

Breast Radiology  
In-Training Test Questions  
for Diagnostic Radiology Residents

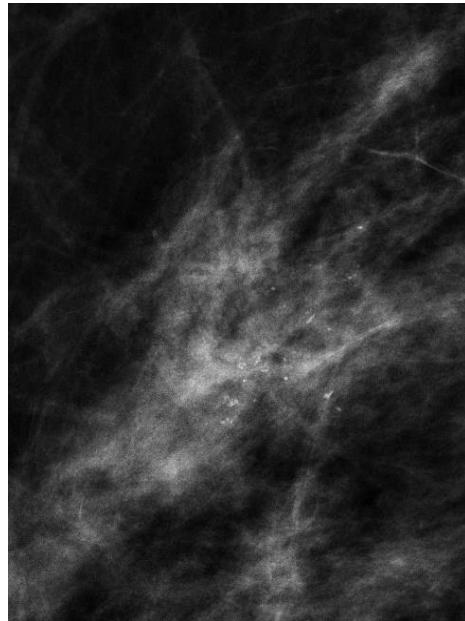
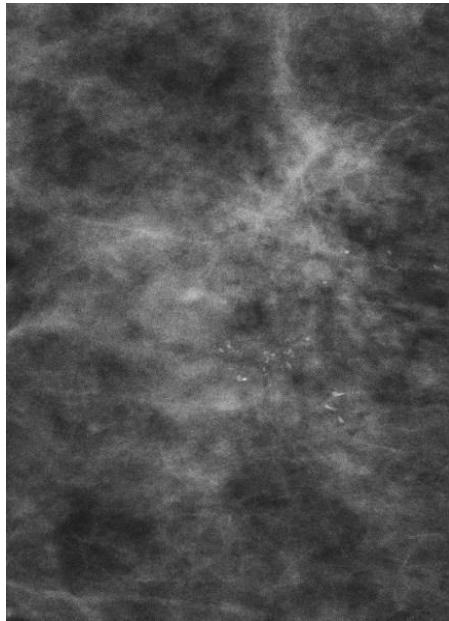


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1. Based on these CC and ML magnification views of the right breast, what is the MOST appropriate BI-RADS assessment category?



- A. 0
- B. 2
- C. 3
- D. 4

**Key:** D

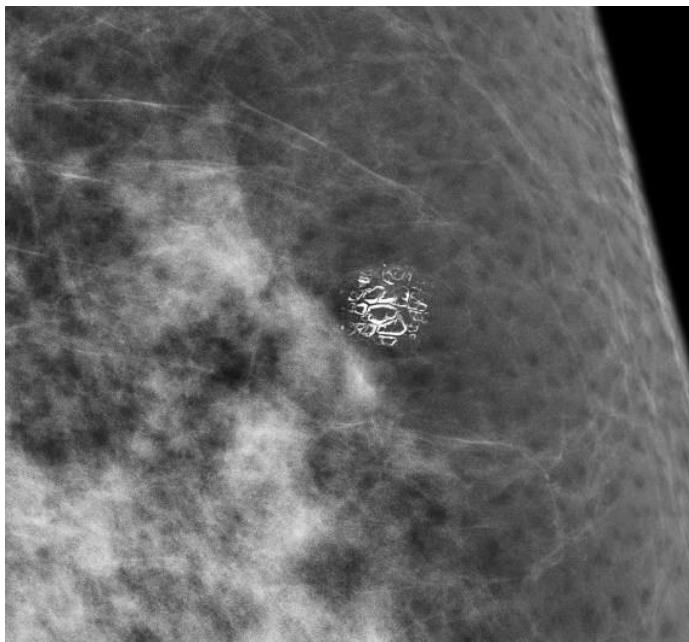
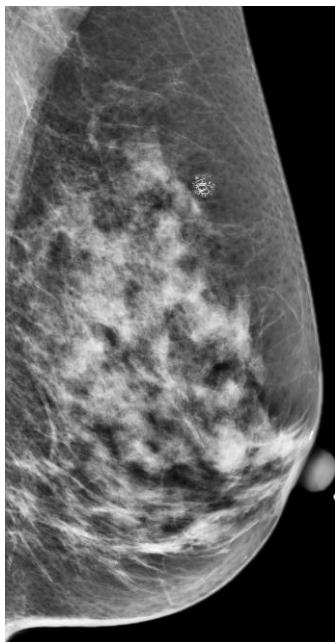
**Rationale:**

This category should be used on screening studies for patients who are to be recalled for additional evaluation. In this case, the appropriate management is a biopsy recommendation and not additional imaging evaluation.

**Reference:**

Dorsi C, Sickles EA, Mendelson EB, et al ACR BI-RADS ATLAS, 5th Edition 2013.

2. You are shown a standard left MLO view and a magnified view of the superior left breast. What is the MOST appropriate recommendation?



- A. Routine annual screening
- B. Ultrasound
- C. Stereotactic core biopsy
- D. Breast MRI

**Key:** A

**Rationale:**

Findings are compatible with calcifications within a mole. No further workup is necessary, and the patient can be advised to resume routine annual screening.

**Reference:**

Cardenosa G. Benign Breast Calcifications Clinical Breast Imaging: The Essentia 2015: Chapter 6.

3. At what age should a woman begin annual screening mammography if she has a family history of breast carcinoma diagnosed in her mother at age 33?

- A. 23
- B. 25
- C. 33
- D. 40

**Key:** B

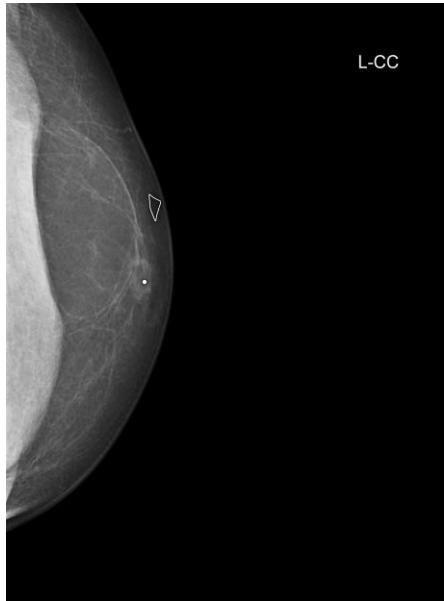
**Rationale:**

Women with mothers or sisters with premenopausal breast cancer should start yearly mammographic screening by age 10 years earlier than the age of diagnosis of the youngest affected relative, but not before age 25.

**Reference:**

NCCN Guidelines.

4. What is the MOST likely etiology of the palpable mass, as indicated by the triangular marker, in this 49-year-old man?



- A. Gynecomastia
- B. Lipoma
- C. Oil cyst
- D. Hamartoma

**Key:** B

**Rationale:**

- A. This mass is lucent centered and not in the retroareolar region.
- B. Correct, encapsulated fat containing mass.
- C. An oil cyst should have rim calcification.
- D. A hamartoma should have elements of fibroglandular tissue admixed with lucency.

5. Punch biopsy of the breast in a patient with nipple ulceration demonstrated Paget disease. Subsequent mammogram and sonogram were negative. What is the BEST next step in patient management?

- A. PET-CT
- B. Breast MRI
- C. Lumpectomy
- D. Mastectomy

**Key:** B

**Rationale:**

PET-CT is not helpful in the initial evaluation of a patient with Paget disease. It is useful in evaluation of patients with suspected metastatic disease.

**Reference:**

Hyo Soon Lim, Su Jin Jeong, Ji Shin Lee, Min Ho Park, Jin Woong Kim, Sang Soo Shin, Jin Gyoong Park, and Heoung Keun Kang. Paget Disease of the Breast: Mammographic, US, and MR Imaging Findings with Pathologic Correlation. RadioGraphics 2011 31:7, 1973-1987 | RadioGraphics 2011 31:7, 1973-1987.

6. In evaluating the axilla in a patient with breast carcinoma, which of the following sonographic axillary lymph node features is considered MOST suspicious for metastatic nodal involvement?

- A. Lymph node size > 2cm
- B. Echogenic hilum
- C. Non-hilar blood flow
- D. Cortical lobulations

**Key:** C

**Rationale:**

- A. Nodal size is not an important factor in determining nodal involvement.
- B. Echogenic hilum is a normal lymph node feature.
- C. Non-hilar blood flow is a suspicious finding and should warrant FNA.
- D. This is a normal axillary nodal finding and is not considered a suspicious finding on its own.

**Reference:**

Bedi DG. Axillary lymph nodes in breast cancer: ultrasound appearance American Journal of Roentgenology 2011 Jul; 197(1):W194.

7. A 23-year-old woman presents for sonographic evaluation of a palpable abnormality within the right breast. What is the MOST appropriate recommendation?



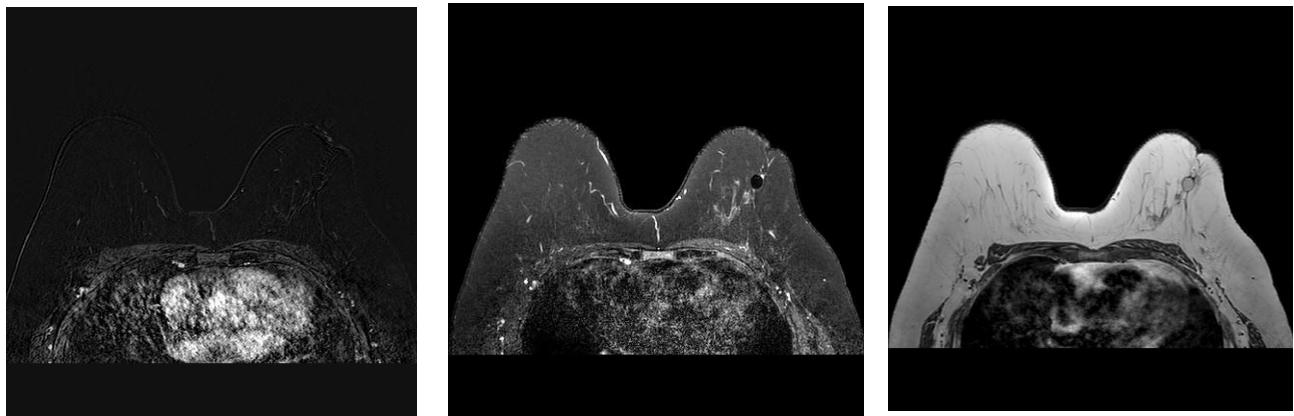
- A. Ultrasound guided needle biopsy
- B. Short term sonographic follow-up in 6 months
- C. Surgical consultation
- D. Clinical management

**Key:** D

**Rationale:**

Sebaceous cysts result from blocked hair follicles causing the accumulation of keratin within plugged ducts. They often present as palpable masses with a black dot on the overlying skin surface. Biopsy and imaging follow-up are not necessary given the benign nature of sebaceous cysts. They can be treated clinically with warm compresses or need additional management and possibly surgery if they become inflamed.

8. You are shown subtraction, T2 weighted and T1 weighted axial images from a screening breast MRI. What is the etiology of the finding in the left breast?



- A. Susceptibility artifact
- B. Hematoma
- C. Fat necrosis
- D. Silicone granuloma

**Key:** C

**Rationale:**

- A. Susceptibility artifact appears as signal drop out from a metallic object. The drop out will be seen on all sequences. On these images, the finding is bright on T1 and dark on T2, and does not enhance, compatible with fat necrosis.
- B. Hematomas tend to be bright on T2 and dark/mixed signal intensity on T1. Findings in this example are the opposite. Bright on T1 and dark on T2.
- C. Fat necrosis is typically non-enhancing and can be diagnosed with certainty on non-fat suppressed T1 images where the internal fat is bright. On fat suppressed T2 weighted images, the fat is of low signal intensity.
- D. Silicone granulomas tend to be of low signal intensity on T2 weighted images and high signal intensity on T1. If they calcify, there will be signal dropout on all sequences.

**Reference:**

Harvey J., Hendricks R et al. Breast MR Imaging Artifacts: How to Recognize and Fix Them  
Radiographics 2007 Nov; 27: S131-S145.

9. What is the intent of breast density notification laws?

- A. To require insurance companies to pay for supplemental screening tests in women with dense breasts
- B. To give women the necessary information to decide on further action if they have dense breast tissue
- C. To inform women of their risk factors for breast cancer
- D. To notify referring physicians of their patient's mammographic breast density

**Key:** B

**Reference:**

Lee CI, et al Breast Density Legislation and Opportunities for Patient-centered Outcomes ResearchRadiology 2012;264(3).

10. What mammographic finding is typically found in patients with inflammatory breast carcinoma?

- A. Pleomorphic calcifications
- B. Nipple retraction
- C. Shrunken breast
- D. Diffuse increased density

**Key:** D

**Rationale:**

Typical mammographic appearance of inflammatory breast carcinoma includes diffuse enlargement of the breast, stromal coarsening, diffuse increased density, skin thickening and enlarged lymph nodes

**Reference:**

Eren D. Yeh, MD, Heather A. Jacene, MD, Jennifer R. Bellon, MD Faina What Radiologists Need to KnowRadiographics 2013; 33:2003–2017.

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1. What is the MOST appropriate recommendation for management of this intra-aortic balloon pump?



- A. It should be replaced
- B. It should be advanced
- C. It should be retracted
- D. No manipulation is indicated

**Key:** C

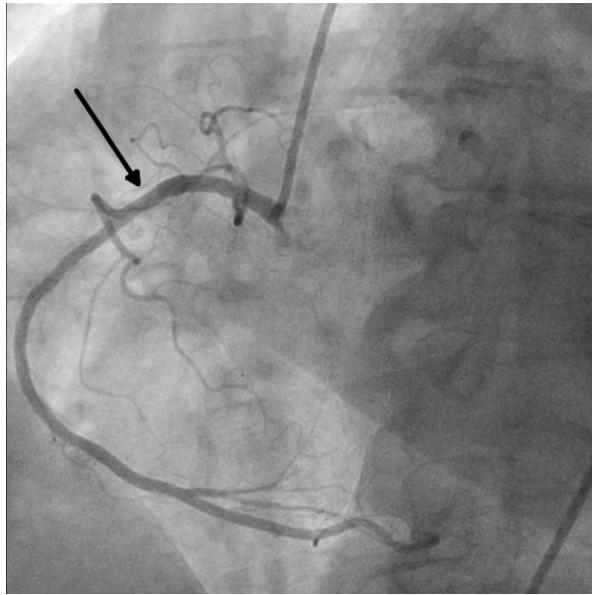
**Rationale:**

The IABP is malpositioned, extending far too superiorly, extending beyond the aorta and well up the left common carotid artery placing the patient at high risk for branch vessel injury, dissection, and potential adverse cerebral insult. Emergent retraction is indicated. The distal tip of the radio-opaque marker should be positioned in the proximal descending thoracic aorta approximately 2 cm distal to the left subclavian artery origin.

**Reference:**

Hunter TB, Taljanovic MS, Tsau PH, Berger WG, Standen JR. Medical Devices of the Chest. RadioGraphics 2004; 24:1725-1746. | RadioGraphics 2004; 24:1725-1746.

2. On this coronary angiogram, what artery is indicated by the arrow?



- A. Left anterior descending
- B. Ramus intermedius
- C. Circumflex
- D. Right Coronary

**Key:** D

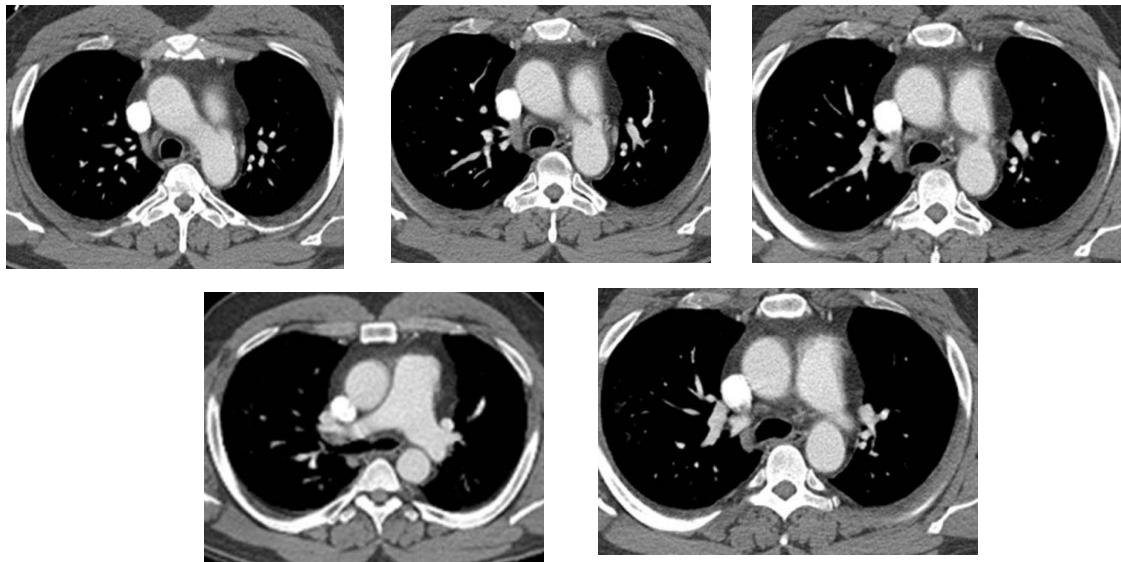
**Rationale:**

This frame of a coronary angiogram depicts injection of the right coronary artery with its characteristic C-shaped projection as it travels in the anterior atrioventricular groove. The left main coronary artery is a short segment vessel which bifurcates almost immediately into the left anterior descending (LAD) and left circumflex (LCx). On single injection of the left main, the left main segment and resulting bifurcations of the LAD and LCx will be observed. The LAD travels in the anterior interventricular groove to the apex of the heart. The LCx travels in the left atrioventricular groove between the left atrium and left ventricle supplying the lateral wall of the left ventricle. The right coronary artery arises as a single vessel from the sinus of Valsalva and travels in the right atrioventricular groove between the right atrium and right ventricle to the inferior part of the interventricular septum. The ramus intermedius, an anatomic variant, is the middle vessel of the trifurcation of the left main coronary artery and is present in 15-30% of patients.

**Reference:**

OBrien JP, Srichai MB, Hecht EM, et al. Anatomy of the Heart at Multidetector CT: What the Radiologist Needs to Know. *Radiographics*. 2007 Nov 1; 27(6):1569–1582.

3. You are shown contiguous contrast-enhanced axial chest CTA images of a patient involved in a motorcycle collision. What is the diagnosis?



- A. Traumatic aortic injury
- B. Penetrating aortic ulcer
- C. Patent ductus arteriosus
- D. Ductus diverticulum

**Key:** C

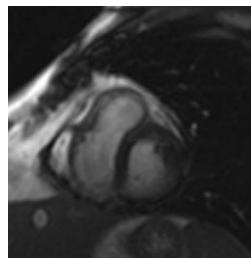
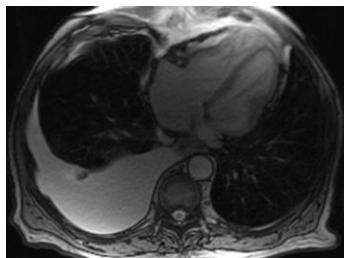
**Rationale:**

- A. The most specific direct signs of aortic injury are intimal flap and luminal thrombus or debris (100%) whereas irregular aortic contour or pseudoaneurysm is the most sensitive (100%). Additional direct signs include pseudoaneurysm, focal contour abnormality, abrupt aortic caliber change, coarctation and active contrast extravasation. Indirect signs include subtle contour abnormalities, hemomediastinum and peri-aortic blood. These signs are not present in this case.
- B. Penetrating aortic ulcer is an atherosclerotic lesion that penetrates the elastic lamina with associated hematoma formation in the media of the aorta. Atheromatous ulcers develop in patients with advanced atherosclerosis, are usually asymptomatic and confined to the intima. Subsequently, the lesion can penetrate through the elastic lamina into the media, causing localized hemorrhage which may then extend along the media, creating the appearance of a thrombosed aortic dissection. Although penetrating ulcers can occur in the ascending aorta or aortic arch, they are usually found in the descending aorta. These imaging features are not present in this case.
- C. There is a well-defined enhancing tubular structure located between the descending thoracic aorta and the main pulmonary artery in the absence of hemomediastinum or other evidence of traumatic aortic injury.
- D. The ductus diverticulum is located in the anterior and medial aspect of the posterior aortic arch at the level of the ligamentum arteriosum. On CT, it shows a smooth focal contour bulge with obtuse margins. In this case, there is an actual communication between the pulmonary artery and the aorta through the patent ductus arteriosus. Such a communication would not occur with a ductus diverticulum.

**Reference:**

Parker MS, Rosado-de-Christenson ML, Abbott GF Thoracic trauma: acute traumatic aortic injury and anatomic variants simulating acute injury Chest Imaging CaseAtlas, 2nd ed 2014, pp 480-494.

4. This 70-year-old patient presents with the insidious onset of heart failure. What is the MOST likely diagnosis?



- A. Restrictive cardiomyopathy
- B. Pulmonary hypertension
- C. Tricuspid stenosis
- D. Constrictive pericarditis

**Key:** D

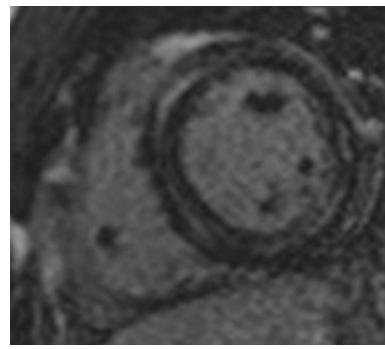
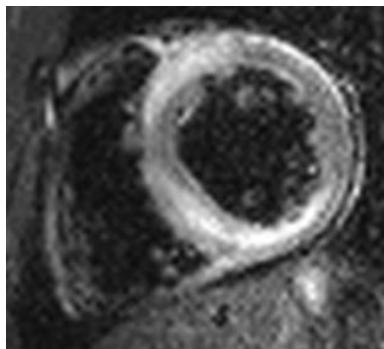
**Rationale:**

Restrictive cardiomyopathy can clinically resemble constrictive pericarditis. This similarity makes CT and MR imaging useful in differentiating these entities. Although patients with restrictive cardiomyopathy and constrictive pericarditis have abnormal diastolic function, the pericardium is not abnormal in patients with restrictive cardiomyopathy.

**Reference:**

Wang ZJ et al. CT and MR imaging of pericardial disease. RadioGraphics 2003; 23:S167–S180.

5. You are shown early and late post-contrast MR images. What is the MOST likely diagnosis?



- A. Acute viral myocarditis
- B. Ischemic cardiomyopathy
- C. Hypertrophic cardiomyopathy
- D. Dilated cardiomyopathy

**Key:** A

**Rationale:**

- A. Myocardial inflammation and resulting edema causes high signal throughout the myocardium on T2 or STIR sequences. Patchy delayed enhancement in this setting is believed to be a consequence of hyperemia, capillary leakage, tissue edema, and cellular necrosis.
- B. Cardiac MRI findings of ischemic cardiomyopathy include myocardial thinning, akinesia or dyskinesia, and delayed enhancement. In ischemic cardiomyopathy, delayed enhancement follows a vascular territory and begins at the subendocardial level and progresses peripherally. In this patient, the foci of delayed enhancement are located throughout the mid myocardium. The increased myocardial signal on STIR images, a finding associated with acute inflammation, is not a characteristic feature of ischemic cardiomyopathy.
- C. The left ventricular myocardium has normal thickness on this examination. In the most common form of hypertrophic cardiomyopathy, the basal septum is thickened. Delayed postcontrast images may show patchy foci of enhancement in the hypertrophied myocardium, reflecting underlying scar. The increased myocardial signal on STIR images in this case, a finding associated with acute inflammation, is not a characteristic feature of hypertrophic cardiomyopathy.
- D. Dilated cardiomyopathy is characterized by progressive cardiac dilation and decline in contractility. In this case, there is no evidence of left ventricular enlargement. Abnormal high signal in the myocardium may be present on T2 and STIR images in patients with dilated cardiomyopathy. In this setting, delayed enhancement most commonly occurs in the mid myocardial and subepicardial regions.

**Reference:**

Hoey ETD, Gulati GS, Ganeshan A, et al. Cardiovascular MRI for Assessment of Infectious and Inflammatory Conditions of the Heart. American Journal of Roentgenology 2011;197:1, 103-112.

6. A curved planar reformation (CPR) of the first obtuse marginal coronary artery is given in image A. Image B is the depiction of the CPR centerline. Image C is a straightened, or string, reformation of the vessel. What is the most likely cause of the defect (arrow) depicted in the proximal portion of the first obtuse marginal in image A?



- A. Vessel lumen narrowing due to non-calcified atherosclerotic plaque
- B. Improper positioning of the centerline causing a false positive stenosis depiction
- C. Stair-step misregistration artifact on a prospectively triggered ("step and shoot") CCTA
- D. Beam hardening artifact causing a false positive stenosis depiction

**Key:** B

**Rationale:**

- A. The defect seen on the reformatted image A is not reproducible on images B and C, therefore this is most consistent with an artifact.
- B. The centerline is positioned incorrectly at the vessel wall resulting in the artifactual stenosis.
- C. "Stairstep artifacts" are due to motion occurring between reconstruction of sequential heartbeats. This motion can be due to breathing, gross motion, or arrhythmia. This artifact is typically more obvious on the coronal and sagittal planes which are perpendicular to the table travel and make the misalignment or shift of continuous cardiac structures obvious. However, this is not seen on the provided images.
- D. Metal density artifacts include beam-hardening, blooming, and streaking. Dark beam-hardening artifacts may simulate a non-calcified plaque in proximity to calcifications, and blooming artifacts commonly make calcified plaque and stents appear to narrow the lumen more than they actually do. On the provided images, there is no metal or calcification to cause this artifact.

**Reference:**

Raff GL, Abidov A, Achenbach S, et al; Society of Cardiovascular Computed Tomography. SCCT guidelines for the interpretation and reporting of coronary computed tomographic angiography. J Cardiovasc Comput Tomogr. 2009 Mar-Apr; 3(2):122-36.

7. Which modality is the BEST for imaging the aortic valve and for the assessment of vascular access for endovascular replacement?

- A. Contrast-enhanced MR angiogram
- B. Transthoracic echocardiogram
- C. Transesophageal echocardiogram
- D. Contrast-enhanced CT angiogram

**Key:** D

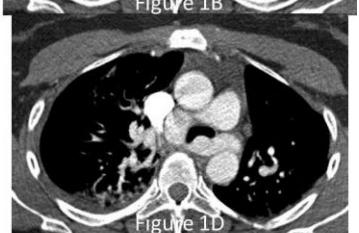
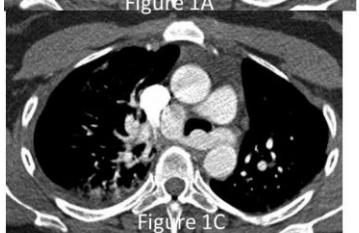
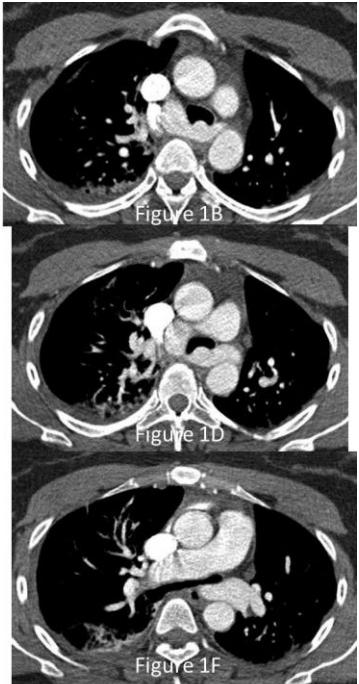
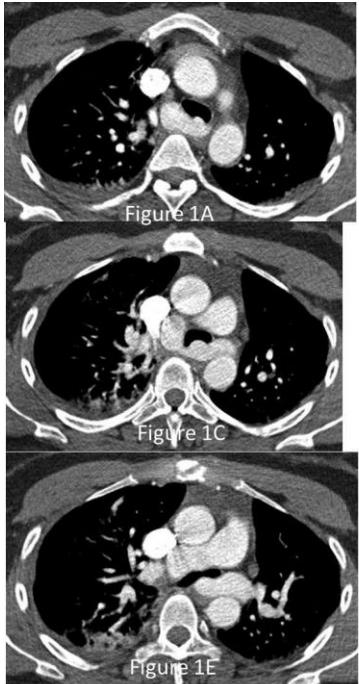
**Rationale:**

Although MRA is accurate at assessing the aortic annulus and adjacent structures, it is limited by its inability to assess for vascular calcifications.

**Reference:**

Wichmann, J. L., Varga-Szemes, A., Suranyi, P., et al. Transcatheter Aortic Valve Replacement: Imaging Techniques for Aortic Root Sizing. *Journal of Thoracic Imaging* 2015; 30(6), 349-358. | *Journal of Thoracic Imaging* 2015; 30(6), 349-358.

8. Based upon these contrast-enhanced chest CT angiographic images from a young woman involved in a high-speed motor vehicle collision being assessed for possible aortic injury, what is the diagnosis?



- A. Traumatic aortic injury
- B. Double aortic arch
- C. Right aortic arch
- D. Pulmonary sling

**Key: D**

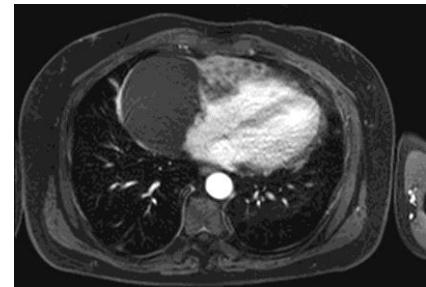
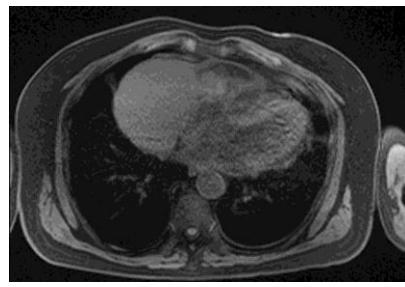
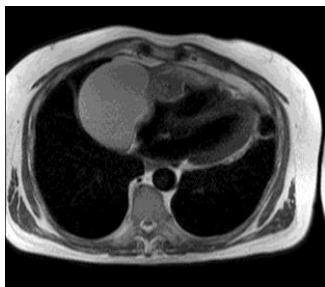
**Rationale:**

- A. CTA imaging features of aortic and great vessel injury are categorized as direct or indirect. The most specific direct signs are intimal flap and luminal thrombus or debris (100%) whereas irregular aortic contour or pseudoaneurysm is the most sensitive (100%). Additional direct signs include: pseudoaneurysm; focal contour abnormality; abrupt aortic caliber change; coarctation; and active contrast extravasation. Indirect signs include: subtle contour anomalies; hemomediastinum; peri-branch vessel and or peri-aortic blood. These direct and indirect signs are not present in this case.
- B. Double aortic arch is a relatively rare congenital cardiovascular anomaly in which two aortic arches form a complete vascular ring that envelop and can compress the aerodigestive tract. Most commonly there is a dominant, larger right arch and a smaller, hypoplastic left arch which course around the trachea and esophagus. The two arches then join together to form a left-sided descending thoracic aorta. These imaging findings are not present in this case.
- C. Right aortic arch affects approximately 0.1% of the population and may exhibit mirror image or non-mirror image branching of the great vessels. In right aortic arch with mirror-image branching, the left brachiocephalic, right common carotid and right subclavian arteries arise in succession. The most common type of right aortic arch exhibits non-mirror image branching, and the left common carotid, right common carotid, right subclavian and aberrant left subclavian arteries arise in succession. The aberrant left subclavian artery may be associated with dilatation of its origin (diverticulum of Kommerell). A coexistent left ligamentum arteriosus results in a complete vascular ring. These imaging findings are not present in this case.
- D. A pulmonary sling is a congenital vascular anomaly in which the left pulmonary artery (LPA) originates from the posterior aspect of the right pulmonary artery (RPA). The anomalous LPA then courses over the right mainstem bronchus, and continues posterior to the trachea and anterior to the esophagus, to supply the left lung. As the LPA courses behind the right main-stem bronchus and leftward behind the trachea, airway compression may occur. This primarily affects the right lung, although compression of the lower trachea and left mainstem bronchus can also occur. Such compression may cause stridor, wheezing, atelectasis, recurrent pneumonia, and tracheomalacia. Approximately 50% of patients with a pulmonary sling have concomitant congenital heart disease, most commonly atrial septal defect (ASD), patent ductus arteriosus (PDA), ventricular septal defect (VSD), and a left-sided SVC, although none were present in this case. There is no sexual or racial predilection for the development of a pulmonary sling.

**Reference:**

LaBelle MF, Rainer WG, Ratzer E, et al. Surgical Repair of Pulmonary Sling in an Adult Ann Thorac Surg 2010; 90:1009-1011.

9. Based upon the axial dark-blood T2, axial fat-suppressed T1 and axial fat-suppressed T1 contrast enhanced images from a 25-year-old patient who presented with chest pain and cardiovascular collapse, what is the MOST likely diagnosis?



- A. Angiosarcoma
- B. Rhabdomyoma
- C. Pericardial cyst
- D. Constrictive pericarditis

**Key:** A

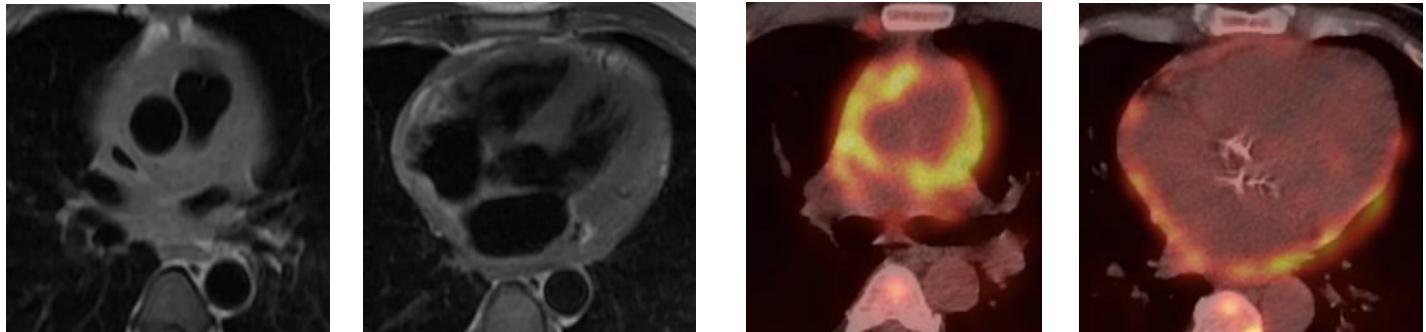
**Rationale:**

Although rare, cardiac angiosarcomas are the most common primary cardiac malignancy in adults. This tumor typically affects the right atrium, presenting with symptoms of compression and pericardial tamponade. These are aggressive malignancies, and are usually metastatic at the time of diagnosis. The tumor is typically heterogeneous on MR imaging, owing to the frequent presence of necrosis within the lesions. They generally display pericardial involvement and will be accompanied by pericardial fluid, typically hemorrhagic. The prognosis for patients with these tumors is very poor, with a typical survival of 3-12 months.

**Reference:**

Motwani M, et al. MR imaging of cardiac tumors and masses: a review of methods and clinical applications. Radiology 2013 Jul; 268(1):26-43.

10. Based upon the axial T1 non-fat sat black blood MR images and corresponding fused axial F-18 FDG PET-CT images, at the level of the great vessels and heart, what is the MOST likely diagnosis?



- A. Pericarditis
- B. Vasculitis
- C. Angiosarcoma
- D. Lymphoma

**Key:** D

**Rationale:**

Although pericardial thickening can be seen in the setting of pericarditis, it is usually thinner than in this case. A more significant pericardial effusion would also be present.

**Reference:**

Jeudy J, et al. From the Radiologic Pathology Archives: Cardiac Lymphoma: Radiologic-Pathologic Correlation. Radiographics 2012; 32: 1369-1380. | Radiographics 2012; 32: 1369-1380.

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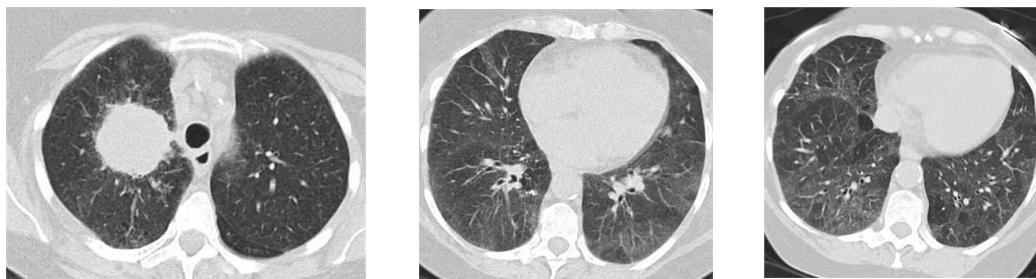
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1. This 43-year-old woman presented for resection of a right upper lobe bronchogenic cancer (first image). She was noted to have lower lobe chronic lung disease (second and third images). What is the MOST likely diagnosis?



- A. Desquamative Interstitial Pneumonia (DIP)
- B. Usual Interstitial Pneumonia (UIP)
- C. Lymphocytic Interstitial Pneumonia (LIP)
- D. Nonspecific Interstitial Pneumonia (NSIP)

**Key:** A

**Rationale:**

Images show patchy ground glass opacities in both lungs with lower lobe predominance in a patient with lung cancer and emphysema. Thus, findings of lower lung ground glass opacities in an individual with history of smoking is suggestive of DIP. The other choices do not have these features and thus incorrect.

**Reference:**

Attili, A, Kazerooni, E, Gross, B, et al. Smoking related interstitial lung disease: Radiologic-Clinical-Pathologic Correlation. Radiographics, Vol 28 Issue 5, Sept 2008.

2. Which one of the following is true regarding Silo filler's disease?

- A. It is a hypersensitivity reaction.
- B. Caused by inhalation of nitrogen dioxide,
- C. Occurs several months after exposure.
- D. CT scan shows bibasilar reticular opacities.

**Key:** B

**Rationale:**

Silo filler's disease is caused by inhalation of nitrogen dioxide arising from fresh silage. Disease usually affects farmers who are filling silos.

**Reference:**

Cornelius, E, Betlach E. Silo-filler's disease. Radiology. Vol 74, Issue 2, Feb 1991.

3. In the evaluation of solitary pulmonary nodule, which of the following patterns of calcification is MOST likely to be considered indeterminate?

- A. Central
- B. Eccentric
- C. Laminar
- D. Popcorn

**Key:** B

**Rationale:**

The presence of calcium within a solitary pulmonary nodule increases the chances that the nodule is benign. Nodules with stippled or eccentric foci of calcifications are visible in about 10-15% of malignancies. Thus, their presence is considered indeterminate in evaluation of solitary pulmonary nodule. Central calcification and laminar or concentric rings of calcium are most seen in granulomas. Popcorn calcifications are typically seen in hamartomas.

**Reference:**

Erasmus J, Connolly J, McAdams HP, Roggli V. Solitary pulmonary nodules: Part I. Morphologic evaluation for differentiation of benign and malignant lesions.

4. Concerning the solitary pulmonary nodule, which CT appearance is MOST predictive of a primary lung carcinoma?
- A. Laminated calcification
  - B. Solid density
  - C. Pure ground glass attenuation
  - D. Mixed solid and ground glass opacity

**Key:** D

**Rationale:**

Pulmonary nodule which persists on follow up examination demonstrating both ground glass and solid component are most likely to be primary lung carcinomas.

**Reference:**

Troung, M, Ko J, Santiago S, et al. Update in the evaluation of the solitary pulmonary nodule. Radiographics. Vol 34 Issue 6, Oct 2014.

5. What is the MOST likely cause of dyspnea in this 78-year-old woman with a history of endometrial carcinoma who is status-post right-sided thoracentesis?



- A. Lymphangitic carcinomatosis
- B. Pulmonary hemorrhage
- C. Re-expansion pulmonary edema
- D. Invasive aspergillosis

**Key:** C

**Rationale:**

- A. Lymphangitic carcinomatosis would present with interstitial thickening and nodularity in a peri-lymphatic distribution.
- B. Hemorrhage from a systemic cause would present as a bilateral process. If unilateral, one may consider iatrogenic injury from chest tube placement, but in this case chest tube is correctly position in the posterior pleural compartment.
- C. Rapid drainage of the pleural effusion results in rapid re-expansion of the ipsilateral lung and resultant pulmonary edema secondary to starling forces.
- D. Incorrect.

**Reference:**

Humphreys R, Berne A. Rapid re-expansion of pneumothorax. Radiology. Vol 96 Issue 3, Sept 1970.

6. What specific portion of the secondary pulmonary lobule is destroyed by centrilobular emphysema?

- A. Proximal acinus elements
- B. Entire acinus
- C. Distal acinus elements
- D. None; the acinus is spared

**Key:** A

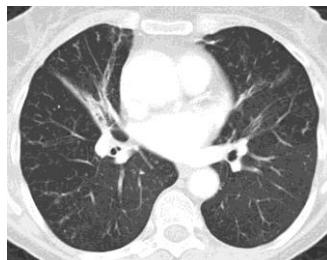
**Rationale:**

- A. A normal pulmonary acinus contained within the secondary pulmonary lobule contains respiratory bronchioles, alveolar ducts, and alveolar sacs. Centrilobular emphysema also referred to as proximal acinar emphysema predominantly affects the proximal elements of the acinus.
- B. Panacinar (also known as panlobular) emphysema destroys the entire acinus and all acini within the secondary pulmonary lobule.
- C. Distal acinar (also known as paraseptal) emphysema is the least common type of emphysema and characteristically destroys the distal portion of the acinus in the periphery of the secondary pulmonary lobule.
- D. All varieties of emphysema affect and destroy some portion of the acinus of the secondary pulmonary lobule.

**Reference:**

Foster W, Pratt P, Roggli V, et al. Centrilobular emphysema: CT pathologic correlation. Radiology. Vol 159 Issue 1, April 1986.

7. You are shown CT images of a 66-year-old woman with hemoptysis. What is the MOST likely diagnosis?



- A. Pseudoaneurysm
- B. Bronchogenic carcinoma
- C. Tuberculosis
- D. Broncholith

**Key:** D

**Rationale:**

A. There is no evidence of a pseudoaneurysm on this non contrast enhanced CT scan.  
B. No nodule or mass suggestive of bronchogenic carcinoma is present on these CT images.  
C. While patients with tuberculosis can present with hemoptysis, there is no finding here to suggest that is the cause of the patient's hemoptysis.  
D. In this case, the lung window images (Images A and B) demonstrate subtotal atelectasis with bronchial dilatation in the right middle lobe. Upon closer inspection, a small high density lesion can be seen within the proximal feeding right middle lobe bronchus. This lesion is shown to advantage on the soft tissue windows (Image C), where it is confirmed to be densely calcified. These findings are consistent with a broncholith, which can be a cause of hemoptysis. The term broncholith is used to describe calcified or ossified material in the bronchial tree. Broncholiths typically result from erosion into the bronchial lumen by adjacent calcified granulomatous lymph nodes, although in situ calcification can occur within aspirated foreign material. When a broncholith is diagnosed on CT examination, the patient should undergo a surgical consultation, as many broncholiths require a thoracotomy for resection. Broncholiths which are almost entirely within the lumen may be candidates for rigid bronchoscopic removal, but this is performed in an operating room setting as an emergent thoracotomy may be necessary if excessive bleeding results.

**Reference:**

Vix V. Radiographic manifestations of broncholithiasis. Radiology. Vol 128 Issue 2, Aug 1978.

8. What anatomic structure is indicated by the arrow?



- A. Right upper lobe bronchus
- B. Left upper lobe bronchus
- C. Bronchus intermedius
- D. Right lower lobe bronchus

**Key:** B

**Rationale:**

B. The uppermost rounded lucency represents the right upper lobe bronchus.

**Reference:**

Parker MS, Rosado de Christenson ML, Abbott GF Normal Thoracic Anatomy Chest Imaging Case Atlas, 2nd edition Thieme, New York, 2012: 1-52.

9. You are shown pre- and post- biopsy CT images of a patient whose PaO<sub>2</sub> was 95%, had difficulty speaking and was confused following removal of a biopsy needle. What is the MOST likely cause of his symptoms?



- A. Hemorrhage
- B. Pneumothorax
- C. Air embolism
- D. Aortic injury

**Key:** C

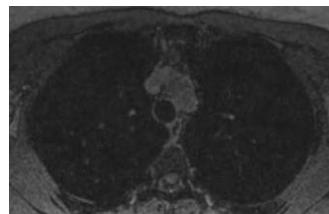
**Rationale:**

- A. Although hemorrhage can complicate percutaneous lung biopsies, there is no evidence of hemorrhage on these images and the patient was not having hemoptysis.
- B. Pneumothorax is a common complication of percutaneous CT guided lung biopsies, affecting 12-45% of patients, with 5-10% of patients requiring thoracostomy tube placement for drainage. The degree of distress caused by a pneumothorax can vary between patients. This patient maintained oxygen saturation and did not demonstrate chest pain or dyspnea, symptoms commonly seen in patients with a pneumothorax. The patient's symptoms of confusion, inability to speak, and inability to follow commands cannot be explained by the pneumothorax.
- C. Venous air embolism is a rare complication of percutaneous CT guided needle biopsy, affecting 0.2-0.7% of patients that undergo the procedure. The mechanism of a venous air embolism is not clearly understood, but proposed etiologies include introduction of air into a vein via the needle and creation of an iatrogenic bronchovenous fistula during needle placement. Many patients who have a venous air embolism experience coughing during the biopsy and this may contribute to air entering the vasculature. Clinically, signs worrisome for an air embolism include cardiac (due to coronary artery embolism) and cerebral (due to cerebral artery embolism) compromise. Many patients with air embolism, however, will be asymptomatic. Air in the arterial system as seen on the post biopsy image confirms the diagnosis. The treatment for venous air embolism is hyperbaric oxygen therapy, which reduces gas bubble volume and replaces nitrogen with oxygen.
- D. There is no evidence of aortic injury on this study. Aortic dissection is not a known complication of percutaneous lung biopsy.

**Reference:**

Kizer K, Goodman P. Radiographic manifestations of venous embolism. Radiology. Vol 144 Issue 1, July 1982.

10. You are shown CT, in-phase and out-of-phase MR images from a 27-year-old woman with myasthenia gravis. What is the most likely diagnosis?



- A. Thymic hyperplasia
- B. Thymoma
- C. Lymphoma
- D. Metastasis

**Key:** A

**Rationale:**

A. Normal and hyperplastic thymus contain fatty tissue, the amount of which increases with age. This can be difficult to detect in the thymus on some standard CT examinations, particularly in young patients, thus making it difficult to differentiate normal and hyperplastic thymus from neoplastic lesions. Chemical-shift MRI imaging can be used as a problem solving tool in these cases, with normal and hyperplastic thymus demonstrating diffuse loss of signal between in- and opposed-phase imaging, as seen in this case.

Differentiating hyperplastic thymus from a thymoma was a clinically relevant question in this patient with myasthenia gravis, as patients who are found to have thymomas are typically poor candidates for minimally invasive surgical resection techniques due to an increased risk of local recurrence. MRI can also be used in other patients to differentiate normal and hyperplastic thymus from neoplastic lesions including lymphoma, thymoma, and metastases, all lesions which would not be expected to lose signal on in- and opposed-phase imaging.

- B. A thymoma would not be expected to lose signal between in- and opposed-phase imaging.
- C. Lymphoma would not be expected to lose signal between in- and opposed-phase imaging.
- D. A metastasis would not be expected to lose signal between in- and opposed-phase imaging.

**Reference:**

Inaoka T, Takahashi K, Mineta M, et al. Thymic hyperplasia and thymus gland tumors: differentiation with chemical shift MR imaging Radiology 2007; 243 (3): 869-876.

**Genitourinary Radiology  
In-Training Test Questions  
for Diagnostic Radiology Residents**



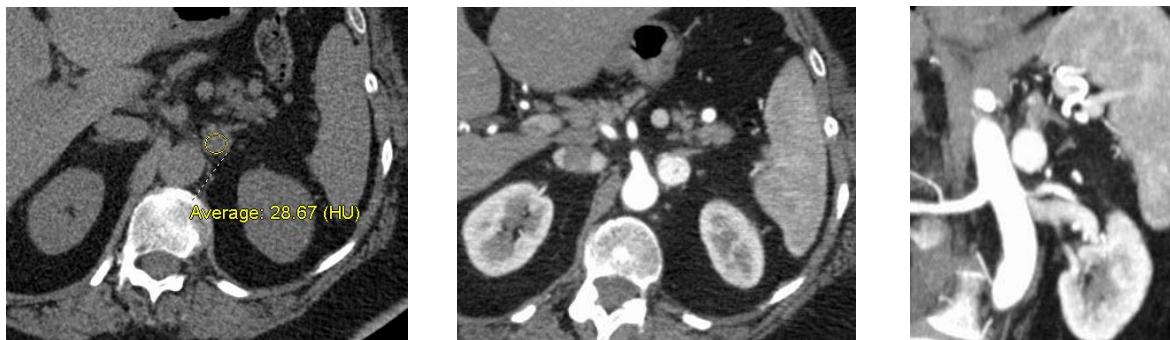
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1. What is the MOST likely explanation for the abnormality in the left adrenal?



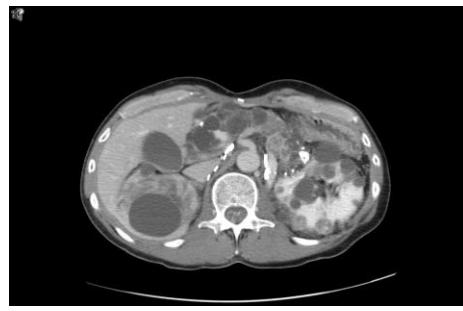
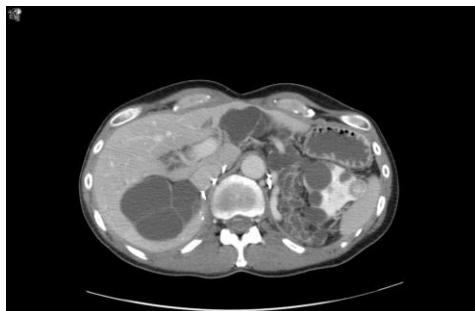
- A. Myelolipoma
- B. Metastasis
- C. Adenoma
- D. Pheochromocytoma

**Key:** D

**Rationale:**

- A. Myelolipomas contain mature adipose tissue, fat density on unenhanced CT (< -30 HU). This lesion measures >20 HU on unenhanced CT, which is too dense for adipose tissue.
- B. Tuberculosis of the adrenal tends to result in peripheral enhancement with central necrosis. Calcifications are also possible. This lesion demonstrates homogenous enhancement.
- C. Adrenal hemorrhage tends to be higher in attenuation, 50-90 HU, on unenhanced CT and does not enhance.
- D. This is a classic pheochromocytoma. The adrenal lesion demonstrates intermediate attenuation on unenhanced CT and brisk enhancement during the arterial phase.

2. What is the MOST likely diagnosis in this 30-year-old man?



- A. Von Hippel Lindau disease
- B. Tuberous sclerosis
- C. Autosomal dominant polycystic disease
- D. Cystic renal disease of dialysis

**Key:** A

**Rationale:**

- A. The combination of cystic renal disease, solid renal neoplasms and cystic pancreatic disease is most compatible with von hippel lindau disease. The patient has also undergone bilateral adrenalectomy. Patients with von hippel lindau disease are at increased risk for pheochromocytoma.
- B. Cystic renal disease is part of the spectrum of Tuberous Sclerosis, however cysts are usually intermingled with angiomyolipomas, which are absent on these images. Patients with Tuberous Sclerosis are not at increased risk for renal cell carcinoma, although it tends to present earlier than in the general population. Additionally, cystic pancreatic disease is not a manifestation of tuberous sclerosis.
- C. Renal manifestations of ADPCKD include bilateral renal cysts and renal enlargement. ADPCKD patients are not at increased risk for renal cell carcinoma. Pancreatic cysts can be seen in patients with ADPCKD, however diffuse pancreatic involvement would be unusual.
- D. Patients with cystic renal disease of dialysis are at increased risk for renal cell carcinoma. The kidneys however, are usually markedly atrophic, and the pancreas is not involved.

**Reference:**

Katabathina, V. S., Kota, G., Dasyam, A. K., Shanbhogue, A. K., Prasad, S. R. Adult Renal Cystic Disease: A Genetic, Biological, and Developmental Primer. Radiographics (2010) 30(6), 1509-1523.

3. Which of the following BEST explains the abnormality in this adult patient with normal-sized kidneys?



- A. Autosomal dominant polycystic kidney disease
- B. Autosomal recessive polycystic kidney disease
- C. Acquired renal cystic disease
- D. Lithium-induced renal disease

**Key:** D

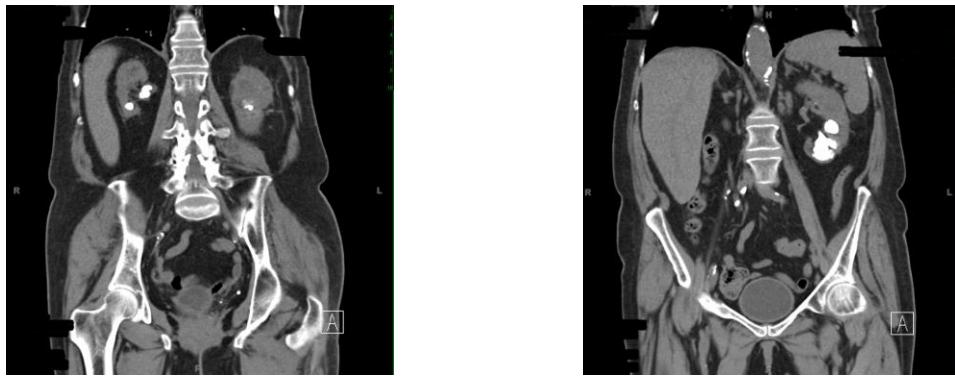
4. What is demonstrated in this image?



- A. Angiomyolipoma
- B. Cortical scar
- C. Duplicated collecting system
- D. Junctional parenchymal defect

**Key:** D

5. What is the MOST likely stone composition in these CT images?



- A. Uric acid
- B. Matrix stone
- C. Calcium oxalate
- D. Cystine

**Key:** C

6. Which one of the following statements about delayed cutaneous contrast reactions is correct?

- A. They often present with a macular rash
- B. Recent treatment with interleukin-2 (IL-2)
- C. They occur within 24 hours of contrast administration
- D. There are no known risk factors

**Key:** B

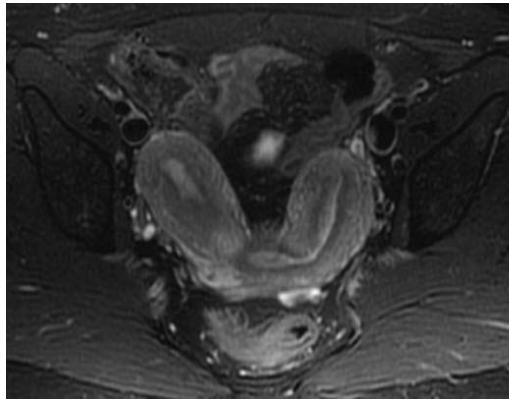
**Rationale:**

- A. Delayed cutaneous contrast reactions often present with a macular rash. Other exanthems are also possible.
- B. Delayed cutaneous contrast reactions are more commonly seen in patients recently treated with interleukin-2 (IL-2).
- C. Delayed cutaneous contrast reactions can occur anywhere from 3 hours to 7 days following contrast administration.
- D. Delayed cutaneous contrast reactions are usually self-limited and usually require nothing more than symptomatic treatment of pruritis.

**Reference:**

American College of Radiology American College of Radiology Manual on Contrast Media, Version 7 American College of Radiology 2010.

7. Which of the following is MOST commonly associated with the abnormality demonstrated in the associated image?



- A. Unilateral renal agenesis
- B. Mesonephric blastoma
- C. Congenital megaureter
- D. Duplex renal collecting system

**Key:** A

**Rationale:**

- A. This is an example of a bicornuate uterus, which is a Mullerian duct anomaly. Mullerian duct anomalies are associated with renal anomalies. Unilateral renal agenesis is the most common renal anomaly.
- B. Mullerian duct anomalies are associated with renal anomalies. Unilateral renal agenesis is the most common renal anomaly.
- C. Mullerian duct anomalies are associated with renal anomalies. Unilateral renal agenesis is the most common renal anomaly.
- D. Mullerian duct anomalies are associated with renal anomalies. Unilateral renal agenesis is the most common renal anomaly.

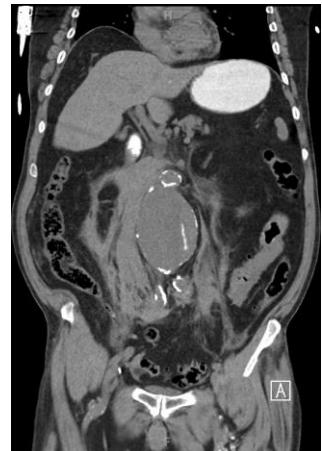
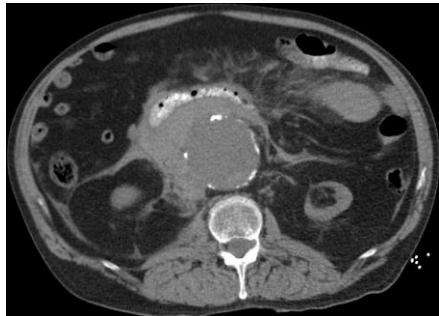
8. Where is the urethral stricture located?



- A. Bulbous urethra
- B. Peno-scrotal junction
- C. Urogenital diaphragm
- D. Fossa navicularis

**Key:** A

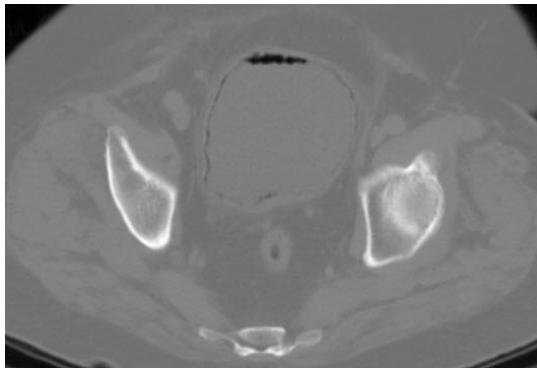
9. The non-contrast CT images shown demonstrate which of the following?



- A. Lymphoma
- B. Retroperitoneal fibrosis
- C. Ruptured abdominal aortic aneurysm
- D. Retroperitoneal liposarcoma

**Key:** C

10. This patient presented with hematuria. What is the MOST appropriate next step in the management?



- A. Conservative management with antibiotics
- B. Emergent surgical consultation
- C. CT urography to determine cause of hematuria
- D. Query history of sigmoid diverticulitis

**Key:** A

**Rationale:**

- A. Gas is present within the bladder wall, diagnostic of emphysematous cystitis. Emphysematous cystitis is treated conservatively, with antibiotics. Over half of the patients diagnosed with emphysematous cystitis are diabetic, therefore, management of blood sugar may also be necessary.
- B. Gas within the bladder wall is compatible with emphysematous cystitis. As opposed to emphysematous pyelonephritis which may be treated surgically, emphysematous cystitis is treated conservatively with antibiotics and bladder drainage.
- C. Gas is seen with the bladder wall compatible with emphysematous cystitis. Since emphysematous cystitis often presents with hematuria, this is the likely explanation for the patient's hematuria and addition imaging is not necessary.
- D. Intravesicular gas (gas within the bladder lumen) can be seen in the setting of a vesicocolic fistula from sigmoid diverticulitis. While there is a small amount of intravesicular gas, the more salient finding in this patient is that of emphysematous cystitis (intramural gas).

**Reference:**

Grayson DE, et al. Emphysematous infections of the abdomen and pelvis: a pictorial review Radiographics 2002. 22(3): p. 543-61.

**Musculoskeletal Radiology  
In-Training Test Questions  
for Diagnostic Radiology Residents**



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1. What ligament is MOST important for maintaining shoulder stability?

- A. Coracohumeral
- B. Superior glenohumeral
- C. Middle glenohumeral
- D. Inferior glenohumeral

**Key:** D

**Rationale:**

- A. The coracohumeral ligament is part of the pulley sling system, which stabilizes the biceps tendon.
- B. The superior glenohumeral ligament is part of the pulley system that stabilizes the biceps tendon
- C. The middle glenohumeral ligament provides some stability to the glenohumeral head but not as much as the inferior glenohumeral ligament.
- D. The inferior glenohumeral ligament is the major stabilizer of the glenohumeral joint, especially during arm abduction and external rotation.

**Reference:**

Bencardino JT Gyftopoulos S Palmer WE. Imaging in Anterior Glenohumeral Instability. Radiology. Vol. 269. No. 2. Nov 2013.

2. What is the most likely diagnosis based on these flexion-extension cervical spine radiographs?



- A. Acute odontoid fracture
- B. Rheumatoid arthritis
- C. Os odontoideum
- D. Diffuse idiopathic skeletal hyperostosis

**Key:** C

**Rationale:**

There is atlanto-axial instability with anterior subluxation demonstrated with flexion. A single well corticated osseous density, the os odontoideum, is present instead of a normal odontoid process. There is no osteoporosis, osseous erosion or crano-cervical settling. There is no ligamentous ossification.

**Reference:**

Matsui H, Imada K, Tsuji H. Radiographic classification of os odontoideum and its clinical significance. Spine 1997;22:1706-1709.

3. You are shown radiographs of a 12-year-old boy. What is the MOST LIKELY diagnosis?



- A. Ewing sarcoma
- B. Giant cell tumor
- C. Chondroblastoma
- D. Simple bone cyst

**Key:** C

**Rationale:**

There is well defined lytic lesion with internal calcifications and sclerotic borders at the greater tuberosity involving the metaphysis, in a child. There is no cortical destruction, periosteal reaction or soft tissue mass. GCT almost always presents in the skeletally mature. It is a purely lytic lesion which, like CHBL may arise in an apophysis. Simple bone cysts are not eccentric although this is the most common site for SBC in the skeletally immature.

**Reference:**

Resnick D. Diagnosis of Bone and Joint Disorders. Tumors and Tumor-like lesions of Bone: Imaging and Pathology of Specific lesions. Saunders. 4th ed. 2002.

4. A 51-year-old man presents with left hip pain. Based on this image, what is the MOST likely etiology?



- A. Chronic injury
- B. Biphosphonate therapy
- C. Neoplasm
- D. Acute trauma

**Key:** C

**Rationale:**

- A. The ossific density shown in this radiograph is the avulsed, displaced lesser trochanter. There is no cortex at its avulsed surface. An old fracture deformity or myositis ossificans would be well corticated.
- B. The characteristic biphosphonate induced complete fracture is subtrochanteric at the shaft. The precursor insufficiency fracture demonstrates transverse lucency at the lateral cortex with focal cortical thickening and a small beak-like projection.
- C. Avulsion of the lesser trochanter in an adult suggests underlying bone marrow infiltration. In this patient, there is a permeative lesion at the inter/subtrochanteric region proven to be lymphoma.
- D. Acute avulsion fracture of the lesser trochanter may occur in young athletes prior to skeletal maturity. Such fractures in adults are usually associated with metastatic disease.

5. You are shown a single lateral radiograph. What is the MOST likely diagnosis?



- A. Klippel-Feil syndrome
- B. Chronic juvenile arthritis
- C. Ankylosing spondylitis
- D. Diffuse idiopathic skeletal hyperostosis (DISH)

**Key:** C

**Rationale:**

There is osseous fusion of the cervical spine with fine syndesmophytes anteriorly at the discs and facet ankylosis posteriorly. There is a fracture at the lower C spine, a known complication. Focal, segmental ankylosis may be seen in Chronic Juvenile Arthritis. It is often associated with an underdeveloped, hypoplastic disc. KF syndrome constitutes varying degrees of congenital bony fusion but not as uniform as this. There is no ligamentous ossification.

**Reference:**

Resnick D. Diagnosis of Bone and Joint Disorders. Ankylosing Spondylitis. Saunders. 4th ed. 2002.

6. What portion of the spine is MOST affected in patients with rheumatoid arthritis?

- A. Craniocervical
- B. Thoracolumbar
- C. Lumbosacral
- D. Sacroiliac

**Key:** A

**Rationale:**

A. Atlanto-axial subluxation and craniocervical settling are the most common spinal abnormalities in patients with RA secondary to inflammation/pannus formation about the odontoid process and at the occipital-C1,C1-C2 facet joints respectively. Instability below the C2 level is less common but well known. Multilevel subaxial subluxation is often diagnostic of RA.

B. Atlanto-axial subluxation and craniocervical settling are the most common spinal abnormalities in patients with RA secondary to inflammation/pannus formation about the odontoid process and at the occipital-C1, C1-C2 facet joints respectively. Instability below the C2 level is less common but well known. Multilevel subaxial subluxation is often diagnostic of RA.

C. Atlanto-axial subluxation and craniocervical settling are the most common spinal abnormalities in patients with RA secondary to inflammation/pannus formation about the odontoid process and at the occipital-C1, C1-C2 facet joints respectively. Instability below the C2 level is less common but well known. Multilevel subaxial subluxation is often diagnostic of RA.

D. Atlanto-axial subluxation and craniocervical settling are the most common spinal abnormalities in patients with RA secondary to inflammation/pannus formation about the odontoid process and at the occipital-C1,C1-C2 facet joints respectively. Instability below the C2 level is less common but well known. Multilevel subaxial subluxation often diagnostic of RA.Sacroiliitis is a feature of the seronegative spondyloarthropathies.

**Reference:**

Resnick D. Diagnosis of Bone and Joint Disorders. Rheumatoid Arthritis. Saunders. 4th ed. 2002.

7. A 67-year-old woman presents with right hip pain. What disorder is associated with this abnormality?



- A. Osteoporosis
- B. Overuse
- C. Osteoid osteoma
- D. Osteomalacia

**Key:** A

**Rationale:**

There is a focal, linear, incomplete, fracture at the lateral subtrochanteric cortex characteristically seen in a small number of patients treated with bisphosphonates for osteoporosis.

This is not a fatigue fracture occurring in an otherwise normal individual.

There is no rounded lucency with cortical thickening to suggest OO.

Looser zones do not occur in this location.

**Reference:**

Porrino JA, Kohl CA, Taljanovic M, Rogers LF. Diagnosis of Proximal Femoral Insufficiency Fractures in Patients Receiving Bisphosphonate Therapy. American Journal of Roentgenology. 2010; 194: 1061-1064.

8. Which of the following structures is MOST commonly fractured with posterior glenohumeral joint dislocation?

- A. Greater tuberosity
- B. Lesser tuberosity
- C. Anterior humeral head
- D. Coracoid process

**Key:** C

**Rationale:**

- A. A greater tuberosity fracture is more commonly associated with anterior glenohumeral joint dislocation.
- B. About 25% of patient with posterior shoulder dislocations have a lesser tuberosity fracture.
- C. Approximately 80% of patients who dislocate their shoulder posteriorly have an anterior impaction fracture of the humeral head. This reverse Hill-Sachs lesion occurs when it strikes the posterior aspect of the glenoid rim. Frequently, the humeral head may become perched on the glenoid owing to the defect and if not reduced, may eventually form a pseudoarthrosis. This impaction may appear on conventional radiographs as a linear region of sclerosis at the anteromedial humeral head, designated the trough sign.
- D. A coracoid fracture is not commonly associated with posterior dislocation but can be seen in skeletally immature patients with anterior glenohumeral joint dislocations.

**Reference:**

Resnick D. Diagnosis of Bone and Joint Disorders. Traumatic Diseases. Saunders. 4th ed. 2002.

9. You are shown lateral and oblique radiographs of the right foot from a 21-year-old man with foot pain. What is the MOST likely diagnosis?



- A. Accessory navicular
- B. Fibrous calcaneonavicular coalition
- C. Os calcaneus secundarius
- D. Anterior process fracture calcaneus

**Key:** D

**Rationale:**

A. A Type II accessory navicular is a well corticated ossification with a broad base adjacent to the medial navicular tubercle, separated by a synchrosis which is susceptible to chronic stress related injury. The Type I accessory navicular is a true, well corticated sesamoid bone within the substance of the posterior tibial tendon at its attachment.

B. Calcaneonavicular and subtalar coalitions are the most common types of developmental malsegmentation anomalies in the foot. They may be osseous, fibrous or cartilaginous. The calcaneonavicular coalition is best appreciated on an oblique radiograph. Even in cases of fibrous or cartilaginous coalition, where a discrete bony bar is absent, the apposing bony margins are typically prominent and appear as an articulation.

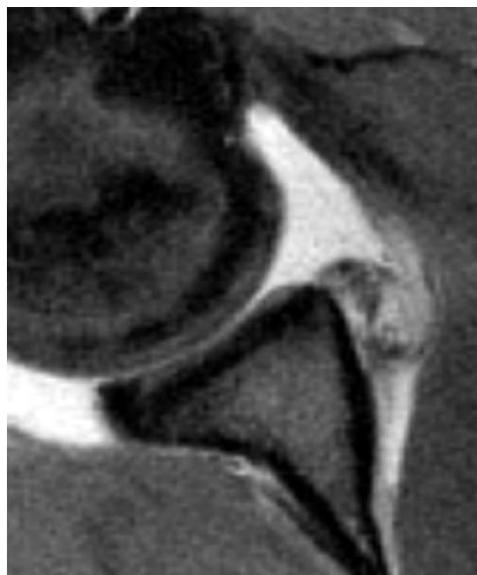
C. This accessory ossicle occurs in about 5% of the population. It is located adjacent to the anterior calcaneal facet and may be confused with an anterior process fracture. It is, however, well corticated. Because of its location, it can limit the range of motion of the subtalar joint if it is sufficiently large.

D. The anterior process of the calcaneus is disrupted and the resulting bone fragment is slightly displaced. There is no cortical bone at the fracture margins. The bifurcate ligament attaches to the anterior process and excessive inversion and plantar flexion of the foot may result in avulsion fracture.

**Reference:**

Yu JS, Cody ME. A template approach for detecting fractures in adults sustaining low-energy ankle trauma. Emerg Radiol 2009; 16: 309-318.

10. You are shown an axial MR image of the shoulder. What is the MOST likely diagnosis?



- A. Buford complex
- B. Biceps tendon dislocation
- C. Nodular tenosynovitis
- D. Bankart lesion

**Key:** D

**Rationale:**

- A. The Buford complex compromises an absent anterior superior glenoid labrum and a thick medial glenohumeral ligament. The current case shows an abnormal anterior inferior glenoid labrum.
- B. The long head of the biceps tendon may dislocate medially. This is often associated with other injuries including subscapularis tendon tear. The long biceps tendon is normally situated at the bicipital groove.
- C. Nodular tenosynovitis or focal PVNS is most common at the knee. The mass at the anterior glenoid represents a torn and displaced glenoid labrum.
- D. The anterior labrum is torn and medially displaced, and the anterior joint capsule is stripped, medially retracted, and bunched up on itself. Tension placed on the anterior band of the inferior glenohumeral ligament and its insertion at the anterior inferior glenoid labrum during anterior glenohumeral dislocation results in avulsion of the anterior inferior glenoid labrum. The degree of displacement, periosteal stripping and periosteal disruption define the bankart lesion and its variants.

**Reference:**

Resnick, D Shoulder Internal Derangement of Joints. 2nd Edition Saunders/Elsevier 2007.

**Gastrointestinal Radiology  
In-Training Test Questions  
for Diagnostic Radiology Residents**



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1. Concerning hepatic metastatic tumors, which one is typically hypovascular?
  - A. Melanoma
  - B. Adenocarcinoma
  - C. Renal cell carcinoma
  - D. Sarcoma

**Key:** B

**Rationale:**

- A. Melanoma metastases are classically HYPERvascular.
- B. Adenocarcinomas tend to be hypovascular.
- C. Renal cell carcinoma metastases are classically HYPERvascular.
- D. Sarcoma metastases are classically HYPERvascular.

**Reference:**

Liver and Biliary System: Evaluation by Multidetector CT, IR Kamel, Liapi E, Fishman EK. Radiol Clin North Am 2005 Nov;43(6) 977-997.

2. Primary sclerosing cholangitis is MOST strongly associated with one of these diseases?

- A. Ulcerative colitis
- B. Crohn disease
- C. Celiac disease
- D. Whipple disease

**Key:** A

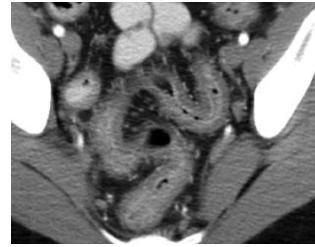
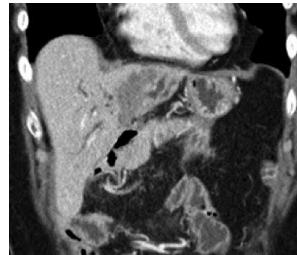
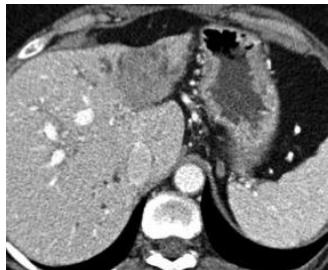
**Rationale:**

- A. Ulcerative colitis is associated with primary sclerosing cholangitis in 50-70% of cases.
- B. Although PSC is associated with inflammatory bowel disease, its association with UC is much stronger.
- C. No association
- D. No association

**Reference:**

Khoshpouri P, Habibabadi RR, Hazhirkarzar B, Ameli S, Ghadimi M, Ghasabeh MA, Menias CO, Kim A, Li Z, Kamel IR. Imaging Features of Primary Sclerosing Cholangitis: From Diagnosis to Liver Transplant Follow-up. Radiographics. 2019 Nov-Dec; 39(7):1938-1964. doi: 10.1148/rg.2019180213. Epub 2019 Oct 18. PMID: 31626561.

3. What disease process predisposed the patient to the left lobe mass?



- A. Cirrhosis
- B. Primary sclerosing cholangitis
- C. Choledochocoele
- D. Recurrent pyogenic cholangiohepatitis

**Key:** B

**Rationale:**

- A. There is an increased risk of cholangiocarcinoma in the setting of cirrhosis but the patient in this case does not have a cirrhotic liver morphology.
- B. One of the most commonly recognized risk factors for cholangiocarcinoma is PSC. This individual has a mass-forming variety of intrahepatic/peripheral cholangiocarcinoma, which is causing capsular retraction and peripheral biliary ductal dilation. There is subtle intrahepatic biliary ductal dilation in the portion of the liver not affected by the mass. The constellation of findings, including the sigmoid colitis are compatible with ulcerative colitis and PSC.
- C. Choledochocoele is a cystic dilatation of the distal intramural portion of the common bile duct. It has an association with cholangiocarcinoma but is not depicted in this case.
- D. While there is an association between recurrent pyogenic cholangiohepatitis and cholangiocarcinoma, it is not illustrated in this case.

**Reference:**

Khoshpouri P, Habibabadi RR, Hazhirkarzar B, Ameli S, Ghadimi M, Ghasabeh MA, Menias CO, Kim A, Li Z, Kamel IR. Imaging Features of Primary Sclerosing Cholangitis: From Diagnosis to Liver Transplant Follow-up. Radiographics. 2019 Nov-Dec; 39(7):1938-1964. doi: 10.1148/radiographics.2019180213. Epub 2019 Oct 18. PMID: 31626561

4. Based on this image, what is the BEST diagnosis?



- A. Carcinoma of the esophagus.
- B. Reflux esophagitis.
- C. Candida esophagitis.
- D. Herpes esophagitis.

**Key:** B

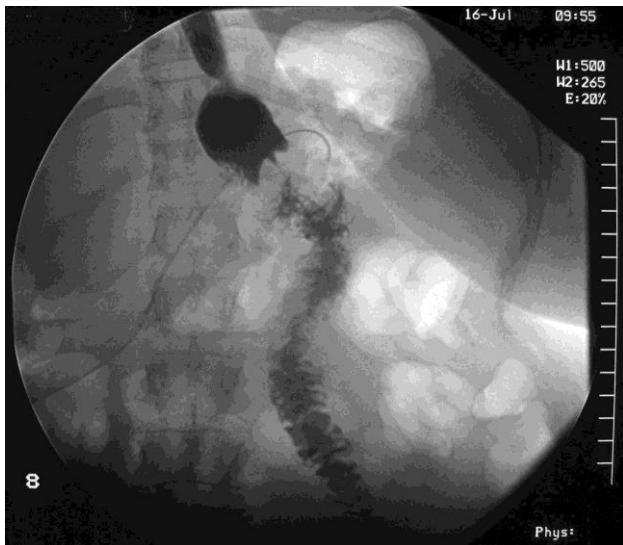
**Rationale:**

- A. Carcinoma of the esophagus would appear more nodular, infiltrative, or frankly mass-like.
- B. This is a classic example of reflux esophagitis.
- C. Candida classically produces plaquelike lesions, not ulcers like in this case.
- D. Herpes classically produces multiple small < 1 cm ulcers in the upper or mid esophagus and not tiny ulcers in the distal esophagus with a stricture.

**Reference:**

Levine MS, Rubesin SE. Diseases of the esophagus: diagnosis with esophagography. Radiology. 2005 Nov; 237(2):414-27. doi: 10.1148/radiol.2372050199. Epub 2005 Sep 16. PMID: 16170017.

5. You are shown a spot image from an upper GI examination. Which of the following is a common complication of the illustrated surgical procedure?



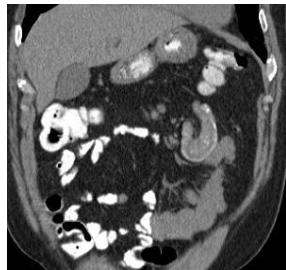
- A. Cholelithiasis
- B. Nephrolithiasis
- C. Candida esophagitis
- D. Gastric lymphoma

**Key:** A

**Reference:**

Seeras K, Acho RJ, Lopez PP. Roux-en-Y Gastric Bypass Chronic Complications. [Updated 2022 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK519489>.

6. What is the MOST appropriate next management step in this 58-year-old asymptomatic patient?



- A. No further management
- B. Air enema
- C. Colonoscopy
- D. Surgical consultation

**Key:** A

**Rationale:**

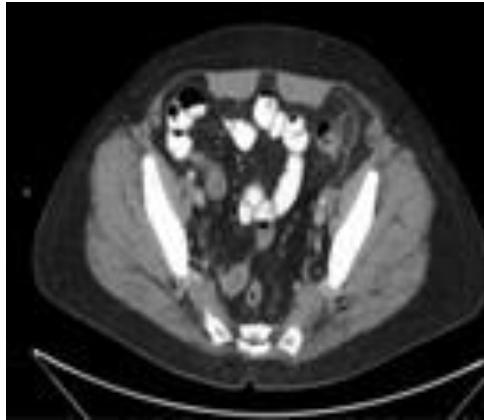
A. The vast majority of non-lead point small bowel intussusceptions are transient and benign. This patient had a CT one month later, and the intussusception had resolved. It was previously believed that all small bowel intussusceptions were worrisome for an underlying lead point. However, with the widespread usage of multidetector CT, recent studies have shown that small bowel intussusceptions are increasingly detected in asymptomatic patients undergoing CT for an unrelated indication. Transient asymptomatic intussusceptions may occur in normal adults, or in patients with celiac or Crohn's disease. Features of a small bowel intussusception more worrisome for a lead point include obstruction proximal to the affected segment, ileocolic intussusception, symptomatic intussusceptions, and possibly a long length of the intussusception. In these cases, further workup may be warranted to evaluate for an underlying mass serving as a lead point. In contrast, 50% of colonic intussusceptions occur secondary to an underlying mass. If a colonic intussusception is seen, further workup for an underlying colon cancer is needed, even if the primary colonic mass is not detected on CT.

- B. This is an appropriate treatment for an uncomplicated pediatric iliocolic intussusception, but has no role for a small bowel intussusception in an adult patient.
- C. This may be used to evaluate for an underlying mass in a colonic intussusception, but has no role in the evaluation of a small bowel intussusception.
- D. Surgery may be indicated if the patient is symptomatic or there are signs of proximal obstruction.

**Reference:**

Horton KM, Fishman EK. MDCT and 3D imaging in transient enteroenteric intussusception: clinical observations and review of the literature. AJR Am J Roentgenol. 2008 Sep; 191(3):736-42. doi: 10.2214/AJR.07.3741. PMID: 18716102.

7. Based on this image, what is the MOST likely diagnosis?



- A. Acute diverticulitis
- B. Epiploic appendicitis
- C. Acute omental infarct
- D. Sclerosing mesenteritis

**Key:** B

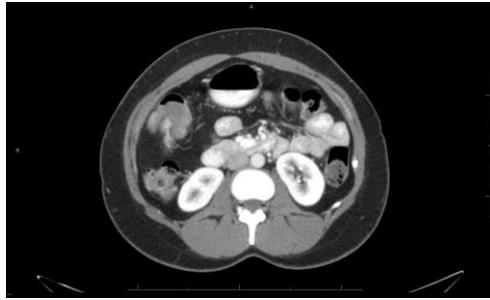
**Rationale:**

- A. Typically, there will be underlying diverticular disease, adjacent inflammatory change, abscess formation and extraluminal gas.
- B. This case displays the characteristic features: left colon more often than right; oval fat attenuation lesion with hyperattenuation center and ring surrounded by inflammatory changes that abuts the colonic wall; usually less than 5 cm in size.
- C. Often large and lacks a hyperattenuating ring and center. Most common in the right colon.
- D. Usually a larger lesion involving the root of the mesentery, not abutting the colon.

**Reference:**

Singh AK, et al. Acute epiploic appendicitis and its mimics. Radiographics 2005; 24(6):1521-1534.

8. A 51 year old man presents with abdominal pain. Based on the CT images, what is the MOST likely diagnosis?



- A. Lipoma
- B. Pneumatosis Coli
- C. Submucosal fat deposition
- D. Intussusception

**Key:** D

**Rationale:**

- A. While there is minimal fat present apparently within the colonic lumen, this represents mesenteric fat pulled in with the intussusception. Not a true lipoma.
- B. The gas seen peripherally represents gas interposed between the intussusceptum and the intussusciens rather than gas within the colonic wall.
- C. While there is minimal fat present apparently within the colonic lumen, this represents mesenteric fat pulled in with the intussusception. Not a true lipoma.
- D. Colonic tubular adenoma serving as a lead point for a colo-colic intussusception.

**Reference:**

Choi S, et al Intussusception in Adults: From Stomach to Rectum. AJR 2004; 183; 691-698.

**Neuroradiology  
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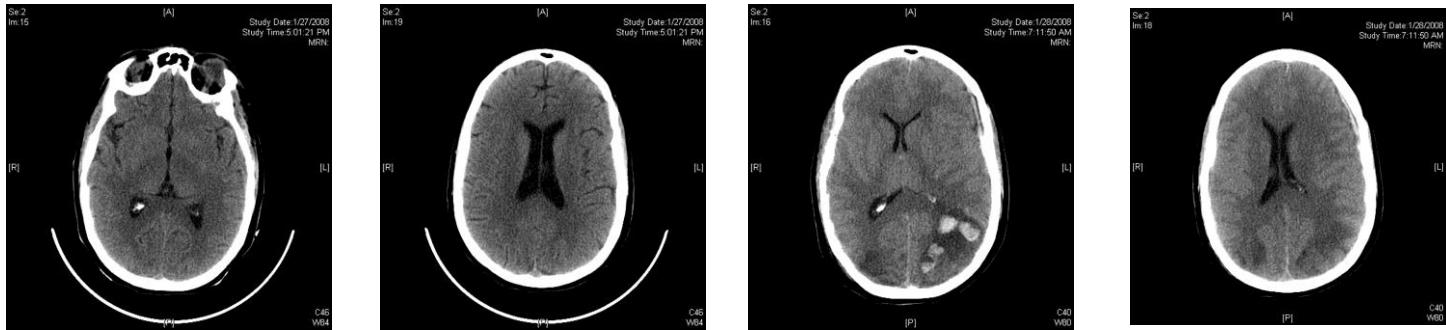


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1. Non-contrast CT images were obtained in a 31-year-old woman with gestational hypertension, onset of altered mental status, and HELLP syndrome (hemolysis, elevated liver enzymes and low platelets). CT imaging 14 hours earlier was normal. What is the MOST likely diagnosis?



- A. Acute hemorrhagic infarction
- B. Sagittal sinus thrombosis
- C. Posterior reversible encephalopathy syndrome
- D. Acute disseminated encephalomyelitis

**Key: C**

**Rationale:**

A. Acute infarction with hemorrhage is unlikely with the patient's clinical presentation and constellation of findings including diffuse as well as focal bilateral parieto-occipital edema. The cortex is spared militating against an acute infarct. Also, bilateral parieto-occipital edema suggests embolic phenomena or watershed infarcts unlikely in this patient with low platelets and a history of hypertension.

B. Sagittal sinus thrombosis is unlikely in the setting of low platelets. No increased density of the sagittal sinus is seen to suggest thrombosis. The parieto-occipital edema is not characteristic for parenchymal lesions found in sagittal sinus thrombosis, which are typically in a parasagittal distribution.

C. The imaging findings are characteristic of posterior reversible encephalopathy syndrome (PRES.) PRES is a neurotoxic state associated with a unique CT or MR appearance including edema which is often widespread but with a parieto-occipital predominance. PRES is classically associated with preeclampsia/eclampsia, severe hypertension, and cyclosporine use following transplantation but can be found in other complex conditions including sepsis and cancer chemotherapy. About 15% of PRES is hemorrhagic. The patient shown had HELLP syndrome which is associated with severe preeclampsia.

D. Acute disseminated encephalomyelitis (ADEM) typically shows multifocal white matter and basal ganglia lesions occurring 10 to 14 days following infection or vaccination. Diffuse edema with parieto-occipital predominance and sulci effacement would be atypical of ADEM. Large (tumefactive) lesions can occur but usually with less mass effect than expected for the lesion size. Also, hemorrhage in ADEM is rare.

**Reference:**

AM Franceschi, O Ahmed, L.Giliberto, M. Castillo. Hemorrhagic PRES as a manifestation of COVID-19 infection. American Journal of Neuroradiology May 2020, DOI: <https://doi.org/10.3174/ajnr.A6595>.

HM Hefzy, WS Bartynski, JF Boardman, D. Lacomis. Hemorrhage in Posterior Reversible Encephalopathy Syndrome: Imaging and Clinical Features. American Journal of Neuroradiology August 2009, 30 (7) 1371-1379; DOI: <https://doi.org/10.3174/ajnr.A1588>.

2. Based upon these axial T1, T2, and contrast-enhanced T1 MR images obtained in a 33-year-old man with a 2-week history of headaches and vomiting, what is the diagnosis?



- A. Pilocytic astrocytoma
- B. Hemangioblastoma
- C. Metastasis
- D. Epidermoid cyst

**Key:** B

**Rationale:**

- A. Pilocytic astrocytomas commonly occur in the cerebellum and may have a prominent cystic component with a solid enhancing mural nodule though the solid tumor component is typically larger than in this case. Also, pilocytic astrocytomas occur from 5 to 15 years of age. Pilocytic astrocytoma would be unlikely in a 33-year-old individual as in this case.
- B. The findings of a cystic cerebellar mass with an intensely enhancing mural nodule in an adult are classic for a hemangioblastoma. Hemangioblastomas most commonly occur in the posterior fossa with 80% in the cerebellar hemisphere. About 60% are cystic as in this case.
- C. The imaging findings of a cystic mass with a mural nodule and absent edema would be very unusual for a metastasis. Also, metastatic disease would not be a likely first choice in a 33-year-old patient. No history of underlying systemic malignancy or additional lesions to suggest metastatic disease was given.
- D. Epidermoids are typically extra axial. Also, the enhancing mural nodule excludes this as a diagnostic possibility.

**Reference:**

Andrew Slater et al. The Natural History of Cerebellar Hemangioblastomas in von Hippel-Lindau Disease. AJNR Am J Neuroradiology, 2003.

3. Which of the following is associated with Chiari I malformations?

- A. Neurofibromatosis type I
- B. Klippel-Feil syndrome
- C. Tuberous Sclerosis
- D. Dyke Davidoff Masson syndrome

**Key:** B

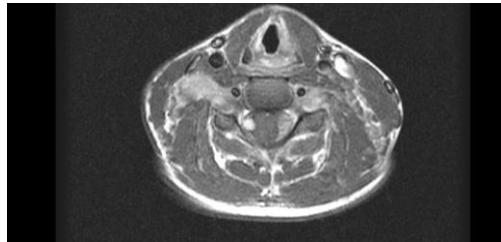
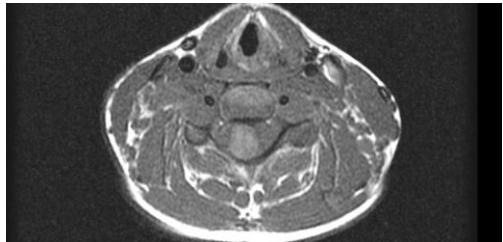
**Rationale:**

- A. NF 1 has several associated intracranial abnormalities including neoplasms and vascular pathology but Chiari 1 is not an association.
- B. Klippel Feil is associated with Chiari 1 malformation.
- C. Tuberous Sclerosis, one of the phakomatoses, is not associated with Chiari 1 syndrome.
- D. Dyke David Masson is associated with Sturge Weber, another of the phakomatoses, not Chiari 1 malformation.

**Reference:**

David Yousem and Robert Grossman. Neuroradiology: The Requisites, Third Edition 2010: Mosby.

4. You are shown axial pre- and post-contrast MRI images of the cervical spine. What is the MOST likely diagnosis?



- A. Neurogenic tumors
- B. Meningiomas
- C. Drop metastases
- D. Spinal cord astrocytoma

**Key:** A

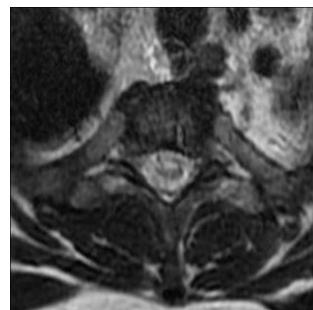
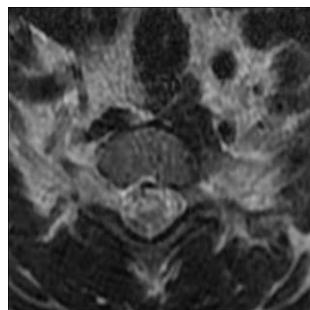
**Rationale:**

- A. Intradural extramedullary and neuroforaminal masses are demonstrated, best for neurogenic tumors (schwannomas or neurofibromas)
- B. The presence of bilateral neural forminal masses makes this choice unlikely.
- C. The intrathecal masses fits with drop mets, however the neuroforaminal masses do not.
- D. The masses are extramedullary, so incorrect choice.

**Reference:**

David Yousem and Robert Grossman. Neuroradiology: The Requisites, Third Edition 2010: Mosby.

5. You are shown sagittal and axial T2 weighted images of the cervical and upper thoracic spine in a 37-year-old woman with acute onset quadripareisis. Concurrent brain imaging was normal (not shown.) What is the MOST likely diagnosis?



- A. Multiple sclerosis
- B. Spinal cord astrocytoma
- C. Acute disseminated encephalomyelitis (ADEM)
- D. Spinal cord infarction

**Key:** D

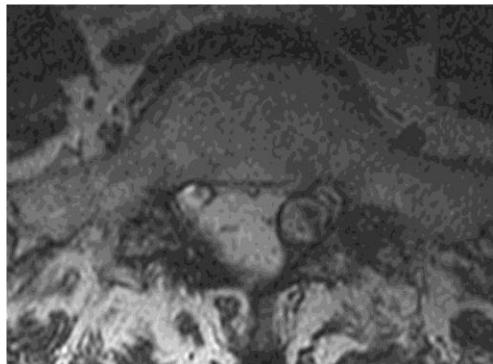
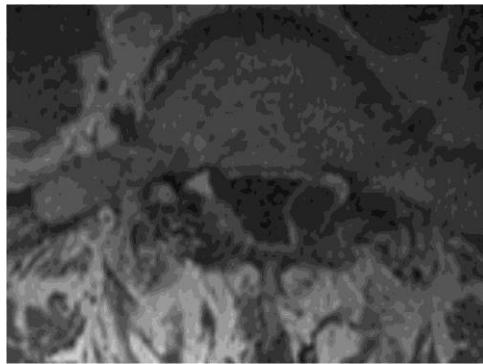
**Rationale:**

- A. Multiple sclerosis lesions are typically focal, uncommonly extend more than 2 vertebral body segments and are more common in the dorsolateral aspect of the cord. A lesion of this extent in the anterior spinal cord would be very atypical for multiple sclerosis. There would likely be multiple intracranial white matter lesions.
- B. An astrocytoma of the spinal cord typically shows fusiform expansion of the cord and characteristically enhances. The imaging findings of this lesion limited to the anterior cord and absence of reported enhancement are not consistent with an astrocytoma.
- C. Acute disseminated encephalomyelitis is an immune mediated inflammatory disorder that typically shows multifocal white matter lesions with variable enhancement. Multisegmental or lesions associated with ADEM would not characteristically involve only the anterior cord but posterior cord white matter as well. Concurrent brain imaging would likely show multiple intracranial white matter lesions.
- D. The images show multisegmental increased T2 signal intensity in the anterior lower cervical and upper thoracic spinal cord involving the gray and white matter with sparing of the dorsal cord. Spinal cord infarction most commonly occurs in the distribution of the anterior spinal artery. Anterior spinal artery infarction involves the central gray matter with sparing of the white matter, extends to the adjacent white matter or involves the entire cross sectional area of the cord as in this case. Acute infarcts would have reduced diffusion. There may be cord swelling and patchy enhancement. An associated vertebral body infarction is pathognomonic.

**Reference:**

MI Vargas, J Gariani, R Sztajzel, I Barnaure-Nachbar, BM Delattre, KO Lovblad, JL Dietemann. Spinal Cord Ischemia: Practical Imaging Tips, Pearls, and Pitfalls. American Journal of Neuroradiology May 2015, 36 (5) 825-830; DOI: <https://doi.org/10.3174/ajnr.A4118>.

6. You are shown axial T1 weighted and T2 weighted images of the lumbar spine at L5. On contrast enhanced imaging (not shown) there was mild peripheral but no central enhancement of the lesion. What is the MOST likely diagnosis?



- A. Hypertrophied ligamentum flavum
- B. Schwannoma
- C. Synovial cyst
- D. Extruded herniated disc fragment

**Key:** C

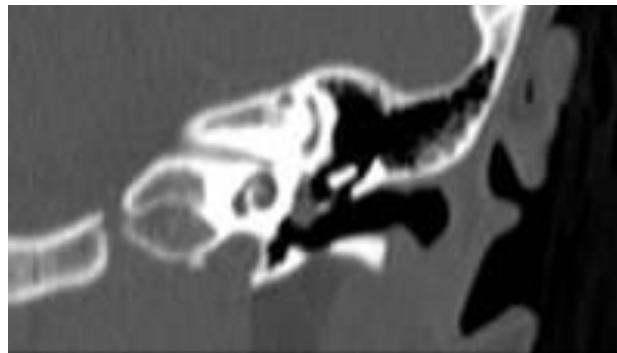
**Rationale:**

- A. The extradural mass in the left spinal canal is T2 hyperintense. Hypertrophied ligamentum flavum is characteristically hypointense on T2 weighted images. Also, hypertrophied ligamentum flavum is typically more diffuse rather than having the appearance of a rounded focal mass as in this case.
- B. Schwannomas typically intensely contrast enhance and are more commonly intradural. This mass shows only peripheral enhancement. While cystic schwannoma is a consideration the extradural location of this mass and uncommon occurrence of a cystic schwannoma make this a less likely consideration.
- C. At MR imaging synovial cysts are commonly T1 hypointense T2 hyperintense and have peripheral but not central enhancement. The lumbar spine is the most common location for synovial cysts (90%). Synovial cysts are associated with degenerative facet disease, have a T2 hypointense rim and are located at the posterolateral aspect of the thecal sac as in the images shown. Though not apparent on these images, communication with the facet joint may be shown at MR imaging.
- D. An extruded herniated disc fragment commonly has an anterior epidural location. A posterolateral location for a disc fragment is uncommon. Herniated disc fragments are not typically as T2 hyperintense and do not characteristically have a T2 hypointense rim.

**Reference:**

DE Jackson, Jr, SW Atlas, JR Mani, D Norman. Intraspinal synovial cysts: MR imaging. Published Online: Feb 1 1989 <https://doi.org/10.1148/radiology.170.2.2911681>.

7. You are shown axial and coronal reformatted images from a temporal bone CT in a child with a middle ear mass suspected on physical exam. What is the MOST likely diagnosis?



- A. Glomus tympanicum paraganglioma
- B. Aberrant carotid artery
- C. Congenital cholesteatoma
- D. Acute otomastoiditis

**Key:** C

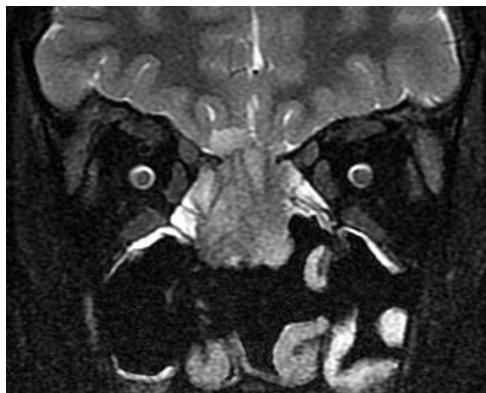
**Rationale:**

- A. Highly vascular mass which commonly overlies the cochlear promontory, without bony erosion. More common in adults, often causing pulsatile tinnitus. Enhances avidly on MRI with contrast.
- B. Anomaly of carotid artery development with collateral vessel enlargement coursing through the middle ear due to embryological regression of cervical ICA segment.
- C. This congenital lesion is typically located MEDIAL to the ossicles but may occur in multiple different middle ear locations. May enlarge and cause bone erosion, leading to conductive hearing loss. Derived from congenital ectodermal rests, resembles epidermoid tumors on pathology. May show restricted diffusion on MRI.
- D. Active middle ear infection, with middle ear opacification and fluid levels. Coalescent infection may cause bony erosion. Clinical signs of infection are often present.

**Reference:**

David Yousem and Robert Grossman. Neuroradiology: The Requisites, Third Edition 2010: Mosby.

8. Based upon these coronal T2W and contrast-enhanced T1W images from an MRI of the paranasal sinuses, what is the MOST likely diagnosis?



- A. Sinonasal Mucocele
- B. Esthesioneuroblastoma
- C. Fibrous Dysplasia
- D. Benign Inflammatory Disease

**Key:** B

**Rationale:**

- A. Mucoceles are typically bright on T1 and T2 and do not enhance.
- B. Esthesioneuroblastoma shows a classic “waist” at the level of the cribriform plate. Common imaging features include avid enhancement on MRI and areas of cystic degeneration, with T2 hyperintensity.
- C. Fibrous Dysplasia is a lesion confined to bone with an expansile appearance. It is confined to the bone.
- D. Benign inflammatory disease often follows fluid signal and is confined to the sinus. There may be mucosal enhancement peripherally. The bone is intact.

**Reference:**

Harnsberger, et al. Esthesioneuroblastoma Diagnostic Imaging: Head NeckSection II: 2, p86-89.

9. A 41-year-old woman presents with a heterogeneous brain mass suspicious for a primary glial neoplasm. Which technique is MOST helpful to determine the highest yield location for biopsy?

- A. MR spectroscopy
- B. CT perfusion
- C. Susceptibility-weighted imaging
- D. Digital subtraction angiography

**Key:** A

**Rationale:**

- A. A.MR spectroscopy allows for assessment of the degree of cellularity and cell membrane turnover in different parts of the tumor (Choline/NAA ratio).
- B. CT perfusion does not allow for assessment of the degree of cellularity and cell membrane turnover in different parts of the tumor.
- C. Susceptibility-weighted imaging does not allow for assessment of the degree of cellularity and cell membrane turnover in different parts of the tumor.
- D. Digital subtraction angiography does not allow for assessment of the degree of cellularity and cell membrane turnover in different parts of the tumor.

**Reference:**

Brindle KM, Izquierdo-García JL, Lewis DY, Mair RJ, Wright AJ. Brain Tumor Imaging. J Clin Oncol 2017 Jul 20;35(21):2432-2438.

10. What is the appropriate management for MOST infantile hemangiomas of the head and neck?

- A. Surgery
- B. Chemotherapy
- C. Embolization
- D. Observation

**Key:** D

**Rationale:**

Infantile hemangiomas usually present before age one. They have a growth phase and then an involutional phase and involute between ages 2 and 8. No intervention is required.

**Reference:**

David Yousem, MD. MBA Head and Neck Imaging, Case Review Series. Saunders 2015:61-62.

**Nuclear Radiology  
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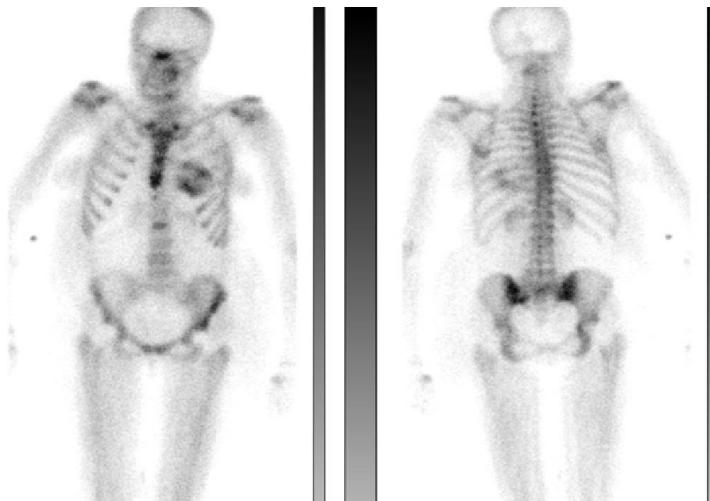
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1. Which of the following is the most likely diagnosis?



- A. Constrictive pericarditis
- B. Cardiac amyloidosis
- C. Cardiac sarcoidosis
- D. Acute myocardial infarction

**Key:** B

**Rationale:**

Tc-99m PYP is an agent that is used to diagnose TTR amyloidosis. This agent has a similar distribution to bone agents like the one shown in this case. Cardiac amyloidosis is the best answer for diffuse or near diffuse myocardial uptake on a bone scan. Constrictive pericarditis would not typically have significant uptake on bone scan nor would cardiac sarcoidosis. Prior myocardial infarction may cause focal areas of uptake, but not this diffuse.

**Reference:**

Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging.

2. Concerning subacute thyroiditis, serum thyroid hormone levels are elevated as the result of which one of the following?

- A. Increased thyroid hormone production
- B. Increased TSH secretion by the pituitary gland
- C. Release of pre-formed thyroid hormone into the circulation
- D. Iodine excess in the thyroid gland

**Key:** C

**Rationale:**

Subacute thyroiditis is a result of release of pre-formed hormones from the thyroid gland most commonly due to a preceding viral illness or upper respiratory infection. The other answer choices do not fit the pathophysiology of subacute thyroiditis.

**Reference:**

Bennett, Oza. Diagnostic Imaging Nuclear Medicine 2015.

3. Regarding hepatobiliary scintigraphy in suspected biliary atresia in the neonatal period, for at least how long should imaging be carried out?

- A. 2 hours
- B. 4 hours
- C. 24 hours
- D. 48 hours

**Key:** C

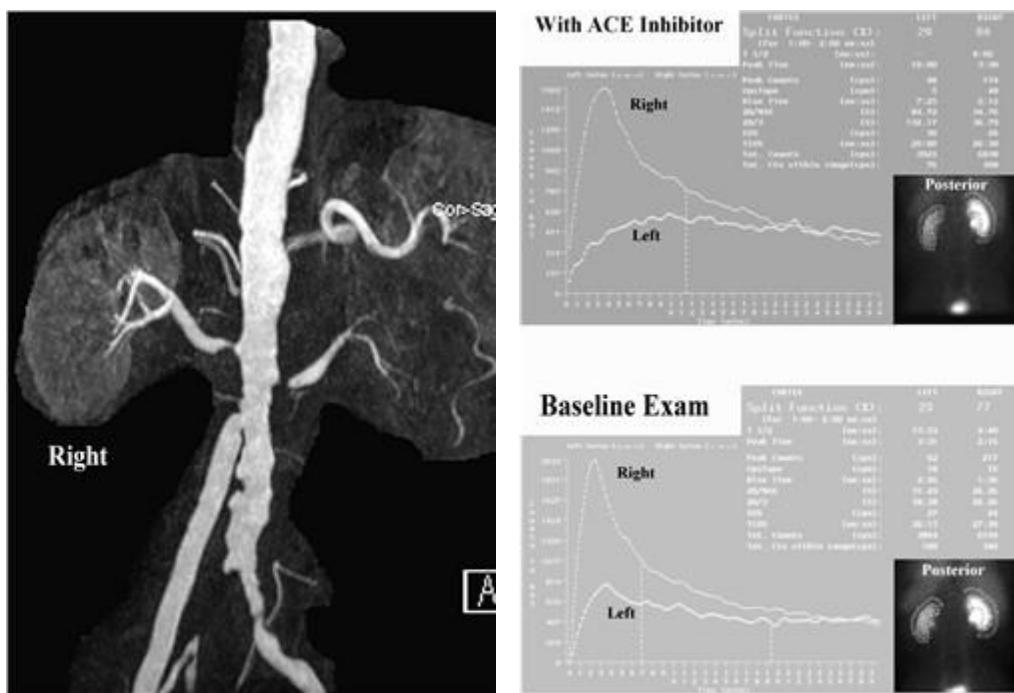
**Rationale:**

In order to diagnose biliary atresia, the standard imaging time to exclude any significant bowel activity is 24 hours. Going longer than 24 hours is not ideal given the 6-hour half-life of the imaging agent.

**Reference:**

Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging, 5th ed., Saunders Elsevier, Philadelphia, p. 230.

4. A 60-year-old patient being evaluated for suspected renovascular hypertension underwent an MRA (figure 1.A) and Tc-99m MAG3 renal scintigraphy, with and without ACE inhibitor administration (figure 1.B). Based on the findings demonstrated, which of the following is CORRECT?



- A. The patient's hypertension is MOST likely to be improved by correction of right renal artery stenosis.
- B. The patient's hypertension is MOST likely to be improved by correction of left renal artery stenosis.
- C. The findings are MOST indicative of balanced bilateral renovascular disease.
- D. There is no evidence of renovascular hypertension.

**Key:** B

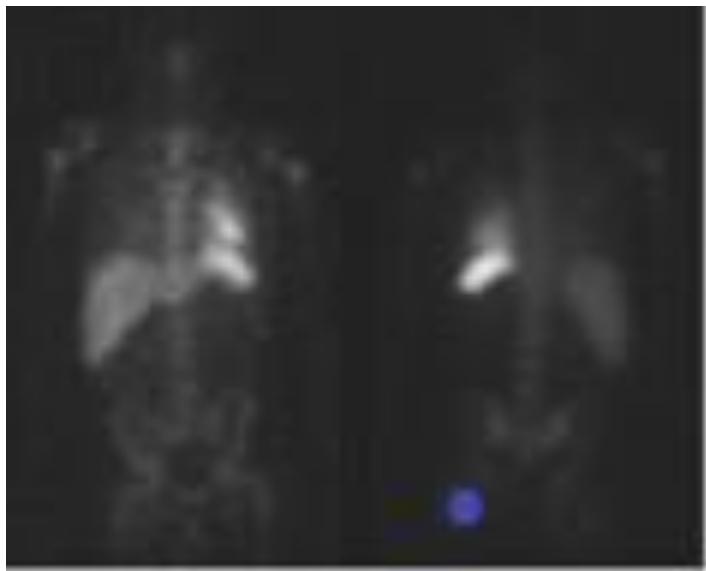
**Rationale:**

After ACE inhibitor administration, the left kidney's function diminishes compared to baseline. This change in function is suggestive of renal artery hypertension. The right kidney is unaffected by the ACE inhibitor therefore A is incorrect. There is no evidence for balanced bilateral renovascular disease.

**Reference:**

Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging, 5th ed., Saunders Elsevier, Philadelphia.

5. A 50-year-old male with cough and fever for 10 days presents for this exam. No prior imaging is available. Which of the following is the next best step?



- A. Chest radiograph
- B. Liver MRI
- C. Repeat imaging in 1 month
- D. Myocardial perfusion scan

**Key:** A

**Rationale:**

- A. The images show abnormal activity in the left chest that likely reflects a pneumonia. A chest radiograph would be the next best step.
- B. No abnormality is shown in the liver.
- C. No follow-up In-111 wbc imaging would be required.
- D. The abnormal uptake is in the lung not the heart.

**Reference:**

Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging. Essentials of Nuclear Medicine Imaging.

6. A 50-year-old male presents with widespread focal osteolytic lesions on radiographs which are F-18 FDG PET positive and Tc-99m-MDP negative. Which of the following is MOST likely?

- A. Metastatic bronchogenic carcinoma.
- B. Metastatic prostate carcinoma.
- C. Paget's disease.
- D. Multiple myeloma.

**Key:** D

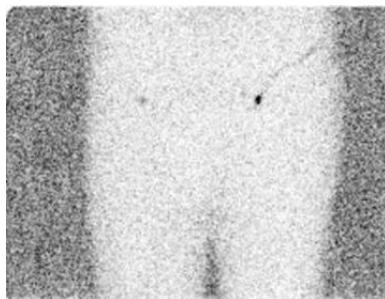
**Rationale:**

Lytic lesions have a predominant osteoclastic process that would not be positive on MDP bone scans that require an osteoblastic bone process for tracer uptake. Metastatic bronchogenic carcinoma and prostate carcinoma typically have osteoblastic lesions and Paget's disease would show increased uptake in the late stages. Early Paget's disease may be osteolytic but would not be widespread and focal as described in the stem. The best choice is multiple myeloma.

**Reference:**

Bennett, Oza. Diagnostic Imaging Nuclear Medicine 2015.

7. Based on this anterior image from a lymphoscintigraphy study, what is the MOST likely diagnosis?



- A. Bilateral sentinel lymph nodes
- B. Left inguinal sentinel lymph node
- C. Right inguinal sentinel lymph node
- D. Absence of nodal uptake

**Key:** A

**Rationale:**

There are bilateral sentinel lymph nodes present. The left lymph node shows a lymphatic channel while the right does not, but both are visible on this planar image. Dynamic images are not provided to discern which node appeared first, so based on the image provided, The best answer is bilateral sentinel nodes.

**Reference:**

Bennett, Oza. Diagnostic Imaging Nuclear Medicine 2015.

8. Regarding Nuclear Regulatory Commission (NRC) regulations concerning radiation exposure during a declared pregnancy of a radiation worker, which of the following is the maximum permissible exposure?

- A. 5 mSv for the entire gestation
- B. 50 mSv for the entire gestation
- C. 5 mSv per gestational month
- D. No set limit if ALARA procedures are followed

**Key:** A

**Rationale:**

The NRC states that the licensee shall ensure that the dose equivalent to the embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed 5 mSv. The exposure to the embryo/fetus should not demonstrate substantial variation from month to month, and the total exposure during the entire pregnancy must be less than 5 mSv. Therefore, the monthly limit is ~0.5 mSv.

**Reference:**

Bennett, Oza. Diagnostic Imaging Nuclear Medicine 2015.

9. Which of the following is considered an unsealed source therapeutic radiopharmaceutical?

- A. 123 I NaI
- B. 68 Ga DOTATATE
- C. 223 Ra dichloride
- D. 137 Cs seeds

**Key:** C

**Rationale:**

- A. This is used for thyroid imaging and 24-hour uptake as well as for surveillance/staging of well differentiated thyroid carcinoma.
- B. This is used to stage and restage neuroendocrine tumors.
- C. This is used to treat bone metastasis in prostate carcinoma.
- D. This is a sealed source therapeutic agent used by radiation oncologists.

**Reference:** Bennett, Oza. Diagnostic Imaging Nuclear Medicine 2015.

10. Which one of the following is MOST LIKELY to produce a whole-lung ventilation-perfusion (V/Q) mismatch on a ventilation-perfusion lung scan?

- A. Large pleural effusion
- B. Fibrosing mediastinitis
- C. Foreign body in a mainstem bronchus
- D. Mucous plugging

**Key:** B

**Rationale:**

Whole lung match (absence of ventilation and perfusion) is caused by foreign body in a mainstem bronchus, chronic mucous plugging, large pleural effusions, pneumothorax, and pneumonectomy. Acute mucous plugging may cause a “reverse” mismatch. The causes of whole lung mismatch include pulmonary artery atresia, large pulmonary embolus in a main pulmonary artery, hilar mass, and fibrosing mediastinitis.

**Reference:**

Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging, 5th ed. Saunders Elsevier, Philadelphia, pp. 187-194.

Pediatric Radiology  
In-Training Test Questions  
for Diagnostic Radiology Residents



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1. Which of the following is an EARLY complication of repair of esophageal atresia with distal fistula?
  - A. Gastroesophageal reflux.
  - B. Recurrent tracheo-esophageal fistula.
  - C. Disordered esophageal peristalsis
  - D. Diverticulum formation.

**Key:** B

**Rationale:**

Acute complications after operative repair of esophageal atresia include anastomotic leak and recurrent fistula. Long-term complications include reflux, disordered peristalsis and recurrent strictures.

**Reference:**

Slater BJ, Rothenberg SS. Tracheoesophageal fistula. Seminars in Pediatric Surgery 2016;25:176-178.

2. What is the MOST likely location of the PICC line tip?



- A. Right atrium
- B. Inferior vena cava
- C. Hepatic vein
- D. Right lower lobe pulmonary artery

**Key:** C

**Rationale:**

- A. The PICC tip is below the diaphragm, therefore it is too low to be in the right atrium.
- B. The tip is below the diaphragm but is too lateral to be in the expected location of the inferior vena cava.
- C. The catheter has entered a persistent left superior vena cava and passed through the coronary sinus into the right atrium and has continued through the IVC into a hepatic vein.
- D. For the tip to be in the right lower lobe pulmonary artery, the catheter would have had to enter the right atrium, and then enter the right ventricle, ascend through the main pulmonary artery into the right pulmonary artery, and then to a lower lobe branch. This is not the course of the catheter.

**Reference:**

Batouty NM, Sobh DM et al. Left superior vena cava: cross-sectional imaging overview. Cardiac Radiology 2020; 125: 237-246.

3. Which of the following ultrasound imaging findings is characteristically present in children with acute appendicitis?

- A. Increased echogenicity surrounding the appendix
- B. Fecoliths measuring 3mm or less
- C. Gas-filled appendix
- D. Complete appendiceal compressibility

**Key:** A

**Rationale:**

- A. The increased echogenicity represents edema, and is analogous to the fat stranding seen on CT scans
- B. Fecoliths smaller than 3mm do not necessarily indicate the presence of appendicitis, and all patients with appendicitis do not have fecoliths.
- C. Air filling of the appendix typically is seen when the appendix is normal. In patients with appendicitis, the appendix is usually fluid-filled.
- D. In appendicitis the appendix is non-compressible to a normal diameter, although some compressibility of the dilated appendix does not exclude the diagnosis when other typical findings are present, and the appendiceal diameter does not become normal.

**Reference:**

- Lowe LH, Penney MW, Scheker Le, Perez R, Stein SM, Heller RM, Shyr Y, Hernanz-Schulman M. Appendicolith revealed on CT in children with suspected appendicitis: how specific is it in the diagnosis of appendicitis? AJR 2000;175(4):981-984.  
Hernanz-Schulman M. CT and US in the diagnosis of appendicitis: an argument for CT. Radiology 2010; 255:3-7.  
Strouse P. Pediatric Appendicitis: An Argument for US. Radiology 2010; 255:8-13.

4. 6 week-old with cardiac, renal and vertebral abnormalities undergoes a VCUG. The abnormal finding shown here is related to which of the following underlying conditions?



- A. persistent urogenital sinus
- B. anal atresia
- C. traumatic fistula
- D. cloacal malformation

**Key:** B

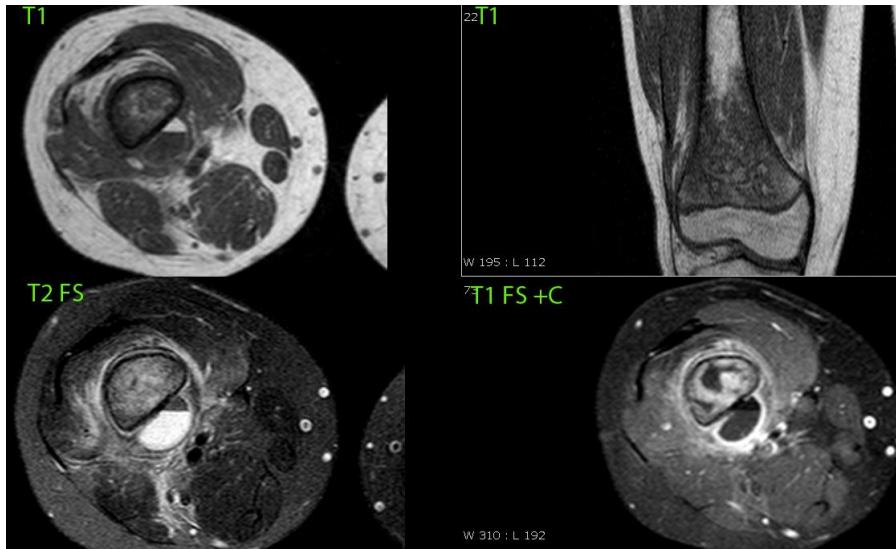
**Rationale:**

- A. Persistent urogenital sinus occurs in females, and therefore it is an incorrect answer in this male infant. In persistent urogenital sinus, there is abnormal communication between the urethra and vagina, and may be seen in intersex conditions such as masculinized females in congenital adrenal hyperplasia.
- B. In this patient with given history suggesting VACTERL complex, imperforate anus with a fistula to the urethra is the most likely answer.
- C. Although this is theoretically possible, there is no history of trauma; further with the given history of problems suggesting the VACTERL complex, imperforate anus with a fistula to the urethra is a much more likely answer.
- D. In the classic cloacal abnormality, the rectum, vagina and urethra all connect together and exit into a single perineal opening, and therefore this is not the most likely answer.

**Reference:**

- Alamo L, Meyrat BJ, Meuwly JY, Meuli RA, Gudinchet F. Anorectal Malformations: Finding the Pathway out of the Labyrinth. Radiographics 2013 Mar-Apr; 33(2):491-512.
- Valenti AL, Giulian M, et al. Persistent urogenital sinus: diagnostic imaging for clinical management. What does the radiologist need to know? Am J Perinatol 2016; 33:425-432.

5. A 13-year-old boy presented with knee pain. What is the MOST likely diagnosis?



- A. Langerhans cell histiocytosis
- B. Osteomyelitis
- C. Ewing sarcoma
- D. Bone infarct

**Key:** B

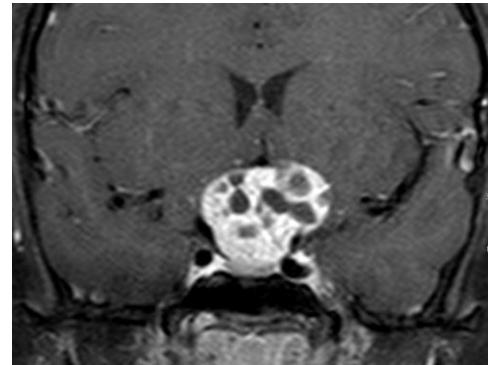
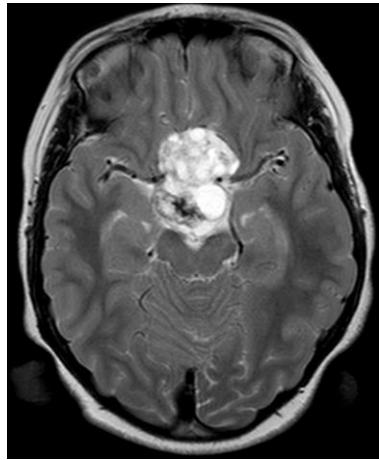
**Rationale:**

- A. Although LCH can have similar image appearance to osteomyelitis, it is typically a space occupying lesion and diaphyseal in location. Associated fluid collection would be unusual in LCH.
- B. Correct. Heterogeneous non-fatty marrow on T1-weighted images with nonenhancing necrotic region on post-contrast images and abscess formation both within and outside bone are classic for osteomyelitis. In some patients, there is destruction of the cortex and fat can be extruded into the abscess forming fat-fluid level as in this patient.
- C. Ewing sarcoma is typically a diaphyseal lesion with associated soft tissue mass. Associated fluid collection is unusual in Ewing sarcoma, particularly with a fluid-fluid level, as in this case.
- D. Early bone infarct may have only bone marrow edema. Late findings include serpiginous hyper- and hypointense signals. Associated fluid collection is unusual in bone infarct; an abscess or a fluid-fluid level as in this case would not be expected as well.

**Reference:**

Pugmire BS, Shailam R, Gee MS. Role of MRI in the diagnosis and treatment of osteomyelitis in pediatric patients. World J Radiol. 2014 Aug 28; 6(8):530-7. doi: 10.4329/wjr.v6.i8.530.

6. What is the MOST likely diagnosis in this 10-year-old boy presenting with headache and abnormal vision?



- A. Craniopharyngioma
- B. Rathke cleft cyst
- C. Hypothalamic/chiasmatic glioma
- D. Suprasellar arachnoid cyst

**Key:** A

**Rationale:**

- A. Axial unenhanced CT image shows a large partially cystic/hypodense suprasellar mass with rim and globular calcifications classic for craniopharyngioma. Craniopharyngioma in pediatric population follows the 90% rule: 90% are cystic, 90% calcify and 90% demonstrate enhancement.
- B. Rathke cleft cyst: usually are less heterogeneous noncalcified lesions that do not enhance.
- C. Hypothalamic glioma/chiasmatic glioma: usually more solid-appearing intensely enhancing masses. Calcification in hypothalamic/chiasmatic glioma is extremely rare.
- D. Suprasellar arachnoid cyst: They do not demonstrate contrast enhancement or calcification.

**Reference:**

Zada G, Lin N, Ojerholm E, et al. Craniopharyngioma and other cystic epithelial lesions of the sellar region: a review of clinical, imaging and histopathological relationships. Neurosurg Focus 2010; 28:E4.

7. A 15-month-old girl presents with a large, palpable abdominal mass. What is the MOST likely diagnosis?



- A. Hepatoblastoma
- B. Neuroblastoma
- C. Wilms Tumor
- D. Renal Cell Carcinoma

**Key:** C

**Rationale:**

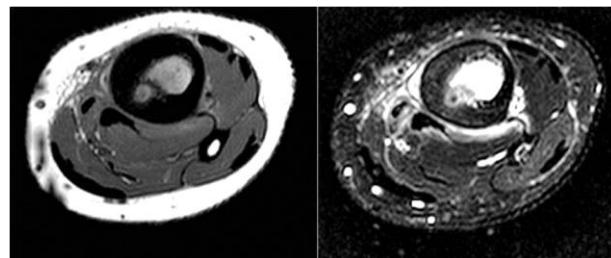
The images show a large mass arising from the right kidney. In a 15 month old child this is most likely a Wilms tumor. Hepatoblastoma and neuroblastoma are excluded by the fact that the mass arises from the kidney, not from the liver or the paraaortic paraspinal plexus or the adrenal gland. Renal cell carcinoma would be exceedingly rare in this age group.

**Reference:**

Lowe LH, Isuani TH, et al. Pediatric renal masses: Wilms tumor and beyond. Radiographics 2000; 20:1585-1603.

Ahmed HU, Arya M, et al. Part I: Primary malignant non-Wilms renal tumours in children. Lancet Oncol 2007; 8:730-737.

8. What is the treatment of choice for this 8-year-old boy presenting with a limp?



- A. Antibiotics
- B. Limb reconstruction
- C. Radiofrequency ablation
- D. Sclerotherapy

**Key:** C

**Rationale:**

Findings of bone sclerosis with a central nidus are consistent with an osteoid osteoma.

- A. Long-term antibiotics would be considered if this were thought most likely to be chronic infection. However, this is less likely than osteoid osteoma on the MRI given the low T2 signal of the nidus, which does not correspond to a visible sequestrum on the plain film. Focal bone abscess should be high signal on T2 weighted imaging.
- B. Although curettage is a tried and true therapy for osteoid osteoma, amputation and/or wide resection with reconstruction would be radical and unnecessary for this benign lesion.
- C. RFA is widely used for treatment of osteoid osteoma, with cure rates in excess of 90% after a single treatment. An RFA probe is placed at the nidus, ideally, and the temperature is increased to 90 C for several minutes. In general, this is considered first-line therapy.
- D. Sclerotherapy, in which the interventional radiologist or surgeon injects generally inflammatory agents to obliterate lymphatic or vascular spaces, is not intended for benign bone lesions.

**Reference:**

Earhart J, Wellman D, Donaldson J, Chesterton J, King E, Janicki JA. Radiofrequency ablation in the treatment of osteoid osteoma: results and complications. Pediatric Radiology 2013 Jul; 43(7):814-9.

9. The MOST common etiology for the abnormality demonstrated in this 10-year-old girl is:



- A. Williams syndrome
- B. Fibromuscular dysplasia
- C. Neurofibromatosis
- D. Atherosclerosis

**Key:** B

**Rationale:**

- A. Williams syndrome does include a vasculopathy that can affect the renal arteries, but multiple other vessels, such as the aorta, are characteristically involved (one cause of Middle Aortic Syndrome).
- B. FMD and NF are the 2 most likely causes of isolated renal artery stenosis in children, with FMD more common.
- C. NF is the second most common cause of RAS in children.
- D. Atherosclerosis is not, except in the most rare of circumstances, a disease of childhood.

**Reference:**

Radford DJ, Pohlner PG. The middle aortic syndrome: an important feature of Williams syndrome. Cardiol Young 2000 Nov; 10(6):597-602.

**Radiation Physics  
In-Training Test Questions  
for Diagnostic Radiology Residents**



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1. The relationship of kVp to radiation dose in a CT examination is which of the following?

- A. Linear
- B. Inversely proportional
- C. Logarithmic
- D. Exponential

**Key:** D

**Rationale:**

The dose varies linearly with mAs but not with kVp, it is approximately proportional to  $kVp^2$ .

**Reference:**

Bushberg, Seibert, Leidholdt, Boone Essential Physics of Medical Imaging Third Edition, 2012, Lippincott, Williams and Wilkins p 202-206.

2. What is the component of an MR system that protects the scanner from external signals broadcasting in the same RF spectrum as the MR excitation signal?

- A. Shim coil
- B. Active gradient
- C. Faraday cage
- D. Mu-metal shield

**Key:** C

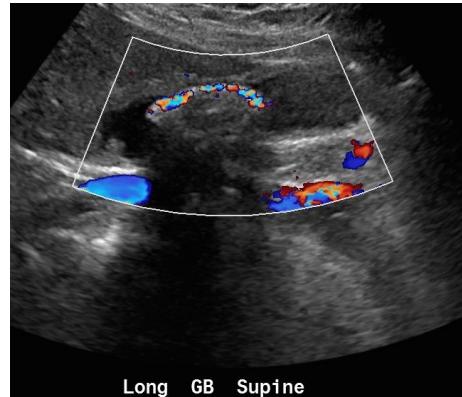
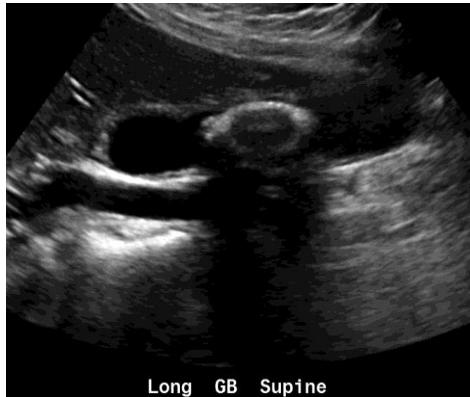
**Rationale:**

A Faraday cage is the type of shielding material used to reduce RF interference.

**Reference:**

Bushberg, Seibert, Leidholdt, Boone Essential Physics of Medical Imaging Third Edition, 2012, Lippincott, Williams and Wilkins p 477-478.

3. What artifact is demonstrated on this image of the gallbladder?



- A. Twinkle
- B. Side lobe
- C. Reverberation
- D. Mirror

**Key:** A

**Rationale:**

This is a type of color Doppler artifact due to strong reflectors and consists of highly aliased signals which originate from the structure being imaged. It is most commonly seen with kidney stones but can be seen with various types of calcifications.

**Reference:**

William Middleton, MD Ultrasound: The Requisites 2016 Chapter 1, 3-31.

4. Which combination of tube current / tube voltage at coronary CT angiography will likely result in the lowest effective radiation exposure to a 5-year-old child for ruling out coronary artery anomalies?

- A. 80 mA/140 kVp
- B. 160 mA/120 kV
- C. 240 mA/100 kVp
- D. 320 mA/80 kVp

**Key:** D

**Rationale:**

Generally, a lower tube voltage will result in a lower dose if appropriate mAs is used. The dose varies linearly with mAs but not with kVp, it is approximately proportional to  $kVp^2$ .

**Reference:**

Bushberg, Seibert, Leidholdt, Boone Essential Physics of Medical Imaging Third Edition, 2012, Lippincott, Williams and Wilkins p 202-206.

AJR 2015; 204:W4-W10, “Tube Potential and CT Radiation Dose Optimization”, D. Lira, A Padole, M. Kalra, S. Singh.

5. What is the source of the image artifact observed?



- A. Damaged CR Plate
- B. Projection of focal spot from debris on collimator
- C. CR reader laser artifact
- D. Electronic noise artifact from CR reader

**Key:** B

**Rationale:**

- A. Observe the shape of the artifact, this is indicative of a projected focal spot from a small object (dirt/dust) in the collimator.
- B. Correct.
- C. Observe the shape of the artifact, this is indicative of a projected focal spot from a small object (dirt/dust) in the collimator.
- D. Observe the shape of the artifact, this is indicative of a projected focal spot from a small object (dirt/dust) in the collimator.

**Reference:**

Walz-Flannigan A, Brossot K, Magnuson D, Scheuler B Pictorial Review of Digital Radiography Artifacts RadioGraphics 2018 Apr; 38(3):833-846.

6. Which fluoroscope configuration is most likely to yield high ambient radiation levels (and hence higher occupational radiation doses)?

- A. Overtable Fluoroscope
- B. Undertable Fluoroscope
- C. C-arm Fluoroscope
- D. O-arm Fluoroscope

**Key:** A

**Rationale:**

The patient's skin entrance is the primary source of radiation to operators. With an X-ray tube situated above the patient, the highest scatter photon flux is generated much higher and above any tableside shielding relative to systems with an x-ray source that is typically below the patient. This configuration yields the highest ambient radiation dose rates and hence occupational dose rates.

**Reference:**

Schuler BA The AAPM/RSNA physics tutorial for residents: general overview of fluoroscopic imaging RadioGraphics 2000; 20:1115-1126.

7. Which of the following QA/QC test results requires immediate remedy before a mammography unit may be used to image patients?

- A. Failure of weekly phantom test
- B. kVp testing demonstrating >5% deviation from the expected/indicated value
- C. Presence of system artifacts determined by the physicist
- D. Paddle visible in image

**Key:** A

**Rationale:**

- A. Failure of the weekly phantom testing required immediate remedy before further imaging can be performed on a patient
- B. kVp testing failure allows for 30 day corrective action
- C. Artifacts found by the physicist allow for 30 day corrective action.
- D. Having the paddle visible in the image allows for 30 day corrective action.

**Reference:**

Bushberg, Seibert, Leidholdt, Boone. The Essential Physics of Medical Imaging 2012:279.

8. Which of the following would BEST optimize spatial resolution in a typical planar nuclear medicine image of a tumor?

- A. Choose a 64 X 64 matrix rather than a 256 X 256 matrix
- B. Position the patient as close as possible to the collimator face
- C. Shorten the study to minimize patient movement
- D. Choose a camera with the thickest crystal available

**Key:** B

**Rationale:**

A 64 X 64 matrix has larger pixels than a 256 x 256 matrix and would result in worse spatial resolution. Shortening the study to minimize movement does not directly affect spatial resolution. A thicker crystal has somewhat worse intrinsic spatial resolution than a thinner one. The best option is to position the patient as close as possible to the collimator face. The collimator resolution is proportional to  $d/L * (L + x)$  where d is the diameter of the holes and L is the hole length, and x is the distance to the patient from the collimator face.

**Reference:**

JT Bushberg, JA Seibert, EM Leidholdt Jr, JM Boone The Essential Physics of Medical Imaging 3rd edition, 2012, 682-689.

9. What effect on the half-value layer (HVL) of the beam will result from adding copper (Cu) to a given X-ray beam at a fixed kVp?

- A. Increase
- B. Decrease
- C. Remain the same
- D. Cannot be determined

**Key:** A

**Rationale:**

- A. Adding attenuation / filtration to a polyenergetic X-ray beam increases the effective energy of the beam, resulting in a more penetrating beam and thereby increasing the HVL.
- B. Adding attenuation / filtration to a polyenergetic X-ray beam increases the effective energy of the beam, resulting in a more penetrating beam and thereby increasing the HVL.
- C. Adding attenuation / filtration to a polyenergetic X-ray beam increases the effective energy of the beam, resulting in a more penetrating beam and thereby increasing the HVL.
- D. Adding attenuation / filtration to a polyenergetic X-ray beam increases the effective energy of the beam, resulting in a more penetrating beam and thereby increasing the HVL.

**Reference:**

Bushberg JT, Seibert JA, Leidholdt EM Jr, Boone JM. Essential physics of medical imaging 3rd ed. Philadelphia, Pa: Lippincott Williams Wilkins 2012 (Page 51).

**Ultrasound  
In-Training Test Questions  
for Diagnostic Radiology Residents**



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1. You are shown 2 images of the gallbladder from a study performed for abnormal liver function tests (LFTs). How should this finding be reported?



- A. Indeterminate, recommend MRI
- B. Malignant, recommend surgical consultation
- C. Infectious, recommend surgical consultation
- D. Benign, no follow-up recommended

**Key:** D

**Rationale:**

- A. The ultrasound imaging features of focal wall thickening involving the fundus with bright echogenic foci and comet tail artifact are characteristic of adenomyomatosis. MRI is not necessary to further characterize.
- B. Gallbladder carcinoma may be focal and mass-like or cause wall thickening, however the presence of bright echogenic foci with comet tail artifact is characteristic of adenomyomatosis.
- C. The patient's history is not suspicious for infection. Wall thickening in association with acute cholecystitis is diffuse and may be associated with hyperemia which is not shown. The bright echogenic foci with comet tail artifact is characteristic of adenomyomatosis.
- D. Imaging features are characteristic of benign adenomyomatosis. No surveillance imaging is advised for this benign, incidental finding.

**Reference:**

Hwang JI, Chou YH, Tsay SH, et. al. Radiologic and pathologic correlation of adenomyomatosis of the gallbladder Abdominal Imaging 1998 23:73-77.

2. What is the minimum threshold portal vein diameter for diagnosing portal hypertension on ultrasound?

- A. 8mm
- B. 10mm
- C. 14mm
- D. 16mm

**Key:** C

**Rationale:**

Studies have shown an association between portal vein diameter greater than 13mm and portal hypertension.

Studies have shown an association between portal vein diameter greater than 13mm and portal hypertension.

Studies have shown an association between portal vein diameter greater than 13mm and portal hypertension.

Studies have shown an association between portal vein diameter greater than 13mm and portal hypertension. Answer C is closer in value to the minimum threshold.

**Reference:**

DA McNaughton, MM Abu-Yousef Doppler US of the liver made simple Radiographics 2011;31:161-188..

3. According to the Couinaud classification system, the caudate lobe corresponds to which of the following hepatic segments?

- A. I
- B. II
- C. IV
- D. VIII

**Key:** A

**Rationale:**

A. The caudate lobe corresponds to subsegment I.

B. Subsegment I is the caudate lobe. Subsegment II is the left lateral superior subsegment.

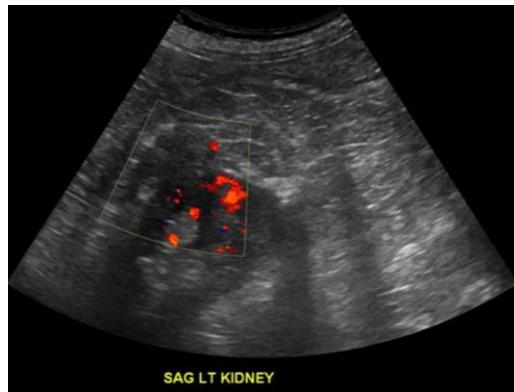
C. The caudate lobe corresponds to segment I. The left medial segment corresponds to segment IV.

D. The caudate corresponds to subsegment I. Subsegment VIII is the right anterior superior subsegment.

**Reference:**

Middleton WD, Kurtz AB, Hertzberg BS. Ultrasound. The Requisites 2nd ed. Mosby 2004:49-51.

4. You are shown 2 images of the left kidney. Which of the following is the MOST likely diagnosis?



- A. Renal cell carcinoma
- B. Simple cyst
- C. Angiomyolipoma
- D. Dromedary hump

**Key:** A

**Rationale:**

- A. The images demonstrate a solid renal mass, with internal echoes and vascular flow on power Doppler imaging. The most likely diagnosis is a renal cell carcinoma.
- B. Sonographic criteria to diagnose a simple cyst includes the following characteristics: Anechoic, posterior acoustic enhancement, and a sharply defined, imperceptible far wall.
- C. The characteristic sonographic appearance of an angiomyolipoma is a well-defined hyperechoic mass. The increased echogenicity is attributed to the fat content, multiple interfaces, heterogeneous cellular architecture, and multiple vessels.
- D. Dromedary hump is a common renal variation seen as a focal bulge on the lateral border of the left kidney. It is a result of adaptation of the renal surface to the adjacent spleen. It can be differentiated from a renal mass because of its similar echotexture to that of adjacent renal parenchyma. It will have similar vascularity to that of adjacent renal parenchyma.

**Reference:**

Dogra V, Rubens D. Ultrasound Clinics Genitourinary Ultrasound/Vascular Ultrasound W.B. Saunders 2006 January; 15:27-30.

5. Which of the following is the MOST consistent ultrasound finding in ovarian torsion?

- A. Absence of arterial flow in the ovary
- B. Absence of venous flow in the ovary
- C. Unilateral ovarian enlargement
- D. Small, peripheral follicles

**Key:** C

**Rationale:**

- A. Color Doppler imaging findings are not consistent due to variable degree of torsion. Initially, the twisted vascular pedicle compromises venous and lymphatic outflow. However, arterial inflow is sustained because arteries have thick, muscular walls and are less collapsible. In addition, a torsed ovary may have arterial flow remaining due to flow arising from both the ovarian and uterine arteries.
- B. Doppler findings may vary depending on degree and chronicity of torsion. The presence of arterial or venous flow does not exclude the diagnosis of torsion. Decreased flow may be present. Absence of venous flow in the presence of arterial flow may also be seen in a normal ovary. Comparison with the flow patterns of the contralateral ovary may be helpful.
- C. Initially, the twisted vascular pedicle compromises venous and lymphatic outflow. This results in diffuse ovarian edema and enlargement, which over time cause the capsule to stretch and increase pressure on the ovary.
- D. US may demonstrate multiple small cysts in the periphery of the engorged ovary. This appearance is likely secondary to follicles that have been displaced to the periphery due to the marked edema and venous congestion. These also may be seen in normal ovaries of fertile women and in patients with polycystic ovary disease and are not diagnostic of ovarian torsion. Multiple peripheral cysts in the setting of pain with a unilaterally enlarged ovary are helpful in diagnosing ovarian torsion.

**Reference:**

Dawood MT, Naik M, Bharwani N, Suderuddin SA, Rockall AG and Steward VR. Adnexal Torsion: Review of Radiologic Appearances. Radiographics 2021; 41:609-624.

6. What type of uterine leiomyoma MOST often produces symptoms?

- A. Intramural
- B. Subserosal
- C. Submucosal
- D. Pedunculated

**Key:** C

**Rationale:**

- A. Intramural fibroids are most common, but not most symptomatic.
- B. Subserosal fibroids can be pedunculated but are not the most symptomatic.
- C. Submucosal fibroids, though less common than intramural fibroids, produce symptoms more frequently.
- D. Pedunculated fibroids are a type of subserosal fibroid, and do not produce symptoms most frequently.

**Reference:**

Yang, Lindsay and Navuluri Rakesh. Uterine Fibroids and Adenomyosis: Imaging and Treatment. Contemporary Diagnostic Radiology. October 2021 (44):1-7.

7. Which of the following is the MOST common diagnostic finding for acute deep vein thrombosis of a lower extremity on ultrasound?

- A. Incomplete filling with color Doppler
- B. Loss of respiratory phasicity
- C. Circumferential wall thickening
- D. Incomplete compressability

**Key:** D

**Rationale:**

- A. Color doppler is a useful adjunct especially when compression cannot be performed due to marked swelling of the limb or due to deep location of the vessel. However, lack of color doppler signal within the vein can be due to technical factors such as color gain setting, or abnormal wall filter setting. Therefore, this is not considered the most diagnostic finding for a DVT.
- B. The normal doppler waveform in a lower extremity ultrasound shows respiratory phasicity. Lack of normal phasic variation can be seen in many other conditions other than a proximal DVT, such as technical factors, patient positioning, pregnancy, compression of a more proximal vessel, as well as other etiologies. This is not considered the most diagnostic finding in a lower extremity ultrasound for DVT.
- C. Circumferential wall thickening is seen with chronic clot, not acute DVT.
- D. Incomplete compressibility of the vein is the most diagnostic finding for DVT.

**Reference:**

Needleman L, Cronan JJ, Lilly MP, Merli GJ, Adhikari S, Hertzberg BS, DeJong MR, Streiff, MB, Meissner MH. Ultrasound for Lower Extremity Deep Venous Thrombosis Multidisciplinary Recommendations From the Society of Radiologists in Ultrasound Consensus Conference. Circulation. April 2018;137:1505–1515.

8. Which of the following Doppler findings in the interlobar arteries of a native kidney is associated with significant stenosis of the main renal artery?

- A. To and fro Doppler pattern
- B. Tardus Parvus waveform
- C. Resistive index 0.8
- D. Turbulent flow with increased velocity

**Key:** B

**Rationale:**

A. The To and fro Doppler pattern refers to the Doppler signal obtained in the neck of a pseudoaneurysm, where the blood goes in and out between the native artery and the vascular collection formed by the pseudoaneurysm. It is not associated with upstream stenosis

B. Finding of a tardus parvus waveform in peripheral renal arteries is an indirect sign of an upstream hemodynamically significant stenosis in the main renal artery. The normal intrarenal arterial waveform includes a steep systolic upstroke, followed by a gradual decrease in velocity throughout later systole and continuous low velocity flow throughout diastole. In the tardus parvus waveform (TPW), the waveform is blunted, with a slow systolic acceleration (tardus) and a low amplitude systolic peak (parvus). This abnormal doppler waveform can often be appreciated visually by the experienced observer. The slow systolic acceleration can be confirmed by the following measurements: The acceleration time (AT) refers to the time between the onset of systole and the FIRST systolic peak. The normal AT is 0.07s or less. The acceleration index (AI) refers to the slope of the systolic upstroke. The normal AI is 3m/s or more. This tardus parvus phenomenon is used to indirectly detect more proximal stenosis in a variety of arteries: for example a TPW in the hepatic artery at the porta hepatis should prompt careful evaluation of the proximal hepatic artery to detect a significant stenosis, a potentially serious complication in patients with a liver transplant. A TPW in the internal carotid artery may indicate a hemodynamically significant stenosis in the ipsilateral common carotid artery.

C. The normal resistive index (defined as peak systolic velocity –end diastolic velocity/ peak systolic velocity) in the kidney is 0.7 or less, indicating relatively low impedance capillary bed in the parenchyma of the normal kidney allowing for continuous low velocity forward flow in diastole. Abnormally high resistive index is a relatively non specific indicator of abnormally high vascular impedance in the kidney from a variety of reasons including severe obstruction, compression of the kidney by a subcapsular hematoma and in the transplanted kidney acute tubular necrosis or acute rejection among others.

D. Turbulent flow with elevated velocity in a peripheral renal artery is associated with an arteriovenous fistula, which is often iatrogenic resulting from a previous biopsy.

**Reference:**

Imaging of Renal Transplant Complications throughout the life of the allograft: comprehensive multimodality review. Radiographics 2019; 39:1327-1355.

9. Which of the following is diagnostic of embryonic demise?

- A. Failure to visualize an embryo by transvaginal sonography in a 13 mm gestational sac
- B. Vaginal bleeding in the first trimester of pregnancy
- C. Absence of fetal cardiac activity in an embryo over 7 mm
- D. Endocavitary blood products without an identifiable gestational sac

**Key:** C

**Rationale:**

- A. The embryo should be visible by transvaginal sonography when the mean gestational sac is over 16 to 18 mm, and is often not visible with normal sacs of smaller size. The yolk sac should be visible by 10 to 12 mm.
- B. Vaginal bleeding in the first trimester is a relatively common symptom and may be noted in patients who have either normal or abnormal intrauterine gestation as well as patients with an ectopic pregnancy. The documentation of a living intrauterine embryo in patients with first trimester bleeding predicts a greater than 90% likelihood of a normal pregnancy.
- C. Cardiac activity may be observed by transvaginal sonography in fetuses as small as 2 mm and is usually easily detected when the embryo reaches 5 mm. While the absence of cardiac activity in an embryo measuring 5 mm should prompt close follow up, some recent studies have shown that in a number of cases despite the absence of cardiac activity a CRL of 5mm, the pregnancy was ultimately viable. Therefore a cut off CRL size of 7mm without cardiac activity has recently been suggested to diagnose embryonic demise.
- D. Blood products within the endometrial canal is a non specific finding and may be noted with ectopic pregnancies which has been called a pseudosac as well as in patients experiencing a spontaneous abortion.

**Reference:**

Douillet PM, Benson CB, Bourne T, Blaivas, M. Diagnostic Criteria for Nonviable Pregnancy Early in the First Trimester for the Society of Radiologists in Ultrasound Multispecialty Panel on Early First Trimester Diagnosis of Miscarriage and Exclusion of a Viable Intrauterine Pregnancy N Engl J Med 2013; 369:1443-1451.

10. Which of the following ultrasound findings is the MOST specific for the diagnosis of thyroid cancer?

- A. Multiple nodules
- B. Hypervascularity
- C. Microcalcification
- S
- D. Size of nodule

**Key:** C

**Rationale:**

- A. Although the risk of malignancy in multiple nodules is comparable to solitary thyroid nodule, multiplicity by itself is not sufficient for making the diagnosis of thyroid cancer. Individual nodule characteristics, such as solid and hypoechoic appearance, with calcifications, and lymph node metastases is more significant in making the diagnosis of malignancy.
- B. Although about 70% of the thyroid malignancies demonstrate hypervascularity compared to the surrounding thyroid parenchyma, it is a non specific finding. In one study, about 50% of the hypervascular thyroid nodules were benign. Perinodular flow is considered more characteristic of benign nodules, although this has been demonstrated in malignancies as well. In contrast, complete avascularity is a more useful sign, and almost always excludes malignancy.
- C. Thyroid microcalcifications are psammoma bodies, which are 10–100- $\mu\text{m}$  round laminar crystalline calcific deposits. Microcalcifications are one of the most specific features of thyroid malignancy, with a specificity of 85.8%–95%. Microcalcifications are found in 29%–59% of all primary thyroid carcinomas, most commonly papillary thyroid cancer. Their occurrence has been described in follicular and anaplastic thyroid carcinomas as well as in benign conditions such as follicular adenoma and Hashimoto thyroiditis. On ultrasound, microcalcifications appear as punctate hyperechoic foci without acoustic shadowing.
- D. The size of a nodule is not helpful for predicting or excluding malignancy. The Society of Radiologists in Ultrasound recently recommended that the selection of a nodule for FNA in a multinodular thyroid be based primarily on US characteristics rather than nodule size. Although nodules with a size of more than 4 cm are slightly more likely to be malignant than are smaller nodules, benign nodules can also reach a reasonably large size.

**Reference:**

Tessler FN, et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): White Paper of the ACR TI-RADS Committee. Journal of the American College of Radiology 2017; 14:587-595.