levels of nerve compression:
In patients with symptoms of nerve root compression, there are four levels that need to be studied: This is the most
cs and less frequently due to spinal stenosis.
2. Level of lateral recess. This is the area below the disc where the nerve runs more laterally towards the foramen. N
ually in combination with hypertrophy of the flavum ligament and bulging of the disc.
3. Foramen. This is the area between two pedicles, where the nerve leaves the spinal canal. Narrowing of the forame
herniation - usually a migrated disc from a lower level.
4. Extra-foraminal. This is the area lateral to the foramen. Nerve compression in this area is uncommon, but is some
there can be a lot of overlap of pathology. For instance a herniated disc can cause nerve compression at the level of
al when there is migration of the disc. When you are looking for nerve compression, you have to study all these level
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images to see how the nerves run at the level of the disc, lateral recess, foramen an
n, but there is a lot of overlap. For instance a disc can herniate and cause nerve compression at the level of the disc,
in the lateral recess or move upward and cause compression at the level of the foramen or extra-foraminal. In patie
row the lateral recess or move upward and narrow the foramen. When there is extreme facet arthrosis bilaterally, it
roots at that level.
Anatomy:
The illustration demonstrates the structures that surround the nerves within the spinal canal. Flavum ligament The f
e of the vertebral canal that connects the laminae of adjacent vertebrae. As a result of aging and instability of the ver
ss on the flavum ligament resulting in hypertrophy and fibrosis. Hypertrophy of the flavum ligament is usually seen i
f the lateral recess or when it is bilateral, in spinal stenosis. Epidural fatThis is the fat that surrounds the dural sac, th
roid therapy, extreme obesitas and rarely idiopathic. Abundant epidural fat can contribute to stenosis of the spinal c
MRI protocol:
The MRI protocol for examination of the lumbar spine in patients with symptoms of nerve compression is quite simp
ate the findings with the transverse T2W-images of the levels of suspected pathology. Do not use a saturation band
e you also want to image the prevertebral soft tissues. Especially look for an aneurysm of the abdominal aorta, since
e difficult to clinically differentiate neurogenic claudication - which is caused by spinal stenosis - from vascular claudi
cy-encoding should be in the AP-direction and consequently the phase-encoding feet-head. This has several advanta
small herniations and delineation of nerve roots.
2. When you have the phase encoding in the AP-direction, you get breating artifacts. That is why some use a saturati
ion you do not have these problems and you do not need a saturation band.
3. Frequency encoding in the feet-head direction can result in poor deliniation of the vertebral endplates due to cher
e water in the disc. This is another reason to use a feet-head phase encoding and an AP frequency encoding. It is bet
to the level where nerve compression is suspected. This has the advantage, that you can follow the involved nerve al
tiple levels with different angulation like in the example on the right, you will not be able to follow the whole nerve tr

Interpretation:
The sagittal T1W-images give you the most diagnostic information. Before you start looking for any hernias, first take
you have detected any abnormality, correlate these findings with the T2W-images (figure). Use of a marker When you
elates with the same location on the other series. If you enlarge the image, you will see the small yellow cross, which
other series. Here the L5 nerve on the right is compressed by a synovial cyst, which is the result of facet arthrosis wit
Prevertebral tissues:
Here a 25 year old patient who presented with low back pain. Notice multiple small masses in the abdomen surroun
bone marrow. The signal intensity of the discus is a little bit higher compared to the bone marrow (bright discus sign
in this patient. This proved to be bone- and lymph node metastases of a carcinoma of the colon. Here another patien
toneum. Here a patient, who presented with severe low back pain. Notice the aortic dissection. Sometimes these aor
Disc herniation:
Disc herniation is displacement of disc material like nucleus pulposus, parts of the annulus fibrosus and cartilage, be
cal (< 90º), broad-based (90º-180º) or caused by bulging of the disc (> 180º). Protrusion indicates that the distance b
tance between the edges of the base. Extrusion is present when the distance between the edges of the disc material
lature for more information about disc herniation nomenclature. Here a focal protrusion at the L5S1 level. The S1 ne
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images and describe the findings. Then continue reading. The findings at the differe
through which the disc herniates (yellow arrow)
3. At the level of the lateral recess, there is a focal herniation of disc material compressing the L5 nerve (yellow arrow
n the edges of the disc material is greater than the distance at the base.
4. Compressed L5 nerve (blue arrow) within the lateral recess. The herniated disc has migrated caudally and is seen
uncontained, i.e. not covered by fibers of the annulus. First study the images. Click to enlarge them. Then continue r
y of a hernia on T1W-images is usually intermediate, while on T2W-images it can be a high signal fresh herniated nuc
re a herniation with high signal (yellow arrow on transverse images) sliding through the annular tear and compressin
trating a structure of very low signal intensity at the L4L5 level (arrow) and at the L5S1 level. Continue with the T2W-i
y is very low. A CT-scan was performed to see if this could be a calcified herniated disc or some artifact. Continue wit
plained by the vacuum phenomena due to nitrogen gas within the herniated disc both on L4L5 (red arrow) and L5S1
Disable Scroll Enable Scroll
Disable Scroll First scroll through these sagittal T1W-images. What are the findings. Then continue with the next serie
Disable Scroll Enable Scroll
Disable Scroll The most striking finding is a intermediate intensity structure posterior to the L3 vertebra (blue arrow)
nia that has migrated cranially compressing the L3 nerve on the right side. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Here another example of disc migration. Notice how the disc herniation at the L3L4 level migrates cau
grated disc simulates a nerve root (green arrow), while in fact the nerve is compressed posteriorly and subsequently
Lateral recess stenosis:
Stenosis of the lateral recess is a common problem especially in older patients. The stability of the vertebral column
trophy of the facet joints and arthrosis, bulging of the disc and more stress on the flavum ligament resulting in hyper
ecess (figure). In advances cases of arthrosis a synovial cyst may form, which contributes to the narrowing. Enable Sc
Disable Scroll Enable Scroll
Disable Scroll Here a patient with bilateral facet arthrosis resulting in narrowing of the lateral recess on both sides w
oll
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Synovial cyst:
Synovial cysts are frequently seen in combination with facet arthrosis. Mostly they lead to stenosis of the lateral face
n and cause foraminal stenosis. Here a patient with severe arthrosis of the facet joints. Notice that there are many sy
1 level a large cyst on the right compresses the S1-nerve (yellow arrow). Enable Scroll
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Disable Scroll Here sagittal T2-weighted images of a patient with a synovial cyst, that completely fills the neuroforam
al, but the nerve iseems to be missing. The nerve is compressed by the cyst. Enable Scroll
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Disable Scroll Here we have the axial images of the same patient. Notice the dumbbell configuration of the synovial c
ysts can be easily overlooked. On these T2W-images it looks as if the foramen is normal. Notice that the nerve is mis
e synovial cyst, which compresses the nerve root against the vertebra (arrows). The nerve can hardly be seen.
Stenosis of the Spinal Canal:
Causes of spinal stenosis: Most common Less common Notice the diffuse narrowing of the lumbar spinal canal. It is
iograph, because the pedicles are very short. You may have to enlarge the image to appreciate this. On the axial T2W
nerve roots. This means that there is a severe spinal stenosis. The epidural fat compresses the nerves from posteric
graph you can suspect congenital narrowing. Usually a small hernia or bulging is enough to cause nerve compressio

s is seen. Notice the short pedicles in combination with facet arthrosis and flavum hypertrophy. Here a patient with
nal stenosis with compression of the nerves (red arrow). It is not that common for metastases to cause nerve compr
stases frequently cause compression because there is not much CSF surrounding the myelum. Fractures can cause s
ony structures like in burst fractures and fractures with rotation and translation. Here a patient with an old burst fra
(red arrow) compressing the cauda (blue arrow).
Epidural lipomatosis:
Epidural lipomatosis is excessive amount of fat within the epidural space compressing the thecal sac. Patients prese
with obesity, like in this case and in patients who are treated with steroids. Continue with the axial images of this pa
Disable Scroll Enable Scroll
Disable Scroll Scroll through the axial images. Notice how the spinal canal is narrowed by the epidural fat. Do not mi
Foraminal stenosis:
Causes of Foraminal stenosis: Stenosis of the neuroforamen is usually the result of a combination of upward disc he
ts with spondylolisthesis. Spondylolisthesis is a condition in which one vertebra slips forward over the one below it, u
s (stress fracture of the pars interarticularis) or facetarthrosis with sliding of the facets. Here a patient with severe fa
Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images of a patient with spondylolisthesis. Here a disc herniation with upward migra
the T1W-image with the axial T2W-images. On the T2W-image it is more obvious that this is a disc herniation. The lo
ages to see it. These foraminal disc herniations can be easily overlooked. Notice how subtle the findings are on the a
the nerve root. The sagittal T1W-image shows the upward migration of the disc. Here a patient with a combination o
lting in compression of the L3 nerve within the foramen. Here a patient with severe anterolisthesis due to bilateral sp
movement of the disc has resulted in severe narrowong of the foramen and nerve compression (yellow arrow). Noti
Extraforaminal nerve compression:
Extraforaminal nerve compression is seen in about 5% of cases. Almost always it is a lateral disc herniation from a lo
Here an example of a lateral disc herniation that produces compression of the superiorly exiting nerve root and gan
posteriorly by a lateral disc herniation at the L4-5 level (green arrow).
None:

None:

Imaging in Acute Stroke:
Majda Thurnher
Department of Radiology, Medical University of Vienna:
Publicationdate 2008-06-30 This review is based on a presentation given by Majda Thurnher and was adapted for th
g subjects: How to identify patients with tissue at risk for guidance in selecting the appropriate therapy Introduction
Introduction:
Penumbra: Occlusion of the MCA with irreversibly affected or dead tissue in black and tissue at risk or penumbra in
is way we can select patients who are candidates for thrombolytic therapy.
CT Early signs of ischemia:
CT has the advantage of being available 24 hours a day and is the gold standard for hemorrhage. Hemorrhage on M
3-6 hrs and virtually all are seen in 24 hours. The overall sensitivity of CT to diagnose stroke is 64% and the specificit
erebral infarction are listed. MCA infarction: on CT an area of hypoattenuation appearing within six hours is highly sp
Hypo attenuating brain tissue:
The reason we see ischemia on CT is that in ischemia cytotoxic edema develops as a result of failure of the ion-pump
brain water content by 1% will result in a CT attenuation decrease of 2.5 HU. On the left a patient with hypoattenuati
ction, because of the location (vascular territory of the middle cerebral artery (MCA) and because of the involvement
tion. Hypoattenuation on CT is highly specific for irreversible ischemic brain damage if it is detected within first 6 hou
o demonstrate hypodensity on CT within first six hours were proven to have larger infarct volumes, more severe sym
risk of hemorrhage. Therefore whenever you see hypodensity in a patient with stroke this means bad news. No hypo
blurred basal ganglia
Obscuration of the lentiform nucleus:
Obscuration of the lentiform nucleus, also called blurred basal ganglia, is an important sign of infarction. It is seen in
st and most frequently seen signs (2). The basal ganglia are almost always involved in MCA-infarction. Two patients w
Insular Ribbon sign:
This refers to hypodensity and swelling of the insular cortex. It is a very indicative and subtle early CT-sign of infarcti
gion is very sensitive to ischemia because it is the furthest removed from collateral flow. It has to be differentiated fr
Dense MCA sign:
This is a result of thrombus or embolus in the MCA. On the left a patient with a dense MCA sign. On CT-angiography
Hemorrhagic infarcts:
15% of MCA infarcts are initially hemorrhagic. Hemorrhage is most easily detected with CT, but it can also be visualiz

CTA and CT Perfusion:
Normal CTA Once you have diagnosed the infarction, you want to know which vessel is involved by performing a CTA
ity. Then continue reading. The findings in this case are very subtle. There is some hypodensity in the insular cortex
is case it is suggestive for infarction, but sometimes in older patients with leukencephalopathy it can be very difficult
mfortable with the diagnosis of MCA infarction. CT Perfusion (CTP) With CT and MR-diffusion we can get a good impr
e ischemic penumbra (tissue at risk). With perfusion studies we monitor the first pass of an iodinated contrast agent
which area is at risk. Approximately 26% of patients will require a perfusion study to come to the proper diagnosis.
The limitation of CT-perfusion is the limited coverage. Studies were performed to compare CT with MRI to see how m
to come to a diagnosis. It was demonstrated that Plain CT, CTP and CTA can provide comprehensive diagnostic infor
In the case on the left first a non-enhanced CT was performed. If there is hemorrhage, then no further studies are ne
which demonstrated a perfusion defect. A CTA was subsequently performed and a dissection of the left internal car
MRI:
On PD/T2WI and FLAIR infarction is seen as high SI. These sequences detect 80% of infarctions before 24 hours. They
FLAIR demonstrating hyperintensity in the territory of the middle cerebral artery. Notice the involvement of the lenti
-sequences is comparable to hypodensity on CT. It is the result of irreversible injury with cell death. So hyperintensity
middle cerebral infarction
Diffusion Weighted Imaging (DWI):
DWI is the most sensitive sequence for stroke imaging. DWI is sensitive to restriction of Brownian motion of extracel
water protons have the ability to diffuse extracellularly and loose signal. High intensity on DWI indicates restriction
First look at the images on the left and try to detect the abnormality. Then continue reading. The findings in this case
he left frontal region with effacement of sulci compared with the contralateral side. You probably only notice these f
ormally read this as 'no infarction'. Now continue with the DWI images of this patient. When we look at the DWI-imag
to notice the infarction. This is why DWI is called 'the stroke sequence'. Signal intensities on T2WI and DWI in time (c
DWI in time we will notice the following: Pseudo-normalization of DWI in a 2 weeks old posterior infarction. Pseudo-n
the left shows a normal DWI. On T2WI there is may be some subtle hyperintensity in the right occipital lobe in the va
r the administration of Gadolinium shows gyral enhancement indicating infarction. First it was thought that everythi
me papers suggesting that probably some of it may be potentially reversible damage. If you compare the DWI image
ice that the affected brain volume in DWI is larger compared to the final infarcted area (respectively 62cc and 17cc).
Perfusion MR Imaging:
Perfusion with MR is comparable to perfusion CT. A compact bolus of Gd-DTPA is delivered through a power injector
on. T2* gradient sequences are used to maximize the susceptibility signal changes. The area with abnormal perfusio
perfusion images helps us to define the tissue at risk, i.e. the penumbra. Diffusion in yellow. Perfusion in red. Misma
n image indicating the area with irreversible changes (dead tissue). In the middle there is a large area with hypoperfu
ed in blue. This is the tissue at risk. This is the brain tissue that maybe can be saved with therapy. T2WI and PDWI in
left a patient with sudden onset of neurological symptoms.
MR was performed 1 hour after onset of symptoms.
First look at the images on the left and try to detect the abnormality. Then continue reading. These images are norm
See next images. DWI and PI On the DWI there is a large area with restricted diffusion in the territory of the right mi
ganglia. There is a perfect match with the perfusion images, so this patient should not undergo any form of thromb
visible on CT (i.e. irreversible changes). There is a match of DWI and Perfusion, so no therapy. On the left another cas
mages Perfusion images demonstrating large penumbra Now we can see that there is a severe mismatch. Almost th
atient is an ideal candidate for therapy. by R von Kummer et al. Radiology 1997, Vol 205, 327-333,
2. Early CT finding in cerebral infarction: obscuration of the lentiform nucleus by N Tomura et al Radiology 1988, Vol
3. State-of-the-Art Imaging of Acute Stroke by Ashok Srinivasan et alRadioGraphics 2006;26:S75-S95
Ultrasound of the Neonatal spine:
Erik Beek and Simone ter Horst and Robin Smithuis and Rutger Jan Nievelstein
Department of Radiology of the Wilhelmina Childrens Hospital, University Medical Center Utrecht and the Alrijne hos
Publicationdate October 29, 2019 Ultrasound is the preferred modality in neonates with suspected occult spinal dysr
OSD implies the presence of one or more spinal cord anomalies, which can cause tethering of the spinal cord and po
und is easy to perform, since the posterior arch of the vertebra is not yet ossified, providing a perfect acoustic windo
Especially the lumbosacral part of the spinal canal with the conus medullaris and the cauda equina can be beautifully
Classification of Spinal dysraphism:

Spina bifida aperta:
Spinal dysraphism or spina bifida is a congenital anomaly resulting in a defective closure of the neural arch.
It is classified into open (spina bifida aperta) and closed dysraphism (spina bifida occulta). Open dysraphism present
ay contain meninges and CSF, called meningocele or contain parts of the spinal cord or nerves, called myelomeningo
at the lesion itself.
It does not add much and can lead to infection.
Ultrasound can be used to examine more cranial parts of the vertebral column, searching for additional anomalies a

er closure of the myelomeningocele.
Spina bifida occulta:
In closed or occult spinal dysraphism, also called spina bifida occulta, there is an intact covering of the skin. The anor
s, hemangiomas, pigmented spots, cutaneous dimples or a subcutaneous mass. Another reason to perform ultrasou
e anal atresia. The term OSD implies the presence of one or more spinal cord anomalies, which can cause tethering
tion deficits.
The terms thickened or fatty filum terminale, spinal lipomas, split cord malformations, dermoid cyst, and syringohyd
Normal anatomy:
Click to enlarge The spinal cord is depicted as a very hypoechoic structure with a central echogenicity.
This central echogenicity is supposed to represent the interface between the anterior commissure and the median a
l cord with central echogenicity. Axial image of the cauda equina. The lower end of the cord is thickened, which is the
row). The cauda equina is seen as a bunch of moving strands.
If the baby is lying in the decubitus position, the strands will gravitate to the dependent posterior side.
If the baby is examined in the prone position with a pillow under the abdomen, the stands will move ventrally. The fi
The dural sac ends at approximately S2.
More distally fatty tissue is present. Video of the normal sagittal anatomy. Always obtain axial views.
The movement of the nerve roots is better seen in the transverse plane compared to the sagittal plane and it is easie
n right decubitus position.
The nerve roots are clustered in the dependent side, but move freely. When the nerve roots do not move freely, it ca
Position of the conus medullaris:
The normal position of the conus is at L!.
It should not be below L2. The best way to determine the position of the conus medullaris is by identifying the lumbo
ral vertebrae (arrow).
It can be helpful to flex and extend the pelvis to see the point of motion of the sacrum. In this newborn the lumbosa
le.
The numbers that we've put in, might be wrong. If one is uncertain, make a panoramic or dual image of the lumbosa
ards with a lateral plain film. Sagittal view of a normal "kyphotic" coccyx in a 2-day-old girl The coccyx, if not yet ossifi
It usually has a kyphotic shape.
On transverse views it should not be confused with a fluid collection or an abscess.
Normal variants:
Two-week-old girl with a sacral simple. There is a slight hydromyelia (white arrow) and a cyst in the filum terminale (y
In this image the central canal is visible as a thin anechoic line in the spinal cord (white arrow).
Although this is sometimes associated with pathology it is frequently seen as a normal finding. Ventriculus terminalis
A small cyst is seen in the proximal filum terminale.
This is called a ventriculus terminalis (or fifth ventricle).
Sometimes it is seen in the conus medullaris.
It is formed during embryogenesis and usually regresses completely during early childhood.
If it stays persistent, it typically measures less than 2 cm in craniocaudal dimension and 2 mm in transverse dimensio
adults. Here a sagittal image of a three-months-old girl who was imaged because of a skin discoloration of the lower
The spinal anatomy was normal and there was no sign of OSD. There is a straight coccyx, which is a normal variant.
Usually the coccyx has a anteriorly bent tip, but sometimes it is straight or even dorsally bent, which is also a normal
Pathology:

Tethered cord:
In many cases occult spinal dysraphism may not cause any symptoms.
However in some cases there may develop neurological problems due to tethering of the cord. A tethered cord is a p
n, so that the cord suffers mechanical stretching, distortion and ischemia with growth and development. In these cas
canal and to look for findings that are associated with a tethered cord (Table).
Low conus medullaris:
Newborn girl with a cloacal malformation.
The conus medullaris is at L5.
No lipoma visible.
Findings were confirmed at MR imaging which was acquired at the age of 9 months.
Continue with the MR. MR image at the age of 9 months. The conus medullaris is now seen at L4.
Thickened filum terminale:
Study the image.
What are the findings? Findings:
The plain film shows a fusion of S4 and S5. This was a newborn boy with an anorectal malformation.
An ultrasound was performed to look for signs of occult spinal dysraphism. This is the transverse video There is a thi
mild hydromyelia. Continue with the sagittal video. On the sagittal video the low ending conus medullaris is seen at L

mit of normal for the width of the filum terminale is 2 mm.
If it is thickened it often shows fatty infiltration with hyperechoic tissue. In healthy newborns, the tip of the conus me
The tip should not be positioned below L2-3.
Hydromyelia:
A hydromyelia is the abnormal widening of the central canal by cerebrospinal fluid. This condition may be either foca
cord. It can be associated with several congenital abnormalities including diastematomyelia, Arnold□Chiari malforma
llection in the cord outside the central canal it is called syringomyelia.
Because it is often not possible to separate these two entities on imaging, it is better to use the term syringohydrom
Transverse images will show the transition of the normal cord into the cord which surrounds a CSF collection
Spinal lipoma:
A spinal lipoma is an encapsulated deposit of fat, neural tissue, meninges or fibrous tissue which extends from the p
cia, muscle or bone to communicate with the spinal canal or meninges. A spinal lipoma is seen as an echogenic mass
The conus can be too low and buried in the lipoma. Here a sagittal image of a newborn boy with anal atresia.
The conus is blunted and ends at L2-L3. There is an echogenic mass which is likely a lipoma.
The filum is thickened. Small lipomas are often led alone. Bigger lipomas in symptomatic patients are removed. On a
s seen.
Dorsal dermal sinus:
This is a connection between the skin and the dural sac, sometimes into the spinal cord.
It presents with a dimple, discoloration of the skin or hairy patches. The conus medullaris can be too low. Three-day-
a dimple. US shows a tract from the skin towards the dural sac at the S1-S2 level, compatible with a dorsal dermal si
The conus medullaris is at a normal level and there is no other intraspinal pathology present. A T1-weigthed image s
onus medullaris is too low at L3-L4. Dermal sinus tracts □are especially important lesions to recognize because they
f infection such as meningitis and spinal cord abscess.
Diastematomyelia:
Diastematomyelia, also named split cord malformation, is a longitudinal split of the spinal cord.
At the point of division, there may be an osseous, fibrous or cartilaginous dividing septum.
Diastematomyelia is commonly associated with a vertebral column abnormality and a tethered spinal cord. The ultra
, who had several antenatal anomalies. There was a lateral rocker bottom feet deformity, lumbar kyphoscoliosis and
al split of the spinal cord at the thoracolumbar level. The bifid cord is asymmetric in volume. Additional plain films of
vertebrae. There was also a dislocated left hip. Newborn girl with an anorectal malformation. The distal sacrum belo
Blunt cord terminus:
This image is of a newborn girl with an anorectal malformation.
The distal sacrum below S4 is absent (arrow).
Since an anorectal malformation is frequently associated with spinal pathology, an ultrasound was performed. If a p
acrum, there is a 50% change of an intraspinal anomaly. In most cases there is a low ending tethered cord. In some c
d. This is a so-called blunt cord terminus.
There is generally a wedge-shaped ending in which the dorsal side reaches further caudally than the ventral side. Co
cord terminus at T12-L1. A blunt cord terminus is a sign of caudal regression syndrome characterized by abnormal c
coccyx is also visible. Continue with the MRI. Sagittal T2-weigthed image showing the cord terminus at Th12. by Kari
2. Use of magnetic resonance imaging to detect occult spinal dysraphism in infants
Rectal Cancer MR staging 3.0:
Doenja Lambregts, Rhiannon van Loenhout, Frank Zijta, Max Lahaye, Regina Beets-Tan and Robin Smithuis
Radiology Departement of the Netherlands Cancer Institute in Amsterdam, the Medical Centre Haaglanden in the Ha
Publicationdate 2021-09-01 This is the third version describing the role of MRI for the staging and restaging of rectal
cancer are total mesorectal excision (TME) and neoadjuvant radiotherapy with or without chemotherapy.
Both have dramatically changed the local recurrence and survival rates. MRI is the most accurate tool for the local st
ropriate treatment.
The decision whether a patient with rectal cancer is a candidate for TME only or neoadjuvant therapy followed by TM
es: In the end section there are two videos on how to report rectal cancer according to the structured reporting chec
If you first want to look at the videos click here.
Introduction:
The illustration shows the mesorectum and the mesorectal fascia, which is the plane for TME resection and the relat
Total Mesorectal Excision:
In TME the entire mesorectal compartment including the rectum, surrounding mesorectal fat and perirectal lymph n
is the standard surgical resection technique for rectal cancer and can be performed as either a low anterior resectio
neal resection (APR), where both the rectum and anal canal are resected.
Risk Stratification:
Local staging with MRI is performed to determine the best surgical strategy and the necessity for neoadjuvant treatm
risk disease and their use for treatment stratification vary between countries and guidelines and are continuously ev
T1, T2 and in several countries also early stage T3ab tumors without evidence of nodal metastases will generally be c

eatment. Intermediate RiskMore extensive T3 tumors and/or tumors with a limited number of suspicious nodes are
x 5 Gy) prior to TME has been shown to reduce the local recurrence risk for these intermediate risk tumors [ref]. Hig
esorectal fascia or adjacent organs, or tumors with many suspicious nodes (N2) are typically regarded as locally adva
iotherapy aiming to induce tumor downsizing and downstaging and enhance the chance of a complete surgical rese
ous) invasion has been proposed as an additional adverse prognostic feature that should be considered a sign of hig
invasive or non-surgical treatment alternatives in tumors that show a complete or near-complete response after neo
MRI plays an important role in addition to endoscopy to help select the right patients for these “organ preserving” tr
treatment include:
Structured Reporting Checklist:
Click for larger view A
good quality MRI report includes all risk factors used to stratify patients
into differentiated treatments, as well as an accurate description of the
relation of the tumor to its surrounding anatomy to inform surgical planning (figure). In
the following chapters we will discuss these various items listed in the reporting template in further detail TNM-prefi
ore treatment.
When defined based on imaging, the prefix “i" (imaging) or “mr” (MRI) are sometimes used as alternatives. “y”
is used to restage tumors after neoadjuvant treatment (chemo and/or
radiotherapy) and can be used for both clinical staging (ycTNM) as well as
pathological staging (ypTNM). “p” indicates the final TNM stage as determined at histopathology after surgery.
Morphology:

Polypoid and Sessile tumors:
Rectal adenocarcinomas typically arise from adenomas that can be either polypoid, which are tumors raised upon a
t more low-grade malignancies and present as a mass projecting into the bowel lumen with a focal attachment or sta
rcular or circular wall thickening. The site where the tumor is attached to the rectal wall is often referred to as the “i
when assessing the T-stage and looking for extramural tumor extension. The degree of attachment to the rectal wall
the radiology report as “from … to … o’clock”, or alternatively using prose descriptions such as “left anterolateral”. Bri
nal.
Solid and Mucinous:
The
distinction between solid and mucinous tumor types is relevant because mucinous
adenocarcinomas have a poorer prognosis and
typically show a poorer response to neoadjuvant treatment. Mucinous tumors show
distinct bright signal on T2-weighted MRI compared to the more intermediate
signal of solid type tumors (figure). A
more rare subtype of rectal cancer is the signet-ring cell carcinoma, which is
associated with a high risk for nodal and distant metastases and poor overall
survival. It is seen in only approximately one percent of cases. On MRI signet-ring cell carcinomas can be difficult to
discern, though they typically show long-segment diffuse bowel wall thickening
and a submucosal growth pattern that results in a ‘target’ appearance on axial
images. The
images show a signet-ring cell carcinoma with diffuse thickening of the rectal
wall and the target appearance on the axial image. Also note the diffuse
infiltration of the mesorectal fat, which is another common finding of signet
ring tumors.
Location:

Sigmoid take-off:
Discriminating
rectal from sigmoid cancer is important because the treatment approach differs
considerably. Routine treatment for sigmoid cancer is upfront resection, while
rectal tumours undergo differentiated treatments varying from surgery only in
low risk tumors to long course neoadjuvant chemoradiotherapy in high risk
tumors. In
2019 an international consensus panel agreed on the “sigmoid take-off” as the preferred
landmark to define the rectosigmoid junction and separate the rectum from the
sigmoid on imaging (ref). The sigmoid take off can be recognized on sagittal MRI as the point from which the sigmoi
cates the sigmoid take-off on a sagittal and axial view The sigmoid take-off can be recognized on sagittal MRI as the p
sacrum and on an axial view as the point from which the sigmoid projects ventrally (figure). Though recognizing the s
to anatomical variations between patients or varying sequence angulation, it is overall an intuitive landmark. Tumors

r starting proximal to the sigmoid take-off are considered sigmoid tumors. Tumor height The anorectal junction marks the transition between the anal canal and distal rectum. It is situated at the level of the anorectal angle, which is caused by contraction of the puborectalis muscle.
On sagittal MRI the anorectal junction is typically situated at the level of an imaginary line between the lower margin of the sacral bone and pubic bone. A common approach to determine the height of rectal tumors is to measure the distance between the lower margin of the tumor and the anorectal junction, or alternatively the distance from the anal verge, which is the transition between the anal epithelium and perianal skin. In some countries such as the US the location of the tumor in relation to the a determine the tumor height.
T-stage:
Click image for larger view This illustration shows the T-stages in the sagittal and axial plane. The table shows an ove sion into the mesorectal fat up to 5mm (T3ab) and the mesorectal fascia is not involved (distance ≥1mm). High risk T sorectal fascia. T4b tumors invade other organs or structures that are situated outside the mesorectum. The TNM cl covered by the umbrella term “structures”. In an international multidisciplinary consensus meeting from 2021 an ex thologists proposed that T4b should include invasion of the structures as mentioned in the table [ref].
T1-T2 – limited to the bowel wall:
T1 and T2 tumors are limited to the bowel wall and have a relatively good prognosis. The key finding to ensure that a tumor remains limited to the bowel wall (T1-2) is the presence of an intact muscularis propria, which can be recognized on MRI as an intact hypointense line surrounding the rectum. Image A cT1-2 tumor in the distal rectum is shown with an intact muscularis propria, which is clearly recognizable as a hypointense outer line of the rectal wall. Pitfall: differentiating T1 from T2 Anatomically, the rectal wall is comprised of 3 main layers: Typically, these 3 separate layers on MRI can only be recognized in the case of submucosal edema. In the absence of edema the rectal wall generally has a two-layered appearance where we can recognize the muscularis propria but cannot distinguish the mucosa from the submucosa. This is the reason why MRI is generally unable to distinguish T1 tumors (growing into the submucosa) from T2 tumors (growing into the muscularis propria). Endorectal ultrasound is more accurate f remain limited to the rectal wall are therefore typically grouped as cT1-2 on MRI.
T3 – invasion into the mesorectal fat:
T3-tumors grow through the muscularis propria into the surrounding mesorectum. On MRI this can be recognized as an interru hypointense muscularis propria with spicular or nodular extension of tumor signal beyond the rectal wall into the mesorectal fat. Image A semicircular rectum tumor with invasion into the mesorectum from approximately 1 to 4 o’clock. It does not grow within 1mm of the mesorectal fascia. The T-stage is T3 MRF- rectal cancer. Subclassification of T3 stage according to invasion depth: Low-risk T3-tumors: High-risk T3-tumors: Pitfall: perirectal stranding It can b tumors (case A) from desmoplastic stranding in T1-2 tumors (case B), which can be a potential cause of overstaging. Note:
The clinical significance to discern T2 from borderline T3 tumors has been argued as various current guidelines – including the Dutch guidel classify T3 tumors with limited extension into the mesorectal fat (cT3ab) in the same good prognostic group as T2 tumors for treatment stratification. In some guidelines, however, T3 disease by itself is still considered a factor used to determine the need for neoadjuvant treatment.
Mesorectal fascia involvement:
The mesorectal fascia (MRF) is a thin fibrous structure that encloses the mesorectal compartment and comprises the anticipated resection plane in TME surgery. On T2-weighted MRI the mesorectal fascia can be recognized as a thin hypointense line surrounding the mesorectum. When a tumor directly invades the MRF or the margin between the tumor and MR In these cases routine TME would induce a risk for local recurrence and neoadjuvant treatment will be required to in achieve a tumor-free resection margin.

When describing involvement of the MRF, you should always describe the location of involvement (e.g., “MRF+ at … o
ors with invasion of the mesorectal fascia. In the left case the distance between the tumor and the MRF is less than 1
volvement of the MRF between 10 and 12 o’clock Pitfall: circumferential resection margin A
radiology report for T3 tumors should include a description of the
smallest distance between the tumor and the MRF, which is sometimes
alternatively referred to in radiological reports as the ‘circumferential resection margin’ (CRM). This
use of CRM as a synonym for MRF is not fully accurate as the CRM is actually
the margin that the surgeon creates when performing a TME. Ideally, this will
be along the MRF, but the CRM may be smaller when the MRF is breached during
surgery or wider when the TME resection specimen includes additional fat
outside the MRF.
Mesorectal fascia versus Peritoneum:
The
low rectum is totally covered by the mesorectal fascia (green line). In the
mid rectum the mesorectum is covered by the mesorectal fascia on the posterior
and lateral side, but on the anterior side it is covered by the visceral
peritoneum (red line indicating the peritoneal reflection). In the high rectum the peritoneal lining extends from the
anterior to the lateral side (yellow line) and the MRF only lines the dorsal
part of the mesorectum. This
distinction is important because invasion of the MRF constitutes T3 MRF+
disease, while growth into the visceral peritoneum entails a risk for tumor spread
into the peritoneal cavity and is staged as T4a disease.
T4a - Invasion of peritoneum or peritoneal reflection:
The
anterior peritoneal reflection marks the transition between the
non-peritonealized and peritonealized portions of the rectum.
On sagittal
T2-weighted images the peritoneal reflection can be recognized as a hypointense
V-shaped thin line, sometimes referred to as the ‘seagull sign’. In
males it is located just above the seminal vesicles. In females it is located at the level of the cul-de-sac
(Douglas). Pitfall: Overstaging of upper rectal tumours: In upper rectal tumors there will often be a close margin betw
that we are dealing with a T4a tumor. Tumors should only be classified as cT4a if there is clear tumor extension into
age on the left shows a tumor with a close relation to the peritoneum and the bladder (white arrow). However there
the peritoneum is therefore not invaded. The image on the right shows definite tumor invasion of the peritoneum (y
eritoneal invasion Note
that in anterior tumors, MRF invasion can only occur in tumors below the
peritoneal reflection.
Tumors above the peritoneal reflection that invade the
peritoneum anteriorly (i.e. T4a tumours) are sometimes erroneously reported as
MRF+ tumors, which is not correct. cT4a MRF- The upper image shows a cT4a tumor in the upper rectum above
the level of the peritoneal reflection. There is involvement of the peritoneum (yellow stippled line), but not of the
mesorectal fascia. cT3 MRF+ The lower image shows a cT3 tumor in the low rectum below the
level of the peritoneal reflection. There is involvement of the mesorectum on the anterior side
(green line), but not of the peritoneum. cT4a MRF+ A combination of involvement of the peritoneum and the mesore
he upper rectum with involvement of the peritoneum on the anterior side and involvement of the mesorectal fascia
T4b – Invasion of surrounding organs or structures:
T4b tumors invade other organs or structures that are situated outside the mesorectum. The beforementioned 2021
e structures as mentioned in the table (reference). Though this has been a topic of debate, the consensus panel prop
at is situated in another anatomical compartment outside the mesorectum (i.e. beyond the MRF), such as the obtura
of T4b disease with respective invasion of the prostate (left) and invasion of
the levator ani (right). Note
Invasion of striated muscles is considered
T4b disease, which includes invasion of the external anal sphincter,
puborectalis and levator ani muscles. This is an example of a cT4b tumor growing beyond the mesorectal compartm
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Recognizing T4b invasion:
Tumor invasion is defined a continuation of tumoral signal extending into an adjacent organ or structure, which is of
through the axial images and see how the intermediate signal intensity of the tumor is seen to extend into the poste
EMVI -Extramural vascular invasion:

Extramural vascular invasion is a risk factor for recurrent disease, metastases and impaired overall survival. EMVI is s
ucture in close proximity to the tumor, when the vessel is expanded by tumor, or if the tumor infiltrates the vessel b
nal extending into an adjacent vessel
structure, expanding and disrupting the vessel contour. Pitfall: How to report MRF involvement by nodes, tumor dep
current guidelines it is not clearly described how to report MRF involvement by tumor-bearing structures other than
experts proposed in 2021 that the MRF should be reported as involved in case of a ≤1 mm margin from either the p
d tumor deposits or from irregular lymph nodes. Potentially malignant, enlarged lymph nodes with a
smooth margin and an apparently intact capsule contacting the MRF have
a very low risk to result in margin involvement at histopathology and should
therefore not be considered as MRF+ to avoid overtreatment.
Anal sphincter and pelvic floor involvement:
The anal sphincter is
comprised of three layers: Together with the iliococcygeus and pubococcygeus
muscles, the puborectalis and levator ani muscles form the “pelvic floor ” In
low rectal cancers, the MRI report should describe the relationship of
the tumor to the anal sphincter and pelvic floor to guide surgical and
radiotherapy planning.
This should include a description of which layers of the
anal sphincter and/or pelvic floor are involved, and whether invasion extends
into the upper, middle or lower thirds of the anal canal. Pitfall anal sphinter and TNM The TNM staging system does
phincter and pelvic floor should be taken into account. In the 2021 expert consensus meeting it was proposed to: A s
rnal sphincter on the left side (arrow).Remember that the invasion of the internal sphincter does not impact the cT-s
lp guide surgical planning. B is an example of a low rectal tumor that invades the internal and external sphincter on t
uborectalis and levator ani muscles. Remember that invasion of the external sphincter, puborectalis and levator equ
Note the normal appearance of the external sphincter and pelvic floor muscles on the left side (green arrow).
N-stage:
Regional lymph node drainage. The lymph nodes in red are all non, regional (M-stage) nodes. In TME only the mesor
inferior mesenteric nodes are excised.
Lymph Node Map:
The terminology used to describe the various lymph node stations in rectal cancer can be a source of confusion. Reg
otice that in standard TME only the mesorectal nodes are excised and in high rectal tumors also the rectalis superior
her regional lymph nodes, which are located lateral to the mesorectum like the obturator and internal iliac nodes are
lude all nodes that – when involved – are considered distant nodal metastases and are therefore part of the M-stage
rs inguinal nodes as regional nodes in case of low rectal tumors extending into the distal anal canal, below the level o
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MR-image shows the mesorectal, internal iliac, obturator and external iliac lymph
node compartments. Remember that external iliac nodes are non-regional and if
positive they are regarded as metastatic disease. The
obturator and internal iliac space are divided by the lateral border of the
main trunk of the internal iliac vessels. The posterior border of the external
iliac compartment is defined by the posterior border of the external iliac
vessels [ref]. Enable Scroll
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the purple area the superior rectal and inferior mesenteric nodes are located. These nodes are sometimes referred t
of the regional N-stage nodes. The level of the highest suspicious node in
this region should be mentioned in the report, as this will impact the chosen
radiotherapy field.
Mesorectal lymph nodes:
The N-stage in rectal cancer is only based on the number of suspicious regionallymph nodes.
Suspicious non-regional lymph nodes are considered metastatic disease. MRI
like other imaging modalities has a relatively low diagnostic performance to
stage lymph nodes. Whether or not N-stage as determined by imaging should be
taken into account for treatment stratification has been the topic of debate,
though most current guidelines still consider positive N-stage on imaging a
high risk sign, warranting neoadjuvant treatment. Best
results are obtained when applying a combination of nodal size and morphology
to characterize mesorectal lymph nodes. See published guidelines by ESGAR and in the Dutch national guidelines [re
are always regarded as suspicious. Smaller lymph nodes require additional morphologically

suspicious features (round shape, indistinct border, heterogeneous signal) in
order to be considered as cN+ as detailed in the Table. Note It is important to mention the level of the most proxima
especially if there are N+ nodes present high in the mesorectum or in the distal
mesosigmoid, along the superior rectal or inferior mesenteric vessels, as these
nodes can impact the radiotherapy field. The same size + morphology criteria
apply to stage these “high mesorectal” nodes.
Lateral lymph nodes:
Lateral lymph nodes are sometimes referred to as extramesorectal lymph nodes.
These are lymph nodes that are located lateral to the mesorectum and are not routinely removed in standard TME r
They need
to be reviewed carefully and mentioned separately in the report. Especially tumors
located below the peritoneal reflection have a tendency to spread to the
internal iliac and obturator compartments.
If pathologic
nodes in these compartments are not additionally treated by lateral nodal
dissection or radiotherapy, they are associated with a higher risk for
recurrence. In
2019, the lateral nodal study consortium proposed a size cut-off of ≥7 mm short axis diameter to stage internal iliac
also showed that – unlike in mesorectal nodes – morphologic features should not
be taken into account (ref). Example
of a pathologic lymph node measuring 9 mm in the left obturator space (arrow). This node
needs to be irradiated or resected separately to avoid recurrence. This
axial T2W-image is of a patient who was treated with a TME. There is a local recurrence of rectal cancer due to an un
by all for radiological staging, the 8th
edition of the TNM further divides the N-stage (table). Pitfall: nodes versus tumor deposits Pathologic lymph nodes a
no widely adopted criteria to discriminate the two. Some define tumor deposits as more irregular nodules that are
ill have a familiar round or oval shape and capsule typical of lymph nodes (ref). These definitions, however, remain t
anel advised to group nodes and deposits together in the cN-stage.
A prose description of the size and morphology of the suspicious lesions should be included in the report (ref). Imag
This sagittal T2W-image shows a low rectal cancer with multiple irregular nodular lesions in the mesorectal fat on the
epresent tumor deposits or pathologic lymph nodes, they are all considered as part of the N-stage, which was cN2 in
ent was classified as locally advanced and received neoadjuvant chemoradiation for tumor and nodal down-staging.
M-stage:
The
M-stage in rectal cancer is based on the presence of suspicious non-regional lymph node metastases and other dista
that non-regional lymph nodes are together considered as one “organ”.
Restaging after neoadjuvant treatment:

Checklist:
A restaging
report basically uses the same descriptors as for primary staging. In addition to yTNM-staging, it is important to give
patients as poor, good or potential complete responders to inform further clinical decision making. In
most cases, a restaging report mainly serves as an up-to-date roadmap for the
surgeon.
In some cases restaging is
also used to select potential candidates for organ-preservation. In the table the main items and criteria that are spec
the restaging setting are summarized.
Response assessment:
After
chemo-radiotherapy, rectal tumors typically decrease in size and undergo a
fibrotic transformation which can be observed as a marked decrease in signal
intensity of the tumor bed on T2-weighted images. In a
small minority of cases (<5%) the tumor completely disappears and an
apparently normalized rectal wall re-appears on MRI after CRT. A
restaging MRI report should start with a general description of the degree of
response. The
response can be classified into: Tumor regression grade (TRG)MRI has known difficulties in differentiating between
fibrosis still containing vital tumor cells and mere fibrosis. Nevertheless there are certain patterns that can help
estimate the risk for significant viable tumor within the fibrosis. The
MR tumor regression grade (mrTRG) is an imaging adaptation of similar TRG

systems used at histopathology and can be used to grade the degree of fibrotic transformation on T2-weighted MRI using a 5-point scale (table)
Diffusion-weighted imaging:
DWI highlights tissue with a high cellular density in which the extracellular movement of water is “restricted”. DWI has been shown to be a useful adjunct to T2-weighted MRI to diagnose the presence of viable residual tumor within the fibrotically changed tumor bed after CRT [reference]. In case of residual tumor, a high signal can typically be observed at the inner margin of the fibrosis on high b-value diffusion-weighted images, with a corresponding low signal on the ADC map. Images The images show the primary staging and restaging T2-weighted images after chemoradiotherapy with predominant fibrosis with minor signal heterogeneity (TRG 3). The corresponding restaging DWI shows a focal area of high signal at the inner margin of the fibrosis with corresponding low signal on the ADC map, indicating restricted diffusion. This was confirmed to be a small tumor remnant (ypT2) at histopathology. Pitfall: staging in case of fibrosisUnfortunately the overall accuracy of MRI to assess yT-stage, yMRF, yEMVI and sphincter invasion after CRT is poorer than in the primary staging setting due to the difficulties of MRI to assess the presence and extent of vital tumour within the fibrotically changed tumor bed. Assessment of MRF involvement after CRT When a fat plane re-appears between involvement is very small. When there is still diffuse infiltration of the MRF by intermediate tumor signal after CRT, the risk for tumor invasion at histopathology is high (around 90%). The most difficult cases are those with diffuse fibrotic infiltration of the MRF. In these cases, the risk for MRF positivity at histopathology is around 50% [reference]. ImagesPre-CTR there is extensive invasion of the MRF from 4-8 o’clock (arrows). After CRT ted from the MRF. A fatplane has appeared with only some minor fibrotic stranding towards the MRF. These are signs indicative of a tumor-free MRF at restaging (yMRF-) Example of a patient with several irregularly enla t nodes have disappeared and only a small node of < 5 mm remains, indicative of a ycN0 stage. yN-stage The diagnostic performance of MRI to restage lymph nodes after CRT is better than for the primary staging of nodes. After CRT, the majority of nodes decrease in size or completely disappear on MRI. Nodes that remain clearly visible after CRT are still at risk. Although the optimal size cut-off remains a topic of debate, a cut-off of ≥5 mm (short axis diameter) has been proposed to diagnose yN+ nodes after CRT [ref]. For the lateral nodes, the lateral nodal study consortium have proposed a cut-off of >4 mm (internal iliac) and >6 mm (obturator), but these criteria are to date considered preliminary and remain to be validated [ref]. Lymph nodes like other lymphoid lting in restricted diffusion and a high signal on DWI. As a result, DWI can be helpful in detecting lymph nodes but is l and metastatic lymph nodes will show high signal. Images
Better visualisation of lymph nodes on DWI compared to corresponding T2WI.
DWI pitfalls:
T2 shine through Diffusion-weighted images are inherently T2-weighted.
T2 shine through refers to the presence of high signal on DWI that is not caused by restricted diffusion, but by long T2-relaxation time (e.g., in fluids).
In rectal DWI this may occur in case of small amounts of fluid in the rectal lumen, which may mimic tumor in the adjacent rectal wall.
To differentiate between this luminal T2 shine-through and tumor one should refer to the ADC map where luminal fluids will show a high signal. T2 dark throughAlso called T2 black out, refers to the markedly low signal observed on the ADC map in areas of dense fibrosis without vital tumor.
This occurs in tissues with a very short T2-relaxation time (such as collagen-rich fibrosis, calcified lesions and cortical bone) and will result in a completely hypointense signal on the ADC map, but also on other series

including the DWI, T2-weighted and T1-weighted sequences.
T2 dark through
should not be mistaken for restricted diffusion suspicious for tumor. Example of shine through of high T2 signal on D
The ADC map shows an example of T2 dark through with distintly low signal in the fibrotically changed rectal wall. Th
ng that there is no actual diffusion restriction. Susceptibility artefacts Abdominal DWI scans are often acquired using
n thereby minimizing the risk of motion artefacts.
The main downside of EPI-DWI is that it is highly prone to susceptibility effects, i.e. distortions or artificial pile up of M
lly at higher field strengths. In rectal DWI, these susceptibility effects mainly occur at the interface between soft tissu
While large artefacts will be easy to recognize as artefacts, more subtle ones projecting over the rectal wall may be e
ts in rectal DWI may be avoided by reducing the amount of gas in the rectal lumen or by using alternative methods o
rone to these susceptibility effects. ImagesThis is a patient with tumor in the right anterolateral rectal wall. Post CRT
ed from 9-12 o'clock. The high signal on DWI is located on the contralateral side, outside the tumor bed and correspo
n. These artefacts should not be mistaken for high signal suspicious of tumor.
MR protocol:
HardwareMRI of rectal cancer may be performed at either 1.5T or 3.0T,
using phased array external surface coils. Use
of an endorectal coil is not routinely recommended. Patient preparationPatient preparation is not mandatory.
Use of spasmolytics may be considered to reduce bowel movement artefacts
(particularly in upper rectal tumors that are more prone to these
artefacts).
Use
of endorectal filling is not routinely recommended since distension of the
rectum and consequent compression of perirectal tissues may interfere with
correct interpretation of the distance between the tumor and mesorectal fascia
. Preparatory
steps to reduce the amount of gas in the rectal lumen may be helpful to avoid
gas-induced susceptibility artifacts on DWI-sequences, although this is mainly
an issue in the restaging setting where DWI plays a more important role.
This
can be achieved for example by giving patients a preparatory micro-enema
or a small volume of rectal filling (up to 60 ml). Sagittal series
The sagittal series is used to localize the tumor and to plan the
axial and coronal series. The cranial border of the field of view (FOV) should
be at the level of the sacral promontory and the caudal border below the anal
canal. Axial series
The axial (or oblique-axial) view should be angled perpendicular
to the tumor axis to allow proper assessment of the extension of the tumor
beyond the rectal wall and the distance between the tumor and MRF. Coronal series
The coronal
sequence should be angled parallel to the tumor axis, which is perpendicular to the axial series. In distal tumors nea
involving the anal canal, the coronal sequences should be planned parallel to
the anal canal or an additional coronal plane parallel to the anal canal
should be added to the protocol to properly assess whether and to what extent the
tumor is invading the anal sphincter (right figure). Example of improper angulation. Click to enlarge image Example s
impact of sequence angulation:In the middle
image the axial view is angled in true axial plane, which is not perpendicular to the tumor axis of this low rectal tumo
This resulted in the false impression that the MRF was involved on the anterior
side (red circle).
In the right image, the axial view is correctly planned
perpendicular to the tumor axis and it was clear that the MRF was not involved
(yellow circle). T2WI
A rectal
MRI protocol should routinely include high resolution 2D T2-weighted sequences
in multiple planes with a slice thickness of ≤3 mm. Although recent technical advances have
improved the quality of 3D T2-weighted sequences, they are not yet commonly
used as a replacement for 2D T2-weighted sequences. The required in plane
resolution is less well documented in guidelines, though a resolution of 0.6 x
0.6 mm or less is generally recommended [ref]. DWI
It is recommended to routinely include a diffusion-weighted imaging (DWI) sequence. Diffusion weighted imaging ca
d are particularly useful for the restaging of tumors after neoadjuvant treatment.

The DWI protocol should include at least one high b-value of ≥ 800 s/mm2.
Apparent diffusion coefficient maps should be calculated from the DWI series to be studied visually alongside the DW
Example of a patient with a lot of faeces in the rectum. The tumor itself is barely recognizable on the T2-weighted MR
ients with very similar semicircular tumors pre- and post-CRT.
On the T2W-images post-CRT both patients show some fibrotic wall thickening in the radiated area, but no obvious s
mass-like diffusion restriction. There is only some shine through of fluid signal in the lumen. In patient B there is foca
A was confirmed to be a complete responder at endoscopy and went into a wait-and-see program.
Patient B underwent resection which confirmed a ypT2 tumor remnant. DWI in restaging after chemoradiation Othe
useful to help characterize
coincidental findings (e.g. bone lesions, ovarian cysts) but are not mandatory
for staging . T1-weighted sequences with an extended field of view can also be
used to cover all relevant lymph node stations within a relatively short
acquisition time. Intravenous contrast: steady-state gadolinium enhanced imaging does not
improve diagnostic accuracy for clinical staging and is not routinely
recommended. Dynamic contrast-enhanced MRI is not routinely recommended for
clinical staging. Fatsuppression: fatsuppressed sequences are not required for staging.
T2-weighted fatsuppressed images may be of added benefit for patients with
concommittant perianal fistulas or abscesses.
Surgery:
This is an
umbrella term for various minimally invasive techniques to excise rectal tumors
endoscopically, through the anus. Endoscopic mucosal resection (EMR) and
endoscopic submucosal resection (ESD) are superficial excision techniques used
for non-cancerous polyps and T1a and T1b tumors.
Transanal minimally invasive
surgery (TAMIS) or transanal endoscopic microsurgery (TEM; a very similar but
older technique) is a full thickness endoscopic resection of all layers of the
bowel wall that can be applied for T1 (and some small T2) tumors.
Organ-preservation:
There
is a growing tendency to consider minimally invasive or non-surgical treatment
alternatives in tumors that show a complete or near-complete response after
neoadjuvant treatment. These alternatives
include the “watch-and-wait”
strategy, where patients with a clinical complete response after neoadjuvant
treatment are deferred from surgery and closely monitored, and local excision
or local radiotherapy techniques for patients with small tumor
remnants. These developments have urged the need for a more accurate radiological
assessment after neoadjuvant treatment and MRI – combined with endoscopy and
clinical examination – plays an important role in the selection and monitoring
of these patients.
Video examples of Staging:
Enable Scroll
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Low Rectal cancer:
In this case we demonstrate how to stage a low rectal cancer.
You can scroll through the images and then go to the video in wich we will explain the staging. Sorry, your browser d
to stage a low rectal cancer. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll
High Rectal cancer:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
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None:

None:

Common Liver Tumors:
Richard Baron
Radiology department of the University of Chicago:
Publicationdate 2006-07-15 This article is based on a presentation given by Richard Baron and adapted for the Radio
ogy at the University of Chicago and well known for his work on hepatobiliary diseases. He has been president of the
art I a basic concept is given on how to detect and characterize livermasses with CT. In Part II the imaging features of
Hemangioma:
Hemangioma is the most common benign liver tumor. It is composed of multiple vascular channels lined by endothe
ize varies from a few millimeters to more than 10 cm (giant hemangiomas). Calcification is rare and seen in less than
emangioma matches the bloodpool in every phase. CT will show hemangiomas as sharply defined masses with the s
characterized by sequential contrast opacification beginning at the periphery as one or more nodular areas of enhan
as the bloodpool. This means that in the arterial phase the areas of enhancement must have almost the density of th
of the same density as the portal vein. Even on delayed images the density of a hemangioma must be of the same de
with contrast. Flash filling hemangioma in unenhanced, arterial and portal venous phase. Notice it matches the bloo
flash filling'). Small HCC and hypervascular metastases may mimic small hemangiomas because they all show homog
es to see if the enhancing areas match the bloodpool, it is usually possible to differentiate these lesions. Giant hema
the bloodpool in all phases. Central scar is hypodens on NECT and stays hypodens. Large hemangiomas can have an
al fibrous scarring. These lesions need to be differentiated from other lesions with a scar like FLC, FNH and Cholangi
e left two large hemangiomas. Notice that the enhancing parts of the lesion follow the bloodpool in every phase, but
nhancement in breast metastasis. RIGHT: nodular discontinuous enhancement in hemangioma. Peripheral enhance
globular and discontinuous. Rim enhancement is continuous peripheral enhancement and is never hemangioma. Ri
iver lesion showing nodular enhancement, progressive fill in and delayed enhancement. Progressive fill in First look a
ue. The lesion definitely has some features of a hemangioma like nodular enhancement in the arterial phase and pro
portal venous phase however, the enhancement is not as bright as the enhancement of the portal vein. The conclus
, so it cannot be a hemangioma. So progressive fill in is a non-specific feature, that can be seen in many other lesions
oma. The delayed enhancement in this lesion is due to fibrotic tissue in a cholangiocarcinoma and is a specific featur
RIGHT: Also a hemangioma but now in a hyperechoic liver, so the lesion is relatively hypoechoic. Notice increased so
S. If you had to pick one word to characterize a hemangioma on US, you would probably say 'hyperechoic'.
You have to realize however, that this simply means that the lesion is hyperechoic to normal liver. If the liver is hyper
c (figure). Another important feature of hemangiomas is the increased sound transmission. This is because the lesion
is Hemangiomas must be differentiated from other lesions that are hypervascular or lesions that show peripheral en

Hepatocellular Carcinoma (HCC):
HCC is the most frequent abdominal malignancy worldwide and is especially common in Asia and mediterrean coun
nsists of abnormal hepatocytes arranged in a typical trabecular pattern. Larger HCC lesions typically have a mosaic a
osis or with hepatitis B/C our major concern is HCC, since 85% of HCC occur in these patients. If you take a cohort of
% of them will have end stage liver disease and 25% will have HCC. Small HCC seen only in arterial phase in a patient
Early appearance of HCC:
It is important to separate the early appearance from the late appearance of HCC. Nowadays we encounter very sma
l lesions that transiently enhance homogeneously. You will only see them in the arterial phase. Sometimes there is ri
s look how they present in the other phases and compare with the bloodpool and remember that rim enhancement
ones that we see in the non-cirrhotic patients. Large HCC with mozaik pattern in a non cirrhotic patient.
Late appearance of HCC:
HCC is a silent tumor, so if patients do not have cirrhosis or hepatitis C, you will discover them in a late stage. They te
rrhage, necrosis and fat evolution. HCC becomes isodense or hypodense to liver in the portal venous phase due to fa
On delayed images the capsule and sometimes septa demonstrate prolonged enhancement. LEFT: Diffusely enhanci
with vessels within the thrombus. HCC and Portal Vein thrombosis Many patients with cirrhosis have portal venous t
common findings and they can be coincidental. It is very important to make the distinction between just thrombus a
portal vein, it will always enhance and you'll see it best in arterial phase. Secondly, if you have a malignant thrombus
sel. Sometimes a tumor thrombus may present with neovascularity within the thrombus (figure).
Differential diagnosis:
Metastases can look like almost any lesion that occurs in the liver.
Hypervascular metastases have to be differentiated from other hypervascular tumors that can be multifocal like hem
Hypovascular metastases have to be differentiated from focal fatty infiltration, abscesses, atypical hypovascular HCC
in portal venous phase (left). Better seen on NECT. Metastases in fatty liver Focal fatty sparing in a diffusely fatty liver
ses. However on nonenhanced scans these regions of fat variation tend to be nonspherical and geographic, with no
fatty liver can also obscure metastases. On a contrast enhanced CT hypovascular lesions can be obscured if the liver
e lesions usually are better depicted (figure). Steatosis of right liver lobe. No lesions detectable. On US multiple lesion
y liver, it is better to do an MRI or ultrasound for the detection of livermetastases. On the left a patient with fatty infil
No metastases were seen, but on an ultrasound of the same region multiple metastases were detected.
Hepatic Adenoma:
Hepatocellular adenomas are large, well circumscribed encapsulated tumors.
They consist of sheets of hepatocytes without bile ducts or portal areas. 80% of adenomas are solitary and 20% are m
of well-differentiated hepatocytes. Adenomas are prone to central necrosis and hemorrhage because the vascular s
lieved to be related to a generalized vascular ectasia that develops due to exposure of the liver to oral contraceptives
eptives an adenoma is the most frequent hepatic tumor. CT will show most adenomas as a lesion with homogeneou
liver in later phases. Unfortunately, this homogeneous enhancement in the late arterial phase is not specific to aden
r metastases and FNH can demonstrate similar enhancement in the arterial phase. Malignant lesions however have
so they may become relatively hypodense in later phases. The finding of hemorrhage as an area of high attenuation
eature of HCC and large hemangiomas. Fat deposition within adenomas is identified on CT in only approximately 7%
ell-defined borders and do not have lobulated contours. A low-attenuation pseudocapsule can be seen in as many as
scans. Coarse calcifications are seen in only 5% of patients. On the left an adenoma with fat deposition and a capsul
e. Chemical-shift imaging showing loss of signal on out-of-phase images can confirm the presence of fat. HCC is know
ence of fat does not help differentiate the lesions. Adenoma with hemorrhage. Adenomas may rupture and bleed, ca
using hepatic hemorrhage are HA and HCC. Although adenomas are benign lesions, they can undergo malignant tra
ormation is rare, for this reason, surgical resection is advocated in most patients with presumed adenomas. Enhanci
ween the CT appearances of adenoma, HCC, FNH, and hypervascular metastases, making a definitive diagnosis base
al correlation in such cases is most helpful. In otherwise healthy young women using oral contraceptives, adenoma i
, acromegaly, or males on anabolic steroids also are more prone to developing hepatic adenomas.
A history of cirrhosis and high AFP levels favor HCC. A history of a primary hypervascular tumor favors metastases. A
of intraperitoneal hemorrhage and the rare occurrence of malignant transformation to HCC, surgical resection has b
icant bleeding from the tumor is as high as 30%. The exact risk of malignant transformation is unknown. Some advo
n AFP levels are elevated, since these two findings are associated with higher risk of malignancy. The value of percut
ial for two reasons. First, histologic studies may lead to misdiagnosis when differentiating HA from FNH. In addition,
med on these hypervascular tumors. Adenomas may diminish after oral contraceptives are discontinued, but this do
diagnosis of FNH can be made using imaging studies, surgery can be avoided and lesions can be observed safely usi
tial diagnosis, surgery usually is indicated.
Focal Nodular Hyperplasia (FNH):
FNH is the second most common tumor of the liver. FNH is not a true neoplasm. It is believed to represent a hyperpl
enous malformation. All the normal constituents of the liver are present but in an abnormally organized pattern. US
scar may be detected as a hyperechoic area, but often cannot be differentiated. With color doppler sometimes the v
tumor, that will be hyperdens in the arterial phase, except for the central scar. On the left a typical FNH with a centra

rdens in the equilibrium phase. MRI will show a hypointense central scar on T1-weighted images. On T2-weighted im
ery typical.
However in 20% of patients the scar is hypointense. Gadolineum enhanced MRI will reveal similar enhancement patt
l phase and isodense to normal liver in the portal venous phase. No scar was seen. The diagnosis of FNH is based on
. However, a typical central scar may not be visible in as many as 20% of patients (figure). Moreover a central scar ma
carcinoma, hepatic adenoma and intrahepatic cholangiocarcinoma. The key to the diagnosis in the lesion on the left
l venous phase and stays that way without a wash out on the delayed phase (not shown). This could also be an aden
WI, T1WI without Gadolineum and a delayed phase after Gadolineum. If you look at the images on the left and just w
l area of high signal? The most common cause would be central necrosis in a tumor. However if you look at the delay
otic tissue and the diagnosis is FNH. Fibrolamellar carcinoma (FLC) has a dark scar on T2WI and FNH has a brigth sca
rential between FNH and FLC will not be possible.
Fibrolamellar carcinoma (FLC):
FLC is an uncommon malignant hepatocellular tumor, but less aggressive than HCC. FLC characteristically manifests
e typical risk factors for HCC such as cirrhosis, elevated alphafetoprotein, viral hepatitis, alcohol abuse are absent. FL
ass with a central scar in an otherwise normal liver. Calcifications occur in 30-60% of fibrolamellar tumors. LEFT: FLC
s enhancement in a lamellar pattern. RIGHT: venous phase with hypodense central scar. Imaging features of FLC ove
Hemangioma and Cholangiocarcinoma. FNH, in particular, may simulate FLC, since both have similar demographic a
will usually be hypointense on T2WI and will less often show delayed enhancement. While FNH is always very homog
on. On the left pathologic specimens of FLC and FNH. At first glance they look very similar. However when you look c
of FLC compared to the homogeneous appearance of FNH. On non enhanced images a FLC usually presents as a big
Cholangiocarcinoma:
Cholangiocarcinoma usually presents as a mass of 5-20cm. In 65% there are satellite nodules and in some cases pun
is often difficult to make for a radiologist and even a pathologist. That is because cholangiocarcinoma has a varied n
ing lesion, because it can have a fibrous or a glandular stroma. It can be located anywhere in the intrahepatic bile du
erial, portal venous and equilibrium phase. First look at the images on the left and try to find good descriptive terms
he folowing characteristics: The finding of an infiltrating mass with capsular retraction and delayed persistent enhan
holangiocarcinoma does not cause mass effect, because when the stroma matures, the fibrous tissue will contract a
that cause retraction of the liver capsule, since most tumors will bulge. The most common tumor that causes retract
ill give a pseudo-cirrhosis appearance. Another cause of local retraction is atrophy due to biliary obstruction or chron
es how difficult the detection of ta cholangiocarcinoma can be. Only on the delayed images at 8-10 minutes after con
fibrous component of the tumor. Some cholangiocarcinomas have a glandular stroma.
Hepatic Metastases:
The liver is the most common site of metastases. The most common organs of origin are: colon, stomach, pancreas,
lobes in 77% of patients and only in 10% of cases there is a solitary metastasis. Hypovascular metastases are the mo
s. They are detected as hypodense lesions in the late portal venous phase. In this phase the attenuation of the norm
uating metastases, sometimes with peripheral enhancement. The rim enhancement that occurs represents viable tu
r (figure). Hypervascular metastases are less common and are seen in renal cell carcinoma, insulinomas, carcinoid, s
te arterial phase at 35 sec after contrast injection. Although breast cancer metastases can be hypervascular, it was sh
show any advantage. Calcified liver metastases are uncommon. Calcification can be seen in metastases of colon, sto
a and melanoma. When calcified liver metastases are revealed by CT in a patient with unknown primary tumor, colon
een in mucinous ovarian ca, colon ca, sarcoma, melanoma, lung ca and carcinoid tumor. On MRI metastases are usu
akes lesions appear larger on T2WI and is very suggestive of a malignant mass. On dynamic contrast-enhanced MRi t
metastasis in a patient with colon cancer. Ultrasound findings At US, metastases may appear cystic,hypoechoic, isoe
esentation of metastases. In these metastases the halo is most probably related to a combination of compressed no
oliferation. This pattern suggests aggressive behavior and is seen in bronchogenic, breast and colon carcinoma, . Ho
be seen in primary malignant liver neoplasms (eg, HCC) and benign liver neoplasms (eg, adenoma in glycogen storag
esses.
Calcified metastases may shadow when they are densely echogenic (figure). This pattern is commonly seen in colore
Liver abces:
The presentation of liver abcesses is very much dependend on the way the bacteria have entered the liver. There are
is through the portal vein as a result of abdominal infection. The bacteria enter through the slow flow portal system
down into the dependent portion of the right lobe. In sepsis the spread will be via the arterial system as in patients w
out through the periphery of the liver. The biliary route is often the result of biliary manipulation as in ERCP. It is usu
re is a direct route as in penetrating injury or direct spread of cholecystitis into the liver. Liver abcess in a patient with
nd try to find good descriptive terms for what you see. Then continue. If you would describe the image on the left, yo
especially because it's clustered. Only when you have a population with livertransplants, bilomas in an infarcted area
mor could look like this. It is very important to make the diagnosis of liver absces because it is a benign disease that
icion. LEFT: Small cyst-like lesion after recent ERCPRIGHT: 3 weeks later a large absces had developed. Whenever you
an ERCP, be very carefull to assume it is just a simple cyst. Biliary abscesses start small but can progress rapidly. The
mall lesion in the left liver lobe progressed to this huge abces. So any cystic structure near the biliary tract in a patien

picious of a liver abces.
BTS guideline of pulmonary nodules:

Guideline of the British Thoracic Society:
Onno Mets and Robin Smithuis
the Academical Medical Centre, Amsterdam and the Alrijne Hospital, Leiderdorp, the Netherlands:
Publicationdate 2017-10-01 This article presents the 2015 guidelines of the British Thoracic Society (BTS) for the man
delines are: The same approach for nodules detected incidentally as for those detected through screening. Introduct
Introduction:

BTS guideline:
The figure shows a comprehensive version of the BTS-algorithms. No follow up for nodules < 5mm and typically ben
al nodules.
* Step 2 Only lesions of 5mm or more require follow up. Divide lesions into solid and subsolid (groundglass or part s
* Step 3 Use the Brock Model application to assess the risk of malignancy for solid lesions >8mm and subsolid lesion
* Step 4 Use the Herder model when you perform a PET-CT. Follow-up takes 1 year if volumetry is used, while manua
ow volume change less than 25% should be regarded stable and discharged after the indicated follow-up interval. Co
y. When there is previous imaging, determine the risk of lung cancer based on the volume doubling time. Example 1
n the RLL of a 55 year old male without a positive family history, but with some emphysema. Follow-up showed long
rged from further CT surveillance. Example 2 A solitary non-spiculated solid nodule of 9 mm (362 mm3) is shown in t
r emphysema. Risk prediction by the Brock model equalled 6.3%, indicating surveillance with CT at 3 months. This sh
th with a VDT <400 days. Wedge resection after wire-localization was performed, diagnosing a pulmonary carcinoid.
BTS Pulmonary Nodule Risk Prediction Calculator:
Click here to use the calculator for the Brock model, Herder model and the volume doubling time calculator after che
or you can calculate: You can also download the calculator-app on your iPhone or Android phone. Click here to see t
s obtained using a 2D caliper technique and 3D nodule volumetry. Note that the 2D measurement is the single maxi
s in the Fleischner method. In case of multiple pulmonary nodules, the risk assessment and follow-up strategy is bas
ncrease ≥25%. When the volume increase is less than 25%, the lesion is called stable.
Brock Model:
McWilliams and colleagues developed the Brock model for pulmonary nodule malignancy risk prediction [2]. Use the
lculate the malignancy risk. Here we see an example of a 45 year old woman with an 8 mm solid nodule not located
y of lung cancer and there is no emphysema. The app calculates a malignancy risk of 1.9%. Here another example of
obe with spiculation. There is a family history of lung cancer and there is emphysema. The app calculates a malignar
Herder model:
The BTS guideline applies the Herder model to reassess the malignancy risk in nodules that are evaluated with PET-C
score ≥10%. It calculates the risk that a nodule will be diagnosed as cancer using : age, smoking status, history of ext
* Nodule characteristics: size, upper lobe location, spiculation.
* FDG-avidity: no - faint - moderate - intense. This model showed excellent performance [3], although the performan
An example of the Herder model in the app is seen here. It is the same 65-year old man as in the example of the Bro
67.7% to 10.4% based on the fact that there was no FDG-uptake in the lesion.
Perifissural nodules:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. by Callister et al. Thorax 2015;70:ii1-ii54. DOI:10.1136/thoraxjnl-2015-207168
2. Probability of cancer in pulmonary nodules detected on first screening CT by McWilliams et al. N Engl J Med 2013;3
3. Clinical prediction model to characterize pulmonary nodules: validation and added value of 18F-fluorodeoxyglucos
90-6
None:

Characterization of Adrenal lesions:
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Publicationdate 2019-03-26 Adrenal lesions are very common. Many of these lesions are incidentally discovered and
s > 1 cm that is detected on imaging exams not performed for suspected adrenal disease. Most of these incidentalor
n malignancy. In this article we will discuss the evaluation and management of adrenal masses by dividing them into
Systematic Approach:
Adrenal incidentalomas are common and seen in about 3% of abdominal CT's, increasing up to 10% in elderly patien
metastases or primary malignant masses without unnecessarily exposing the majority of patients to the burden of c
e whether a lesion has typically benign or indeterminate imaging features. If it is indeterminate, do a washout-CT or
an adenoma, then you have to choose between follow up, PET-CT, biopsy or resection. When an adrenal incidentalor

ow long-term stability in comparison to prior imaging.
2. If the lesion is indeterminate and 1-4 cm in diameter: We will now discuss each of these possibilities.
Typically Benign lesions:
Many adrenal lesions can be categorized as typically benign and need no follow up (table): 'No enhancement' is defin
ed CT. Here some examples of typically benign lesions. Lipid-rich adenoma 70% of adenomas contain high intracellu
sity equal to or below 10 HU is considered diagnostic of a lipid-rich adenomas. Using a safe threshold value of 10HU
h specificity of 96-98% for the diagnosis of an adenoma [5-7]. Lipid-poor adenoma 30% of adrenal adenomas do not
HU and cannot be differentiated from non-adenomas on an unenhanced CT. These adenomas are called lipid-poor.
ut. These lipid-poor adenomas will be discussed in the chapter on indeterminate lesions. The images show bilateral
analysis of an abdominal aneurysm. The scan in the arterial phase shows bilateral lesions with a density of 50 HU. O
both adrenal glands was less than 10 HU, proving these to be lipid-rich adenomas. Cyst An uncomplicated cyst is a w
has a thin wall and may have thin septa. It may be an endothelial cyst or a pseudocyst, which are the most common,
s may have thicker walls. Hemorrhage or debris may cause increased internal attenuation. Both benign and maligna
ensity measurements are unreliable. Features of an underlying tumor may be an irregular thick wall of 5 mm or mor
lcifications Lesions with benign calcifications Coarse rounded, peripheral or septal calcifications are typically benign
benign origin. Punctate, dystrophic and irregular calcifiations are not typically benign and can be seen in: Myelolipom
nts. Usually they are easy to recognize on CT or MR because they contain areas of macroscopic fat. Calcifications are
macroscopic fat, which is specific for the diagnosis myelolipoma. On the right a different case with high SI on T1W-in
nother adrenal mass mainly composed of macroscopic fat. Diagnosis: myelolipoma.
Indeterminate lesions 1-4 cm:
Many adrenal lesions cannot be confidently diagnosed as either lipid-rich adenomas or another benign entity becaus
only an enhanced CT to start with. These lesions are called indeterminate. These include the 30% of adenomas that
enoma you can do a CT washout scan and look for rapid wash-out, or an MRI and look for signal drop on the out-of-p
Adrenal Washout:
Adenomas, both lipid-rich and lipid-poor, rapidly wash out contrast. Non-adenomas, for instance metastases, genera
dedicated adrenal washout CT protocol consists of a non-contrast, a contrast -enhanced scan with a delay of 60-90 s
east 2/3 of the lesion to ensure a representable assessment. Absolute enhancement wash out 60% is proof of an a
on an enhanced scan while the patient is still on the table, then a second scan of the adrenals at 15 minutes after co
lculated. Relative enhancement wash out 40% is proof of an adenoma [5,6,8]. Adrenal washout pitfallsImportant ex
e and relative washout percentages within the adenoma-range, in decreasing order of occurence:
Washout Calculator:
Click here to go to the Adrenal Characterization Calculator.
Lipid-poor adenomas:
The images show an indeterminate lesion on the nonenhanced CT (density 24 HU). The absolute washout in this pati
ly adenomas show different enhancement compared to malignant lesions. On an enhanced CT at 60 sec most adeno
how strong enhancement. There is however too much overlap in enhancement to allow accurate differentiation betw
MRI Out-of-phase imaging:
Lipid-poor adenomas can also be diagnosed with out-of-phase imaging. They contain enough microscopic fat to caus
due to the chemical shift artefact. These images are of a 65- year-old female patient with an incidental discovery of a
enal stones. The presence of microscopic fat is demonstrated by the signal drop on the opposed-phase image. The p
mogeneous and measures 5.2 cm. The lesion did not change in size and was not hormonally active. It was diagnosed
oma discovered on a non-contrast and arterial phase CT scan in a 61-year old male patient with an abdominal aneur
shows subtle inhomogeneous signal drop compared to in-phase. Note that the fat-suppressed T1 does not help in t
ges. The subtle central hyperintensity on the T1 fat sat is also hyperintense on the T2-weighted images and doesn't e
T images from years before, the lesion turned out to be a slowly growing adenoma with recent internal hemorrhage
Indeterminate lesions > 4 cm:
The maximum diameter of the adrenal mass is predictive of malignancy. In particular, lesions > 4 cm are more likely
s size is important for two more reasons. The overall prognosis is better for small adrenocortical carcinomas and sm
techniques. Therefore, the recommendation for an indeterminate adrenal mass > 4 cm in size and no history of canc
timely treat a possible primary adrenal cortical carcinoma [3,9]. The next cases are examples of indeterminate lesion
a history of cancer. All diagnoses were histologically proven and showed a wide variety of both benign and malignan
geneous ill-defined mass larger than 4 cm. There is a hypo-enhancing center, which is probably the result of central
ealed an adenocarcinoma, probably from primary lung carcinoma. Surprisingly, extensive imaging analysis, including
l carcinoma The image shows a 67 mm heterogeneously enhancing relatively well defined lesion. This proved to be a
mage shows a large indeterminate lesion with different densities and a partly calcified rim. Biopsy revealed an adren
a heterogeneously enhancing, relatively well-defined indeterminate lesion. It proved to be a pheochromocytoma. Aty
spots. The lesion was resected because of its large size and indeterminate imaging features. This proved to be an ac
Specific Adrenal tumors:
Pheochromocytomas: strong enhancement in all 4 cases, even in the smaller tumors
Pheochromocytomas:

Pheochromocytomas are rare tumors that originate in the adrenal medulla. Usually, tumors are larger than 3 cm wh
tumors. A typical pheochromocytoma will have an unenhanced density >10 HU, or higher in case of hemorrhage. Th
st to adenomas they usually have delayed washout [4,5]. Pheochromocytoma with small cyst In 10% pheochromocyt
arrows). This image shows another pheochromocytoma with multiple cysts. Larger tumors are prone to hemorrhag
ed "imaging chameleons" because many imaging features overlap with other tumors [5]. The so called classic "light b
s is seen in 65% of cases [4]. Imaging pitfalls Because of these pitfalls diagnosis of pheochromocytoma is based on a
clear medicine imaging findings and biochemical confirmation. 10% tumor? Pheochromocytomas have been called th
lateral, 10% familial, 10 % extra-adrenal and 10% occurred in children. It has now become clear, however, that actual
erited [18]. Moreover, the percentage of tumors that are bilateral, extra-adrenal, pediatric or malignant differ with ea
dromes are multiple endocrine neoplasia (MEN) type IIA/B, von Hippel-Lindau, neurofibromatosis type I, familial para
d Carney triad [5, 18]. 10 - 49% of pheochromocytomas are incidentally discovered in asymptomatic patients. The rad
diagnosis of a pheochromocytoma. The biochemical diagnosis is made by measurement of plasma free or urinary fra
iopsy has to be avoided. Myelolipomas

Myelolipomas:

Adrenal myelolipomas are benign, relatively rare (0,08-0,2%) tumors that contain variable amounts of bone marrow
ss they are very large (due to mass effect) or bleed [5]. The presence of macroscopic fat makes them easy to recogni
0 HU. At MR imaging the fatty portions will be hyperintense on non fat-saturated T1-weighted images and show sign
s are seen in approximately 24% of cases. Axial and coronal image showing a large right myelolipoma with bleeding.

Cysts:

Here a small cyst is seen on CT and on a T2W-image. Images show unenhanced and contrast-enhanced CT of a cyst.

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Adrenocortical carcinoma:

Adrenocortical carcinomas (ACCs) are rare aggressive tumors with an incidence of approximately 1-2 per million per
a mixed Cushing's and virilisation syndrome are the most common presentation. Virilisation, feminisation or hypera
drenocortical carcinomas usually present with abdominal symptoms like nausea, vomiting, abdominal fullness, flank
cinomas may be sporadic or associated with hereditary syndromes, including MEN1, Lynch syndrome, Beckwith-Wie
hildhood and in the fourth and fifth decade of life [5]. Typical imaging features of adrenocortical carcinomas are [5,1
ge III or IV disease at the time of diagnosis, which explains the dismal prognosis of this diagnosis, with 5-year surviva
rtant to look for adjacent organ invasion, and for lymph node and distant metastases, most commonly in lung, liver a
e tumor is bulky and shows heterogeneous enhancement. Note the 'stellar' central hypodensity. There is capsular en
es, but also enhance inhomogeneously. Also note the dystrophic calcifications and areas of necrosis (red arrows). MI
red on ultrasound. Top row: mild T1W hypointensity, moderate T2W hyperintensity and intense hyperintensity on DW
ncement with inhomogeneous progressive capsular enhancement in the portal and delayed phase. Axial and corona
VC invasion. The coronal image also shows tumor extension into the right renal vein. Axial and coronal CT images of
sion (yellow arrow). IVC and renal vein tumor invasion are seen in up to 20% of patients. More than half of ACC patie
oor 5-year survival. Here a large right adrenal adrenal carcinoma with extensive abdominal and mediastinal para-aor
ma

Atypical adenomas:

Lesions are considered atypical for adenoma if they show: The following lesions were all resected because of large si
a 68 mm right hyperenhancing adrenal lesion with small calcifications and cystic spots, uncharacteristic for an adeno
an enlarged left adrenal gland with a 6,4 cm well encapsulated hypodense, possibly cystic lesion, but with a density
udocyst. Atypical adenoma with hyperdense strands as a result of internal bleeding The image shows a 7,6 cm left ad
histology, this was shown to be due to internal bleeding in an adenoma. Atypical adenoma with no signal drop and h
adenoma. There is no signal drop on the opposed phase image. The post contrast image shows heterogeneous enh

Pitfalls fatty lesions:

Oncocytoma of the left adrenal with fatty components. Macroscopic fat is fairly specific for myelolipomas, but has als
astatic clear cell renal cell carcinoma, pheochromocytoma and even adrenocortical carcinoma. If the macroscopic fat
confidently made [4]. It is safe to follow-up incidentally discovered, asymptomatic adrenal myelolipomas. Usually the
effect, pain), hormonally active or complicated by bleeding [5]. The image shows a fat-containing adrenal lesion, whi
s and some calcifications. This lesion was removed because of its large size of 13 cm and uncertain origin. It turned o
is another very large adrenal lesion of uncertain origin with macroscopic fat and dystrophic calcifications. This prove

MRI protocol:

MRI is usually deployed as a problem solver after inconclusive CT or if contrast enhanced CT is contra-indicated. MRI
nsiderable overlap in ADC values between benign and malignant adrenal lesions [11]. Most radiologists use visual ev
images. However, it is also possible to measure the change in signal intensity within a ROI placed over the adrenal le
e image, using the spleen as internal reference organ. Either the adrenal-to-spleen ratio (ASR) or the adrenal signal in
al MRI calculator [12,13]. An ASR <0.71 and SI-index >16.5% indicate an adrenal adenoma. The reported sensitivity fo
maging is less sensitive than washout CT for detecting lipid-poor adenomas, in particular when unenhanced CT dens
pulmonary embolism scan. Using the Adrenal MRI calculator the adrenal spleen ratio (ASR) and signal intensity inde
esion and the spleen on both the in-phase and out-of-phase images. Based on the signal intensities measured within

0,71) and and the SII is 39,5% (> 16,5%), indicating that this is an adenoma.
PET-CT:

FDG - Nonspecific adrenal tumor imaging:
Malignant tumors have higher glucose metabolism than benign tumors. This enables PET-CT imaging with the glucos
certain adrenal tumor, but can be used to differentiate pheochromocytomas, paragangliomas, adrenocortical carcin
T in mediastinal and bone window setting Images depict mediastinal and bone window setting of a patient with a bu
o be an adrenocortical carcinoma. There is a faint, ill-defined liver lesion in segment 6 and there are non-specific scle
e... PET-CT performed for complete staging shows intense uptake in the adrenal tumor, indicative of its malignant na
a bone metastasis in T12. Approximately 20-40% of patients with an adrenocortical carcinoma present with metasta
malignant lesions with high sensitivity (100%), but with lower specificity (87- 97%). False positives are due to a small r
ctious lesions, that mimic malignant lesions [14]. Possible false negatives are hemorrhagic, necrotic or small (5-10 m
ry cancers, like minimally invasive adenocarcinoma or carcinoid tumors [14]. Apart from visual evaluation it is also po
cut-off value (SUVmax 2,68-3.7) or an adrenal-to-liver SUV ratio (reported cutoff values 1.29-1.45) to differentiate be
d specificity [14, 15]. Combining FDG PET-CT and adrenal washout CT can further improve the accuracy for diagnosin
right adrenal mass, suspicious for a malignancy, based on the large size and heterogeneity. This lesion is an adrenoc
uent FDG PET-CT performed for staging purposes showed only mild uptake and only in the most avidly enhancing pa
e. This lack of FDG-avidity might be due to a lower grade tumor with lower mitotic rate or large hemorrhagic or necro
med 3 months after left adrenalectomy for a large adrenocortical carcinoma showing an enhancing nodule posterior
ly this lesion, which proved to be a metastasis on subsequent follow-up imaging. The left renal subcapsular hematon
Pheochromocytoma-specific imaging:
Axial arterial and venous phase CT show a hypervascular left-sided adrenal incidentaloma. Plasma free metanephrin
included a MIBG SPECT and a FDG PET-CT, which both showed intense uptake in the left adrenal tumor, but no evide
nate from chromaffin cells in the adrenal medulla. These are neuroendocrine cells that express cell membrane nore
opamine and a few other hormones. This is the basis for the use of tracers like 131I- and 123I-MIBG, which accumula
ochromocytomas and paragangliomas. 18F-dihydroxyphenylalanine (DOPA) and 18F-fluorodopamine (DA) are 18F-la
ging [19]. Pheochromocytomas and paragangliomas also have somatostatin receptors and thus can be imaged using
ing replaced more and more by PET-CT using 68 gallium-labeled somatostatin analogues like DOTA-TOC, DOTA-NOC
nhomogeneously enhancing right adrenal lesion with a small cyst, which could not be diagnosed as an adenoma wit
ephrines were elevated and the lesion was diagnosed as a pheochromocytoma. MIBG SPECT for staging showed inte
hich in contrast showed uptake only slightly higher than normal liver. This is highly unusual for pheochromocytomas
he primary tumor lacks FDG uptake, the sensitivity for finding metastases on an FDG PET-CT will be very low. The up
known SDHD-gene mutation which is associated with a high risk for developing pheochromocytomas and paragangl
formed, which showed intense uptake, helping to confirm the diagnosis of a pheochromocytoma. A year later, scree
take in the right adrenal gland, but also intense uptake in a glomus caroticum tumor on the left as seen on the coron
tary gland are normal, as is the normal excretion by the kidneys to the bladder. Pheochromocytomas express somat
in-analogue. In this case 68 gallium-labeled DOTATOC is used. This patient presented with widespread metastatic dis
ection of a pheochromocytoma. Continue with the PET-CT... PET-CT of the same patient with 68 gallium-labeled DOT
Endocrine evaluation:
Up to 15% of all adrenal tumors are functional: Current guidelines from the European Society of Endocrinology (ESE)
American College of Radiology (ACR) [2,3] recommend an initial biochemical evaluation of all adrenal incidentaloma
hyperaldosteronism. The following hormones should be assessed in all patients with an adrenal incidentaloma: The
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None:

Large airway disease:
Onno Mets and Hans Daniels
Radiology and Pulmonology department University Medical Center Amsterdam:
Publicationdate 2023-05-20 Pathology of the
trachea and central bronchi is infrequently encountered, and therefore most
radiologists find it challenging. Although there is a relatively limited differential diagnosis, pathology
nevertheless varies between congenital, benign, primary malignant and
metastatic disease. This article summarizes
the typical imaging features of the differential diagnostic considerations of large airway diseases and hopefully serv
then.
Introduction:
The central airways consist of the
trachea and main bronchi, before the airways branch towards the periphery into
the lobar, segmental and subsegmental airways on both sides. The trachea has a length of about 10-15 cm and has a
intrathoracic component. It contains about 15-20 horseshoe shaped cartilaginous
rings.
The posterior wall of the trachea and main bronchi is membranous and
does not contain cartilage, which is important for the imaging differential
diagnosis, as will be discussed later. The inner lining of the airways consists
of respiratory ciliated epithelium interspersed with goblet cells, minor
salivary glands and neuro-endocrine cells.
Furthermore, the airways contain
muscle tissue, cartilage, nerves, etc.
All of which may give rise to pathology.
Differential diagnosis:
Central airway
pathology can be divided into subgroups, either by etiology (ie. inflammatory,
neoplastic, etc.) or by imaging appearance (ie. nodular, single/multifocal, diffuse
infiltration, etc.). In the table an overview based on
disease etiology subgroups to provide a comprehensive overview. This is a flow-chart that is based on imaging appea
s.
Nodular - differential:
Nodular
lesions protrude into the lumen and distort the smooth inner contour of the
airway.
Only a minority of these lesions will have specific morphologic
features.
Here some examples of nodular or mass lesions in the trachea and
bronchi.
Wall thickening - differential:
At the site
of involvement there is loss of the normal smooth and thin contour of the
tracheal and bronchial wall.
Only a few diseases have specific morphologic
features.
Here some examples of both focal and diffuse central airway wall
thickening.
Iatrogenic:

Post-intubation:
The most common iatrogenic central airway
pathology is focal stenosis after endotracheal intubation or tracheostomy.
Focal fibrosis may occur in reaction to necrosis caused by cuff pressure or due
to direct iatrogenic damage of the tracheal wall. Typically, a subglottic
stenosis near the thoracic inlet is seen with an hourglass shape in the coronal
plane, due to a short segment of focal scarring in the trachea (figure). Bronchoscopy images from above and below t
level of the vocal cords, show a significant subglottic narrowing of the trachea.
Radiotherapy:
When applied to tumors in proximity to
the central airways radiotherapy can cause airway narrowing, fistula, necrosis and sometimes massive hemoptysis.
In addition mediastinal fatty
infiltration and esophageal wall thickening may be present in the acute phase. Image
Wall thickening of the trachea bifurcation post-radiotherapy.
Foreign body:
Aspiration of a foreign body is rare in adults, and most often encountered in children.
Among adults aspiration of dental parts is relatively common, especially in the trauma population. Conventional ima
nding on material composition.
Indirect signs might be present though, for example unilateral hyperinflation or lung atelectasis due to check valve m
ce during dental surgery, visible in the right lower lobe bronchus. BronchiolithEndobronchial calcification which may
calcification of aspirated foreign material, or migration or erosion and
extrusion of adjacent calcified material from for example a lymph node or
ossified bronchial cartilage.
Mucus:
The most encountered focal abnormality in the trachea is mucus.
In large quantities it can cause bronchial obstruction and atelectasis, especially in the ICU setting.
In most cases it represents an irrelevant finding, but small quantities sticking to the airway wall may create a diagnos
In general mucus may show an associated mucus thread and is often not dense enough to be seen on the soft tissue
When in doubt whether focal airway wall pathology is present, follow-up imaging or bronchoscopy might be conside
Mucus will resolve or change position on follow-up CT imaging, whereas a solid lesion persists.
Extrinsic compression:

Enlarged goiter:
Intrinsic versus extrinsic pathology is one
of the first differentiations that has to be made when interpreting CT
imaging. The most common cause of extrinsic compression
is intrathoracic extension of an enlarged thyroid, causing
displacement of the trachea more than narrowing. Other mediastinal
causes are:
Lymph nodes:
Compression of the right main bronchus by enlarged lymph nodes.
Double aortic arch:
This patient has a double aortic arch which compresses the trachea.
Fibrosing mediastinitis:
Fibrosing mediastinitis is a more tricky
cause of extrinsic compression and displacement as it is often hard to diagnose
with certainty.
On CT imaging it can show considerable overlap with findings of
airway involvement due to a central lung malignancy.
Repetitive negative tissue
sampling and follow-up will often seal the case eventually. Image
Right-sided fibrosing mediastinitis in a 51 year old male, showing soft tissue density around the right main bronchus
way and vessel
compression, with localized lung volume loss and interstitial thickening due to
edema.
Benign neoplasm:

Hamartoma:
Hamartoma is a benign lesion that is composed

of various mesenchymal tissues such as chondroid cartilage, fat and fibrous tissue.
It is the most common benign lung tumor and most often located more peripherally in the lung parenchyma, but sometimes arises in the airways. Image Endobronchial hamartoma as an incidental finding in the middle lobe of a 73 y.o male. CT characteristics of a hamartoma are indep the left lower lobe bronchus in a 58 y.o female. Lipoma Typically seen as an endoluminal lesion without soft tissue component due to its pure fatty nature. It arises from the submucosal fat tissue of the tracheobronchial tree. The lesion is often pedunculated, although this is not always evident on CT. Leiomyoma Leiomyoma arise from the smooth muscle cells of the trachea. Typically it is seen as an endoluminal mass in relation to the posterior wall. The lesion may show heterogeneous density due to cystic degeneration as a result of poor vascularity.
Papilloma:
A squamous cell papilloma is the solitary variant of tracheobronchial papillomatosis, where papillomatous growth of the epithelium is a response to HPV infection. Laryngeal involvement is more common than central airway involvement occurs it may be seen on CT as multifocal nodularity not extending beyond the wall, and Tracheobronchial papillomatosis with lung involvement in a 54 y.o male, showing two papillomas in the trachea.
Continue with the lung window... The image shows multiple cystic lesions in both lungs (arrowheads). In rare cases e es most often in the dependent apical segments of the lower lobes. There is a small risk of malignant transformation nnoma
Miscellaneous:
Given that any cell type present in the central airways may give rise to pathology, all kind of rare lesions can develop. This includes for example neurogenic blastic tumor.
Malignant neoplasm:
Several primary malignant lesions arise in the central airways.
Often they cause respiratory symptoms, and sometimes hemoptysis.
In line with the benign neoplastic lesions, a specific radiological diagnosis is challenging.
Patient characteristics such as age, smoking history, as well as lesion morphology and location may give clues and will influence the order of differential diagnostic considerations.
Given that any cell type present in the central airways may give rise to pathology, all kind of rare lesions develop.
This includes for example malignant lesions such as chondrosarcoma. Radical surgical resection is the preferred treatment, but often technically impossible.
Depending on the histology and stage of the tumour, other modalities such as chemoradiotherapy may be used with curative intent.
Squamous cell carcinoma:
Squamous cell carcinoma is the most common primary malignancy of the trachea.
Generally, it occurs in older patients with a substantial smoking history.
Typically, an irregular mass is seen that tends to invade surrounding tissues outside the airway wall. Image Irregular focal mass that invades the trachea wall and peritracheal tissue in a 66 y.o male. PA:
Squamous cell carcinoma.
Adenoid cystic carcinoma:
Adenoid cystic carcinoma (ACC) is the next most common primary malignancy of the central airways. Contrary to squamous cell carcinoma there is no association

with smoking. Patients also tend to be younger, mostly middle-aged. Radiologically adenoid cystic carcinoma can pre
a: Image Severe luminal narrowing by a focal mass in 48 y.o female. PA: Tracheal adenoid cystic carcinoma. The mali
he less common mucoepidermoid carcinoma (see below).
The tumor is mostly very centrally located.
The most common sites for metastases are the lung parenchyma and the liver. ImageIrregular
more diffusely infiltrating mass with long segment of wall thickening invading the mediastinum in a 51 y.o female.
PA:
adenoid cystic carcinoma. Bronchoscopic view of
obstructing tracheal adenoid cystic carcinoma. Mucoepidermoid
carcinoma (MEC) As mentioned above, MEC is a tumour
that arises from the submucosal minor salivary glands. It is found in younger
patients - often younger than those with ACC - and has no known association
with smoking. It has a predilection for the more distal airways, as they are found
more often in the segmental/lobar airways and rarely in the trachea. CT imaging features are non-specific; an
enhancing focal soft tissue mass, with varying degrees of heterogeneity. Some
show internal calcification. Post-obstructive changes may be present. Carcinoid in the left main bronchus
Carcinoid:
Carcinoid tumours are low-grade
neuroendocrine tumours (NET) that originate from the neuroendocrine cells in
the airway wall.
Histopathologically, they may be typical or atypical, depending
on the mitotic rate and the presence of focal necrosis.
The majority are
typical carcinoids though, and these behave quite indolent.
They are found in
both younger and older patients, and there is no association with smoking. ImageWell-defined mass in the left main
bronchus in a 39 year old male.
Continue with the PET-CT... High uptake on PET-CT confirming the neuroendocrine cell origin The 68Ga-Dotatate PET
Carcinoids arise in the more central airways (although hardly
ever in the trachea) as well as in the more peripheral ones, all the way
towards the outer third of the lung. On CT carcinoid is a well-defined lesion, often hyperdense on post-contrast CT gi
Calcifications may be present in a minority.
Post-obstructive changes are common due to luminal obstruction, and may be the reason it is found.
Some lesions also show an extraluminal component, which excludes the option of complete curation through an end
Anatomical surgical resection is needed in these cases. Continue with the bronchoscopic view... Bronchoscopic view
ell-defined and
vascularized lesion obstructing the lower lobe orifice.
PA: Carcinoid. Metastasis of colorectal cancer
Metastases:
Metastatic disease to the
central airways does occur through distant hematogenous or lymphatic spread.
Although uncommon, it is sometimes seen for instance in breast carcinoma, renal cell cancer and colorectal carcinon
e solid nodules
projecting into the airway lumen.
Larger and more peripheral lesions may cause
airway obstruction.
Usually airway metastatic disease is not an isolated finding, but seen in patients with known metastatic disease. Imag
lesion in the proximal trachea in a 52 y.o female with prior colorectal
cancer.
PA: metastasis of colorectal cancer.
Infection:

TB:
As with most other infectious diseases, pathogens causing
tracheobronchial infection can be either bacterial, fungal or viral. Community acquired bronchitis is mostly triggered
infection. Sometimes infection may be associated with procedures such as
tracheostomy, as shown on the left. Although tuberculosis can cause central airway
abnormalities, isolated tracheobronchitis is very rare.
Central airway involvement during more widespread thoracic
disease is more likely, and can reveal itself on CT imaging as irregular focal

or more diffuse wall thickening.
In the chronic phase it may lead to focal
airway stenosis due to airway remodelling and formation of fibrosis in reaction
to ulceration of submucosal tubercles. Image
Focal wall thickening with luminal narrowing of the trachea and right main bronchus in a 63 y.o female with remote T
ns causing tracheobronchitis might also be encountered, for example by Aspergillus, Candida or Histoplasmosis.
This occurs primarily in the immunocompromised population.
In line with the above mentioned TB morphology, it may cause non-specific CT findings of focal or more diffuse wall t
f the disease. ImageDiffuse
circumferential wall thickening of the trachea and central bronchi with
uptake on FDG-PET scan (blue arrow) in a 72 y.o male after tracheostomy due to
complicated thyroidectomy.
Clinically labelled as low-grade infectious,
despite the fact that no specific pathogen was cultured.
Inflammatory:

Relapsing polychondritis:
Relapsing polychondritis is an auto-immune disorder that affects
the cartilage in the central airways with recurrent episodes of inflammation
and possible destruction and fibrosis.
As cartilage in other parts of the body
may also be affected, clinically one may see ear and nose involvement as well
(eg. saddle-nose deformity). Cardiovascular disease such as cardiac valve
disease and aortic aneurysm can occur. On CT imaging of the chest central airway wall
thickening with soft tissue density is seen.
Abnormalities typically spare the
posterior wall which lacks cartilage. Beyond the acute phase calcification and stenosis may form, as well as
excessive airway collapse in expiration (ie. tracheobronchomalacia) due to
cartilage destruction. ImageRelapsing polychondritis in a 55 y.o female, showing inflammatory central airway wall th
owhead). No thickening of posterior wall (yellow arrow).
Granulomatosis with polyangiitis:
Granulomatosis with polyangiitis (GPA), previously known as Wegener's granulomatosis, is a
multisystem necrotizing vasculitis that affects the medium and small size vessels with involvement of paranasal sinu
Clinically
it is associated with elevated c-ANCA titers.
GPA can cause irregular
circumferential wall thickening of the central airways, which can lead to
stenosis in later stages of the disease.
This is typically seen in the
subglottic trachea but also occurs in the main stem and lobar bronchi. Synchronous
pulmonary findings of cavitating consolidations and ground glass caused by the
vasculitis – due to necrosis and alveolar hemorrhage, respectively – are
helpful to sort the differential diagnostic considerations. Image
Central airway involvement in GPA showing circumferential tracheal wall thickening at the level of the carina in a 43 y
t of the left main bronchus with stenosis.
Amyloidosis:
Tracheobronchial amyloidosis is characterized by submucosal
deposition of abnormal amyloid protein.
It is a very rare disease, which is
usually isolated but can be associated with systemic amyloid disease. The protein deposition can either be focal (ie. n
amyloidoma) or more diffuse and infiltrative.
Amyloid in the airway walls leads
to dense and calcified, strikingly irregular soft tissue thickening on CT
imaging.
There is no cure, and therapeutic options such as external beam
radiation and bronchoscopic debulking are focussed on limiting luminal
obstruction to relieve respiratory symptoms. Image
Tracheobronchial amyloidosis in a 61 y.o
female, showing irregular airway wall thickening with dense and calcified foci causing
significant luminal narrowing of the right main bronchus.

Bronchoscopy
shows typical yellowish irregular lesions. Sarcoidosis
The most common manifestations of sarcoidosis in the chest
are symmetrical hilar and mediastinal lymphadenopathy and pulmonary parenchymal
involvement with lymphatic distribution of small nodules.
This imaging
morphology is classic, but the disease is known for its wide range of
appearances and may be considered in the differential diagnosis for a lot of
imaging findings. Although histopathologically granulomatous involvement of the
airways is relatively common, CT signs of central airway involvement in
sarcoidosis are relatively rare.
Of course, architectural distortion and airway
obstruction may be caused by extrinsic compression due to peribronchial fibrosis, which is often seen in the hilar regions.
In addition, direct airway remodelling due to granulomatous involvement
of the central airways may lead to circumferential airway wall thickening.
If
present, it is almost always part of more extensive thoracic disease and not an
isolated finding. Inflammatory bowel disease (IBD)Both
ulcerative colitis (UC) and Crohn's disease (CD) may show airway involvement.
More common than central airway disease is peripheral bronchial wall thickening
and bronchiectasis, as well as signs of involvement of the smaller airways (ie.
bronchiolitis and air trapping).
When
the trachea and main bronchi are involved, CT imaging may show nonspecific
circumferential wall thickening, luminal narrowing and postobstructive
findings. Tracheobronchopathia osteochondroplastica
Tracheobronchopathia osteochondroplastica:
The etiology of this disease is not well known.
It is
characterized by submucosal osteocartilaginous nodules that on CT imaging
present as multiple small calcified nodules that only involve the cartilaginous
portion of the central airways, and thus spares the posterior wall of the
trachea.
This disease may be an incidental finding, but may also
cause mild respiratory symptoms.
The prognosis is generally good and in
asymptomatic cases no interventions are needed.
If needed, therapeutic options may be focussed on limiting luminal obstruction caused
by the osteocartilaginous nodules. ImageTracheobronchopathia
osteochondroplastica in a 67 y.o female with non-specific airway symptoms,
showing multiple small nodules along the cartilaginous part of the trachea
Congenital:
Two examples of a tracheal bronchus
Tracheal bronchus:
Airway branching variation is very common, especially at
the segmental level.
Several anatomical variants are encountered on a more
regular basis and might be worth mentioning, although patients are mostly asymptomatic.
If
they do lead to symptoms, this is mostly due to recurrent infections caused by abnormal
drainage. In case of a tracheal
bronchus (also called pig bronchus) the
right upper lobe parenchyma is partially aerated through a separate bronchus
that originates directly from the supracarinal portion of the trachea. Image
Incidental tracheal
bronchus in a 28 y.o male scanned for oncology follow-up (axial image) and in a 77 y.o male scanned in trauma setti
Cardiac bronchus:
This truly supernumerary bronchus
originates on the medial side of the bronchus intermedius, opposite to the

right upper lobe orifice.
This might be a blind ending structure, or an airway
that aerates a small amount of lung parenchyma. ImageCardiac
bronchus (arrowhead) in a 57 y.o female in follow-up for interstitial lung disease. Tracheobronchomegaly in a 59 y.o
with evident posterior diverticulosis.
Tracheobronchomegaly:
Tracheobronchomegaly (also called Mounier-Kuhn syndrome) is caused by
abnormal elastic fibres and smooth muscle cells in the central airways.
Typically, it is seen in middle aged men who present with
chronic cough and/or recurrent infections. CT findings: Williams-Campbell syndrome with widespread bronchiectasis
Williams-Campbell syndrome:
This
disease is characterized by congenital cystic bronchiectasis, and typically
presents with recurrent infections.
It is thought to be caused by cartilage
deficiency in the subsegmental bronchi (ie. 4th to 6th order).
It therefore shows bilateral diffuse
bronchiectasis on CT imaging, with typical sparing of the lower order bronchi
and trachea.
This in contrast to
tracheobronchomegaly that typically involves the 1st to 4th order bronchi. ImageLocalized perihilar bronchiectasis b
pheral airways.
This was a 46 y.o male with the
diagnosis of Williams-Campbell syndrome, presenting with recurrent infections,
mild hemoptysis and longstanding airway symptoms.
None:

Ovarian cystic lesions:
Wouter Veldhuis, Robin Smithuis, Oguz Akin and Hedvig Hricak
Department of Radiology of the University Medical Center of Utrecht, of the Rijnland hospital in Leiderdorp, the Neth
g Cancer Center, New York, USA:
Publicationdate 2011-05-18 In this review the imaging features of normal ovaries and the most common ovarian cyst
or the diagnostic workup and management of ovarian cystic masses is presented based on the findings of ultrasoun
application this results in hi-res images at full retina resolution.
Normal ovaries:

premenopausal:
The normal ovary contains over two million primary oocytes at birth, about 10 of which mature each menstrual cycle
es the dominant follicle and grows to a size of 18-20 mm by mid-cycle, when it ruptures to release the oocyte. The ot
the oocyte, the dominant follicle collapses, and the granulosa cells in the inner lining proliferate and swell to form th
the corpus luteum degenerates, leaving the small scarred corpus albicans. Graafian follicles Graafian follicles The no
ages show two normal ovaries with several anechoic, simple cysts consistent with Graafian follicles. On T2-weighted
ded by darker solid ovarian stroma. FDG-PET pitfall - normal premenopausal ovaries In some pre-menopausal wome
in the menstrual cycle. Because in pre-menopausal women a PET-positive ovary may be either an adnexal neoplasm
f physiologic mid-cycle FDG uptake and to correlate this finding with the clinical history. FDG-PET in pre-menopausal
k of the menstrual cycle. In post-menopausal women, the normal ovaries show only minimal uptake of FDG. Any incr
le neoplasm. LEFT: Postmenopausal woman. The ovary is a T2 dark tissue clump near the proximal end of the round
rominent, but is still likely to be normal
Post-menopausal:
Post-menopause is defined as 1 year or more of amenorrhea. In Western countries the average age of menopause is
er and gradually stop forming Graafian follicles. Note, however, that follicular cysts may persist several years after m
l woman the ovary is no more than a dark tissue clump near the proximal end of the round ligament. The axial T2-we
hough a bit prominent, this is likely to be completely normal. Only if, by chance, there happened to be prior imaging
s would start with a benign solid lesion such as ovarian fibroma or fibrothecoma.
Functional cysts:
By far the most common cystic ovarian lesions are benign functional ovarian cysts. Functional cysts are Graafian folli
ut are otherwise benign. In the early post-menopause phase, 1-5 years after the final menstrual period, sporadic ovu
in late menopause, which is defined as more than 5 years since the final menstrual period, when ovulation is unlikel
.
Follicular cyst:

A dominant Graafian follicle sometimes fails to ovulate and does not involute. When it becomes larger than 3 cm, it i
but may become much larger. On ultrasound follicular cysts present as simple unilocular, anechoic cysts with a thin
d components, no enhancing septations, and no more than physiologic ascites. Follicular cysts will usually resolve sp
Corpus luteum cyst:
A corpus luteum may seal and fill with fluid or blood, forming a corpus luteum cyst. The transvaginal ultrasound ima
wer Doppler analysis. The characteristic circular Doppler appearance is called the 'ring of fire'. Note, there is good th
ith a, partially involuted, corpus luteum cyst. Remember that women who are on birth control pills usually won't forn
he other hand, use of fertility drugs that induce ovulation, increases the chance of developing corpus luteum cysts. C
re' on ultrasound. At pathologic examination the collapsed bloody cyst can be clearly seen. Corpus luteum cyst Corp
involuting corpus luteum cyst (arrow). This is a normal finding. The right ovary is also normal. Hemorrhagic cyst with
through-transmission
Hemorrhagic ovarian cyst:
When a Graafian follicle or follicular cyst bleeds, a complex hemorrhagic ovarian cyst (HOC) is formed. On ultrasound
cyst with fibrin-strands or low-level echoes and good through transmission. On MRI hemorrhagic cysts are bright on
l vascularity on Doppler ultrasound or internal enhancement on CT or MRI. Hemorrhagic ovarian cysts have variable
een. Clinically the classic presentation is with acute pain. However HOC can also be an incidental finding in an asymp
show multiple simple and one complex right ovarian lesion (red arrow). The latter demonstrates diffuse low-level ec
nsmission (blue arrow). These findings indicate the presence of a hemorrhagic cyst. Continue with the MR-images. H
patient. The right ovary contains multiple simple T2 bright cysts with thin borders and no solid components. On the
lex cyst (arrow). There is a small amount of ascites around the right ovary, but not enough to raise concern of a poss
lex cyst is bright, indicating either fat or blood content. On the T1-weighted image with fatsat the lesion remains brig
there is no enhancement, confirming that this is a hemorrhagic ovarian cyst. An endometrioma would be in your dif
lack of enhancement in a lesion, that is bright on the pre-contrast T1-weighted image. Hemorrhagic ovarian cyst in b
d left ovary: on both sides there is what appears to be a solid lesion. There is however good through transmission, w
ts. On Doppler US (not shown) there was no vascularity. Continue with the MR examination. Hemorrhagic ovarian cy
at, blood or high protein fluid. Fat saturation does not suppress the signal in these lesions. In an image with overall r
ng teratoma and confirms the suggestion of hemorrhagic fluid. Hemorrhagic ovarian cyst. Left:image without subtra
both lesions show typical 'shading'. The gradual drop in T2 is thought to be caused by a combination of increasing v
s the dependent portion of the lesion. There is no enhancement on the subtraction image (Post-Gd minus Pre-Gd). A
crease over the already very bright pre-contrast image would be very hard to appreciate otherwise.
Other benign cystic and cyst-like lesions:
Vaginal ultrasound showing a large hypoechoic cystic lesion with diffuse low-level echo's
Endometrioma:
Cystic endometriosis or endometrioma is a type of cyst formed when endometrial tissue grows in the ovaries. It affe
ic pain associated with menstruation. The ovaries are involved in approximately 75% of patients with endometriosis.
(about 95%) of patients present with a classic homogeneous, hypoechoic cyst with diffuse low level echoes. Rarely it
can be multilocular and have thin or even thick septations. Transvaginal ultrasound: endometrioma with two hypere
bout one third of patients, on careful examination, small echogenic foci can be seen adhering to the wall. These have
tute small blood clots or debris. It is important to differentiate these foci from true wall nodules. In the presence of t
The transvaginal ultrasound shows a typical endometrioma, with hyperechoic wall foci. At Doppler US no vascularity
al US-image that shows a cystic lesion with a hyperechoic structure. There is a wide differential diagnosis including o
atoma with hyperechoic Rokitansky nodule, hemorrhagic cyst with clot and endometrioma with clot or debris. Contin
ut to show the same, predominantly cystic lesion. If additional imaging is needed for cysts that are indeterminate at
on the right correlates nicely with the ultrasound image. On T2-weighted images endometriomas typically show 'sha
action image. MRI confirms the absence of any enhancement, confirming that it is most likely debris within the cyst.
ght on T1-weighted images. On T1-fatsat images an endometrioma will remain bright. This in contrast to teratomas,
lude a T1 fat suppressed sequence, because this makes small T1 bright lesions more conspicuous. Endometrioma Th
ough transmission. There is no internal or wall vascularity on Doppler. On ultrasound this can again either be a hem
ometrioma 6 months later a follow-up MRI was performed. The lesions are bright on T1-weighted images. The bright
There is T2 shading consistent with a hemorrhagic lesion. There is no enhancement. The fluid-fluid level in the right o
he lesions persist after 6 months makes bilateral endometrioma much more likely than hemorrhagic cysts. Axial MR
Polycystic ovary syndrome:
The Poly-Cystic Ovary Syndrome (PCOS) is also known as Stein-Leventhal syndrome. Imaging can confirm or suggest
l cycle irregularities and either typical clinical signs of hirsutism, obesity, infertility, acne, male balding pattern or bioc
image in a patient with polycystic ovary syndrome On the left a sagittal T2-weighted image in a patient with increase
e small peripherally located simple cysts
The obesity associated with this syndrome is evident from the abundance of fat, showing bright on these FSE T2-wei
Theca lutein cysts. The septations do not show enhancement on Doppler evaluation.
Ovarian hyperstimulation syndrome - Theca lutein cysts:
Ovarian hyperstimulation syndrome is a relatively rare condition. It is caused by hormonal overstimulation by hCG, a

ccur in gestational throphoblastic disease, PCOS or in patients receiving hormonal therapy. It can also be seen in pre
ur in normal pregnancies, the reported natural course is spontaneous resolution after birth. In normal pregnancies t
Hormonal overstimulation more often occurs in molar pregnancy, erythroblastosis fetalis or in plural pregnancies. C
multiloculated cyst that can totally replace the ovary. The clinical history is the distinguishing feature to make the dia
cysts: US images of a young pregnant woman. In both ovaries there are multiple cysts. Right image shows an invasiv
ages are of a young pregnant woman, who had multiple ovarian cysts. The other ovary is not shown but showed a si
n hyperstimulation syndrome are in the clinical history - a young pregnant woman - and in the last image of the uter
e molar pregnancy.
PID with tubo-ovarian abscess:
Tubo-ovarian abscess (TOA) usually arises as a complication of Chlamydia or Gonorrhoeae infection that rises from t
led complex cystic ovarian lesion is seen with abundant flow. The presence of a thickened endometrium or hydrosal
shows a left complex cystic lesion with thick enhancing walls and internal gas. It looks like an abscess. Note the relat
s unlikely to be a peri-diverticular abscess. Continue with the reconstructed images. On the sagittal image notice, tha
this is an ovarian lesion (arrow). The coronal image shows the anatomic connection to the uterus. There is a gasbubb
ection rising from the uterine cavity via the salphinx to involve the ovary (click or tap the image to enlarge).
Benign cystic ovarian neoplasms:
Mature cystic teratoma with a Rokitansky nodule or dermoid plug
Mature cystic teratoma:
A very common benign ovarian lesion that may appear cystic is a mature cystic teratoma, also called dermoid cyst. M
lignant teratoma. Benign cystic teratomas typically occur in young women of child-bearing age. At imaging they are u
lateral in ~15%. Up to 60% may contain calcifications. The cystic component is fluid fat, produced by sebaceous gland
eristic ultrasound appearance is that of a cystic mass, with a hyperechoic solid mural nodule, which is called a Rokita
In another case the transvaginal ultrasound shows the 'tip-of-the-iceberg' sign: acoustic shadowing from the hyperec
l gas and the lesion may be overlooked. A fat-fluid level may be present, caused by fat floating on more aqueous fluid
by hair floating in the cyst cavity. Mature cystic teratomas, even though benign, are often resected because of increa
lication. Other complications associated with teratoma are infection, rupture (spontaneous or trauma) and, rarely, ha
on can occur but is also rare (Axial T1-weighted image in the same patient shows a bright lesion with an internal sep
e T1-weighted image with fat suppression there is suppression of the signal. This confirms the fatty content and is di
fat in a right sided cystic teratoma at CT.
Cystadenoma and cystadenofibroma:
Cystadenoma and cystadenofibroma are also common benign ovarian tumors. They can be either serous or mucino
and may look like a simple cyst. Mucinous cystadenomas are most often multilocular with thin (
The locules may contain complex fluid, due to proteinaceous debris or hemorrhage, or both. The finding of papillary
alignancy or a cystadenocarcinoma. Transvaginal ultrasound shows a 5.1x5.2-cm dominant left ovarian cyst. The cyst
There is, however, a nodule on the posterior wall that shows no flow on Doppler. This may be a follicular cyst with sc
th MRI is recommended. T2-weighted image of the same patient shows thin enhancing septations (as well as motion
umor nodules and no adenopathy or peritoneal deposits. There is only a small amount of ascites. This proved to be
ior wall a solid mural nodule is found, which is avascular. No secondary signs of malignancy. Continue with the MRI.
cystic left ovarian lesion, with a solid nodule on the posterior wall. At post-contrast axial T1W-FatSat the thin septa ar
these findings the distinction between a benign ovarian lesion such as a cystadenofibroma and a malignant lesion c
denofibroma. The next case is a transabdominal ultrasound that shows a left-sided multiloculated cystic mass. This l
ied. Enable Scroll
Disable Scroll Scroll through the images Enable Scroll
Disable Scroll Scroll through the images CT of the same patient shows a multi-loculated cystic mass adjacent to the b
ick septations and irregular wall thickening. On the basis of this CT the distinction between a benign ovarian lesion su
ot be made. The lesion was resected and found to be a cystadenofibroma.
Malignant cystic ovarian neoplasms:
Remember, the role of imaging is not to determine the histological nature of a lesion, but to distinguish benign from
e examples given here serve as a demonstration of suspicious imaging features, not as a guide for determination of
Serous ovarian cystadenocarcinoma:
Ultrasound shows a complex solid-cystic mass in the left ovary, and another, very large complex solid-cystic mass in
lid-cystic mass with thick, enhancing septations in the right ovary. These findings are very suspicious for a malignant
ows). Pathology showed a serous ovarian cystadenocarcinoma. This is the most common type of ovarian cancer.
Mucinous ovarian cystadenocarcinoma:
Ultrasound shows a very large multi-loculated cystic lesion in the region of the right adnex. Some locules are anecho
teineous content, such as hemorrhage or, in this case, mucin. The septations are thin, except for the dorsal septation
canresolution at great depth.
The septations are avascular.
There are no solid components.
There was no ascites. Despite the absence of solid components and despite the absence of vascularity on color Dopp

picious for a cystic neoplasm and warant further evaluation. The CECT shows similar findings.
The locules are of different attenuation, consistent with varying protein content. There is no ascites orperitoneal dep
cystadenocarcinoma of low malignant potential. Specimen of the mucinous cystadenocarcinoma The thin, relatively
of ascites and peritoneal carcinomatosis and the absence of invasion, suggest a lesion of low malignant potential (LM
g findings alone. Especially the absence of invasion in ovarian stroma cannot be judged reliably on imaging.
Endometrioid ovarian carcinoma:
On ultrasound both ovaries are markedly enlarged and contain cystic components with intracystic solid components
ateral, are suspicious for a cystic ovarian neoplasm and warrant further evaluation. Again, the role of imaging is to co
sion that can be classified as definitely benign nor a lesion that can be safely followed-up: action is required. CT of th
c lesions, bulging into the abdomen. The purpose of the CT is not to confirm what was already known from the ultras
ot possible to determine the histologic type of the tumor. This is not relevant. This patient will undergo surgery. For e
ovarian tumors - even after surgery, the exact tumor subtype is much less important for the prognosis than factors
surgery was in removing all of the disease. For this patient the relevant findings are on the image on the left. There i
showed this was an endometrioid ovarian carcinoma.
Cystic metastases to the ovaries:
While metastases to the ovary are most commonly solid - such as for example Krukenbergs metastases - cystic ovari
both ovaries. While a serous cystadenocarcinoma may very well be bilateral, they are more often unilocular than mu
cancer (blue arrow). Clearly visible are cystic implants on the peritoneal reflection (red arrow).
These were cystic ovarian metastases of a colorectal cancer.
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Peritoneal Pathology:
Angela Levy
Chief Gastrointestinal Radiology, Department of Radiologic Pathology, Armed Forces Institute of Pathology, Washing
ity of the Health Sciences, Bethesda, MD:
Publicationdate 2009-08-28 This review is based on a presentation given by Angela Levy and adapted for the Radiolo
agnosis of cystic and solid peritoneal and mesenteric masses. In Peritoneum and Mesentery - part I: Anatomy
the normal anatomy and physiology of the peritoneum and peritoneal cavity are discussed. You can click on images
Differential Diagnosis:
Differential diagnosis of cystic peritoneal masses
Cystic masses:
The first step when diagnosing peritoneal or mesenteric masses is to separate them into cystic and solid. Secondly w
ction, i.e. abscess or as a result of pancreatitis, perforation or bile peritonitis can simulate a cystic mass. Especially flu
mass. Lastly we have to know which cystic masses are common and look for specific features of these masses. Other
ncreatic pseudocyst and mesothelial cyst are very uncommon and have no specific features.
* Peritoneal inclusion cyst
is a less common benign primary peritoneal tumor.
It is also known as benign multicystic mesothelioma. This name is very confusing since there is no relation with the m
It is seen in women with prior gynaecological surgery or infection. Differential diagnosis of solid peritoneal masses
Solid masses:
Usually there are omental metastases, i.e. omental cake and ascites.
* NHL and lymph node metastases
Are the most common diagnoses of a mesenteric mass. NHL is the most common cause of lymphadenopathy and us
* Carcinoid
Presents as a spiculated mesenteric mass often with a central calcification. It metastasize to the liver. There is assoc
* Sclerosing mesenteritis
May look like carcinoid. There is a wide spectrum of presentations ranging from an infiltrative solid mass to the mor
is, which presents as a lipomatous mass, usually with no clinical implication.
* Mesenteric fibromatosis
Is also known as intraabdominal fibromatosis, abdominal desmoid or desmoid tumor. It is a locally aggressive tumo
stroma resulting in a low attenuation on CT and a high attenuation on T2WI.

* Mesothelioma Accounts for 20% of all mesotheliomas and is associated with asbestos exposure and pleural plaque
Cystic Masses:
Mucinous Carcinomatosis with a tumor nodule along the right paracolic gutter
Mucinous Carcinomatosis:
Mucinous carcinomatosis is the most common cystic tumor to affect the peritoneal cavity. Usually these metastases
nal tract (stomach, colon, pancreas). The prognosis is poor. However, when low-grade mucinous adenocarcinoma of
ically pseudomyxoma peritonei, which is a distinct tumor with a better prognosis. In peritoneal carcinomatosis we se
r deposits, and bowel obstruction. Pseudomyxoma peritonei with pronounced scalloping of the liver and almost dest
Pseudomyxoma peritonei:
Pseudomyxoma peritonei is the result of a mucinous adenocarcinoma of the appendix, which presents as a mucocel
acterized by recurrent and recalcitrant voluminous mucinous ascites due to surface growth on the peritoneum witho
pseudomyxoma peritonei is scalloped indentation of the surface of the liver and spleen. Unlike peritoneal metastase
seudomyxoma peritonei with a little bit of scalloping and a mucocele of the appendix Pseudomyxoma peritonei (2) C
ny scalloping of the liver. Notice the thickened falciform ligament. There is a mucocele of the appendix (arrow). This f
ened mesentery (arrow) On the left another case of pseudomyxoma peritonei. There is compression of the mesente
re are also some calcifications. Pseudomyxoma peritonei is often confused with mucinous carcinomatosis. Unlike ca
as omental cake or peritoneal tumor deposits. Lymphangioma
Mesenteric cyst - Lymphangioma:
Mesenteric cyst is a descriptive term for any cystic lesion within the mesentery. Usually it is a lymphangioma. Other n
onpancreatic pseudocyst and mesothelial cyst are very uncommon and have no specific features. Lymphangioma is
he neck, but 5% of lymphangiomas are abdominal. Lymphangioma has enhancing septa. Unlike in cystic peritoneal n
ptated cystic lesion without ascites the most likely diagnosis is a lymphangioma. Lymphangioma Lymphangioma is o
y very difficult to separate the tumor from the bowel and in many cases the bowel also has to be resected. The case
s appreciate the septations, although the specimen clearly shows multiple septations. Ultrasound or MR depict these
Enteric Duplication Cyst:
Enteric duplication cyst is a cyst with a wall that has all three layers of the bowel wall, i.e. mucosa, submucosa and m
cysts when we see a cystic mass adjacent to the bowel, we have to realize, that these are rare lesions.
They may occur anywhere in the mesentery, so either adjacent to or away from the bowel. On the left an enteric dup
ent was suspected of having a cystic pancreatic tumor. The specimen demonstrates all the bowel wall layers.
Nonpancreatic Pseudocyst:
Nonpancreatic pseudocyst is a residual of an old hematoma or infection. Most of these patients have a history of pri
n be some debris within the lesion. The patient on the left had had a car accident eight months before. This is proba
Notice the thickened wall on the CT and the debris on the ultrasound. On the left a specimen and CT image of a non
old hematoma or abscess. You can suggest this diagnosis when you have a positive history and you see this thickene
Enteric cyst and mesothelial cyst:
These are also mesenteric cysts.
They are rare and have nonspecific imaging features.
The case on the left was diagnosed as a lymohangioma, simply because a lymphangioma is by far the most common
At surgery this was a mesothelial cyst. Peritoneal Inclusion Cyst
Peritoneal Inclusion Cyst:
Also called Multilocular peritoneal inclusion cyst or Benign cystic mesothelioma. This is an uncommon benign primar
lioma. It occurs in premenopausal women with prior gynaecological surgery or infection that results in peritoneal sca
loculated in the pelvis. The imaging features of a peritoneal inclusion cyst are non-specific except that it has to be loc
emonstrating a multicystic pelvic lesion next to the uterus, which proved to be a peritoneal inclusion cyst. Peritoneal
ction Sometimes the ovary is seen 'trapped' with the septate fluid collection (figure). Peritoneal inclusion cyst (2) Whe
ay extend into the upper abdomen as is seen in the case on the left. Notice that the left ovary is encircled by the cyst
lusion Cyst Peritoneal inclusion cyst (3) On the left another example of a peritoneal inclusion cyst. There is a nice cor
on cyst in a man extending into the upper abdomen Peritoneal inclusion cyst (4) On the left images of a male patient
tic mass extending from the pelvis along the right paracolic gutter to the upper abdomen. In a male patient this is a v
ges of a pseudomyxoma peritonei which was discussed before. In peritoneal inclusion cysts however, you will not se
Tuberculosis:
TB can produce very thick ascites, that can be loculated in distribution. Because of this, it can simulate a cystic lesion
l ileum and lymphadenopathy. The lymph nodes most often are of low attenuation (caseated). So these are the thing
the peritoneum is usually very thick (arrow). Echinococcal cyst with daughter cysts (arrows)
Echinococcal Cyst:
It is unusual for an echinococcal cyst to be located in the peritoneum. It favors the liver, the spleen and even the kidn
toneum and in the spleen. Notice the daughter cysts as small dark lesions within the large peritoneal cyst (arrows). E
re seen.
Solid Masses:
Omental cake (arrows) and ascites in a patient with peritoneal metastases

Peritoneal metastases:
Peritoneal metastases are the most common peritoneal solid masses. Gastrointestinal and ovarian cancers are the m
ental cake and ascites. On the left a CT demonstrating omental cake in a patient with ovarian cancer. Metastasis of a
n the left a patient with a lung carcinoma. This solitary solid mass was found in the pelvis. Based on the history this w
like ... can have the same presentation. Biopsy is needed to make the diagnosis. This proved to be a metastasis of th
Lymphoma:
NHL is the most common cause of lymphadenopathy. Usually there are other sites with lymphoma. The CT attenuati
hancement. Heterogeneous attenuation is seen only in cases with aggressive histology. During treatment the attenu
lcification may occur. Carcinoid
Carcinoid:
Carcinoid is a slow-growing neuroendocrine tumour most commonly found in the small bowel. Less than 10% of pat
overproduction of serotonin, which can lead to symptoms of cutaneous flushing, diarrhea and bronchoconstriction.
o appreciate than the primary tumor in the small bowel.
There is associated bowel wall thickening due to a desmoplastic reaction. On the left a patient with a typical carcinoi
traction and wall thickening. There is a metastasis in the liver (yellow arrow). Positive octreoscan in a patient with car
er patient with a carcinoid. The right image is the octreoscan, which is positive in 85% of carcinoids, so this can be a g
n also detect liver metastases on the scan (blue arrows). Notice that there is no activity of a primary tumor in the sm
n be quite small.
Gastrointestinal Stromal Tumor - GIST:
Primary small bowel tumors can extend into the mesentery and the typical example of that is the GIST. You can have
wel, that you may not appreciate it. On CT they are of mixed density due to necrosis and hemorrhage and they tend
left.
Inflammatory Pseudotumor:
This disease can affect lung, orbit and mesentery. Inflammatory pseudotumor is a diagnosis by exclusion. Usually th
nic inflammation with an unclear pathogenesis. Probably it is an occult infection due to minor trauma or post surgica
Mesenteric fibromatosis - Desmoid:
Mesenteric fibromatosis is also known as intra-abdominal fibromatosis, abdominal desmoid or desmoid tumor. On t
th, abdominal fullness, and a palpable abdominal mass. First study the images on the left and continue with the MR.
al diagnosis. Mesenteric fibromatosiswith high signal on T2WI First of all this is a well circumscribed lesion with a low
and there are some small strands of enhancement within the lesion. On MR there is a low signal on T1 as we would e
he low density on CT this tells us that there is mucin within the lesion. This finding is very suggestive of the diagnosis
adolinium enhancement Mesenteric fibromatosis - Desmoid (2) The enhancement on MR is more intense compared
ut on MR we can appreciate the enhancement better. It tells us that the lesion is well vascularized. Mesenteric fibrom
is a benign proliferative process that is locally aggressive and can recur, but it does not metastasize. The small bowe
ilial adenomatous polyposis (FAP). On the left images of another patient with mesenteric fibromatosis. Notice that th
agenous or fibrous stroma. So there are two distinct patterns. Mesenteric fibromatosis - Desmoid (3) On the left aga
eater omentum (upper image) and the gastrosplenic ligament (lower image). Mesenteric fibromatosis arising in the r
sis On the left an unusual location, because normally there is no mesentery deep in the pelvis. This patient had famil
e ileum was performed. Now accompanying that J-pouch is mesentery in which mesenteric fibromatosis has develop
e tumor. In familial adenomatous polyposis the mesenteric fibromatosis is almost always post operative and occurs
uding abdominal wall fibromatosis. These cases can be very aggressive. It usually comes back and when it does, it co
treated as conservatively as possible. Panniculitis mesenterialis
Sclerosing Mesenteritis:
This disease has multiple synonyms reflecting the wide histologic spectrum: mesenteric panniculitis, fibrosing meser
nic inflammation of unknown etiology. This entity is more common than previously thought. The signs and symptom
omplications, but in many cases it is an incidental finding on CT made for other reasons. The image on the left is the
for other reasons. This form is mostly named panniculitis mesenterialis. In a more advanced stage you can have sign
in these masses dystrophic calcifications can be seen as well as lucent areas of fat (arrow) Sclerosing mesenteritis (2)
tice the retraction of the bowel and also notice the resemblance to carcinoid. In these cases the octreoscan can be a
uated in the root of the mesentery and this makes a surgical procedure extremely difficult. These lesions are treated
and sometimes anti-estrogens as long as possible.
Malignant mesothelioma:
Malignant mesothelioma is one of the primary peritoneal malignancies (Table on the left). Malignant mesothelioma S
ce of lymphadenopathy. Just like pleural mesothelioma, it is associated with asbestos exposure. On the left a patient
f the peritoneum. The diagnosis was suggested because of the pleural calcifications. Malignant mesothelioma Malign
he intra-peritoneal structures. In the case on the left there is besides encasement of the bowel and the liver, also enc
of the same case. Primary peritoneal serous carcinoma
Primary Peritoneal Serous Carcinoma:
This tumor is also one of the primary peritoneal malignancies.
It occurs exclusively in women. This tumor is histologically identical to malignant ovarian surface epithelial tumors. It

of tumors previously diagnosed as ovarian cancer are diagnosed as primary peritoneal serous carcinoma. Consider t
sis if you think of metastatic ovarian cancer but the ovaries are normal. On the left a typical case. There is ascites and
er, but the ovaries were normal. Desmoplastic Small Round Cell Tumor
Desmoplastic Small Round Cell Tumor:
This tumor is also one of the primary peritoneal malignancies. It is a rare malignancy of uncertain origin. It occurs pr
is diagnosis if you see something that looks like peritoneal carcinomatosis in a young man that has no history of a pr
gnosis. Desmoplastic small round cell tumor begins as a dominant mass and then multiple masses occur within the
other tumors, however, the age of the patient provides the clue to the diagnosis. NHL would be number one in the d
USA, Javier Arn?iz, MD, Janet C. Shaw, Lt Col, USAF, MC and Leslie H. Sobin, MD
2. Secondary Tumors and Tumorlike Lesions of the Peritoneal Cavity: Imaging Features with Pathologic Correlation b
Leslie H. Sobin, MD RadioGraphics March 1, 2009 29:347-373
3. Expert Differential Diagnoses: Abdomen: Published by Amirsys? by Michael Federle
Acute Scrotum in Children:
Gael J. Lonergan
Chief of Radiology of the Children's Hospital of Austin, Washington, DC:
Publicationdate 2007-5-1 0 This article is based on a presentation given by Gael Lonergan at the 'Teaching in Holland
is. In this overview we will discuss the following subjects: by Gael J. Lonergan
Testicular torsion:
Testicular torsion with twisted spermatic cord (arrow). Torsion occurs when an abnormally mobile testis twists on th
with acute onset of severe testicular pain. The ischemia can lead to testicular necrosis if not corrected within 5-6 hou
undergo spontaneous detorsion. In a child with an acute scrotum, testicular torsion is not the most common conditi
mmon cause of scrotal pain. Typically, it has a more gradual onset than testicular torsion and patients may endure p
appendage torsion Testicular appendage torsion appears as a lesion of low echogenicity with a central hypoechogen
n't see it and we do the US just to exclude a testicular torsion. We should see torsion of testicular appendices more a
lar appendix and epididymitis are more common, our goal is mainly to detect or exclude a testicular torsion. We war
mergency. Testicular torsion: Optimal setting for color on normal side, followed by examination of symptomatic side
Color doppler:
Complete absence of intratesticular blood flow and normal extratesticular blood flow on color Doppler images is dia
Yet, the presence of flow within the testis does not exclude the presence of torsion, because incomplete vascular ob
n the left shows a testicular torsion of the left testis. This case is very obvious because there is no flow on the affecte
ged torsion, the testis is typically hypoechoic and inhomogeneous and is often accompanied by a surrounding hydro
By the time these sonographic findings occur, surgical salvage of the testicle is unlikely. Use at least a 10 MHz linear t
side and optimize the settings for low flow, low resistance and low velocity. The background 'noise' should just be vis
the normal side, don't touch any of the settings' and go to the symptomatic side. Small testis in a very young child, d
y young child it can be difficult to examine the testes because they are very small and mobile. The prepubertal testis
s about 30cc. With age the testis increases in echogenicity, so in a very young child the small testis can be difficult to
s retracted into the inguinal canal (figure). At the start of the examination you can put your finger on the inguinal can
Color Doppler imaging has limited sensitivity for detecting blood flow in pediatric patients with a testicular volume o
ore cases. On the far left a child of 10 months old with torsio testis. There is more flow in the tissues around the test
e child has cellulitis. The case next to it is an older child. The gray scale ultrasound shows an abnormal testis. So this
that this definitely is a torsio testis.
Presentation:
The testis is usually elevated as a result of the torsion and the shortening of the cord itself and may be in a transvers
is itself, a hydrocele or skin thickening.
Gray scale Ultrasound:
Gray scale ultrasound is helpfull, not in making the diagnosis, but in predicting the outcome. For the first 4-6 hours th
is salvagable, so a normal appearance on gray scale means good outcome. After this period the testis becomes hete
nd scrotal wall may swell and become hypoechoic. A worsening appearance of the testis on gray scale US correlates
or outcome. The way to look at differences in echogenicity, is to get a transverse image of both testes. The images on
c. This testis is probably not salvagable. The testis may appear more echogenic or less echogenic, it doesn't matter, a
Epididymitis:
Epididymitis is the most common inflammatory process involving the scrotum and more common in adults. Infection
thra or prostate and are typically caused by urinary tract pathogens or sexually transmitted organisms (Chlamydia o
due to infection with Streptococcus or Staphylococcus. In urinary tract abnormalities also infection with E.Coli is see
sterile urine through the ejaculatory ducts, for instance if the ureter inserts in the prostatic urethra, this may lead to
ild with a meningocele who had epididymitis. Due to increased bladder pressure and contractions against a closed s
te, but also into the epididymis, which resulted in epididymitis. The case on the left shows the typical features of epid
is a hydrocele and scrotal wall thickening. With color doppler there is increased flow. A normal epididymis has only l
Orchitis:
Orchitis is characterized by focal, peripheral, hypoechoic testicular lesions that are poorly defined, amorphous, or cr

color Doppler sonography images and is usually accompanied by epididymal hyperemia due to concomitant epididy
orchitis. Focal testicular infarction can occur as a complication of epididymitis when swelling of the epididymis is sev
ears as a hypoechoic intratesticular mass devoid of blood flow. The complications of orchitis are abscess formation a
week before with a hyperemic testis and epididymitis. Due to ongoing infection, the pressure within the testis increa
be easily mistaken for torsion. On the left two cases with abnormal areas within the testis probably due to absces fo
Trauma:

Hematocele:
In trauma there is either a hematocele or testicular hematoma. In the acute phase the hemorrhage is echogenic and
rotal or intra-abdominal hemorrhage. It represents bleeding between the leaves of the tunica vaginalis and appears
lop loculations, which appear as thick septations. It is important to be able to tell if the testis is intact, because if ther
y. On the left a patient with a typical hematocele.
Testicular rupture:
Testicular rupture is seen as focal alterations of testicular echogenicity correlating with areas of intratesticular hemo
ete fracture plane is identified in fewer than 20% of cases, although visible alterations in the testicular contour are a
und demonstrated a large hematocele. There was doubt whether the echogenic structure indeed was a testis. MR w
that the echogenic structure is a result of fresh hematoma. On the left another patient with a rupture, that was seen
a with no identifiable testis due to rupture.
Hernia:
LEFT: herniated bowel in preterm.RIGHT: left-sided hernia in constipated child due to intermitted herniation of sigmo
ts. Sometimes we can see them on plain films as we see in the case on the left. If they are filled with bowel, they are
ith soft tissue Longitudinal view of inguinal canal. The herniated bowel is seen next to the testis (arrow). The ultrasou
continued in the standing position. The bowel or omentum is visible separate from the testis (figure). The intestinal l
rcerated hernia is a cause of acute scrotal pain. Peristalsis suggests viability and absence of peristalsis is worrisome
Idiopathic Scrotal Edema:
Idiopathic scrotal edema is seen in school-aged boys. They present with scrotal skin swelling. So the clinical question
es and epididymes are normal and all that we see on US is skin edema. If this is all we see and the child does not hav
s, than we can make the diagnosis of Idiopathic scrotal edema. Although this is an idiopathic disease, so we don't kn
is. It is far more reasuring for parents to be told, that their child has a specific diagnosis, that it is benign and will go a
you don't know what it is, but it is no torsion, so you don't really worry about it. J US Med 1997; 16: 23.
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None:

None:

Traumatic Intracranial Hemorrhage:
Amber Bucker, Henriette Westerlaan, Aryan Mazuri, Maarten Uyttenboogaart and Robin Smithuis
University Medical Center Groningen and Alrijne Hospital in Leiderdorp, the Netherlands:
Any type of bleeding inside the skull or brain is a medical emergency.
The most common causes of hemorrhage are trauma, haemorrhagic stroke and subarachnoid haemorrhage due to
Complications are increased intracerebral pressure as a result of the hemorrhage itself, surrounding edema or hydr
s traumatic hemorrhages.
Non-traumatic hemorrhages are discussed here. Press ctrl+ for larger images and text on a PC or □+ on a Mac.
Most images can be enlarged by clicking on them.
Localization of hemorrhage:
Extra-axial hemorrhage -Intracranial extracerebral Intra-axial hemorrhage - intracerebral
Anatomy of the meninges:
Meninges are the three membranes that envelop the brain and spinal cord: the dura mater, the arachnoid mater, an
Cerebrospinal fluid is located in the subarachnoid space between the arachnoid mater and the pia mater. Dura mate
cord.
It consists of two layers: the inner meningeal layer and the outer periosteal layer. Arachnoid is a layer with delicate fi
ttach to the pia mater.
Arachnoid granulations - also called Pacchionian granulations - are small protrusions of the arachnoid mater throug
es of the brain, and allow cerebrospinal fluid to exit the subarachnoid space and enter the blood stream. Pia mater
The pia mater allows blood vessels to pass through and nourish the brain.
The arachnoid and pia mater together are sometimes called the leptomeninges.

Traumatic hemorrhage:

Epidural hematoma:
An epidural hematoma is a bleeding that occurs between the dura and the skull.
It is mostly seen in children who have a head injury with fracture of the temporal bone resulting in tearing of the mid
the midline because it is located between the dura and the skull.
However since the dura is tightly adherent to the adjacent skull near suture lines, an epidural hematoma usually doe
Disable Scroll Enable Scroll
Disable Scroll A 11 year-old boy fell off his bike probably due to an epileptic convulsion.
He hit the curb with his head.
His level of consciousness was lowered and his EMV score was 2-4-3.
He presented with bradycardia, hypertension, abnormal posturing and a non-reactive dilated right pupil, which are
findings A craniotomy was performed subsequently and the torn middle meningeal artery was coagulated. Clinical
Subdural hematoma:
A subdural hematoma is a collection of blood between the inner layer of the dura and the arachnoid.
It cannot cross the midline, but can be located near dural folds like the falx or the tentorium. It usually results from r
It usually occurs in head trauma and especially in patients who are treated with antcoagulantia. It is most common in
In brain atrophy the venous subdural structures are less well “packed” against the skull, which give them more space
ral hematoma.
There is midline shift (left image). The patient was operated and the hematoma was evacuated (right image). The ima
perdense and isodense areas. This can be seen in hyperacute bleeding, but can also be seen in rebleeding. There is
esulting in dilatation of the temporal horn of the right lateral ventricle (arrow). An acute subdural hematoma is hype
onic subdural hematoma appears hypodens to brain parenchyma (isodens to CSF). Sign of active bleedingIn the acut
e mixed components of the hemorrhage: fresh in flow of non clotted blood (hypodens) and clotted blood (hyperdens
hematoma As a subdural hematoma ages, the density of the hematoma will decrease and may be the same as the d
a case of an isodense subdural hematoma which is very hard to detect (arrows). Notice that on a higher level there i
hematoma may be isodense to the brain. This is seen in patients with severe anemia, disseminated intravascular co
ref). When a chronic subdural hematoma (> 21 days) becomes hypodens to parenchyma and isodens to CSF, it may r
chnoid layer which causes CSF to leak to the subdural space,. A subdural hematoma can spread along the falx and te
Subarachnoid hemorrhage:
The images show hyperdense blood in the subarachnoid space of the Sylvian fissure (yellow arrow). Notice the subga
a coupe contrecoupe type of injury. This is another coupe contrecoupe type of injury with contusional hemorrhages
se (red arrow). There is a subarachnoid hemorrhage on the right with a fracture of the parietal bone (yellow arrow).
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Diffuse Axonal Injury:
High-impact trauma with acceleration-deceleration forces, especially rotational acceleration, can lead to stretching a
CT has a low sensitivity for detecting DAI. In closed traumatic brain injury with no traumatic subarachnoid hemorrha
man had a high energy trauma with his motorcycle.
The initial EMV score was 2-5-3 and his pupils were non-reactive and dilated. CT findings Continue with the MRI imag
Disable Scroll Enable Scroll
Disable Scroll MRI was requested because of persisting cognitive deficits. MRI findings In closed traumatic brain injur
r hemorrhage a DAI is unlikely.
DAI can be diagnosed accurately conventional MRI, including T2*GRE or SWI.
The presence of DAI on MRI in patients with traumatic brain injury results in a higher chance of unfavourable functio
grading, the odds ratio for unfavourable functional outcome increases threefold with every grade.
Lesions in the corpus callosum in particular are associated with an unfavourable functional outcome. This patient ha
Scroll
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Duret hemorrhage:
A 54-year-old man, who was treated with anticoagulants after aortic valve replacement, developed severe headache
The following day his condition worsened with loss of consciousness, respiratory distress and a non-reactive dilated
The initial CT of his head showed an acute subdural hemorrhage along the left convexity with subfalcine and uncal h
y the CT showed an acute bleeding within the brainstem, which had a lethal outcome. This brain stem hemorrhage is
They are small linear areas of bleeding in the midbrain and upper pons of the brainstem caused by a traumatic dow
ation through the tentorial hiatus. by Sara Shams, MD et al. Cerebrovasc Dis. 2016
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Small Bowel Tumors:
Rinze Reinhard and Gerdien Kramer
Radiology department of the VU medical centre, Amsterdam, the Netherlands:
Publicationdate 2014-05-21 Small bowel tumours are rare, accounting for 3-6% of gastrointestinal tumors. The clinica
ntestinal bleeding, abdominal pain or small bowel obstruction. In this article we will focus on the four most common
cussed.
Overview:
The table shows the features of the most common malignant small bowel tumors. Click on the table to enlarge the im
lyps form.
* MEN-1 syndrome Multiple endocrine neoplasia type 1 or Wermer's syndrome is a syndrome in which endocrine tu
Adenocarcinoma:
Adenocarcinoma represents 25-40% of all small bowel neoplasms. However coloncarcinoma is 50 times more comm
hese are found with endoscopy. The jejunum is the second most prevalent site. Risk factors: Study the coronal recon
pical imaging representation of a small bowel adenocarcinoma is a focal unilocular, circumferential mass with should
omas present as an intraluminal polypoid mass, which can lead to intussusception. Ulceration is a quite common fea
nother example of a duodenal carcinoma presenting as irregular wall thickening in the distal duodenum (arrows). Ad
rs show bright enhancement. Metastases to the liver and peritoneum occur frequently. The images show a circumfe
junum Large adenocarcinomas can mimic a lymphoma as in this case. The images show an irregular mass in the pro
lumen is not obstructed. There is a large conglomerate of hypodense lymph nodes in the adjacent mesentery, consi
to be an adenocarcinoma, but these findings could very well represent a lymphoma. Here the endoscopic image of t
mal jejunum with aneurysmatic dilatation. On top of our differential diagnostic list would be a lymphoma, but this pr
ures that favour adenocarcinoma are fat stranding due to mesenteric fat infiltration and lymph node metastases. In
ccur and are usually more bulky. The images show a short obstructing circular mass in the jejunum (yellow arrow) wi
inoma. Adenocarcinoma in the jejunum Post-contrast T1W-image with fatsat (left) and T2W-image (right) show an ob
tenotic dilatation. Top images show a circular mass in the proximal jejunum with FDG uptake (yellow arrows). Lower
esenteric lymphadenopathy (red arrows), consistent with adenocarcinoma. First study the images. Then continue rea
s. So this is not a small bowel feces sign. The findings are: One could consider the diagnosis of Crohn's disease. How
rminal ileum (not shown) was normal, which would be uncommon. At surgery this proved to be an adenocarcinoma.
cted with MRI than with CT. Adenocarcinoma in Crohn's disease As mentioned before 50% of small bowel adenocarc
opy. The jejunum is the second most prevalent site. Occurrence in the ileum is often related to Crohn's disease as in
mesenteric infiltration with foci of extraluminal air indicating perforation. This proved to be an ulcerating adenocarc
e pre-operatively due to lack of typical imaging features. The risk is related to the duration and anatomical extent of
of active Crohn's disease. Crohn's disease with stenosis but no carcinoma. Here a patient with active Crohn's disease
t does not have an adenocarcinoma. The findings are: Here another adenocarcinoma located in the jejunum. There a
w arrows). It should not be mistaken for mesenteric panniculitis as these large necrotic lymph nodes are pathologic.
Lymphoma:
Lymphoma in the terminal ileum Lymphomas make up about 20 % of all small bowel tumors. The distal ileum is the
present in the distal ileum. Risk factors include celiac disease, Crohn's disease, SLE, immunocompromised state and
cal presentation of a small bowel lymphoma is a thick walled infiltrating mass with aneurysmal dilatation without ob
bowel wall and the myenteric nerve plexus. Here a typical presentation (figure). There is irregular wall thickening of
the proximal jejunum A less common presentation is as an intraluminal polypoid mass or a large excentric mass with
on and formation of fistulas. As mentioned before, large adenocarcinomas and lymphomas can have similar imaging
splenomegaly are findings that support the diagnosis of a lymphoma. Infiltration of the mesenteric fat favours the di
as a large thick walled mass in the proximal jejunum with FDG uptake. Dilated lumen at the site of the mass and pre
mages and take special notice of the first image. Then continue reading. The findings are: EATL Here another patient
ith luminal dilatation. There is infiltration of the mesentery. Pathology showed a T-cell lymphoma in celiac disease. Th
This is a type of T-cell lymphoma that affects the small intestine in patients with celiac disease. EATL lymphoma in a p
lymphoma in celiac disease.
Carcinoid tumor:
Small intraluminal mass in the ileum (yellow arrow). Associated spiculated mesenteric mass with adjacent desmopla
uroendocrine tumors. Neuroendocrine tumors of the small can be divided in well-differentiated - also known as carc
e carcinoma. Here we will discuss the carcinoid tumors. Carcinoid tumors constitute 2% of all gastrointestinal tumors
des, exceeding that of adenocarcinoma, making it the most common small bowel malignancy. The most common loc
llowing appendectomy. It is uncommon to diagnose a carcinoid of the appendix on imaging studies. These images ar
tumor proved to be a carcinoid of the appendix. The second most common location is the distal ileum. The stomach,

tiple in about one third of cases. There is an association with multiple endocrine neoplasia type I (MEN I). Here a typi
oplastic reaction and retraction of adjacent small bowel loops with wall thickening (arrows). Carcinoid with calcificati
ased on intraluminal component of carcinoid. Note small liver metastasis (arrow). Carcinoid metastases The likelihoo
the incidence of nodal and liver metastases is approximately 20-30% in patients with carcinoid tumors smaller than
for liver metastases when tumors are 1-2 cm. In patients with primary tumors greater than 2 cm, the incidence of no
astases are usually hypervascular and can show central necrosis. Most of the lymph node metastases show calcificat
arcinoid tumor. Same patient. Four years after the initial CT multiple liver metastases are seen. Notice hypervascular
rome The carcinoid syndrome occurs in approximately 5% of carcinoid tumors and becomes manifest when vasoact
y occurs in patients who have liver metastases. Symptoms include flushing and diarrhea and less frequently broncho
in-induced fibrosis of the cardiac valves, notably the tricuspid and pulmonary valves. The images show a carcinoid tu
stic reaction (yellow arrow). Carcinoid presenting as hyperenhancing lesion in the late arterial phase Carcinoid tumor
ears. They start as small submucosal lesions (images). As the carcinoid grows, thickening of the bowel wall occurs, le
tumors can cause an intense desmoplastic reaction with retraction of bowel loops and fibrosis, sometimes leading t
s are non-specific. It can present as a small submucosal nodule with arterial enhancement (image) and sometimes th
GIST:
Typical GIST in the ileum presenting as an exophytic tumor. Gastrointestinal stromal tumors are mesenchymal tumo
uently occur in the stomach, followed by jejunum and ileum. Occurrence in colon, rectum, esophagus and appendix
e small bowel they are more often malignant than in the stomach. Tumors smaller than 2 cm are usually benign, wh
redominantly grow extraluminally and can show necrosis, hemorrhage, calcification (post therapy) and fistula forma
terogeneous enhancement and a clear delineation from the mesentery. An intraluminal mass is far less common. Ob
el wall, in contrast to adenocarcinoma. Unlike carcinoid tumors, the primary lesion in a GIST is large. Both GIST and ly
tases are usually hypervascular and can be missed on a single portal venous phase CT. Lymph node metastases are
nother diagnosis. Mesenteric or omental metastases are more common in recurrent disease than at first presentatio
metastases can be easily missed, as they often have a low-density center. After chemotherapy (Imatinib or Gleevec),
cystic. Despite radical surgical resection, 40-90 % of patients have recurrence of disease in liver or mesentery. Gleeve
nce in resected GIST showing hypodense livermetastases and a large heterogeneous peritoneal metastasis.
Differential diagnosis:
The differential diagnosis of small bowel tumors includes many infectious and inflammatory diseases, that all preser
umors are metastases, which are more common than primary malignancies. Multiple intraluminal metastases in a p
Metastases:
The spread of metastases to the small bowel can be intraperitoneal, hematogenous, lymphatic or by direct extension
in primary tumors originating from ovary, appendix and colon. Metastatic cells implant on the mesenteric border of
oma, melanoma and renal cell carcinoma. They can be polypoid and can cause intussusception. Here a patient with
to metastasis. Right image shows intussusception in coronal plane as well as an enlarged mesenteric lymph node (y
small bowel metastasis. This patient had a history of colon- and esophaguscarcinoma. This patient has multiple intra
metastases from an unknown primary. Also note the intussusception (red arrow) en soft tissue metastasis in the lef
al ileal wall thickening with some enhancement in Crohn's disease.
Crohn's disease:
Wall thickening in inflammatory or infectious small bowel disease should be differentiated from malignant wall thick
are ulcerations, increased mesenteric vessels (comb sign), skip lesions and increased surrounding fat (creeping fat). A
cinoma is well-established. Differentiating these two is challenging pre-operatively when there are no typical imaging
ion that is refractory to medical therapy. Crohn's disease with multiple lesions (arrows). Active Crohn's disease. Long
l enhancement.
Sclerosing or fibrosing mesenteritis:
Sclerosing or fibrosing mesenteritis develops in the mesentery and can be mass-like and mimic a malignant tumor li
rentiated by the 'fat ring sign',which means there is preservation of fat surrounding the mesenteric vessels.
Desmoid:
Desmoid is a rare, benign, locally aggressive mass composed of fibrous tissue. It is the most common primary tumor
oplasm. Most desmoids are sporadic tumors, but some occur in the setting of Gardner syndrome. There is often a hi
ze, but do tend to recur. The high recurrence rate favors the use of nonsurgical therapy. Mesenteric desmoids usuall
be displaced or encased. Because these tumors can be very hard, percutaneous biopsy can be challenging.
Adenomas:
Adenomas are pre-cancerous lesions that can present as polypoid pedunculated masses on a stalk, a sessile mass (r
ogeneous enhancement and are usually nonobstructive. Extraserosal extension is suggestive of malignant degenera
owel polyps, mainly located in jejunum. Patient with Peutz-Jeghers syndrome with ileal polyp as leadpoint for intussu
Polyposis syndromes:
Intestinal polyposis syndromes can be divided into the broad categories of familial adenomatous polyposis (like Gard
ers syndrome) and other rare polyposis syndromes. Patients with these syndromes often have multiple small bowel
l bowel neoplasms. Here a patient with Peutz-Jeghers, who has multiple polyps in the jejunum. The largest polyp in th
onal T1 FS post contrast and coronal T2 show enhancing well defined intraluminal jejunal mass..

Hemangioma:
Most intestinal hemangiomas are located in the jejunum. They can be sessile or pedunculated and they usually show
ayed phase.
Leiomyoma:
Leiomyomas are rare mesenchymal benign tumors. The origin may be intraluminal, submucosal or extraluminal. Be
geneous enhancement.
Lipomas:
These are well-circumscribed intraluminal masses with fat attenuation. Liposarcoma of the small bowel is extremely
unction. Low signal intensity of the mass on MR T2 fatsat (right lower image). Endoscopic view of lipoma (right upper
Mesenteric ischemia:
Target sign due to ischemic small bowel segment. Note mesenteric edema and ascites. Target sign A target sign is a
ularis. It is a benign sign and is usually due to inflammation, ischemia or radiation enteritis.
Typhlitis:
Target sign in a patient with neutropenic sepsis, consistent with enterocolitis. Neutropenic enterocolitis is a life-threa
in individuals with hematologic malignancies who are neutropenic and have breakdown of gut mucosal integrity as a
ord "typhlon," or cecum) describes neutropenic enterocolitis of the ileocecal region; we prefer the more inclusive ter
nd/or large intestine are often involved (8).
Technique:
Small bowel tumors can be detected on standard abdominal CT in patients with non-specific symptoms However if t
ically, CT-enterography or MRI-enterography or enteroclysis is performed. Both MRI and CT have good performance
personal preferences. We prefer MRI enteroclysis as tumors are often well depicted in the dilated bowel loops witho
water or methylcellulose) is the enteric contrast media with low signal on T1-weighted images and high signal on T2-
W-image with fatsat. Notice that the small bowel is well distended. Luminal distension should be ≥ 2 cm. Bowel wall t
ops can be easily misinterpreted as wall thickening or abnormal enhancement. On the coronal T1W-image the jejuna
thickening and prominant enhancement. On the T2W-image during the same examination there is normal distentio
are equivocal or to look for metastatic disease. G. Masselli, M.C. Colaiacomo, G. Marcelli et al. Br J Radiol 2012; 85: 8
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None:

Pulmonary nodule - Benign versus Malignant:

Differentiation with CT and PET-CT:
Ann Leung and Robin Smithuis
Department of Radiology, Stanford University Medical Center, Stanford, California and the Department of Radiology,
Publicationdate 2007-05-20 A solitary pulmonary nodule is defined as a discrete, well-marginated, rounded opacity l
d by lung parenchyma, does not touch the hilum or mediastinum, and is not associated with adenopathy, atelectasis
s and are treated as malignancies until proven otherwise. The differential diagnosis of a solitary pulmonary nodule is
r malignant. In this overview we will discuss some of the new features that can help to differentiate between benign
CT: benign versus malignant:
Benign pattern of calcification
Calcification:
Diffuse, central, laminated or popcorn calcifications are benign patterns of calcification. These types of calcification a
patterns of calcification should not be regarded as a sign of benignity. The exception to the rule above is when patie
calcification pattern can be seen in patients with osteosarcoma or chondrosarcoma. Similarly the central and popco
previously had chemotherapy. Relationship between SPN-size and chance of malignancy in patients with high risk fo
Size:
A solitary pulmonary nodule (SPN) is defined as a single intraparenchymal lesion less than 3 cm in size and not assoc
3 cm in diameter is called a mass. This distinction is made, because lesions greater than 3 cm are usually malignant,
en et al studied the relationship between the size of a SPN and the chance of malignancy in a cohort at high risk for l
left. They concluded that benign nodule detection rate is high, especially if lesions are small. Of the over 2000 nodule
Growth:
Comparison with prior imaging studies is often the most useful procedure to determine the importance of the findin
benignity. Transverse image (left) and coronal reconstruction (right)Three-dimensional ratio = transverse dimension
Shape:

Japanese screening studies showed that a polygonal shape and a three-dimensional ratio > 1.78 was a sign of benign
ets (multi-sided). A peripheral subpleural location was also a sign of benignity in this study. The three-dimensional ra
and dividing it by the maximal vertical dimension. A large three-dimensional ratio indicates that the lesion is relative
lignant lesion with spiculation at the margin.
Margin:
Air bronchogram sign seen in
Air Bronchogram sign:
Recent studies have showed that an air bronchogram is more commonly seen in malignant pulmonary nodules. It is
rcinoma. The case on the left shows an airbronchogram seen as a linear lucency (broad arrow) and as a more cystic
face. On the left two solitary pulmonary nodules. Based upon the morphology, which lesion has the most malignant
lucencies within it. The lesion next to it is lobulated in contour and has some spicules radiating to the pleura. It is hov
e should be most concerned that the lesion on the far left is malignant. It proved to be an adenocarninoma, while th
ronchograms should not mislead you in thinking that it probably is infection. Partly solid nodule containing ground-g
Solid and Ground-glass components:
Another result from screening studies is that nodules containing a ground-glass component are more likely to be ma
ar left a lesion that only has a ground-glass appearance and next to it a lesion that has both ground-glass and solid c
on the far left and 2:3 for the lesion with both ground-glass and solid components. Baseline scan and scans after con
Contrast enhancement:
Contrast enhancement less than 15 HU has a very high predictive value for benignity (99%). After a baseline scan, 4 c
s only for nodules with the following selection criteria:
PET-CT: benign versus malignant:
False negative PET in a patient with adenocarcinoma. Activity is not sufficient for the diagnosis malignancy. PET-CT pl
ry nodules. When you perform PET-CT, you have to realize the following: With these specificity numbers, there will be
lence of granulomatous disease. On the left a patient with an adenocarcinoma, that was not hypermetabolic on the
Conclusion:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. Stephen J. Swensen et al Radiology 2005;235:259-265.
2. Indeterminate Solitary Pulmonary Nodules Revealed at Population-Based CT Screening of the Lung: Using First Fol
Shodayu Takashima et al. AJR 2003; 180:1255-1263
3. Small Solitary Pulmonary Nodules (1 cm) Detected at Population-Based CT Screening for Lung Cancer: Reliable Hig
AJR 2003; 180:955-964
4. CT Screening for Lung Cancer Frequency and Significance of Part-Solid and Nonsolid Nodules Claudia I. Henschke
None:

None:

Shoulder - Rotator cuff injury:
Robin Smithuis, Frank Smithuis and Henk-Jan van der Woude
Alrijne hospital in Leiderdorp, Amsterdam University Medical Centre and the Onze Lieve Vrouwe Gasthuis in Amsterd
Publicationdate 2022-03-23 The rotator cuff plays an important role in the stabilization of the glenohumeral joint du
Rotator cuff tearsare the most common cause of shoulder pain and result in loss of strength and loss of stability of t
omical variations of osseous outlet in patients with impingement symptoms. Anatomy
Anatomy:
Anterior view of the shoulder
Rotator cuff:
The rotator cuff is composed of the tendons of the subscapularis, supraspinatus, infraspinatus and teres minor, that
The main function of the rotator cuff is to stabilize and center the humeral head in the glenoid cavity during moveme
id.
The rotator cuff – as the name suggests – also plays a major role in the internal and external rotation of the arm. Sub
with insertion of the tendon on the lesser tuberosity.
The subscapularis muscle is a powerful internal rotator which also supports the arm during abduction and adduction
of part of the subscapularis tendon. SupraspinatusThe supraspinatus muscle is located in the suprascapular fossa w
inatus muscle initiates the abduction of the arm, which is continued by the deltoid muscle, which is the great abduct
The long head of biceps tendon is anatomically and functionally related to the rotator cuff. The tendon arises from th
ular. It exits the gleno-humeral joint and passes through the rotator interval between the subscapularis and supraspi
Posterior view of the shoulder InfraspinatusThe infraspinatus muscleis located posterior to the scapula, inferior to th
heson the posterior aspect of the greater tuberosity.
The infraspinatus muscle is a strong external rotator and additionally assists in both abduction and adduction. Teres
atus muscle.

The tendon attaches on the greater tuberosity.
The teres minor muscle's function consists primarily of external rotation and adduction of the arm. Other structures
rum and glenohumeral ligaments.
Acromion types:
Four types of acromial arch are described.
In the Bigliami classification type 1-3 were described. later a fourth convex type was added. Type 2 with the curved s
only type that is associated with an increased incidence of shoulder impingement.
Os Acromiale:
Failure of one of the acromial ossification centers to fuse will result in an os acromiale.
It is present in 5% of the population.
Usually it is an incidental finding and regarded as a normal variant. An os acromiale may cause symptoms due to art
because if the os acromiale is unstable, it may be pulled inferiorly during abduction by the deltoid, which attaches he
s.
An os acromiale must be mentioned in the report, because in patients who are considered for subacromial decompr
rther destabilize the synchondrosis and allow for even greater mobility of the os acromiale after surgery and worsen
ale with degenerative changes, i.e. subchondral cysts and osteophytes (arrow).
Etiology of rotator cuff tears:
The etiology of rotator cuff tears can be traumatic, like in a direct trauma to the subscapular muscle and tendon or a
ve trauma in overhead sports-activity.
This is usually seen in younger people. In older people the cause of rotator cuff tears is degenerative as seen in suba
s of the tendons.
Partial thickness tears:
Partial thickness tears are rotator cuff tears that do not have a full transmural extension from the articular side to th
Articular-sided partial tears are more common than bursal-sided, because the eccentric forces are more intense on a
healing is reduced. Partial thickness tears are best visualized on coronal PD and T2WI with and without fat suppressi
MR arthrography is very sensitive for detection of even small PTT, but only on the articular surface.
The ABER position allows assessment of both the vertical and interstitial component. Report on the extent of tendon
ial thickness tears may progress to full thickness tears. Bursal-sided tear not visible on MR arthrogram. Bursal-sided
aticular contrast cannot fill the defect (figure). On MR partial thickness tears have a signal intensity equal to water on
Images
On the T2W-image there is a large bursal-sided tear.
Notice that on the MR-arthrogram the tear is not visible, as the intra-articular contrast cannot reach the defect in the
Rim-rent tear:
Rim-rent tears are a common type of partial-thickness rotator cuff tears. They are commonly overlooked on MRI, pos
types of tears and failure to inspect the anterior-most fibers of the rotator cuff [ref]. The image is a coronal T1-weigh
ar-sided tear of the distal supraspinatus tendon or rim-rent tear, also called PASTA lesion - partial articular supraspin
. Images
Illustration and coronal T1 fat-suppressed MR arthrogram.
Full Thickness tears:
Full thickness tears (FTT) extend from the bursal surface all the way to the articular surface. Full thickness tears can b
kness tears.
Incomplete full thickness tears:
The hall mark on MRI of an incomplete full thickness tear is a gap filled with fluid on T2WI. However sometimes the g
ssue and the signal will not equal water. ImagesThere is an incomplete small full thickness tear of the distal suprasp
There is some cyst formation in the humeral head at the insertion site with some bursal reaction and intratendinous
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. What are the findings? There is a full thickness tear of the anterior part of th
bursal side. Since the posterior fibers of the supraspinatus tendon are intact, this is called an incomplete full thickne
There is no retraction. Enable Scroll
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Complete full thickness tears:
Click on image to enlarge and then scroll through the images. There is a full thickness tear of the supraspinatous ten
Notice the fatty streaks in the teres minor, supra- and infraspinatus muscle. The most common location of full thickn
rotator cuff tear in two directions.
Muscle atrophy - Tangent sign:
Measurement of muscle atrophy by Warner is based on the oblique sagittal plane image medial to the coracoid proc
A line is drawn from the edge of the coracoid to the inferior scapular tip and from the scapular spine to the coracoid
trophy.
If the muscle is just below this line, moderate atrophy is present.

If there is barely any muscle visible, there is severe atrophy. The left image shows a normal muscle anatomy on a sag
thickness tear of both the supra- and infraspinatus tendon with retraction.
There is fatty atrophy of the supra- and infraspinatus muscle. Irregular full thickness tear. On fat suppressed images
eplacement. Images
On the fat suppressed image on the left you might think that the supraspinatus muscle is normal (blue arrow).
However on the image without fat suppression you can appreciate the extreme muscle atrophy and fatty replaceme
The red arrow indicates the full thickness tear of the supraspinatous tendon. Sometimes it can be difficult to differen
at the first image, it looks like an articular-sided partial thickness tear. However there is irregular extension of contra
ar side on the left to the bursal side on the right indicating a full thickness tear.
Biceps tendon:
The long head of the biceps tendon inserts at the superior glenoid tubercle. Then it runs through the glenohumeral j
the intertubercular sulcus. The biceps tendon contributes in prevention of superior migration of the humeral head.
n with a partial thickness tear of the subscapularis tendon and a full thickness tear of the supraspinatus tendon
Dislocation of long head biceps tendon:
Disruption of the transverse humeral ligament may lead to medial dislocation of the biceps tendon.
The biceps tendon may shift in or beneath the subscapularis tendon with subscapularis tendon disruption. ImagesM
mages.
There is medial dislocation of the biceps tendon within the subscapularis tendon (arrow).
There is a partial thickness tear of the subscapularis tendon.
On the PDW-image there is a fluid filled gap at the distal insertion of the supraspinatus tendon and contrast extendi
ness tear of the supraspinatus tendon.
Subscapularis tendon:
Subscapularis tears are seen after direct trauma, forced abduction and exorotation or with recurrent anterior shoulc
Subscapularis tear after direct trauma.
There is retraction of the subscapularis tendon anteriorly with peritendinous edema on axial PD-weighted and coron
The biceps tendon is not dislocated (arrowhead). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll This patient had a direct anterior shoulder trauma. ImagesAxial T2-weighted fat suppressed and obliqu
There is an incomplete rupture of the subscapularis tendon combined with edema due to fracture of the lesser tube
Shoulder impingement:
When you raise your arm to shoulder height, the space between the acromion and rotator cuff narrows.
The acromion can rub against or "impinge" on the tendon and the bursa, causing irritation and pain.
Impingement and damage to the rotator cuff tendons are the most common shoulder problems that occur in the na
ogether. In any shoulder examination we should look for signs of impingement like a narrowed subacromial space, a
Types of impingement:
Images
Primary extrinsic impingement due to dowsloping of the acromion with tendinosis of the supraspinatus tendon Thic
impingement. In this patient the coracoacromial ligament is thickened and compresses the supraspinatus tendon.
Tendinosis:
Rotator cuff tendinosis is degeneration of the tendon. It is also called tendinitis or tendinopathy. Common MRI-findir
Tendinosis with thickening of the supraspinatus tendon.
ONly on PDW-images you will see increased signal.
Calcifying tendinosis:
This is a painful shoulder condition characterized by calcium deposits in the rotator cuff. In most cases there is spor
n persist.
This is more often seen in women age 30-50y. Ultrasound
US will show the presence, location and size of the calcium deposits and can help in guidance for therapeutic needlir
In the resting phase the deposits appear hyperechoic and arc shaped.
In the resolving phase the deposits are non-arc shaped, fragmented, cystic and nodular.
In the reabsorption phase increased Doppler vascularity can be seen. MRIUsually the MRI shows low signal intensity
representing edema in the resorptive phase.
Rotator cuff arthropathy:
Rotator cuff arthropathy is a pattern of joint degeneration due to loss of stabilizing function by the rotator cuff.
The rotator cuff provides a net inferiorly directed force, balaced by a superiorly directed force by the deltoid muscle.
en: Signs of irrepairability and indication for reverse total shoulder arthroplasty are: Hamada classification for rotato
omial space (arrowhead) secondary to a rotator cuff tear with retraction of both the supraspinatus tendon (yellow ar
tient has a narrowed subacromial space. Notice that the narrowing is well seen on the image with the shoulder in ex
case 3 These images show an acromioclavicular cyst, also referred to as Geyser sign, which is secondary to rotator c
egenerated AC joint with disruption of inferior AC joint capsule.
Parsonage Turner syndrome:

Parsonage–Turner syndrome is a neuritis involving the brachial plexus.
It is also referred to as idiopathic brachial plexopathy or neuralgic amyotrophy. It is characterized by sudden, excruc
onage–Turner syndrome is a rare disorder that generally involves one upper limb, mostly the axillary nerve, the upp
long thoracic nerve are affected. It may present with symptoms of an isolated peripheral nerve lesion, although the p
al PD image and coronal T2 fat-suppressed image.
Slightly increased signal of SSp and Isp when compared to the subscapularis and teres minor and mild atrophy, cons
MR protocol:

None:

Shoulder instability - MRI:
Robin Smithuis and Henk Jan van der Woude
Radiology department of the Rijnland hospital, Leiderdorp and the Onze Lieve Vrouwe Gasthuis, Amsterdam, the Ne
Publicationdate 2012-05-21 A Bankart lesion is an injury of the anterior glenoid labrum due to anterior shoulder disl
ptible to repeated dislocations. In this article we will focus on: Bankart tears and variants Introduction
Introduction:
Clockwise approach. Click on image to enlarge
Clockwise approach to labral pathology:
A Clockwise approach to the labrum is the easiest way to diagnose labral tears and to differentiate them from norma
and Bankart lesions. SLAP is an acronym that stands for 'Superior Labral tear from Anterior to Posterior'. SLAP tears
cated, which tears the labrum off the glenoid. SLAP tears typically extend from the 10 to the 2 o'clock position, but ca
the biceps tendon. Bankart lesions are typically located in the 3-6 o'clock position because that's where the humeral
te a labral tear. They also have a typical location. They are not in the 3-6 o'clock position, which makes it easy to diffe
nd to the 1-3 o'clock position, but then there should also be a tear in the 3-6 o'clock position. Labral variants howeve
Dislocation:
The shoulder is a very mobile and therefore unstable joint. It is the most dislocated joint in the body. The humeral he
e coracoid process.
Anterior dislocation:
The shoulder almost always dislocates to anterior and inferior, because motion to superior is limited by the acromio
ior direction is limited by the posterior rim of the glenoid which is in an anteverted position. An uncommon cause of
oid. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The dislocation of the humeral head to antero-inferior causes damage to the antero-inferior rim of the
ly in younger patients this results in a Bankart fracture or a Bankart lesion which is a tear of the anteroinferior labrum
ue to these recurrent dislocations significant bone loss and erosion of the anterior glenoid rim may occur, which ma
oll
Disable Scroll Anterior dislocation with Bankart fracture Enable Scroll
Disable Scroll Anterior dislocation with Bankart fracture The images show a subtle Bankart fracture (arrows). Scroll th
Disable Scroll Enable Scroll
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Bankart fracture:
This is a post-reduction view. Notice the very large fracture of the glenoid rim with displacement. Scroll through imag
placed fragment of the glenoid rim is seen in the 3-6 o'clock position. On the coronal image a large Hill-Sachs defect
he glenoid rim on the humeral head. 3D-reconstruction of a large bony Bankart in the 2 - 6 o'clock position. LEFT: Hil
l below coracoid.
Hill-Sachs:
On MR a Hill-Sachs defect is seen at or above the level of the coracoid process. Hill-Sachs is a posterolateral depressi
racoid in the first 18 mm of the proximal humeral head. It is seen in 75-100% of patients with anterior instability. The
he attachment site of the infraspinatus tendon can simulate a Hill-Sachs, but usually this is not a diagnostic problem
Disable Scroll Enable Scroll
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Posterior dislocation:
Posterior dislocations are uncommon and easily missed, because there is less displacement compared to the anterio
rnal rotation. On the transscapular-Y view the humeral head is displaced posteriorly. Sometimes the displacement is
is slightly rotated. Sometimes an axillary view can be of help, but when in doubt go to CT. Scroll through images. Pos
dislocation. On the transscapular-Y view the humeral head is displaced posteriorly. Notice the distance between the
wide. Posterior dislocations are uncommon and not as obvious on the X-rays as an anterior dislocation. Approximate
itial presentation, because of a low level of clinical suspicion and insufficient imaging. Posterior dislocation-fracture F
locations. Posterior dislocations are associated with epileptic seizures, high energy trauma, electrocution and electro
een with a fracture. Enable Scroll

Disable Scroll Enable Scroll
Disable Scroll The MR-images are of a patient who had undergone both an anterior aswell as a posterior dislocation.
terior aspect of the humeral head (blue arrow) and an impression fracture on the anterior aspect as a result of poste
slocation This was an incidental finding on a chest-film. There is a superior dislocation of the humeral head. This is p
tear with progressive cranialisation of the humeral head and erosion of the acromion.
Bankart and variants:
Axial images of Bankart lesions and variants Bankart-lesions and variants like Perthes and ALPSA are injuries to the a
3-6 o'clock position because they are caused by an anterior-inferior dislocation. The only exception to this rule is the
ion and injury to the inferoposterior labrum. Bankart tears may extend to superior, but this is uncommon. Detachme
of the anterior scapular periosteum with or without an osseus fragment of the glenoid.
* Reverse Bankart Detachment of the posteroinferior labrum (6-9 o'clock) with tearing of the posterior scapular perio
* Perthes Detachment of the anteroinferior labrum (3-6 o'clock) with medially stripped but intact periosteum.
* ALPSA = Anterior Labral Periosteal Sleeve Avulsion. Medially displaced labroligamentous complex with absence of
* GLAD = GlenoLabral Articular Disruption. Represents a partial tear of anteroinferior labrum with adjacent cartilage
Bankart lesion:
Bankart lesions are labral tears without an osseus fragment. MR arthrography or arthroscopy are optimal to diagnos
eroinferior labrum (3-6 o'clock) with complete tearing of the anterior scapular periosteum. The arrow points to the d
the anterior glenoid and the labral fragment is displaced anteriorly (arrow). Osseus Bankart
Osseus Bankart:
Bankart lesions with an osseus fragment are common findings in patients with an anterior dislocation and are frequ
tient with an osseus Bankart (arrow) On MR-arthrography it may be difficult to depict the osseus fragment. On CT it i
(arrow). Enable Scroll
Disable Scroll Bankart lesion with superior extension Enable Scroll
Disable Scroll Bankart lesion with superior extension Scroll through the images. There is an osseus Bankart lesion (cu
here is also a Hill-Sachs defect (red arrow). Bankart lesion with superior extention Sagittal MR-arthrogram demonstra
n a MR arthrogram ABER-view Here another patient with an osseus Bankart seen on four consecutive images of a MR
glenoid and the avulsed anterior rim (arrow)
Reverse Bankart:
CT-images in another patient show a reversed osseus Bankart in a patient with posterior dislocation. Axial MR-arthro
everse Bankart. Notice the detatched labrum at the 6-9 o'clock position on the sagittal MR-arthrogram. Perthes lesio
ipped (arrow)
Perthes lesion:
A Perthes lesion is a labroligamentous avulsion like a Bankart, but with a medially stripped intact periosteum. On ima
n labrum may be held in its normal anatomic position by the intact scapular periosteum, which thereby prevents con
with the arm in the neutral position may fail to detect the labral tear. In the ABER position however there is tension
of the inferior glenohumeral ligament and you have more chance to detect the tear. The arrow points to the intact p
lockwise. The images in ABER-position demonstrate a detached anterior labrum. The image on the right is rotated 90
anatomy. Images of a MR-arthrogram. The image on the left shows an absent anterosuperior labrum, which is called
the 4 o'clock position. It is not clear whether the labrum is normal. Continue with the images in ABER-position. Bufo
Disable Scroll Enable Scroll
Disable Scroll In the ABER-position it is obvious that there is a Perthes lesion (black arrow). Due to the ABER-position
anteroinferior labrum and contrast fills the tear. The red arrow points to the absent labrum - Buford complex. ALPSA
ALPSA:
An ALPSA-lesion is an Anterior Labral Periosteal Sleeve Avulsion. The anterior labrum is absent on the glenoid rim. Th
ex. Enable Scroll
Disable Scroll ALPSA Enable Scroll
Disable Scroll ALPSA Images of a patient with an ALPSA-lesion. Notice the medially displaced labrum. ALPSA-lesion In
an absent antero-inferior labrum. The coronal images shows the medially displaced labrum (red arrow). Enable Scro
Disable Scroll ALPSA-lesion Enable Scroll
Disable Scroll ALPSA-lesion This is a difficult case. First scroll through the images and try to find out what is going on.
indicating a prior anterior dislocation (blue arrow). Now you know that you have to look for a Bankart or variant. Nex
al images you want to make sure whether this is a variant like a labral recess or labral foramen or whether this is a S
means that it is a SLAP-lesion. The yellow arrow points to the anterior glenoid rim. The anterior labrum is absent at t
normal variant. The structure anterior to the glenoid is not a thorn labrum, but the middle glenohumeral ligament. N
. Finally there is a medially displaced inferoanterior labrum at the 3-6 o 'clock position, i.e. an ALPSA-lesion (black arr
GLAD:
A GLAD-lesion is a GlenoLabral Articular Disruption. It represents a patial tear of the anteroinferior labrum with adja
t. GLAD-lesion The images show a partial tear of the anteroinferior labrum with adjacent cartilage damage at the 4-6
Disable Scroll GLAD lesion Enable Scroll
Disable Scroll GLAD lesion Scroll through the images. There is a Bankart lesion with extension into the cartilage, i.e a

HAGL:
LEFT: Normal axillary recess (blue arrow). RIGHT: Abnormal axillary recess due to avulsion of the IGHL (red arrow) HA
There is discontinuity of the IGHL attachment on the humerus with leakage of contrast. Another patient with an avul
ion. by Asgar M. Saleem, Joong K. Lee, Leon M. Novak AJR 2008; 191:1024-1030
2. MR Imaging and MR Arthrography of Paraglenoid Labral Cysts by Glenn A. Tung et al AJR June 2000 vol. 174 no. 6 1
3. CT and MR Arthrography of the Normal and Pathologic Anterosuperior Labrum and Labral-Bicipital Complex by M
Solid Renal Masses:
Rinze Reinhard, Mandy van der Zon-Conijn and Robin Smithuis
Radiology department of the Onze Lieve Vrouwe Gasthuis in Amsterdam, Medical Center Haaglanden-Bronovo in the
tal in Leiderdorp, the Netherlands:
Publicationdate 2016-06-14 Most renal masses are incidental findings. Many of these masses are renal cell carcinom
omas from benign disease, although in many cases it may not be possible. There are certain imaging findings, howev
hese imaging findings may offer guidance to patients and referring physicians in making management decisions. Op
on or follow up with watchful waiting. In this article we will discuss imaging features of benign and malignant renal tu
Differentiation of renal masses:
The steps in the differentiation of a renal lesion are: Once you have followed these steps, there will be many cases in
oma is still on top of your list of differential diagnoses. Use CT and MR to look for findings that are in favor of a benig
oma.
CT:
Hyperdensity on unenhanced CTA lesion with a density > 70 HU on an unenhanced CT scan is a hemorrhagic cyst. He
s we also need to check the post-contrast series for any enhancement. Lack of enhancement confirms the cystic natu
reliable sign of an angiomyolipoma. Thin slices can be helpful to determine the density. Unfortunately 5% of AMLs do
stinguished from renal cell carcinoma. In rare cases, RCCs can also contain fat. The presence of calcifications and fat
10-20 HU can be due to pseudo-enhancement in a cyst as a result of beam hardening. MRI can be helpful in differen
enhancement can also be seen in low-enhancing lesions like papillary renal cell carcinoma, which usually is a less ag
ogeneous enhancement and a high attenuation value on unenhanced CT (> 40 HU) is in favor of the diagnosis of a lip
ncement is seen in clear cell carcinoma, lipid-poor AML and oncocytoma. Since clear cell carcinoma is far more comm
the most likely diagnosis, especially in a large and heterogeneous mass. Mention the possibility of a lipid-poor AML
an option in poor surgical candidates.
MRI:
High signal on T1-weighted images is typically seen in hemorrhagic or proteinaceous cysts and in angiomyolipomas t
r does not result in a high signal on T1-weighted images but it results in a signal drop on out of phase images.
This can be seen in minimal fat AML or RCC. 82% of clear cell RCC have intracellular fat, which has a 90% specificity fo
better than CT in the accurate diagnosis of a cystic lesion and it can better depict enhancement and differentiate CT-
avor of papillary RCC or minimal fat angiomyolipoma. High T2 is typically seen in clear cell RCC but is not specific, sin
h overlap between benign and malignant tumors.
Ball or Bean:
Another way to look at renal solid masses is to look at the shape. Solid lesions can be divided into ball-type and bean
nt as expansile masses, deforming the renal contour. Renal cell carcinomas and oncocytomas are typical ball-type le
ean-shape of the kidney is preserved. Bean-type lesions are more difficult to detect and usually not visible on unenh
ential diagnosis of ball-type and bean-type lesions.
Bean-type lesions:
The radiologic features of bean-type lesions are generally nonspecific. Notice the similar appearance of the lesions in
by integrating clinical and imaging data.
Size of a tumor:
The size of a tumor is regarded as the most important predictor of malignancy and aggressive histologic grade (1). Th
f the size of a tumor is less than 3 cm the risk of metastatic disease is negligible. Most incidentally found renal masse
either low grade RCC, indolent malignancies or benign lesions. In renal masses of 1-2 cm which were surgically remo
benign histology. The growth rate of a small renal mass on serial imaging however has not been shown to provide re
Renal cell carcinoma:
Renal cell carcinoma (RCC) is a typical ball-type lesion. 50% of RCCs are incidental findings on imaging studies perfor
etween 60 and 70 years. RCC is associated with hereditary syndromes, such as von Hippel-Lindau, tuberous sclerosis
arcinoma, followed by papillary and chromophobe RCC. Multilocular cystic RCC is uncommon and discussed here. Re
ively in patients with sickle cell trait.
Clearcell RCC:
This is the most common subtype of RCC, accounting for 70% of all RCCs. These tumors arise from the renal cortex a
terogeneous due to necrosis, hemorrhage, cystic components or calcifications. In rare cases, RCCs can also contain e
sider the possibility of a RCC. Clear cell carcinoma best seen in nefrogenic phase A typical feature of clear cell carcino
s can be difficult to assess when the lesion is small and located in the renal cortex, which also enhances strongly. The
the detection of these lesions, as the renal parenchyma enhances homogeneously and more intensely than the tum

and hyperintense on T2-weighted images. Typically renal cell carcinomas do not have extracellular fat, which differen
have intracellular fat, which leads to a drop in signal intensity on T1 opposed-phase images compared to in-phase im
t make the mistake to conclude that you are dealing with an angiomyolipoma. Von Hippel-Lindau disease is associate
l. Patients with a clear cell RCC have a 5-year survival of 50-60%, which is worse than papillary or chromophobe RCC.
ly visible on the unenhanced image on the left, clearly visible in the nephrogenic phase shown on the right. PA showe
filtrative growth pattern. While this is only a small portion of the RCCs, the overall prevalence of RCC makes it an imp
iltrative bean-type lesion. Infiltrative RCCs are aggressive and hypervascular. It alters the internal architecture of the
normalities can be similar to those seen in transitional cell carcinomas.
Papillary RCC:
Papillary RCC accounts for 10-15% of all RCCs. These lesions are typically homogeneous and hypovascular and can th
cement of papillary renal cell carcinoma can be very subtle, up to only 10-20 HU difference between unenhanced an
e to necrosis, hemorrhage or calcifications. On MR they are frequently iso- to hypointense on T1 and hypointense on
ered in the lesion, often with calcifications. Bilateral and multifocal tumors are more frequently seen in papillary RCC
hromophobe RCC
Chromophobe RCC:
5% of the RCCs are of the chromophobe type. It is a solid, sharply demarcated and sometimes slightly lobulated lesio
t enhancement, similar to oncocytomas. It is not possible to differentiate chromophobe RCC from an oncocytoma on
stics. The enhancement of a chromophobe RCC is often homogeneous and less intense than in clear cell RCC. The pr
RCC with a 5-year survival of 80-90%. Chromophobe RCC and luncysts in a patient with Birt-Hogg-Dubé syndrome Ch
irt-Hogg-Dubé syndrome is a rare disorder. These patients have small papular skin lesions called fibrofolliculomas, lu
different kinds of renal cell carcinoma: most frequently chromphobe RCC, less commonly oncocytoma, and rarely cle
Staging RCC:
RCC can invade the perinephric fat beyond the renal fascia and can extend into the renal vein, inferior vena cava or t
now whether there is tumor thrombus in the IVC and if it extends into the chest above the diaphragm (need for a tho
ents have metastases at presentation. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Click to enlarge and scroll through images of a T4 renal cell carcinoma Venous tumor thrombus The co
the diaphragm (arrows). A thoracic surgeon will be needed during surgery. Metastases of RCC in the pancreas. Meta
s at presentation. Common sites are the lung, liver, lymph nodes and bones. Less common sites are pancreas, adren
The image shows a patient with metastases in the pancreas.
Angiomyolipoma:
Angiomyolipoma (AML) is the most common benign solid renal mass. It is composed of angiomatous tissue, smooth
is of AML can be made. On CT an AML is usually a well-defined, heterogeneous tumor, located in the renal cortex and
or necrosis within the tumor is rare. The presence of both fat and calcifications should raise the suspicion of a RCC. E
of the lesion. Multiple Angiomyolipomas in a patient with tuberous sclerosis. Multiple Angiomyolipomas Sporadic AM
an incidental finding. In 10-20% of cases angiomyolipomas are multiple and bilateral. This is mainly seen in patients
abnormal vessels within an AML, it is prone to bleeding. Patients can present with acute flank pain due to spontaneo
ization was performed to stop the bleeding. Preventive embolization is recommended in tumors larger than 4 cm, ev
the left kidney.
Minimal fat Angiomyolipoma:
In 5% of AMLs there is no detectable fat on CT. The fat can be obscured by internal hemorrhage or it can be a so call
gnal on fat-suppressed images. Microscopic or intracellular fat, seen as a drop in signal intensity on T1 opposed-pha
but can also be present in renal cell carcinoma. Since the fat is likely to be intracellular in RCC, it is unlikely to be visib
Oncocytoma:
Oncocytoma in left kidney with central scar Oncocytoma is the second most common benign solid renal mass. 3-7%
rcated lesions with uniform enhancement at CT and often have a central scar. The central scar can not be distinguish
cocytoma is the most commonly excised benign solid mass. Oncocytoma in right kidney with central scar Calcificatio
m in diameter, but can be multifocal and bilateral. In less than 10% of cases oncocytoma and chromophobe RCC occ
Transitional cell carcinoma:
TCC in left kidney preserving the bean shape of the kidney Transitional cell carcinoma (TCC) also known as urothelial
e urinary tract. Most frequently the TCC arises in the renal pelvis, as a low-grade, superficial tumor, producing a foca
tely 15% of the TCCs are of a more aggressive type with infiltrative growth, altering the regional architecture of the a
e renal contour. TCC is a typical bean-type lesion (see figure). Upper-tract TCC has a peak incidence in the 60- to 70-y
factors are smoking, chemical carcinogens, cyclophosphamide therapy and analgesic abuse, particularly long-term u
the kidney TCC is hard to detect on unenhanced CT images. The nephrogenic phase is the optimal phase to show the
ry phase images show collecting system abnormalities such as dilated calyces, calyces distended by tumor or unopa
ive with invasion of the retroperitoneum. Regional lymphadenopathy and distant metastases to the lungs and bones
of recurrence, therefore requiring thorough surveillance. TCC has a greater risk of seeding after percutaneous biops
en there is suspicion of TCC.
Lymphoma:

B-cell lymphoma with renal and bone involvement (arrows) The kidney is a common extranodal site of lymphoma inv
he kidney is rare. Renal lymphoma usually presents as multiple poorly enhancing masses, but may also present as re
soft-tissue masses. Diffuse infiltration of the renal interstitium results in nephromegaly and is more common in Burk
y and a bone lesion in a patient with B-cell lymphoma. Here another patient with lymphoma located in the mediastin
th kidneys in a patient with lymphoma. Continue with the PET-CT. PET-CT shows diffuse renal involvement and also p
Metastases:
Infiltrative lesion in the lower pole of the right kidney, which has considerably grown six months later, with extensive
gcarcinoma. Primary malignancies that most commonly metastasize to the kidney are lung, breast, gastrointestinal t
se of a known malignancy as part of widespread disease. In rare cases a renal metastasis may manifest as a solitary
ma. A percutaneous biopsy can be performed to solve this problem. Multiple liver and renal metastases. Thrombus i
multifocal and bilateral, with an infiltrative growth pattern. They show mild enhancement, much less than that of the
however, as in melanoma, and sometimes breast cancer. The image shows a patient with multiple renal metastases.
lung cancer. There is a metastasis in the left kidney and there are multiple lymph node metastases (arrows). If this w
te from a renal cell carcinoma with lymph node metastases.
Infection:
Pyelonephritis and renal abscess can be tumor mimics, but in most cases the history and the clinical findings help yo
areas in both kidneys. Based on the imaging alone the main differential is multifocal pyelonephritis, lymphoma and r
s of flank pain and there was no history of a primary tumor or lymphoma. So the diagnosis is pyelonephritis. A CT sc
enal abnormalities on the first scan were therefore consistent with an episode of multifocal pyelonephritis. Renal ab
ents present with urinary tract infection, flank pain and fever. On CT a renal abscess usually presents as a non-specif
esion. Cystic lesion with thick enhancing rim and infiltration of perirenal fat in a patient with a renal abscess The rena
filtration of the perirenal fat (figure). In patients with an atypical clinical presentation the complex cystic appearance
cell carcinoma. This patient had a typical presentation with right flank pain and laboratory findings consistent with a
ogenic lesion with some echolucency, which indicates a fluid-containing component. This proved to be an abscess. X
s an uncommon condition caused by a chronic granulomatous infection with accumulation of lipid-laden macrophag
. It results in diffuse renal destruction, but can be segmental as well. Renal enlargement is present in all patients and
mple of a xanthogranulomatous pyelonephritis. There is destruction of the right kidney, multiple calculi and surroun
osarcoma.
Infarction:
Renal infarction Renal infarction usually results from thromboembolismin cardiovascular disease. The common clini
se CT will show a wedge-shaped area of decreased attenuation followed in a later stage by atrophy. When the whole
tion. Only the outer cortex may still enhance through collaterals resulting in a cortical rim sign. Here another case of
patient with multiple systemic emboli.
Pitfalls:
Pseudo-enhancement in a renal cyst.
Pseudo-enhancement:
Pseudo-enhancement is a pitfall to be aware of in the evaluation of renal masses. As mentioned before a small differ
t on contrast-enhanced CT images due to beam-hardening. This case shows pseudo-enhancement in a lesion which
Dromedary hump:
Prominent columns of Bertin, bulging of the renal contour and focal renal hypertrophy can look like a renal mass on
the corticomedullary phase the normal corticomedullary pattern in these pseudotumors can be appreciated, disting
ney on ultrasound. CT shows a bulging of the left renal contour, commonly referred to as a dromedary hump. Pseud
e right. Here is another case. In the nephrogenic phase one could argue there is a lesion in the left kidney. In the cor
tumor.
CT protocol:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. AJR 2014; 202:1196-1206
2. Simplified Imaging Approach for Evaluation of the Solid Renal Mass in Adults by Ray Dyer, MD, David J. DiSantis, M
08
Esophagus I: anatomy, rings, inflammation:
Terrence C. Demos, MD, Harold V. Posniak, MD, Wayde Nagamine, MD and Mary Olson, MD
Department of Radiology of the Loyola University Medical Center, USA:
Publicationdate 2007-11-26 In Esophagus part I we will discuss: Vascular impressions. Anatomy and Function
Anatomy and Function:
LEFT: Lateral view: Epiglottis (red arrow). Post cricoid impression (yellow arrows). Cricopharyngeous impression (whit
ws)
Hypopharynx:
Common structures that we can visualize are: If a normal pouch becomes enlarged, it is termed a lateral pharyngeal
* Cricopharyngeal muscle impression:

Extrinsic impression on posterior esophagus by contracted muscle. Esophagus mucosa: normal thin, parallel, uniform
phageal junction (left), Fundal adenocarcinoma invades esophagus (right) At the gastroesophageal junction smooth,
arrow). Image next to it shows abnormal gastroesophageal junction: Barium outlines thick, irregular mucosal folds (a
pharyngeal achalasia in 46-year-old woman. Feeling of lump in throat. Persistent indentation (arrow) by cricopharyng
Upper esophageal sphincter:

Lower esophageal sphincter:
This distention is best demonstrated by breath holding in inspiration or a Valsalva maneuver. Do not mistake this for
arch.
Gastroesophageal reflux:
Spontaneous gastroesophageal reflux has been demonstrated in up to 1/3 of patients with reflux esophagitis. Variou
tivity, but these are generally discredited as not being physiologic. In addition many asymptomatic patients have spo
tive or specific for relating symptoms to reflux.
Esophageal peristalsis:
Normal: Abnormal: On the left tertiary contractions on first swallow (left). Normal primary contraction on next swallo
sient, and intermittent contractions that are inconstant in location and not accompanied by symptoms, usually in old
ree images during examination show collections resembling diverticula C. Image later in examination shows resoluti
ns may simulate diverticula. On the left images of a patient with tertiary contractions, that during the examination lo
nced chest pain during examination
Diffuse esophageal spasm:
Diffuse esophageal spasm produces intermittent contractions of the mid and distal esophageal smooth muscle, asso
e contractions on at least 10% of swallows. Diagnosis is based on imaging, manometry, and symptoms.
Nutcracker esophagus:
Nutcracker esophagus is a non-cardiac cause of chest pain attributed to high amplitude distal esophageal peristalsis
does not have imaging manifestations LEFT: Dilated esophagus (arrows) appears as long, well-defined structure para
Narrowing (arrow) at hiatus.
Achalasia:
LEFT: CT shows dilated esophagus (arrow) that led to esophagram.RIGHT: Esophagram shows narrowing (arrow) at le
ed esophagus (arrows) is projected behind right atrium.MIDDLE and RIGHT: Smooth, tapered narrowing just above d
fluoroscopy some peristalsis was seen with typical smooth, tapered narrowing just above diaphragm (arrows).
Lower esophageal rings:
Esophageal ring due to muscular contraction. It varies during examination and may not persist. No definite anatomic
to muscular contraction. It varies during examination and may not persist. On the left another patient with a non-pe
B-ring The esophageal B-ring is located at the squamocolumnar junction, also termed the 'Z' line. The appearance d
a 'B' ring (arrows) several cm above diaphragm at the apex of sliding hiatus hernia. Note unchanged appearance on
agia. The image on the far left does not show a abnormality, but distal esophagus not distended . With dilation of the
aused intermittent obstruction is demonstrated at the apex of a hiatus hernia (arrowhead). On the left a 71-year-old
lling defect (arrow) is a piece of meat that passed into stomach during study. Follow-up esophagram shows Schatzki
Webs and Diverticula:

Esophageal web:
On the left images of an asymptomatic 52-year-old man. AP and Lateral views show short, thin web (arrows) with mi
man with dysphagia due to web. There is > 50% luminal narrowing Zenker's diverticulum in early and late phase of s
Diverticula:
Pulsion diverticula are due to increased intraluminal pressure.
There are many pulsion diverticula: On the left a patient with a Zenker's diverticulum as a result of premature closur
dary to adjacent disease. Most located in mid-esophagus. Zenker's diverticulum on chest film, barium study and CT
Zenker's diverticulum:
A Zenker's diverticulum is a pulsion hypopharyngeal false diverticulum with only
mucosa and submucosa protruding through triangular posterior wall weak
site (Killian's dehiscence) between horizontal and oblique components
of cricopharyngeus muscle. The etiology is controversial and is probably due to elevated upper esophageal
pressure, cricopharyngeus dysfunction and reflux. The clinical presentation can be dysphagia, regurgitation, aspirati
or a mass or air-fluid level on neck or chest radiographs. The esophagram shows collection with midline posterior or
cricopharyngeus protruding lateral, usually to left, and caudal with
enlargement. Killian-Jamieson diverticulum: AP and lateral view Killian-Jamieson diverticulum is a pulsion diverticulu
ervical esophagus below the cricopharyngeus muscle, unlike the posterior, midline origin of a Zenker's diverticulum.
l view confirms diverticulum does not originate posteriorly as a Zenkers diverticulum would. LEFT: Small diverticulum
w) in patient with aspiration Epiphrenic diverticulum These pulsion diverticula are classified by their location near th
If large they can narrow the esophagus or lead to aspiration. Large epiphrenic diverticulum On the left another exam

verticulum (arrow) extends to the right just above diaphragm. This patient was asymptomatic Aortopulmonary windo
rtopulmonary window.
Fixed protrusion is an inconsequential diverticulum. On the left small aortopulmonary diverticula (arrows), that are i
diverticulum (arrow) due to hilar granulomatous disease.
Calcified adenopathy (asterisk). In the middle a pulsion diverticulum (arrow) due to high intraluminal pressure. On th
ler myotomy for achalasia. On the left a traction diverticulum (arrows) secondary to post primary TB. It simulates a c
can be seen in reflux esophagitis.
On the left a patient with a hiatus hernia, reflux esophagitis, and pseudodiverticula (arrows) at site of proximal strictu
ing esophageal duplication (arrows). RIGHT: Extravasation from iatrogenic perforation of hypopharynx in neonate Ot
On the left two patients with a iatrogenic perforation and a patient with a communicating duplication cyst.
Hiatus hernia:
The types of hiatus hernia are listed in the table on the left. The relationship between hiatus hernia, reflux and reflux
tients with gastroesophageal reflux disease (GERD) have hernias. Many patients with hiatus hernias do not have reflu
of reflux correlates poorly with GERD.
A sliding hiatus hernia is of doubtful significance when an isolated finding in the absence of clinical or imaging findin
endoscopic findings of esophagitis, not presence of a hiatus hernia. Sliding hernia On the left initially, GE junction is l
gh hiatus. Neither the hernia or stricture (arrow) due to reflux esophagitis were visible early in the examination. Para
progressive hiatal widening, increasing protrusion and rotation of the stomach can lead to gastric volvulus that can b
ation. On the left two examples. On the far left gas filled gastric fundus (asterisk) protrudes through hiatus but GE ju
l hernia with most of 'upside down' stomach in chest with greater curvature (arrows) flipped up. On the left a mixed
ndus, but unlike a paraesophageal hernia, the gastroesophageal junction (arrow) is above rather than below the diap
Inflammation and Infection:
Gastroesophageal reflux (GERD) is the most common cause of esophagitis. Other causes of esophagitis are listed in t
Reflux esophagitis:
The findings on barium studies are listed in the table on the left. Air-contrast esophagram shows thick esophageal m
e contrast esophagram shows stricture (arrow) and sliding hiatus hernia On the left Irregular stricture (arrowhead) a
ular mucosa and web-like (arrow) stricture
Barrett's esophagus:
Barrett's esophagus (columnar metaplasia) is the result of long-standing reflux esophagitis. Most patients have reflu
n the left a patient with a Barrett's esophagus.
The reticular mucosa is characteristic of Barrett's columnar metaplasia, especially with the associated web-like (arrow
with an adenocarcinoma. There are abnormal distal mucosal folds. The upper margin of adenocarcinoma makes righ
nt with GERD and Barrett's esophagus.
Infectious esophagitis:
Candida esophagitis On the left a patient with an infectious esophagitis due to candida. The barium stury shows num
mmunocompromised patient. Cytomegalovirus esophagitis On the left an AIDS patient with an infectious esophagitis
ne. Crohn's esophagitis On the left a patient with Crohn's disease. There is a granulomatous esophagitis with aphtho
disease. The figure on ther right shows the more common colonic aphthous ulcers. TB esophagitis On the left a patie
rregular sinus tract from proximal esophagus (arrow). Chest radiograph shows enlarged lymph nodes widening med
Pseudodiverticulosis:
Dilated mural glands or pseudodiverticulosis, is usually associated with histologic or endoscopic signs of inflammatio
patient with esophageal pseudodiverticulosis. Eosinophilic esophagitis This diagnosis may be suggested by peripher
y. Patients often have dysphagia and allergies. Imaging finding include diffuse narrowing, strictures, and a ringed app
e transient or associated with reflux. Steroid therapy is often curative. On the left a patient with eosinophilic esophag
ns (arrows) due to ring-like indentations, that are characteristic of eosinophilic esophagitis. Glycogen acanthosis Glyc
copy. The reported
incidence at endoscopy is 5 to 15% of all patients. These benign epithelial collections of glycogen produce small muc
Nodules are smooth and well-defined. This may be a degenerative process and produces no symptoms. Feline esopl
g study no longer shows folds Feline esophagus The delicate, concentric and transiently appearing folds of a feline e
fixed folds indicative of longitudinal scarring from reflux esophagitis. The characteristics of a feline esophagus are: M
Textbook of Gastrointestinal Radiology. 2nd ed. Philadelphia, PA:W.B. Saunders, 2000:190-257, 316-509 by Gore RM,
2. Levine MS, Rubesin SE, Laufer I. Double Contrast Gastrointestinal Radiology 3rd ed. Philadelphia, PA:W.B. Saunder
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Cardiac Anatomy:
Tineke Willems and Marieke Hazewinkel
Radiology department of the University Medical Centre Groningen and the Medical Centre Alkmaar, the Netherlands
Publicationdate 2009-02-13 This review is based on a presentation given by Tineke Willems and was adapted for the
diac anatomy in the order of normal blood flow: from the right to the left. Cardiac Axes
Cardiac Axes:

Axial slices through the heart Cardiac CT with ECG triggering offers good image quality of the heart when compared
logy, analysis of the acquired images requires a systematic approach. First of all, it is important to understand that th
at of other anatomic structures: the right ventricle, for example, does not lie completely on the right, but more anter
terior. Also, the heart does not always maintain the same position within the mediastinum - in young people it tends
to rest on the diaphragm, a more horizontal orientation. Cardiologists analyze the heart using cardiac axes. These a
order to assess the heart properly. Axial slices, such as those imaged on the left, are useful for a global assessment o
dium. 4-chamber view. RA=right atrium, RV=right ventricle, LA=left atrium, LV=left ventricle
4-chamber view:
On the left is a 4-chamber view, achieved by rotating upwards from the apex of the heart on the axial slices. In this a
, and the left ventricle next to the left atrium. The mitral valve comes into view and - depending on the contrast proto
e of this cardiac axis is that the apex of the heart is well demarcated.
Note that the apex is formed by the left ventricle. 3-chamber view. LA=left atrium, Ao=aorta, LV=left ventricle
3-chamber view:
When the border between the mitral and aortic valves is localized on the axial slices and the images are rotated from
reconstructed. On this image, the left atrium, left ventricle, mitral-, aortic valve and proximal aorta ascendens are vis
o=aorta, LA=left atrium, LV=left ventricle
5-chamber view:
On the left is an image of a 5-chamber view, which is similar to the 4-chamber view, but additionally displays the aort
eved by rotating the 4-chamber view a little more cranially. 2-chamber view. LA=left atrium, LV=left ventricle
2-chamber view:
The 2-chamber view in the image on the left is achieved by rotating the images perpendicularly to the mitral valve an
the left atrium ventricle and mitral valve. It is a good view for analyzing ventricular function, especially that of the inf
consecutive short axes must be reconstructed making use of the 3- and 4-chamber views.
Cardiac anatomy from right to left:
Axial (left) and coronal oblique (right) reconstructions of the heart, depicting the right atrium and its main contributin
or and inferior vena cava. IVC=inferior vena cava, A=anterior, SVC=superior vena cava
Right atrium:
The cardiac anatomy will be discussed in the order of normal blood flow: from the right to the left. In the normal situ
e arm - reaching the right atrium via the superior vena cava. The right atrium has an anterolateral position in the hea
va enters through the roof of the right atrium. The inferior vena cava enters the right atrium from below near the ca
ight atrium is the coronary sinus, (venous return of the coronaries) which enters anterior to, and just to the left of th
structions showing the crista terminalis (blue arrows) and its location in the right atrium
Crista terminalis:
In the right atrium lies the crista terminalis, a muscular ridge that runs from the entrance of the superior- to that of t
part of the right atrium - the sinus venosus - from the trabecularized right atrial appendage.
On the images on the left it is visible as a smooth linear structure (blue arrows). This is not always the case, however,
ight) reconstructions showing the coronary sinus as it enters the right atrium (blue arrows). A=anterior, P=posterior
Coronary sinus:
The coronary sinus is the main draining vein of the myocardium. It runs in the atrioventricular groove on the posteri
ity of the tricuspid valve. On the left is a reconstruction illustrating the course run by the coronary sinus in the atriov
xial (left) and 3D-reconstructions (right) of the heart demonstrating the right atrial appendage (blue arrows). Ao=aort
Right atrial appendage:
The right atrial appendage is the trabecularized part of the right atrium. It partially covers the atrioventricular groove
Characteristically, it is flat and triangular in shape and contains small muscular bundles which run parallel to the atri
ructions showing the right ventricle. The blue arrows indicate the moderator band. RA=right atrium, RV=right ventric
Right ventricle:
Blood leaves the right atrium and enters the right ventricle via the tricuspid valve. This valve has three leaflets and th
(in contrast to the papillary muscles of the mitral valve, which do not). The right ventricle is shaped differently to the
e and the cavity of the right ventricle is effectively wrapped around it. The right ventricle also has a thinner wall whic
moderator band is another distinguishing feature of the right ventricle.
It runs from the septum to the lateral wall of the right ventricle, and plays a key role in the electrophysiological condu
onstruction showing the tricuspid (TV) and pulmonary (PV) valves as well as the cavity of the right ventricle (RV). The
Pulmonary valve:
Next, blood runs towards the pulmonary valve - first entering the smooth, muscular infundibulum of the right ventri
e tricuspid valve by a thick muscle known as the crista supraventricularis (blue arrow in the image on the left). This d
ral and aortic valves lie side by side. On the left is a summary of the characteristics which are specific for the right ve
right ventricle in cases with complex congenital cardiac anatomy. Axial reconstructions showing the pulmonary vein
Pulmonary veins:
Oxygen-rich blood enters the left atrium via the pulmonary veins. In most cases, there are two pulmonary veins on t
rain into the superior pulmonary vein. 3D-reconstructions showing the pulmonary veins as they enter the left atrium

especially on the right, where an anomalous insertion is associated with atrial fibrillation. Axial and 3D-reconstructio
endage (yellow arrows).)
Left atrial appendage:
The left atrial appendage is a finger like, trabecularized structure which originates supralaterally in the left atrium. It
covers the left coronary artery in it. Its small, parallel-running muscles should not be mistaken for thrombus. 3D-rec
d the left coronary artery (yellow arrow) after the left atrial appendage has been removed. A=anterior, S=superior).)
must be removed, so that the LCX and proximal LAD may be visualized. Axial (left) reconstruction, 3-chamber view (
ng the relationships between the left atrium, ventricle and aortic root. LA=left atrium, R=right coronary cusp, L=left c
e
Left ventricle:
Blood enters the left ventricle via the mitral valve. This is a complex valve, consisting of an annulus and posterior and
ary muscles via cord-like tendons called chordae tendinae. The papillary muscles insert into the lateral and posterior
uations the left ventricle has a uniform thickness, varying end-diastolically from 0.6 to 1.0 cm. Blood enters the aorti
re appears to be a fibrous connection between the mitral and aortic valve. 3-chamber (left) and coronal (right) recon
Aortic valve:
Like the pulmonary valve, the aortic valve has three cusps. Just cranially to it there is a slight dilatation of the aortic r
during diastole, supplying the coronary arteries with oxygen-rich blood. The image on the right shows that the coron
ending aorta. Axial reconstruction depicting the tricuspid aortic valve with its right and left coronary (R and L respect
ves are named according to their relationship with the coronary arteries, namely the right coronary, left coronary an
A. Kazerooni AJR 2004; 182:993-1010
None:

None:

Sharp foreign bodies in GI tract:
by Julien Puylaert and Frank Zijta
Amsterdam UMC and Haaglanden MC, The Hague:
Publicationdate 15 nov 2020 This is an overview of the widely variable US and CT presentation of sharp foreign bodi
This pictorial essay is based on a literature search and our personal experience with 49 cases and will enable you to
d also to help the clinician to choose the best and least invasive treatment. For critical comments and additional rem
Introduction:
Accidental ingestion of sharp foreign bodies is a potentially life-threatening event.
If a sharp foreign body gets stuck in the pharynx or esophagus, the patient will usually notice its presence and will se
body, unnoticed by the patient, is able to reach the stomach, it may penetrate at some point, the wall of the stomac
symptoms.
This often leads to serious delay and may even be fatal. This table contains the key points in the history of the patien
The ingested foreign bodies are fish or poultry bones and wooden sticks as tooth picks and cocktail sticks.
Patients virtually never remember swallowing, and even show disbelief when confronted with the diagnosis. The ave
Patients with perforation of small or large bowel often have a previous laparotomy in their history. Perforating foreig
and are increasingly recognized by the use of US and CT, so there is a key role for the radiologist, in primary detecti
contains the key points in the clinical, US and CT findings. Pain is variable and atypical.
CRP usually rises quickly in the first 24 hours. Perforation of the stomach always occurs in the prepyloric region.
Abscesses may occur in the peritoneal cavity, abdominal wall, iliopsoas muscle and liver.
The foreign body itself may be rather inconspicuous and is easily missed.
This requires awareness and active searching on CT scan This table contains the key points of the treatment. Whene
minimal invasive surgery, guided by the US and CT findings.
Abscesses can be drained percutaneously, or evacuated surgically together with removal of the foreign body. In all in
Antibiotics alone may be the definitive treatment, especially in case of small fish bones and after successful abscess
oration and yet leave the bowel naturally.
This is called pinprick-and-pass.
Epidemiology and pathophysiology:
Hyperdense bones in three asymptomatic patients It is unknown how often sharp foreign bodies on their journey th
Probably many fishbones eventually pass with the stool without any problem.
When specifically looked for, it is not uncommon to find hyperdense bones (arrow) in the bowel lumen, as in these th
ating sharp foreign bodies are fish bones, chicken bones and wooden sticks as toothpicks or cocktail sticks. The vast
ect, and when confronted with the sharp object, often show remarkable disbelief. Many patients wear denture plate
ossible to differentiate bones from wooden sticks on CT, but fishbones are generally rather hyperdense and curviline
lf of the patients with small bowel perforation, have a history of a previous abdominal surgery. Adhesions cause loca
o “take the corner”. Once a sharp object penetrates the wall of stomach or bowel, omentum and mesentery will try t
in the peritoneal cavity, in the liver, in the abdominal wall or in the iliopsoas muscle. The foreign body may lie withi

, significant migration of the object may occur. One third of the perforating sharp foreign bodies lies within reach of
option for the patient. A 59-year old woman with atypical upper epigastric pain for two days. US reveals remarkable
ic, curvilinear structure (arrowheads), suspect for a fishbone. CT confirms the diagnosis.
Note how the fishbone (arrow) could easily be missed on the coronal CT alone.
Uneventful recovery after endoscopic removal. US and CT show a fishbone perforating the stomach wall just before
ucosal swelling with a central ulceration (arrow). Deep instrumentation with a large forceps into this area eventually
nts with deeply located, lower abdominal pain since 3 weeks. Lab: 15 leukocytes, CRP 150. She had multiple gynaeco
eign body, which, at both ends, appeared to perforate the sigmoid. Endovaginal US confirmed that the foreign body
During the endoscopical procedure, the chicken bone had to be broken in two parts in order to be safely removed. U
not reachable for the endoscope and is well accessible for the surgeon, in principle surgical removal of the foreign
resection at age four) presented with epigastric pain and a CRP of 155. US and CT confirmed a bony structure (arrow
p 6 cm bone was removed. The patient ate Peking duck two days earlier. A vital 83-year old man presented with acut
tuck in the jejunum. After 24 hours of conservative therapy with antibiotics, the pain did not diminish and the CRP w
asily be removed by means of a small jejunal incision, there was no need for bowel resection. The patient made a qu
erfect condition. He can still not imagine that he ever swallowed such a large bone chip In case of deeply located abs
n combination with long-term antibiotics. In some patients this may be the definitive treatment. This 61-year old lad
s obese and had several other contraindications for surgery. After multiple percutaneous drainage procedures and t
e still in place, apparently encapsulated. Now, ten years later, she is still doing fine. At times, it may be very difficult t
This patient presented with upper abdominal pain and a CRP of 245. US and CT revealed a slightly hyperdense, strai
ery two days later the liver abscess was evacuated, but the foreign body was not found. Afterwards the patient did w
ss with the foreign body (arrowheads) still in situ. Eventually, the patient recovered with long-term antibiotic treatme
or liver tissue they traverse, and thus may be hardly or not visible on CT scan. In these cases, focused US can be of h
g and local bowel wall thickening, suggested a local perforation, but no foreign body was seen. Immediate US of this
ing through the bowel (b.) wall into the surrounding inflamed fat (*). In patient B, antral wall thickening and a nearby
owever could not be identified on CT. US, performed with knowledge of the CT findings, easily detected the, apparen
s and the fishbone, after migration, becomes encapsulated. Antibiotics may be of help in the encapsulation process.
in since 12 hours (Lab: 15 leukocytes, CRP 7).
The next day the pain subsided, but the CRP went up to 65. US of the periumbilical area, showed edematous wall thi
There was a tiny fluid collection (f.) and inflammation of the hyperechoic and non-compressible mesentery (*). Subs
nding (*) in the mesentery. In the left paracolic gutter, a fishbone (arrow) was found.
Apparently the fishbone, after perforating the jejunum, did migrate to that spot.
Subsequent laparoscopical exploration was unable to identify the fishbone.
She made an uneventful recovery with antibiotics. CT scan, performed for other reasons 18 months later, showed sli
Patient is still doing well eight years later. In case of relatively mild symptoms in patients with small, perforating fishb
y be a good first option. These three different patients all made an uneventful recovery with antibiotics only. Sometir
This 72 year old lady presented with acute epigastric pain and a CRP of 180, caused by a fishbone, perforating her st
Her symptoms rapidly subsided and her CRP was normal again in three days.
She made a full recovery, and 11 years later is still doing fine. Two different patients with an encapsulated fishbone
ormed for other reasons. Both patients did not recall a period of upper epigastric pain and had unchanged CT image
be done in order to drain the abscess and remove the foreign body. In this patient, only a small peri-umbilical incisi
s 58-year old patient presented with pain LLQ and a CRP of 105, suspect for diverticulitis. US found a ovoid mass of i
epiploic appendagitis. Subsequent CT revealed a straight, hyperdense foreign body (arrows) surrounded by fat stran
The patient was treated with antibiotics. One week later an abscess did develop, which was percutaneously drained.
edure.
Perforating diseases of the GI tract:

Causes of perforation:
If at US or CT bowel wall thickening is found in combination with fat stranding, free air configurations and/or absces
s. The mnemonic PSI-ABCD may be helpful: In the table, the star-classification indicate the frequency of these potent
In 99,99 % of cases, one of these seven conditions is the cause of the perforation or walled-off perforation. In our ho
foreign bodies of 3-4 cases per year.
This is partially explained by a large immigrant population, eating exotic fish species. Especially Surinamese people w
e fishbone perforations.
Pinprick-and-pass:
A sharp foreign body may cause a perforation, but may yet pass normally with the stool (”pinprick-and-pass”). This 8
onitis and a CRP of 200, clinically suspect for appendicitis.
US showed a small focal area of inflamed hyperechoic fat (arrowheads), harbouring a little fluid (*) and an ill-unders
The presumed US diagnosis was epiploic appendagitis with a small central area of hemorrhage. CT confirmed local f
kening of a neighbouring small bowel loop.
Using the mnemonic PSI-ABCD, all conditions were excluded, except for a sharp foreign body. After specific searchin

ently, this fishbone had caused a perforation, and was later propelled by some small bowel contents. The patient wa
Illustrative cases:
This 37-year old woman had progressive epigastric pain since 4 days. US detected a reflective curvilinear structure (a
creas, suspect for a fishbone. (gb=gallbladder).
CT without contrast confirmed a fishbone stuck in the pancreas. At gastroscopy, no fishbone was seen, only a small
We assumed that this was the point where the fishbone must have penetrated while the remaining end of the fishbo
mach wall (see drawing). Encouraged by this knowledge the endoscopist performed deep instrumentation with a lar
The patient made a full recovery and told us having eaten “jarabaka” a week earlier, a Surinamese fish, known for its
ogressive epigastric pain for 24 hours.
US revealed an aortic aneurysm of 5.2 cm. Immediate CT scan excluded rupture, however some subtle fat stranding
. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll CT revealed a fishbone (arrow) in the duodenum, perforating its ventral wall. At gastroscopy the fishbo
ration of the fishbone due to bile pigments. When confronted with the results, the patient could not imagine ever ha
LLQ and a CRP of 21, suspect for diverticulitis. Initial US shows wall thickening of the sigmoid, inflamed fat (*) and a
Closer inspection of the area where the most inflamed, non-compressible fat (green arrowheads and *) was seen, re
e of bone and subtle fat stranding (*) around the sigmoid. Endoscopic removal was relatively easy. This is a 60-year o
CT scan showed an abscess in the quadrate lobe, harbouring a fishbone, migrated from the stomach to the liver. End
(arrow), so endoscopic removal was impossible. At surgery, the abscess was drained and the fishbone removed. A 7
firms the abscess and identified a straight, slightly hyperdense sharp foreign body, apparently migrated from the sm
Shape and density suggested a wooden pen rather than a fishbone. With only minimal invasive surgery, both pus an
Patient had artificial denture, a previous appendectomy and had the habit of “shoving-off” meat of his sateh-pen with
and a CRP of 173, suspect for diverticulitis.
He had a left nefrectomy 20 years ago. US revealed an abscess in the abdominal wall harbouring a thin, curvilinear s
ishbone (arrow) within a moderately defined, abdominal wall abscess.
Note how easily the fishbone could have been missed if only i.v. contrast CT had been made. Location of abscess and
Using only a very small incision, pus and fishbone could be removed. Uneventful recovery. A 57-year old man (previo
ng of the sigmoid (s.) wall and an unclear mass at the left side.
At this time, the small hyperechoic line (arrow) was missed.
The CT diagnosis was sigmoid diverticulitis or sigmoid malignancy.
Colonoscopy was unable to reach the area. On a repeated CT one week later, we were lucky that the straight and slig
full length on the coronal CT. At surgery, part of the sigmoid was resected together with a large inflammatory mass,
A temporary stoma was made.
The patient showed disbelief and firmly denied ever having swallowed such a stick. During an endodontal procedure
ile”.
He had no abdominal complaints, but became worried when, after a week, he did not find it in his stool. CT without c
l fat stranding. At surgery a part of the jejunum was resected including the endofile. Young (31 years) Surinamese wo
r diverticulitis.
Previous history of uterine rupture. US shows hypoechoic mass left of the uterus (u.) suspect for tubo-ovarian absce
In the periphery a thin, curvilinear reflection (arrows) is seen. Endovaginal US confirms a fishbone (arrows) in the wa
ose relation to the sigmoid, which also shows focal wall thickening. At surgery, TOA and fishbone, densely adhered t
forating the sigmoid, migrated into the left ovary, causing a TOA.
Note the greenish discoloration of the fishbone, probably due to biliary pigments. Obese 80 year old lady with strong
She had a previous cholecystectomy.
Lab: leukocytes 21, CRP 125. US showed inflamed fat (*) around edematous small bowel (b.), containing a strange re
The US images in two perpendicular planes, suggested that this foreign body had a flat nature. CT confirmed small b
inspection in the axial and coronal CT plane, revealed an intraluminally localized, slightly hyperdense, double-layered
ocal small bowel usuration by a sharp vegetable peel.
After the operation, this was recognized by the patient as the peel of an unripe mango, used in her self-made mango
l infarction, suddenly developed pain in the RLQ and a CRP of 70, suspect for appendicitis.
He was nursed in isolation for suspected MRSA. US showed a normal appendix of 4 mms and wall thickening of the t
Next to the ileum a possible air bubble (green arrow) was observed. Within the ileal lumen, a linear reflective structu
The aspect in multiple planes, suggested a flat foreign body. On one end, a apparently sharp edge (white arrow) stuc
Disable Scroll Enable Scroll
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None:

Perianal Fistulas:
Susanne Tonino and Robin Smithuis
Radiology Department of the Medical Centre Alkmaar and the Rijnland hospital, Leiderdorp, the Netherlands.:
Publicationdate 2009-01-21 Perianal fistula is a common disorder that often recurs because of infection that was mis
n this review we will address the anatomy, pathogenesis, classification and scanning protocol of perianal fistulas. by
Anatomy:
The anatomical anal canal extends from the perineal skin to the linea dentata. Surgically, the anal canal extends from
upper border of the puborectal muscle which is digitally palpable upon rectal examination. The anorectal ring lies ap
f the surgical anal canal is about 4-5 cm. The anal sphincter is comprised of three layers: Puborectal muscle forming
the pubic symphysis, forming a 'sling' around the anorectum. The puborectal muscle is contracted at rest and accou
uring defecation. Coronal T2W-image On axial and coronal MR-images the different layers of the anal sphincter and
Perianal fistula:
A perianal fistula is an abnormal connection between the epithilialised surface of the anal canal and the skin. The ca
Classification:
The most widely used classification is the Parks Classification which distinguishes four kinds of fistula: intersphincter
The most common fistulas are the intersphincteric and the transsphincteric. The extrasphincteric fistula is uncomm
cases the connection with the original fistula tract to the bowel is lost. A superficial fistula is a fistula that has no rela
t part of the Parks classification. These are more often due to Crohns disease or anorectal procedures such as haem
MR Protocol and Reporting:
Protocol A localizer in three directions is needed in order to align the T2 sequences axial and coronal to the anal can
used. We use a TRUE FISP, which is the name that Siemens uses for a steady-state precession gradient-echo sequen
without fatsat (left) and with fatsat (right) T2W images without fatsat better display the anatomy, while the fatsat ima
a fistula, it is important to mention the following characteristics: The drawing on the left illustrates the anal clock, wh
patient is in the supine lithotomy position (2). This scheme corresponds to the orientation of axial MR images of the
Examples of Perirectal Fistulas:

Intersphincteric fistula:
On the left axial T2W images with and without fat saturation. An intersphincteric fistula is located at 6 o'clock. Contin
s caudally towards the skin. There is no connection with the external sphincter. Enable Scroll
Disable Scroll Use the arrows to scroll through the images. Enable Scroll
Disable Scroll Use the arrows to scroll through the images. On the left coronal images of another patient with an inte
es. Transsphincteric fistula with sphincter defect at 6 o'clock
Transsphincteric fistula:
On the left an axial T2WI and T2WI + fatsat of a transsphincteric fistula. The defect through the internal and external
n the fat sat images. Transsphincteric fistula with sphincter defect at 11 o'clock On the left axial T2W-fatsat images o
'clock. On the left an example of a suprasphincteric fistula. There are two tracts in the ischioanal region. The right sid
mucosal opening lies at the
level of the linea dentata (black arrow).
Extrasphincteric fistula:
On the left coronal T2W-images of a small abscess in the left ischioanal fossa, the fistula runs through the levator an
teric. Enable Scroll
Disable Scroll Use the arrows to scroll through the images. Enable Scroll
Disable Scroll Use the arrows to scroll through the images.
Complex fistula:
On the left an example of a complex fistula. Two tracts in the left buttock form a single tract (no. 1-2). This fistula bre
hincteric space it divides again into two tracts (no. 5). One ends blindly in the intersphincteric space (no. 6). The othe
fect at 1 o'clock.
Crohn's disease:
On the left a patient with a perianal fistula who has Crohn's disease. Continue with the coronal images. On the coron
l fatsat images depict the transmural inflammation with infiltration of the mesenteric fat.
Treatment:
Treatment is focussed on the elimination of the primary and secondary tracts, prevention of
recurrence and to retain continence. The treatment given depends on the anatomy of the fistula, if it is a simple fistu
low mucosal defect is can be probed in the OR to identify the mucosal defect at the
linea dentata, then the tract can be opened. This is only possible if the external sphincter is not involved. Seton fistul
is pulled through the
fistula, it then is tightened every 2 weeks or so in order to obtain pressure necrosis so that
the Seton is slowly pulled through the muscle. This has the advantage that the muscle is slowly cut and fibroses at th
to cause as little damage as possible to the sphincter complex. If there is an extrasphincteric fistula, the lower part is

rectum, is then surgically closed. This patient was already known to have an intersfincteric fistula, the mucosal defec
th a low signal intensity. This is the Seton which was inserted to treat the fistula.
Differential diagnosis:
Sinus pilonidalis Sinus pilonidalis On the left an example of a sinus pilonidalis. There is a small abscess just above th
octitis On the left images of a patient who presented with anal complaints. No fistula was seen. There is, however, a
ianal abscess Abscess in the Ischioanal space An abscess in the ischioanal space with no connection to the sphincter
2. MR Imaging Classification of Perianal Fistulas and Its Implications for Patient Management. by John Morris Radiogr
3. MRI of Perianal Crohn's Disease by Karin Horsthuis and Jaap Stoker
Nonvascular Mediastinal Masses:
Marilyn J. Siegel and Valerie Niehe
Mallinckrodt Institute of Radiology, St. Louis, MO and the Medical Centre Haaglanden in the Hague, the Netherlands:
Publicationdate 2011-07-10 This review is based on a presentation by Marilyn Siegel and was adapted for the Radiolo
diatric and chest radiology. In this review we will discuss the most common non-vascular mediastinal masses in the c
on vascular anomalies of the aorta, pulmonary vessels and systemic veins in the chest.
Differential diagnosis:
The differential diagnosis of a mediastinal mass is based on identifying its location in anterior, middle or posterior m
cement.
Normal anatomy:

Thymus:
In infants and young children (
In older children, the thymus gradually assumes a triangular or arrowhead configuration with straight or concave ma
ls. Marked lobularity of the thymus is always abnormal. In prepubertal children, the thymus is homogeneous. The at
it may be heterogeneous, containing areas of fat. Anatomic variations include extension into the posterior mediastin
thymus that extends cranially to the brachiocephalic vessels. It is contiguous with the normal thymus and extend be
fect.
Normal Lymph nodes:
There are no well-established data concerning size of normal lymph nodes in infants and young children. Mediastina
des should then not exceed 1 cm in the widest dimension. The azygoesophageal recess is dextroconvex in children y
ars of age, and concave in adolescents and adults. Recognizing the normal dextroconvex appearance is important so
Anterior Mediastinal Masses:
Anterior mediastinal masses are usually of thymic origin.
Hodgkin lymphoma:
Lymphoma is the most common anterior mediastinal mass in children, with Hodgkin lymphoma occurring three to f
ystic areas, due to ischemic necrosis consequent to rapid tumor growth, can be seen. Lymphadenopathy from lymph
ngle area to large conglomerate soft tissue masses in multiple regions. Thymic enlargement and lymphadenopathy s
findings include airway narrowing and compression of vascular structures. PET-CT of Hodgkin lymphoma Hodgkin ly
ymphomatous mass is most common located in the anterior mediastinum and reflects lymphadenopathy or infiltrat
al shape with convex, lobular lateral borders. Hodgkin lymphoma The chest film shows the typical features of Hodgk
he CT-images of the same patient show a large soft tissue mass in the anterior mediastinum, which arises in the thyr
lymphoma Two more cases of Hodgkin lymphoma. Again these cases show an anterior mediastinal mass and paratr
Non-Hodgkin lymphoma:
Non-Hodgkin disease in children occurs in the first and second decade of life. The disease usually involves the nodes
n of the disease is not contiguous, it can skip a location. Non-Hodgkin lymphoma Non-Hodgkin disease, in contrast t
lymph nodes are seen in the right paratracheal , hilar and subcarinal areas. Thymic hyperplasia
Thymic hyperplasia:
Thymic hyperplasia is another cause of thymic enlargement.
In childhood, thymic hyperplasia is most often 'rebound' hyperplasia associated with chemotherapy, particularly the
ing the course of chemotherapy or after therapy completion and occurs 3 to 10 months after the start of chemother
n of lymphocytes from the cortical portion of the gland due to high serum levels of glucocorticoids, followed by repo
eturn to normal. On CT, hyperplasia appears as diffuse enlargement of the thymus, with preservation of the normal
increase in volume of the thymus.
CT, MRI of PET cannot differentiate rebound hyperplasia from infiltration of the thymus by tumor. The absence of ot
CT's supports the diagnosis of rebound hyperplasia. The thymus usually returns to its normal size in 3 to 6 months.
Thymoma:
Thymomas are common and account for 20% of mediastinal neoplasms. Thymic carcinomas are extremely rare and
the left and a carcinoma on the right. The thymic carcinoma has invaded the superior vena cava (arrow). Benign ma
Germ-cell tumors:
Germ-cell tumors are the most common cause of a fat containing lesions in the anterior mediastinum and the secon
oximately 90 % are benign germ-cell tumors. Most arise in the thymus. On CT, a benign teratoma is a well-defined, th

ium, fat and soft tissue. The soft tissue component in benign teratoma is minimal.
Size is not an indicator of malignancy. Benign mature teratoma Mature teratomas can be very large and still be benig
atomas.
They tend to have irregular or nodular walls and a predominance of soft tissue components. They also may show pu
nonteratomatous germ-cell tumors in the pediatric population are choriocarcinoma, embryonal cell cancer and yolk-
Thymolipoma:
Thymolipoma is an infrequent fat-containing thymic tumor.
At CT, it appears as a heterogeneous mass containing fat and soft tissue elements. Calcifications are absent. Thymol
Lymphangioma or Cystic hygroma:
Lymphangiomas are developmental tumors of the lymphatic system. In the mediastinum they are almost always an
lvement is rare. Lymphangioma is a benign, but aggressive tumor that shows mass effect and may encase vessels ar
s of age. At CT it appears as nonenhancing, thin-walled, multiloculated mass with near water attenuation. T2 with fat
better delineate the extension of the lesion. The MRI in this patient shows a cystic mass in the neck extending into th
e presence of contrast enhancement of the wall or internal septations suggests superimposed infection or a hemang
Thymic cysts:
Thymic cysts are usually congenital lesions resulting from persistence of the thymopharyngeal duct. They can also oc
s masses of near water attenuation on CT. The attenuation value may be higher than that of simple cysts when the c
ldren thymoma, thymic carcinoma and goiter are so uncommon, that you should put them very low in your different
Middle Mediastinal masses:
In the middle mediastinum we will find foregut duplication cysts or lymph nodes. Foregut cysts in the middle medias
s are lined by respiratory epithelium and most are located in the subcarinal or right paratracheal area in close proxim
trointestinal mucosa and are located in a paraspinal position in the middle to posterior mediastinum near the esoph
Bronchogenic Cysts:
The images show a well defined lesion of water attenuation in close proximity to the trachea or bronchus, which is ty
ages show more examples of bronchogenic cysts and their close proximity to the airway. Enteric cyst
Enteric foregut cyst:
The images show a well defined lesion of water attenuation in the lower mediastinum in close proximity to the esopl
Mediastinal lymphadenopathy:
Mediastinal lymphadenopathy is usually caused by lymphoma or granulomatous disease. Metastatic disease from rh
n CT, adenopathy can appear as discrete, round, soft tissue masses or as a single soft tissue mass with poorly define
granulomatous disease, fungal infection or metastatic disease from osteosarcoma. Areas of low attenuation suggest
Posterior Mediastinal masses:
Posterior mediastinal masses are of neural origin in approximately 95 % of cases and may arise from sympathetic ga
) or from nerve sheaths (neurofibroma or schwannoma). In the first decade of life they are usually malignant, most c
lly benign (ganglioneuroma, neurofibroma, rarely schwanoma). Neuroblastoma presenting as a mass in the posterio
Neuroblastoma:
Neuroblastoma typically is fusiform in shape, of soft tissue density; 50% of thoracic tumors have calcifications. Neuro
uently invades the vertebral canal. The CT-images show a calcified mass in the posterior mediastinum extending ove
stoma On the MR-images the invasion of the vetebral canal is better seen (arrows). LEFT: Ganglioneuroma, RIGHT: N
Other Neurogenic Tumors:
In the 2nd decade other neurogenic tumors are seen like
ganglioneuroma, neurofibroma and rarely schwanoma. They are round or oval in shape, smaller in size than ganglio
types of tumor may cause pressure erosion of a rib and invade the spinal canal.
Neurenteric Cyst:
Neurogenic cysts contain neural and gastrointestinal element. They are commonly associated with vertebral anomal
s well demarcated and has a near water attenuation value on CT and water signal intensity on MRI, as shown in the c
inal area and adjacent to the sternum.
Extramedullary hematopoiesis:
Extramedullary hematopoiesis accounts for less than 0.1 % of the lesions in the posterior mediastinum. It is characte
It occurs with severe anemia. On CT it is seen as a paravertebral mass and occurs with coarse bone trabeculation in
Pediatric Chest CT part II:

Vascular Anomalies of Aorta, Pulmonary and Systemic vessels:
Vascular Anomalies of Aorta, Pulmonary and Systemic vessels
CT contrast injection and protocols:
Robin Smithuis
Radiology department of the Rijnland Hospital in Leiderdorp, the Netherlands:
Publicationdate 2014-06-01 Optimal contrast enhancement is important for a succesful diagnostic CT-scan. In this ar
enhancement
Basics of contrast-enhancement:

Enable Scroll
Disable Scroll Scroll through the phases of enhancement. You can enlarge the images by clicking on it. Enable Scroll
Disable Scroll Scroll through the phases of enhancement. You can enlarge the images by clicking on it.
Phases of enhancement:
The purpose of contrast-enhanced CT (CECT) is to find pathology by enhancing the contrast between a lesion and the
ular compared to the normal tissue and in some cases a lesion will be hypervascular to the surrounding tissue in a c
phase a CT should be performed depending on the pathology that you are looking for. Scroll through the images to s
the contrast is still in the arteries and has not enhanced the organs and other soft tissues.
* Late arterial phase - 35-40 sec p.i. or 15-20 sec after bolustracking. Sometimes also called "arterial phase" or "early
l vein can be seen. All structures that get their bloodsupply from the arteries will show optimal enhancement.
* Hepatic or late portal phase - 70-80 sec p.i. or 50-60 sec after bolustracking. Although hepatic phase is the most ac
this phase the liver parenchyma enhances through bloodsupply by the portal vein and you should see already some
* Nephrogenic phase - 100 sec p.i. or 80 sec after bolustracking. This is when all of the renal parenchyma including th
ect small renal cell carcinomas.
* Delayed phase - 6-10 minutes p.i. or 6-10 minutes after bolustracking. Sometimes called "wash out phase" or "equi
uctures except for fibrotic tissue, because fibrotic tissue has a poor late wash out and will become relatively dense c
nt of infarcted scar tissue in cardiac MRI. Hypervascular lesion is best seen in late arterial phase.
Timing of CECT:
Timing of CT-series is important in order to grab the right moment of maximal contrast differences between a lesion
hase in comparison to a late arterial phase. The CT-images are of a patient who underwent two phases of arterial im
see the arteries, but we only see some irregular enhancement within the liver. In the late arterial phase we can clear
col to the type of scanner, the speed of contrast injection and to the kind of patient that you are examining. If you ha
can the liver. For late arterial phase imaging 35 sec is the optimal time, so you start at about 25 seconds and end at a
will be able to examine the whole liver in 4 seconds. So you start scanning at about 33 seconds, which is much later.
ave only limited time before the surrounding liver will start to enhance and obscure a hypervascular lesion. For Late
t to be too early, because you want to load the liver with contrast and it takes time for contrast to get from the porta
because the delayed or equilibrium phase starts at about 3-4 minutes. So you start at 75 seconds with whatever sca
Total amount of contrast:
In many protocols a standard dose is given related to the weight of the patient: In some protocols we always want to
pancreatic carcinoma or liver metastases. Patient with liver cirrhosis and multifocal HCC injected at 2.5ml/sec (left) a
Injection rate:
5cc/sec through a 18 gauge i.v. catheter 3-4cc/sec through a 20 gauge pink venflon The upper images are of a patien
mined after contrast injection at 2.5ml/sec. Because of poor enhancement the examination was repeated at 5ml/sec
.
Oral contrast:
Some prefer to give positive oral contrast to mark the bowel. This however has some disadvantages: We use fat cont
nk milk we simply use water. Polyethylene glycol (PEG) is also used, and Volumen®, which is a low density barium su
bowel distension. The CT-image shows nice enhancement of the normal bowel wall (yellow arrows) and no enhance
positive oral contrast was given.
Rectal contrast:
Rectal contrast is given in cases of suspected bowel perforation or anastomosis leakage. We use positive contrast: 75
formation is given in the protocol anastomosis leakage.
Liver:
Hypervascular tumor (left) enhances in late arterial phase. Hypovascular tumor (right) enhances poorly and is best se
Dual blood supply:
The conspicuity of a liver lesion depends on the attenuation difference between the lesion and the normal liver. On a
se the inherent contrast between tumor tissue and the surrounding liver parenchyma is too low. When we give i.v. co
supply to the liver. Normal parenchyma is supplied for 80% by the portal vein and only for 20% by the hepatic artery
phase at 70-80 sec p.i. and only a little bit in the late arterial phase at 35-40 sec p.i.. All liver tumors however get 100%
ervascular tumor will be best seen in the late arterial phase. A hypovascular liver tumor however will enhance poorly
surrounding liver does also enhance poorly in that phase. This tumor is best seen when the surrounding tissue enha
This figure is to summarize the enhancement patterns. In the late arterial phase at 35 sec hypervascular lesions like
he normal parenchyma shows only minimal enhancement. Hypovascular lesions like metastases, cysts and abscesse
Fibrotic lesions like cholangiocarcinoma and fibrotic metastases hold the contrast much longer than normal parench
late enhancement is comparable to what is seen in cardiac infarcts in MRI of the heart. If you want to characterize a l
i.e. 150cc contrast at 5cc/sec. through a 18 gauge green venflon. In most cases you also want to scan the whole abdo
outinely perform a NECT in order keep the radiation dose as low as possible. When you know in advance, that you ar
p.i. is sufficient.
Pancreas:
Pancreatic carcinoma is best imaged at 35 sec p.i. Liver metastases are best imaged at 70 sec p.i.

Pancreatic carcinoma:
Pancreatic carcinoma is a hypovascular tumor and is best detected in the late arterial phase at 35-40 sec p.i. when th
ar tumor does not. Metastases in the liver are best detected at 70-80 sec p.i., when the liver parenchyma enhances c
ncreatic carcinoma from a focal chronic pancreatitis. A NECT can be included in the protocol to detect calcifications i
l. Some radiologists use a longer delay for scanning of the pancreas at 50 sec p.i.
Acute pancreatitis:
Imaging in acute pancreatitis is best done after 72 hours of presentation. read more... Ct performed in the first two d
n be best detected in the late arterial phase at 35 sec p.i. CT examination of the pancreas should always be done wit
h small pancreatic carcinomas aswell as pancreatic necrosis in pancreatitis are difficult to detect. It is a matter of per
0 sec p.i. Some perform one single CT somewhere inbetween 35 and 70 sec, but that is not what we prefer.
Ileus:
Especially in small bowel obstruction (SBO) you need to answer the most important question: is there strangulation?
following reasons: Do not use positive oral contrast, because this will obscure bowel wall enhancement. The coronal
ith ileus due to a small bowel obstruction. Notice the cluster of thick walled loops with poor enhancement and edem
with strangulation. This patient needs immediate surgery. If this patient would have been given positive oral contras
more about closed loop obstruction.
Anastomosis leakage:
Leakage after bowel surgery is a great clinical problem. Patients, who are suspected of leakage, need the best CT-pro
to convince the clinician. You do not want to tell the surgeon that there is probably leakage, but you are not sure. A
with the CECT with rectal contrast, because you don't want to end up in a discussion whether some hyperdense stuf
se bowel content or contrast from an earlier examination. Enable Scroll
Disable Scroll Anastomotic leak. Images on the left prior to rectal contrast and on the right after rectal contrast. Enab
Disable Scroll Anastomotic leak. Images on the left prior to rectal contrast and on the right after rectal contrast. Here
section of a sigmoid carcinoma. Compare the NECT without oral or rectal contrast on the left with the images on the
the fluid collection in the right lower abdomen is the result of leakage from the bowel (arrow).
Pulmonary emboli:
Good quality CT scanning is the most important factor for the diagnosis of pulmonary emboli. On a poor quality scan
m to top, because if a patient can't hold his breath, then you will have less breathing artefacts in the lower lobes, wh
ing does not cause that much movement as in the lower parts of the lung. We ask the patient to breath in normally a
, which will be explained in a moment. For good timing bolus tracking is needed. A ROI is placed in the pulmonary tru
d to breath in and scanning is started immediately. Transient Interruption of Contrast: Deep inspiration results in dil
m the inferior vena cava.
Transient interruption of contrast:
TIC is a flow artefact, that consists of relatively poor contrast enhancement in the pulmonary arteries, while there is g
s not logic at all. This vascular phenomenon occurs when the patient performs a deep inspiration just before the sca
od from the inferior vena cava (IVC). More unopacified blood from the IVC than opacified blood from the SVC enters
teries. This phenomanon is especially seen in younger patients, who are capable of deep inspiration. 1. Optimal 2. To
depends on good contrast delivery and perfect timing. Scans for pulmonary emboli are frequently of poor quality in
n is the following: The images demonstrate: Enable Scroll
Disable Scroll Scroll through the images. Enable Scroll
Disable Scroll Scroll through the images. Thick MIP reconstructions can be helpful in following the vessels and detect
Overview of CT-protocols:
The table shows an overview of some of the CT-protocols, that we use (click to enlarge). They are based on a 64-slice
acturer. In this table only specific protocols are summarized, since most institutions have their own standard protoco
2. CT angiography for pulmonary embolism detection: the effect of breathing on pulmonary artery enhancement usi
8, 2013
3. Split-Bolus MDCT Urography with Synchronous Nephrographic and Excretory Phase Enhancement by Lawrence C.
4. How Much Dose Can Be Saved in Three-Phase CT Urography? by Pär Dahlman and Aart J. van der Molen AJR 2012;
None:

Cystic Abdominal Masses in Children:
Erik Beek
Radiology department of the University Medical Center Utrecht in the Netherlands:
Publicationdate 2017-11-01 Cystic masses in the abdomen of a child are common. Many of these are discovered with
complaints and imaging is performed. The cyst is either the cause of the complaints or an incidental finding. In this p
asses in children. Ultrasound is often all that is needed for a diagnosis and will help the pediatrician or pediatric surg
metimes CT can be useful.
Systematic Approach:

Differentiate cystic from solid:

Origin of lesion Claw sign This refers to the acute angles between lesion and parenchyma that indicates that this lesi
een, ductus choledochus, ovaries and pancreas. Normal ovaries excludes ovarian cysts. Specific features Small cyst i
suggests origin from the digestive tract, e.g. duplication cyst or Meckels diverticulum
Differential diagnosis:
The most common cystic lesions in the pediatric abdomen are listed in the table. Rare cysts that we will not discuss a
he origin. A "claw sign", an organ draped over a cyst, can help to pinpoint its origin. Look for the abdominal organs a
asily exclude cysts of the liver, spleen, kidneys, pancreas and choledochal duct. Neonatal girlsIn neonatal girls you ar
girls are very mobile and an ovary with a cyst can even be located at the liver hilum, so do not rely on its typical pelvi
follicle cysts. Only the depiction of two normal ovaries excludes an ovarian cyst, unless the cyst is clearly arising from
etermined origin are probably lymphangiomas. These can be so large that they can be confused with ascites. Look fo
the liver to diagnose the fluid collection as ascites. The content of a lymphangioma is often cloudy and looks like a "s
content usually remains clear.
Ovarian cysts:
Newborns and infantsWith the introduction of prenatal ultrasound, ovarian cysts are often detected antenatally. Ova
into simple, anechoic, thin-walled cysts or complicated cysts. Complicated cysts are thick-walled, and can have debri
reports state that these will regress, but most are resected. Postpubertal The majority of ovarian cysts in postpubera
r the management of ovarian cysts in infants. Generally cysts >4 cm and complicated cysts are operated. Cysts 2.5 - 4
ontaneously over time and follow-up is not necessary.
Ovarian torsion:
Suggestive features for ovarian torsion are: Here an antenatally detected cyst, confirmed after birth in a newborn gir
ion of the left ovary was found.
Follicular cyst:
The majority of ovarian cysts in postpuberal girls are functional cysts. Normally several oocytes mature into follicles i
cle, which ruptures and releases the oocyte. After release of the oocyte, the dominant follicle collapses, and the gran
the corpus luteum of menstruation. Over the course of 14 days the corpus luteum degenerates, leaving the small sca
Read more... So if one is thinking of a possible ovarian tumor process, do a follow-up ultrasound 2 weeks after the la
a corpus luteum cyst
Corpus luteum cyst:
A corpus luteum may seal and fill with fluid or blood, forming a corpus luteum cyst. The transvaginal ultrasound ima
wer Doppler analysis. The characteristic circular Doppler appearance is called the 'ring of fire'. Note, there is good th
ith a, partially involuted, corpus luteum cyst. Follow-up after one month demonstrated resorption of the mass and a
Hemorrhagic ovarian cyst:
When a Graafian follicle or follicular cyst bleeds, a complex hemorrhagic ovarian cyst (HOC) is formed. On ultrasound
ed cyst with fibrin-strands or low-level echoes and good through transmission. On MRI hemorrhagic cysts are bright
rnal vascularity on Doppler ultrasound or post-contrast internal enhancement on CT or MRI. Hemorrhagic ovarian cy
cularity can be seen. Clinically the classic presentation is with acute pain. However HOC can also be an incidental find
Ovarian teratoma:
Ovarian teratomas are composed of ecto-, meso-, and endoderm. They can become apparent as a large painless ma
cause an acute abdomen. Some are incidental findings. On US a cystic mass can be seen with calcifications. Sometim
and fat. If the tumor contains lots of bone, hair, or calcifications, it is echogenic and sonographic diagnosis is challeng
o the wall of a cyst, containing hair, bone, teeth or fat. A plain abdominal film can sometimes show teeth or bone. CT
the lesion. On MRI some solid parts display high signal on T1, with low signal on fat suppressed sequences due to th
r Gadolineum. Pathology demonstrated a immature teratoma. The US- image shows a cystic lesion in the lower abdo
orsion of the right adnex was seen. On pathology a teratoma was demonstrated. Malignant teratoma
Ovarian malignancy:
Ovarian malignancies are rare. The chance of malignancy is greater in younger girls (1-8 y) than in girls (15-19 y). Her
ominal mass. It is a partly cystic, partly solid tumor with some calcifications. The solid parts are inhomogeneous. The
nant parts, with lymph node metastasis. A mirror artefact of the bladder can mimick a cystic ovariumtumor. When in
e this problem.
Intestinal duplication cyst:
Intestinal duplication cysts are duplications of the bowel. The majority do not communicate with the bowel. They car
in the jejunum and ileum. Most are on the mesenteric side and, if resected, a bowel resection is necessary. Intestina
truction, abdominal pain. They can be found at prenatal ultrasound. In typical cases a multilayered lining is seen, ide
cyst was infected the layers can be sloughed off. Ultrasound is usually sufficient to make the diagnosis. Here an ante
ed cyst and two normal ovaries. At operation a duplication of the ileum was resected. A six-month-old girl presented
ucture at the inner side of the duodenum. The cyst was partially resected, the common wall with the duodenum was
an unusual appearance of a duplication cyst. Ultrasound demonstrated an echogenic lesion in the left upper abdom
a tumor of the mesentery was resected. On macroscopic examination a tumor filled with a putty-like substance was
as found.
Lymphangioma:

Large lymphangiomas can resemble ascites. Look for fluid anterior to the liver or in Morrisons pouch to exlude a lym
c channels, comparable to the cystic lesions in the neck. Sometimes the term omental cyst or mesenteric cyst is usec
udy, unilocular or septated and small to very large. In very large lesions with only a few septa the differentiation from
spaces like ascites does, but they can be very soft with a plicated wall. CT will demonstrate masses with water densit
ge they can even appear solid. The MRI characteristics depend on the absence or presence of bleeding or infection. U
s are variable after bleeding. A one-year-old boy presented with a swollen abdomen. A huge cystic lesion was seen w
ris was visible. A T2-weigthed coronal MR better shows the extension of the lesion. At operation it was attached to th
gioma. Here a two-year-old boy with bilious vomiting. Ultrasound showed a large thin-walled multicystic tumor, whic
ry was resected.
Renal cystic masses:

Renal cysts:
Contrary to adults, simple renal cysts are rare in children. Especially in young children think of a syndrome if you see
indau syndrome, Zellweger syndrome, among others. In children on dialysis the native kidneys will demonstrate cyst
essive infantile polycystic disease are outside the scope of this article. A very tortuous, debris filled ureter with perist
Hydronephrosis:
A simple hydronephrosis of the kidney is easy to recognize. It can be due to a ureteropelvic junction stenosis, ureteri
uge it can be difficult to recognize as such, especially if debris is present. It can mimic a dilated bowel loop, especially
f debris with peristalsis. A high frequency probe can show a thin layer of renal tissue surrounding the cystic structure
o be part of a well-functioning kidney. Radionuclear examination or MRU, after nephrostomy, can provide informatio
ve-month-old boy with an antenatally detected dilated pyelocalyceal system and no visible ureter, in accordance with
ed pyelocalyceal system is well seen. One-year-old boy was referred with a diagnosis of a cystic nephroblastoma. Ult
xamined from the left flank with a high frequency linear array probe some parenchymal tissue was visible surroundi
phrosis. At first it was thought that there were some solid parts in the cyst. But when pressure was applied with the
with more overview. The cause was a pyeloureteric stenosis. The left kidney had 33% split renal function on renogra
Multicystic kidney disease:
A kidney, which is mainly composed of cysts of different sizes, is most likely a multicystic dysplastic kidney. In multicy
ureter. In approximately 25% of children with MCKD the contralateral kidney is affected by anomalies like reflux, ure
majority of MCKD will regress in size over time. Patients are followed with ultrasound to monitor the growth or involu
dney. The image is of a one-month-old boy with a MCKD on prenatal ultrasound. Some tissue and several large cysts
side. This is compatible with a MCKD. Antenatally a duplex system of the left kidney was diagnosed with hydronephr
r pole of the left kidney and some smaller cysts (not shown). No normal parenchyma was visible. On MCUG reflux in
ted due to the upper pole mass. This is probably a MCKD confined to the upper pole. MCKD can affect one pole of a
Cystic nephroma:
Cystic nephroma consist of multiple cysts and septa and occur predominantly in young boys and older women. Thes
incidental finding during imaging. A cystic nephroma can also be merely composed of cysts and look like a lymphang
the remnants of the kidney from which the tumor stems. A seven-year-old boy was examined after passing a kidney
n biopsy failed to remove the lesion. During five years follow-up it was stable. On MRI the lesion has a fuzzy demarca
appearance is consistent with a cystic nephroma.
Nephroblastoma:
here an one and a half year old girl with a palpable tumor in the left abdomen. Ultrasound showed a large tumor co
T2 weighted coronal image the cysts are well displayed. The remainder of the left kidney is at the caudal side of the
astoma was diagnosed.
Abdominal abscess:
Abdominal abscesses can be seen after inflammation of abdominal organs, often appendicitis, and postoperatively.
imaging strategy in children relies more on ultrasound then in adults, and during drainage procedures general anest
Meckels diverticulum:
An inflamed Meckels diverticulum is easily mistaken for an intussusception or appendicitis. A Meckels diverticulum is
ileum. It can contain heterotopic remnants of gastric or pancreatic tissue. It is often asymptomatic and detected inci
en below the age of two. It can present with intestinal bleeding, intussusception, or volvulus with obstruction. It can
m 99-m pertechnetate scintigraphy, depicting the ectopic gastric mucosa. An inflamed Meckels diverticulum can be d
tion or appendiceal mass because it presents with a thickened bowel wall. Nine-year-old boy with rectal bleeding. At
the bladder, with a multilayered wall. This was diagnosed as eiither a Meckels diverticlum or a duplication cyst. At op
with abdominal pain. US and CT show a cystic structure with surrounding inflammation above the bladder. US demo
s diverticulum or duplication cyst. At operation a Meckels diverticulum was resected. Six-year-old girl presenting with
as suspected. Ultrasound showed a cystic lesion with a whirlpool sign, either a duplication cyst or a Meckels diverticu
volvulus was found.
Extrapulmonary sequestration:
Extralobar pulmonary sequestrations can occur in the retroperitoneum, mostly on the left in a suprarenal position. T
ass. Cystic parts are commonly present. This lesion should be in the differential diagnosis of an adrenal hemorrhage

Postnatally a partly cystic, partly solid mass was seen in the left upper abdomen, separate from the spleen, kidney a
equestration was made. This was confirmed on pathology.
Choledochal cyst:
The therapy of choledochal cyst is resection, because it is a precancerous disease. Choledochal cyst is a rare anomal
l mass, and abdominal pain. This triad is present in less than half of the patients. A long common channel of the cho
dochal cyst. Pancreatic juices are believed to reflux into the choledochal duct, causing an erosion of its wall. The Tod
most common, followed by type 4. Ultrasound can demonstrate these lesions. MRCP can support the diagnosis. Ch
mpacted it can cause bile duct dilatation and give the erroneous impression that type 4 is present instead of type 1.
enatally dectected cyst of the choledochal duct, confirmed on postnatal ultrasound as a Todani type 1 cyst. This was
a Roux en Y loop
Hydrometrocolpos:
If a vaginal septum persists the proximal vagina (colpos) and / or uterus (metros) can be dilated with fluid or blood, c
onatal girls in who it is often detected prenatally, and in pubertal girls in whom menstrual blood accumulates in the
atresia of transverse vaginal septum. It can be associated with renal agenesis. The kidneys should always be imaged
diagnosis. Anomalies of the uterus are better seen with MRI. The differential diagnosis includes: Douglas abscess, re
udy cyst in the lower abdomen, with a small uterus on top in a neonatal girl, consistent with a hydrocolpos.
Adrenal hemorrhage:
In a patient with left adrenal hemorrhage the patency of the left renal vein should be determined. Adrenal hemorrha
ss, which slowly liquefies in the course of several weeks. Pediatricians can become restless if the liquefaction is late t
ow and of calcifications favors a hemorrhage. Also decrease in size over time speaks for a hemorrhage. If an adrenal
cystic lesion, which can incidentally be detected. Sometimes a part of the adrenal gland is still visible with its charact
structed upper pole moiety of a duplex kidney. A left sided adrenal hemorrhage is associated with left renal vein thro
contrary to the right adrenal vein, which connects to the inferior caval vein. Like all hemorrhages an adrenal hemorr
oy with delayed passage of meconium. On US an incidental finding of an cystic transformed adrenal hemorrhage, pr
rn boy presented with hematuria. Ultrasound showed a left renal vein thrombosis with a swollen kidney and absent
epresenting a left adrenal hemorrhage. One-month-old girl with fever and an adrenal haemorrhage on the left. Infec
percutaneous drain was placed. The lesion resolved slowly.
Splenic cyst:
Splenic cysts can be congenital or acquired, mostly posttraumatic. Congenital cysts are also named epithelial or epid
er trauma or after infection. They can be anechoic or contain debris. In smaller cysts the diagnosis is straightforward
origin. Multiple cysts can be seen in lymphangiomatosis. A 16-year-old girl underwent imaging for an ovarian tumor
seen. It is stable over the last four years.
Hematoma:
Duodenal hematoma can cause complete obstruction of the duodenum. Hematomas in the abdomen are generally
hoic or anechoic and can present as a cystic mass. An adequate history will lead to the correct diagnosis.
Duodenal hematoma:
A seven-year-old boy started vomiting a few hours after a duodenoscopy with biopsy. Ultrasound demonstrated a ec
toma. After 6 weeks an anechoic lesion with some septa is seen Fifteen-year-old girl with anorexia nervosa and signs
echogenic cystic lesion below the pancreas against the duodenal wall. It looked like a hematoma. At further history t
Teratoma:
Do not mistake a mirror artefact of the bladder for a cystic teratoma!!
Sacrococcygeal teratoma:
A sacrococcygeal teratoma is composed of solid tissue, cysts and calcifications. They are often detected at prenatal u
umours can escape detection at birth and present later with constipation. The alpha-fetoprotein level will be elevate
be confirmed on ultrasound. An MRI is often made to document the exact extension of the tumor, especially to depi
s well in newborns and infants. Two-year-old girl with a sacral mass. On ultrasound a cystic lesion anterior to the sac
. It was completely resected. The intraspinal extension was visible on ultrasound, but MRI provides a better overview
a presacral cystic mass. Newborn girl with a sacrococcygeal teratoma with external and internal solid and cystic part
Teratoma of the gastric wall:
Teratomas can be present in other locations than the ovary or the sacrococcyx. They will consist of cystic, solid and/o
sing, as is their organ of origin. MRI is important here. For-month-old boy with a large mass in the abdomen. Ultraso
rom the solid abdominal organs. MRI demonstrates the party cystic and partly solid mass. At operation a benign tera
Pancreatic pseudocyst:
A pancreatic pseudocyst is a fluid collection with a fibrous wall. It can occur after trauma to the pancreas or after par
especially used in leukemia treatment. In older girls cystic tumors of the pancreas can occur. The most common is a
esion of the pancreatic tail. After excision pathologic examination showed a solid pseudopapillary tumor.
Urachal cyst:
The urachus is a connection between the primitive bladder and the umbilical cord. If it does not obliterate several re
to escape through the umbilicus. The most common remnant is a diverticulum on top of the bladder. It is also possib
the urachus. Nine-year-old boy with right lower abdominal pain since 3 days. The boy was suspected to suffer from a

cyst above the bladder. After antibiotic treatment the lesion was excised. Pathologic examination showed a urotheli
None:

Stress fractures:
Most common sites of stress fractures
From the Radiology Department of the Academical Medical Centre, Amsterdam and the Rijnland Hospital, Leiderdor
Publicationdate 2007-05-23 One of the most common injuries in sports is the stress fracture. In this review we will di
Location:
A stress fracture is an overuse injury. Bone is constantly attempting to remodel and repair itself, especially when ext
the bone, it causes an imbalance between osteoclastic and osteblastic activity and a stress fracture may appear. Mus
tures. For every mile a runner runs, more than 110 tons of force must be absorbed by the legs. Bones are not made
ck absorbers. As muscles become tired and stop absorbing, all forces are transferred to the bones. Stress fractures u
taken place. Especially professional or recreational athletes and militairy
recruits are subject to change in training intensity (increased), type of
training or training circumstances (new shoes, other training surface etc.)
and thus at increased risk of developing a stress fracture. However,
sedentary people may also develop stress fractures if suddenly an active
lifestyle is adopted. Insidious onset of pain and swelling over the affected region is the most important complaint, in
last after the training, eventually causing the athlete to stop exercising. Finally pain is experienced at rest. Stress frac
lower extremity, especially the lower leg and the foot (Figure). Typical stress fracture of the distal shaft of the second
ormation is seen at 4 weeks follow up.
Radiography:
Radiographs have a sensitivity of 15-35% for detecting stress fractures on initial examinations, increasing to 30-70% a
ogists should not be comforted by negative radiographs and should initiate further state of the art imaging. Radiogra
overt fractures and to rule out other diseases,
like infections or tumours. On the left a 42-year old female who walks long
distances and has been experiencing forefoot pain for a month. On the initial radiograph no fracture is seen. After 4
the site of the stress fracture. Stress fracture: Normal radiograph, while STIR image already shows a high signal inte
recent onset of pain over a region of the 2nd metatarsal bone. At presentation, the radiograph was negative for frac
ion Recovery)sequence showed a high signal intensity of
bone marrow and the surrounding soft tissue,
indicating bone marrow edema as a result of a
stress fracture. Stress fractures radiographically show the following signs:
MRI:
MRI has surpassed bone scintigraphy as the imaging tool for stress fractures, showing equal sensitivity (100%) but a
etail and more precisely depicting the tissues involved. Radiograph, STIR and T1WI of grade 3 stress fracture of 3rd m
WI) and T2-weighted images (T2WI) are used for characterization and grading. Grading is based on signs seen at MRI
ecent onset of forefoot pain, persisting after training. At presentation MRI showed a high signal on the STIR- and a
low signal on T1WI (i.e. grade 3 stress
fracture). Grade 4 stress fracture of the navicular bone. T1WI and CT (axial image and coronal reconstruction) On the
highest league of amateur football. He suffered from midfoot pain with a recent increase in
complaints. T1WI shows a definite fracture line in the navicular bone, indicating a grade 4 stress fracture. Correspon
and coronal reconstructions.
Femoral neck fractures:
Stress fracture of the femoral neck located on the compression side. There are two types of stress fractures of the fe
due to tension exerted on the fracture
elements.
These fractures are at risk for complete fracture and avascular necrosis. If conservative therapy fails, open reduction
mpression fracture of the femoral neck. The radiograph is normal, but MR depicts the fracture and bone marrow ed
ograph made one month later shows evolvement to
complete fracture. Although this is a low-risk fracture, the follow-up radiographs at 3 and 13 months did show poor h
Fractures of Tibia and Fibula:
Stress fracture on the medial side of the proximal tibia in a 42-year old runner. Courtesy Dr Wuisman (3)
Tibia:
The tibia is the most common location of stress fractures (more than 50%). On the left a 42-year old man with pain in
running competition. The initial x-ray was reported as normal, but a T2-weigthed gradient echo of the knee shows bo
stress fracture. In retrospect, the sclerotic line on the x-ray also indicates the stress-fracture. X-ray and CT-scan show
gus muscle. Courtesy Dr Wuisman (3) On the left a 24-year old runner with pain in his lower leg since four months. In
was present even in rest. The x-ray was initially reported as normal. A bone-scan (not shown) showed a focal increas
on and revealed a vertically oriented fissure at the insertion of the flexor digitorum longus muscle. The patient was t

followed by a gradual increase in training-activity. Stress fracture of the lower tibia. On the left a 50-year old male, wh
ing contest without any training beforehand. Gradually pain developed in the lower leg and in
the end he was unable to walk any further. The x-rays show a stress fracture of the lower tibia. Doing too much too s
ss fracture: Initial coronal STIR image and CT at 11 months follow-up. On the left a 25-year old professional soccer pl
s on coronal STIR
sequence MRI was seen, but there was doubt about
the presence of a fracture line. At 11 months follow-up a clear fracture line is visualized by CT. Post operative radiogr
lower leg cast at 12 months. It shows a just discernable fracture line at the
typical location: the junction of the tibial plafond
and inner vertical line of the medial malleolus Bilateral stress fracture of the distal fibula: Initial radiographs and Bon
Fibula:
Fibular fractures account for 10% of stress fractures. Stress fractures of the fibula typically occur in the distal one-thi
ankles, more pronounced on the left than on the right. Radiographs made at presentation were unremarkable. Bone
a on both sides. The radiograph at 6 weeks follow-up (not shown) confirmed bilateral stress fractures with healing te
Fractures of the Foot:
Grade 3 stress fracture of the tarsal navicular bone.
Tarsal bones:
The navicular bone is the most common site for stress fractures of the tarsus. On the left a 16-year old male athlete
midfoot pain during training,
lasting for several hours afterwards. There is high signal intensity in the navicular bone on the sagittal STIR-image. O
te fracture line. Stress fracture of 4th metatarsal: Radiograph at presentation and at 3 weeks follow up.
Metatarsal bones:
The metatarsal bones are common sites for stress fracures (25% of stress fractures). On the left a 15-year old female
n with walking. The radiograph taken at presentation is unremarkable. Follow-up at 3 weeks shows complete fractur
action Stress fracture of 2th metatarsal: Radiograph at presentation and at 1 and 3 months follow up. On the left a 3
holiday.
The radiograph at presentation is normal. At 1 and 3 months follow-up, clear healing tendencies can be seen, indicat
of great toe: sagittal STIR and axial CT.
Sesamoid bones:
Sesamoid bones are uncommon sites for stress fractures. On the left a 14-year old male soccer player with persister
the
great toe is indicated by a high signal intensity
on an MR sagittal STIR-sequence at
presentation. A CT performed at presentation shows sclerosis of the medial sesamoid and confirms the diagnosis of
High and low risk stress fractures:
Stress fractures can be divided into high and low risk stress fractures according to their likelihood of uncomplicated
ow Risk fracture sites: 2nd + 3rd metatarsal Fredericson M, Bergman AG, Hoffman KL, Dillingham MS. Tibial stress re
hy with a new magnetic resonance imaging grading system. Am J Sports Med 1995; 23:472-481 by J.L.Bron, G.B.van S
eeskd. 2007;151:621-6
4. Stress fractures in the lower extremity. The importance of increasing awareness amongst radiologists. Berger, FH,
), 16-26.
Cervical Cancer - MR staging:
Stephanie Nougaret[1], Doenja Lambregts[2] and Annemarie Bruining[2]
[1] Dept. of Radiology, Montpellier Cancer Centre, France and [2] the Netherlands Cancer Institute, Amsterdam:
Publicationdate 5-10-2023 In
this article we describe the role of MRI for the local staging of cervical
cancer. In
addition to clinical and pathological examination, MRI has an important role in
identifying patients with advanced disease and thereby to guide treatment
planning.
It also aids in selecting patients eligible for fertility-preserving
strategies.
MRI is also important to monitor treatment response and to detect
recurrent disease during post-treatment follow up. We will discuss: Overview
of current FIGO staging Introduction
Introduction:
Cervical cancer represents the fifth most common cancer type
in women and - together with endometrium cancer - accounts for 0,7% of all
cancer related deaths in the world (1,2).
Persistent human papilloma virus infection is the key risk

factor responsible for nearly all cervical cancers.
HIV infection is a second
known risk factor, which increases the risk for cervical cancer by
approximately six-fold.
Most common types of cervical cancer are squamous cell
carcinoma followed by adenocarcinoma and some rare other types such as
neuroendocrine tumors. Cervical cancer can be effectively prevented by vaccination
against HPV. Secondary prevention includes HPV DNA testing to screen for
active infection and prompt treatment of cervical pre-cancer.
The primary
treatment for advanced cervical cancer (stage ≥ IB) is chemoradiotherapy (CRT)
followed by brachytherapy.
In the vast majority of cases, this results in a complete
local tumor response and no further surgical intervention is needed.
In the
minority of cases with persistent tumor after completion of CRT, addition surgical
resection is required. Early cases are treated with conservative surgery. The key risk factors in cervical cancer to asse
tumor size, invasion into parametrium, pelvic side wall, vagina, bladder or
rectum, and lymph node involvement. Like the uterus, the cervix shows distinct layers on T2W MRI. The cervical muc
The normal cervical stroma
has a low signal with an intact outer border.
The external cervical os is
the opening between the cervix and vagina.
The internal cervical os is the opening
between the cervix and the uterine cavity. The zonal MRI anatomy of the uterus and cervix varies with age.
During the reproductive age the different layers of the uterus and cervix are well recognizable and the muscular part
year-old woman (left image).
There is an IUD in the uterine cavity, which can be recognized as a hypointense linear structure. In postmenopausal w
visible and the cervical stroma, junctional zone and myometrium appear more
homogeneously hypointense on T2W-images, like in this 70-year-old woman (right
image). With age, the female reproductive organs gradually become
smaller with a more pronounced loss in volume for the uterus compared to the
cervix.
Staging Cervical Cancer:

MR reporting checklist:
The MRI report in cervical cancer should address the key risk
factors used to stage the patient as listed in the table in order to determine
the most appropriate treatment strategy. Additional factors to report, that are mainly used for
surgical treatment planning: This schematic overview shows how the key risk factors that should be assessed on MR
ng.
Tumor type and size:
The tumor size should be measured in the longest possible
dimension, which is often best visualized in the sagittal and sometimes in the
coronal plane. Cervical tumors can show either an exophytic (typically in
younger women), diffuse infiltrative or endocervical (typically in older women
and/or adenocarcinomas) growth pattern.
Note that in the right image where
there is an endocervical mass, this mass causes obstruction of the cervical
canal with widening of the uterine cavity which is filled with high signal
fluid and intermediate signal blood resulting in a blood-fluid line.
Vaginal invasion:
Invasion of the vaginal wall can be recognized on T2-weighted
MRI as the extension of relatively hyperintense soft tissue extending into the
vaginal wall. In case of vaginal invasion you need to establish whether
this concerns the upper 2/3 (stage IIA) or lower 1/3 (stage III) of the vagina, as this impact patient management.
Stage IIA1/IIA2 may be eligible for upfront surgery.
In contrast lower vaginal involvement preclude surgery and patients are referred for chemoradiation.
Parametrial invasion:
When the hypointense stromal ring of the cervix is intact

(left image), MRI can predict the absence of parametrial invasion with a high
negative predictive value of more than 90%. Interruption of the hypointense stromal ring of the cervix (right
image) and tumoral signal intensity or soft tissue mass extending into the
parametrium are signs indicative of parametrial invasion (FIGO stage IIB). Pitfall
- Expansion versus invasion This example shows a large tumor that expands the cervix. Note that there is no actual i
hypointense stromal ring of the cervix is completely intact as indicated by the
arrowheads.
Pelvic sidewall invasion:
Pelvic sidewall
invasion is defined as invasion or tumor abutment within < 3 mm of the
internal obturator, levator ani or piriformis muscles, or the iliac vessels,
either with or without obstruction of the ureter resulting in hydronephrosis (stage IIIB).
Sacrouterine ligament invasion:
This sagittal MRI shows a locally advanced cervical cancer (circle) with extensive invasion along
the sacrouterine ligaments (arrows).
Bladder and rectal invasion:
The case on the
left shows a cervical tumor with clear invasion of the dorsal bladder wall
extending into the bladder lumen.
This represents stage IV disease. Pitfall
- Invasion versus bullous edema The image shows a cervical tumor invading the upper 1/3 of
the vagina. There is a hyperintense layered appearance of the bladder
wall (arrows) consistent with bullous edema. There is no intermediate T2-weighted signal intensity or
nodularity within the bladder, suggesting that there is no actual tumor
invasion into the bladder.
Lymph node staging:
The regional lymph nodes in staging cervical cancer include all lymph nodes in the pelvis and para-aortic nodes up to
It is important to detect para-aortic lymph node metastases, as presence of these nodes requires adaptation of the r
ve the level of the renal veins are considered distant metastases. MRI has a
limited diagnostic performance for pelvic lymph node staging.
It mainly
relies on nodal size as a criterion; size cut-offs vary in literature but a
commonly used threshold is 1 cm.
Reported sensitivities (±40-90%) and
specificities (±80-100%) for MRI vary widely.
PET/CT is more accurate than MRI
and is used for pelvic lymph node staging, as well as for the assessment of
para-aortic lymph nodes and distant lymph node metastases above the level
of the renal veins (3). Images
There is a locally
advanced cervical cancer with right-sided parametrial and pelvic sidewall
involvement.
There is a 7 mm node dorsal to the right external iliac
vein (white arrow) which is indeterminate on MRI.
Based on its size it is not
clearly pathologic.
On corresponding
PET/CT the primary tumor is clearly FDG-avid, as is the small para-iliac lymph
node (black arrow), thereby diagnosing it as N+.
MR protocol:
The recommended MRI protocol is summarized in the table. Addional
recommendations are as follows: Patient
preparation: Note that contrast-enhanced images are not required for
cervical cancer staging.
Scheduling the examination according to the menstrual
cycle is not required.
Sequence planning:
The MR sequences are planned relative to
the long axis of the cervical canal.
The axial plane is perpendicular to the long axis of the cervical canal. The coronal plane is parallel to the long axis of

Pitfall: variations in cervical anatomy:
The
position of the cervical canal needs to be taken into account and the perpendicular and parallel MRI
sequences need to be planned accordingly. Example showing
how flexion, and in particular version impact sequence planning.
In this case
there is anteversion of the cervix and retroflexion of the uterus.
Remember that in
cervical cancer, the axial sequences are planned perpendicular to the cervical
canal. Another
example showing the cervix in retroversion and the uterus in anteflexion.
See how
this variation in position impacts corresponding sequence planning.
Fertility preservation:
Fertility preserving surgery (trachelectomy) can be offered
in selected patients with early stage cervical cancer, based on the criteria
shown in the Table. Example showing how to assess the distance to internal
cervical os The image shows an exophytic cervical tumor. The distance from the tumor to the internal os measured a
the stalk of the lesion is > 1cm. The patient was eligible to trachelectomy.
FIGO stage:
The International
Federation of Gynaecology and Obstretrics (FIGO) staging system that is most
commonly used to stage cervical cancer was traditionally designed as a clinical surgical staging system.
However, current evidence and clinical guidelines
recommend to include imaging findings (in particular MRI) for staging and
treatment planning as it provides crucial information on tumor size and depth,
extent of invasion into surrounding organs and structures, and lymph node
status, which are essential in choosing the most appropriate treatment
strategy.
An overview of the current 2023 FIGO stages for cervical cancer is
provided in this Table.We refer readers to the complete FIGO guidelines for more detailed
info (4).
Response assessment:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. CA Cancer J Clin. 2021;71(3):209-49.
2. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2022. CA Cancer J Clin. 2022 Jan;72(1):7-33. doi: 10.3322/c
3. Clinical evidence on PET-CT for radiation therapy planning in cervix and endometrial cancers. Haie-Meder C, et al.
4. Staging, recurrence and follow-up of uterine cervical cancer using MRI: Updated Guidelines of the European Societ
a Manganaro , Yulia Lakhman , Nishat Bharwani, Benedetta Gui, Silvia Gigli , Valeria Vinci, Stefania Rizzo, Aki Kido, Ter
Forstner , Stephanie Nougaret. PMID: 33852049 DOI: 10.1007/s00330-020-07632-9
MRI examination of the Elbow:
by Mark Anderson
University of Virginia Health Sciences Center:
Publicationdate 2013-10-05 This review is dased on a presentation given by Mark Anderson and adapted for the Rad
pathology. MRI technique
MRI technique:

Scan planes:
Just like in the shoulder you need to be sure to get the imaging planes correctly in a standardized way. Use the axis o
n. The sagittal images are scaned perpendicular to the coronal scan. In this way you get very persistent images and y
Imaging sequences:
T1In every joint that is studied you should have at least one T1-sequence not only to look at the anatomy, but also as
ages will show marrow abnormalities, but T1 can be helpful in telling us what is really going on. T1 is certainly used in
logy, whether it is in the bone marrow, ligaments or muscle because of the high water content. It can also be used to
thin sections to image the cartilage and the ligaments. In the MR-protocol we do T1 and T2-fatsat in all three imaging
MR-arthrography:
Typically the radiocapitellar joint is punctured from lateral with the patient prone and the arm flexed 90 degrees ove
you are interested in the lateral ligaments and you inject lidocaine or contrast into these ligaments. So more recentl
fossa (blue arrow). Diluted gadolinium is injected, i.e. 0,05cc + 10cc saline (an "off-label" use in the US). Indications fo

Anatomy and Pitfalls:
When you study the anatomy of the elbow, it is good to use the inside-out approach. First study the bones and then
ng structures.
Tendon attachments:
Common flexor tendon Attaches at the medial epicondyle Ulnar collateral ligament or UCL Starts at the undersurfac
ich is the medial side of the coronoid process. Common extensor tendon Originates at the lateral epicondyle. Latera
the common extensor tendon. Lateral ulnar collateral ligament This is a somewhat confusing term for a tendon that
ngs down behind the radial head and attaches at the area of the ulna that is called the supinator crest - see lateral vi
is tendon Attaches on the coronoid process. Annular ligament Attaches on the volar side of the sigmoid notch of the
ide of the sigmoid notch.
Pseudodefect of the capitellum:
This is a finding that you frequently see on coronal images. It looks like an osteochondral lesion, but if you look at th
through the posterior non-articular portion of the capitellum. So when the elbow is fully extended, a portion of the r
pitellum. On a coronal view we will be looking at the radial head which is covered with cartilage and opposite to it th
ly is somewhat irregular.
Pseudo-loose body:
Another common finding is a small piece of fat that you'll see on the sagittal image, that looks like a small loose body
he articular surface of the olecranon. Typically the olecranon has two pieces of cartilage with a small area inbetween
Plica:
This structure on the lateral side of the joint is sometimes seen and is a plica. It can be prominent and almost look lik
thickened or irregular and it may be a cause of symptoms.
Elbow Mechanics:
The elbow serves as a hinge joint when we look at the humeroulnar and radiocapitellar joint. The other joint is the pr
pination. Many acute and chronic injuries occur as a result of throwing. During the throwing motion in the phase of l
that are pulling the elbow. The valgus overload results in enormous tension on the medial side trying to pull things a
ression (blue arrows). On the posterior side it causes shear forces along the head of the olecranon (black arrow).
Valgus overload syndrome:
All these forces make up what is called the "valgus overload syndrome" with very characteristic injuries to the elbow
gus overload there are shear forces on the posteromedial part of the humeroulnar joint. Notice the subchondral scle
subchondral bone marrow edema and cartilage loss (yellow arrow). Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll These are images of a 20 year old baseball pitcher. Scroll through the images. On the coronal images t
there is osteophyte formation on the medial part of the joint (red arrow). As we go further posteriorly there is a sma
lsion of part of the UCL. This is better appreciated on the radiograph. Continue with the axial scan. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll As we look on the axial scan, we can appreciate the huge osteophyte formation. Notice that the ulnar n
s may present with ulnar neuropathy.
Posterolateral Rotatory instability:
There are different stages of instability of the elbow joint and the final stage is dislocation. In stage 1 there is subluxa
r collateral ligament. In stage 2 there is more injury, where the coronoid perches the trochlea and there is more ligam
the humerus in a true dislocation and you may tear the ulnar collateral ligament, which results in a very unstable - fl
Elbow dislocation:
Here a lateral view of the elbow of a patient who fell on the outstretched arm. The radiograph shows joint effusion (r
h the MR-images. Now here is the MR. Study the images and then continue reading... Coronal view: Sagittal view: All
in the article of Zehava Rosenberg in AJR 2008 entitled: MRI Features of Posterior Capitellar Impaction Injuries These
d hand two weeks ago while skateboarding. On physical exam there was decreased range of motion of the elbow an
tinue reading... What is the structure on the axial image behind the radial head? Sagittal view: The structure behind t
ickened as a result of the posterior dislocation.
Osteochondral lesions:

OC lesion of capitellum:
Osteochondral lesion is the new name for osteochondritis dissecans or OCD. The chronic valgus overload can cause
result of repetitive impaction and shear forces. The radiograph is of a 15 year old baseball player with 4 year history
al lucency in the capitellum and some fragmntation. This is typical for a osteochondral lesion of the capitellum and th
h the MR... The MR-arthrogram confirms the osteochondral lesion. There is gadolinium in between the humerus and
don't have gadolinium, look for joint fluid undercutting the fragment. There is a loose body in the posterior recess of
een on the axial image. The osteochondral lesion of the capitellum is typically seen in throwers and gymnasts (11-15
aring. Here another case in a 20 year old gymnast. Again there is lucency on the radiograph. The MR-arthrogram sho
ge shows subchondral bone abnormality, but not much of a fragment. There is some cartilage thinning, but not a de
dies. These images are of a young baseball player, who presented with elbow pain at age 14. The T2W-fatsat image s

sly someone told him to keep throwing, because he came back three years later at age 17 and you can see what can
fessional. The T1W-image shows fragmentation (yellow arrow) with a loose body (red arrow). The T2W-image demon
een the fragment and the humerus. At arthroscopy there is depression and irregularity of the cartilage of the capitel
ATS-procedure is performed, which we will discuss now.
OATS procedure:
OATS stands for osteochondral autologous transfer. Pieces of cartilage and bone are taken out of some other non-w
t the cartilage is taken from the non-weight bearing part of the knee. Then holes are drilled in the capitellum and the
re the hole in the capitellum is filled with four pieces of bone and cartilage. The radial head is seen opposite the capi
OC lesion of trochlea:
These images are of a patient with anterior elbow pain. There was no recent injury. The clinical diagnosis was a bicep
al MR-images are quite uncommon. If you would see this in the capitellum you would call it an osteochondral lesion
e trochlea. Notice the small cystic changes (white arrow). There is also a small cartilage defect. An osteochondral lesi
ave an immature skeleton. It is seen in the lateral trochlea like in this case due to repetitive hyperextension in an are
rochlea due to laxity and posteromedial abutment. Here a different patient. Notice that it is a young patient, because
n in the lateral trochlea (yellow arrows). Notice the edema in the subchondral bone (red arrow). The cartilage is still i
Ulnar Collateral Ligament:
The ulnar collateral ligament (UCL) is situated on the medial side and it has three components. The anterior bundle i
algus forces. On MR this is the most important structure. The posterior bundle attaches distally in a fan-shape on the
verse bundle runs from the olecranon to the olecranon, so it doesn't do much. The UCL (in yellow) originates on the
the common flexor tendon. It attaches on a small process on the medial side of the coronoid, which is called the sub
Disable Scroll Enable Scroll
Disable Scroll Always use the axial images when you study the ligaments, especially the UCL. Scroll through the imag
t is normal to see some high signal in the proximal part (arrow). Notice how it firmly attaches to the sublime tubercle
UCL tear:
Remember that the UCL should attach very tightly on the sublime tubercle. In this case it doesn't, so even on these t
t there is some marrow edema in the sublime tubercle. The mechanism of injury to the UCL is usually chronic tensile
er overhead throwing-athletes. A tear can also occur in a fall on the outstretched hand. Most commonly there is a co
ery hard to see. That is why in these athletes MR-arthrogram is usually performed. Study the images and then contin
lbow pain. A partial tear is seen creating a 'T-sign'. First study the coronal T2-fatsat images and then continue reading
aches to the sublime tubercle (yellow arrow). On the next two images there is some soft tissue edema and more abn
posterior bundle. Now you remember that the axial images can be helpful. So continue with the axial image. On the
There is only some edema next to it. However the posterior bundle is not o.k. This is partial tearing. We see this occa
ntact and their elbow is not unstable. They somehow have torn their posterior bundle, which causes pain. They do n
te a while. Now here is the last case. This is a 38 year old male who has been weight-lifting for 20 years. He complain
is abnormal with some areas of very high signal indicating a partial tear. On the lateral side there is subchondral ede
instability due to the chronic partial tearing.
UCL repair:
UCL repair is done by placing tunnels in the medial epicondyle. They run done to the sublime tubercle and a graft is
essional baseball player who had a UCL reconstruction. Notice the tunnels (arrow). This operation usually works very
Disable Scroll Enable Scroll
Disable Scroll If you scroll through the MR-images you can see the tunnel in the medial epicondyle. Just like in an ACL
y down. On the coronal images despite the spiky artifacts it almost looks like a normal UCL. Here we see images of a
ion of the bone and disruption of the graft. On the CT-scan it is better appreciated that there is a fracture through th
Lateral Collateral Ligament:
Here an illustration of the lateral collateral ligament complex. It consists of the radial collateral, the lateral ulnar colla
adial collateral ligament, first try to identify the common extensor tendon, because right underneath it you will find t
posteriorly you will see the LUCL - the lateral ulnar collateral ligament, which sweeps behind the radial head (white a
iate from the RCL, but sometimes it can be identified on a sagittal MR-artrogram. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through these images. You can also enlarge them.
Common Extensor Tendon:
The common extensor tendon originates at the lateral epicondyle. On a T1W-images the tendon should have a low s
Lateral Epicondylitis:
Lateral epicondylitis is also known as the tennis elbow, although in 95% of cases it is seen in non-tennis players. It is
results in partial tearing and tendinosis. Typically, the extensor carpi radialis brevis is the component that is involved
ives a poor response to conservative treatment. Here a typical case. There is thickening and abnormal intrinsic signa
Common Flexor Tendon:
The common flexor tendon originates at the medial epicondyle. On a T1W-images the tendon should have a low sign
Medial Epicondylitis:
This is the counterpart of the lateral epicondylitis and also known as the golfer's elbow. Here the common flexor ten

ly partial tearing. However this can be quite painful. Here we have the coronal T1W- and T2W-images. There is partia
Little Leaguer's Elbow:
First study the images of a patient with pain on the medial side, then continue reading... The findings are very subtle
steopenic. In these cases we usually ask for a comparison view, because it can be very subtle. The diagnosis is a Littl
e lucency on the radiograph, which looks like a widened physis, is due to cartilage ingrowth in the metaphysis. Contin
ere is marrow edema in the medial epicondyle and also in the adjacent bone (yellow arrow). Little Leaguer's elbow is
. By the way this could also be called a Salter-Harris type I fracture, if it was an acute traumatic event. Notice the norm
weak link in valgus stress is not the ulnar collateral ligament but the physis. Here another case. This patient is a little
he right the physis is still a little bit open. Continue with the MR... On the MR there is marrow edema. Notice that the
aches, so there is also some tearing of the UCL. Here some more views of a different patient.
Biceps tendon:
Enable Scroll
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Disable Scroll Scroll through the axial images of the biceps tendon from the musculotendinous junction to the attach
s tendon is much like pathology in the achilles tendon. There can be tendinosis, partial tear and complete tear with c
ar old male who experienced a sudden pain and a tearing sensation when lifting a box. There was pain with pronatio
int. No ecchymosis or palpable mass. On the sagittal image the tendon is thickened, but distally the tendon is lost. M
to figure out if the tendon is retracted and whether there is a partial or complete tear... Well on the sagittal image it
ith the next images.
Tear of distal biceps tendon:
There is a complete tear, because if we follow the tendon all the way to the radial tuberosity, we can see that the ten
The reason why the tendon is not retracted is because the broad bicipital aponeurosis - also known as lacertus fibro
nly inserts to the radial tuberosity, but also via the lacertus fibrosus into the fascia of the flexor pronator mass on th
ps is encircled on the upper left image. When the aponeurosis is also thorn, then the tendon retracts and you get an
le. A distal biceps tendon tear is an uncommon injury. It is seen in about 5% of biceps injuries. It is the result of a suc
proximal biceps tendon tear is more common. Usually it is the long head of the biceps that is completely torn. Here
ome intermediate signal. This could be tendinosis, but always look at the T2W-images to look for a tear. In this case t
ges we were not sure about a possible tear. Maybe there only was some tendinosis or tendinitis. The axial images de
that your axial scan goes all the way to the tuberosity, because is you stop too early, like in this case, then you will or
sure about a possible tear. Here an easy case, because the tendon is retracted as can be best seen on the sagittal im
Radiobicipital bursitis:
Here are sagittal and axial images of a patient who was referred to an orthopedic oncology surgeon for a mass near
ut the question is, what is the structure that we are looking at and what is within it. The structure is the radiobicipital
ndon does not have a tendon sheaht, so tenosynovitis is not a possibility. The differential diagnosis for the low inten
PVNS and rice bodies. It turned out to be rice bodies. In any synovial lined joint or bursa these rice bodies can be for
ophy. The villi will outgrow their blood supply, become necrotic and fall into the joint or bursa. They are called rice bo
e rice. Here another case. The white arrow in the left sided image is pointing to the bursa. Notice that the biceps is in
an interosseous bursa (red arrow) was described by Abdalla Skaf in Radiology in the article entitled: Bicipitoradial Bu
mor or they can cause impingement on the radial nerve when they become very large.
Brachialis tendon:
The brachialis originates from the lower half of the front of the humerus, near the insertion of the deltoid muscle. It
assists the biceps in flexing the elbow. The thick tendon inserts on the anterior surface of the coronoid process of th
ndon (yellow arrows) with the biceps tendon (red arrows), notice that the brachialis is almost all muscle. It only has a
Chronic avulsion:
This image is of a 68 year old woman who injured her arm approximately 10 years previously and now presents with
tinue with the MR... First study these axial T1W-images and then continue reading... Radiograph The cortex of the ul
nderlying bone abnormality like for instance a bone tumor. MRI The biceps tendon is indicated by the red arrow and
at the insertion of the brachialis tendon on the coronoid process, there is tearing of the tendon with a lot of bone ma
is was a chronic type of avulsion injury with partial tearing of the tendon. The bone reaction can mimic an aggressive
he oncologic surgeon, because there was concern about a possible juxta-cortical osteosarcoma. The MR however rev
nts, but may also be seen in older patients. The problem is that they may mimic infection or tumor.
Nerves:
Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images.
Ulnar nerve:
Here we see the ulnar nerve within the cubital tunnel. The posterior band of the ulnar collateral band forms the floo
dy the images. This patient had ulnar nerve neuropathy. What is the cause? Cubital tunnel syndrome is a common p
ithin the cubital tunnel, where the nerve passes beneath the cubital tunnel retinaculum. Possible causes of cubital tu
s article by Gustav Andreisek et al entitled: Peripheral neuropathies of the median, radial and ulnar nerves: MR imag

able cause... The ulnar nerve is not where it is supposed to be. Now the nerve could be dislocated, but in this case th
s performed in patients in whom the ulnar nerve is compressed against the medial epicondyle. So the question is, w
it. This can be subcutaneous, submuscular or intramuscular. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll So when we go back to the image, you will notice that it can be difficult to find the nerve. Any of these s
to do it, is to follow the structures distally until you find the ulnar nerve distally in its normal position in the proxima
ximally, you will notice that this was a subcutaneous transposition. In this case, there is neuritis. There is enlargemer
er sign is non-uniform enlargement of the fascicles, which is seen on the sagittal image (arrow).
Radial nerve:
The radial nerve can be best identified at the level of the radial head, where you can see superficial and deep branch
ce to find the radial nerve. The deep radial branches form the posterior interosseus nerve which penetrates the supi
and then continue reading. What are the findings? The findings are: So the atrophy is a result of compression of the
rve.
Median nerve:
The median nerve goes down behind the Lacertus fibrosis, which is the aponeurosis of the biceps and penetrates th
Denervation:
Nerve pathology can present as thickening of the nerve when there is neuritis or as a result of compression of the ne
a and/or atrophy of the muscle. In this case there is chronic atrophy with high sinal on T1, which is irreversible. In ea
high signal on T2W-images and that is reversible. This is a 48 year old male with Marfan's syndrome, who had a sud
te denervation. Notice on the T1W-image that there is no atrophy. Only edema on the T2W-image. This was due to p
Soft Tissue Masses:
Around the elbow all kind of soft tissue masses can occur, which are also seen in other places. If you cannot make a
psy, because in many cases you cannot tell the diagnosis. The image shows an oval lesion, which just looks like a sch
he nerve, but it turned out to be a synovial sarcoma in an 11 year old boy. Only make a diagnosis when you are sure
t or hematoma. Cat scratch disease Here a 37 year old male who presented to the emergency department with pain,
he last 3 weeks. On MR a mass was seen just above the medial epicondyle, where the epitrochlear lymph nodes live.
MR-findings you still have to call this mass indeterminate. The final diagnosis was cat scratch disease based on high
who also came with a mass in the peritrochlear region. It looks quite homogeneous and cystic. Continue with the pc
rominent internal vascularity on the sagittal ultrasound image. So this was not a cystic mass. Again this was diagnose
Here some additional images of the nerve-sheath tumor look-a-like, which turned out to be a synovial sarcoma.
Neonatal Chest X-Ray:
Joost van Schuppen, Laura Kox, Wes Onland, Robin Smithuis and Rick van Rijn
Radiology, Nuclear medicine and Neonatology department of the Amsterdam University Medical Centre:
In this review we will discuss a systematic approach to the neonatal chest radiograph.
Close collaboration between neonatologists and radiologists is the key in achieving the correct diagnosis, since the ra
dings on the chest film can be rather subtle.
Clinical information like age of the neonate, gestational age and therapy with ventilation or surfactant is vital for the
discuss a diagnostic approach based on radiographic and clinical findings and subsequently we will discuss the speci
positions, lines and catheter positions are discussed in Tubes and lines in neonates.
Introduction:
Preterm infants show different types of pathology compared to
term infants.
For example, respiratory distress syndrome (RDS) is almost
exclusively seen in preterm infants.
Meconium aspiration (MA) on the other
hand, is seen in full term or late term neonates in combination with
meconium-stained amniotic fluid during labor.
Infants born between 34 and 37 weeks of gestation can have
diseases occurring in both preterm and full-term infants. Invasive mechanical ventilation and surfactant therapy will
have a huge impact on the radiographic findings and are essential clinical information
for the radiologist. Here is a list of common pulmonary disorders in neonates
based on acute and chronic disease, complications of ventilation and congenital
anomalies (Table). * CPAM was previously referred to as congenital cystic adenomatoid malformation (CCAM) and pr
tal anomalous pulmonary venous return. The pulmonary veins do not connect to the left atrium, but enter the syste
ts by looking at the technique of the radiograph.
Then the position of lines and tubes is analyzed.
See Lines and tubes in Neonates.
After these steps, the chest film can be interpreted for pathology. This is done in a stepwise manner: The postnatal a
rs are acute conditions and some disorders at a present later stage. In addition, the course of illness and therapy so
Pattern Approach:

Chest abnormalities can be divided into: In some cases there is a combination of radiopaque and radiolucent abnorm
s challenging.
For example, pulmonary interstitial emphysema (PIE)
can be regarded as lucencies, but can also be interpreted as radiating linear radiopaque abnormalities.
Notice that a diaphragmatic hernia can be a focal radiopaque or radiolucent
Radiopaque - High Attenuation:
RDS Respiratory
distress syndrome in preterm neonates presents with low lungvolume, air
bronchograms and symmetric fine granular opacities, ranging from mild disease
to complete white out of the lungs. TTN
Transient tachypnea of the newborn is seen in full term neonates with mild respiratory distress and presents with s
al effusions. MAS
Meconium aspiration is seen in full term and late term neonates and presents with coarse bilateral densities, that ca
pping. Atelectasis Atelectasis
can be seen in tube malpositioning and as complication, e.g. in RDS and meconium aspiration.
Radiolucent - Low attenuation:
Air Leak
Most radiolucent lung abnormalities are the result of air leakage usually as a complication of positive pressure ventil
It can be the result of malpositioning of the tube with hyperinflation of one lung or in the case of atelectasis, there ca
PAM
is the most common congenital lung malformation, but is still a rare disease.
There is a microcystic and a macrocystic form. The latter presents as a
radiolucent abnormality. Often in the first hours the lesion is not containing
air yet and can present as radiopaque. Congenital diaphragmatic herniaThis is a birth defect of the diaphragm and c
The herniation of abdominal organs into the chest results in underdevelopment of the lung.
Respiratory Distress Syndrome (RDS):
RDS is also known as hyaline membrane disease (HMD), idiopathic respiratory distress syndrome (IRDS) and surfacta
It is a result of deficiency of surfactant due to
immaturity of the lungs in preterm infants. Surfactant production starts between 24 to 28 week of gestational age. T
t birth. It ranges from 50% in newborns at 26-28 weeks gestation and decreases to 25% in newborns at 30-31 weeks.
ain air and cause diffuse bilateral micro-atelectasis, in combination with fibrin and cellular debris due to alveolar dar
s the newborn to expand the lungs properly. Endogenous production of surfactant will begin at approximately 36 - 7
, the diagnosis of RDS is restricted to the first week of life. Imaging Imaging findings are often most
severe at birth, but may peak at 12- 24 hours after birth.
In many preterm neonates improvements
in treatment, including antenatal glucocorticoid administration, surfactant
replacement therapy and better ventilatory strategies have decreased the
prevalence of RDS.
When prolonged
mechanical ventilation is necessary, this increases the risk of lung injury and air
leak and can evolve into chronic lung disease. 33 weeks + 5 weeks gestational age, day one.
First look at the image.
What are the findings? Findings: This is a typical case of RDS. 29 weeks + 1, day one. CPAP.
First look at the image.
What are the findings? Findings: This is a severe case of RDS.
The differential diagnosis
includes pulmonary infection due to the asymmetric consolidation.
Grading:
Grading of RDS can be
performed but is not used when the patient is on invasive mechanical ventilation
support. There are 4 grades of staging RDS. As the lungs cannot expand
properly in RDS, hyperinflation in a preterm infant without mechanical
ventilation makes the diagnosis of RDS highly unlikely. Image
One day old neonate, 27 weeks of gestational age.
Granular opacification of both lungs.
Vessels and cardiac silhouette are well depicted. Conclusion: RDS grade 1. Peripherally inserted central catheter(PIC
back to the level of the superior vena cava and right atrium. One day old neonate, 29
weeks of gestational age. Image Conclusion: RDS grade 2. One day old neonate, 26 weeks of gestational age. Image C
neonate, born at 27 weeks of gestational age. Image No grading because this neonate is on mechanical ventilation. F
Treatment:

Preventive treatment of RDS consists of antenatal
corticosteroid administration in women at risk for preterm
delivery. After birth, RDS may require treatment with exogenous
surfactant.
If the infant is supported with ventilation, surfactant is administered intra-tracheally
as a liquid bolus. The clinical and radiological result of this treatment can often
be seen shortly after the administration of the surfactant.
The surfactant is often not evenly distributed, which can lead to more patchy aeration of the lung parenchyma.
Differentiation from other entities such as neonatal pneumonia
can be difficult. ImageOne day old boy, gestational age 25 weeks and 5 days.
Transient Tachypnea of the Newborn (TTN):
Transient Tachypnea of the Newborn (TTN) is also known as wet
lung or retained fetal lung liquid. TTN is a diffuse lung
disorder that results from delayed clearance of fetal lung fluid after birth,
leading to relative surfactant efficacy.
It is seen more frequently – but not
exclusively – in full term neonates after cesarean delivery.
Delayed clearance of fetal
lung fluid causes transient respiratory distress that improves within 48–72
hours after birth. Imaging In many cases the clinical
presentation is mild and there is no need for a chest radiograph. Only in some cases a chest
x-ray is performed to rule out complications.
The imaging findings may be
similar to those of RDS, showing diffuse granular opacities, or of pneumonia
with more coarse opacities. Full term infant, 2 hours after elective caesarean section with some respiratory distress.
supportive therapy the respiratory distress disappeared the next day. Image of a neonate with gestational age of 41
No need for ventilatory
support. Image Clinical follow up was uneventful 41 Weeks neonate. 24 hours old.
Respiratory distress, no
ventilatory support Image Spontaneous improvement within 48 hours.
Meconium Aspiration:
Meconium aspiration results in diffuse pulmonary
disease and it is the most common cause of significant morbidity and mortality
among full-term and post-term neonates. When intra-uterine hypoxia occurs, usually during labor, this
can lead to the fetus prenatally excreting meconium.
Inhalation of the meconium containing amniotic fluid results in a
chemical bronchiolitis with obstruction of the smaller airways
and surfactant dysfunction resulting in air trapping and
atelectasis.
Meconium aspiration can impede the transition from prenatal fetal
circulation to postnatal neonatal circulation. In 10–15% of births meconium staining of the amniotic fluid is present,
ation. The term Meconium Aspiration Syndrome is used to describe the
combination of sterile chemical pneumonitis and persistent fetal circulation or
persistent pulmonary hypertension of the newborn (PPHN).
Usually, this condition
presents within a few hours after birth. Imaging Chest film of a full term newborn with meconium stained amniotic f
d amniotic fluid. Image Conclusion: chest radiograph in
keeping with meconium aspiration. Without staining of the amniotic fluid the
differential diagnosis would include neonatal pneumonia or TTN. X-ray of a full term newborn with meconium staine
Pulmonary hemorrhage:
Pulmonary hemorrhage is uncommon in neonates. Premature neonates are most at risk.
Other associated
factors are a persistent ductus arteriosus, surfactant treatment and mechanical
ventilation. The exact etiology remains unclear.
The
radiographic signs are nonspecific and difficult to distinguish from other
disorders such as RDS.
This means that the diagnosis can only be made, when there is leakage of red blood or pink effusion from the
endotracheal tube. Supportive measurements consist of ventilator support and
sometimes xylometazoline or adrenalin, which is administered via

the tracheal tube. Mild hemorrhage can be hard to distinguish from RDS.
Massive bleedings show complete opacification of one or both lungs. Image The most likely diagnosis of this chest x-
given the clinical information of blood via the tracheal tube, the diagnosis is
pulmonary hemorrhage, possibly in combination with RDS. Image of a neonate with gestational age of 41 weeks.
After 24 hours intubated for respiratory distress.
Blood via the endotracheal tube. Image The differential
diagnosis includes pneumonia and RDS in maternal diabetes.
In case of meconium
stained amniotic fluid, mecoinum aspiration could be considered as well, but this
is often more coarse. Premature, 28 weeks of gestational age treated for RDS.
Blood via the tracheal tube. Image
Persistent ductus arteriosus:
The ductus arteriosus is
the connection between the pulmonary artery and the aorta.
Normally the ductus is open before birth and closes in term infants within
the first day after birth as arterioles feeding the wall of the ductus contract
in reaction to oxygen. Preterm infants have fewer of these arterioles and sometimes an increase in oxygen does not
in a high pulmonary blood flow.
The diagnosis usually is suspected 5 - 7 days after birth, when there is pulmonary overflow or systemic steal. Prostag
he open duct.
In some cases, surgical closure can be achieved either via a lateral
thoracotomy with a clip, or later in life via an intra-arterial approach using
a coil. ProstaglandinsIn neonates with a ductal-dependent cardiac disorder Prostaglandins can be used to keep the d
patent, which can be life-saving. Premature with previously normal chest radiographs. Image Ultrasound confirmed
w 2 month old. Treatement for RDS
Bronchopulmonary Dysplasia:
Bronchopulmonary dysplasia (BPD) also known as chronic lung
disease of the premature, is a disorder of lung injury and repair originally
ascribed to positive-pressure mechanical ventilation and oxygen toxicity.
BPD is nowadays a purely clinical diagnosis characterized by the requirement of oxygen for at least 28 days in an infa
f surfactant replacement therapy, chest
radiographs of infants with classic BPD demonstrated coarse reticular lung
opacities, cystic lucencies, and markedly disordered lung aeration that
reflected alternating regions of alveolar septal fibrosis and hyperinflated
normal lung. Nowadays after the introduction of prenatal steroids and
postnatal surfactant and more sophisticated ventilatory support, BPD is
infrequently seen in infants with a birth weight of more than 1200 grams and
over 32 weeks of gestational age. However, despite these advances in neonatal care, the
prevalence of BPD has changed little over the last decades due to the treatment
and improved survival rate of even more very preterm infants. As a result of these changes, the international criteria
the diagnosis BPD were changed from 28 days postnatal age to 36 weeks postmenstrual
age. Therefore, the term BPD should be avoided before this
postmenstrual age. Premature, born at 27 weeks of gestational age. Now 6 weeks of age.
History of intubation and mechanical airway support. ImageBilateral perihilar opacification and increased interstitial
the history, BPD is the most likely diagnosis. Premature, born at 27 weeks of gestational age. Now 8 weeks
of age. History of extensive mechanical ventilation with prolonged
need for oxygen support. ImageBilateral perihilar opacifications with a coarse interstitial pattern as a sign of chronic
combination with the radiological findings BPD is the most likely diagnosis. Premature at 28 weeks, now 7 weeks of a
Bilateral diffuse
interstitial markings, with some atelectasis on the left. Given the history in combination with the radiological findings
Atelectasis:
Complete atelectasis of the left lung Atelectasis often occurs due to malposition of tracheal
tubes, or to low positive pressure when using invasive mechanical ventilation. Failure to clear mucus or secretion can
plugging of mucus. Deficiency of surfactant can cause micro-atelectasis, leading
to diffuse atelectasis. Treatment depends on the cause of the atelectasis, such as
change of tracheal tube position, change in ventilatory support (pressure),
alternating position from side to side, or in case of surfactant deficiency, intratracheal administration of surfactant. I
left lung due to selective intubation on the right. PICC line in situ with tip
in superior vena cava. NG tube in situ. Atelectasis of the right middle lobe This preterm neonate was treated for resp
ihilar streaking can be seen, making the diagnosis of pneumonia most likely.

There is atelectasis
of the right middle lobe, probably due to mucus impaction of the bronchus. Notice the position of the nasogastric ca
the right. This is a neonate of 41 weeks gestational age, who was treated for asphyxia, including
hypothermia treatment. Sudden respiratory distress. ImageBilateral opacification of the upper lobes most likely due
There is some subtle streaky opacity most
pronounced retrocardial in the left lower lobe. This could be some atelectasis aswell.
Neonatal Pneumonia:
Pneumonia can be difficult
to distinguish from other entities such as RDS or bronchopulmonary dysplasia.
In the majority of cases the clinical course, together with intratracheal sputum cultures and biochemical parameters
Without signs of infection, a consolidation on a chest radiograph is unlikely to be caused by pneumonia. Risk factors
distress, treated with CPAP after delivery. History of maternal infection. First study the image.
What are the findings. Image
Bilateral increased lung volume with asymmetric increased opacification of the lungs with subtle consolidation of rig
Hyperinflation of left upper lobe. This child developed signs of infection, both clinically and in the laboratory findings
The radiographic findings were attributed to neonatal pneumonia. A full term neonate, with respiratory distress afte
Hyperinflation of both lungs and cardiac enlargement with increased
interstitial markings and vascular markings. No pleural fluid. The differential diagnosis includes TTN and neonatal pn
tory distress, and the neonate developed signs of
infection. One
might argue that there could be a combination of TTN and pneumonia.
Ventilation associated complications:
Air leakage as a result of barotrauma in newborns present as: Pneumothorax can occur spontaneously or as a comp
positive pressure ventilatory support. The introduction of surfactant treatment and improved
ventilatory support has significantly decreased the incidence. Rupture of terminal airways results from high pressure
insufflation of collapsed lung tissue. This causes air leakage into the
pulmonary interstitium, lymphatic system or pleural space. A specific finding on neonatal chest films is air leak
tracking along the bronchi termed pulmonary interstitial emphysema (PIE). Air within the interstitium can cause stiff
lungs and diminished blood flow, leading to a reduced blood oxygenation. Pneumothorax can cause collapse of a lu
relatively non-compliant and volume loss is often limited. When additional pneumomediastinum is present, a 'lifted
thymus' can be seen, also known as the 'Spinnaker Sign'.
Pneumothorax:
Neonate 3 days old with RDS. Gestational age: 34 weeks.
First study the image.
What are the findings? Image PitfallIn newborns an important pitfall is the presence of a skin fold, which can be mist
ers and can be traced outside the chest cavity or cross-over pulmonary vessels. ImageA term newborn with an abdo
There are signs of
fluid overload with accentuated blurry vessels. Skinfolds project over the right lower lung (arrows).
The lines cross anatomical borders, e.g. diaphragm and do
not follow pleura or lungs. Left arm projecting over hemi-thorax, resulting in sharp
radiopaque line (arrowhead). Images of a neonate with respiratory distress.
37 weeks gestational age
After primary caesarean section. Left image
Hyperinflation on the left side.
Mild displacement of the midline
structures to the right.
A pneumothorax is visible on the left side (arrow) Right image
On the follow up chest x-ray, the pneumothorax has spontaneously resolved. A pneumothorax can be very subtle, si
pulmonary disorders the lungs are not compliant and will not collapse.
Often in
a supine neonate, the pneumothorax only manifests ventrally. Sometimes only sharpening of the mediastinal structu
unilateral lucency is noted. Image Full term infant shortly after birth with mild pulmonary
distress. Due to fluid in
the lung parenchyma these lungs were stiff and did not collapse. Neonate 32 weeks gestational age. Treated for RDS
distress. First study the image.
What are the findings? Image
There is a a pneumothorax on the right side.
Midline structures are displaced to the left.
The left lungs
shows reticulonodular markings in keeping with RDS.

The right lung is not completely collapsed due to stiffness of the parenchyma in RDS and fluid.
Pneumomediastinum:
Pneumomediastinum is recognized as air inside the
mediastinum. The classical sign is the so-called spinnaker sign
(arrowhead).
This is caused by the thymus being 'lifted up' from the lower
mediastinum by the mediastinal air. First study the image.
What are the findings? Image Image
Air can be recognized
between the thymus and the heart, which indicates a pneumomediastinum. No apparent pneumothorax is
recognized.
The thymus
is uplifted on both sides (arrows). A cross table lateral view can help
to confirm the presence of a pneumothorax or a pneumomediastinum. Image
Air can be recognized between the
thymus and the heart, which indicates a pneumomediastinum.
No apparent pneumothorax is recognized. A full term neonate after meconium aspiration. Pneumomediastium, in c
NG tube in situ.
Pulmonary Interstitial Emphysema (PIE):
Pulmonary interstitial emphysema (PIE) is leakage of air into
the perivascular and peribronchial spaces as a result of rupture at the
bronchiolo-alveolar junctions.
PIE is recognized as either small bubbles or linear air
collections along the bronchovascular bundle radiating from hilum to the
periphery.
PIE can be bilateral or unilateral.
Once PIE is established, air may dissect centrifugally along
bronchovascular sheaths or lymphatic channels to form subpleural blebs, which
may rupture into the pleural space and produce a pneumothorax. ImagePreterm infant born at 27 weeks gestationa
Now 6 weeks old.
Mechanical ventilation for RDS. First study the image.
What are the findings? Findings: Neonate, gestational age 30 weeks, day 1, sudden deterioration after MIST. First stu
What are the findings? ImageBilateral radiating bubbly lucencies, with
hyperinflation of both lungs.
These are typical findings in PIE. Neonate, gestational age 27 weeks, treated for RDS.
At age of 2 days sudden deterioration. First study the images.
What are the findings? Image 1Bilateral reticulonodulair opacities in keeping with IRDS,
treated via CPAP. Image 2At the age of 2 days the X-ray
shows radiating lucencies in the left lung as a result of PIE. These images are of a neonate gestational age 32 weeks,
uding a pneumothorax on the left side, which was drained.
After
drainage there was a deterioration. Image 1
The radiograph shows bilateral radiating bubbly lucencies due to bilateral PIE.
This is more pronounced on the left side. Image 2
In follow up the child also developed a pneumothorax on the right side.
Congenital anomalies:
The most common congenital anomalies in neonates are:
Congenital pulmonary airway malformation:
Congenital pulmonary airway malformation (CPAM) was until recently know as congenital cystic adenomatoid malfo
It is a spectrum of bronchopulmonary foregut malformations. There are three histological types: Image1 week old ch
On prenatal routine imaging, a cystic lesion was seen in the upper left
lobe.
The radiograph shows a delineated lucent area in the apical part of the
left upper lobe (arrow).
There is a slight mediastinal shift to the right. Radiographic findings in CPAM Contrast
enhanced CT scan is essential in the analysis of CPAM and sequesters.
Given that CPAM and sequester often are hybrid lesions,
feeding arterial vessels need to be visualized or ruled out before surgical
intervention. ImageCT scan of the same patient as above.
The lucent lesion in the left upper lobe has a multicystic aspect. Because the largest cyst has a diameter of more tha

type I CPAM. Images of a neonate, 40 weeks gestational age.
Antenatal suspicion of large CPAM on the left side.
At birth respiratory distress Images
Radiograph shows a large round opacified lesion.
Severe displacement of
midline structures with atelectasis of the right lung.
Deep position ETT. NG tube in situ. Because of the need of direct intervention a CT after IV contrast was performed.
CT shows a large cystic lesion in the upper lobe of
the left lung, with displacement of vascular and bronchial structures.
The lesion has relation to any systemic vessel, Which excludes a sequester.
This is a CPAM, which is not yet aerated.
Pulmonary sequestration:
A pulmonary sequestration is a segment of dysplastic lung
tissue, which is separate from the rest of the lung. It receives an anomalous
systemic vascular supply. The most common type is the intralobar type, which is
situated within a normal lobe and has no own visceral pleura.
Usually there is
a normal venous return via the pulmonary veins. In contrast the extralobar type is situated outside of the
normal lung and has a separate visceral pleural and a systemic venous return. Most sequestrations are detected on
present as a mass in the basal lobes, usually paramedian on the left. ImageNeonate, 39 weeks gestational age, anter
lobe.
Radiograph shows a subtle, not well circumscribed lesion on the
left lower lobe.
CT at age of one month shows a mixed lesion, both cystic and
solid, with a large feeding artery from the descending aorta, in keeping with
sequester. Imaging Management is controversial. Some advocate surgical resection because of the risk of infection
and cardiac failure due to the left to right shunting.
Others advocate a wait and
see approach, as these sequestrations can resolve spontaneously.
Before surgical management MR or CT is needed to analyze the blood supply and the type of the sequestration.
Congenital Lobar Emphysema:
Congenital lobar emphysema, now known as congenital lobar
overinflation, is a condition in which there is hyperexpansion of a lobe of the
lungs. Narrowing or weakness of a lobar bronchus causing a
check-valve mechanism is the most likely cause. Symptoms depend on the degree of lobar hyperexpansion. A mildly
in size with time and close follow-up is warranted in these cases. Progressive
hyperexpansion of a lobe can occur and cause significant, sometimes life-threatening,
symptoms. Those cases are treated with lobectomy. Usually congenital lobar emphysema is detected on prenatal ult
Antenatal there was suspicion
of a CPAM.
The chest radiograph and CT show hyperinflation of the right upper lobe with architectural distortion.
The right lower lobe is compressed, but probably has a normal architecture.
Displacement of
mediastinum and heart and atelectasis of the left lung. Images of a 6 months old neonate with mild respiratory symp
splacement of
midline structures and some atelectasis of the lower lobe. The CT confirms overinflation
of the right upper lobe.
Diaphragmatic hernia:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here to watch the video of Medical Action Myanmar and if you like the Radi
ll gift by Agrons GA, Courtney SE, Stocker JT, Markowitz RI. From the archives of the AFIP. Radiographics 2005; 25:104
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Temporal Bone Anatomy 1.0:
Erik Beek and Robin Smithuis
Radiology department of the University Medical Centre of Utrecht and the Rijnland Hospital, Leiderdorp, the Netherl
Publicationdate 2006-07-15 Updated version: 21-2-2007 In this review we present the normal coronal and axial anato

images.
Temporal bone:
The middle ear consists of the tympanic cavity and the antrum. The antrum is a large aircell superior and posterior t
he aditus ad antrum. The epitympanum or attic is the upper portion of the tympanic cavity above the tympanic mem
. The tympanic membrane, the malleus, incus and stapes transfer soundwaves to the stapes footplate, which is attac
Axial anatomy:
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Disable Scroll Scroll through the axial anatomy.
Scroll through the axial anatomy from inferior to superior:

Axial anatomy from inferior to superior:
At the most inferior level we see the facial nerve passing inferiorly to finally reach the stylomastoid foramen (not sho
otid canal. Also at this level is the top of the jugular bulb.
Tympanic membrane:
The manubrium of the malleus (yellow arrow) is connected to the tympanic membrane. Malleus (yellow arow). Roun
leus (yellow arow) anterior to the long process of the incus. The round window is indicated by the blue arrow. The ro
ions within the cochlea and thus serves as a release valve. Stapes (green arrow) is seen connecting to the oval windo
Stapes:
The base of the stapes rocks in and out against the oval window. The vibrations are transmitted via the endolymph t
Cochlea:
Within the cochlea the movement of the hair cells convert the sound-vibrations into nerve impulses, that travel over
terprets the impulses as sound. . The head of the malleus is seen anterior to the head of the incus (yellow arrow).
Tympanic segment of the facial nerve:
In this image at the level of the internal auditory canal, the tympanic segment of the facial nerve is seen just medial a
malleus (yellow arrow) is seen anterior to the head and the short process of the incus.
Geniculate ganglion of the facial nerve:
At this level the aditus ad antrum is seen. This is the connection between the tympanic cavity and the antrum. The la
auditory canal angles sharply forward, nearly at right angles to the long axis of the petrous bone, to reach the genicu
(first genu of the facial nerve) to run posteriorly as the tympanic segment along the medial wall of the epitympanum
Antrum:
The antrum is a large aircell superior and posterior to the tympanic cavity and connected to the tympanic cavity via t
ls. On this last posterior coronal image the facial nerve assumes a vertical position to exit the petrous bone through
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Coronal anatomy:
The petrous bone is positioned in an oblique orientation from posterolateral to anteromedial. As a result most struc
g coronal images go from anterior to posterior. First we will see the tympanic membrane with the ossicles, followed
posterior image will show the point where the facial nerve exits the temporal bone at the stylomastoid foramen. Scu
to the incus (green arrow)
Scutum:
The scutum (yellow arrow) is a sharp bony spur formed by the lateral wall of the tympanic cavity and the superior wa
tructure to erode as a result of a cholesteatoma, that is formed by medial retraction of the pars flaccida of the tympa
it will result in ossicular destruction. If the cholesteatoma passes posteriorly through the aditus ad antrum into the m
re of the dura and erosion of the lateral semicircular canal with deafness and vertigo, may result. On the left the mos
this point the nerve makes a U-turn. It is named the genu or geniculum and represents the geniculate ganglion. The
us. Coronal reconstruction clearly demonstates that the incus (I) is positioned posterolateral to the malleolar head (H
ing posterolaterally. In many illustrations you will see the incus connecting medially to the malleus, but this is not co
ly demonstated that the incus is positioned posterolaterally to the malleolar head. The long crus of the incus subseq
e arrow) is seen medial to the Incus (green arrow) A coronal image slightly more posteriorly will show the facial nerve
auditory canal and runs towards the geniculate ganglion (medial white arrow). The lateral portion is the part that co
irst genu. Long crus of the incus is seen connecting to the Stapes (blue arrow).Facial nerve in internal auditory canal
Facial nerve canal:
The facial nerve is seen in the internal auditory canal and entering the temporal bone (medial white arrow). The later
rve running in the facial canal and curving around the oval window niche. At this point, the nerve runs in a horizonta
. The incus (orange arrow) is seen connecting to the stapes (blue arrow). Coronal scan showing the facial nerve (white
r canal.
Anatomy:
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Disable Scroll Anatomy Interactive Digital Education (part I), F.J.A. Beek, radiologist, Radiology department of the Wilh
of Utrecht, the Netherlands
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None:

Contrast-enhanced MRA of peripheral vessels:
Tim Leiner
Department of Radiology, Maastricht University Hospital:
Publicationdate 2005-7-29 Contrast-enhanced MR angiography (CE-MRA) is more sensitive and specific for diagnosis
mpared to Duplex (1). CE-MRA detects more patent arteries than IA-DSA in patients with chronic critical ischemia and
(2). It is important to distinguish between patients with intermittend claudication and patients with chronic critical isc
is overview guidelines are given how to tailor the MRA-examination by optimizing the use of surface coils, k-space fill
Department of Radiology, Maastricht University Hospital, the Netherlands*
Periferal Arterial Occlusive Disease:
Patient with intermittend claudication on the left and an isolated stenosis in the left iliac artery.
Intermittend claudication:
Intermittend claudication is a benign form of periferal arterial occlusive disease.
Typically these patients have 'single level' disease usually an isolated stenosis in the iliac or femoral artery. Mostly th
xercise training. There is only a relative indication for invasive therapy in order to relief the symptoms (usually PTA,
will progress to more severe disease i.e. critical ischemia. When MRA is performed in these patients perfect imaging
rform a infragenual procedure in patients with these complaints. A one-step examination from aorta to the lower leg
. Patient with chronic critical ischemia and 'multi level' disease.
Chronic critical ischemia:
In patients with chronic critical ischemia
however, there is rest pain and/or tissue loss.
They typically have 'multi level' disease with bilateral, severe stenoses or occlusions in multiple arteries and segment
nvasive therapy.
The goal is wound healing and limb saving. In these patients it is the job of MRA to find patent arteries in the lower le
attempt must be made to find vessels in the lower legs and feet because if no arteries are found amputation will be
First you have to focus on the lower leg and feet with the best spatial resolution possible. Secondly the iliac and femo
rie will usually not be a problem at these levels.
How to optimize the Imaging Protocol:

Equipment requirements:
Centric k-spacing provides the capability to acquire the optimal part of the central k-space during the arterial-phase
time is used for increasing spatial resolution. Venous enhancement will not be of much of a problem because if the c
ntrast in the image. The arterio-venous (AV) window will be enlarged allowing longer scan time. If centric k-space filli
tricks). Surface coils Although some advocate the use of the bodycoil for imaging all three station, surface coils will d
leg and feet a surface coil is mandatory. a 3-station coil is optimal for MRA from the aorta to the feet. If not available
ynergy spine coils are very helpfull,
Spatial resolution:
As a rule of thumb you need at least 3 pixels per vessel-diameter in order to reliably differentiate between 50% steno
needed (figure). Sagittal MIP of TOF-series from aorta to the level of the feet. Variation in width and angulation will r
Planning the series:
The CE-MRA series can be planned on a rough TOF-serie that gives you a good idea where the vessels of interest are
size and the angulation of the boxes at iliac, femoral and crural level. Especially at the femoral level a small box usua
ed up going to the lower leg. Large lower box to cover the pedal arch At the crural level especially if the pedal arch ha
olution at this level has to be high. This results in more thin slices and a longer scan time. How to beat venous enhan
lained later. Three station CE-MRA in patient with intermittent claudication. Fast scanning was possible with SENSE.
Contrast bolus-timing:

Injection protocol:
In patients with intermittent claudication a one-step examination with imaging of 3 sequential stations is optimal. In
pedal arch included are examined. Secondly a separate contrast injection is necessary for the examination of the Ao
stem contrast can be delivered at a higher rate.
Tips and Tricks in MRA:
Dedicated imaging of crural arteries and pedal arch in patient with critical ischemia.
How to beat venous enhancement in lower legs:
Prolong the arterio-venous (AV) window by venous compression. Use a midfemoral compression with a pressure cuf
sually works fine. Use centric k-space filling if available. If ontrast appears in the veins, this will not add much to the c

es of k-space are scanned, which mostly add to he resolution in the image. In patients with critical ischemia do a bipl
Centric k-spacing not available:
At the iliac level centric k-spacing is not necessary. Linear filling of k-space works good at this level and provides the a
rrival of the contrast-bolus. If centric k-spacing is not available at your MR-machine, use linear filling of k-space at all
ial contrast in the images will be less optimal and the risk of venous enhancement will be greater. A 3-station coil.
3-station coil not available:
A 3-station coil is optimal for MRA from the aorta to the feet. If not available use as many surface coils as possible. Sy
he best surface coil that you have for imaging the lower leg and feet and consider to do a biphasic examination.
Problems with breath-hold:
The most important issue in MRA of the aorta and iliac arteries is that the patient manages to hold his breath. A lowe
n scan with breathing artifacts. Before the actual series start you need to practise the breath-hold with the patient. If
scantime by lowering the matrix-size and increasing the slice thickness at the expense of in-plane resolution. Radiolo
2. Comparison of Contrast-Enhanced Magnetic Resonance Angiography and Digital Subtraction Angiography in Patie
logy. 39(7):435-444, July 2004. by Leiner, Tim MD, PhD et al.
Carpal instability:
Louis A. Gilula and Ileana Chesaru
Mallinckrodt Institute of Radiology Washington University St. Louis, Missouri, USA and the Westeinde hospital the Ha
Publicationdate 2005-08-23 This article is based on a presentation given by Louis Gilula and adapted for the Radiolog
e wrist is presented to look for carpal instability and fracture dislocation. Secondly cases are presented as examples
Wrist analysis:
When you analyse the wrist to look for possible carpal instability and fracture dislocation, you should ask yourself th
t. This is essential to be able to make statements about improper alignment or abnormal axes of carpal bones. Is the
be parallel when profiled. Any overlap indicates abnormal tilting, dislocation or fracture. Is there any disruption of th
a fracture. What is the shape and axis of the carpal bones. Give special attention to lunate, scaphoid and capitate. An
ation. Answering these questions will help you find clues to carpal instability, dislocation and fractures.
Radiography:
Positioning
PA view should be taken with the wrist and elbow at shoulder height. Only in this position, the radius and the ulna ar
and become relatively shorter. So it will be impossible to make any statements on the length of the ulna (plus or min
Lateral view is taken with the elbow adducted to the side. Shoulder, elbow and wrist are again in one plane. This pos
PA view. Extensor carpi ulnaris groove (yellow arrow) seen radial to the midportion of the ulnar styloid. PA view A co
s groove radial to the midportion of the ulnar styloid. The PA and lateral view are equally important and thus should
ong and the lateral view shows in what direction the bones move.
Sometimes an oblique view will also be obtained, especially if you want to look at the trapezium-trapezoid joint in pr
can see the volar edges of respectively scaphoid, pisiform and capitate separately and lined up as shown on the left.
oking through that, one can see the convexity of the scaphoid. Distally from the scaphoid is the trapezium. The angu
ne that bridges the proximal and distal half of the wrist is the pisiform. Capitate is the rounded bone fitting inside th
ake out the hook of the hamate. Same projection of ulna and ulnar styloid on PA and lateral view due to malposition
positioning may result in the same view of the ulna on both the PA and lateral view as shown in the case on the left.
ame image of a bone. Normal oblique radiograph of the wrist and schematic representation Oblique view An oblique
the trapezio-trapezoidal joint.
Joint spaces: parallelism and symmetry:
The joint spaces of the wrist have a width of 2 mm or less. Only the radiocarpal joint is slightly wider. The carpometa
The capitolunate joint is considered the baseline joint width to which other joint spaces can be compared. One shou
l intercarpal, the midcarpal, the distal intercarpal and the carpometacarpal joint spaces. Study the carpal bones as pi
rist with the outlines tracing the outer margins of the bonesRIGHT: Schematic representation of the wrist with the lin
joints should be symmetrical. Furthermore, when viewed in profile (tangentially), the cortical margins of the bones c
not viewed in profile do not display this parallelism, e.g. the distal portion of the scaphoid that articulates with the ca
the carpal bones as pieces of a jigsaw puzzle that all fit together, as opposed to tracing carpal bones by their outer c
ne is not paralleling the others, that is out of place. If the rest of the bones still parallel each other, they have stayed
the wrist, with dislocation of the lunate The picture on the left shows abnormal overlapping of the lunate with the ca
urface of the scaphoid, but nothing paralleling it. There is also abnormal widening of the radiolunate space. The othe
onclusion that the lunate is displaced while the other bones have stayed together.
Carpal arcs:
PA radiograph of the wrist. The three normal carpal arcs The next step is looking at the three carpal arcs: smooth cu
ft. The first arc is a smooth curve outlining the proximal convexities of the scaphoid, lunate and triquetrum. The seco
nd the third arc follows the main proximal curvatures of the capitate and hamate. PA radiograph of the wrist and sch
Distruption of carpal arcs An arc is disrupted if it cannot be traced smoothly. A break in one of the arcs indicates a fr
ion or dislocation. On the left one can note the disruption of arc I at the lunotriquetral joint. Disruption of the second
apholunate joint and the lunotriquetral joint is seen on the left. Although there is a gap in the first arc, it can still be t

Disruption of the third carpal arc at the capitohamate joint Disruption of the third carpal arc is shown in the next cas
ate joint.
Shape of carpal bones:
Schematic representation of the lunate shape in different positions
Lunate shape:
The lunate has a trapezoidal shape, as the sides converge from the proximal surface to the distal surface, which are
in shape. Awareness of this fact prevents thinking the lunate might be dislocated based only on its appearance, that
tilting or just be tilted. LEFT: Lunate dislocation: capitate is centered over the radius and lunate is tilted out.RIGHT: P
and capitate is tilted out dorsally.
Lunate vs. perilunate dislocation:
Common dislocations of the wrist are the lunate and perilunate dislocations. The key to differentiation between both
over the radius and the lunate is tilted out, it is a lunate dislocation. If however the lunate centers over the distal rad
ilunate dislocation (figure). LEFT: Lateral radiograph of the wrist in extention showing scaphoid elongationRIGHT: PA
f the scaphoid
Scaphoid shape:
The scaphoid shape changes with movement of the wrist. In ulnar deviation or extension the scaphoid elongates to f
(the trapezium). LEFT: PA radiograph of the wrist in radial deviation showing foreshortening of the scaphoid: signet r
showing tilting of the scaphoid towards the palm Both with radial deviation aswell as flexion of the wrist the space b
d fills this space it will foreshorten and tilt towards the palm. This will give scaphoid a signet ring appearance (figure)
Axis of the carpal bones:
Drawing the longitudinal axes of some of the carpal bones on a lateral radiograph and measuring the angles betwee
tionship. The three most important axes are those through the scaphoid, the lunate and the capitate, drawn on the l
Scaphoid axis:
The true axis of the scaphoid is the line through the midpoints of its proximal and distal poles. Since the midpoint of
parallel line can be used that is traced along the most ventral points of the proximal and distal poles of the bone (fig
g the distal palmar and dorsal bordersRIGHT: Radiograph with lunate and scaphoid axis drawn.
Lunate axis:
The axis of the lunate runs through the midpoints of the convex proximal and concave distal joint surfaces and can b
istal palmar and dorsal borders of the bone as demonstrated on the left. **Scapholunate angle Normal: 30 - 60? Qu
bility of the wrist. LEFT: Capitate axisRIGHT: Radiograph with lunate and capitate axis drawn.
Capitate axis:
The capitate axis joins the midportion of the proximal convexity of the third metacarpal and that of the proximal sur
Abnormal: > 30?.**This indicates instability of the wrist. LEFT: Dorsal tilting of the lunate in DISIRIGHT: Scapholunate
DISI or dorsiflexion instability:
DISI is short for dorsal intercalated segmental instability. The intercalated segment is the proximal carpal row identif
it being the part in between the proximal segment of the wrist consisting of the radius and the ulna and the distal se
. So all this means is that in DISI or dorsiflexion instability the lunate is angulated dorsally. If you think lunate is tilted
-80?is questionably abnormal, >80? is abnormal) and the capitolunate angle (In the figure on the left the scapholuna
s angle is considered abnormal if greater then 80 degrees. LEFT: Volar tilting of the lunate in VISIRIGHT: Scapholunat
VISI or volarflexion instability:
Volar intercalated segmental instability or palmar flexion instability is when the lunate is tilted palmarly too much. W
riant, especially if the wrist is very lax.
Systematic review and diagnosis:
In the next cases we advise you to first look at the images on the left and give a full description of the radiographs. L
carpal bones. Find out if there are any fractures and then try to make the diagnosis Then read the text on the right t
Systematic interpretation of the case on the left shows us the following: On the PA-view all the carpal bones parallel
e disrupted at the LT and SL joints. Triangular shaped lunate So by just looking at the PA view we can make the diagn
he TL joint since there is overlapping of the triquetrum and the lunate. Also overlapping of the hamate and the lunat
scaphoid and proximal pole of capitate. So these bones form a unit. Also parallelism between triquetrum, hamate, c
cture of capitate and scaphoid So these findings indicate that this is a transscaphoid, transcapitate perilunate fractur
indicating the fracture-dislocation line. Same case with additional oblique and lateral view showing the dorsal disloca
process. Broken arcs I and II at LT joint. Some parallelism between lunate and proximal pole of scaphoid with the rad
ards the palm. All the other carpals show parallelism exept for lunate, the proximal pole of scaphoid and the radius.
e PA-view alone it is very difficult to say if this is a lunate or perilunate dislocation. The triangular shape of the lunate
tilting. Perilunate dislocation with fracture of scaphoid and ulnar styloid processThe volar tip of lunate is also broken
Now we see that there definitely is a perilunate dislocation. So the triangular shape of the lunate is the result of just
lunate is seen. So this patient is at risk for recurrent dislocation. Case 4 Analysis: The case on the left shows severe a
Carpal arcs are normal and there is normal paralelism.The scaphoid is elongated which means it is dorsally tilted. O
sally. The proximal carpal row has moved as a unit, so there is no dissociation. Final diagnosis: non-dissociated DISI v
Analysis: Loss of parallelism at LT joint resulting in broken arc I and II. Lunate and scaphoid are parallel to each other

e to palmar tilting. Lunate is parallel to scaphoid. So the triangular shape must be the result of palmar tilting. The pr
al view demonstrates the volar tilting of lunate which was already suspected on the PA view. Final diagnosis: VISI wit
Analysis: Widened and narrowed joints, but there is normal parallelism , so there is no dislocation. Scapholunate dis
e scaphoid due to palmar tilt. Arthrosis of the Radioscaphoid and Capitolunate joint due to the abnormal movement
ase it is post-traumatic due to the SL-ligament tear. SLAC (scapholunate advanced collapse) refers to a specific patte
ed chronic scapholunate dissociation or from chronic scaphoid non-union The degenerative changes occur in areas
degeneration in the unstable lunatocapitate joint, as capitate subluxates dorsally on lunate. SLAC of CPPD TYPE On t
istics of CPPD with SLAC are: Decreased size of proximal scaphoid due to erosion and resorption. Scaphoid fossa ero
Müllerian duct anomalies:

Department of Radiology of the Meander Medisch Centrum of Amersfoort and of the University Medical Center of U
Publicationdate 20-6-2021 Variant
anatomy and true anomalies of the female internal genitalia are very common.
Diagnosis is important, not only to understand future risk of complications,
but also because some anomalies may benefit from treatment. Attempting
to master this topic by simply memorizing different variants is a suboptimal
approach: Müllerian duct anomalies (MDAs) are not a discreet set, but a
continuous spectrum of aberrations. With a little knowledge of the underlying
embryology, clinical classifications of MDAs are easier to understand, and the
reader is better equipped to deal with the inevitable overlap in appearance
encountered in clinical practice. This
article begins with a very brief summary of embryological Müllerian duct
development and then takes you through the spectrum of MDAs on the basis of the
European (ESHRE/ESGE) consensus classification, providing more in-depth developmental
details along the way. Imaging
protocols are also briefly addressed, and we provide a checklist to help with
reporting of MDAs.
Embryology:
The female reproductive tract develops from a pair of Müllerian ducts that form the fallopian tubes, uterus, cervix a
The ovaries and lower third of the vagina have a different embryological origin (genital ridge and urogenital sinus, re
ducts, followed by fusion of the two ducts into a single uterus, cervix and upper vagina. Finally resorption of the sept
cavum.
Failure of formation of the Müllerian ducts can result in an aplastic or
hemi-uterus.
Failure or incomplete fusion of the ducts can result
in a bicorporeal uterus. Non or incomplete septal resorption results in a
septate uterus.
Associated anomalies:
There is a close relation between the paramesonephric ducts of Müller and the mesonephric ducts of Wolff. The latt
he kidneys.
Therefore abnormalities of the urinary tract often coexist with MDAs, in 30-50% of cases.
Usually urinary tract anomalies are unilateral and ipsilateral to the malformed Müllerian duct derivative. The inciden
reported in up to 29% of cases.
Classification of Müllerian duct anomalies:
European classification system ESHRE/ESGE. Click for larger view. The table shows the European classification syste
dysmorphic shaped uterus either as a T-shaped cavum due to abnormally thick uterine walls or as a T-shaped cavum
t of failure of resorption of the septum. There is an internal indentation. The outer contour of the uterus is normal a
uterus. Class U3 is a bicorporeal uterus with a left and right corpus as a result of failure of fusion. The outer contour
oreal septate uterus has both an external cleft and a septum. Class U4 is a hemi-uterus as a result of unilateral failu
uterus as a result of bilateral failure of formation of the Müllerian ducts. Class U6 are unclassified cases
Imaging:
HSG showing abnormal uterine cavity. Differentiation between septate and bicorporeal uterus is not possible
Hysterosalpingography:
Müllerian duct anomalies are often first detected on hysterosalpingography (HSG) during the work-up of infertility. H
information about the uterine cavity and not about the external contour of the uterus.
The next step in the diagnosis is often ultrasound or MRI. Sorry, your browser doesn't support embedded videos.
Ultrasound:
Transabdominal and transvaginal ultrasound are often the first imaging modalities used to evaluate the internal sex
When indeterminate or complex, MR imaging is used. The transabdominal ultrasound shows a uterus with normal e
Internal indentation in the cavum is present continuous to the level of the internal os of the cervix. Classification: U2

MRI:
MRI is considered the gold standard in the classification of MDAs due to the detailed anatomic information provided
a hydrosalpinx.
Further analysis was done with MRI. Continue with the MR-images. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The subsequent MRI shows a small, curved and
off-midline positioned uterus on the right. No rudimentary horn is present on the left side. The cervix is not necessar
classification of this case, since a hemi-uterus it is usually accompanied by
unilateral cervical aplasia. The vagina does not show any abnormalities (V0). Kidneys showed normal anatomy (not s
the uterine body
MRI protocol:
For patient preparation the use of an anti-peristaltic agent is recommended as well as an empty urinary bladder prio
Vaginal opacification with ultrasound gel can be used when vaginal pathology is expected.
In menstruating patients imaging during secretory phase can be considered.
How to report Müllerian duct anomalies:

Checklist:
Click for larger view Besides the main classes of the uterine anomalies a co-existent class is used for describing the c
When unsure about the classification, a description of the findings is sufficient to avoid improper use of the classes.
Besides the female genital tract anomalies always report on the kidneys.
U0 normal uterus:
U0 was added to the classification to be able to describe abnormalities of the cervix or vagina in co-existent classes i
U1 dysmorphic uterus:
SubclassU1a T-shaped
Narrow uterine cavity due to thickened lateral walls with a correlation 2/3 corpus and 1/3 cervix. SubclassU1b Infanti
verse correlation of 1/3 corpus and 2/3 cervix lenght. SubclassU1c all othersGroup including all minor deformities of
ze.
U2 septate uterus:
SubclassU2aPartial septate uterus with an internal indentation of more than 50% of the uterine wall thickness dividi
. SubclassU2b
Complete septate uterus. The septum divides the uterine cavity up to the level of the internal cervical os. A hysteros
outcomes. Enable Scroll
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Disable Scroll Study the images and then continue reading. The findings are: Classification: U2bC0V0. Enable Scroll
Disable Scroll Complete septate uterus Enable Scroll
Disable Scroll Complete septate uterus Study the images and the continue reading. The findings are: Classification: U
y, since it manifests in the final phase of uterine development, which is the resorption of the septum.
U3 bicorporeal uterus:
SubclassU3aPartial bicorporeal uterus. Indentation not reaching the cervix and no septum (<150% UWT) SubclassU3
the cervix. Possibly including the cervix and vagina. In 75% a longitudinal vaginal septum is present. SubclassU3cBicc
combination with a septum (>150% UWT). In 25% a longitudinal vaginal septum is present. When the fusion of the M
as bicornuate uterus).
When there is no fusion at all, this leads to a
complete duplication of uterine horns, cervix and often also of the proximal
vagina (also known as uterus didelphys). Subclass U3a and U3b usually do not need surgical intervention unless a va
When symptomatic, e.g. pain during intercourse, the septum can be resected. Enable Scroll
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Disable Scroll Study this set of images.
Then continue reading. The findings are: Classification: U3bC2V0 Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll Study the images and then continue reading. The findings are: Classification: U3bC2V2 Other possible
ndometriosis. Continue with the next image in this case... On the same side as the septum there is an agenesis of th
This is seen consistent with the Herlyn-Werner-Wunderlich syndrome.
This is also known as OHVIRA - obstructed hemivagina and ipsilateral renal agenesia.
The contralateral kidney is hypertrophic (arrow).
U4 hemi-uterus:
SubclassU4aHemi-uterus with a rudimentary functional cavity,
communicating or non-communicating. SubclassU4b
Hemi-uterus with no horn or a horn without rudimentary cavity. In case of arrest in formation of one of the Müllerian
knows as unicornuate uterus).

As mentioned before, hemi-uterus is often accompanied
by cervical aplasia and therefore it is not necessary to mention this in the
final classification. Special attention has to be paid to the presence of
endometrium in a rudimentary cavity.
In case of non-communication, hematometra and
endometriosis may be present.
Even a pregnancy can occur in a functional rudimentary
cavity with the chance of uterine rupture. On T2WI the presence of endometrium can be evaluated
and in particular post-contrast T1WI or DWI may be helpful. A hemi-uterus does not need surgical intervention.
The presents of a rudimentary horn however is
essential to report for the aforementioned reason.
A description of the horn and location may aid in
surgical planning. Enable Scroll
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Disable Scroll Study the images and then continue reading. The findings are: Classification: U4aV0. Enable Scroll
Disable Scroll Enable Scroll
Disable Scroll The images show a small, curved and off-midline uterus with a normal zonal anatomy.
No rudimentary horn is seen.
There is a normal cervix and vagina.
Kidneys showed normal anatomy (not shown). Classification: U4bV0.
U5 aplastic uterus:
Subclass U5aA rudimentary functional cavity is present, uni- or bilateral. SubclassU5bNo functional rudimentary cavi
ures are seen, which is non-developed rudimentary tissue (arrowheads) In class U5 the Müllerian ducts are not, or n
Usually there is a complete agenesis, also known as Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome.
The typical form of MRKH syndrome (type I) is characterized by congenital absence of uterus, cervix and upper vagin
The atypical form (type II) is characterized by the presence of both Müllerian duct anomalies and also non-gynaecolo
tems. On MRI the non-developed rudimentary tissue may be present with low signal on T2WI.
These bilateral ‘uterine buds’ may be seen as fibrous linear structures, and a rudimentary uterus as triangular shape
re present, but sometimes in an atypical position. ImagesThe sagittal images show the abcense of a uterus, but on th
rudimentary tissue (arrowheads)
The kidneys showed normal anatomy (not shown). No cervix or upper vagina are seen.
Classification: U5bC4V4.
Continue with the axial images... The ovaries are normal, but in an atypical position.
These findings correspond with the MRKH type I syndrome. Classification: U5bC4V4. Enable Scroll
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Disable Scroll Study the images and then continue reading. Classification: U5aC4V4.
U6 unclassified:
This class is created to make sure that other classes are not incorrectly used when not fully applicable. Only few case
Co-existent class cervix and vagina:
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V3 hymen imperforatus:
During embryology the fused Müllerian ducts grow
downward until colliding with the primitive urogenital sinus.
There the
tuberculum of Muller is formed, following by the growth of two solid evaginations
i.e. the bulbi sinovaginalis.
The two bulbi fuse together and proliferate,
forming a massive cellular plate around the 3th month of gestation.
This plate
is called the vaginal plate.
Downward canalization follows, after which the
upper and lower vagina stay separated by the hymen. Normally the hymen
perforates around birth. If the canalization of the
vaginal plate is not completed or the perforation of the hymen doesn’t
occur, mucus from the cervical glands, which are stimulated
by the maternal estrogen, collects above the hymen. This may lead to hydrometrocolpos and to
hematometrocolpos if it manifests after the menarche. Images Kidneys showed normal anatomy (not shown). Imagi
r, MD • Aliya Qayyum, MBBS RadioGraphics 2012; 32:E233–E250

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Special Ankle Fractures:

Detection of 'Not So Obvious' Fractures:
Robin Smithuis
Radiology Department of the Rijnland Hospital, Leiderdorp, the Netherlands:
Publicationdate 2012-10-01 The ankle is the most frequently injured joint. Management decisions are based on the i
focus on detection of fractures, that may not be so obvious at first sight. Before you read this article, you need to un
on injuries that were highlighted in Ankle - Fractures 1 and 2.
Posterior malleolus fractures:
Almost all fractures of the posterior malleolus are part of a rotational injury resulting in a Weber B or Weber C fractu
Weber C (figure). In some cases the tertius fractures are easily seen on the x-rays, but frequently they can be difficul
a tertius fracture can be the only clue to an unstable ankle injury. Ankle - Fractures 2 - Fracture mechanism and Radi
alleolus When we study the radiographs of a patient with an ankle injury, we have to study the region of the posterio
gap between the fracture parts and detection depends on optimal radiography and a high level of suspicion. The ima
ency is the clue to a tertius fracture (red arrow). It results from subtle malalignment of the fracture fragment. Likewis
Trimalleolar Weber B fracture In this case there is a Weber B fracture with avulsion of the medial malleolus. The brig
ment. This tertius fracture can also be seen on the lateral view, but in many cases we need all the information of bot
more examples of the bright line that indicates a tertius fracture. In some cases a fracture of the posterior malleolus
een on CT. First study the radiographs and then continue with the CT. By the way....there are two fractures. You can
of the tertius at the insertion of the posterior syndesmosis (red arrows). The alignment is so perfect, that you do not
een on the AP-view as indicated by the red arrows, but this is questionable. Notice that there is also an avulsion at th
fracture. This combination of findings implicate that the ankle is unstable. A syndesmotic screw has to be inserted. .
had a distortion of the ankle and had pain on both medial and lateral side. She was referred to the radiology depart
rd AP-, Mortise- and lateral view and showed them to the radiologist, who was a little bit puzzled. First study the imag
st decided first to order a CT to find out if there really was a tertius fracture. Continue with the CT and be amazed. En
Disable Scroll Enable Scroll
Disable Scroll Scroll through the images. It is amazing, that such a large tertius fragment is so difficult to see on the r
dial side indicating rupture of the medial collateral ligaments (arrow). Do you have an idea what kind of injury this is?
indications of a Weber C or Pronation Exorotation injury. Since there is no fibula fracture seen on the x-rays of the a
there was some swelling on the medial side and although the patient did not complain of any pain higher in the low
is spot was marked and a fracture was found. This case illustrates the importance of medial soft tissue swelling aswe
en we can conclude that this patient first had a rupture of the medial collateral ligaments (stage 1), followed by a rup
fracture (stage 3) and finally an avulsion of the posterior malleolus, i.e. PE stage 4. At surgery the ankle was found to
an indication for fixing the posterior malleolar fracture, since the fragment involved more than 25% of the articular s
and the only abnormality is seen on the lateral view. This was thought to be an avulsion of the posterior malleolus. K
onal radiographs were taken. Continue with the images of the lower leg. A subtle high fibula fracture is seen (arrow).
nsen: Pronation Exorotation injury stage 4.
Isolated Tertius fracture:
A fracture of the posterior malleolus as an isolated finding is very uncommon. It is seen when someone's foot hits th
by the talus. The size of this fragment depends on the direction of the force (figure).
Salter-Harris fractures:
The Salter-Harris classification describes fractures that involve the epiphyseal plate or growth plate. The most comm
ures can be easily missed. In many cases there is only minimal or no displacement. The fracture through the growth
l variations of the growth plate.
And finally we tend not to look carefully at the epiphysis.
Type I:
Type I Salter-Harris fractures tend to occur in younger children (5). It is a transverse fracture through the cartilage of
a type I growth plate fracture will appear normal. Most type I growth plate injuries are treated with a cast. Healing of
e.
Type II:
A type II growth plate fracture starts across the growth plate, but the fracture then continues up through the metaph
tends to occur in older children. Often type II growth plate fractures must be repositioned under anesthesia, but hea
roll

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Type III:
Type III is a fracture through the growth plate and epiphysis sparing the metaphysis. A type III fracture also starts thr
f the bone, and into the adjacent joint.
These injuries can be concerning because the joint cartilage is disrupted by the fracture. Proper positioning is essent
tend to affect older children in whom the growth plate is partially closed. Study the images and then scroll to the ne
ssed (blue arrow). The fracture through the growth plate is only seen on CT. Continue with the CT images. The CT-im
epiphysis. Enable Scroll
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Disable Scroll Study the images and then scroll to the next images. This is also a Salter-Harris type III fracture. Notice
se fractures in a moment.
Type IV:
Type IV is a fracture through all three elements of the bone, the growth plate, metaphysis and epiphysis. Notice that
through the growth plate is in the axial plane and the metaphyseal fracture is in the coronal plane. These fractures a
xt chapter. Proper positioning is also essential with type IV growth plate fractures, and surgery may be needed to ho
Type V:
Type V growth plate injuries occur with the growth plate is crushed. Type V growth plate fractures carry the most cor
These types of fractures may permanently injure the growth plate, requiring later treatment to restore alignment of
Triplane fracture:
Triplane fracture This fracture is named triplane because it occurs in the coronal, sagittal and axial plane. It is actuall
adolescents in the period, when the medial tibial epiphysis is closed, while the lateral portion is still open leaving it v
e medial part of the growth plate since this is already closed, the epiphysis will fracture. As in most ankle fractures th
udy the images and then continue reading. Triplane fracture At first this looks like a Weber B fracture with an obliqu
ows). Notice however that this fracture line stops at the level of the epiphyseal plate. So this is the fracture of the me
cency within the epiphysis, which is the epiphyseal fracture in the sagittal plane. Notice also that the medial epiphysi
blue arrows). We have to assume that there is an epiphysiolysis of this lateral portion. Here another example. There
(red arrow). The fracture through the epiphysis is indicated by the blue arrow.
Maisonneuve fracture:
In 1840 Maisonneuve described a frature of the proximal shaft of the fibula, which was caused by exorotation force
es are easily overlooked because the patients rarely complain of pain in the region of the proximal fibula, since the a
hould suspect a high Weber C or Maisonneuve fracture: Isolated fracture of the medial malleolus According to Lauge
which results in a Weber C fracture. So we have to look for higher stages. The injury can continue to the following: In
ot be visible on the radiographs of the ankle. So even in a Weber C stage 4 sometimes only a fracture of the medial m
es and ligamentous injury on the left and the resulting x-rays on the right. Isolated fracture of the posterior malleolu
ry uncommon. Most fractures of the posterior malleolus are part of a complex ankle injury, either Weber B or Weber
stic oblique fracture. So if there is a tertiu sfracture and no sign of a Weber B fracture, then we have to start looking
wing combination: An isolated tertius fracture on the ankle radiographs indicates the presence of an unstable ankle
s do not rule out a Weber C fracture. We may have the following combination: Example 1 On the left images of a pati
r B fracture, because we see no fracture. A high Weber C is still a possibility, i.e.
+ medial ligament rupture
+ high fibular fracture
+ posterior syndesmosis rupture. Additional radiographs of the lower leg were taken and demonstrated a high fibu
* Final report Weber C stage 4, i.e. medial collateral ligamentous rupture, rupture of the anterior syndesmosis, high f
mosis. Teaching point No fracture on the radiographs of the ankle does not exclude an unstable ankle injury This cas
eds surgery even when the radiographs of the ankle do not show a fracture. In any patient with an ankle injury you s
Weber C fracture or do I need additional imaging. Example 2 There is a fracture of the posterior malleolus. Classifica
f the posterior malleolus is uncommon, but as part of a supination exorotation (Weber B) or pronation exorotation in
ilms to look for signs of a Weber B or C fracture. No sign of an oblique fracture of the lateral malleolus, so we can ex
Weber C fracture, i.e. medial rupture or avulsion, high fibular fracture and finally a posterior malleolar fracture. Now
arrow). Additional radiographs of the lower extremity demonstrate a high fibular fracture (blue arrow).
* Final report Weber C stage 4. Example 3 In this case no fracture is seen, but only soft tissue swelling on the medial
ture, which is a high Weber C fracture. Additional x-rays of the lower leg were taken. There is a high fibula fracture.
Tillaux fracture:
External rotation injury of the ankle is the most common ankle injury and can lead to a Weber B or Weber C fracture
r tibiofibular ligament (or anterior syndesmosis). Less frequently it leads to an avulsion of the anterolateral tibial epip
for higher stages of this exorotation injury. The x-ray shows a subtle Tillaux fracture, which is better appreciated on t
stages of an exorotation injury. What is going on here? There is a Tillaux fracture due to avulsion of the anterolateral
an be a stage 2 of a Weber C fracture. Stage 1 is rupture of the medial collateral ligaments and stage 3 is a fibula frac
king for stage 4, which is rupture or avulsion of the posterior syndesmosis. Do you now see the tertius fracture on th

a syndesmotic screw needs to be inserted. Stages of exorotation injuries of the ankle Another Tillaux in a patient wit
he lateral malleolus, a Tillaux and a medial malleolar fracture.
juvenile Tillaux:
All the profits of the Radiology Assistant go to Medical Action Myanmar which is run by Dr. Nini Tun and Dr. Frank Sm
o be the brother of Robin Smithuis. Click here or on the image below to watch the video of Medical Action Myanmar
ion Myanmar with a small gift. East Lancashire Foot and Ankle Hyperbook
4. Free AO Surgery Reference The AO Surgery Reference is a huge online repository of surgical knowledge, consisting
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