

Breast Radiology In-Training Exam Questions for Diagnostic Radiology Residents



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December 2021

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1. What is the optimal time of the menstrual cycle to perform a breast MRI in a pre-menopausal patient?

- A. Days 1-6
- B. Days 7-14
- C. Days 15-21
- D. Days 22-28

Key: B

Rationale:

Estrogen can cause contrast enhancement of benign breast parenchyma in premenopausal females. This is most pronounced in weeks 1 and 4 of the cycle and least during the 2nd week of the cycle, making day 7-14 the optimal time to perform breast MRI. This is assuming a 4-week menstrual cycle.

Reference:

Delille JP, Slanetz PG, Yeh ED, Kopans DB, Garrido L. Physiologic changes in breast magnetic resonance imaging during the menstrual cycle; perfusion imaging, signal enhancement, and influence of the T1 relaxation time of breast tissue. *Breast J* 2005; 11:236-241.

2. Per MQSA guidelines, what is the timeframe within which lay letters must be sent to patients with BI-RADS 1 and 2 results?

- A. 10 days
- B. 30 days
- C. 60 days
- D. 90 days

Key: B

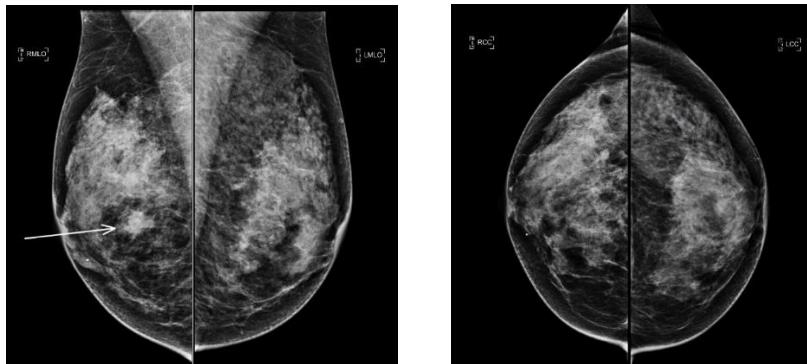
Rationale:

MQSA requirement is 30 days.

Reference:

MQSA regulations.

3. What is the best BI-RADS descriptor for the finding depicted by the arrow on the right MLO view?



- A. Oval mass
- B. Irregular mass
- C. Focal asymmetry
- D. Asymmetry

Key: D

Rationale:

- A. In order for a mammographic finding to be classified as a mass, it needs to be seen on two orthogonal projections. The finding demonstrated by the arrow is seen on only one view. A one-view-only mammographic finding is called an asymmetry prior to diagnostic imaging evaluation. Most (>75%) asymmetries represent summation artifacts; the rest are found to be other types of asymmetry or masses.
- B. An irregular mass can only be classified as such if seen on two orthogonal projections and following evaluation of its margins on spot compression views. In this case, the finding is demonstrated on only one view and no spot compression views are shown.
- C. A focal asymmetry: formerly called focal asymmetric density, is an asymmetry of fibroglandular-tissue density seen on two different mammographic projections but lacking the convex-outward contours and conspicuity of a mass. It usually represents an island of normal dense breast tissue, but its lack of specific benign characteristics may warrant further evaluation, especially if it is not interspersed with fat. In a retrospective study of 300 consecutive nonpalpable breast cancers, 3% were identified as focal asymmetries. The likelihood of malignancy among findings characterized as focal asymmetry (without associated mass, calcifications, architectural distortion, sonographic abnormality, or palpable correlate) is <1%.
- D. A one-view-only mammographic finding is called an asymmetry prior to diagnostic imaging evaluation. Most (>75%) asymmetries represent summation artifacts; the rest are found to be other types of asymmetry or masses. In this case, the finding is demonstrated on one-view only as part of a screening study without diagnostic workup shown.

Reference:

D'Orsi CJ, Sickles EA, Mendelson EB, Morris EA et al. ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System.5th Edition. Reston, VA, American College of Radiology. 2013; 223-243.

4. What is the most appropriate management of a developing mammographic asymmetry with no sonographic correlate in a 50 year-old patient?

- A. Routine screening mammography
- B. Six month follow up
- C. Breast MRI
- D. Stereotactic core biopsy

Key: D

Rationale:

A. A developing mammographic asymmetry is a focal asymmetry that is new, larger, or denser on current examination than previously. The likelihood of malignancy among findings characterized as developing asymmetry is approximately 15%. Routine screening mammography would not be appropriate in this setting.

B. A developing mammographic asymmetry is a focal asymmetry that is new, larger, or denser on current examination than previously. The likelihood of malignancy among findings characterized as developing asymmetry is approximately 15%. Six month follow up is reserved for findings that have a <2% chance of malignancy and therefore would not be appropriate in this setting.

C. A developing mammographic asymmetry is a focal asymmetry that is new, larger, or denser on current examination than previously. The likelihood of malignancy among findings characterized as developing asymmetry is approximately 15%. Breast MRI would not really change management since the mammographic finding needs to be evaluated with biopsy.

D. A developing mammographic asymmetry is a focal asymmetry that is new, larger, or denser on current examination than previously. The likelihood of malignancy among findings characterized as developing asymmetry is approximately 15%. In the absence of a sonographic correlate, stereotactic core biopsy would be appropriate.

Reference:

Sickles EA. (2011) Mammography: Asymmetries, Masses, and Architectural Distortion. In: Hodler J., von Schultheiss GK, Zollikofer CL (eds) Diseases of the Heart and Chest, Including Breast 2011-2014. Springer, Milano.

5. In evaluating the axilla in a patient with breast carcinoma, which axillary lymph node feature is considered MOST suspicious for metastatic involvement of the node?

- A. Nodal short axis size greater than 2 cm
- B. Focal cortical thickening of 2 mm
- C. Hilar effacement
- D. Cortical lobulations

Key: C

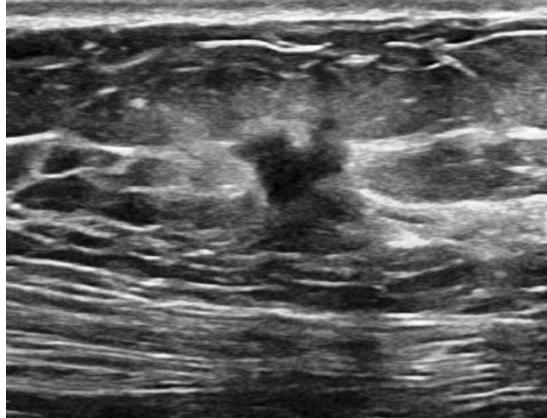
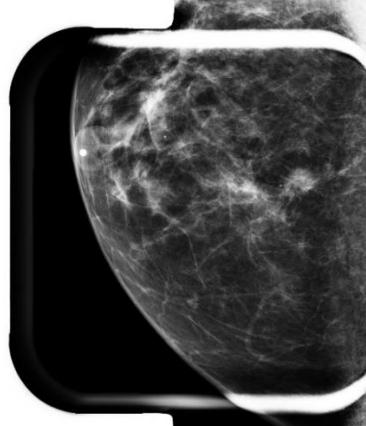
Rationale:

- A. Benign axillary lymph nodes are typically smaller than 2 cm in maximal size. However, morphologic criteria of the node such as cortical thickening, hilar effacement and non-hilar cortical flow are more important than size criteria in identification of metastatic disease.
- B. Characteristics of lymph nodes concerning for malignancy include cortical thickness greater than 3 mm.
- C. Hilar effacement is considered a characteristic of a lymph node concerning for malignancy.
- D. Cortical lobulations are often seen in normal lymph nodes and are not considered concerning for malignancy in the absence of other findings.

Reference:

Sun SC, Moseley TW, Kuerer HM and Yang WT. Imaging-based approach to axillary lymph node staging and sentinel lymph node biopsy in patients with breast cancer. AJR 2020;214(2): 249-258.

6. A 40 year-old patient is recalled from screening mammography for a spot compression view and ultrasound, as shown. What is the most appropriate Bi-Rads Category?



- A. 2
- B. 3
- C. 4
- D. 6

Key: C

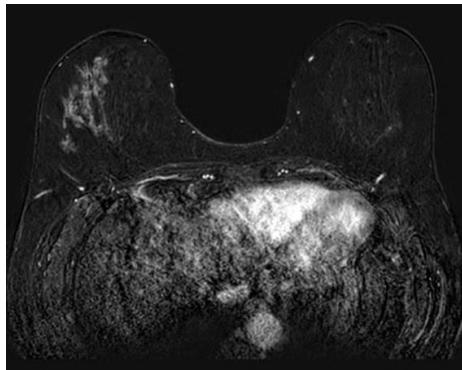
Rationale:

- A. BiRads category 2 is used for benign findings. In this example, the findings are suspicious and should be coded as Bi-Rads 4.
- B. Bi-Rads category 3 is used for probably benign findings that carry a less than 2% chance of malignancy. In this example, the findings are suspicious and should be coded as Bi-Rads 4.
- C. Correct. Findings shown here are suspicious, require biopsy and should be coded Bi-Rads category 4.
- D. Bi-Rads category 6 should be used for biopsy proven malignancy, which is not the case here since biopsy has not yet occurred.

Reference:

D'Orsi CJ, Sickles EA, Mendelson EB, Morris EA et al. ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System.5th Edition. Reston, VA, American College of Radiology. 135.

7. What is the best description of the enhancement pattern in the right breast?



- A. Diffuse moderate background
- B. Linear fibrocystic
- C. Multiregional non mass
- D. Regional clumped nodular

Key: D

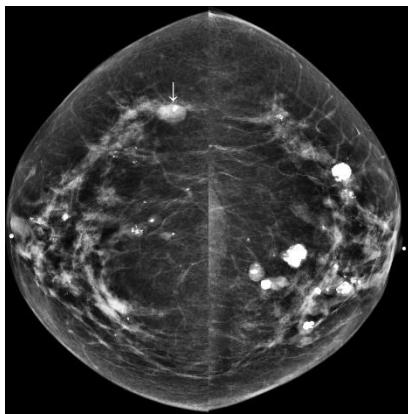
Rationale:

- A. Background parenchymal enhancement is the descriptor used for bilateral overall pattern of enhancement, which is usually diffuse and symmetric. In this case, there is focal enhancement of the lateral right breast which is asymmetric and not diffusely present.
- B. Linear fibrocystic enhancement. While fibrocystic enhancement can appear linear, a diagnosis of linear fibrocystic enhancement cannot be made without biopsy of the linear area.
- C. Multiregional non mass enhancement is most often due to background enhancement.
- D. Regional non mass enhancement is defined as an area of enhancement that involves more than 25% of a quadrant and does not appear to conform to a ductal distribution. Internal enhancement pattern of clumped further characterizes the findings.

Reference:

Giess CS, Raza S, Birdwell RL. Patterns of nonmasslike enhancement at screening breast mr imaging of high-risk premenopausal women. Radiographics 2013; 33(5).

8. What is the MOST likely etiology of the mass indicated by the arrow?



- A. Fibroadenoma
- B. Metastasis from a non-breast primary
- C. Invasive ductal carcinoma with DCIS
- D. Intracystic papillary carcinoma

Key: A

Rationale:

- A. Bilateral coarse or popcorn calcifications, many of which are located within circumscribed masses, are typically benign and consistent with bilateral fibroadenomas.
- B. Metastatic disease may also present as bilateral masses but is much less common than fibroadenomas and does not usually calcify.
- C. Invasive ductal carcinoma with DCIS may calcify but the calcifications would be a suspicious-type morphology (amorphous, coarse heterogeneous, fine pleomorphic, or fine linear). Additionally, the bilateral multiple masses are not a typical distribution for invasive ductal carcinoma, which is usually a unilateral finding.
- D. Intracystic papillary carcinoma (ICPC) typically presents as a unilateral mass, or less commonly multiple unilateral masses. ICPC is usually a round or oval circumscribed mass, usually without associated calcification.

Reference:

Sickles, EA, D'Orsi CJ, Bassett LW, et al. ACR BI-RADS® Mammography. ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System. 2013. Pages 72-76 and 101-102.

9. A 48-year-old patient with a family history of breast cancer (mother, diagnosed at age 42) also has a history of (non-pseudoplastic) lobular carcinoma in situ found after excision of right breast calcifications. What annual screening protocol should be advised?

- A. Mammography and MRI
- B. Ultrasound and MRI
- C. Mammography and FDG PET-MRI
- D. Ultrasound and thermography

Key: A

Rationale:

A. Women with lobular neoplasia - atypical lobular hyperplasia or lobular carcinoma in situ (LCIS) - have a lifetime risk of 10% to 20%. For women with LCIS at biopsy, breast cancer risk is bilateral, and most cancers occur more than 15 years after the diagnosis. Atypical ductal hyperplasia (ADH) confers increased risk but to a lesser degree than LCIS. At a median follow-up of 17 years, the relative risk for invasive cancer is 4- to 5-fold for women with ADH and 6- to 10-fold for women with LCIS. Recent work shows the cumulative risk for invasive cancer 10 years after a diagnosis of ADH was 2.6 times higher than without ADH. For women with personal histories of breast cancer not included in the above, or with LCIS or atypia on prior biopsy, MRI should be considered, especially if other risk factors are present.

B. There is no evidence to support screening ultrasound and MRI without mammography in women with a history of LCIS. Women with lobular neoplasia - atypical lobular hyperplasia or lobular carcinoma in situ (LCIS) - have a lifetime risk of 10% to 20%. For women with LCIS at biopsy, breast cancer risk is bilateral, and most cancers occur more than 15 years after the diagnosis. Atypical ductal hyperplasia (ADH) confers increased risk but to a lesser degree than LCIS. At a median follow-up of 17 years, the relative risk for invasive cancer is 4- to 5-fold for women with ADH and 6- to 10-fold for women with LCIS. Recent work shows the cumulative risk for invasive cancer 10 years after a diagnosis of ADH was 2.6 times higher than without ADH [For women with personal histories of breast cancer not included in the above, or with LCIS or atypia on prior biopsy, MRI should be considered, especially if other risk factors are present.

C. There is no evidence to support PET-MRI for screening in this population. Women with lobular neoplasia - atypical lobular hyperplasia or lobular carcinoma in situ (LCIS) - have a lifetime risk of 10% to 20%. For women with LCIS at biopsy, breast cancer risk is bilateral, and most cancers occur more than 15 years after the diagnosis. Atypical ductal hyperplasia (ADH) confers increased risk but to a lesser degree than LCIS. At a median follow-up of 17 years, the relative risk for invasive cancer is 4- to 5-fold for women with ADH and 6- to 10-fold for women with LCIS. Recent work shows the cumulative risk for invasive cancer 10 years after a diagnosis of ADH was 2.6 times higher than without ADH. For women with personal histories of breast cancer not included in the above, or with LCIS or atypia on prior biopsy, MRI should be considered, especially if other risk factors are present.

D. There is no evidence to support this combination of modalities for screening in this population. Women with lobular neoplasia - atypical lobular hyperplasia or lobular carcinoma in situ (LCIS) - have a lifetime risk of 10% to 20%. For women with LCIS at biopsy, breast cancer risk is bilateral, and most cancers occur more than 15 years after the diagnosis. Atypical ductal hyperplasia (ADH) confers increased risk but to a lesser degree than LCIS. At a median follow-up of 17 years, the relative risk for invasive cancer is 4- to 5-fold for women with ADH and 6- to 10-fold for women with LCIS. Recent work shows the cumulative risk for invasive cancer 10 years after a diagnosis of ADH was 2.6 times higher than without ADH. For women with personal histories of breast cancer not included in the above, or with LCIS or atypia on prior biopsy, MRI should be considered, especially if other risk factors are present.

Reference:

Monticciolo DL, Newell MS, Moy L, Niell B, Monsees B, Sickles EA. Breast Cancer Screening in Women at Higher-Than-Average Risk: Recommendations From the ACR. JACR J Am Coll Radiol. 2018 Mar; 15(3 Pt A):408-414. doi: Review/guidelines.

10. A patient presents for baseline screening mammography. How many circumscribed masses must be present for the mammogram to be classified BI-RADS 2?

- A. At least 2, with 1 in each breast
- B. At least 3, with 1 in each breast
- C. At least 4, with 1 in each breast
- D. At least 5, with 2 in each breast

Key: B

Rationale:

If multiple bilateral similar-appearing circumscribed masses are seen on screening mammography, the case can be considered BIRADS Category 2: Benign if there are at least a total of 3 masses, with at least 1 in each breast.

Reference:

JW Leung, EA Sickles Multiple Bilateral masses detected on screening mammography: assessment of need for recall imaging American Journal of Roentgenology 2000 Jul; 176 (1): 23-9.

Cardiac Radiology In-Training Test Questions for Diagnostic Radiology Residents



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1. Which contrast medium injection protocol appears most promising for the detection of left-to-right intracardiac shunts?
 - A. Monophasic (contrast medium only)
 - B. Biphasic (contrast medium, followed by saline)
 - C. Biphasic (contrast medium, followed by contrast medium / saline mix)
 - D. Triphasic (contrast medium, followed by contrast medium / saline mix, followed by saline)

Key: B

Rationale:

A. Saline flush improves the efficiency of contrast medium utilization by pushing the underutilized contrast medium within the injection tubing and peripheral veins into the central blood volume and having it contribute to a stronger contrast enhancement. Additionally, saline flush reduces streak artifact from dense contrast medium in the brachiocephalic vein and superior vena cava on thoracic CT studies.

B Correct - After peripheral intravenous injection, contrast medium travels to the right heart, the pulmonary circulation, and the left heart before reaching the central arterial system. As contrast medium circulates in the body, it is diluted by the blood, and the bolus disperses as it moves downstream through the circulatory system. In addition, contrast material-enhanced blood recirculates and may contribute to the overall pattern of contrast enhancement achieved at CT imaging acquisition. The shape of contrast material bolus injection can be tailored to achieve a desired enhancement pattern. With single contrast injection, the time-enhancement response progressively increases and peaks shortly after the completion of the injection and is followed by a relatively rapid decline in enhancement. This enables differential contrast concentration in the right and left heart chambers and visualization of the shunt due to difference in attenuation of the shunted blood. C and D Incorrect - A biphasic-rate injection typically results in a double-peaked arterial contrast enhancement. This is because the contrast enhancement pattern in a vessel increases earlier (because of the fast first-phase injection) and declines before the contrast material in the slow second-phase injection reaches the area of interest. This usually provides opacification of all cardiac chambers and shunted blood is not visualized.

Reference:

Bae KT. Intravenous Contrast Medium Administration and Scan Timing at CT: Considerations and Approaches. Radiology 2010;256:1, 32-6.

2. Which of the following is MOST commonly associated with sinus venosus atrial septal defect?
- A. Partial anomalous pulmonary venous return
 - B. Endocardial cushion defect
 - C. Down syndrome
 - D. Ebstein anomaly

Key: A

Rationale:

- A. Sinus venosus atrial septal defect is most associated with partial anomalous pulmonary venous return. Because of this association, special attention should be made to identify the presence or absence of a sinus venosus defect when partial anomalous pulmonary venous return is identified.
- B. Endocardial cushion defect is associated with Down syndrome.
- C. Down syndrome is associated with several congenital heart defects, including endocardial cushion defect. Sinus venosus atrial septal defect is most associated with partial anomalous pulmonary venous return.
- D. There is no documented association between Ebstein anomaly and sinus venosus atrial septal defect.

Reference:

Rajiah P, Kanne JP. Cardiac MRI: Part 1, Cardiovascular Shunts. AJR 2011 197:4, W603-W620.

3. Which is the MOST likely etiology of a diffusely enlarged right coronary artery?

- A. Stenosis
- B. Fistula
- C. Aneurysm
- D. Dissection

Key: B

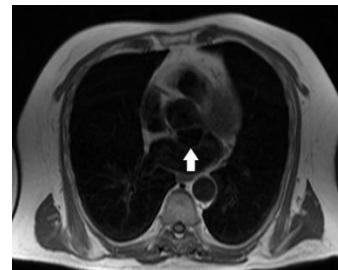
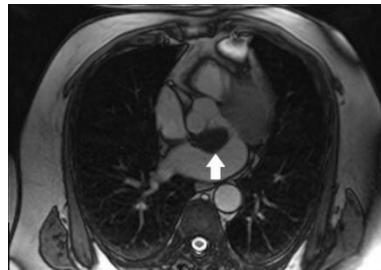
Rationale:

- A. Stenosis can cause focal distal (poststenotic) dilatation, but not diffuse enlargement of the artery.
- B. A coronary artery fistula is defined as a connection between a coronary artery and a cardiac chamber or great vessel, with the connection bypassing the myocardial capillary bed. Coronary fistulas can arise from many sites; the more proximal the site where the feeding artery arises from the main coronary artery, the more dilated the feeding artery tends to be.
- C. Coronary artery aneurysms are coronary artery segments that have a diameter that exceeds the diameter of normal adjacent coronary segments or the diameter of the patient's largest coronary vessel by 1.5 times and involve less than 50% of the total length of the vessel, whereas coronary artery ectasia involves $\geq 50\%$ of the coronary artery length.
- D. Imaging findings seen in coronary artery dissection include luminal stenosis, focal wall thickening (intramural hematoma) and linear hypodensity ("flap"). There is no associated diffuse enlargement of the artery.

Reference:

- Díaz-Zamudio M, Bacilio-Pérez U, Herrera-Zarza MC, Meave-González A, Alexanderson-Rosas E, Zambrana-Balta GF, Kimura-Hayama ET. Coronary artery aneurysms and ectasia: role of coronary CT angiography. Radiographics. 2009; 29:1939-1954.

4. What is the most likely etiology of the lesion denoted by the white arrows in this 76-year-old man in whom a mass was detected along his aortic valve on recent echocardiography?



- A. Rhabdomyoma
- B. Fibroma
- C. Lipomatous hypertrophy of the atrial septum
- D. Papillary fibroelastoma

Key: D

Rationale:

A and B are Incorrect - because rhabdomyomas and fibromas are typically seen in the pediatric population. Rhabdomyomas are typically isointense on T1, slightly hyperintense on T2 and demonstrate minimal enhancement on delayed gadolinium imaging. They favor the ventricular myocardium, and are multiple in number in 90% of affected patients. More than 50% of affected patients carry the diagnosis of tuberous sclerosis.

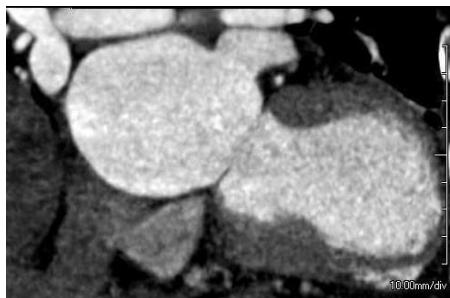
C. Lipomatous hypertrophy of the atrial septum is characterized by fat deposition. The lesion in this case does not follow fat signal characteristics on the provided pulse sequences.

D. Papillary fibroelastomas are the most common neoplasm of the cardiac valves, and the second most common benign cardiac neoplasm. They classically present in older adults and are typically hypointense on both T1 and T2 sequences, owing to their high fibrous content. They can be indistinguishable from thrombus and myxoma. They may be asymptomatic; however, they can also result in stenosis or insufficiency of the affected valve. They can be treated with excision or valve replacement.

Reference:

Abbara S, et al. Papillary Fibroelastoma Diagnostic Imaging: Cardiovascular 2008. I4 22-23.

5. What is the diagnosis based on this systolic cine CT image of a recently widowed 60-year-old woman with chest pain?



- A. Amyloidosis
- B. Hypertrophic obstructive cardiomyopathy
- C. Takotsubo cardiomyopathy
- D. Fabry Disease

Key: C

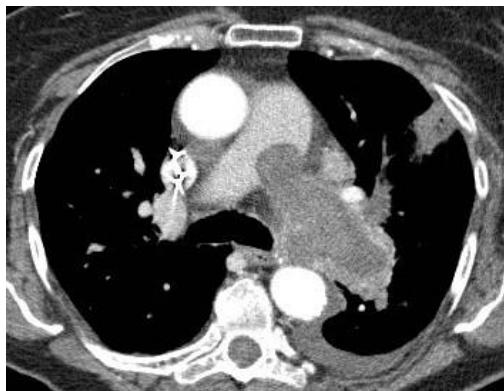
Rationale:

- A. Cardiac amyloidosis typically shows diffuse myocardial thickening without segmental wall motion abnormalities as shown here.
- B. The basal myocardium is normal in this case. The abnormality on the CT image is the dilatation of the apical portion of the left ventricle.
- C. Apical ballooning is shown on the provided image; along with the provided history of a recent stressful event, this finding is characteristic of Takotsubo cardiomyopathy. This cardiomyopathy occurs more often in postmenopausal elderly women, is characterized by a transient hypokinesis of the left ventricular (LV) apex and is associated with emotional or physical stress.
- D. Cardiac involvement by Fabry disease is characterized by myocardial hypertrophy and it commonly affects the basal inferolateral wall as opposed to apical involvement in Takotsubo cardiomyopathy.

Reference:

Komamura K, Fukui M, Iwasaku T, Hirotani S, Masuyama T. Takotsubo cardiomyopathy: Pathophysiology, diagnosis and treatment. World Journal of Cardiology 2014; 6(7):602-609.
doi:10.4330/wjc.v6.i7.602.

6. A 73-year old male presents with chronic chest pain and worsening shortness of breath. Based on the image provided, what is the next most appropriate step?



- A. FDG-PET/CT
- B. Anticoagulation
- C. Follow up CT in 3-6 months
- D. Echocardiography

Key: A

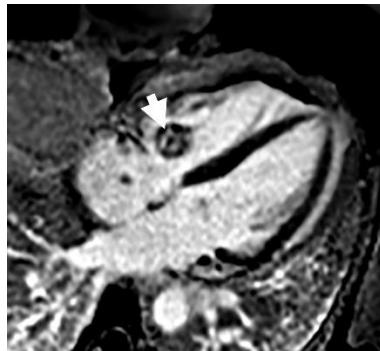
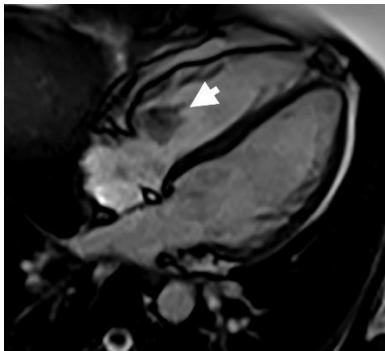
Rationale:

- A. The abnormality shown represents a pulmonary artery intimal sarcoma. Of the options provided FDG-PET/CT is the most likely to distinguish the lesion from pulmonary thromboembolism and confirm the presence of neoplasm.
- B. The abnormality shown represents a pulmonary artery intimal sarcoma. Anticoagulation alone would be inadequate. The patient would likely return with worsening symptoms and more advanced disease.
- C. The abnormality shown represents a pulmonary artery intimal sarcoma. Follow up CT in 3-6 months would also be inappropriate, as it would result in an unnecessary delay in diagnosis.
- D. The abnormality shown represents a pulmonary artery intimal sarcoma. Echocardiography could perhaps distinguish the lesion from thromboembolic disease by demonstrating internal vascularity on color Doppler imaging, however it is less likely to confirm the diagnosis of neoplasm than FDG-PET/CT.

Reference:

Ropp AR, Burk AP, Kligerman SJ, Leb JS, and Frazier AA. Intimal Sarcoma of the Great Vessels: From the Archives of the AIRP Radiographics Accepted for publication March – April 2021.

7. What is the MOST LIKELY diagnosis in this patient with the above findings (arrows)?



- A. Metastasis
- B. Myxoma
- C. Angiosarcoma
- D. Papillary Fibroelastoma

Key: A

Rationale:

A. Cardiac metastasis are 20-40 times more common than primary cardiac neoplasms. Metastases to the heart occur via lymphatics, hematogenous spread, direct extension, or transvenous spread. Cardiac metastases are typically hypointense on T1 weighted imaging and hyperintense on T2 weighted imaging. Most metastases enhance with gadolinium. Thrombus is the most common intracardiac mass, however these are most commonly found in the atria and adjacent to aneurysms and do not enhance. Patients may exhibit obstructive symptoms depending on site of flow obstruction. Surgery, chemotherapy, or radiation are often required.

B. Myxomas are the most common benign primary cardiac tumor. They are most common in the left atrium and are often attached to the interatrial septum by a stalk-like attachment. They may exhibit enhancement on post-contrast imaging.

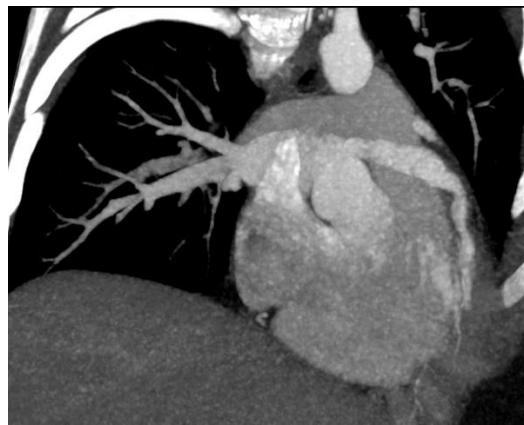
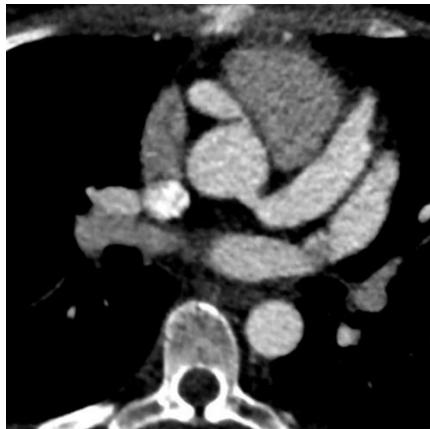
C. Angiosarcoma is a rare primary malignant cardiac tumor. They are infiltrative, aggressive-appearing tumors which most commonly arise from the walls of the atria. They are heterogeneously isointense on T1 weighted imaging and heterogeneously hyperintense on T2 weighted imaging. They usually exhibit heterogeneous enhancement. Prognosis is dependent upon location, mitotic rate, and presence of metastases.

D. Papillary fibroelastoma is the second most common benign primary cardiac neoplasm (myxoma is most common). They are pedunculated masses which typically arise from the aortic and mitral valves. They are round, oval, or irregular in shape and are connected via a thin stalk to the valve leaflet. Unlike vegetations, they often form on the body of the valve away from free edge of the leaflet. They are isointense on T2-weighted imaging and may enhance. Surgical excision is curative.

Reference:

Caroline Chiles, Pamela K. Woodward, Fernando R. Gutierrez, Kerry M. Link Metastatic Involvement of the Heart and Pericardium: CT and MR Imaging Radiographics 2001; 21(2):439-449.

8. Based upon axial and coronal images from a contrast-enhanced CT angiogram, what is the MOST likely etiology of the abnormality in this 9-year-old boy with chest pain?



- A. Iatrogenic
- B. Idiopathic
- C. Vasculitis
- D. Atherosclerosis

Key: C

Rationale:

- A. Iatrogenic injury is unlikely in a young child without a stent or history of prior intervention.
- B. In the United States, atherosclerosis is the most common cause for coronary artery aneurysm disease; however, Kawasaki disease is the most common cause in some countries and in pediatric population. Coronary artery aneurysm or ectasia develop in 15%–25% of untreated children with Kawasaki disease.
- C. Multiple coronary arteries aneurysms in a young child suggest Kawasaki disease.
- D. Atherosclerosis is not evident on imaging and would be inconsistent with patient's age.

Reference:

Johnson PT, Fishman EK. CT angiography of coronary artery aneurysms: detection, definition, causes, and treatment. AJR Am J Roentgenol. 2010 Oct; 195(4):928-34.

9. What is the metallic object overlying the heart on this PA chest radiograph?



- A. Implantable loop recorder
- B. Leadless pacemaker
- C. Subcutaneous cardioverter-defibrillator
- D. Object external to patient

Key: B

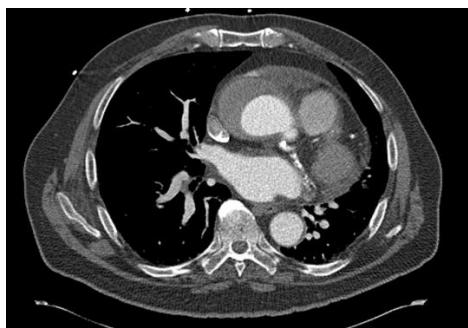
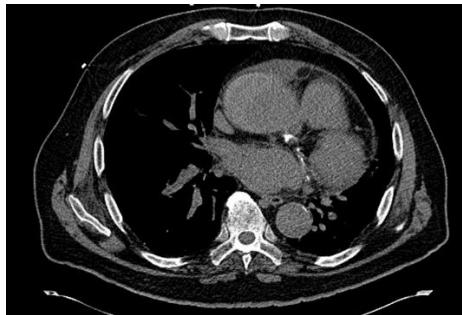
Rationale:

- A. Implantable loop recorders, also known as insertable cardiac monitors, are small devices that are placed subcutaneously, usually in the subcutaneous tissue overlying the left pectoralis muscle.
- B. A leadless cardiac pacemaker is seen as a radiolucent oblong small device in the right ventricle. It is important to differentiate these from loop recorders which are longer and more rectangular in shape reminiscent of a USB stick, whereas these are more cylindrical with more rounded edges. Positioning can be confirmed on lateral views.
- C. Subcutaneous cardioverter-defibrillator is visualized on radiographs as a long lead along the left sternal border and generator close to the left mid-axillary line.
- D. This is a typical appearance of implantable loop recorder.

Reference:

Aguilera AL, Volokhina YV, Fisher KL. Radiography of cardiac conduction devices: a comprehensive review. *Radiographics*. 2011 Oct; 31(6):1669-82.

10. Based on these axial unenhanced (Figs. A, B) and contrast-enhanced (Figs. C, D) CT images of a 70-year-old man who presented with the acute onset of chest pain, what is the diagnosis?



- A. Stanford Type A aortic dissection
- B. Stanford Type B aortic dissection
- C. Aortic intramural hematoma
- D. Penetrating atherosclerotic ulcer

Key: C

Rationale:

- A. The key finding on contrast-enhanced images is an intimal flap separating two lumens that extends in a longitudinal spiral fashion. Often, there is a convexity of the intimal flap toward the false lumen that surrounds the true lumen.
- B. Characteristic findings of an aortic intramural hematoma include a crescentic hyperattenuating fluid collection at unenhanced computed tomography (CT) and a smooth, nonenhancing, thickened aortic wall at contrast material–enhanced CT.
- C. Stanford Type B refers to descending not ascending aortic dissection
- D. Penetrating atherosclerotic ulcer is a focal ulceration penetrating through the aortic intima into the aortic wall, usually in the mid to distal third of the descending aorta

Reference:

Litmanovich D, Bankier AA, Cantin L, Raptopoulos V, Boiselle PM. CT and MRI in diseases of the aorta. AJR Am J Roentgenol. 2009 Oct; 193(4):928-40. doi: 10.2214/AJR.08.2166. PMID: 19770313.

Chest Radiology In-Training Test Questions for Diagnostic Radiology Residents



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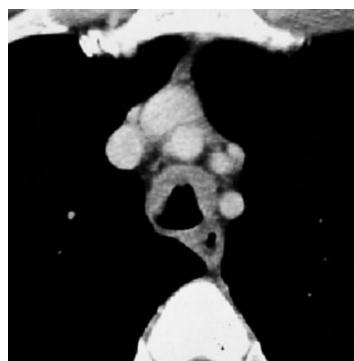
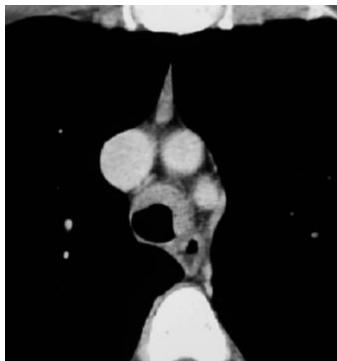
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1. What is the MOST likely diagnosis in a 56-year-old woman with increasing cough and the following images from a CT scan?



- A. Adherent mucus
- B. Amyloidosis
- C. Mucoepidermoid carcinoma
- D. Tracheobronchopathia osteochondroplastica

Key: B

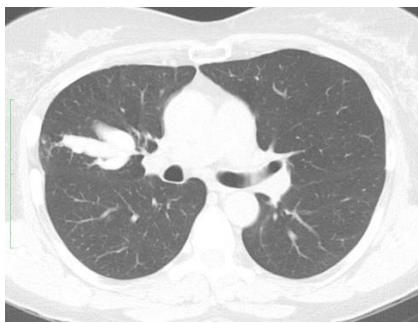
Rationale:

- A. Although adherent mucus is not infrequently seen along both dependent and non-dependent areas of the tracheobronchial tree, it is most often lower in attenuation than soft tissue.
- B. Contrast-enhanced chest CT (mediastinal window) shows abnormal soft tissue extending anterolaterally along the tracheal wall and narrowing the lumen. There is no soft tissue infiltration or obliteration of adjacent peritracheal tissue planes. Amyloidosis is a rare disease that may affect the lung or tracheobronchial tree. Tracheobronchial involvement is the most common and severe form of thoracic amyloidosis, is rare and usually involves the trachea in a slow, indolent manner. Affected patients may be asymptomatic or have dyspnea, cough, hemoptysis and hoarseness. On CT, amyloidosis manifests as nodular or plaque-like focal or circumferential airway thickening and may result in irregular narrowing or luminal occlusion. Calcification within the areas of mural thickening and associated paratracheal/peribronchial lymphadenopathy may also be seen.
- C. Mucoepidermoid carcinoma manifests as a polypoid, well-defined endoluminal nodule or mass typically found in the central bronchi. Affected patients are usually young adults and children presenting with cough, hemoptysis and/or wheezing. CT often shows a well-defined ovoid or lobular endoluminal mass that parallels the orientation of the airway in which it originates. Intrinsic foci of high attenuation or calcification may be present.
- D. Tracheobronchopathia osteochondroplastica typically manifests on CT as small multifocal mural nodules in the trachea and proximal bronchi, with calcification of some or all nodules; and characteristically spares the membranous posterior of the tracheal wall.

Reference:

Parker MS, Rosado de Christenson ML, Abbott GF Airways Disease Chest Imaging Case Atlas 2nd edition 2012, Thieme, New York; pp. 149-152.

2. Which one of the following pulmonary diseases does the patient likely have?



- A. Chronic obstructive pulmonary disease (COPD)
- B. Lung cancer
- C. Asthma
- D. Pneumoconiosis

Key: C

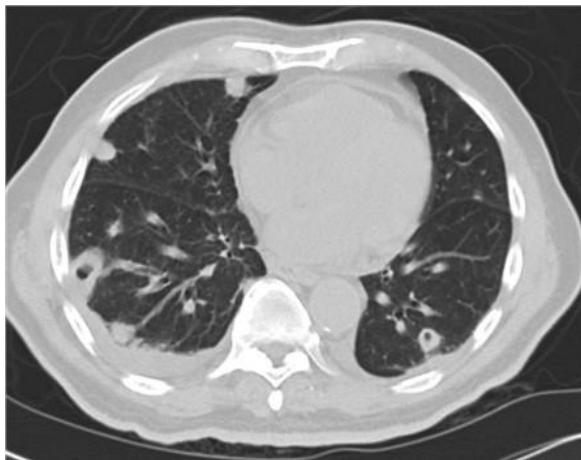
Rationale:

- A. Allergic bronchopulmonary aspergillosis is associated with asthma.
- B. Allergic bronchopulmonary aspergillosis is associated with asthma.
- C. Allergic bronchopulmonary aspergillosis (ABPA) is an immunologically mediated lung disease that predominantly affects patient with longstanding asthma. The classic radiographic presentation is demonstrated in this case with central bronchiectasis with high attenuation mucus.
- D. Allergic bronchopulmonary aspergillosis is associated with asthma.

Reference:

Shah A, Panjabi C Allergic aspergillosis of the respiratory tract Eur Respir Rev 2014 Mar 1; 23(131):8-29.

3. What is the MOST likely diagnosis?



- A. Septic emboli
- B. Metastatic renal cell cancer
- C. Langerhans cell histiocytosis
- D. Pulmonary lymphoma

Key: A

Rationale:

- A. Images show multiple nodules, some with cavitation in both lungs. Findings are mostly in the peripheral aspect suggesting hematogenous spread. Combination of those findings suggest septic emboli.
- B. Renal cell metastasis do not cavitate.
- C. Langerhans cell histiocytosis appears as irregular cysts in both lungs.
- D. Incorrect.

Reference:

Michael B. Gotway, Shelley R. Marder, Douglas K. Hanks, Jessica W. T. Leung, Samuel K. Dawn, Alisa D. Gean, Gautham P. Reddy, Philip A. Araoz, W. Richard Webb. Thoracic Complications of Illicit Drug Use: An Organ System Approach. RadioGraphics. Volume 22, Issue suppl_1 Oct 1 2002.

4. What is the MOST likely diagnosis?



- A. Sarcoidosis
- B. Lung cancer
- C. Asbestosis
- D. Amyloidosis

Key: A

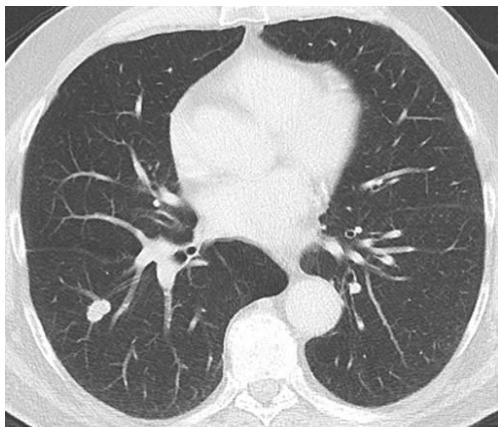
Rationale:

- A. Central lung dominant bilateral military micronodules, and bilateral pathologically enlarged hilar lymph nodes are classic imaging findings of sarcoidosis.
- B. The bilateral central lung lesions with peribronchial changes do not suggest primary lung cancer.
- C. Peripheral and lower lung dominant interstitial lung fibrosis and pleural changes are typical of lung disease related to asbestos exposure. These features are absent in this case.
- D. Pulmonary nodules / consolidation / airway thickening with calcifications are classic for amyloidosis. These features are absent in this case.

Reference:

Dhakshinamoorthy Ganeshan , Christine O. Menias, Meghan G. Lubner, Perry J. Pickhardt, Kumaresan Sandrasegaran, Sanjeev Bhalla. Sarcoidosis from Head to Toe: What the Radiologist Needs to Know. Radiographics. Vol 38, issue 4, July 1, 2018.

5. You are shown a CT image of a 74-year-old man with a 2 cm adenocarcinoma in the right lower lobe. Which one of the following nodal station would preclude the patient from having surgery?



- A. Right Hilar
- B. Left Hilar
- C. Right Paratracheal
- D. Subcarinal

Key: B

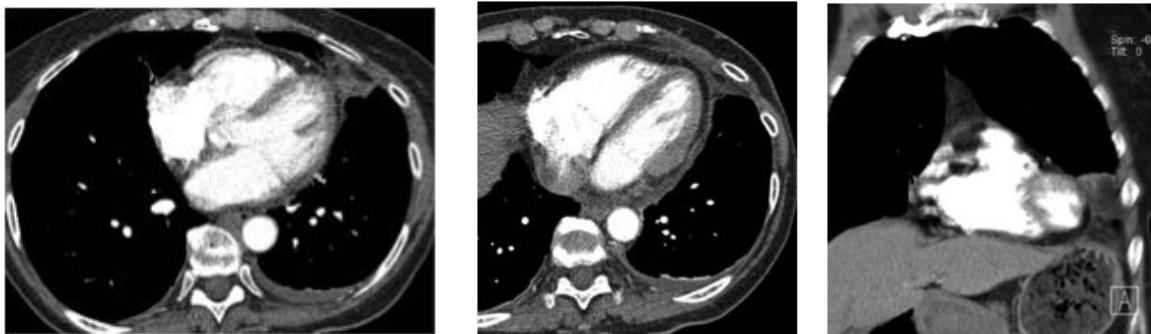
Rationale:

- A. Right hilar lymph node in someone with right-sided bronchogenic carcinoma is ipsilateral hilar disease, N1 and resectable if no distant metastases.
- B. Left hilar disease in someone with right-sided bronchogenic carcinoma is contralateral hilar disease which is N3, usually precludes surgical resection.
- C. Ipsilateral mediastinal disease is considered N2, still resectable assuming no distant metastases.
- D. Subcarinal disease is considered N2, still resectable assuming no distant metastatic disease.

Reference:

Stacy J. UyBico, Carol C. Wu, Robert D. Suh, Nanette H. Le, Kathleen Brown, Mayil S. Krishnam. Lung Cancer Staging Essentials: The New TNM Staging System and Potential Imaging Pitfalls. Radiographics, Vol 30, issue 5, Aug 31, 2010.

6. Based upon these CT images from a 37 year-old man presenting with acute chest pain, what is the MOST likely diagnosis?



- A. Sarcoma
- B. Epipericardial fat necrosis
- C. Non-Hodgkins lymphoma
- D. Morgagni hernia

Key: B

Rationale:

- A. Lack of enhancing soft tissue component and preserved tissue planes argues against a malignant tumor such as sarcoma.
- B. Epicardial fat necrosis appears as hazy changes in the anterior mediastinal fat.
- C. Lymphoma would appear as a mass in the mediastinum.
- D. Morgagni hernia occurs at the right cardiophrenic angle and would contain portions of the abdominal content such as bowel, and omentum.

Reference:

Giassi Kde S1, Costa AN, Bachion GH, Apanavicius A, Filho JR, Kairalla RA, Lynch DA. Epipericardial fat necrosis: an underdiagnosed condition. Br J Radiol. 2014 Jun; 87(1038):20140118. doi: 10.1259/bjr.20140.

7. What is the MOST likely diagnosis?



- A. Mediastinal hematoma
- B. Sternal dehiscence
- C. Pericardial effusion
- D. Pneumomediastinum

Key: B

Rationale:

- A. The patient has malaligned sternal wires, an arterial blood gas is not necessary.
- B. Sternal dehiscence appears as a shift in alignment of the sternal wires.
- C. Pericardial effusion would not be visible on the portable chest radiograph.
- D. Pneumomediastinum would demonstrate irregular lucencies representing air in the mediastinum. This is not present on the provided image.

Reference:

Boiselle PM, Mansilla AV, Fisher MS, McLoud TC. Wandering wires: frequency of sternal wire abnormalities in patients with sternal dehiscence. American Journal of Roentgenology 1999 Sep; 173(3):777-80.

8. Which one of the following is MOST likely true concerning diffuse tracheal abnormality?
- A. There is circumferential thickening of the trachea in Wegener Granulomatosis
 - B. Tracheobronchopathia Osteochondroplastica is a pre-malignant condition
 - C. Relapsing polychondritis affects the posterior membrane of the trachea
 - D. Widening of the transverse diameter of the trachea is seen in saber-sheath trachea

Key: A

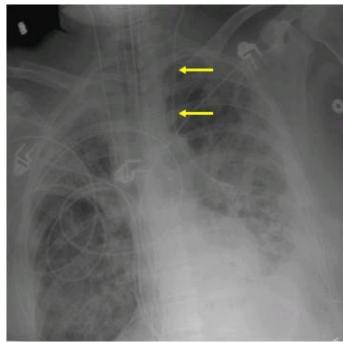
Rationale:

- A. Wegner granulomatosis causes circumferential thickening of the trachea.
- B. Tracheobronchopathia Osteochondroplastica is a benign condition.
- C. Relapsing polychondritis affects the anterior and lateral portions of the trachea as it causes inflammation of the cartilage.
- D. Saber sheath trachea causes narrowing of the transverse diameter of trachea.

Reference:

JS Kwong, NL Müller, RR Miller. Diseases of the trachea and main-stem bronchi: correlation of CT with pathologic findings. Radiographics. Vol 12, issue 4, July 1, 1992.

9. What is the MOST likely location of the tip of the catheter denoted by the arrow?



- A. Left superior intercostal vein
- B. Left sided superior vena cava
- C. Left internal mammary vein
- D. Left upper lobe pulmonary vein

Key: D

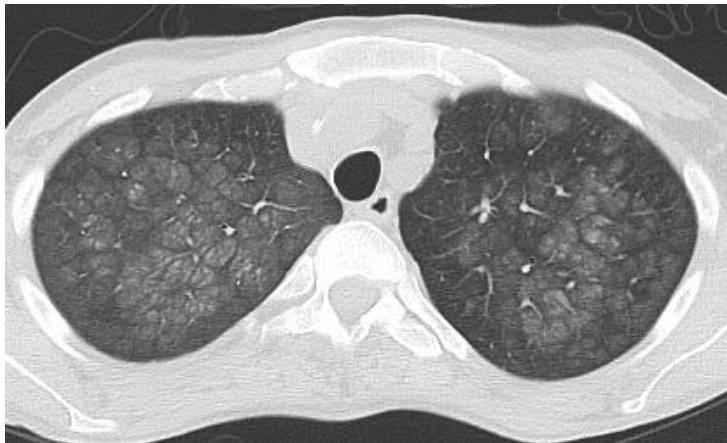
Rationale:

- A. Incorrect.
- B. A catheter in a left superior vena cava would not be expected to deviate laterally.
- C. A catheter in the left internal mammary vein would not be expected to deviate laterally.
- D. This catheter course is typical for a catheter in which has entered an anomalous left upper lobe pulmonary vein.

Reference:

Khushboo Jhala, Anji Tang, Mark Hammer. Five-Step Guide to Central Venous Catheter Placement with 3D Anatomic. Radiographics, Vol 41, issue 5, Sept 1, 2021.

10. What is the distribution of the pulmonary findings?



- A. Centrilobular
- B. Random
- C. Perilymphatic
- D. Tree-in-bud

Key: A

Rationale:

- A. These are ground glass nodules that spare the subpleural lung and interlobular septa.
- B. Random nodules are solid and randomly distributed in the lungs.
- C. Perilymphatic nodules are solid and occur on the interlobular septa and peribronchonchial distribution.
- D. They appear as branching tubular opacities.

Reference:

Raoof S1, Amchentsev A, Vlahos I, Goud A, Naidich DP. Pictorial essay: multinodular disease: a high-resolution CT scan diagnostic algorithm. Chest 2006 Mar; 129(3):805-15. Lung nodule approach.

Gastrointestinal Radiology In-Training Test Questions for Diagnostic Radiology Residents



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1. Caroli disease is characterized by saccular ectasia of which of the following?
 - A. Cystic duct
 - B. Intrahepatic bile ducts
 - C. Pancreatic duct
 - D. Extrahepatic bile ducts

Key: B

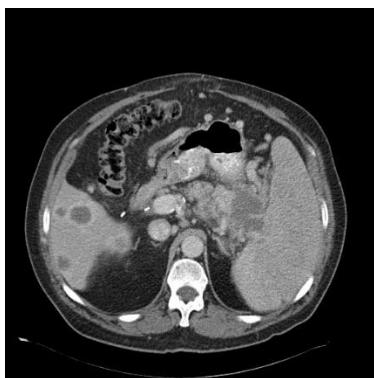
Rationale:

- A. Caroli's disease involves the intrahepatic biliary ducts.
- B. Caroli's disease involves the intrahepatic biliary ducts.
- C. Caroli's disease involves the intrahepatic biliary ducts.
- D. The extrahepatic ducts are usually spared.

Reference:

RadioGraphics 2005; 25:659–670.

2. Based on the CT findings, what is the resectability status in this patient?



- A. Borderline resectable
- B. Resectable
- C. Nonresectable

Key: C

Rationale:

- A. There are metastases in the liver.
- B. There are liver metastases.
- C. The stage IV disease (liver metastases) make this pancreatic adenocarcinoma nonresectable for cure.

Reference:

Brennan DD, Zamboni GA, Raptopoulos VD, Kruskal JB Comprehensive Preoperative Assessment of Pancreatic Adenocarcinoma with 64-Section Volumetric CT. RadioGraphics 2007; 27:1653-1666.

3. Which embryologic anomaly is associated with choledochal cysts?

- A. Pancreatic divisum
- B. Anomalous pancreaticobiliary junction
- C. Annular pancreas
- D. Low insertion of the cystic duct

Key: B

Rationale:

All represent anomalies of the pancreaticobiliary system but only anomalous pancreaticobiliary junction is associated with choledochal cysts.

Reference:

Hae Kyung Lee, MD, Seong Jin Park, MD, Bum Ha Yi, MD, A Leum Lee, MD,¹ Jong Ho Moon, MD, and Yun Woo Chang, MD. Imaging Features of Adult Choledochal Cysts: a Pictorial Review. Korean Journal of Radiol. 2009 Jan-Feb; 10(1): 71–80.

4. Patients with hereditary hemochromatosis are at increased risk for developing which of the following neoplasms?

- A. Focal nodular hyperplasia
- B. Hepatocellular carcinoma
- C. Hepatic adenoma
- D. Cholangiocarcinoma

Key: B

Rationale:

A. FNH is a benign liver lesion, with a higher incidence in women of childbearing age and using oral contraceptives. This does not have an association with hemochromatosis.

B. Hereditary (primary) hemochromatosis is an inherited disorder characterized by abnormal iron deposition in multiple organs, including the liver, pancreas, and heart. Hepatic iron overload leads to irreversible organ damage manifested by hepatic fibrosis and cirrhosis. HCC accounts for approximately 30% of deaths in patients with hereditary hemochromatosis.

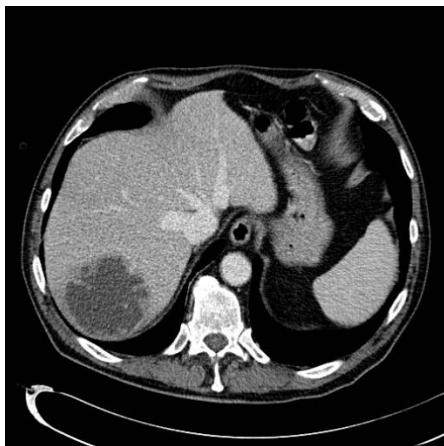
C. Hepatic adenomas are benign liver tumors associated with oral contraceptive and anabolic steroid use. Multiple hepatic adenomas may be seen in patients with glycogen storage disease. Adenomas are benign but have a risk of tumoral hemorrhage and a low risk of malignant transformation.

D. Cholangiocarcinoma is a neoplasm of the biliary tree and is associated with biliary pathology such as primary sclerosing cholangitis and choledochal cysts.

Reference:

RadioGraphics 2009; 29:1575–1589.

5. A 62-year-old man presented with abdominal pain. What condition predisposes to the findings demonstrated on the CT scan?



- A. Colonic diverticulitis
- B. Cirrhosis
- C. Pancreatitis
- D. Colonic adenocarcinoma

Key: A

Rationale:

- A. The hepatic lesions have the typical appearance of pyogenic abscesses, i.e. large hypoattenuating lesion with a lobular contour that suggests coalescence of multiple smaller abscesses into a single large cavity. Pyogenic abscesses, particularly when multiple, can be caused by hematogenous dissemination (portal venous or arterial). The presence of SMV thrombus in this case points to septic thrombophlebitis/ pylephlebitis from intraabdominal infection, most commonly diverticulitis.
- B. The hepatic masses have typical appearance of abscesses, not HCC. SMV thrombus can be secondary to cirrhosis with portal hypertension but is not usually associated with hepatic abscess.
- C. Pancreatitis is unlikely to cause liver abscesses.
- D. The hepatic abscesses in this case can mimic necrotic metastases. However, the combination of SMV thrombus and hepatic lesions points to pylephlebitis.

Reference:

RadioGraphics 2016; 36:1001–1023.

6. Based upon the findings on this CT obtained in a patient presenting with nausea, vomiting and abdominal pain, what is the MOST appropriate management of the patient?



- A. A therapeutic air or water-soluble contrast enteroclysis study
- B. Pill endoscopy to evaluate the small bowel mucosa.
- C. Surgery, as there is likely a small bowel mass as the underlying cause.
- D. No treatment, as this is likely a transient, self-limited process

Key: C

Rationale:

- A. Although air-contrast enemas may be used to reduce ileo-colonic intussusceptions in pediatric patients, such attempts at reduction are generally not successful in adults.
- B. Pill endoscopy would be contraindicated in the setting of an on-going SBO.
- C. Long segment obstructive small bowel intussusceptions in adults are most often caused by an underlying small bowel mass, either benign or malignant. Surgery is usually required to relieve the obstruction.
- D. Although self-limited/transient small bowel intussusceptions are sometimes seen on CT they are usually short segment, non-obstructive and often asymptomatic - none of which is true in this case.

Reference:

Review of SB intussusceptions on CT. The most distinguishing feature of self-limited intussusceptions was length less than 3.5 cm.

7. A patient complains of right lower quadrant pain after being admitted to the hospital with an acute myocardial infarction. A CT scan of the abdomen was performed. What is the MOST likely diagnosis?



- A. Acute appendicitis
- B. Ischemic colitis
- C. Infectious colitis
- D. Typhlitis

Key: B

Rationale:

- A. No inflamed appendix shown, pneumatosis not typical for appendicitis.
- B. Both clinical history and the finding of pneumatosis are suggestive of ischemic colitis.
- C. Both the clinical history and the finding of pneumatosis are more suggestive of ischemic colitis.
- D. No indication of neutropenia.

Reference:

Thoeni RF and Cello JP CT imaging of colitis. Radiology 2006; 240:623-638.

8. This 73-year-old woman had an incidental lesion identified within the pancreas on abdominal CT performed to evaluate a benign renal lesion. A multiphasic pancreatic CT was requested. What is the most likely diagnosis?



- A. Intraductal mucinous pancreas neoplasm
- B. Cystic pancreatic endocrine neoplasm
- C. Serous cystadenoma
- D. Mucinous cystic neoplasm

Key: B

Rationale:

- A. The margins and enhancement are not suggestive of IPMN.
- B Correct.
- C. In differential for cystic lesions but would not have hyperenhancing margins.
- D, Imaging findings not consistent with this process.

Reference:

Lewis RB, Lattin GE, Paal E. Pancreatic Endocrine Tumors: Radiologic-Clinicopathologic Correlation. RadioGraphics 2010; 30:1445-1464.

9. Where are gastrointestinal carcinoids MOST likely to occur?

- A. Esophagus
- B. Stomach
- C. Small Bowel
- D. Rectum

Key: C

Rationale:

- A. Esophageal carcinoids are rare, representing 0.05% of all gastrointestinal carcinoids and 0.02% of esophageal cancers.
- B. Approximately 9% of carcinoids occur in the stomach.
- C. Small bowel is the most common location for carcinoid tumors, accounting for 42% of carcinoids.
- D. Rectal carcinoids account for 27% of carcinoid tumors in the gastrointestinal tract.

Reference:

Levy, AD, Sabin, LH. From the Archives of the AFIP. Gastrointestinal Carcinoids: Imaging Features with Clinicopathologic Comparison RadioGraphics 2007; 27:237-257. | RadioGraphics 2007; 27:237-257.

Genitourinary Radiology In-Training Test Questions for Diagnostic Radiology Residents



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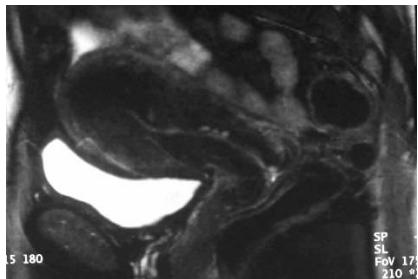
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1. In a 50 year-old patient with unilateral small, smooth kidney, which of the following is the MOST LIKELY etiology?

- A. Acute renal vein thrombosis.
- B. Lymphoma
- C. Autosomal dominant polycystic kidney disease
- D. Renal artery stenosis

Key: D

2. What is the MOST likely diagnosis?



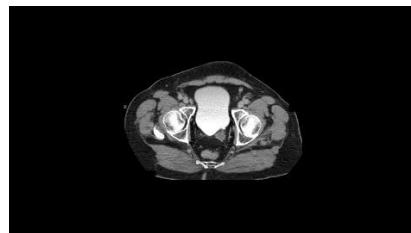
- A. Leiomyoma
- B. Adenomyosis
- C. Endometrial cancer
- D. Cervical cancer

Key: B

Rationale:

Although leiomyomas typically have low intensity on T2 weighted images, they would be expected to be round and well defined.

3. What accounts for the appearance of the right renal fossa?



- A. Previous nephrectomy
- B. Renal agenesis
- C. Ectopic kidney
- D. Multicystic dysplastic kidney

Key: B

4. What is the MOST likely diagnosis?



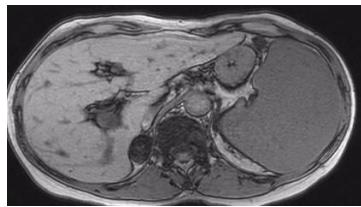
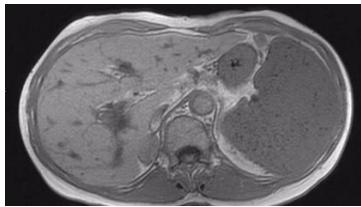
- A. Urachal cyst
- B. Patent urachus
- C. Adenocarcinoma
- D. Metastatic implant

Key: A

Rationale:

- A. This is a typical appearance of a urachal cyst -- a midline cyst above bladder dome, which typically has low density contents due to mucin production. It may have rim calcification, as in this case. There is no communication with the urinary bladder or umbilicus. The spectrum of anomalies due to incomplete obliteration of the embryonic connection between the bladder dome and the allantoic duct includes: Patent urachus: Entire urachal channel fails to close; Urachal cyst: Umbilical and bladder openings close; channel in between remains open and fluid filled, as in this case; Urachal sinus: Dilatation of urachus at umbilical end; does not communicate with bladder; Urachal diverticulum (or urachal remnant): Dilatation of urachus at vesical end; does not communicate with umbilicus.
- B. In patent urachus, which also falls on the spectrum of anomalies due to incomplete obliteration of the embryonic connection between the bladder dome and the allantoic duct, the entire urachal channel fails to close. In contradistinction, in this case, there is no communication between the bladder or the umbilicus with the cystic structure.
- C. Urachal cancer is a form of cancer that arises in the urachus. Most urachal cancers are adenocarcinomas. However, in this case there is no mass to suggest urachal cancer/adenocarcinoma.
- D. While some peritoneal implants could have cystic appearance, and may rarely even have calcification, there usually would be more soft tissue and typically ascites. This lesion has appearance much more consistent with a urachal cyst.

5. What is the MOST likely diagnosis in this 58-year-old woman with breast cancer and an adrenal lesion found on CT?



- A. Adenoma
- B. Cyst
- C. Hemorrhage
- D. Metastasis

Key: A

Rationale:

- A. Although most adrenal adenomas are non-functioning, they contain variable amounts of lipid based hormonal precursors within their cells. If there is sufficient quantity, the presence of lipid will result in signal loss on opposed phase T1 GRE images due to the signal of lipid-associated protons cancelling the signal of water-associated protons. MRI using in and opposed sequences (chemical shift imaging) has 81-100% sensitivity and 94-100% specificity for the diagnosis of adrenal adenoma.
- B. Congenital adrenal cysts are rare. The most common adrenal cystic lesion is a pseudocyst, secondary to chronic hemorrhage. In either scenario, these lesions would not be expected to lose signal of opposed-phase imaging.
- C. Blood products would not be expected to lose signal on opposed-phase images. Conversely, if the concentration of iron is high enough, there may be signal loss on in-phase images due to the longer TE leading to greater dephasing of signal.
- D. Except in rare cases, metastases do not contain intracellular lipid and therefore will not lose signal on opposed phased images. One exception would be a metastatic nodule from clear cell renal cell carcinoma, as this tumor is known to contain intracellular lipid.

Reference:

Taffel M, Haji-Momenian S, Nikolaidis P, Miller FH. Adrenal imaging: a comprehensive review. Radiologic Clinics of North America 2012 Mar 31; 50(2):219-43.

6. What is the main risk factor for contrast-induced acute kidney injury?

- A. Diabetes
- B. Preexisting kidney impairment
- C. Hypertension
- D. Congestive heart failure

Key: B

Rationale:

A. B. D. Diabetes and hypertension both contribute to CKD. Even in the absence of clinically diagnosed CKD, endothelial dysfunction with reduced production of nitric oxide and vasoconstriction of vasa recta can be observed in patients with hypertension and diabetes and can contribute to the development of CI-AKI. However, preexisting kidney impairment is the main risk factor for CI-AKI.

B. Preexisting kidney impairment is the main risk factor for CI-AKI. In patients with CKD, an increase from 4 to 20 % in the incidence of CI-AKI has been observed as the baseline serum creatinine level rose from 1.2 to 2.9 mg/dl.

7. What is the MOST likely diagnosis for the findings in the adrenal gland in this 66-year-old man with sepsis?



- A. Abscess
- B. Hematoma
- C. Hyperplasia
- D. Tuberculosis

Key: B

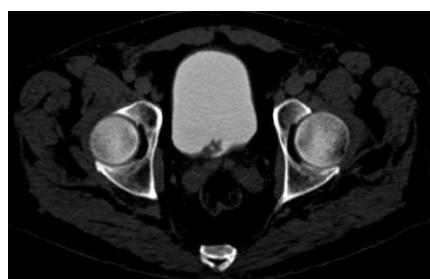
Rationale:

- A. An adrenal abscess is extremely uncommon. In this case, the high attenuation within the adrenal gland would be atypical for an abscess, which is usually of low attenuation, with rim enhancement.
- B. Adrenal hemorrhage can occur from traumatic or non-traumatic etiology. Non-traumatic causes include sepsis/stress, bleeding diathesis, adrenal tumor and neonatal stress. Hemorrhage can involve one or both adrenal glands. On CT, adrenal hemorrhage will manifest as diffuse or mass-like adrenal enlargement. The hemorrhage will typically be hyperdense, which can be an excellent clue in making the diagnosis. Density measurements range between 50-90 HU in the acute to subacute stage and decrease over time. Most hematomas resolve completely, although some can persist over time and organize into an adrenal pseudocyst.
- C. Hyperplasia can result in an enlarged adrenal, however the mass-like appearance and high attenuation are inconsistent with hyperplasia.
- D. The appearance of adrenal tuberculosis is nonspecific, and can vary with the acuity of the disease. Findings on CT include soft tissue masses, cystic change and calcifications.

Reference:

Kawashima A, Sandler CM, Ernst RD, Takahashi N, Roubidoux MA, Goldman SM, Fishman EK, Dunnick NR. Imaging of nontraumatic hemorrhage of the adrenal gland. Radiographics 1999 Jul;19(4):949-63.

8 What is the MOST likely diagnosis?



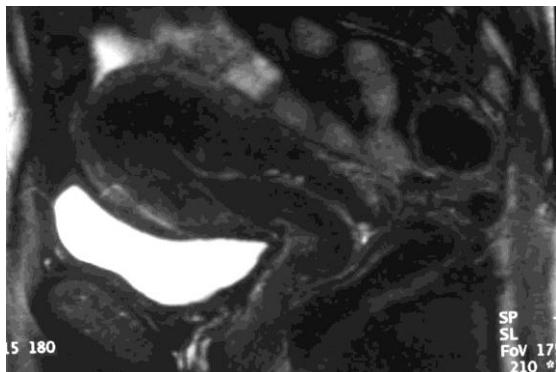
- A. Urothelial cancer
- B. Foreign body
- C. Bladder stone
- D. Ureterocele

Key: A

Rationale:

Irregularly marginated soft tissue density mass protruding into the bladder lumen is the typical appearance of transitional cell (urothelial) cancer.

9. What is the MOST likely diagnosis?



- A. Leiomyoma
- B. Adenomyosis
- C. Endometrial cancer
- D. Cervical cancer

Key: B

Rationale:

Although leiomyomas typically have low intensity on T2 weighted images, they would be expected to be round and well defined.

10. Which of the following is the MOST common cause of papillary necrosis?

- A. Contrast induced nephropathy
- B. Renal vein thrombosis
- C. Analgesic abuse
- D. Diabetes

Key: D

Rationale:

- A. Contrast induced nephropathy is a known cause of acute tubular necrosis, not papillary necrosis.
- B. Renal vein thrombosis can cause papillary necrosis but is not the most common etiology.
- C. Analgesic abuse or overuse is a cause of papillary necrosis, but not the most common cause.
- D. Diabetes is the most common cause of papillary necrosis in adults.

Interventional Radiology In-Training Test Questions for Diagnostic Radiology Residents



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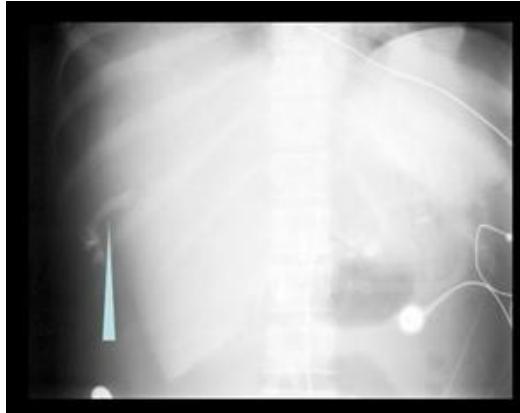
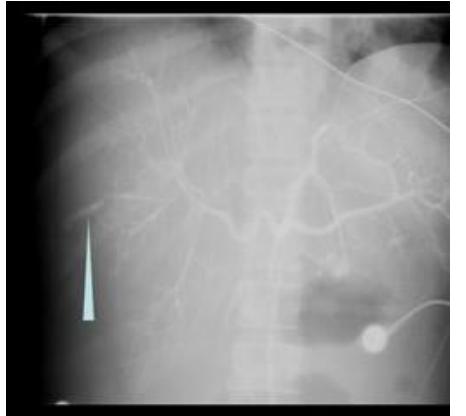
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1. This patient bled significantly following liver biopsy. What is the arrow on the two provided images pointing to?



- A. Hepatic artery
- B. Hepatic vein
- C. Portal vein
- D. Contrast extravasation

Key: D

Rationale:

- A. The density visible on the arterial phase image persists on the delayed image when no contrast remains visible in the arteries or even the veins.
- B. Note that the edge of the liver on the second image is separated from the abdominal wall by ascitic fluid. The contrast collection is curving around the liver edge and puddling in the ascites. This is extravasated contrast from a brisk arterial bleed.
- C. Note that the edge of the liver on the second image is separated from the abdominal wall by ascitic fluid. The contrast collection is curving around the liver edge and puddling in the ascites. This is extravasated contrast from a brisk arterial bleed.
- D. The first image is from the arterial phase of a celiac arteriogram. The second is a much-delayed post venous phase image. On the first image, there is a linear collection of contrast connected to a branch right hepatic artery. The second shows persistence of the same contrast collection. Note that the edge of the liver on the second image is separated from the abdominal wall by ascitic fluid. The contrast collection is curving around the liver edge and puddling in the ascites. This is extravasated contrast from a brisk arterial bleed. When contrast has this linear configuration, it has been termed the pseudo vein sign.

Reference:

Bell DJ, D'Souza D et al Pseudovein <https://radiopaedia.org/articles/pseudovein-sign-b>.

2. Which, if any, of these two aneurysms ruptured?



- A. The superior aneurysm
- B. The inferior aneurysm
- C. Both
- D. Neither

Key: B

Rationale:

The first aortogram, injected through a catheter at the level of the diaphragm, shows two saccular abdominal aortic aneurysms with simultaneous opacification of the inferior vena cava. The second injection was made with the catheter withdrawn into the infrarenal aorta. This again shows the aortocaval fistula, but without opacification of the larger aneurysm; indicating that the smaller, lower aneurysm had ruptured. The presence of the aortocaval fistula indicates a ruptured aneurysm. According to Laplace's law, the larger aneurysm is the favorite to rupture. According to Damon Runyon, the race is not always to the swift, nor the battle to the strong. But that's the way to bet. In this case the underdog won.

Reference:

Runyon D www.azquotes.com/author/12776-Damon_Runyon.

3. Which of the following parameters correlates most strongly with a hemorrhagic complication during the course of thrombolysis for lower extremity ischemia?

- A. The amount of lytic agent infused
- B. The duration of ischemia (days)
- C. The plasma fibrinogen level
- D. The rate of heparin infusion

Key: C

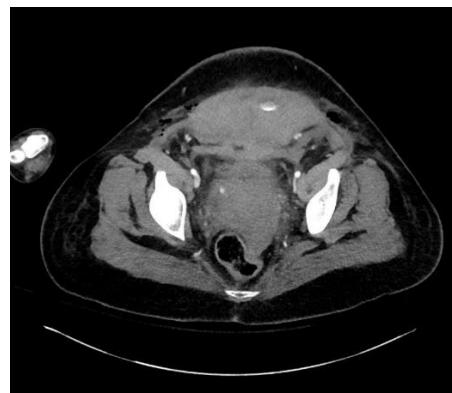
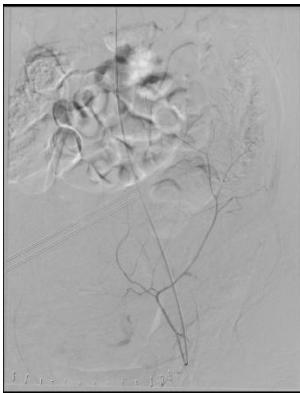
Rationale:

Patients with bleeding complications had a significantly lower plasma fibrinogen level at the end of infusion. For the other parameters, there was no significant difference between the patients that did or did not bleed.

Reference:

Results of a prospective randomized trial evaluating surgery versus thrombolysis for ischemia of the lower extremity. The STILE trial. Ann Surg 1994; 220:251-268.

4. What is the most appropriate treatment for this 37 year-old woman with hemorrhage following an unplanned C-section?



- A. Embolization
- B. Hysterectomy
- C. Vaginal packing
- D. Vasopressin infusion

Key: A

Rationale:

- A. Having situated a catheter in the bleeding artery, transcatheter embolization is the appropriate treatment.
- B. C. Vaginal packing and hysterectomy are inappropriate here because the patient is not bleeding from her uterus.
- D. Intravenous vasopressin infusion is not appropriate because the source of the hemorrhage is unrelated to a failure of involution of the post-partum uterus. Arterial infusion of vasopressin, a vasoconstrictor, is a possibility, but has for many years now been supplanted by the refinement of microcatheters, micro guidewires, microcoils or other embolic material.

Reference:

Geschwind JFH, Dake MD Abrams' Angiography Interventional Radiology Wolters Kluwer 2014, Philadelphia.

5. A 65 year-old female presents to IR with “high pressures during dialysis” through a Left Brachiocephalic Fistula. Upon physical exam it was noted that the patient had breast swelling, arm swelling and noticeable chest wall collateral veins. Which of the following is the most likely etiology of the patient’s symptomatology?

- A. Arteriovenous Fistula Arterial Anastomotic stenosis
- B. Central Venous Stenosis
- C. Dialysis Associated Steal Syndrome
- D. Hepatic Cirrhosis

Key: B

Rationale:

- A. This would present with low flow or thrombosis within the outflow tract, not arm swelling.
- B. Central venous stenosis results in arm, facial swelling, chest wall collaterals and can cause breast swelling.
- C. This presents with hand pain worsened during dialysis, paresthesia and finger ischemia when severe.
- D. While this may cause chest wall collateral vein formation and anasarca, it is often diffuse and does not present with unilateral symptoms.

Reference:

H.J Mehta Central Venous Stenosis: What Should a Nephrologist Know? Indian Journal of Nephrology 2017 Nov-Dec; 27(6): 427–429. A good review article of clinical presentation for central venous stenosis in patients with ESRD.

6. Portal Hypertension is defined by which of the following pressure values?

- A. Portal Venous Pressure: > 3mmHg. Portosystemic Gradient >1mmHg
- B. Portal Venous Pressure: > 4mmHg. Portosystemic Gradient >2mmHg
- C. Portal Venous Pressure: > 10mmHg. Portosystemic Gradient >5mmHg
- D. Portal Venous Pressure: > 8 mmHg. Portosystemic Gradient > 2mmHg

Key: C

Rationale:

- A. Both values are too low.
- B. Both values are too low.
- C. Portal Hypertension is defined by a PSG greater than 5mmHg or a portal venous pressure of greater than 10 mmHg.
- D. Both values are too low.

Reference:

Hepatology, VOL. 65, NO. 1, 2017

Portal Hypertensive Bleeding in Cirrhosis: Risk Stratification, Diagnosis, and Management: 2016 Practice Guidance by the American Association for the Study of Liver Diseases, Guadalupe Garcia-Tsao,^{1,2} Juan G. Abraldes,³ Annalisa Berzigotti,⁴ and Jaime Bosch.

7. What is the half-life of Yttrium 90?
- A. 23 hours
 - B. 6 hours
 - C. 64 hours
 - D. 68 hours

Key: C

Rationale:

- A. Incorrect.
- B. This is the half-life of Tc-99.
- C. This is the half-life of Y-90.
- D. This is the half-life of Gallium-68.

Reference:

M.S Bhangoo et al Radioembolization with Yttrium-90 microspheres for patients with unresectable hepatocellular carcinoma Journal of Gastrointestinal Oncology J Gastrointest Oncol. 2015 Oct; 6(5): 469–478. This paper describes the physical properties of Y-90.

8. Which of the following imaging studies is the most sensitive with regards to evaluation for gastrointestinal hemorrhage?

- A. CT Angiography of the Abdomen and Pelvis
- B. Conventional Angiography
- C. Nuclear Scintigraphy (99m-Tc Labelled RBC Scan)
- D. MRA of the abdomen and pelvis

Key: C

Rationale:

- A. While this is the easiest and fastest of imaging studies and is commonly utilized to evaluate for GI bleeding it is not the most sensitive.
- B. This modality provides the ability to treat gastrointestinal bleeding it can only identify rapid arterial bleeding at a rate of roughly 0.5ml/min.
- C. This is the most sensitive evaluation for active GI bleeding with detection at rates of 0.10ml/min.
- D. Incorrect.

Reference:

Bruno M. Graca et al Gastroenterologic and Radiologic Approach to Obscure Gastrointestinal Bleeding: How, Why, and When? Radiographics Jan 1 2010 <https://doi.org/10.1148/rg.301095091>. Excellent review article with images of all of the commonly used modalities and techniques for evaluation for GI bleeding.

9. Which of the following is an indication to embolize a visceral artery aneurysm?

- A. Patient age >70
- B. Aneurysm size >2 cm
- C. ESRD
- D. Aneurysm size > 4cm

Key: B

Rationale:

- A. Young age i.e of reproductive age particularly in females is an indication to intervene on visceral artery aneurysms.
- B. Aneurysm size greater than 2 cm is an indication for intervention on visceral artery aneurysms as the risk of rupture increases.
- C. Incorrect.
- D. At this size, rupture is imminent.

Reference:

M Chadha, C Ahuja Visceral Artery Aneurysms: Diagnosis and Percutaneous Management Seminars in Interventional Radiology Semin Intervent Radiol. 2009 Sep; 26(3): 196–206.

10. Which of the following is a CONTRAINDICATION to placement of a PICC line?

- A. Platelet count (PC) 50 - 109/L
- B. International Normalized Ratio (INR) 2
- C. ESRD
- D. Dual Antiplatelet Therapy

Key: C

Rationale:

- A. PICC Lines can be placed at even lower platelet counts.
- B. PICC lines can be placed safely with elevated INR.
- C. PICC Lines should not be placed in patients with ESRD in order to preserve the upper extremity veins in order for AV Fistula and/or Graft creation for hemodialysis.
- D. PICC lines can be safely placed in patients on dual antiplatelet therapy i.e ASA/Plavix.

Reference:

J Potet et al. Peripherally inserted central catheter placement in patients with coagulation disorders: A retrospective analysis Diagnostic and Interventional Imaging Volume 96, Issue 11, November 2015, Pages 1147-115 This paper describes the safety of placing PICC lines in patients with coagulation disorders.

Musculoskeletal Radiology In-Training Test Questions for Diagnostic Radiology Residents



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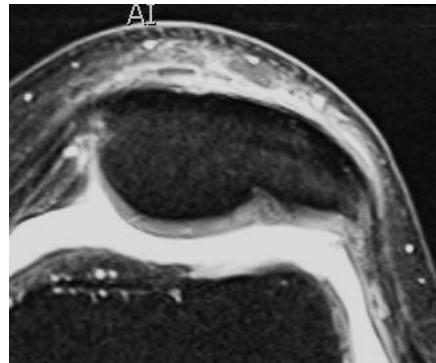
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1. You are shown coronal and axial MR images from a 23-year-old woman with knee pain. What is the MOST likely diagnosis?



- A. Osteochondral defect
- B. Dorsal patellar defect
- C. Chondroblastoma
- D. Subchondral cyst

Key: B

Rationale:

A. An osteochondral defect demonstrates focal bone and articular cartilage abnormalities often with separation and fluid in the cleft of the defect. The dorsal patella defect appears round, with well-defined margins, abutting the articular cartilage at the superolateral aspect of the patella. Radiographically, it has a lytic appearance with sclerotic margins. It is often bilateral. It is considered congenital/developmental in nature.

B. This is a benign lesion that appears round, with well-defined margins, abutting the articular cartilage at the superolateral aspect of the patella. Radiographically, it has a lytic appearance with sclerotic margins. It is often bilateral. It is considered congenital/developmental in nature. C. Chondroblastoma is the most common benign neoplasm of the epiphysis in the immature skeleton. It is understandable that they occur in epiphysioid bones such as the patella, tarsal and carpal bones. They are round and well defined but are more central in the bone and do not abut the articular cartilage.

D. A subchondral cyst is associated with abnormal overlying articular cartilage.

Reference:

Johnson JF, Brogdon BG. Dorsal defect of the patella: incidence and distribution. AJR Am J Roentgenol 1982; 139:339-340.

2. What portion of the proximal tibia is MOST commonly injured at the time of ACL rupture?
- A. Lateral capsule insertion
 - B. Posterior plateau
 - C. Intercondylar eminence
 - D. Gerdy's tubercle

Key: B

Rationale:

- A. Avulsion fracture at the lateral proximal tibia, at the site of joint capsule insertion, with contributions from the lateral collateral ligament and iliotibial band, due to varus stress at the time of ACL rupture, is known as the Segond fracture. Although such fractures are associated with ACL rupture approximately 90% of the time, ACL rupture is not commonly associated with Segond fracture because the most common mechanism of ACL injury involves valgus, not varus stress.
- B. ACL rupture and subsequent insufficiency allow for impaction of the femoral condyles and posterior tibial plateau at the time of injury. Because most injuries involve valgus stress, the lateral compartment is most commonly affected. Contusion or impaction at the posterior lateral tibial plateau is, therefore, one of the most common associated injuries and a significant secondary sign of ACL tear.
- C. The intercondylar eminence may be avulsed in younger individuals at the site of ACL insertion anterior to the anterior tibial spine. In such cases, the ACL remains intact.
- D. Gerdy's tubercle is the site of iliotibial band insertion and is not injured at the time of ACL rupture.

Reference:

Resnick D, Kang HS, Pretterklieber ML. Knee. Internal Derangements of Joints. Saunder. 2nd ed. 2007.

3. A mass at Guyon canal will compress which of the following nerves?

- A. Ulnar
- B. Radial
- C. Suprascapular
- D. Median

Key: A

Rationale:

- A. The ulnar nerve courses through Guyon's canal at the anteromedial wrist, bounded by the pisiform medially, hamate hook laterally, flexor retinaculum and volar carpal ligament. The canal also contains the ulnar artery. More proximally, the ulnar nerve may be compressed at the cubital tunnel behind the medial epicondyle.
- B. The radial nerve may be compressed at the axilla, upper arm, elbow, forearm, and wrist. The posterior interosseous or radial tunnel syndrome may occur at the elbow. At the wrist the superficial radial nerve or the posterior interosseous nerve may be compressed.
- C. The suprascapular nerve may be compressed at the suprascapular notch or spinoglenoid notch.
- D. Compression neuropathy of the median nerve is most common at the carpal tunnel of the wrist, i.e., carpal tunnel syndrome. More proximally, it is vulnerable to compression at the cubital fossa (pronator syndrome) and at the elbow and forearm beneath the flexor muscles at the interosseous membrane (anterior interosseous nerve syndrome or Kiloh-Nevin syndrome). In the small percentage of the population with a supracondylar spur at the distal humerus, the median nerve may be compressed at the fibro-osseous tunnel formed by the ligament of Struthers.

Reference:

Resnick D, Kang HS, Pretterklieber ML. Wrist and Hand. Internal Derangements of Joints. Saunders. 2nd ed. 2007.

4. What is the MOST reliable radiographic sign of osteomyelitis in the diabetic foot?

- A. Bone fragmentation
- B. Soft tissue gas
- C. Joint subluxation
- D. Cortical erosion

Key: D

Rationale:

- A. Although osteomyelitis will destroy involved bone, the bone usually does not fragment. Fragmentation is associated with neuropathic disease and reflects repeated fracturing due to lack of proprioception and pain sensation and subsequent abnormal stress to the joint involved.
- B. Although soft tissue gas may reflect a gas-forming organism, more often than not, it reflects communication with the nearby soft tissue ulceration. Neither situation implies infection of the bone itself.
- C. Although septic arthritis is common in the diabetic foot, joint subluxation is characteristic of neuropathic disease. Septic arthritis may erode and destroy subarticular bone, but joint alignment is maintained.
- D. Osteomyelitis in the diabetic foot is secondary to direct extension from nearby soft tissue ulceration. The earliest radiographic finding is focal loss of cortex or cortical erosion which may be very subtle. MRI is much more sensitive for the detection of bone infection.

Reference:

Resnick D. Infectious Diseases. Diagnosis of Bone and Joint Disorders. Saunders. 4th ed. 2004.

5. Which one of the following constitutes the Buford complex?

- A. Absence of the anterior superior glenoid labrum and thickening of the middle glenohumeral ligament
- B. Impaction fracture at the posterolateral humeral head and injury of the anterior inferior glenoid labrum
- C. Brachial neuritis and denervation edema of the rotator cuff musculature
- D. Full thickness rotator cuff tear with fluid at the glenohumeral joint, subacromion subdeltoid bursa and acromioclavicular joint

Key: A

Rationale:

- A. Congenital absence of the anterior superior glenoid labrum is associated with compensatory thickening of the middle glenohumeral ligament, the so called "Buford complex."
- B. The Hill-Sachs fracture deformity and the bony and fibrocartilagenous Bankhart lesions are the sequela of anterior shoulder dislocation.
- C. Brachial neuritis and subsequent muscle edema and atrophy about the shoulder constitute the Parsonage-Turner syndrome.
- D. The "geyser" phenomenon refers to the appearance of fluid extending from the glenohumeral joint to the subacromion-subdeltoid bursa to the A-C joint and adjacent superficial soft tissues as a result of chronic rotator cuff tear with subsequent tearing of the acromioclavicular ligaments.

Reference:

Resnick D, Kang HS, Pretterklieber ML. Shoulder. Internal Derangements of Joints. Saunder. 2nd ed. 2007

6. Henry's knot refers to the crossover of what two foot tendons?

- A. Flexor digitorum longus and flexor hallucis longus
- B. Peroneus longus and peroneus brevis
- C. Posterior tibial and flexor digitorum longus
- D. Achilles and plantaris

Key: A

Rationale:

- A. The knot of Henry is the crossing of the FDL and FHL tendons at the plantar aspect of the midfoot.
- B. The knot of Henry is the crossing of the FDL and FHL tendons. The peroneus brevis typically is situated anterior to the peroneus longus, posterior to the lateral malleolus.
- C. The knot of Henry is the crossing of the FDL and FHL tendons. The posterior tibial tendon is medial to the flexor digitorum longus and flexor hallucis longus tendons throughout its course.
- D. The knot of Henry is the crossing of the FDL and FHL tendons. The plantaris tendon inserts medial to the Achilles at the calcaneus.

Reference:

OSullivan E, Carare-Nnadi R, Greenslade J, Bowyer G. Clinical significance of variations in the interconnections between flexor digitorum longus and flexor hallucis longus in the region of the knot of Henry. Clin Anat. 2005 Mar; 18(2):121-5.

7. Which one of the following may be a sequela of a primary bone neoplasm?

- A. Hypertrophic osteoarthropathy
- B. Paget disease
- C. Osteomalacia
- D. Neuropathic arthropathy

Key: C

Rationale:

- A. Clubbing of the digits and periostitis constitute HO which may be primary or secondary, the latter much more common, usually associated with primary bronchogenic carcinoma. Joint pain and swelling are more typical of the secondary form. There is no association with bone neoplasm.
- B. Certain neoplasms are known to arise in long standing Pagets disease of bone, including osteosarcoma and giant cell tumor. Pagets disease is not a sequela of bone neoplasia.
- C. Tumor induced osteomalacia is a well-documented phenomenon in both children and adults. Bone and soft tissue tumors have been implicated, the most frequent association with soft tissue hemangiopericytoma. Bone lesions include non-ossifying fibroma, giant cell tumor, osteoblastoma and fibrous dysplasia. Hypophosphatemia is characteristic of this hypophosphatemic, vitamin D refractory type rickets/osteomalacia. Decreased renal tubular absorption of phosphate may be secondary to a tumor elaborated substance that directly affects the proximal tubule.
- D. Neuropathic arthropathy results from peripheral neuropathy, usually seen in patients with diabetes. There is no relation to bone neoplasia.

Reference:

Resnick D Osteomalacia Diagnosis of Bone and Joint Disorders 4th ed, Saunders 2002.

Neuroradiology In-Training Test Questions for Diagnostic Radiology Residents



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1. Sturge-Weber syndrome is associated with which of the following?
 - A. Autosomal dominant inheritance
 - B. Neuronal migration anomalies
 - C. Lisch nodules
 - D. Dyke Davidoff Masson syndrome

Key: D

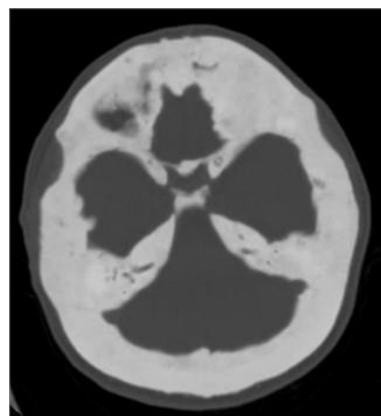
Rationale:

- A. Sturge Weber Syndrome(SWS) is not hereditary. It is caused by a random mutation.
- B. SWS is caused by vascular overgrowth and affects the skin and nervous system. It is not the result of neuronal migration abnormalities like grey matter heterotopia and lissencephaly.
- C. Lisch nodules are melanocytic hamartomas of the iris, often associated with neurofibromatosis (NF) I.
- D. Dyke Davidoff Mason syndrome is a condition characterized by hemicerebral atrophy/hypoplasia secondary to brain insult usually in fetal or early childhood period and is accompanied by ipsilateral compensatory osseous hypertrophy and contralateral hemiparesis. It is characterized by: thickening of the skull vault (compensatory); enlargement of the frontal sinus (also ethmoidal and mastoid air-cells); elevation of the petrous ridge; ipsilateral falcine displacement; and capillary malformations (are a novel finding for children with Dyke-Davidoff-Masson syndrome).

Reference:

Encephalotrigeminal Angiomatosis: A Review with Emphasis on Head and Neck Manifestations: Larsen, B.R.; Rosztoczy, M.S.; Van Tassel, D.C.; Larson, C.R.; Avedikian, S.A.; Gridley, D.G., Neurographics, Volume 11, Number 3, 1 May 2021, pp. 166-174(9).

2. A 60-year-old woman presents with hearing loss. You are shown a scout image and a non-contrast cross sectional image at the level of the internal auditory canals. What is the MOST likely diagnosis?



- A. Paget disease
- B. Chronic dilantin exposure
- C. Osteopetrosis
- D. Otosclerosis

Key: C

Rationale:

- A. Paget disease is described as the cotton wool appearance of the skull, not the diffuse expansile sclerotic appearance seen in this case.
- B. Dilantin causes calvarial thickening because of increased osteoblast proliferation. This results in increase in the diploic space without associated increased sclerosis as seen in this case.
- C. Osteopetrosis, also known as Albers-Schönberg disease or marble bone disease, is an uncommon hereditary disorder that results from defective osteoclasts. Bones become sclerotic and thick, but their abnormal structure actually causes them to be weak and brittle.
- D. The term otosclerosis is somewhat of a misnomer. Much of the clinical course is characterized by lucent rather than sclerotic bony changes and hence it is more appropriately known as otospongiosis which is a term preferred by many head and neck radiologists. It is a primary osteodystrophy of the otic capsule (bony labyrinth of the inner ear). It is one of the leading causes of deafness in adults.

Reference:

Craniofacial Manifestations of Systemic Disorders: CT and MR Imaging Findings and Imaging Approach.V.
Carlota Andreu-Arasa, Margaret N. Chapman, Hirofumi Kuno, Akifumi Fujita, Osamu Sakai,
RadioGraphics Vol. 38, No. 3 Published Online: May 14 <https://doi.org/10.1148/rg.2018170145>.

3. Hyperintense signal of the vertebral endplates on both T1 and T2 describes which type of Modic change?

- A. Type I
- B. Type II
- C. Type III
- D. Type IV

Key: B

Rationale:

- A. Type I describes edematous change that is hypointense T1, hyperintense T2.
- B. This is the correct answer and describes fatty endplate change.
- C. Type III changes are sclerotic with decreased signal on both T1 and T2.
- D. There are no Type IV changes in the Modic classification.

Reference:

Modic MT, Steinberg PM, Ross JS, et al. Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. Radiology 1988; 166:193–99.

The Modic Vertebral Endplate and Marrow Changes: Pathologic Significance and Relation to Low Back Pain and Segmental Instability of the Lumbar Spine.

R. Rahme and R. Moussa American Journal of Neuroradiology May 2008, 29 (5) 838-842;
DOI: <https://doi.org/10.3174/ajnr.A0925>.

4. A neonate presents with a "thin film" hemorrhage. What is the MOST likely diagnosis?
- A. Benign external hydrocephalus
 - B. Sinus thrombosis
 - C. Herpes encephalitis
 - D. Non-accidental trauma

Key: D

Rationale:

- A. This is benign macrocrania characterized by benign enlargement of the extraxial spaces causing external hydrocephalus. This presents at 3-6 months and resolves by 2-3 years.
- B. Dural venous sinus thrombosis can be seen in trauma and can be associated with venous infarct and hemorrhage though these hemorrhages are not characterized by thin film hemorrhages.
- C. Herpes encephalitis can be hemorrhagic though these parenchymal type hemorrhages are not described as thin film like.

Reference:

<https://radiologykey.com/abusive-head-trauma-extra-axial-hemorrhage-and-nonhemic-collections/>
The pathogenesis of retinal and subdural haemorrhage in non-accidental head injury in infancy: assessment using Bradford Hill criteria. Meghan J Acres, James A Morris
Med Hypotheses. 2014 Jan; 82(1):1-5. doi: 10.1016/j.mehy.2013.09.017. Epub 2013 Sep 16.

5. Which of the following lesions of the carotid space MOST commonly splays the internal and external carotid artery?

- A. Vagal schwannoma
- B. Pseudoaneurysm
- C. Paraganglioma
- D. Thrombophlebitis

Key: C

Rationale:

- A. The vagus nerve is located in the posterior aspect of the carotid space. Schwannomas of the vagus nerve tend to displace the vessels anteriorly.
- B. Pseudoaneurysms are located in the carotid space but do not splay the internal and external carotid arteries.
- C. Paragangliomas or Carotid body tumors classically splay the internal and external carotid arteries within the carotid space.
- D. Thrombophlebitis occurs at the level of the jugular vein and is posterior and lateral to the external and internal carotid arteries.

References:

Paragangliomas of the Head and Neck: Radiologic and Pathologic Correlation

Archana B. Rao, Kelly K. Koeller, Carol F. Adair, Radiographics 19:1605-1632.

6. Which of the following entities MOST closely resembles multiple sclerosis on MR imaging?

- A. Lupus cerebritis
- B. ADEM
- C. Fat emboli syndrome
- D. CADASIL

Key: B

Rationale:

- A. Lupus Cerebritis is characterized by extensive patchy and confluent areas of FLAIR hyperintensity as opposed to the smaller more focal lesions of multiple sclerosis.
- B. ADEM is usually a monophasic illness as opposed to MS, although, within the episode, individual lesions may be of varying stages of evolution, with different lesions maturing over a number of weeks. Appearances vary from small punctate lesions to tumefactive regions, which have less mass effect than one would expect for their size, distributed in the supratentorial or infratentorial white matter. Compared to multiple sclerosis, involvement of the callososeptal interface is unusual. Lesions are usually bilateral but asymmetrical. Involvement of cerebral cortex, subcortical grey matter - especially the thalamus - and the brainstem is not very common, but if present are helpful in distinguishing from multiple sclerosis.
- C. The "starfield pattern" on MR imaging is that used to described MR brain imaging findings of fat emboli syndrome. A differential to consider for the starfield pattern on MRI includes many other causes of multiple small foci of infarction or hemorrhage, although generally, only fat emboli will result in the very large number of tiny lesions characteristic of a starfield appearance.
- D. MRI is the investigation of choice, often demonstrating widespread confluent white matter hyperintensities as opposed to the focal lesions of MS. More circumscribed hyperintense lesions are also seen in the basal ganglia, thalamus and pons. Although the subcortical white matter can be diffusely involved, in the initial course of the disease involvement of the anterior temporal lobe (86%) and external capsule (93%) are classical. There is relative sparing of the occipital and orbitofrontal subcortical white matter, subcortical U-fibers and cortex. Cerebral microhaemorrhages have been reported to occur in ~45% (range 25-70%) of cases.

Reference:

Roxana Mialin , MD Meriam Koob , MD, PhD Jérôme de Seze , MD Jean Louis Dietemann , MD Stéphane Kremer , MD, PhD Acute Disseminated Encephalomyelitis Confined to the Brainstem Radiology 2011; 260:911– 914.

7. What is the MOST common imaging finding on MR for a Type 1 spinal dural arteriovenous fistula?

- A. Subarachnoid hemorrhage
- B. No abnormality on conventional MR sequences
- C. Intramedullary hemorrhage
- D. Intramedullary T2 hyperintense signal

Key: D

Rationale:

- A. Type 1 DAVF rarely present with subarachnoid hemorrhage.
- B. Type 1 DAVF does present with findings including T2 hyperintensity within the cord as well as vascular prominence along the surface of the cord.
- C. Intramedullary hemorrhage is not an imaging finding in Type 1 DAVF.
- D. -Intramedullary T2 hyperintense signal representing venous congestion is frequently found in this abnormality given the eponym Foix-Alajouanine syndrome. Initially, patients have a spastic paraplegia which progresses to flaccidity, loss of sphincter control, and ascending sensory level.

Reference:

Spinal arteriovenous malformations causing Foix-Alajouanine syndrome, a case report and review of the literature. Nahid Sadighi, MD Abasin Tajmalzai, MD, and Faeze Salahshour, MD
Radiol Case Rep. 2021 Aug; 16(8): 2187–2191.

8. In the setting of traumatic brain injury, what is the purpose of diffusion tensor imaging?
- A. Assess microstructural change in white matter
 - B. Measure brain activity by detecting changes in blood flow
 - C. Evaluate metabolites
 - D. Assess cerebral perfusion

Key: A

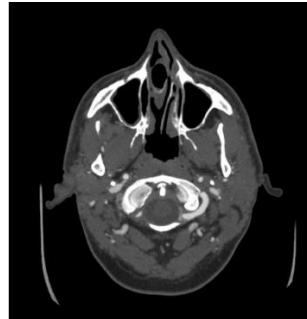
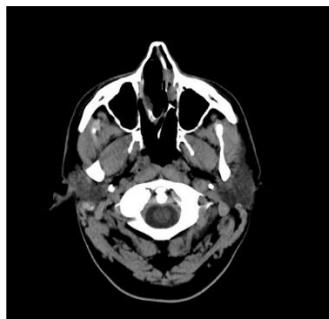
Rationale:

- A. Diffusion tensor imaging assesses microstructural change in white matter to identify axonal injury. MRI technique that uses anisotropic diffusion to estimate the axonal (white matter) organization of the brain.
- B. Functional MR measures brain activity by detecting changes in blood flow, not DTI.
- C. Magnetic resonance spectroscopy (MRS) is the technique that is used to measure metabolites and identify and refine differential diagnoses, not DTI.
- D. Cerebral perfusion is used to assess and quantitate cerebral blood flow and can be helpful in differentiating cerebral blood flow from radiation necrosis.

Reference:

Shenton M, Hamoda H, Schneiderman J, et al. A Review of Magnetic Resonance Imaging and Diffusion Tensor Imaging Findings in Mild Traumatic Brain Injury. *Brain imaging and behavior*. 2012; 6(2):137-192.

9. A 40-year-old male patient presents to ED with worsening left-sided neck pain for one week. Based on the CT images, what is the diagnosis?



- A. Carotid pseudoaneurysm
- B. Jugular thrombosis
- C. Carotid dissection
- D. Carotid occlusion

Key: C

Rationale:

- A. Psuedoaneurysm is a "false aneurysm" characterized by a focal outpouching that is contiguous with the vessel and is supported only by the adventitia or surrounding hematoma; a contained leak. Arterial dissection, spontaneous or traumatic, is a common cause of extracranial internal carotid artery pseudoaneurysms.
- B. As this is a CT and CTA, the venous system is not well demonstrated. No definite contrast in the vein is appreciated.
- C. Typical target picture in arterial dissection. On unenhanced brain CT, crescentic shaped hyperattenuating area within the vessel corresponds to intramural wall hematoma seen in arterial dissection. CT angiogram shows widening of the external diameter of the left internal carotid artery compared to the right with narrow eccentric lumen due to the intramural hematoma.
- D. Arterial dissection can result in vessel occlusion, however, in this case the vessel is still patent.

Reference:

Mathieu H. Rodallec, Véronique Marteau, Sophie Gerber, Loïc Desmottes, and Marc Zins Craniocervical Arterial Dissection: Spectrum of Imaging Findings and Differential Diagnosis RadioGraphics 2008 28:6, 1711-1728.

10. A 73-year-old man who presented after the acute onset of left hemiparesis is being considered for endovascular revascularization. Prior to catheter angiography, the interventional neuroradiologist would like to evaluate for an ischemic penumbra. Which of the following is the most appropriate study?

- A. CT perfusion
- B. Non-contrast MRI
- C. Transcranial Doppler ultrasound
- D. Non-contrast CT

Key: A

Rationale:

- A. ACT perfusion can depict an ischemic penumbra as an area of prolonged mean transit time and preserved or increased cerebral blood volume.
- B. Non-contrast MRI cannot assess ischemic penumbra.
- C. Transcranial Doppler ultrasound cannot assess for ischemic penumbra.
- D. Non-contrast CT cannot assess for ischemic penumbra.

Reference:

Y.W. Lui, E.R. Tang, A.M. Allmendinger and V. Spektor Evaluation of CT Perfusion in the Setting of Cerebral Ischemia: Patterns and Pitfalls American Journal of Neuroradiology (AJNR) 2010 Oct;31(9):1552-63.

Nuclear Radiology In-Training Test Questions for Diagnostic Radiology Residents



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1. Differences in what property allows the safe administration of greater than 10 times the dose of In-111 labeled pentetreotide (octreotide) compared to In-111 labeled white blood cells?

- A. Radiopharmaceutical avidity
- B. Mechanism of localization
- C. Stability of compound
- D. Routes of excretion

Key: D

Rationale:

In-111 pentetreotide is excreted predominantly through the urinary system and much less through the hepatobiliary system thereby the biologic half-life is less than In-111 labeled wbc allowing for higher dosages for imaging.

2. A High Radiation area is one in which a person receives no more than how many millirem (mrem) exposure in one hour at a distance of 30 cm from the radiation source?

- A. 1 mrem (0.01 milliSievert)
- B. 10 mrem (0.1 milliSievert)
- C. 100 mrem (1 milliSievert)
- D. 1000 mrem (10 milliSieverts)

Key: C

Rationale:

According to the NRC, a high radiation area is any area with dose rates greater than 100 millirems (1 millisievert) in one hour 30 centimeters from the source or from any surface through which the ionizing radiation penetrates. Areas at licensee facilities must be posted as "high radiation areas" and access into these areas is maintained under strict control.

Reference:

<https://www.nrc.gov/reading-rm/basic-ref/glossary/high-radiation-area.html>.

3. Regarding shin splints, increased tracer uptake in which of the following patterns is MOST typical on a three-phase bone scan?

- A. Focal in the anterior tibial diaphysis on the flow study
- B. Diffuse in the anterior tibial diaphysis on delayed static images
- C. Diffuse in the posteromedial tibial diaphysis on the blood pool images
- D. Diffuse in the posteromedial tibial cortex on delayed static images

Key: D

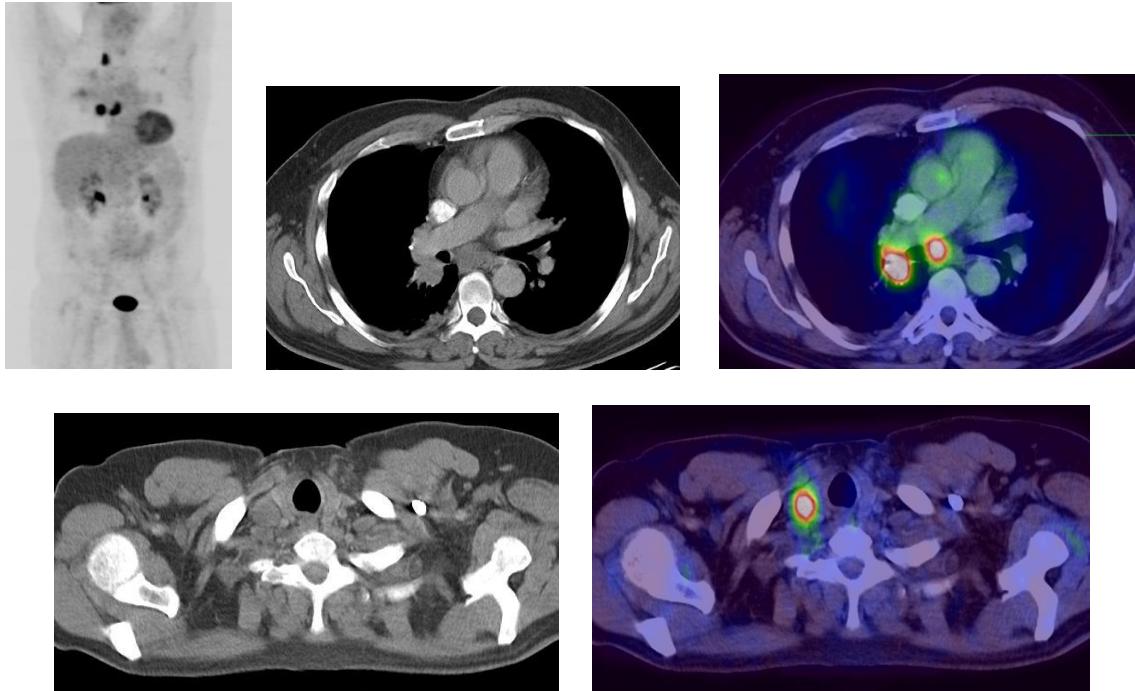
Rationale:

- A. The activity is usually linear or fusiform, and not typically present on the flow phase in shin splint syndrome. Focal round or oval activity is more typical of stress fracture.
- B. The activity is usually linear or fusiform, typically located in the posteromedial tibial cortex. Focal round or oval activity is more typical of stress fracture.
- C. The blood pool activity is typically normal.
- D. The typical appearance of shin splints is linear or fusiform increased bone phase activity along at least one third of the shaft length of tibia at the posteromedial cortex.

Reference:

Flynt L, Balon HR. 17-year-old runner with shin pain. J Nucl Med Technol. 2014 Sep; 42(3):238-9. doi: 10.2967/jnmt.113.135897. Epub 2014 Jun 26. PMID: 24970898.

4. This patient underwent biopsy of a 1.9 cm right infrahilar lung nodule (right lower lobe) which revealed non-small cell carcinoma. Subsequent F-18 FDG PET-CT was obtained. What is the MOST likely stage of this patient's lung cancer?



- A. Stage IB
- B. Stage IIA
- C. Stage IIIB
- D. Stage IV

Key: C

Rationale:

There are nodal lesions in the subcarinal space (N2) and right supraclavicular region (N3) without metastatic disease (M0) shown on the MIP image. Based on staging of non-small cell lung cancer, this is stage IIIB.

Reference:

Brett W. Carter, John P. Lichtenberger III, Marcelo K. Benveniste, Patricia M. de Groot, Carol C. Wu, Jeremy J. Erasmus, and Mylene T. Truong. Revisions to the TNM Staging of Lung Cancer: Rationale, Significance, and Clinical Application. *RadioGraphics* 2018 38:2, 374-391.

5. If a patient is injected with 99m Tc MAA for a pulmonary perfusion scan in the upright position, how will distribution of the tracer to the upper and lower lung zones change, respectively?

- A. Increase/Increase
- B. Decrease/Increase
- C. Decrease/Decrease
- D. Increase/Decrease

Key: B

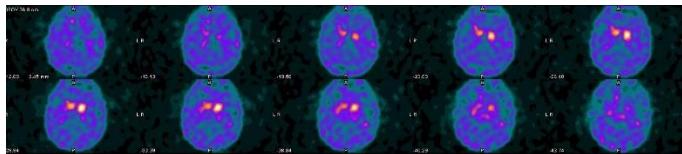
Rationale:

Tc-99m MAA should be injected while the patient is supine. If the tracer is given while the patient is upright, more of the tracer will go to the larger and more prevalent lower pulmonary arteries and less to the upper arteries.

Reference:

J. Anthony Parker, R. Edward Coleman, Erin Grady, Henry D. Royal, Barry A. Siegel, Michael G. Stabin, H. Dirk Sostman, Andrew J.W. Hilson. SNM Practice Guideline for Lung Scintigraphy 4.0. Journal of Nuclear Medicine Technology Mar 2012, 40 (1) 57-65.

6. A 65-year-old man undergoes this study. Which one of the following is MOST likely a dominant clinical symptom?



- A. Tremor
- B. Seizure
- C. Dementia
- D. Headaches

Key: A

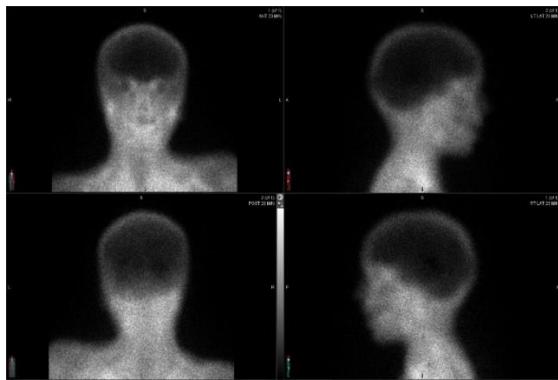
Rationale:

I-123 ioflupane is used to assess dopamine transporters in the striatum and clinically helps to differentiate essential tremor from Parkinson disease (PD), progressive supranuclear palsy (PSP) and multisystem atrophy (MSA). The major clinical presentation is tremor, except for patients with PSP. Seizures and headaches are not generally a complaint in these disorders. PSP and MSA are progressive neurodegenerative disorders, which can present with Parkinson-like symptoms. MSA affects the autonomic and motor functions. PSP affects gait, balance, eye movements and thinking with mild dementia.

Reference:

Bega, D., Kuo, P.H., Chalkidou, A. et al. Clinical utility of DaTscan in patients with suspected Parkinsonian syndrome: a systematic review and meta-analysis. *npj Parkinsons Dis.* 7, 43 (2021).

7. Tc-99m HMPAO was administered. What is the best interpretation of the exam?



- A. Absent cerebral perfusion.
- B. Preserved flow
- C. Non-diagnostic exam

Key: A

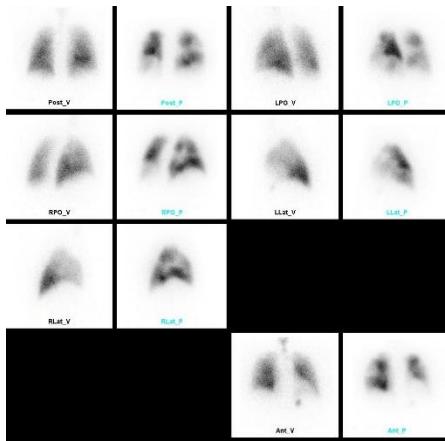
Rationale:

- A. There is absent cerebral parenchymal uptake compatible with absent cerebral perfusion.
- B. No tracer is shown in the brain parenchyma.
- C. The exam is diagnostic and shows no brain perfusion.

Reference:

Bennett and Oza. Diagnostic Imaging Nuclear Medicine. Elsevier. 2016.

8. In this patient with a normal chest radiograph, what is the probability range for the presence of pulmonary embolism?



- A. 0-5%
- B. 10-19%
- C. 20-79%
- D. 80-100%

Key: D

Rationale:

- A. This range is typically for very low probability.
- B. This range is for low probability.
- C. This range is for intermediate probability.
- D. This range is for high probability, which is the best interpretation of this study given the multiple large mismatch perfusion defects present.

Reference:

Bennett and Oza. Diagnostic Imaging Nuclear Medicine. Elsevier. 2016.

Pediatric Radiology In-Training Test Questions for Diagnostic Radiology Residents



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1. What is the maximum recommended insufflation pressure during air reduction of intussusception in the US?

- A. 80 mm Hg
- B. 100 mm Hg
- C. 120 mm Hg
- D. 150 mm Hg

Key: C

Rationale:

- A. The maximum recommended insufflation pressure for air reduction enema for the treatment of intussusception is 120 mm Hg.
- B. The maximum recommended insufflation pressure for air reduction enema for the treatment of intussusception is 120 mm Hg.
- C. The maximum recommended insufflation pressure for air reduction enema for the treatment of intussusception is 120 mm Hg.
- D. The maximum recommended insufflation pressure for air reduction enema for the treatment of intussusception is 120 mm Hg.

Reference:

Applegate, K, Hernanz-Schulman M. Intussusception. Chapter 107 *Caffey's Pediatric Diagnostic Imaging*, 13th edition, 2020, Elsevier, Philadelphia, PA.

2. A left-sided superior vena cava typically drains into which of the following?

- A. Right superior vena cava
- B. Inferior vena cava
- C. Left innominate vein
- D. Coronary sinus

Key: D

Rationale:

- A. A left-sided superior vena cava typically drains into the coronary sinus.
- B. A left sided superior vena cava typically drains into the coronary sinus.
- C. The left innominate vein is often absent in patients with persistent left superior vena cava.
- D. A left superior vena cava typically drains into the coronary sinus. Left superior vena cava is one of the common causes of enlargement of the coronary sinus; the other is intracardiac anomalous pulmonary venous connection.

Reference:

Irwin RB, Greaves M, Schmitt M. Left superior vena cava revisited. European Heart Journal Cardiovascular Imaging, 2012; 13:284-291.

3. Which of the following conditions should be included in the differential diagnosis of the findings in this 4 year old boy?



- A. Fracture
- B. Osteomyelitis
- C. Meyer's dysplasia
- D. LCH – Langerhans Cell Histiocytosis

Findings: Femoral heads are small, flattened and irregular.

Key: C

Rationale:

- A. There is no evidence of fracture.
- B. Osteomyelitis in this age typically involves the metaphysis and demonstrates radiolucent areas of bone destruction and periosteal reaction.
- C. Meyer's dysplasia is not a true dysplasia. It represents delay in ossification of femoral head nucleus. It is typically seen in patients less than 5 years old with peak age of 2-3 years. It is bilateral in approximately 50% of cases. There is male predilection. Patients are usually asymptomatic. Radiographically, the epiphysis is smaller with multiple nuclei of ossification which usually fuse by 5 years of age.
- D. LCH would be exceedingly rare in the epiphyses and wouldn't have this appearance.

Reference:

Dysplasia Epiphysialis Capitis Femoris.: Rose SM, Chung ES et al. Journal of Paediatric Orthopaedics 2005; 25:18-21.

4. A 9-month-old infant presents with difficulty swallowing. Based on the lateral neck radiograph, what is the MOST likely diagnosis?



- A. Croup
- B. Epiglottitis
- C. Enlarged adenoids
- D. Normal expiratory radiograph

Findings The epiglottis and aryepiglottic folds are thickened.

Key: B

Rationale:

- A. There should be subglottic narrowing and the epiglottis should not be enlarged in patients with croup.
- B. The epiglottis is enlarged in this patient with difficulty swallowing consistent with epiglottitis.
- C. The adenoids are not enlarged.
- D. The radiograph is not obtained in expiration (the prevertebral soft tissues are not thickened) and the epiglottis is enlarged suggesting that this is not the correct diagnosis.

Reference:

Epiglottitis and Croup. Sobol SE, Zapata S. Otolaryngologic Clinics of North America 2008;41:551-566.

4. According to the current American Academy of Pediatrics guidelines, which imaging study should be performed first in a 2-year-old girl presenting with a febrile urinary tract infection?

- A. Tc-99m dimercaptosuccinic acid (DMSA) scan
- B. Voiding cystourethrogram
- C. Renal and bladder ultrasound
- D. MR urogram

Key: C

Rationale:

- A. According to the American Academy of Pediatrics clinical practice guidelines, a renal and bladder ultrasound should be the initial examination.
- B. According to the American Academy of Pediatrics clinical practice guidelines, a renal and bladder ultrasound should be the initial examination.
- C. According to the American Academy of Pediatrics (AAP) clinical practice guidelines, a renal and bladder ultrasound should be the initial examination. The newest AAP clinical practice guidelines state that a voiding cystourethrogram is no longer recommended in patients 2 months-24 months of age being evaluated for their first febrile initial urinary tract infection (UTI) if the renal and bladder ultrasound is normal.
- D. According to the American Academy of Pediatrics clinical practice guidelines, a renal and bladder ultrasound should be the initial examination.

References:

- Urinary Tract Infection: Clinical Practice Guideline for the Diagnosis and Management of the Initial U TI in Febrile Infants and Children 2-24 Months. Roberts KB, Subcommittee on Urinary Tract Infection, Steering Committee on Quality Improvement and Management, AAP. *Pediatrics* 2011;595-610.
Wan J, Skoog SJ et al. Section on Urology Response to new guidelines for the diagnosis and management of UTI *Pediatrics* 2012;129: 843-852.

5. Fetal MRI and post-natal renal ultrasound are performed on a child with a GU abnormality. Which of the following is the MOST likely diagnosis?



- A. Renal cyst
- B. Ureterovesical junction obstruction
- C. Obstructed upper pole moiety
- D. Vesicoureteral reflux

Findings:

The prenatal MR shows a ureterocele, dilated ureter, and dilated renal pelvis. Post-natal ultrasound shows a duplex kidney with severe dilation of the upper pole pelvis and abnormal and decreased upper pole renal parenchyma.

Key: C

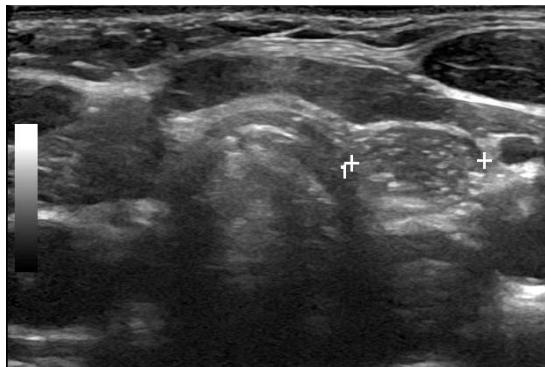
Rationale:

- A. Renal cysts of this size would be exceedingly rare in the newborn and would not be associated with the ureteral dilatation or the ureterocele shown on the MR image.
- B. Ureterovesical junction obstruction typically occurs in an orthotopic ureter with a distal aperistaltic segment. Although there may be obstruction at the ureterocele, this choice does not include the diagnosis.
- C. Correct.
- D. Reflux does not cause findings of duplex upper pole with ureterocele as shown here.

Reference:

Berrocal T, López-Pereira P, Arjonilla A, Gutiérrez J. Anomalies of the distal ureter, bladder, and urethra in children: embryologic, radiologic and pathologic features. Radiographics 2002 Sep-Oct; 22(5):1139-64 | Radiographics 2002 Sep-Oct; 22(5):1139-64.

6. An ultrasound study was performed on an 8-month-old girl with pre-auricular cellulitis. An axial image below the level of the thyroid at the base of the neck was also obtained. What is the MOST likely etiology of the structure outlined by the calipers?



- A. Calcified lymph node
- B. Thymic tissue
- C. Thyroglossal duct cyst
- D. Lymphatic malformation

Findings:

The appearance in this case is typical of thymic tissue with stippled echogenic foci distributed diffusely throughout a hypoechoic background.

Key: B

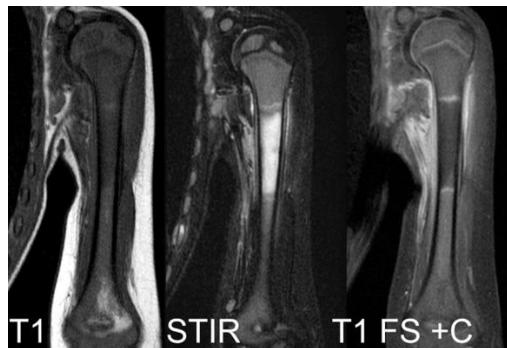
Rationale:

- A. The structure seen does not have the typical configuration of a lymph node (oval shape, linear hyperechoic hilum). The stippled densities do not demonstrate acoustic shadowing and do not represent calcifications.
- B. Thymic tissue from the mediastinum often slides into the neck with respiration. Video clips in the sagittal plane will often show the structure sliding through the thoracic inlet in and out of the base of the neck.
- C. A thyroglossal duct cyst typically is in the midline. Also, the cyst would be hypoechoic.
- D. Lymphatic malformations do commonly occur in the neck, but they typically have cystic (hypo echoic or anechoic) spaces with or septations on ultrasound.

Reference:

Ozel A, Akdur P, Celebi I, et al. Ectopic cervical thymus as a rare cause of pediatric neck mass: the role of ultrasound and MRI in the diagnosis. Med Ultrasound 2015; 17(2):248-251.

8. A 3-year-old girl with leukemia presented with acute left arm pain. What is the MOST likely etiology of the diaphyseal lesion?



- A. Osteomyelitis
- B. Pathologic fracture
- C. Bone infarct
- D. Acute leukemia

Findings:

The patient has diffuse marrow replacement from the underlying leukemia, best appreciated on T1 weighted image showing loss of fat signal. However, the focal STIR hyperintense lesion is non enhancing consistent with perfusion defect or bone infarct in child with leukemic marrow replacement.

Key: C

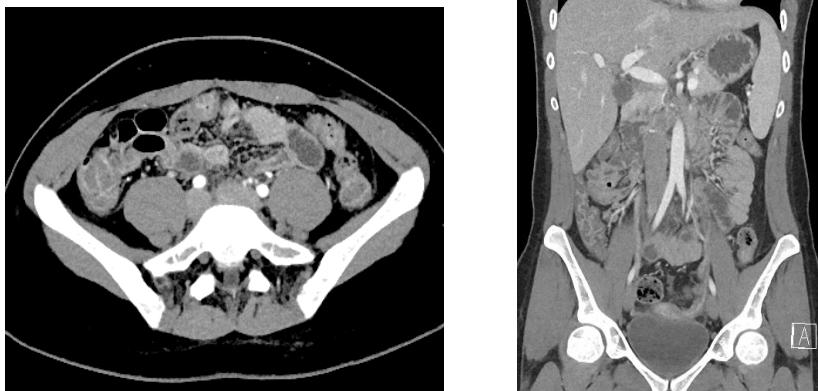
Rationale:

- A. There should be increased enhancement in osteomyelitis.
- B. Area around a fracture should enhance. In addition, there is no evidence of fracture.
- C. This choice describes the findings
- D. The patient has diffuse marrow replacement from leukemia. However, the hyperintense lesion demonstrate no contrast enhancement compatible with bone infarct, one of the complications of leukemia.

Reference:

Diego Jaramillo. What is the optimal imaging of osteonecrosis, Perthes, and bone infarcts? Pediatr Radiol (2009) 39 (Suppl 2):S216–S219.

9. A 17 year-old oncology patient presents with abdominal pain. What is the most likely diagnosis?



- A. Henoch-Schönlein purpura
- B. Intussusception
- C. Crohn disease
- D. Neutropenic enterocolitis

Findings:

The images show wall thickening and mucosal hyperemia of the ascending colon.

Key: D

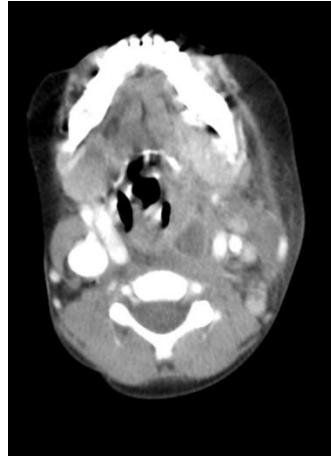
Rationale:

- A. Henoch-Schönlein purpura can cause bowel wall but much more commonly involves the jejunum.
- B. Intussusception leads to bowel thickening, but this is due to bowel within bowel, not primary thickening of the wall as is present here.
- C. Crohn disease typically involves the terminal ileum, and is not expected as a complication of chemotherapy.
- D. Neutropenic colitis occurs in patients with bone marrow suppression related to chemotherapy and most commonly involves the cecum and ascending colon as seen in this case.

References:

- Boland GW, Lee MJ, Cats AM, et-al. Antibiotic-induced diarrhea: specificity of abdominal CT for the diagnosis of Clostridium difficile disease. Radiology. 1994; 191 (1): 103-6.
Van de Wetering, Kuijpers TS et al. Pseudomembranous and neutropenic enterocolitis in pediatric oncology patients. Support Care Cancer 2003; 11:581-586

10. You are shown images of an 11-month-old child with dysphagia. Which is a potential complication of the condition shown?



- A. Carotid artery dissection
- B. Intracranial extension
- C. Pneumomediastinum
- D. Jugular vein thrombosis

Findings:

The radiograph shows retropharyngeal mass effect and the CT demonstrates a fluid attenuation collection in the retropharyngeal soft tissues with enhancing rim diagnostic of retropharyngeal abscess.

Key: D

Rationale:

- A. Carotid artery pseudoaneurysm may occur, but not dissection.
- B. The infection can spread vertically to the skull base, but not intracranially.
- C. Neck infections can spread vertically into the superior mediastinum, but do not cause pneumomediastinum.
- D. A complication can be jugular vein thrombosis, also known as Lemierre Syndrome.

Reference:

Pinto A, Scaglione M, Scuderi MG, Tortora G, Daniele S, Romano L. Infections of the neck leading to descending necrotizing mediastinitis: Role of multi-detector row computed tomography. Eur J Radiol. 2008 Mar; 65(3):389-94.

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1. With all other factors held constant, increasing the fluoroscope magnification mode (smaller field-of-view) will result in which of the following?

- A. Increase the magnification gain for an image intensifier based system
- B. Increase in the reference point air kerma rate
- C. Decrease operator dose rate
- D. Allow for a higher regulatory air kerma rate

Key: B

Rationale:

The air kerma rate (output) will increase with increased system magnification. The dose to the operator increases when the beam output hitting the patient's skin increases, since the operator receives scattered radiation from the patient.

Reference:

Bushberg JT, Seibert JA, Leidholdt EM Jr, Boone JM. Essential physics of medical imaging. Lippincott Williams & Wilkins 2012:294-296, 309-310.

2. What is the MOST likely effect of radiation exposure of 2 Gy (200 rad) during the preimplantation stage of pregnancy?

- A. Embryonic death
- B. Gross malformation
- C. Growth retardation
- D. Intellectual disability

Key: A

Rationale:

Malformations may occur during the organogenesis state at this dose level but are not possible at the preimplantation stage. Embryonic death may not occur at this dose but is possible and more likely than any of the other options. Growth retardation and intellectual disability are also associated with later pregnancy stages, not preimplantation.

Reference:

ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation, 2018. Pages 3, 16-18.

3. What is the purpose of Multipoint Dixon Technique used in MR imaging of the spine?
- A. Enhance CSF suppression
 - B. Eliminate metallic distortion
 - C. Make fat suppression more uniform
 - D. Compensate for motion

Key: C

Rationale:

Multipoint Dixon techniques are used to make fat suppression more uniform.

Reference:

Barger AV, DeLone DR, Bernstein MA, Welker KM. Fat Signal Suppression in Head and Neck Imaging Using Fast Spin-Echo-IDEAL Technique. AJNR Am J Neuroradiol 2006 Jun-Jul;27:1292–94.

4. In a SPECT/CT imaging system, what is the purpose of the scintillation camera collimators?
- A. Rejecting x-ray scatter from the CT scan procedure
 - B. Providing attenuation correction for SPECT reconstruction
 - C. Eliminating scatter from gamma ray tissue interactions
 - D. Allowing only photons from a defined direction to reach the crystal

Key: D

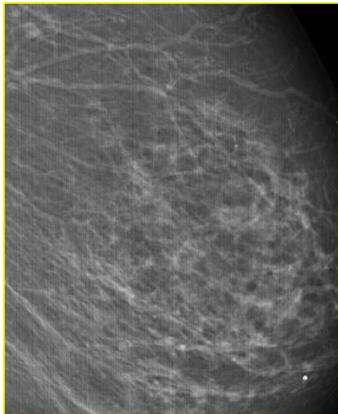
Rationale:

- A. Scintillation camera collimators do not selectively reject scatter.
- B. The CT scan image is used for attenuation correction of the gamma-ray photons.
- C. Although gamma-rays do scatter, the collimators do not selectively remove scattered radiation from primary radiation. Scattered photons are rejected by energy discrimination, although not all are rejected.
- D. A projection image is formed by only allowing gamma rays from a defined direction to reach the crystal. For example, in a parallel hole collimator, only photons parallel or almost parallel to the holes will pass through.

Reference:

Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone The Essential Physics of Medical Imaging, 3rd edition 2012, pages 677-681.

5. What is the source of the digital mammography artifact, in the form of vertical lines, observed in this image?



- A. Focal Spot
- B. Patient motion
- C. Electronic noise from power supply
- D. Dust in the collimator assembly

Key: C

Rationale:

Typically, repeating lines in an image are caused from an electronic source, in this case the power supply.

Reference:

Ayyala RS, Chorlton M, Behrman R, Kornguth PJ, Slanetz PJ Digital Mammographic Artifacts on Full-Field Systems: What Are They and How Do I Fix Them? RadioGraphics 2008 Nov; 28(7):1999-2009DXIT form 4-2020.

6. What is a typical transmission factor for 0.5 mm Pb apron used in fluoroscopy?

- A. 0.25
- B. 0.1
- C. 0.05
- D. 0.005

Key: C

Rationale:

A typical lead shield of 0.5 mm Pb equivalence will attenuate approximately 95% and therefore the transmission factor would be 5%.

Reference:

McCaffrey JP, Shen H, Downton B, Mainegra-Hing E Radiation attenuation by lead and nonlead materials used in radiation shielding garments Medical Physics 2007 Feb;34(2):530-538DXIT form 4-2020.

7. Regulations limit the air kerma rate at 30 cm from a fluoroscope image receptor for Digital Subtraction Angiography (DSA) to which of the following?

- A. 44 mGy/min (5 R/min)
- B. 88 mGy/min (10 R/min)
- C. 176 mGy/min (20 R/min)
- D. No regulatory limit

Key: D

Rationale:

- A. this is the limit for systems without automatic brightness control (not common), and also, For DSA, there are no regulatory air kerma limits.
- B. This is the limit for normal fluoroscopy mode.
- C. This is the limit for high dose or boost mode.
- D. There is no regulatory limit for DSA.

Reference:

Bushberg JT, Seibert JA, Leidholdt EM Jr, Boone JM Essential physics of medical imaging 3rd ed. 2012 Philadelphia, Pa: Lippincott Williams Wilkins, pages 304, 872-873.

8. Which of the following fluoroscopic image artifacts are unique to image intensifier based systems?

- A. Aliasing
- B. Focal Spot Blurring
- C. S-distortion
- D. Lag

Key: C

Rationale:

The correct answer is C, S-distortion. This is a warping of the image due to stray magnetic fields such as the earth's magnetic field affecting the electrons traveling between cathod and anode inside the image intensifier. Magnetic fields do not have this effect on digital detectors. Focal spot blurring is unrelated to the image intensifier. Lag is related to the frame rate of the fluoroscopy beam, not the image receptor. Aliasing is related to digitization of images.

Reference:

Nickoloff EL The AAPM/RSNA physics tutorial for residents: Physics of flat-panel detectors versus image intensifiers and more. RadioGraphics 2011; 31:591-602.

Bushberg JT, Seibert JA, Leidholdt EM Jr, Boone JM. Essential physics of medical imaging. Lippincott Williams & Wilkins 2012:289-290.

Ultrasound Radiology In-Training Test Questions for Diagnostic Radiology Residents



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1. Ultrasound was performed on a woman with a history of urinary tract infections. What is the cause of the abnormality demonstrated?



- A. Congenital
- B. Iatrogenic
- C. Infectious
- D. Neoplastic

Key: A

Rationale:

- A. Ureterocele is a congenital abnormality of the distal ureter at the ureterovesical junction within the submucosal bladder wall.
- B. Ureterocele is not iatrogenic.
- C. Ureterocele does not result from infection.
- D. Bladder neoplasm usually appears as a solid mass and not the cystic appearance of ureterocele, and the ureteral jet extending from the lesion is characteristic of ureterocele.

Reference:

Madeb R, Shapiro I, Rothschild E, Halachmi S, Nativ O. Evaluation of ureterocele with Doppler sonography. J Clin Ultrasound. 2000 Oct; 28(8):425-9. doi: 10.1002/1097-0096(20001).

2. In a patient with a prior history of papillary thyroid cancer, which of the following features of a neck lymph node would MOST likely be considered benign?

- A. Cystic change
- B. Fatty hilum
- C. Microcalcifications
- D. Increased vascularity

Key: B

Rationale:

- A. Cystic change within a cervical lymph node is abnormal and suspicious for metastatic disease.
- B. Benign cervical lymph nodes are oval shape, have an echogenic, fatty hilum, homogeneous hypoechoic cortex and show vessels that enter at the hilum.
- C. Microcalcifications are not present in benign lymph nodes and would be considered suspicious for metastatic thyroid cancer.
- D. Increased vascularity, especially within the cortex of a lymph node is suspicious for metastatic disease. Benign lymph nodes show vascular flow within hilar vessels.

Reference:

Kumbhar SS, O'Malley RB, Robinson TJ, Maximin S, Lalwani N, Byrd DR, Want CL. Why Thyroid Surgeons are Frustrated with Radiologists: Lessons Learned from Pre-and Postoperative US. *Radiographics* 2016; 36:2141-2153.

3. In a twin pregnancy, when is the BEST time to obtain an ultrasound to determine chorionicity?

- A. Second trimester
- B. First trimester
- C. Third trimester
- D. Anytime during pregnancy

Key: C

Rationale:

- A. After the first trimester, determination of chorionicity is more difficult.
- B. Ultrasound determination of chorionicity is best in the first trimester.
- C. Ultrasound determination of chorionicity difficult in the third trimester.
- D. The first trimester is the best time to determine chorionicity.

Reference:

ISUOG Practice Guidelines: role of ultrasound in twin pregnancy. *Ultrasound in Obstetrics and Gynecology* 2016;47:247-263.

4. What is the normal echogenicity of the pancreas in adults?

- A. Hyperechoic to the liver
- B. Hypoechoic to the liver
- C. Hypoechoic to the spleen
- D. Isoechoic to both the liver and spleen

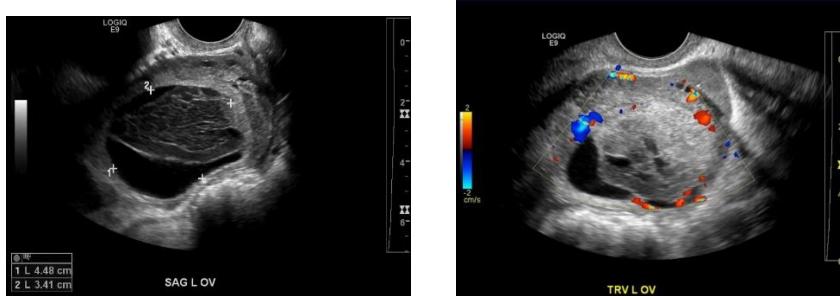
Key: A

Rationale:

- A. The echogenicity of the normal pancreas is variable depending on the amount of fatty replacement, but usually slightly higher than the normal liver.
- B. The echogenicity of the normal pancreas is slightly higher than liver.
- C. The normal pancreas can be hypoechoic, isoechoic or hyperechoic as compared to the spleen.
- D. The pancreas is most commonly hyperechoic to the liver and can be hypoechoic, isoechoic or hyperechoic as compared to the spleen.

Reference: Pancreas in Ultrasound: The Requisites. Elsevier 2015 Pages 179-191.

5. According to both SRU and ACR O-RADS guidelines, what is the appropriate management for this finding in a premenopausal woman?



- A. Follow-up ultrasound in 6 weeks
- B. MRI of the pelvis
- C. CT of the abdomen and pelvis
- D. No follow-up recommended

Key: D

Rationale:

- A. No follow up is recommended for a classic hemorrhagic cyst, which is less than 5 cm in a woman of reproductive age group.
- B. This lesion shows findings of a classic hemorrhagic cyst including reticular pattern and retractile clot. Given classic imaging features, MRI is not needed for further characterization.
- C. CT abdomen and pelvis does not play a role in further characterizing ovarian lesions.
- D. The ultrasound images demonstrate a classic hemorrhagic cyst, which is less than 5 cm in a woman of reproductive age group. According to the SRU consensus on ovarian cysts, this does not need any follow-up and can be left alone.

Reference:

- Levine D, et al. Management of asymptomatic ovarian and other adnexal cysts imaged at US Society of radiologists in ultrasound consensus conference statement. Ultrasound Quarterly. 2010; 26:121-131.
Andreotti RF, et al. O-RADS US risk stratification and management system: A consensus guideline from the ACR Ovarian-Adenexal Reporting and Data System Committee. Radiology 2020; 294:168-185.

5. Which of the following peak systolic velocities (PSV) is the MOST universally accepted minimum Doppler criteria for renal artery stenosis?

- A. 125-150 cm/s
- B. 180-200 cm/s
- C. 250-275 cm/s
- D. 300-325 cm/s

Key: B

Rationale:

The most universally accepted Doppler criteria for renal artery stenosis is a PSV of 180-200 cm/s or greater in the region of stenosis and a renal artery to aortic ration RAR> 3.3 or 3.5.

Reference:

Pellerito JS, Revzin MV Ultrasound Assessment of Native Renal Vessels Introduction to Vascular Ultrasonography 6th ed. Philadelphia, PA: Elsevier Saunders; 2012:522-524.

6. Which of the following describes a typical ultrasound appearance of focal parenchymal involvement of the kidney with lymphoma?

- A. Hyperechoic mass
- B. Heterogeneous mass
- C. Calcified mass
- D. Hypoechoic mass

Key: D

Rationale:

- A. Renal lymphoma is typically hypoechoic or nearly anechoic on ultrasound.
- B. Renal lymphoma is typically homogeneous and hypoechoic or nearly anechoic.
- C. Focal parenchymal involvement of the kidney with lymphoma is typically homogeneous, hypoechoic or anechoic.
- D. Hypoechoic to anechoic US appearance reflects the underlying homogeneity of lymphoma deposits, which offer very few tissue interfaces to the insonating beam. They do not demonstrate posterior acoustic transmission as would be expected in cystic lesions.

Reference:

Sheth S, Ali S, Fishman E. Imaging of Renal Lymphoma: Patterns of Disease with Pathologic Correlation Radiographics 2006, Vol.26: 1151-1168.

8. Focal fatty sparing is characteristically located in which hepatic segment?

- A. IV
- B. VI
- C. VII
- D. VIII

Key: A

Rationale:

Correct Focal fatty sparing and focal fatty liver both most commonly involve the periportal region of the medial segment of the left lobe, segment 4. Focal fatty sparing is also characteristically located in segments 5 and 2.

Reference:

Wu S, Tu R, Liu G, et al. Focal Fatty Sparing Usually Does Not Arise in Preexisting Nonalcoholic Diffuse Homogeneous Fatty Liver. J Ultrasound Med 2014; 33:1447-1452.
PubMed Advanced Search.

9. A 1.5 cm hyperechoic lesion is identified within a cirrhotic liver on ultrasound. What is the next step in management?

- A. Follow-up ultrasound imaging in 6 months
- B. Liver MRI
- C. 18 FDG PET/CT
- D. No further follow-up necessary

Key: B

Rationale:

- A. In a cirrhotic liver, any solid mass detected on ultrasound should be considered malignant until proved otherwise and needs further evaluation with MRI or triphasic CT.
- B. Any solid lesion seen in a cirrhotic liver by ultrasound should be considered malignant until proved otherwise and needs further evaluation with MRI or triphasic CT.
- C. A solid lesion seen on ultrasound in a patient with cirrhosis should be considered malignant until proved otherwise and needs further evaluation with MRI or triphasic CT. PET/CT would not be the next step in management.
- D. Ultrasound is not sensitive but highly specific for HCC in a cirrhotic liver. Any solid mass detected on ultrasound in a cirrhotic liver should be considered malignant until proven otherwise and needs further evaluation with MRI or triphasic CT. Even masses that have a typical appearance of hemangioma have a 50% chance of being HCC.

Reference:

Middleton WD, Kurtz AB, Hertzberg BS. Ultrasound The Requisites 2nd ed. Mosby 2004; 61-64.

10. What is the cause of the gallbladder wall abnormality (arrow) and posterior artifact (arrow head)?



- A. Adenomyomatosis
- B. Calcification (porcelain gallbladder)
- C. Adherent sludge
- D. Emphysematous cholecystitis

Key: D

Rationale:

- A. Dirty shadowing can be mistaken for comet tail artifact, which occurs with cholesterol crystals in the setting of adenomyomatosis, but the finding is too diffuse and lacks the characteristic reverberations and does not explain the inflammation.
- B. This entity typically causes a more uniform "clean" shadow, without clear luminal visualization.
- C. This entity can cause a variety of echo patterns but typically have well-defined margins without shadowing that obscures the lumen.
- D. This diagnosis is best appreciated on other modalities but by ultrasound, the most specific finding is the dirty shadowing produced by the intraluminal gas from tissue necrosis (gangrene).

Reference:

Sunnapwar A, et al. Emphysematous cholecystitis: Imaging findings in nine patients. Indian Journal of Radiology and Imaging 2011, Vol 21, Issue 2, pp 142-146.