

**Breast Radiology
In-Training Exam Questions
for Diagnostic Radiology Residents**

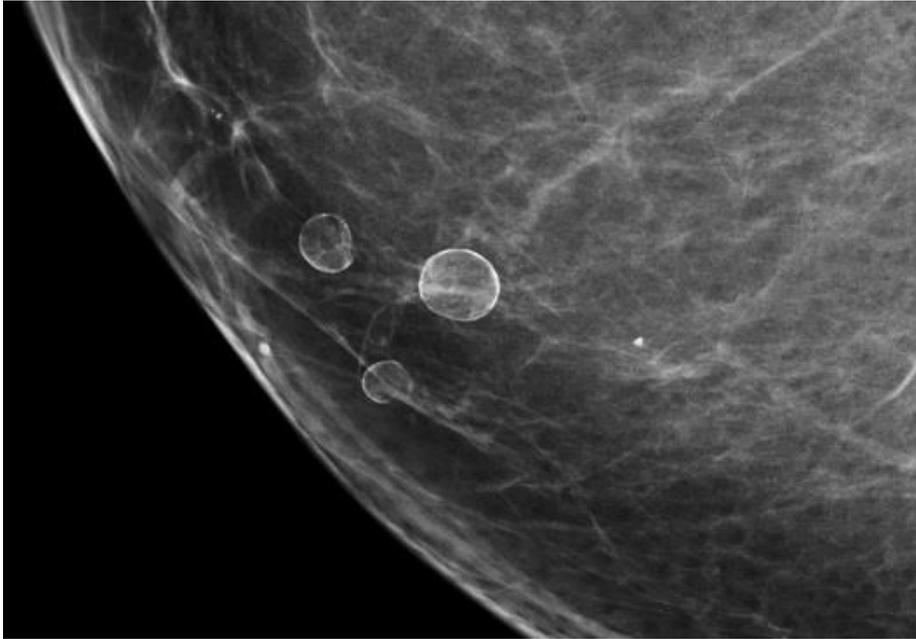


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1. For the image shown, what is the MOST appropriate BI-RADS® category?



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

Key: B

Rationale:

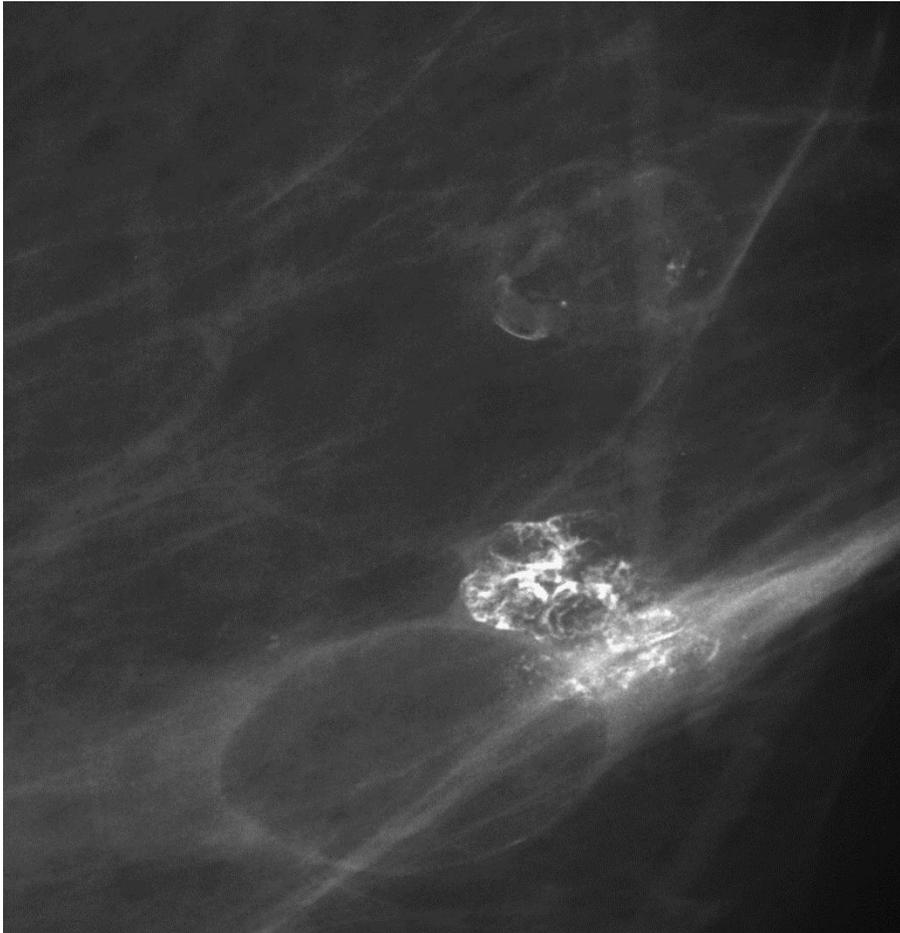
A: Incorrect. BI-RADS 0 would require additional imaging evaluation. That is not the case here, where findings are classical for benign calcifications and do not require additional studies.

B: Correct. BI-RADS 2 is the correct answer in this case where findings are classical for calcifying cysts/fat necrosis, which are benign findings.

C: Incorrect. BI-RADS 3 would require short term follow up. This would not be appropriate in this case where findings are classical for benign calcifications.

D: Incorrect. BI-RADS 4 findings are suspicious and would warrant biopsy. In this case, findings are classically benign and do not warrant biopsy.

2. Based upon this 90 degree ML magnification view from a patient who is status-post lumpectomy, what is the MOST likely diagnosis?



- A. Dermal calcifications
- B. Milk of calcium
- C. Fat necrosis
- D. Recurrent carcinoma

Key: C

Rationale:

A: Incorrect. While dermal calcifications typically have lucent centers, the calcifications shown here are too large to be classified as dermal.

B: Incorrect. These calcifications do not layer in a fashion consistent with benign milk of calcium, but are classical for post-surgical fat necrosis.

C: Correct. The findings of coarse rim like calcifications, intermixed with lucency, and the history of prior surgery, are consistent with the correct diagnosis of fat necrosis.

D: Incorrect. Findings are classical for post-surgical fat necrosis and there is no evidence for recurrent carcinoma.

3. What is the MOST common enhancement pattern of ductal carcinoma in situ (DCIS) on breast MRI?
- A. Segmental heterogeneous
 - B. Clumped linear
 - C. Stippled punctate
 - D. Reticular/dendritic

Key: B

Rationale:

A: Incorrect. Segmental enhancement denotes a triangular region or cone of enhancement and is used to describe the distribution of the enhancement rather than the specific characteristics. While DCIS may enhance in a segmental distribution, other benign pathologies may do so as well.

B: Correct. DCIS characteristically enhances in a non-mass-like fashion and may be clumped or linear in distribution.

C: Incorrect. Stippled enhancement tends to be diffuse and distributed uniformly and evenly throughout the breast. It is most commonly associated with fibrocystic change.

D: Incorrect. This pattern is often seen in women with involuted breasts where the abnormal enhancement pattern shows distorted trabecular thickening and foreshortening of the normal tissue. This is more commonly associated with invasive ductal carcinoma.

4. A patient undergoes stereotactic core biopsy of a cluster of indeterminate calcifications, with pathology showing atypical ductal hyperplasia. What is the MOST appropriate recommendation?
- A. Routine annual mammography
 - B. Six month follow-up mammography
 - C. Breast MRI
 - D. Surgical excision

Key: D

Rationale:

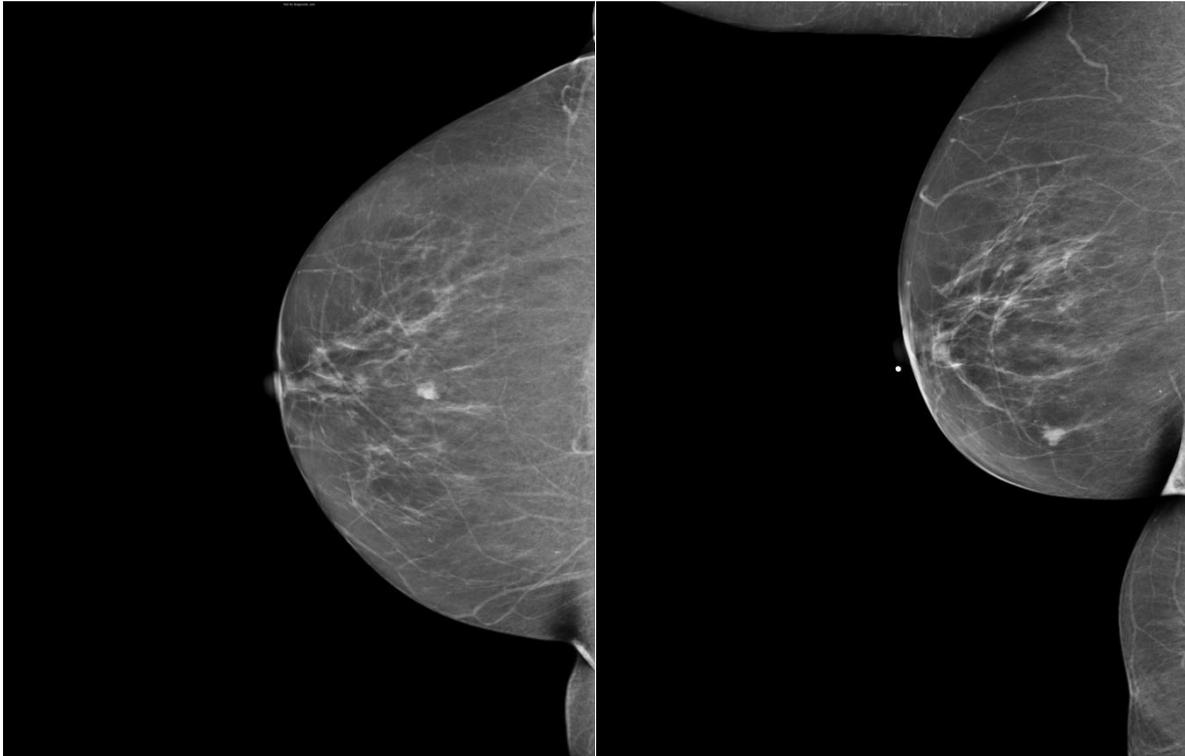
A: Incorrect. Following biopsy yielding ADH, routine annual mammography is not the appropriate recommendation. The patient should be referred for surgical excision.

B: Incorrect. Following biopsy yielding ADH, short term follow up is not appropriate. The patient should be referred for surgical excision.

C: Incorrect. Following biopsy yielding ADH, the patient is now considered high risk. However, breast MRI is not the most appropriate recommendation. Rather, the patient should be referred for surgical excision.

D: Correct. This is the most appropriate recommendation following a core biopsy yielding ADH.

5. The patient is scheduled for needle localization excision of a biopsy proven invasive ductal carcinoma. What is the MOST appropriate approach for needle localization excision?



- A. Superior
- B. Inferior
- C. Lateral
- D. Medial

Key: B

Rationale:

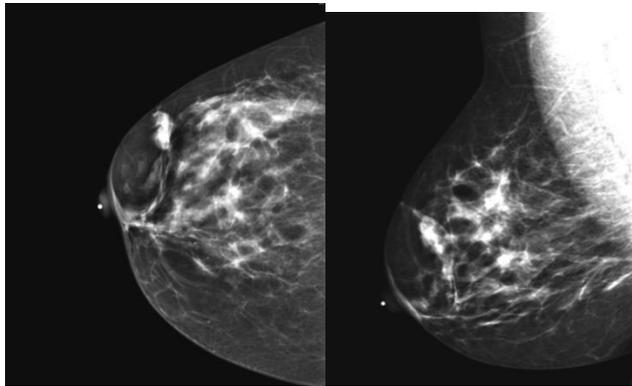
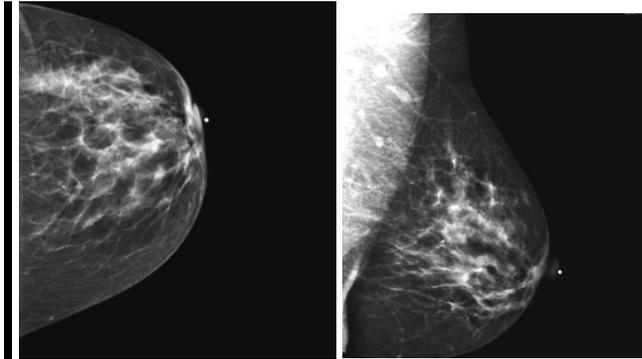
A: Incorrect. The lesion is located at the 6:00 axis. The shortest distance would be from inferior rather than superior.

B: Correct. The lesion is located at the 6:00 axis of the right breast. As such, the shortest approach is from below or inferior.

C: Incorrect. The lesion is located at the 6:00 axis. The shortest distance would be from inferior rather than lateral.

D: Incorrect. The lesion is located at the 6:00 axis. The shortest distance would be from inferior rather than medial.

6. A 50-year-old woman presents for a routine screening mammogram. The MOST appropriate BI-RADS® classification is:



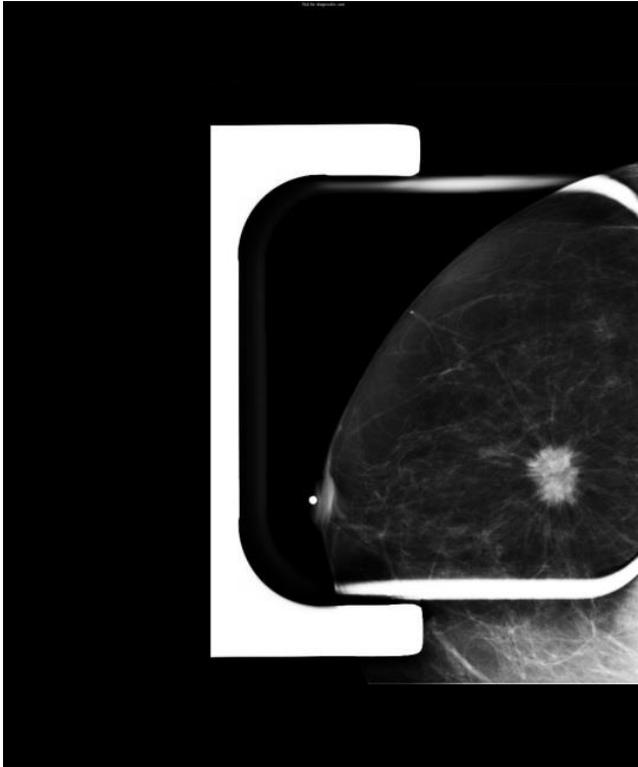
- A. BI-RADS 1
- B. BI-RADS 2
- C. BI-RADS 3
- D. BI-RADS 4

Key: B

Rationale:

- A: Incorrect. There is a right breast hamartoma, which is a benign finding. BI-RADS 1 should be used for a negative study, rather than a study with a clear benign finding.
- B: Correct. BI-RADS 2 is the correct category for this study due to the benign hamartoma which is present in the right breast.
- C: Incorrect. BI-RADS 3 category should not be used for a screening mammogram and would be incorrect in this case in any event, since the finding is classically benign.
- D: Incorrect. BI-RADS 4 should be reserved for suspicious findings which require biopsy. That is not the case here, where findings are classically benign.

7. A patient returns for additional views of the right breast following a screening study. Spot compression views and ultrasound were obtained. No abnormality was demonstrated on ultrasound. What is the MOST appropriate next step?



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

Key: D

Rationale:

A: Incorrect. In the presence of a spiculated mammographic mass, biopsy is necessary. Routine annual mammography is not appropriate.

B: Incorrect. In the presence of a spiculated mass, six month follow up is not appropriate. Biopsy is necessary.

C: Incorrect. In view of the presence of a spiculated mass, breast MRI is not the most appropriate recommendation at this time. Biopsy is necessary.

D: Correct. In the presence of a spiculated mass which is not visualized under ultrasound, stereotactic core biopsy would be appropriate in order to acquire a biopsy, as the mass is mammographically visible.

8. What is the MOST common mammographic presentation of male breast cancer?
- A. Architectural distortion
 - B. Calcifications
 - C. Mass with calcifications
 - D. Noncalcified mass

Key: D

Rationale:

A. Incorrect. Male breast cancer does not typically present as architectural distortion, but most commonly presents as a spiculated non-calcified mass.

B: Incorrect. Male breast cancer may present with calcifications, but this is not the most common presentation.

C: Incorrect. Male breast cancer generally presents as a dense non-calcified mass.

Calcifications are less common in male breast cancers than in female breast cancers.

D: Correct. A non-calcified mass is the most common presentation of male breast cancer.

9. A 45-year-old woman is placed into a BI-RADS® 3 category after a diagnostic workup. According to the BI-RADS lexicon, such a finding is associated with less than what percent chance of malignancy?
- A. 1%
 - B. 2%
 - C. 5%
 - D. 10%

Key: B

Rationale:

A: Incorrect. BI-RADS 3 denotes a less than 2% chance of breast cancer.

B: Correct. Patients with a BI-RADS 3 finding should have a less than 2% chance of malignancy. The finding is not expected to change over the 6 month follow up time interval.

C: Incorrect. BI-RADS 3 findings should have a less than 2% chance of malignancy. If the abnormality is thought to carry a greater risk for malignancy, biopsy should be recommended.

D: Incorrect. BI-RADS 3 findings should have a less than 2% chance of malignancy. If the abnormality is thought to carry a greater risk for malignancy, biopsy should be recommended.

10. You are shown a bilateral mammogram in an 80-year-old male with a palpable left breast lump. The most likely diagnosis is:



- A. Gynecomastia
- B. Invasive ductal carcinoma
- C. Invasive lobular carcinoma
- D. PASH (pseudoangiomatous stromal hyperplasia)

Key: B

Rationale:

A: Incorrect. Gynecomastia classically presents as a flame shaped retroareolar density but in this case, there is a spiculated mass in the retroareolar breast, which is suspicious for malignancy.

B: Correct. A spiculated mass of the male breast with nipple retraction is most likely carcinoma. Ductal carcinoma is statistically more common than lobular carcinoma in males, and is more likely to be mass like in presentation.

C: Incorrect. The male breast does not typically contain lobules and as a result, it is extremely unusual for males to develop invasive lobular carcinoma.

D: Incorrect. PASH, a benign entity, is unusual in a male and would not present as a spiculated mass with nipple retraction.

**Cardiac Radiology
In-Training Exam Questions
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1. Coronary artery aneurysms can be caused by which of the following?

- A. Hypertension
- B. Syphilis
- C. Atherosclerosis
- D. Neoplasm

Key: C

Rationale:

A: Incorrect. Hypertension may result in coronary artery disease. However, hypertension is not considered to be a direct cause of coronary artery aneurysm.

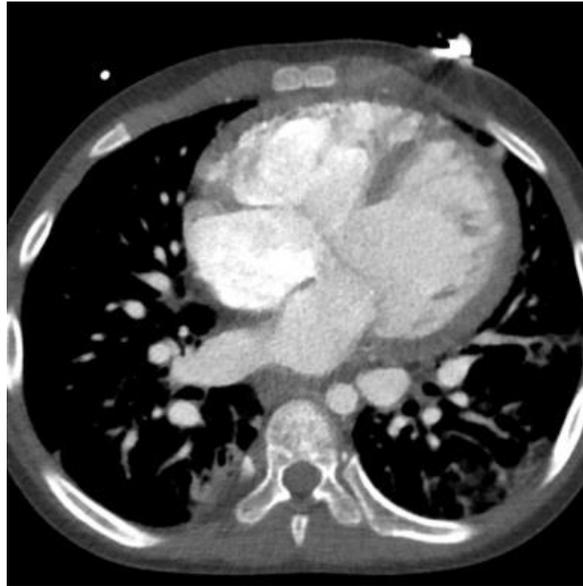
B: Incorrect. Syphilis typically affects vessels which have a vaso vasorum. The ascending aorta is most commonly involved and marked aneurysmal dilatation may result. Because the coronary arteries do not have significant vaso vasorum, they are not affected by syphilis infection.

C: Correct. Atherosclerosis is the most common cause of coronary artery aneurysms in the United States.

D: Incorrect. Neoplasms are not known to cause coronary artery aneurysms.

Reference: Johnson PT, Fishman EK. CT angiography of coronary artery aneurysms: detection, definition, causes and treatment. Am J Roentgenol 2010; 195:928-934.

2. What is the MOST likely diagnosis in this 8-year-old child with long-standing dyspnea?



- A. Muscular ventricular septal defect
- B. Sinus venosus atrial septal defect
- C. Ostium secundum atrial septal defect
- D. Endocardial cushion defect

Key: D

Rationale:

A: Incorrect. The ventricular septal defect demonstrated in the case is largely a membranous defect, and is not isolated to the muscular septum. In addition, there is also an ostium primum atrial septal defect.

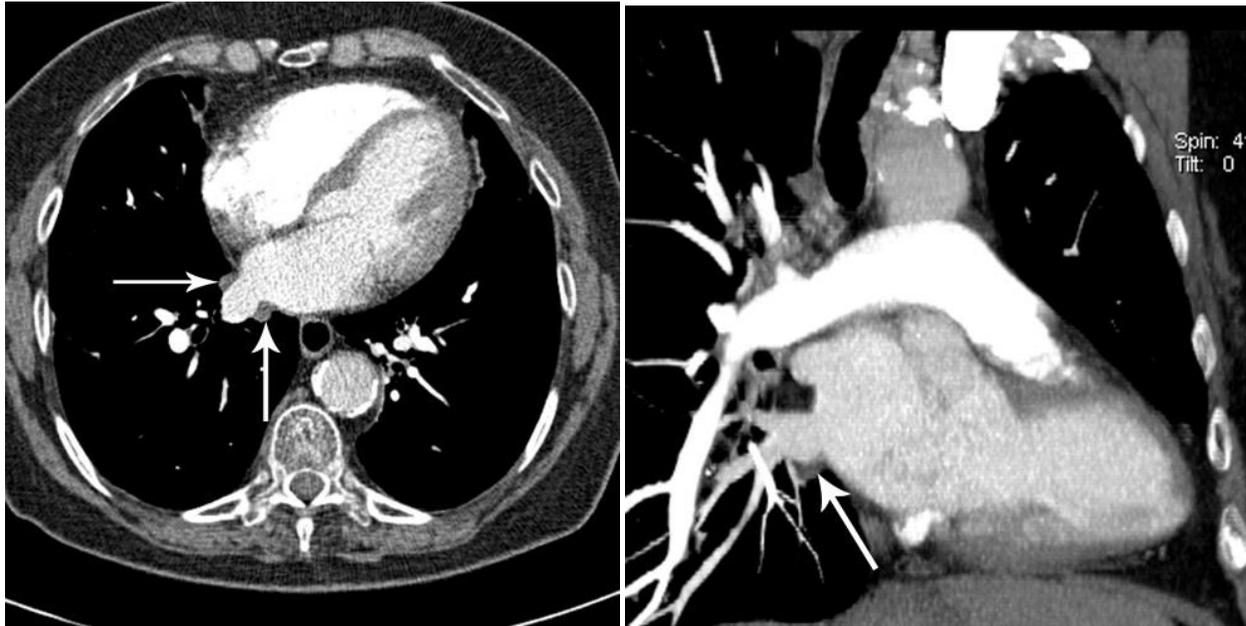
B: Incorrect. The atrial septal defect in this case involves the ostium primum. Sinus venosus defects are typically located superiorly connecting the left atrium and the junction of the superior vena cava and right atrium. Less commonly, the atrial septal defect can occur at the junction of the right atrium and the inferior vena cava.

C: Incorrect. The atrial septal defect in this case involves the ostium primum. The ostium secundum atrial septal defect is located at the level of the foramen ovale.

D: Correct. Endocardial cushion defects (ECD) are characterized by interruptions in the normal development of the endocardial cushion, which is comprised of the upper portion of the ventricular septum, the lower (ostium primum) portion of the atrial septum, and the atrioventricular valves. Affected patients will have ostium primum atrial septal defects with or without clefts/defects in the atrioventricular valves, and defects in the upper ventricular septum. As in this case, the atrial and ventricular septal defects may be large, with a common AV valve, resulting in the complete AV canal subtype of ECD.

Reference: Rajiah P, Kanne JP. Computed tomography of septal defects. *J Cardiovasc Comput Tomogr* 2010; 4:231-245.

3. What is denoted by the white arrows in these images from a contrast-enhanced CT?



- A. Pulmonary vein recess
- B. Pulmonary vein thrombus
- C. Pulmonary artery embolus
- D. Right hilar lymph node

Key: A

Rationale:

A: Correct. Recesses from the pericardial cavity can be seen in several locations. A recess that is reliably present, and may contain fluid, is seen at the junction of the inferior pulmonary veins and the left atrium. Fluid within these pulmonary vein recesses may be mistaken for hilar lymph nodes.

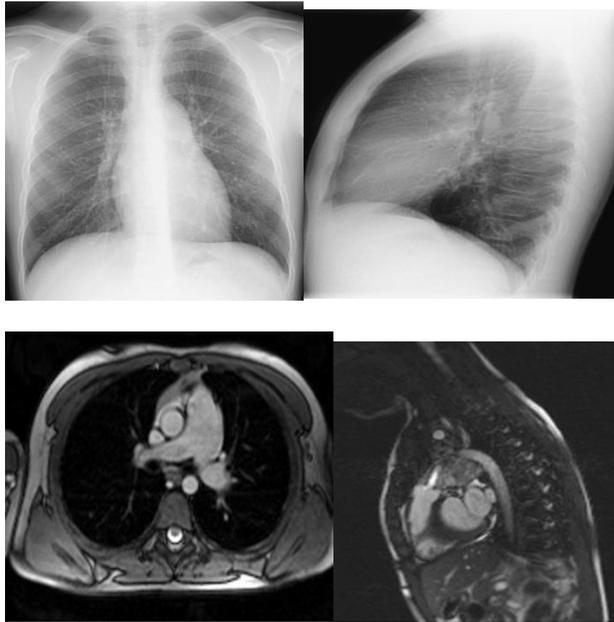
B: Incorrect. Pulmonary vein thrombus is rarely encountered, but can be seen as a complication of lung carcinoma, or may be iatrogenic from mediastinal surgery or pulmonary vein ablation. The characteristic location and fluid density of the above finding is not consistent with thrombus.

C: Incorrect. The structures in question are in association with the pulmonary vein, not the pulmonary artery.

D: Incorrect. While normal lymph nodes may be seen at the hila, the fluid-density structure is in the classic location for a pulmonic vein recess.

Reference: Truong MT, Erasmus JJ, Gladish GW, et al. Anatomy of pericardial recesses on multidetector CT: implications for oncologic imaging. *Am J Roentgenol* 2003; 181:1109-1113.

4. Based upon the findings on this PA and lateral chest radiographs and steady-state free precession MR images of a 10-year-old girl are provided, what is the MOST likely diagnosis?



- A. Ehlers-Danlos syndrome
- B. Kawasaki syndrome
- C. Pulmonary valve stenosis
- D. Bicuspid aortic valve

Key: C

Rationale:

A: Incorrect. Ehlers-Danlos syndrome may be accompanied by dilation of the great vessels, but this typically affects the aorta. Valvular (usually aortic and mitral) regurgitation is also frequent. However, the provided images show a high-velocity jet extending into the pulmonary artery, indicating pulmonary valve stenosis.

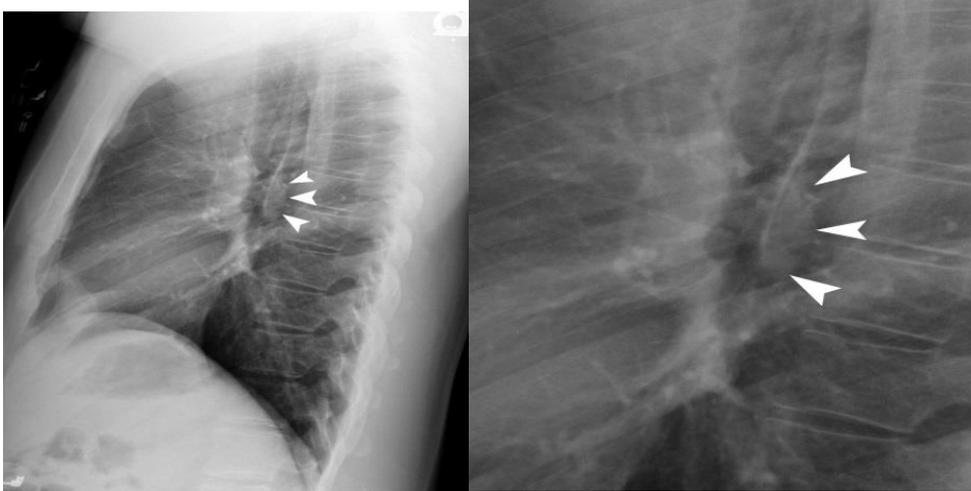
B: Incorrect. The cardiovascular manifestations of Kawasaki syndrome included coronary artery aneurysms. The pulmonary artery is not affected.

C: Correct. Pulmonary valve stenosis is typically congenital in origin, and is usually characterized by dome-shaped valve leaflets which are partially fused, and extend in a windsock-like fashion into the proximal pulmonary artery. Acquired pulmonary valve stenosis is quite rare, but can be seen as a sequela of rheumatic heart disease or metastatic carcinoid syndrome. Pulmonary valve stenosis is frequently accompanied by aneurysmal dilation of the main pulmonary artery, and often the left pulmonary artery, due to the direction of the high-velocity jet of flow through the stenotic valve. In this case, the stenotic jet is visible on the sagittal MR image obtained during systole.

D: Incorrect. Bicuspid aortic valve would not lead to a dilated pulmonary artery. In addition, there is a high-velocity jet extending into the proximal main pulmonary artery, indicating pulmonary valve stenosis.

Reference: Rajiah P, Nazarian J, Vogelius E, Gilkeson RC. CT and MRI of pulmonary valvular abnormalities. Clin Radiol 2014; 69:630-638.

5. What normal structure is denoted by the white arrowheads?



- A. Left pulmonary artery
- B. Right pulmonary artery
- C. Azygos vein
- D. Left atrial appendage

Key: A

Rationale:

A: Correct. The ovoid density marked on the images represents the left pulmonary artery. On the lateral chest radiograph, the left pulmonary artery is located just posterior to the ovoid lucency of the confluence of the left and right upper lobe bronchi.

B: Incorrect. The ovoid density anterior to the bronchi is the right pulmonary artery.

C: Incorrect. The azygos vein is not commonly seen on the lateral chest radiograph, but may be seen as an ovoid density along the right lateral margin of the mediastinum, at the level of the lower right trachea, on the PA radiograph.

D: Incorrect. While the left atrium can be easily seen on the lateral chest radiograph, being located at the posterior and superior margin of the cardiac silhouette, the left atrial appendage is generally superimposed upon the cardiac silhouette, and is not commonly seen in the lateral projection.

Reference: McComb BL. The chest in profile. *J Thorac Imag* 2002; 17:58-69.

6. Coronary artery aneurysms are associated with which of the following?

- A. Kawasaki disease
- B. Giant cell arteritis
- C. Sjögren syndrome
- D. Hypertension

Key: A

Rationale:

A: Correct. Kawasaki disease (mucocutaneous lymph node syndrome) results in panarteritis and can result in coronary artery aneurysm or ectasia, premature atherosclerosis as well as stenosis. It is the most common cause of coronary artery aneurysms in childhood. Approximately one half of coronary artery aneurysms caused by Kawasaki disease will regress spontaneously.

B: Incorrect. Although other inflammatory diseases such as Takayasu arteritis and Behcet syndrome may result in coronary artery aneurysms, there is no association between giant cell arteritis and coronary artery aneurysms.

C: Incorrect. Although other inflammatory diseases such as Takayasu arteritis and Behcet syndrome may result in coronary artery aneurysms, there is no association between Sjögren syndrome and coronary artery aneurysms.

D: Incorrect. Although atherosclerosis can result in coronary artery aneurysms, there is no known association between hypertension and coronary artery aneurysms.

Reference: Johnson PT, Fishman EK. CT angiography of coronary artery aneurysms: detection, definition, causes and treatment. *Am J Roentgenol* 2010; 195:928-934.

7. What is a potential life threatening complication of congenital absence of the pericardium?
- A. Herniation and strangulation of the heart
 - B. Acute pulmonary embolism
 - C. Pericardial effusion
 - D. Thrombosis of the superior vena cava

Key: A

Rationale:

A: Correct. Although uncommon, herniation of cardiac structures with resultant strangulation of the heart through a pericardial defect can be fatal.

B: Incorrect. The presence of congenital absence of the pericardium is not associated with life threatening acute pulmonary embolism.

C: Incorrect. In the case of congenital pericardial defect, there is communication between the pericardial space and the adjacent pleural space. Therefore, there is continuity between the pericardial space and the pleural space, preventing accumulation of pericardial fluid.

D: Incorrect. Thrombosis of the superior vena cava (SVC) is not an expected complication of congenital pericardial defect. When it occurs, thrombosis of the SVC is usually not life threatening.

Reference: Rajiah P, Kanne JP. Computed tomography of the pericardium and pericardial disease. J Cardiovasc Comput Tomogr 2010; 4:3-18.

8. What is the most common form of congenital pericardial absence?

- A. Partial right sided
- B. Complete right sided
- C. Partial left sided
- D. Complete left sided

Key: D

Rationale:

A: Incorrect. Cases of complete bilateral absence, partial left absence and right pericardial absence are uncommon. Complete left pericardial absence is the most common defect.

B: Incorrect. Cases of complete bilateral absence, partial left absence and right pericardial absence are uncommon. Complete left pericardial absence is the most common defect.

C: Incorrect. Cases of complete bilateral absence, partial left absence and right pericardial absence are uncommon. Complete left pericardial absence is the most common defect.

D: Correct. Cases of complete bilateral absence, partial left absence and right pericardial absence are uncommon. Complete left pericardial absence is the most common defect.

Reference: Khandaker MH, Espinosa RE, Nishimura RA, et al. Pericardial disease: diagnosis and management. Mayo Clin Proc 2010; 85:572-593.

9. What is the MOST common cause of constrictive pericarditis in the United States?

- A. Tuberculosis
- B. Uremia
- C. Idiopathic
- D. Prior cardiac surgery

Key: C

Rationale:

A: Incorrect. Tuberculosis is the most common cause of constrictive pericarditis worldwide, but is not a common culprit of this condition in the United States.

B: Incorrect. Uremia can be a cause of constrictive pericarditis but it is not the most common cause worldwide or in the United States.

C: Correct. In the United States, most cases of constrictive pericarditis are idiopathic as no specific cause is identified. Many cases which are classified as idiopathic are also likely post-viral in nature but occur after the initial illness has abated, making specific diagnosis difficult.

D: Incorrect. Prior cardiac surgery may result in constrictive pericarditis, but it is not the most common etiology in the United States.

Reference: Schwefer M, Aschenbach R, Heidemann J, et al. Constrictive pericarditis, still a diagnostic challenge: comprehensive review of clinical management. *Eur J Cardiothorac Surg* 2009; 36:502-510.

10. Regarding the anomalous course of coronary arteries, which of the following types carries a risk for sudden cardiac death?

- A. Interarterial
- B. Retroaortic
- C. Prepulmonic
- D. Subpulmonic

Key: A

Rationale:

A: Correct. When the course of the coronary artery is between the aorta and pulmonary artery (interarterial) there is a high risk for sudden cardiac death. Theories as to the cause include compression of the artery between the aorta and pulmonary artery, which dilate during exercise, and a slit-like coronary ostium. Other anomalous courses do not carry this risk.

B: Incorrect. A retroaortic course of an anomalous coronary artery is not associated with sudden cardiac death.

C: Incorrect. A prepulmonic course of an anomalous coronary artery is not associated with sudden cardiac death.

D: Incorrect. A subpulmonic course of an anomalous coronary artery is not associated with sudden cardiac death.

Reference: Kim SY, Seo JB, Do KH, et al. Coronary artery anomalies: classification and ECG-gated multidetector row CT findings with angiographic correlation. *RadioGraphics* 2006; 26:317-334.

**Chest Radiology
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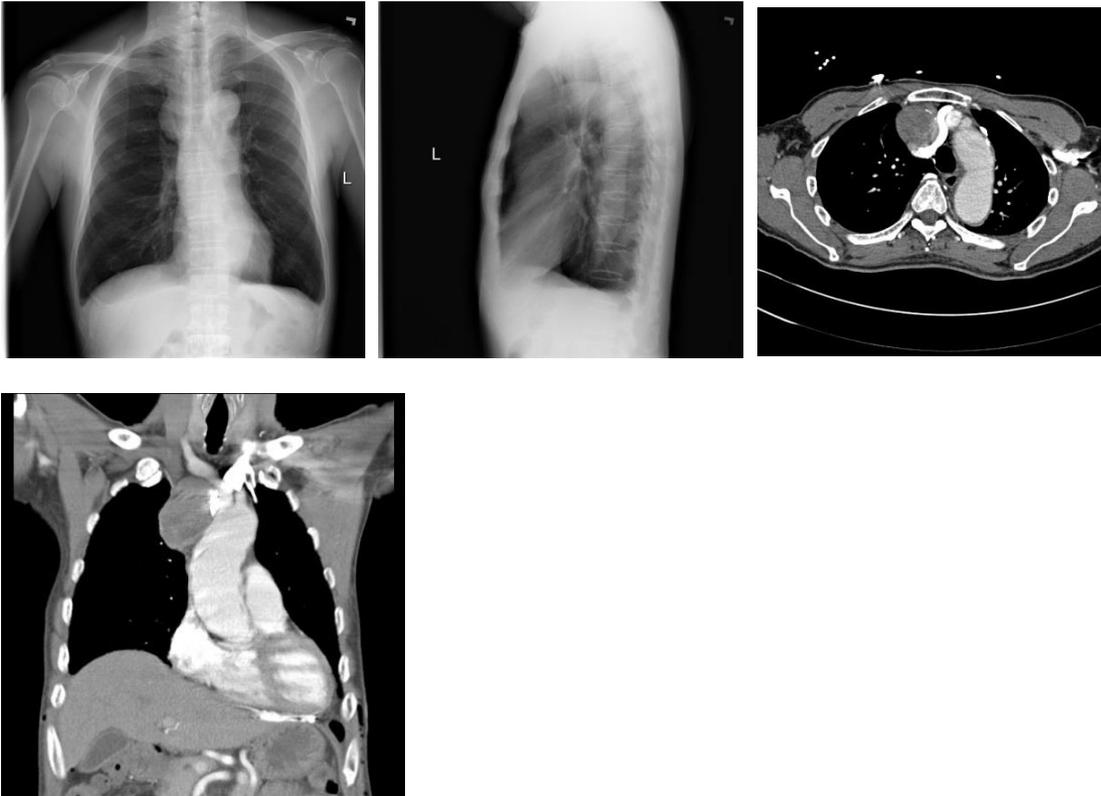
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1. You are shown chest radiographs and a CT scan of a 55-year-old asymptomatic man. What is the most likely diagnosis?



- A. Goiter
- B. SVC Thrombosis
- C. Aortic pseudoaneurysm
- D. Thymoma

Key: D

Rationale:

A: Incorrect. The lesion is present in the anterior mediastinum and images do not demonstrate continuity of the lesion with the thyroid gland.

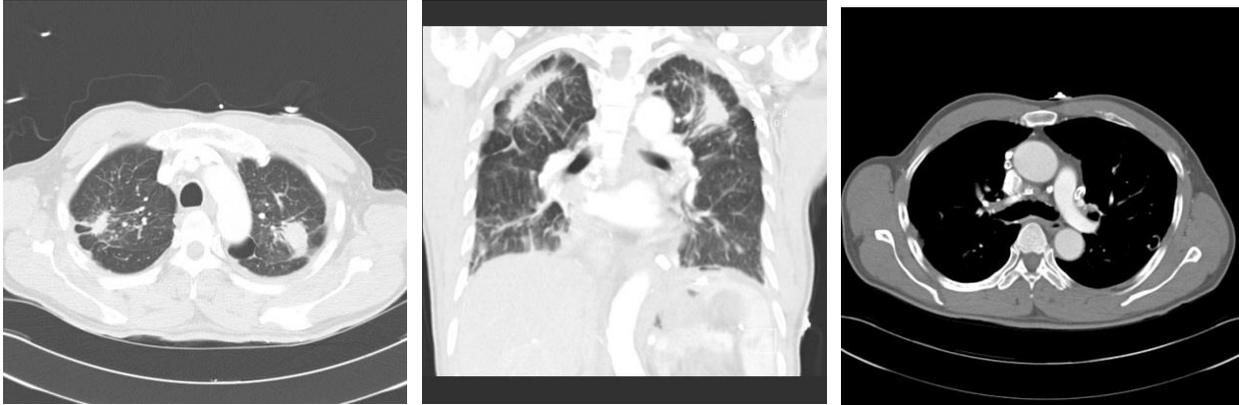
B: Incorrect. The lesion is above the level of the SVC and displaces the brachiocephalic venous confluence posteriorly. In addition, images do not show any collaterals and or the SVC being obstructed.

C: Incorrect. The aorta has a normal contour and the images do not show any focal out-pouching arising from the aorta.

D: Correct. The mass is situated in the anterior mediastinum. Given the patient's age, asymptomatic history and location of the lesion, the most likely diagnosis is thymoma.

Reference: CT evaluation of the anterior mediastinum: spectrum of disease. P M Tecce, E K Fishman, J E Kuhlman. Radiographics. Sept 1994, Vol 14:973-990.

2. You are shown CT images of a 66-year-old man with a history of gastric cancer. What is the MOST likely diagnosis?



- A. Metastatic disease
- B. Eosinophilic pneumonia
- C. Pneumoconiosis
- D. Synchronous lung cancers

Key: C

Rationale:

A: Incorrect. Patient has a history of gastric cancer. However symmetric appearance of masses in the upper lobes with architectural distortion would be unusual for metastasis. Metastatic disease usually occurs more commonly in the lower lobes and in the peripheral aspect.

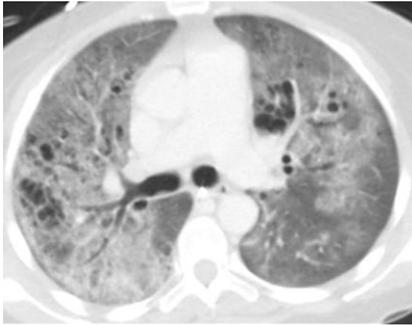
B: Incorrect. Eosinophilic pneumonia occurs within the upper lobes but is usually present in the peripheral aspect which is not present in the provided images.

C: Correct. Pneumoconiosis occurs as a result of combined exposure to coal and silica. Opacities in the upper lobes in symmetric fashion is highly suggestive of pneumoconiosis. The opacities may eventually coalesce at which time they are called progressive massive fibrosis. Diagnosis often confirmed with exposure/occupational history.

D: Incorrect. It is very unusual for synchronous tumors to be symmetric in appearance.

Reference: Pneumoconiosis: Comparison of Imaging and Pathologic Findings Semin Chong, Kyung Soo Lee, Myung Jin Chung, Joungho Han, O Jung Kwon, Tae Sung Kim Radiographics. Jan 2006, Vol. 26: 59-77, 10.

3. You are shown a CT image of a 40-year-old man with dyspnea. What is the MOST likely diagnosis?



- A. Sarcoidosis
- B. Alveolar proteinosis
- C. Pneumocystis jirovecii pneumonia
- D. Pulmonary hemorrhage

Key: C

Rationale:

A: Incorrect. Alveolar sarcoidosis is the least common manifestation of sarcoid in the lungs (2% of all sarcoid presentation in the chest). On chest radiograph and CT, it appears as several large airspace “masses” frequently with air bronchograms. Alveolar sarcoid occurs when granulomas become confluent and compress airspaces.

B: Incorrect. Diagnosis of pulmonary alveolar proteinosis (PAP) can be inconclusive on initial plain chest radiographs. Imaging manifestations can be variable and include: bat wing pulmonary opacities as well as bilateral central symmetrical lung opacities with relative apical and costophrenic angle sparing. On CT, there is smooth thickening of interlobular septal lines, and ground glass attenuation.

C: Correct. Although up to 90% of chest radiographs in patients with pneumocystis jirovecii pneumonia (PJP) are abnormal, appearances are often non-specific. High resolution computed tomography (HRCT) is more sensitive. Look for ground-glass attenuation predominantly involving perihilar or mid lungs (there may be a mid, upper or lower zone predilection depending on whether the patient is on prophylactic aerosolised medication. If so, the poorly ventilated upper zones are prone to infection, whereas in those who are not the lower zones are more frequently involved). Additionally, reticular densities or septal thickening may also be present. As such, a 'crazy paving pattern' may therefore be seen when both ground-glass opacities and septal thickening are superimposed on one another. Finally, pneumatoceles are seen in up to 30% of PJP cases. The above findings are present in provided image.

D: Incorrect. Chest radiograph findings in patients with pulmonary hemorrhage are non-specific there may be evidence of bilateral air-space consolidation with relative apical sparing. CT may show areas of widespread ground glass opacification, + / - crazy paving pattern, + / - areas of consolidation. However, pneumatoceles are not present in pulmonary hemorrhage and thus this choice is incorrect.

Reference: Pulmonary cysts associated with Pneumocystis carinii pneumonia in patients with AIDS. J S Sandhu, P C Goodman Radiographics. Oct 1989, Vol. 173: 33-35.

4. You are shown a CT image from a 35-year-old man presenting with the new onset of chest pain. What is the MOST likely diagnosis?



- A. Tuberculosis
- B. Langerhans' cell histiocytosis
- C. Septic Emboli
- D. Sarcoidosis

Key: C

Rationale:

A: Incorrect. Tuberculosis typically presents in the upper lobes as an alveolar consolidation. Cavitation is rare. Lobar pneumonia is almost always associated with lymphadenopathy.

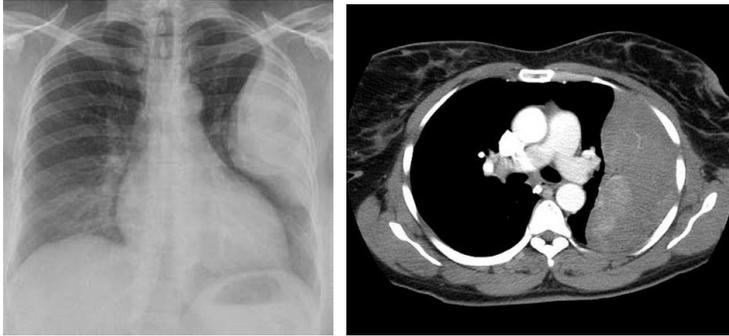
B: Incorrect. Early in Langerhans' cell histiocytosis, the most common imaging manifestation is that of small upper lobe predominant nodules, which typically range from 1 to 10 mm in diameter and are usually bilateral and symmetric in distribution. As the disease progresses, reticulonodular abnormalities may predominate. Advanced disease may result in a predominance of cystic changes.

C: Correct. Typical patients with septic emboli include IV drug abusers, those with history of tricuspid valve endocarditis and those with long-standing indwelling catheters. On imaging, multiple round or wedge-shaped opacities and cavitation (frequent finding and usually thin-walled) are present.

D: Incorrect. Parenchymal sarcoidosis typically presents with a reticulonodular or acinar pattern. Commonly, the nodules are larger (up to 10 mm in size), representing the coalescence of numerous interstitial granulomas. In these cases, air bronchograms may be present.

Reference: Pulmonary septic emboli: diagnosis with CT. J E Kuhlman, E K Fishman, C Teigen. Radiology. Jan 1990, Vol. 174: 211-213.

5. You are shown chest radiograph and axial CT image of a 50-year-old woman with long-standing hypoglycemia. What is the MOST likely diagnosis?



- A. Solitary fibrous tumor
- B. Malignant mesothelioma
- C. Loculated pleural effusion
- D. Pleural metastasis

Key: A

Rationale:

A: Correct. Fibrous tumors of the pleura are rare, mesenchymal primary tumors of the visceral pleura that are less common than diffuse malignant mesothelioma. The localized form is less common and not related to asbestos exposure or smoking. Doege–Potter syndrome (DPS) is a paraneoplastic syndrome in which hypoglycemia is associated with the presence of one or more non-islet fibrous tumors in the pleural cavity.

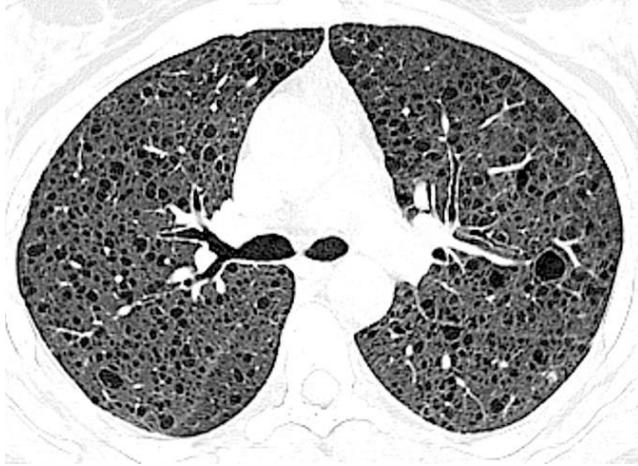
B: Incorrect. Mesothelioma is the most common primary neoplasm of pleura. Its latency period can range anywhere from 20-45 years following occupational exposure to asbestos. On imaging, look for multiple tumor masses involving predominantly the parietal pleura and to a lesser degree the visceral pleura. The disease progresses to thick sheetlike / confluent masses resulting in lung encasement.

C: Incorrect. Loculated pleural effusion (also called empyema) is an inflammatory fluid collection in the pleural space. It occurs most frequently with bacterial pneumonia. Radiographs may show a loculated pleural effusion which does not move freely in decubitus positioning. On CT, look for pleural fluid (with or without underlying or associated parenchymal consolidation), loculation and thickening of the pleura. Split pleura sign can also be seen on contrast enhanced CT, showing enhancing visceral and parietal pleura with interposed fluid.

D: Incorrect. In the setting of pleural metastasis, chest radiographs are insensitive. In cases where multiple nodular regions or pleural thickening are present, the diagnosis may be evident, especially if the primary tumor or other metastatic deposits are visible. On CT, look for circumferential or nodular pleural thickening, parietal pleural thickening greater than 1 cm or mediastinal pleural involvement.

Reference: Unusual Primary Lung Tumors: A Radiologic-Pathologic Overview. Ana Giménez, Tomás Franquet, Rosa Prats, Pilar Estrada, Jordi Villalba, Silvia Bagué. Radiographics. May 2002, Vol. 22: 601-619.

6. You are shown a CT image of a 37-year-old woman. What is the MOST likely diagnosis?



- A. Lymphocytic interstitial pneumonitis
- B. Idiopathic pulmonary fibrosis
- C. Langerhans' cell histiocytosis
- D. Lymphangiomyomatosis

Key: D

Rationale:

A: Incorrect. On CT, lymphocytic interstitial pneumonitis (LIP) can be seen with diffuse mediastinal lymphadenopathy, ground-glass change, scattered thin walled cysts: usually deep within the lung parenchyma and range from 1 - 30 mm (useful for differentiation between lymphoma or the lung).

B: Incorrect. UIP should be considered in patients who present with low lung volumes, subpleural reticular opacities, macrocystic honeycombing, and traction bronchiectasis, the extent of which increases from the apex to the bases of the lungs.

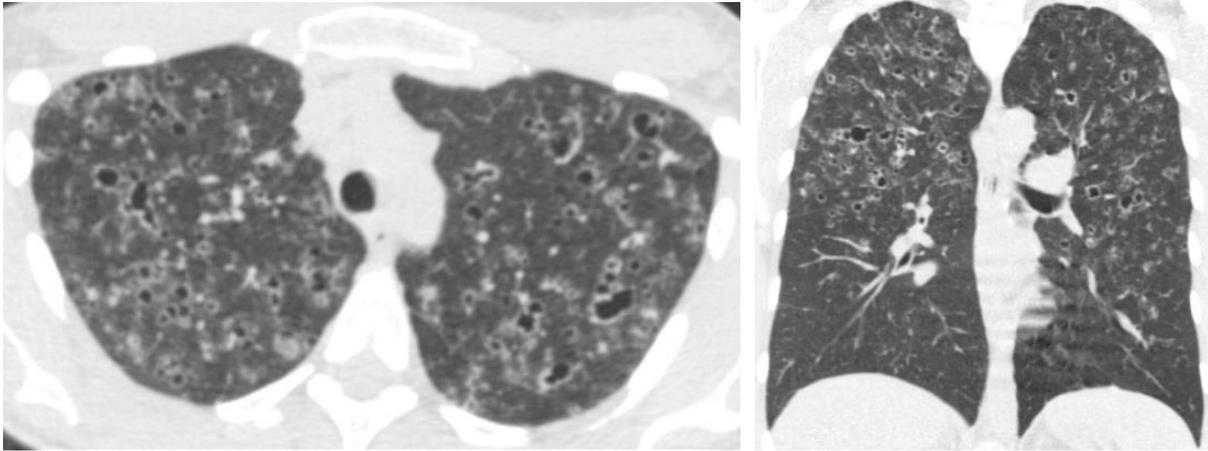
C: Incorrect. Common features of patients with LCH include age peak between 20-40 years. On imaging, irregular shaped cysts and multiple small nodules with a predilection for apices are noted. LCH patients can present with recurrent pneumothoraces (25%). Rib lesions with fractures are common in adolescent and young adult patients.

D: Correct. Lymphangioleiomyomatosis (LAM) is a rare interstitial lung disease that affects women exclusively, typically during their reproductive years. On radiographs, LAM manifests with normal-to-large lung volumes and interstitial reticular opacities. CT demonstrate bilateral diffuse thin-walled cysts and may also demonstrate associated pleural effusion or pneumothorax.

Reference: Lymphangioleiomyomatosis: Radiologic-Pathologic Correlation

Gerald F. Abbott, Melissa L. Rosado-de-Christenson, Aletta Ann Frazier, Teri J. Franks, Robert D. Pugatch, Jeffrey R. Galvin Radiographics. May 2005, Vol. 25: 803-828.

7. You are shown CT images of a 33-year-old with progressive shortness of breath. What is the MOST likely diagnosis?



- A. Centrilobular emphysema
- B. Idiopathic pulmonary fibrosis
- C. Langerhans cell histiocytosis
- D. Lymphocytic interstitial pneumonitis

Key: C

Rationale:

A: Incorrect. CT is currently the modality of choice for detecting emphysema. It is able to discriminate between centrilobular, panlobular, and paraseptal emphysema. Centri-lobular is by far the most common type encountered, and is a common finding in asymptomatic elderly patients. It is predominantly located in the upper zones of each lobe.

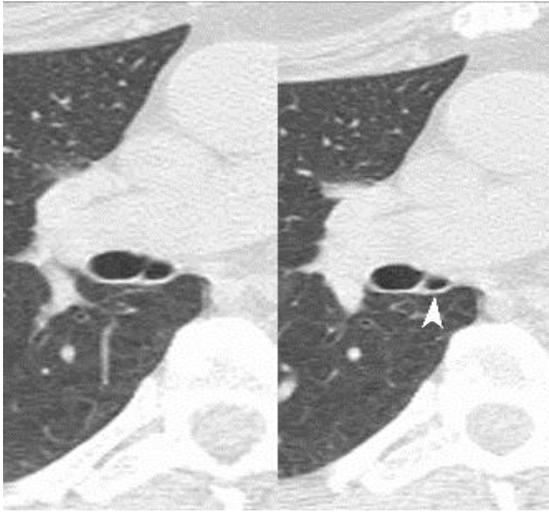
B: Incorrect. IPF should be considered in patients who present with low lung volumes, subpleural reticular opacities, macrocystic honeycombing, and traction bronchiectasis, the extent of which increases from the apex to the bases of the lungs.

C: Correct. Common features of patients with LCH include age peak between 20-40 years. On imaging, irregular shaped cysts and multiple small nodules with a predilection for apices are present. LCH patients can present with recurrent pneumothoraces (25%). Rib lesions with fractures are common in adolescent and young adult patients.

D: Incorrect. On CT, lymphocytic interstitial pneumonitis (LIP) can be seen with diffuse mediastinal lymphadenopathy, ground-glass change, scattered thin walled cysts: usually deep within the lung parenchyma and range from 1 - 30 mm (useful for differentiation between lymphoma or the lung).

Reference: From the Archives of the AFIP: Pulmonary Langerhans Cell Histiocytosis Gerald F. Abbott, Melissa L. Rosado-de-Christenson, Teri J. Franks, Aletta Ann Frazier, Jeffrey R. Galvin. Radiographics. May 2004, Vol. 24: 821-841.

8. You are shown two CT images of a woman. Which one of the following options best characterizes the pertinent annotated finding (white arrowhead)?



- A. Bronchial diverticulum
- B. Lung cyst
- C. Tracheal bronchus
- D. Accessory cardiac bronchus

Key: D

Rationale:

A: Incorrect. Tracheobronchial diverticula are blind-ending airways that often arise from the main stem bronchi.

B: Incorrect. Tracheal air cysts are tracheal diverticula manifesting as air-filled thin-walled blind-ending structures at the thoracic inlet. These exhibit a normal mucosal lining and cartilage within their walls.

C: Incorrect. Tracheal bronchus is characterized by its anomalous origin from the lateral tracheal wall (usually within 2.0 cm from the carina) and typically supplies the right upper lobe. It is also known as “pig bronchus” or “bronchus suis” (the usual anatomic bronchial morphology in pigs and certain other mammals).

D: Correct. Composite CT image (lung window) shows an incidental accessory cardiac bronchus. Accessory cardiac bronchus is an anomalous bronchus that arises from the medial aspect of the right main stem or intermediate bronchus and courses caudally towards the heart and mediastinum (hence the “cardiac” designation). It is typically blind-ending but may be surrounded by normal or vestigial lung parenchyma. Affected patients are often asymptomatic, but hemoptysis and recurrent infection have been reported.

Reference: Accessory cardiac bronchus: CT features and clinical significance. G McGuinness, D P Naidich, S M Garay, A L Davis, A D Boyd, H H Mizrachi. Radiology. Nov 1993, Vol. 189: 563-566.

9. You are shown CT images of a young man involved in a high-speed motor vehicle collision. Which one of the following best describes the course and positioning of the left-sided thoracostomy tube?



- A. Well-positioned in the pleural space
- B. Intra-fissural placement
- C. Intra-mediastinal placement
- D. Intra-parenchymal placement

Key: C

Rationale:

A: Incorrect. The left-sided thoracostomy is not appropriately positioned in the pleural space but rather has been inadvertently placed in the mediastinal compartment.

B: Incorrect. Intrafissural deployment of thoracostomy tubes can be difficult to appreciate on routine chest x-rays. The specific relationship of the pleural drain relative to both standard and accessory fissures is more readily appreciated on MDCT with multi-planar reconstructions in sagittal, sagittal oblique, and coronal planes on lung window settings.

C: Correct. Selected contrast-enhanced chest CTA axial (Fig. 7A-D) and coronal (Fig. 7E-F) reformatted images (mediastinal windows) demonstrate a left-sided thoracostomy tube introduced over the 6th lateral rib, mid-axillary line that is malpositioned following an intramediastinal course with the distal tip lodged in the mediastinal fat between the main pulmonary artery and proximal descending thoracic aorta. Malpositioning of thoracostomy tubes occurs in 26-58% of placements under emergent conditions. Inadvertent anomalous placement of thoracostomy tubes may be the result of operator inexperience but more often is related to loss of normal palpable landmarks used to guide placement. The latter more often occurs with morbidly obese patients or deformity of the chest wall (e.g., crush injuries, flail chest, severe scoliosis, burns, etc.). Failure of pneumothorax to decompress following thoracostomy tube placement may be the result of such chest tube malpositioning and may serve as a clinical clue. MDCT with its multi-planar capabilities is an excellent modality for delineating thoracostomy tubes inadvertently positioned in aberrant locations (e.g., intrafissural, intramediastinal, extrathoracic chest wall soft tissues or subcutaneous, and subdiaphragmatic) that may go under appreciated on routine chest x-rays.

D: Incorrect. Intraparenchymal chest tube placements can be difficult to recognize clinically and radiographically. Radiographic clues to possible intraparenchymal thoracostomy tube placement include: sudden onset of extensive extra-alveolar air; hemorrhage or hematoma manifest as ground-glass opacity or consolidation surrounding the chest tube; abrupt or gradual increase in either parenchymal or pleural opacity following the thoracostomy tube placement. Again, MDCT and multiplanar reconstructions (lung windows) in sagittal, sagittal oblique, and coronal planes are more sensitive for delineating the aberrant course and lung penetration.

Reference: Medical Devices of the Chest. Tim B. Hunter, Mihra S. Taljanovic, Pei H. Tsau, William G. Berger, James R. Standen. Radiographics. Nov 2004, Vol. 24: 1725-1746.

10. You are shown a CT image of a 50-year-old man with a history of lung carcinoma. What is the MOST likely diagnosis?



- A. Lung cancer recurrence
- B. Radiation pneumonitis
- C. Pulmonary hemorrhage
- D. Pulmonary edema

Key: B

Rationale:

A: Incorrect. While adenocarcinoma in situ (BAC) can present with ground glass attenuation, it is not a common presentation for pulmonary metastasis.

B: Correct. Up to 8 weeks following radiation therapy, acute radiation pneumonitis can occur. On CT, there are ground glass opacities / consolidation, lucencies and volume loss in the region of the radiation port.

C: Incorrect. In the adult patient, pulmonary hemorrhage is commonly found in patients with history of recent chest trauma or vasculitis. It can also occur in patients with pulmonary edema.

D: Incorrect. Pulmonary edema typically occurs diffusely in both lungs and often will present with septal lines as well as pleural effusions.

Reference: Radiation-induced Lung Disease and the Impact of Radiation Methods on Imaging Features
Kyung Joo Park, Jin Young Chung, Mi Son Chun, Jung Ho Suh. Radiographics. Jan 2000, Vol. 20: 83-98.

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

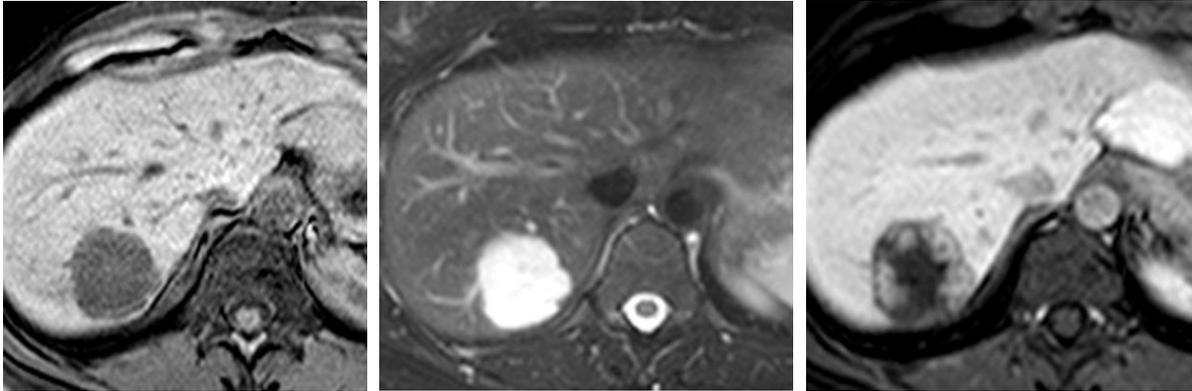


QUALITY IS OUR IMAGE

Released July 2017

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*Commission on Education
Committee on Residency Training in Diagnostic Radiology*

1. This 44-year-old woman is being evaluated for a focal liver lesion detected on an abdominal sonogram. Based on the provided pre- and post-contrast MRI images, what is the MOST likely diagnosis?



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

Key: B

Rationale:

A: Incorrect. As these are hepatocellular in origin, these are typically isointense to background liver on the unenhanced T1 weighted image.

B: Correct. enhancement pattern with marked T2 hyperintensity and peripheral nodular enhancement on post-contrast imaging

C: Incorrect. HCC typically demonstrates mild T2 hyperintensity.

D: Incorrect. Adenomas have a variable MR appearance, but may exhibit intravoxel fat and heterogeneous T2 hyperintensity.

Reference:

Fowler, K. J., J. J. Brown and V. R. Narra (2011). "Magnetic resonance imaging of focal liver lesions: approach to imaging diagnosis." *Hepatology* 54(6): 2227-2237.

2. Which of the following conditions is typically associated with gallbladder carcinoma?
- A. Choledochal cyst
 - B. Adenomyomatosis
 - C. Cholelithiasis
 - D. Recurrent pyogenic cholangitis

Key: C

Rationale:

A: Incorrect. Choledochal cysts are rare, and associated with ductal rather than GB carcinoma.

B: Incorrect. This is a benign hyperplastic cholecystosis with no malignant association.

C: Correct.

D: Incorrect. Recurrent pyogenic cholangitis is occasionally associated with ductal cholangiocarcinoma

Reference:

Elsayes, K. M., P. T. Staveteig, V. R. Narra, J. R. Leyendecker, J. S. Lewis, Jr. and J. J. Brown (2006). "MRI of the peritoneum: spectrum of abnormalities." *AJR Am J Roentgenol* 186(5): 1368-1379.

Katabathina, V. S., A. K. Dasyam, N. Dasyam and K. Hosseinzadeh (2014). "Adult bile duct strictures: role of MR imaging and MR cholangiopancreatography in characterization." *Radiographics* 34(3): 565-586.

3. Which of the following pancreatic neoplasms has the LOWEST malignant potential?
- A. Serous cystic neoplasm
 - B. Islet cell tumor
 - C. Mucinous neoplasm
 - D. Solid and papillary epithelial neoplasm

Key: A

Rationale:

A: Correct. The serous (or microcystic) neoplasm has NO malignant potential.

B: Incorrect. Islet cell neoplasms are often benign, but may be large and malignant, especially when non-functioning.

C: Incorrect. Mucinous pancreatic tumors, whether cystic or intraductal papillary, have a significant risk of malignancy.

D: Incorrect. This is a low grade malignant pancreatic neoplasm.

Reference:

Low, G., A. Panu, N. Millo and E. Leen (2011). "Multimodality Imaging of Neoplastic and Nonneoplastic Solid Lesions of the Pancreas." *RadioGraphics* 31(4): 993-1015.

4. Where does the Killian-Jamieson diverticulum arise?
- A. The pyriform sinus
 - B. The nasopharynx
 - C. At Killian's dehiscence
 - D. The lateral pharyngo-esophageal junction

Key: D

Rationale:

A: Incorrect. They occur below the cricopharyngeal muscle.

B: Incorrect. They occur at the pharyngo-esophageal junction.

C: Incorrect. Zenker diverticula arise at this location.

D: Correct. Killian-Jamieson diverticula arise from the lateral esophagus, as opposed to Zenker diverticula which arise posteriorly.

Reference:

Tao, T. Y., C. O. Menias, T. E. Herman, W. H. McAlister and D. M. Balfe (2013). "Easier to Swallow: Pictorial Review of Structural Findings of the Pharynx at Barium Pharyngography." *RadioGraphics* 33(7): e189-e208.

5. What radiographic abnormality of the stomach is MOST common in cases of remote injury from caustic ingestion?
- A. Diffuse narrowing
 - B. Deep ulcers
 - C. Thickened folds
 - D. Large polypoid masses

Key: A

Rationale:

A: Correct. A diffusely narrowed stomach or linitis plastica is common after healing from prior caustic ingestion.

B: Incorrect. Deep ulcers are infrequently seen, even in the acute phase.

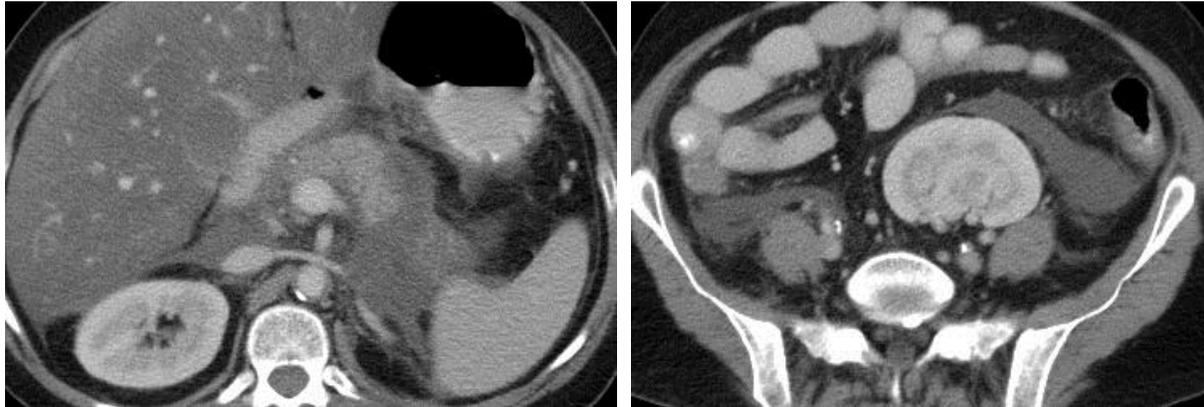
C: Incorrect. The radiographic finding most commonly seen months/years after ingestion is diffuse or segmental narrowing (linitis plastica).

D: Incorrect. Polypoid masses are not seen in either the acute or chronic stage of caustic injury.

Reference:

Nagi, B., R. Kochhar, B. R. Thapa and K. Singh (2004). "Radiological spectrum of late sequelae of corrosive injury to upper gastrointestinal tract. A pictorial review." *Acta Radiol* 45(1): 7-12.

6. This 45-year-old man presented with nausea, vomiting and abdominal pain two days after Thanksgiving. Based on the images, what is the most likely diagnosis?



- A. Acute cholecystitis
- B. Acute pancreatitis
- C. Pancreatic neuroendocrine tumor
- D. Autoimmune pancreatitis

Key: B

Rationale:

A: Incorrect. There is peripancreatic fluid. There are no findings of acute inflammatory change involving the gallbladder.

B: Correct. CT demonstrates peripancreatic fluid without a discrete wall characteristic of acute interstitial edematous pancreatitis.

C: Incorrect. No hypervascular pancreatic mass is seen.

D: Incorrect. The pancreas in autoimmune pancreatitis is usually diffusely enlarged and sausage shaped. While there is loss of normal pancreatic lobulations in autoimmune pancreatitis, there is typically not diffuse peripancreatic edema (as seen in this case).

References:

Vlachou, P. A., K. Khalili, H. J. Jang, S. Fischer, G. M. Hirschfield and T. K. Kim (2011). "IgG4-related sclerosing disease: autoimmune pancreatitis and extrapancreatic manifestations." *Radiographics* 31(5): 1379-1402.

Foster, B. R., K. K. Jensen, G. Bakis, A. M. Shaaban and F. V. Coakley (2016). "Revised Atlanta Classification for Acute Pancreatitis: A Pictorial Essay." *Radiographics* 36(3): 675-687.

7. A 65-year-old man presented with abdominal pain. What is the correct diagnosis based on this contrast enhanced CT scan?



- A. Intussusception
- B. Lipoma
- C. Volvulus
- D. Colitis

Key: A

Rationale:

A: Correct. A soft tissue mass can be seen acting as the lead point in this case of colo-colic intussusception.

B: Incorrect. Although there is a lead point mass, it demonstrates soft tissue attenuation consistent with pathologically proven adenocarcinoma.

C: Incorrect. There is no mesenteric twist.

D: Incorrect. Although there is wall thickening, there is no pericolic inflammation and a colitis does not account for the findings of the intussusception.

Reference:

Kim, Y. H., M. A. Blake, M. G. Harisinghani, K. Archer-Arroyo, P. F. Hahn, M. B. Pitman and P. R. Mueller (2006). "Adult intestinal intussusception: CT appearances and identification of a causative lead point." *Radiographics* 26(3): 733-744.

8. What is the MOST common type of biliary cancer?

- A. Intrahepatic cholangiocarcinoma
- B. Extrahepatic cholangiocarcinoma
- C. Ampullary carcinoma
- D. Gallbladder carcinoma

Key: D

Rationale:

A: Incorrect.

B: Incorrect

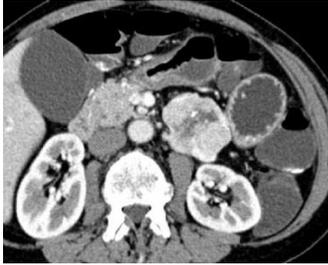
C: Incorrect.

D: Correct. Gallbladder carcinoma accounts for 80-95% of biliary tract malignancies.

Reference:

Hundal, R. and E. A. Shaffer (2014). "Gallbladder cancer: epidemiology and outcome." *Clinical Epidemiology* 6: 99-109.

9. A 46-year-old man presented with a six month history of abdominal pain. Based on this image from the arterial phase of a dual phase CT scan of the abdomen, which of the following diagnoses is MOST likely?



- A. Pancreatic adenocarcinoma
- B. Pancreatic islet cell tumor
- C. Serous cystadenoma
- D. Mucinous cystic neoplasm

Key: B

Rationale:

A: Incorrect. Pancreatic adenocarcinomas are hypovascular. Although they can be mildly heterogeneous, they usually do not have areas of frank necrosis. Central dystrophic calcification within a pancreatic adenocarcinoma would be distinctly unusual, as would be components of hypervascular enhancement.

B: Correct. Islet cell tumors of the pancreas are often hypervascular, especially during the arterial phase of contrast enhancement. It is common for larger islet cell tumors to undergo central necrosis, and to have coarse central dystrophic calcification. The imaging features in this case are most consistent with an islet cell tumor. The lesion showed uptake at octreotide scan (not shown), and was subsequently proven to be a VIPoma.

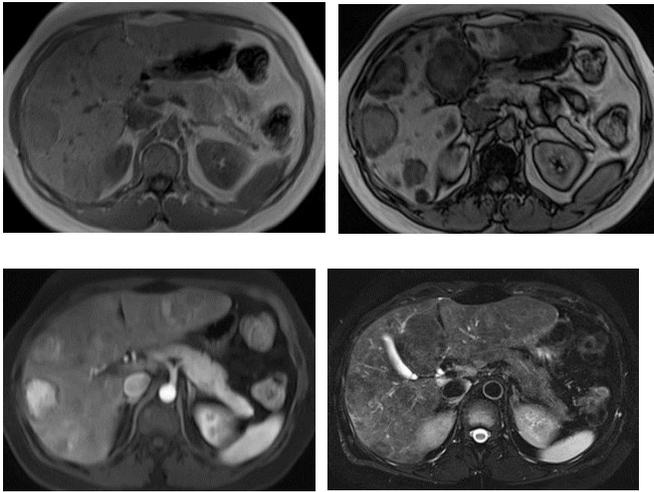
C: Incorrect. Serous cystadenomas are microcystic tumors with locules < 2 cm in diameter. As a result, they tend to have a somewhat homogeneous honeycomb appearance. Although some serous cystadenomas have enhancing stellate scars with dystrophic calcification, the irregular heterogeneity as demonstrated in this case of islet cell neoplasm would be unusual. They are also far more common in elderly women.

D: Incorrect. Mucinous cystic neoplasms (MCNs) are usually multicystic masses with fluid-filled locules > 2 cm. Their cystic composition dominates their imaging appearance. Benign MCNs can have a few faintly enhancing septae. Malignant MCNs can have thicker enhancing septae and soft tissue nodules. However, even a malignant MCN would not likely present as a solid, centrally necrotic mass. When mucinous cystic neoplasms calcify, it is usually peripheral.

Reference:

Low, G., A. Panu, N. Millo and E. Leen (2011). "Multimodality Imaging of Neoplastic and Nonneoplastic Solid Lesions of the Pancreas." *RadioGraphics* 31(4): 993-1015.

10. Based upon these images from an MRI performed on a 30-year-old female with abdominal pain and mildly elevated liver enzymes, who is otherwise in good health, without significant medical history and with normal alpha-fetoprotein levels, what is the MOST likely diagnosis?



- A. Metastatic carcinoid tumor
- B. Multifocal hepatocellular carcinoma
- C. Hepatic adenomatosis
- D. Metastatic colorectal cancer

Key: C

Rationale:

A: Incorrect. Hepatic metastases from a carcinoid primary can be hypervascular but are typically hyperintense on T2WI. Also they do not contain intracellular lipid and therefore do not typically lose signal on out-of-phase T1WI.

B: Incorrect. Although well differentiated HCC can lose signal on out-of-phase T1WI because of intra-hepatocyte lipid and certainly has imaging features that overlap with adenomas, the age of the patient, the overall health of the patient, the absence of chronic liver disease and the normal alpha-fetoprotein all argue against multifocal HCC. Fibrolamellar HCC is a consideration in this patient but is typically a solitary, large mass - not multifocal like this case. Also, multifocal HCC would typically be T2 hyperintense.

C: Correct. Typical patient demographic. More than 10 adenomas (w/o other risk factors for adenoma formation or glycogen storage disease) makes the diagnosis. Signal loss on out-of-phase T1WI is common in adenomas as is the heterogenous hypervascularity. Patients are often asymptomatic unless there is acute hemorrhage of one of the adenomas.

D: Incorrect. Although a common cause of multifocal liver masses, the hypervascularity, intracellular lipid content and T2 isointensity of the lesions in this case would all be very atypical for colorectal metastases.

Reference:

Anderson, S. W., J. B. Kruskal and R. A. Kane (2009). "Benign Hepatic Tumors and Iatrogenic Pseudotumors." *RadioGraphics* 29(1): 211-229.

**General Competency Radiology
In-Training Test Questions
for Diagnostic Radiology Residents**



QUALITY IS OUR IMAGE

Released July 2017

Sponsored by:
*Commission on Education
Committee on Residency Training in Diagnostic Radiology*

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1. A 26-year-old man with lumbar spine surgery 2 years ago presents with new low back pain and L5 radiculopathy. The MOST appropriate initial imaging examination is:
 - A. lumbar spine MRI scan without contrast material.
 - B. lumbar spine MRI scan without and with contrast material.
 - C. myelography and post-myelography CT scan of the lumbar spine.
 - D. radiographs of the lumbar spine.

Key: B

Rationale:

A: Incorrect. Lumbar spine MRI without contrast material received an appropriateness rating of 6 from the ACR Appropriateness Criteria for this indication (see below).

B: Correct. Within the context of the ACR Appropriateness Criteria (Registered Trademark), this scenario would fall under the category of Variant 5: "Prior lumbar surgery (Low Back Pain)." Lumbar spine MRI scan without and with contrast material (B) received a rating of 8 (9=most appropriate). Please see the "ACR Appropriateness Criteria (Registered Trademark): Low Back Pain" for additional discussion.

C: Incorrect. Myelography and post-myelography CT scan of the lumbar spine received an appropriateness rating of 5 from the ACR Appropriateness Criteria for this indication (see above).

D: Incorrect. Radiographs of the lumbar spine received an appropriateness rating of 5 from the ACR Appropriateness Criteria for this indication (see above).

2. Which of the following examinations involves the highest level of patient exposure to ionizing radiation?
- A. FDG-PET-CT scan of the head
 - B. Tc-99m HMPAO brain scan
 - C. Radiographic skull series
 - D. Head CT scan without and with contrast material

Key: A

Rationale:

A: Correct. The average radiation exposure from an FDG PET-CT study is approximately 14.1 mSv, which is higher than the dose from any of the other three procedures listed in the question.

B: Incorrect. The average radiation exposure a Tc-99m HMPAO brain study is approximately 6.9 mSv.

C: Incorrect. The average radiation exposure from radiographic skull series is approximately 0.1 mSv.

D: Incorrect. The average radiation exposure from a head CT study with and without contrast material is approximately 4 mSv.

Reference:

Mettler FA, Jr, et.al. Radiol 2008: 248:254-263.

3. In a patient with no history of malignancy and a sonographically discovered adrenal mass less than 3 cm in diameter, the MOST appropriate initial imaging test is:
- A. I-123 MIBG scan.
 - B. Abdominal angiography.
 - C. abdominal CT scan without contrast.
 - D. F-18 FDG PET-CT scan.

Key: C

Rationale:

A: Incorrect. Not the most appropriate initial examination (see below).

B: Incorrect. Not the most appropriate initial examination (see below).

C: Correct. In a patient with no history of malignancy and an incidentally discovered adrenal mass less than 3 cm in diameter, the most appropriate initial imaging test is an abdominal CT without contrast (if a non-contrast CT has not already been performed). An I-123 MIBG scan or an FDG-PET whole body are not indicated. MIBG scanning may be indicated if there is clinical suspicion of pheochromocytoma.

D: Incorrect. Not the most appropriate initial examination (see above).

4. According to the Accreditation Council of Graduate Medical Education (ACGME), working in inter-professional teams to enhance patient safety and improve patient care quality is a resident experience associated with which general competency?
- A. Systems-based Practice
 - B. Interpersonal and communication skills
 - C. Practice-based learning and improvement
 - D. Medical knowledge

Key: A

Rationale:

A: Correct. This is the correct competency for this experience. As stated in the ACGME Common Program Requirements for systems-based practice, residents must demonstrate the ability to work in inter-professional teams to enhance patient safety and improve patient care quality. Residents must also demonstrate an awareness of and responsiveness to the larger context and system of health care, as well as the ability to call effectively on other resources in the system to provide optimal health care.

B: Incorrect. Interpersonal and communication skills is not the correct competency for this experience. As stated in the ACGME Common Program Requirements for interpersonal and communication skills, residents must demonstrate interpersonal and communication skills that result in the effective exchange of information and collaboration with patients, their families, and health professionals.

C: Incorrect. Practice-based learning and improvement is not the correct competency for this experience. As stated in the ACGME Common Program Requirements for practice-based learning and improvement, residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence, and to continuously improve patient care based on constant self-evaluation and life-long learning.

D: Incorrect. Medical knowledge is not the correct competency for this experience. As stated in the ACGME Common Program Requirements for medical knowledge, residents must demonstrate knowledge of established and evolving biomedical, clinical, epidemiological and social behavioral sciences, as well as the application of this knowledge to patient care.

5. Which of the following BEST describes the duty of a radiologist who suspects a colleague is impaired due to alcohol use?
- A. Contact local law enforcement
 - B. Offer to counsel the impaired physician
 - C. Report the colleague to the hospital
 - D. Disregard the situation and see if it recurs

Key: C

Rationale:

A: Incorrect (see below).

B: Incorrect (see below).

C: Correct. "Physicians should report all instances of significantly impaired or incompetent colleagues to hospital, clinic, or other relevant authorities."

D: Incorrect (see above).

Reference:

American College of Radiology's (ACR) Code of Ethics.

6. When connected with information about a patient's health status, which of the following is **not** considered protected health information?
- A. Social security number
 - B. Address
 - C. Telephone number
 - D. Zip code

Key: D

Rationale:

A: Incorrect (see below).

B: Incorrect (see below).

C: Incorrect (see below).

D: Correct. The Privacy Rule of HIPAA establishes regulations for the use and disclosure of protected health information (PHI), which includes information about health status, health care, or payment for health care that can be linked to a specific person through name, medical record number, social security number, address, telephone number, and so on.

7. According to the American College of Radiology's (ACR) Code of Ethics, how should an ACR member handle a situation in which they identify that a colleague is acting illegally?
- A. Report it to the proper authorities.
 - B. Speak about it directly with the person involved.
 - C. Speak about it with the person's supervisor.
 - D. Tell other healthcare colleagues about their concerns.

Key: A

Rationale:

A: Correct. The American College of Radiology's (ACR) Code of Ethics includes 3 sections: "Principles of Ethics," "Rules of Ethics," and "Disciplinary Procedures for Violation of Rules of Ethics. (reference: <http://www.acr.org/~media/ACR/Documents/PDF/Membership/Governance/2009%20Code%20of%20Ethics.pdf> accessed 10/9/12)" In Section I, this scenario is addressed and the passage reads as follows: "The medical profession should safeguard the public and itself against physicians deficient in moral character or professional competence by reporting to the appropriate body, without hesitation, perceived illegal or unethical conduct of members of the medical profession. (reference: <http://www.acr.org/~media/ACR/Documents/PDF/Membership/Governance/2009%20Code%20of%20Ethics.pdf> accessed 10/9/12)" Thus, the correct answer is "A."

B: Incorrect. Speaking with the person directly about the problem may not offer the proper objectivity to address the situation properly.

C: Incorrect. Speaking with the person's supervisor about it may seem like a more appropriate choice than "B", but still is not optimal, in that the supervisor may have conflicting agendas and/or responsibilities.

D: Incorrect. Choice "D" seems inappropriate, not only because it may bring in previously-uninvolved parties, but also because it presumably has very little likelihood of appropriately rectifying the situation.

Reference:

[Http://www.acr.org/~media/ACR/Documents/PDF/Membership/Governance/2009%20Code%20of%20Ethics.pdf](http://www.acr.org/~media/ACR/Documents/PDF/Membership/Governance/2009%20Code%20of%20Ethics.pdf) accessed 10/9/12.

8. What is meant by the term “system-based practice”?
- A. Control of a medical facility by a larger parent institution
 - B. Use of specific local institutional guidelines for the conduct of medical practice
 - C. Awareness and use of the larger context of health care system resources
 - D. Adherence to specific governmental regulations concerning medical practice

Key: C

Rationale:

A: Incorrect (see below).

B: Incorrect (see below).

C: Correct. System-based practice refers to the awareness and responsiveness to the larger context and system of health care and associated system resources with which residents should become familiar with and responsive to in order to optimize patient care.

D: Incorrect (see above).

Reference:

<http://www.ucdenver.edu/academics/colleges/medicalschoo/education/graduatemedicaleducation/GMEDocuments/Documents/2.Internal%20Review%20and%20Accreditation/ACGME%20General%20Competencies.pdf>.

9. According to the “ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography (CT),” which images should be archived?
- A. Images illustrating normal findings only
 - B. Images illustrating abnormal findings only
 - C. Images illustrating normal and abnormal findings
 - D. No images need to be archived

Key: C

Rationale:

A: Incorrect. Both normal and abnormal images need to be archived (see below).

B: Incorrect. Both normal and abnormal images need to be archived (see below).

C: Correct. The ACR has several “practice guidelines” and “technical standards” (reference: <http://www.acr.org/Quality-Safety/Standards-Guidelines> accessed 10/15/12). The document “ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography (CT)” states: “Images of all appropriate areas, both normal and abnormal, should be recorded in a suitable archival format.”

D: Incorrect. Both normal and abnormal images need to be archived (see above).

Reference:

http://www.acr.org/~media/ACR/Documents/PGTS/guidelines/CT_Performing_Interpreting.pdf accessed 10/16/12.

10. According to ACGME, which of the following is a goal of the New Accreditation System Educational Milestones?

- A. Create a logical trajectory of professional development in essential elements of competency
- B. Address the inefficiencies and disparities in healthcare delivery
- C. Provide a framework for sustained support from CMS for graduate medical education
- D. Transfer the responsibility of providing quality and safety programs to the ACGME

Key: A

Rationale:

A. Correct. Educational milestones' aim is to create a logical trajectory of professional development in essential elements of competency and meet criteria for effective assessment, including feasibility, demonstration of beneficial effect on learning, and acceptability in the community.

B. Incorrect. This is not a part of the goals for the educational milestones.

C. Incorrect. This is not a part of the goals for the educational milestones.

D. Incorrect. This is not a part of the goals for the educational milestones. In fact, this concept is contrary to what has been asked of residency training programs.

Reference:

Nasca TJ, Philibert I, Brigham T, Flynn TC. The next GME accreditation system--rationale and benefits. N Engl J Med. 2012 Mar 15; 366(11):1051-6.

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



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1. An ultrasound was performed because the strings of an intrauterine device (IUD) were not found on physical examination. The endometrium is normal in thickness, but the IUD is not visualized. What is the next best step in the management of this patient?
 - A. Laparoscopic retrieval
 - B. Observation
 - C. Abdominal radiograph
 - D. Pelvic MRI

Key: C

Rationale:

A: Incorrect. In the absence of a visualized intrauterine IUD, the IUD could have been expelled or could have perforated the uterus. If an IUD is not visualized on an abdominal radiograph, then it has been expelled and no intervention would be necessary. Laparoscopic retrieval is only indicated if it has been documented that the IUD has perforated the uterus.

B: Incorrect. In the absence of an intrauterine IUD, the IUD could have been expelled or could have perforated the uterus. It is not appropriate to observe the patient if there is a possibility that the IUD has perforated the uterus and is in an intraabdominal location. Therefore, additional imaging, abdominal radiograph, is indicated.

C: Correct. Abdominal radiograph is required to diagnose expulsion of the IUD and can diagnose complete uterine perforation if the IUD is located above the pelvic brim.

D: Incorrect. While an IUD can be seen as a signal void on MRI, MRI is not routinely used to evaluate IUD's.

Reference:

HE Boortz et al. "Migration of Intrauterine Devices: Radiologic Findings and Implications," *Radiographics* 2012; 32:335-352.

2. Which of the following features differentiates a bicornuate uterus from a didelphys uterus?
- A. Widely splayed uterine horns
 - B. Partial fusion of the lower uterine segment
 - C. Two endometrial canals
 - D. Presence of a vaginal septum

Key: B

Rationale:

A: Incorrect. The uterine horns will be widely splayed in both didelphys and bicornuate uterus; therefore, this feature cannot be used to discriminate the two entities.

B: Correct. Partial fusion of the lower uterine segment is seen in the setting of bicornuate uterus whereas there is no fusion of the lower uterine segment in the setting of didelphys.

C: Incorrect. Both bicornuate and didelphys uterus will have two endometrial canals; therefore, this feature cannot be used to discriminate between the two entities.

D: Incorrect. The presence of a vaginal septum is not specific to any one of the mullerian duct anomalies; therefore, this feature cannot be used to discriminate between the two entities.

Reference:

SC Behr et al., "Imaging of Mullerian Duct Anomalies," Radiographics 2012; 32:E233-E250.

3. If the location the calculus is in question, what would you do before reimaging the pelvis?



- A. Administer intravenous contrast
- B. Drain the bladder
- C. Perform a cystogram
- D. Place the patient in the prone position

Key: D

Rationale:

A: Incorrect. Delayed post-contrast images can be used to help differentiate a ureteral calculus from a phlebolith since excreted contrast defines the course of the ureter. In this case, the calculus projects over the bladder resulting in a differential of a distal ureteral calculus or a passed stone.

B: Incorrect. Decompressing the bladder will not differentiate a ureteral stone from a passed stone.

C: Incorrect. A cystogram may obscure the stone and will not differentiate a ureteral stone from a passed stone.

D: Correct. Scanning the patient in the prone position can differentiate a passed stone from a calculus within the distal ureter at the level of the ureterovesicular junction.

Reference:

J Levine, et al. "The value of prone scanning to distinguish ureterovesical junction stones from ureteral stones that have passed into the bladder: leave no stone unturned," Am J Roentgenol 1999 Apr; 172(4):977-981.

4. The most appropriate next step in the management of this atraumatic patient is:



- A. therapeutic dose anticoagulation and hyperbaric therapy.
- B. immediate surgical consultation.
- C. intravenous antimicrobial therapy and observation.
- D. more frequent patient repositioning and wound checks.

Key: B

Rationale:

A: Incorrect. The findings do not demonstrate any stigmata of pelvic thrombophlebitis or obvious venous occlusion. Hyperbaric therapy is sometimes used in the treatment of Fournier's gangrene, but should not be the first line of direct treatment.

B: Correct. Fournier's gangrene is an aggressive process requiring immediate surgical intervention.

C: Incorrect. Fournier's gangrene requires immediate surgical intervention. Though antibiotics may provide some benefit, they are not the mainstay for treatment.

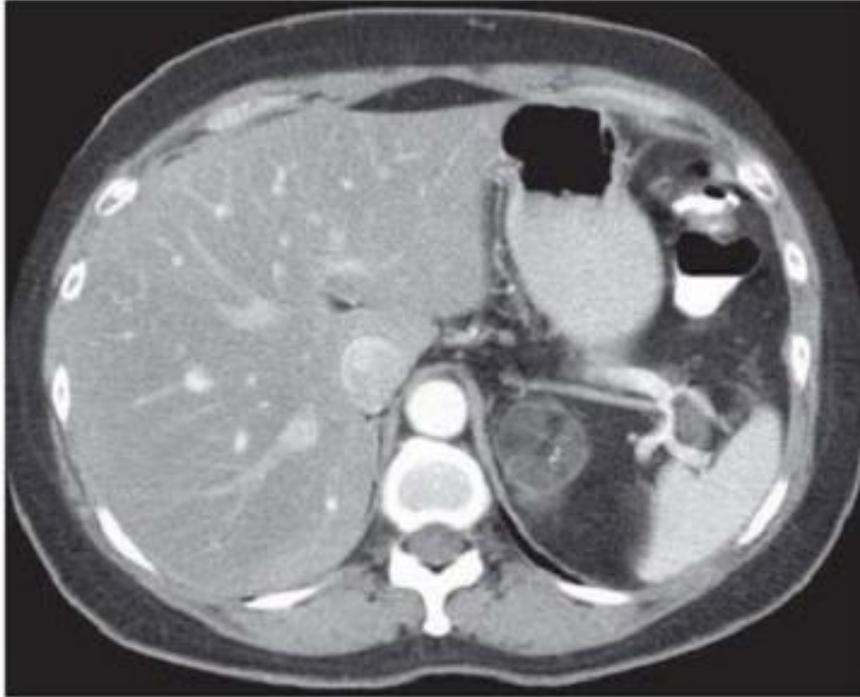
D: Incorrect. Again, Fournier's gangrene requires acute attention and is not treated conservatively. The image does not reflect decubitus ulcers.

References:

NR Dunnick, CM Sandler & JH Newhouse, Textbook of Uroradiology 5th Ed, Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA, 2013.

RN Uppot, HM Levy & PH Patel, "Case 54: Fournier Gangrene," Radiology 2003; 226:115-117.

5. Based upon this abdominal CT image from a 39-year-old woman, what is the MOST likely diagnosis?



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

Key: D

Findings: Left adrenal mass containing gross fat and a small amount of coarse calcium.

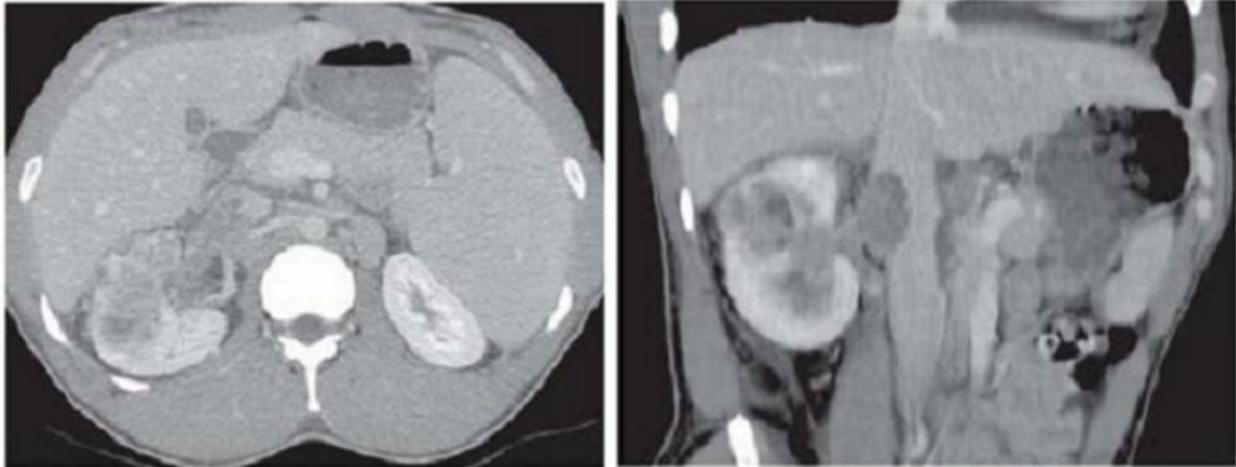
Rationales:

- A. Incorrect. Adenomas rarely calcify. Although 80% do contain fat, it is intracytoplasmic, and is usually not grossly fatty as in this case.
- B. Incorrect. Lymphangioma should be water density and not fatty.
- C. Incorrect. The adrenal glands are a common site of metastatic disease, but adrenal metastases are typically soft tissue density. Larger metastases to the adrenals may have central necrosis or areas of hemorrhage, but would not have a fatty component.
- D. Correct. Myelolipomas are uncommon benign tumors of the adrenal gland comprised of mature adipose cells and hematopoietic tissue. They are functionally inactive and usually are detected as incidental findings. A grossly fatty adrenal mass is virtually diagnostic of a myelolipoma.

Reference:

Dunnick NR, Sandler CM, & Newhouse JH, *Textbook of Uroradiology*. 5th ed. Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA, 2013.

6. What is the MOST likely diagnosis for this 25-year-old man with sickle cell trait?



- A. Non-Hodgkin lymphoma
- B. Angiomyolipoma
- C. Renal medullary carcinoma
- D. Transitional cell carcinoma

Key: C

Findings: A large infiltrative mass is present in the right kidney with extension of mass into the renal pelvic fat, the right renal vein and IVC. There is also retroperitoneal lymphadenopathy and splenomegaly.

Rationales:

A. Incorrect. Non-Hodgkin's lymphoma can involve the kidney but is seen on presentation in only 5.8% of cases. Although it can involve the kidney as a single mass, renal lymphoma most commonly presents as multiple lymphomatous masses. Additionally, renal vein and IVC invasion would be distinctly unusual for lymphoma.

B. Incorrect. Angiomyolipoma is a benign tumor of the kidney that is characterized by regions of macroscopic fat (seen in 95% of cases). No areas of fat density are seen in the images provided with this case. Additionally, renal vein and IVC invasion and lymphadenopathy would not be a characteristic of this benign tumor.

C. Correct. Renal medullary carcinoma is an unusual tumor that almost always occurs in young patients with sickle cell trait. No cases have been reported in patients with sickle cell disease. The tumor arises from the calyceal epithelium and grows in an infiltrative pattern. It is a very aggressive tumor with early metastases to lymph nodes and vascular invasion.

D. Incorrect. Transitional cell carcinoma can fill the renal pelvis and diffusely infiltrate the kidney as in this case. However, transitional cell carcinomas typically affect older individuals and would be rare to affect someone of this age. Also, transitional cell carcinomas would not demonstrate vascular invasion as in this case.

References:

Dunnick NR, Sandler CM, & Newhouse JH, *Textbook of Uroradiology*. 5th ed. Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA, 2013.

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

7. You are shown a delayed contrast-enhanced CT image in a 60-year-old with hematuria. What is the MOST LIKELY diagnosis?



- A. Schistosomiasis
- B. Blood clots
- C. Cystitis cystica
- D. Transitional cell carcinoma

Key: D

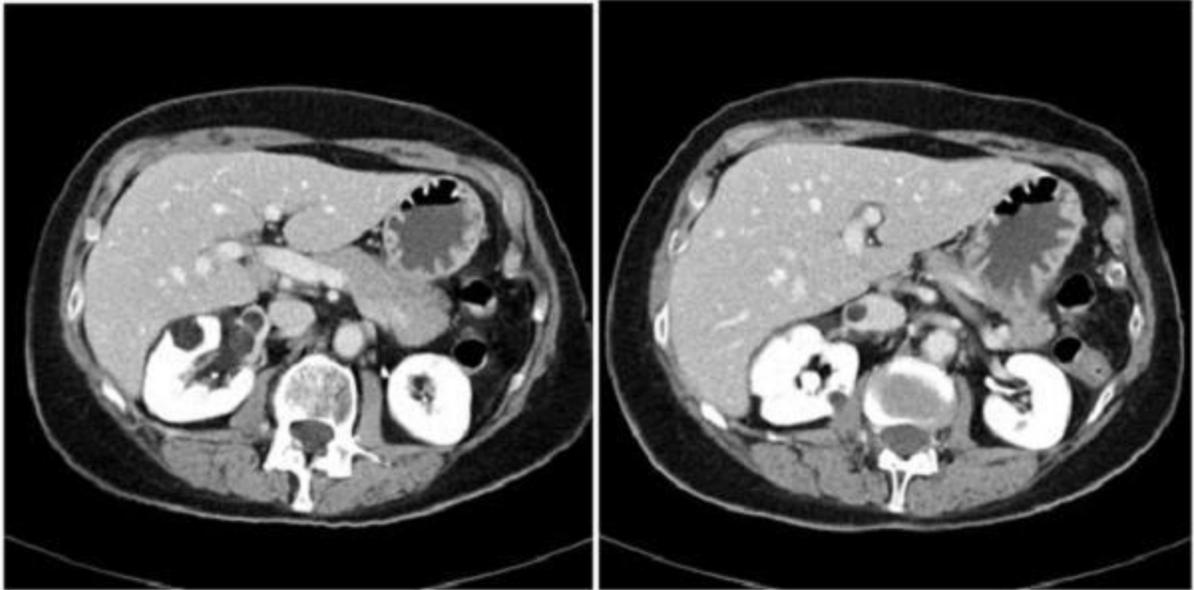
Rationales:

- A. Incorrect. Not a typical appearance. No calcifications.
- B. Incorrect. Should not be adherent to the wall and enhancing.
- C. Incorrect. Not cystic.
- D. Correct. Often multifocal. Classically enhance. Rarely calcify.

Reference:

Dunnick NR, Sandler CM, & Newhouse JH, *Textbook of Uroradiology*. 5th ed. Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA, 2013.

8. You are shown two images from a contrast-enhanced CT scan of the abdomen. What is the MOST LIKELY diagnosis?



- A. Angiomyolipoma
- B. Renal cell carcinoma
- C. Oncocytoma
- D. Multilocular cystic nephroma

Key: A

Rationales:

- A. Correct. The mass is nearly completely fat density when compared to subcutaneous fat.
- B. Incorrect. Although renal cell carcinoma more commonly extends into the IVC and can contain a small amount of fat, this mass has no significant soft tissue component.
- C. Incorrect. Oncocytomas are not predominantly fat density and can have a central scar.
- D. Incorrect. These masses are cystic and commonly extend into the renal pelvis and not the IVC.

Reference:

Dunnick NR, Sandler CM, & Newhouse JH, *Textbook of Uroradiology*. 5th ed. Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA, 2013

9. You are shown a CT image of the pelvis in a patient with vaginal carcinoma. What is the MOST LIKELY diagnosis for the bladder finding?



- A. Simple ureterocele
- B. Ectopic ureterocele
- C. Pseudoureterocele
- D. Fungus ball

Key: C

Rationales:

- A. Incorrect. The mass invades from the vagina through the posterior bladder. A simple ureterocele is a nonmalignant focal dilatation of the submucosal distal ureter.
- B. Incorrect. The mass invades from the vagina through the posterior bladder. An ectopic ureterocele is a nonmalignant focal dilatation of the submucosal distal Ectopic ureter.
- C. Correct. Looks like an ureterocele, but in this case it is the result of a malignancy invading the bladder trigone.
- D. Incorrect. Mobile, often multiple, laminated, gas-containing filling defects within the bladder.

Reference:

Dunnick NR , Sandler CM, & Newhouse JH, *Textbook of Uroradiology*. 5th ed. Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA, 2013.

Vascular Interventional Radiology
In-Training Test Questions
for Diagnostic Radiology Residents



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1. What vascular abnormality is demonstrated at the thoraco-abdominal level?



- A. Pulmonary sequestration
- B. Scleroderma
- C. Scimitar syndrome
- D. Pulmonary AVM

Key: A

Rationale:

A: Correct. A pulmonary sequestration is an unusual disorder in which a portion of the lung develops independently, deriving its blood supply from a systemic artery.

B: Incorrect. Scleroderma and numerous other chronic lung conditions can cause hypertrophy of systemic collaterals, bronchial, intercostal, phrenic arteries which then communicate with the pulmonary arteries. But there are no systemic to pulmonary artery communications shown here.

C: Incorrect. Scimitar syndrome is characterized by an abnormal vascular communication between the lung parenchyma and the systemic circulation. But the abnormal communication is aberrant venous drainage to the inferior cava, not an aberrant arterial blood supply as depicted here.

D: Incorrect. The aneurysm superficially resembles the appearance of a pulmonary AVM. But the blood supply here is derived from the aorta, not from a pulmonary artery. And there is no early dilated draining vein. Aberrant arteries become aneurysmal.

Reference:

Shah V, Agrawal R, et al. Pulmonary sequestration.

<https://radiopaedia.org/articles/pulmonary-sequestration>.

2. Yttrium-90 microspheres are MOST commonly used to treat:

- A. liver cancer
- B. lung cancer
- C. uterine fibroids
- D. endometriosis

Key: A

Rationale:

A: Correct. Candidates for embolic therapy with Yttrium-90 microspheres are patients with unresectable primary cancers or metastatic disease to the LIVER.

B: Incorrect.

C: Incorrect.

D: Incorrect.

Reference: Liapi E, et al. Chapter 69 Radioembolization for hepatocellular carcinoma. Mauro, et al. Image-Guided interventions. Saunders, 2008, Philadelphia.

3. Regarding patients with portal hypertension, which of the following might be an indication for a transjugular intrahepatic portosystemic shunt?
- A. Refractory ascites
 - B. Hepatic encephalopathy
 - C. Biliary obstruction
 - D. Hepatocellular carcinoma

Key: A

Rationale:

A: Correct. Refractory ascites is a typical indication for a TIPS procedure.

B: Incorrect. The other responses are actually contraindications for TIPS.

C: Incorrect. The other responses are actually contraindications for TIPS.

D: Incorrect. The other responses are actually contraindications for TIPS.

Reference:

Brooks DM. Changing Chapter 111 Transjugular intrahepatic portosystemic shunts.

Mauro, et al. Image-Guided interventions. Saunders, 2008, Philadelphia.

4. CT images from the ER of a patient with back pain. What is the MOST likely diagnosis?



- A. Infection
- B. Dissection
- C. Penetrating ulcer
- D. Inflammatory aneurysm

Key: A

Rationale:

A: Correct. Imaging manifestations of infectious aortitis include aortic wall thickening, periaortic fluid, saccular aneurysm or pseudoaneurysm, and occasionally intramural gas.

B: Incorrect. This is an infection, not a dissection. There is no true or false lumen. There is no intimal flap.

C: Incorrect. Penetrating atherosclerotic ulcer of the aorta is a distinct pathological entity and represents an ulcerated, atheromatous lesion with the ulcer penetrating deeply into the wall of the aorta. In addition to the ulcer, the thickened wall, as seen in this case, is caused by the associated hematoma. If communication between the newly formed hematoma and the aortic lumen develops, a classic double barrel aortic dissection with an intimal flap may be produced.

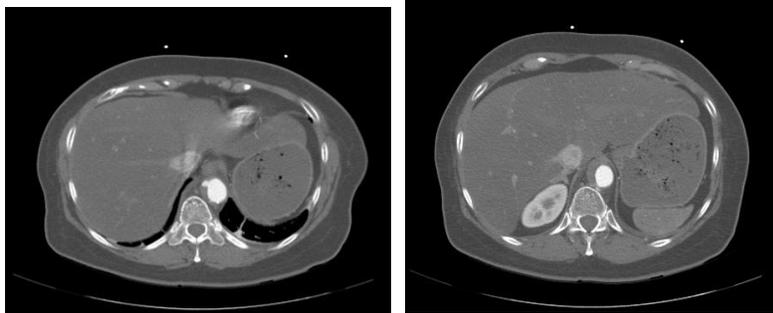
D: Incorrect. The usual appearance of an inflammatory aneurysm is an AAA surrounded by a symmetric soft tissue mass or wall thickening.

Reference:

Restrepo CS, Ocazonez D, Suri R, Vargas D Aortitis: imaging spectrum of the infectious and inflammatory conditions of the aorta. *Radiographics* 2011; 31:435-451.

Hayashi H, Matsuoka Y, Sakamoto I et al. Penetrating Atherosclerotic Ulcer of the Aorta: Imaging Features and Disease Concept. *Radiographics* 2000; 21:995-1005.

5. A patient presenting to the Emergency Department with back pain undergoes a CT scan. What is the MOST likely diagnosis?



- A. Infection
- B. Dissection
- C. Penetrating ulcer
- D. Inflammatory aneurysm

Key: C

Rationale:

A: Incorrect. Imaging manifestations of infectious aortitis include aortic wall thickening, periaortic fluid, and the development of a saccular aneurysm or pseudoaneurysm. There is occasionally gas in the aortic wall.

B: Incorrect. This is an infection, not a dissection. There is no true or false lumen. There is no intimal flap.

C: Correct. Penetrating atherosclerotic ulcer of the aorta is a distinct pathological entity and represents an ulcerated, atheromatous lesion with the ulcer penetrating deeply into the wall of the aorta. In addition to the ulcer, the thickened wall, as seen in this case, is caused by the associated hematoma. If communication between the newly formed hematoma and the aortic lumen develops, a classic double barrel aortic dissection with an intimal flap may be produced. This has not yet occurred in this case.

D: Incorrect. The usual appearance of an inflammatory aneurysm is an AAA surrounded by a symmetric soft tissue mass or wall thickening. Although there is wall thickening here, there is no aneurysm.

Reference:

Restrepo CS, Ocazonez D, Suri R, Vargas D. Aortitis: imaging spectrum of the infectious and inflammatory conditions of the aorta. *Radiographics* 2011; 31:435-451.

Hayashi H, Matsuoka Y, Sakamoto I, et al. Penetrating Atherosclerotic Ulcer of the Aorta: Imaging Features and Disease Concept. *Radiographics* 2000; 21:995-1005.

6. A 31-year-old woman presents with a bluish discoloration to her hand. What is the most likely diagnosis?



- A. Hypothenar hammer syndrome
- B. Systemic lupus erythematosus
- C. Thromboemboli
- D. Arteriovenous malformation

Key: D

Rationale:

A: Incorrect. Characteristic for hypothenar hammer syndrome is damage to the ulnar artery resulting more commonly in occlusion. Occasionally, repetitive trauma to the ulnar artery may result in aneurysm formation with distal emboli to the small arteries of the hand. **INCORRECT**

B: Incorrect. Lupus, in common with the other collagen vascular diseases, may manifest as an arteritis causing stenoses and occlusions of the small arteries in the hand.

C: Incorrect. Intraluminal filling defects are the hallmark of thromboemboli to the hand.

D: Correct. Congenital arteriovenous malformations are characterized by enlarged feeding arteries, a dense tumor stain and early draining veins

Reference:

Greenspan, et al. Imaging strategies in the evaluation of soft-tissue hemangiomas of the extremities: correlation of the findings of plain radiography, angiography, CT, MRI, and ultrasonography in 12 histologically proven cases. *Skeletal Radiology* 1992, Volume; 21: 11-18.

7. Which of the following actions is MOST likely to reduce the incidence of central line-associated blood stream infections?
- A. Choice of femoral rather than subclavian vein insertion sites
 - B. Credentialing personnel responsible for the insertion and maintenance of the lines
 - C. Administering systemic antibiotics routinely before insertion of the line
 - D. Routinely administering anticoagulant therapy after placing the line

Key: B

Rationale:

A: Incorrect. The Society of Interventional Radiology recommends subclavian in preference to femoral insertion sites.

B: Correct. Based on the best scientific evidence, the Society of Interventional Radiology recommends that: 1. Periodically assess knowledge of and adherence to guidelines for all personnel involved in the insertion and maintenance of intravascular catheters; 2. Designate only trained personnel who demonstrate competence for the insertion and maintenance of peripheral and central intravascular catheters.

C: Incorrect. The Society of Interventional Radiology recommends specifically against the use of antibiotics.

D: Incorrect. The Society of Interventional Radiology recommends specifically against the use of anticoagulant prophylaxis.

Reference:

Miller DL, O'Grady NP. Guidelines for the Prevention of Intravascular Catheter-related Infections: Recommendations Relevant to Interventional Radiology for Venous Catheter Placement and Maintenance Donald L. Miller, MD, and Naomi P. O'Grady, MD. J Vasc Interv Radiol 2012; 23:997-1007.

8. Catheter-based arterial sympathectomy is a therapeutic modality with application for:
- A. refractory hypertension.
 - B. reflex sympathetic dystrophy.
 - C. low back pain.
 - D. gastroesophageal reflux disease.

Key: A

Rationale:

A: Correct. Catheter based renal arterial sympathectomy is an evolving interventional technique for treating refractory hypertension.

B: Incorrect. The sympathetic nervous system has been implicated in the pathophysiology of reflex sympathetic dystrophy, or complex regional pain syndrome or Sudeck's atrophy. There is no transcatheter technique to treat this disease.

C: Incorrect. Low back pain may actually be a complication of this transcatheter technique.

D: Incorrect. GERD is not yet amenable to transcatheter techniques.

Reference:

Krum H, Schlaich M, Whitbourn R, Sobotka PA. Catheter-based renal sympathetic denervation for resistant hypertension: a multicentre safety and proof-of-principle cohort study
Lancet 2009; 373:1275-1281

9. Catheter-based sympathectomy for control of hypertension addresses what anatomical structure?
- A. Renal artery
 - B. Celiac axis
 - C. Adrenal artery
 - D. Stellate ganglion

Key: A

Rationale:

A: Correct. Catheter based arterial sympathectomy, is an interventional procedure that seeks to control hypertension by ablating sympathetic nerves associated with the renal arteries.

B: Incorrect.

C: Incorrect.

D: Incorrect.

Reference:

Krum H, Schlaich M, Whitbourn R, Sobotka PA. Catheter-based renal sympathetic denervation for resistant hypertension: a multicentre safety and proof-of-principle cohort study. *Lancet* 2009; 373:1275-1281.

10. Which of the following is a contraindication for placement of a transjugular intrahepatic portosystemic shunt?

- A. Multiple hepatic cysts
- B. Refractory ascites
- C. Portal hypertensive gastropathy
- D. Budd Chiari syndrome

Key: A

Rationale:

A: Correct. Refractory ascites is a typical indication for a TIPS procedure.

B: Incorrect. The other responses are actually indications for TIPS.

C: Incorrect. The other responses are actually indications for TIPS.

D: Incorrect. The other responses are actually indications for TIPS.

Reference:

Brooks DM. Changing. Chapter 111 Transjugular intrahepatic portosystemic shunts in Mauro, et al. Image-Guided interventions, Saunders, 2008, Philadelphia.

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



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1. Based upon this image from a 41-year-old man, what is the MOST likely diagnosis?



- A. Spinoglenoid notch ganglion cyst
- B. Rotator cuff tendinopathy
- C. Quadrilateral space syndrome
- D. Parsonage Turner Syndrome

Key: C

Rationale:

A: Incorrect. Space occupying lesions at the spinoglenoid notch, usually ganglion or paralabral cysts, may compress that portion of the suprascapular nerve that innervates the infraspinatus muscle. This may lead to subsequent infraspinatus muscle atrophy.

B: Incorrect. The image provided shows atrophy of the deltoid and axillary musculature and does not demonstrate the rotator cuff.

C: Correct. The axillary nerve traverses the quadrilateral space and supplies the teres minor and deltoid muscles. Compression neuropathy related to space occupying mass or more commonly, fibrous bands, known as Quadrilateral space syndrome, may lead to subsequent atrophy.

D: Incorrect. Parsonage Turner syndrome or acute brachial neuritis may involve varying combinations of nerves related to the brachial plexus, most commonly the long thoracic, suprascapular and phrenic. Isolated axillary nerve involvement is rare. Axillary nerve involvement is usually associated with multiple peripheral nerve involvement.

References:

Suprascapular nerve entrapment: evaluation with MR imaging. R C Fritz, C A Helms, L S Steinbach, H K Genant Radiology, Feb 1992, Vol. 182: 437-444.

Quadrilateral space syndrome: findings at MR imaging. C S Linker, C A Helms, R C Fritz. Radiology, Sep 1993, Vol. 188: 675-676.

2. What neoplasm is MOST likely to arise within longstanding Paget disease of bone?

- A. Giant cell tumor
- B. Osteosarcoma
- C. Fibrosarcoma
- D. Chondrosarcoma

Key: B

Rationale:

A: Incorrect. GCT is a known but infrequent complication of Pagets disease. It usually involves the skull or facial bones of patients with polyostotic disease. Most are benign.

B: Correct. Osteosarcoma is the most common neoplasm associated with Pagets disease of bone, representing about 80% of such secondary tumors. These lesions are quite aggressive and the prognosis is poor. They appear as lytic lesions superimposed upon long standing pagetoid bone.

C: Incorrect. FD is not associated with Pagets disease of bone.

D: Incorrect. Malignant transformation of Pagets disease of bone is an uncommon complication. Chondrosarcoma represents about 10% of these cases.

References:

Complications in Paget Disease at MR imaging. R D Boutin, D J Spitz, J S Newman, L Lenchik, L Steinbach
Radiology, Dec 1998, Vol. 209: 641-651.

Paget Disease of Bone. Diagnosis of bone and joint disorders. 4th edition. Ed. Donald
Resnick. Philadelphia, USA: Saunders, 2002.

Paget Disease of Bone. RadioGraphics, Sep 2002, Vol. 22: 1190.

3. What is the most likely diagnosis?



- A. Ewings sarcoma
- B. Chondroblastoma
- C. Osteomyelitis
- D. Osteosarcoma

Key: D

Rationale:

A: Incorrect. Although Ewings sarcoma is a malignant primary bone tumor occurring in the skeletally immature, it more commonly occurs at the diaphysis without bone sclerosis.

B: Incorrect. Chondroblastoma is a benign, well defined lytic lesion of the epiphysis.

C: Incorrect. Osteomyelitis is commonly metaphyseal and may have aggressive periosteal reaction but new bone formation, manifesting as sclerosis at the medullary canal and soft tissues, is not a feature.

D: Correct. This is a typical appearance of osteosarcoma.

References:

The many faces of osteosarcoma. M D Murphey, M R Robbin, G A McRae, D J Flemming, H T Temple, M J Kransdorf RadioGraphics, Sep 1997, Vol. 17: 1205-1231.

Osteosarcoma. Diagnosis of bone and joint disorders. 4th edition. Ed. Donald Resnick. Philadelphia, USA: Saunders, 2002.

Imaging Characteristics of Primary Osteosarcoma: Nonconventional Subtypes Gail Yarmish, Michael J. Klein, Jonathan Landa, Robert A. Lefkowitz, Sinchun Hwang RadioGraphics, Oct 2010, Vol. 30: 1653-1672.

4. What neoplasm is MOST commonly associated with aneurysmal bone cyst?
- A. Enchondroma
 - B. Giant cell tumor
 - C. Osteoid osteoma
 - D. Hemangioma

Key: B

Rationale:

A: Incorrect.

B: Correct. Most aneurysmal bone cysts occur in children and teenagers and are not associated with any underlying condition. Some are associated with other bone tumors, the most common being giant cell tumor, osteoblastoma, fibrous dysplasia and chondroblastoma.

C: Incorrect.

D: Incorrect.

Reference:

Aneurysmal Bone Cyst. Diagnosis of bone and joint disorders. 4th edition. Ed. Donald Resnick. Philadelphia, USA: Saunders, 2002.

5. Which one of the following is MOST likely to involve the vertebral body?

- A. Osteoid osteoma
- B. Aneurysmal bone cyst
- C. Infection
- D. Clay shovelers fracture

Key: C

Rationale:

A: Incorrect. About 10% of osteoid osteomas involve the vertebra. Most of these occur at the posterior elements. Because of their small size and the complex anatomy of the posterior elements, they are often not demonstrated with conventional radiography. Secondary signs such as painful scoliosis or premature facet arthrosis may suggest the diagnosis which is best confirmed with CT examination.

B: Incorrect. Aneurysmal bone cyst may occur at the axial or appendicular skeleton. Involvement of the spine is almost always at the posterior elements.

C: Correct. Septic spondylitis is almost always a vertebral body osteomyelitis, adjacent to the vertebral body endplate that progresses to the intervertebral disc and adjacent vertebral body. The process usually appears to be centered at the disc by the time the patient is imaged, but that is not where it originates. The term "discitis" therefore is a bit misleading.

D: Incorrect. The clay shovelers fracture is an avulsion fracture of the spinous process, usually at the cervicothoracic region. It results from an abrupt traction force of an intact interspinous ligament during forced flexion.

References:

MR Imaging Assessment of the Spine: Infection or an Imitation? Sung Hwan Hong, Ja-Young Choi, Joon Woo Lee, Na Ra Kim, Jung-Ah Choi, Heung Sik Kang *RadioGraphics*, Mar 2009, Vol. 29: 599-612.

MR Imaging Findings in Spinal Infections: Rules or Myths? Hans Peter Ledermann, Mark E. Schweitzer, William B. Morrison, John A. Carrino *Radiology*, Aug 2003, Vol. 228: 506-514.

6. You are shown an x-ray of a 10-year-old boy. What is the MOST likely diagnosis?



- A. Sinding-Larsen-Johansson disease
- B. Patellar sleeve fracture
- C. Intra-articular chondroma
- D. Osgood-Schlatter disease

Key: B

Rationale:

A: Incorrect. This overuse condition produces hypertrophic changes at the inferior pole of the patella secondary to chronic, repetitive avulsion of bone. There is minimal displacement and no involvement of the articular cartilage. There is no proximal retraction of the patella.

B: Correct. This lateral radiograph is characteristic of an acute osteochondral avulsion fracture of the inferior pole of the patella. The fracture fragment is not completely corticated and there is a donor site at the patella. The patella itself is retracted proximally. It results from eccentric contraction of the quadriceps on a flexed knee, often associated with high impact jumping.

C: Incorrect. Solitary intra-articular chondroma is an uncommon entity that has a predilection for Hoffa's fat. They commonly demonstrate cartilaginous calcification. This lateral radiograph is characteristic of an osteochondral avulsion fracture of the inferior pole of the patella. The fracture fragment is not completely corticated and there is a donor site at the patella. The patella itself is retracted proximally.

D: Incorrect. Osgood-Schlatter disease is thought to be a chronic avulsion injury related to repetitive microtrauma and traction at the patella tendon insertion at the anterior tibial tubercle. It usually occurs in adolescent boys involved in activities that require jumping and kicking. Conventional radiographs may be normal or reveal fragmentation anterior to the tibial tubercle, soft-tissue swelling, and/or obliteration of the inferior angle of the infrapatellar fat pad. This lateral radiograph is characteristic of an osteochondral avulsion fracture of the inferior pole of the patella. The fracture fragment is not completely corticated and there is a donor site at the patella. The patella itself is retracted proximally.

References:

Patellar sleeve fracture: demonstration with MR imaging. D G Bates, M T Hresko, D Jaramillo *Radiology*, Dec 1994, Vol. 193: 825-827.

Avulsion Fractures of the Knee: Imaging Findings and Clinical Significance Christopher J. Gottsegen, Benjamin A. Eyer, Eric A. White, Thomas J. Leach, Deborah Forrester *RadioGraphics*, Oct 2008, Vol. 28: 1755-1770.

Injuries and Conditions of the Extensor Mechanism of the Pediatric Knee Carolyn S. Dupuis, Sjirk J. Westra, Joseph Makris, E. Christine Wallace *RadioGraphics*, May 2009, Vol. 29: 877-886.

7. Which of the following structures constitute the pes anserinus?
- A. Sartorius, semitendinosus, gracilis tendons
 - B. Biceps femoris tendon, fibular collateral ligament
 - C. Sartorius, semimembranosus, semitendinosus tendons
 - D. Rectus femoris and vastus medialis, lateralis, intermedius tendons

Key: A

Rationale:

A: Correct. These three tendons insert at the proximal medial tibia and have the gross appearance of a goose's foot, hence the term "pes anserinus."

B: Incorrect. The biceps femoris tendon and fibular collateral ligament insert at the fibula head as the conjoined tendon.

C: Incorrect. The semimembranosus tendon has a broad insertion at the posterior medial tibia and is not a component of the pes anserinus.

D: Incorrect. These four tendons comprise the quadriceps tendon.

References:

Posteromedial Corner of the Knee: The Neglected Corner Ryan B. Lundquist, George R. Matcuk, Aaron J. Schein, Matthew R. Skalski, Eric A. White, Deborah M. Forrester, Christopher J. Gottsegen, Dakshesh B. Patel RadioGraphics, Jul 2015, Vol. 35: 1123-1137.

Acute pes anserine bursitis: MR imaging. J R Forbes, C A Helms, D L Janzen Radiology, Feb 1995, Vol. 194: 525-527.

8. You are shown a radiograph of a 60-year-old woman. What is the MOST likely diagnosis?



- A. Psoriatic arthritis
- B. Erosive osteoarthritis
- C. Rheumatoid arthritis
- D. Gout

Key: B

Rationale:

A: Incorrect. The patient does not have peripheral erosions and much of the subchondral cortex is intact. There is no soft tissue swelling, or periosteal reaction. The osteophytes of erosive OA are different from the cupping associated with psoriatic arthritis.

B: Correct. The central erosions and peripheral osteophytes give the typical "gullwing" appearance of erosive OA. Much of the subchondral cortex is intact.

C: Incorrect. The patient does not have peripheral erosions and much of the subchondral cortex is intact. There are osteophytes and there is no periarticular osteopenia. The MCP joints are normal.

D: Incorrect. There are no tophi or para-articular erosions and the joint space is not preserved.

Reference:

Erosive Osteoarthritis. *Diagnosis of bone and joint disorders*. 4th edition. Ed. Donald Resnick. Philadelphia, USA: Saunders, 2002.

9. What is the cause of greatest morbidity in patients with osteoporosis?

- A. Hip fracture
- B. Kyphosis
- C. Multiple Myeloma
- D. Colles fracture

Key: A

Rationale:

A: Correct. Hip fractures secondary to osteoporosis, cause the greatest morbidity and mortality. About 50% result in permanent inability to walk without assistance. One quarter of such patients require long-term care. Mortality rates of up to 20% have been reported.

B: Incorrect. Vertebral compression fractures are a hallmark of osteoporosis. Some trauma may be associated. However, fracture may occur spontaneously. Vertebral fractures typically occur at the thoracolumbar junction and mid-thoracic region. Increasing thoracic kyphosis results. In severe cases, this may be associated with impaired pulmonary function and digestive problems including early satiety and weight loss.

C: Incorrect. Diffuse skeletal osteopenia, without well-defined areas of bone lysis, may occur in patients with plasma cell or multiple myeloma. This appearance may simulate osteoporosis but is not a complication of the disease.

D: Incorrect. Colles fracture of the distal radius typically occurs after a fall onto the outstretched hand and are common in patients with osteoporosis. Although wrist fractures cause less morbidity than hip fractures, they usually require 4–6 weeks in a plaster cast, and up to one-third of patients may have continued pain, deformity, and functional impairment.

References:

Integrated Imaging Approach to Osteoporosis: State-of-the-Art Review and Update Giuseppe Guglielmi, Silvana Muscarella, Alberto Bazzocchi RadioGraphics, Sep 2011, Vol. 31: 1343-1364.

Osteoporosis Imaging: State of the Art and Advanced Imaging Thomas M. Link Radiology, Apr 2012, Vol. 263: 3-17.

10. You are shown an oblique radiograph of the elbow. What is the MOST likely sequela?



- A. Metastases
- B. Malignant transformation
- C. Biceps tendon tear
- D. Entrapment neuropathy

Key: D

Rationale:

A: Incorrect. Surface osteosarcomas arise at the periosteal surface of the bone but do not have such a uniform appearance. They may metastasize.

B: Incorrect. An osteochondroma may undergo malignant transformation of its cartilagenous cap to chondrosarcoma. Unlike an osteochondroma, this lesion points toward the joint. This location, about 5-7 cm proximal to the elbow is characteristic of a supracondylar process.

C: Incorrect. The supracondylar process has no relationship with the biceps tendon.

D: Correct. The spurpacondylar process of the humerus is a bony, beak-like projection, 5-7 cm proximal to the elbow, pointing towards the joint, seen in up to 3% of the population. It may be unilateral or bilateral. A band of fibrous tissue, the ligament of Struthers, may connect the tip of the supracondylar process and the medial epicondyle. The median nerve and brachial artery or one of its branches pass through this fibroosseus tunnel allowing for median nerve compression.

Reference:

Peripheral Neuropathies of the Median, Radial, and Ulnar Nerves: MR Imaging Features. Gustav Andreisek, David W. Crook, Doris Burg, Borut Marincek, Dominik Weishaupt RadioGraphics, Sep 2006, Vol. 26: 1267-1287.

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

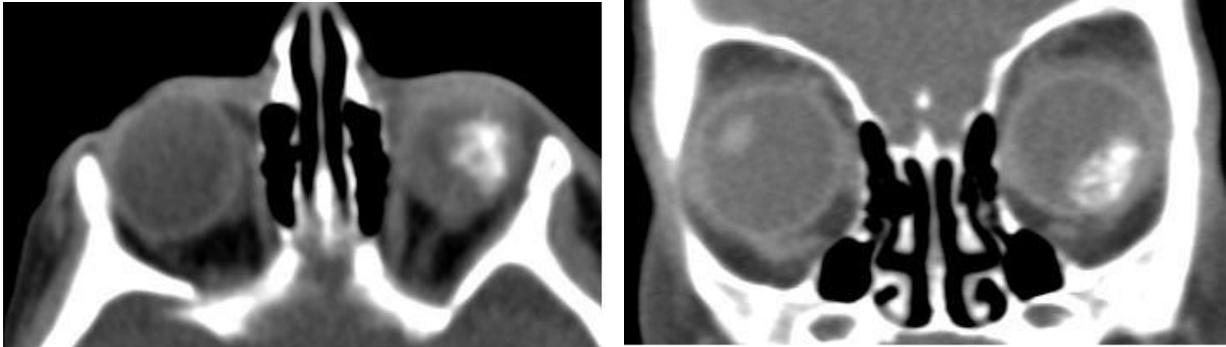


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1. Based upon these unenhanced axial and coronal CT images of the orbit on an 8-month-old-child, which of the following lesions is associated with the hereditary form of this entity?



- A. Osteogenic sarcoma
- B. Osteoid osteoma
- C. Giant cell tumor
- D. Aneurysmal bone cyst

Key: A

Rationale:

A: Correct. Osteogenic sarcoma. The CT demonstrates an ocular mass with calcification which should be considered retinoblastoma until proven otherwise. Patients with the familial hereditary form of retinoblastoma have a higher incidence of the subsequent development of osteogenic sarcoma. No such association exists for the other answers.

B: Incorrect. Osteoid Osteoma is not associated with the hereditary form of retinoblastoma.

C: Incorrect. Giant Cell Tumor is not associated with the hereditary form of retinoblastoma

D: Incorrect. Aneurysmal bone cyst is not associated with the hereditary form of retinoblastoma

Reference:

Susan H. James, MD, William C. Halliday, MD, and Helen M. Branson, MD, Trilateral Retinoblastoma: Radiographics, May 2010;Volume 30 Issue 3.

2. You are shown a lateral view of the internal carotid artery from a cerebral angiogram. What persistent artery is demonstrated?



- A. Fetal posterior cerebral
- B. Hypoglossal
- C. Proatlantal
- D. Trigeminal

Key: D

Rationale:

A: Incorrect. The persistent fetal PCA is an enlarged posterior communicating artery that results in preferential supply to the PCA from the internal carotid artery (ICA) instead of the basilar artery. The posterior communicating artery and the persistent fetal PCA arise from the supraclinoid ICA, not the cavernous ICA as in this case.

B: Incorrect. The persistent hypoglossal artery is a congenital variant that arises from the high cervical carotid artery and supplies the vertebrobasilar system after passing through the hypoglossal canal. This anomaly occurs in 0.03% to 0.26% of the population.

C: Incorrect. Origin of proatlantal artery is usually at the C2 or C3 level. The proatlantal artery enters the skull through the foramen magnum. Two types of proatlantal arteries have been described. The type 1 proatlantal artery arises from the internal carotid artery and the type 2 proatlantal artery arises from the external carotid artery.

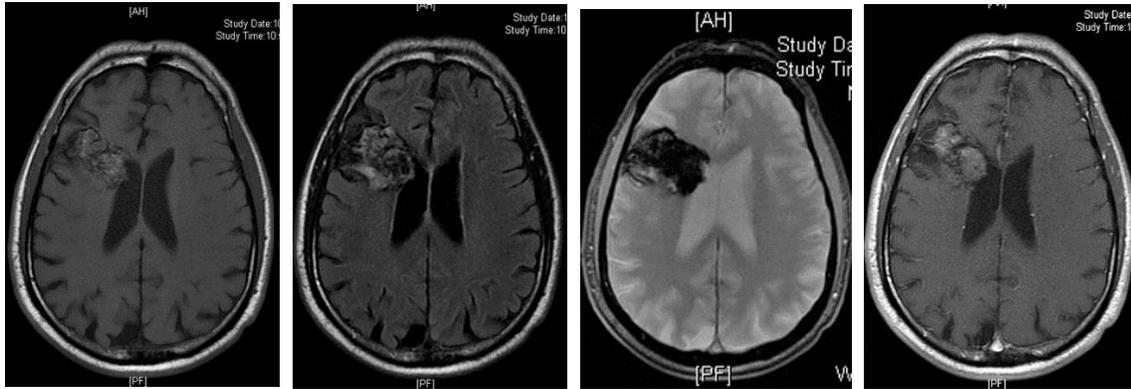
D: Correct. The persistent trigeminal artery (PTA) is the most frequent carotid-basilar anastomosis and is seen in 0.3% of angiograms. The PTA has two variations as classified by Saltzman. In Saltzman type 1 anatomy, the basilar artery proximal to the insertion of the PTA may be hypoplastic, and the posterior communicating artery might absent. Thus, the PTA is the main supply to the distal basilar artery, posterior cerebral artery, and superior cerebellar artery territories. In Saltzman type 2 the PTA joins the basilar artery below the origin of the superior cerebellar arteries, and the posterior cerebral arteries receive their blood supply predominantly through patent posterior communicating arteries. The incidence of these two main types is equal. Numerous Saltzman variants, sometimes called Saltzman type 3, have been described as well.

References:

Saltzman GF. Patent primitive trigeminal artery studied by cerebral angiography. *Acta Radiol.* 1959; 51: 329-36.

Dimmick SJ, Faulder KC. Normal variants of the cerebral circulation at multidetector CT angiography. *Radiographics.* 2009; 29: 1027-43.

3. You are shown T1-weighted, T2-weighted FLAIR, gradient echo and contrast enhanced T1-weighted images of a 36-year-old male. What is the most likely diagnosis?



- A. Hemorrhagic infarction
- B. Glioblastoma multiforme
- C. Cavernous malformation
- D. Arteriovenous malformation

Key: C

Rationale:

A: Incorrect: A hemorrhagic infarct would be expected to have associated edema and greater mass effect. Also, the heterogeneity of the signal intensity of the hemorrhagic products would be unusual in a hemorrhagic infarct.

B: Incorrect: A glioblastoma multiforme may be hemorrhagic but would have associated edema or nonenhancing tumor and greater mass effect. Also, greater enhancement would be expected.

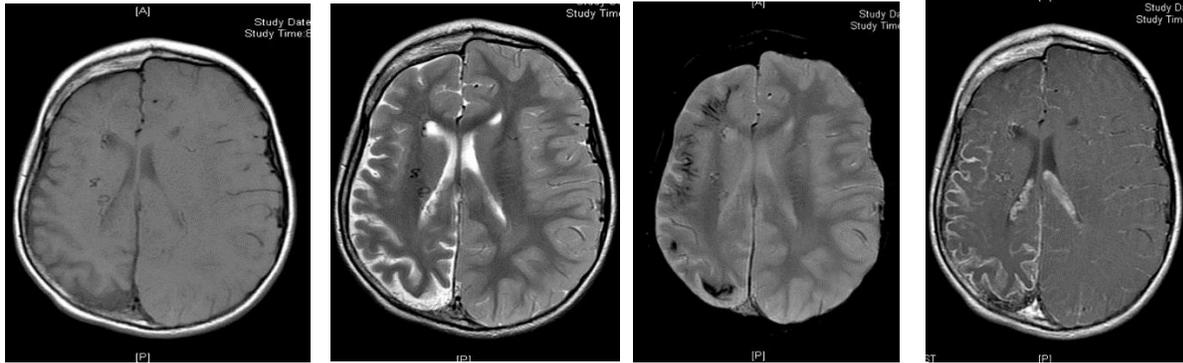
C: Correct: The images show a right frontal mass with signal intensity consistent with hemorrhage of various ages including T1 hyperechoicity, T2 hypointensity and gradient echo susceptibility with no associated edema, minimal enhancement and minimal mass effect on the ventricle. The findings are most consistent with a cavernous malformation.

D: Incorrect: The lesion is too mass-like, lacks serpentine flow voids or dilated feeding vessels expected in an arteriovenous malformation.

Reference:

Vilanova JC, Barceló J, Smirniotopoulos JG et-al. Hemangioma from head to toe: MR imaging with pathologic correlation. Radiographics. 24 (2): 367-85.

4. Based upon the images from a 7-year-old female with seizures, what is the diagnosis?



- A. Chronic right middle cerebral artery infarction
- B. Meningioangiomas
- C. Meningitis
- D. Sturge-Weber Syndrome

Key: D

Rationale:

A: Incorrect: While chronic right middle cerebral artery infarction may cause hemiatrophy pial enhancement as in this case would not occur. Also, there is no gliosis evident on the T2 weighted images as would be expected in an infarct.

B: Incorrect: Atrophy is typically absent in meningioangiomas and homogeneous rather than pial enhancement is found.

C: Incorrect: While leptomeningeal enhancement can be found secondary to meningitis hemiatrophy with associated calvarial thickening and absence of sulcal effacement make meningitis an unlikely diagnosis.

D: Correct: The images show leptomeningeal enhancement secondary to pial angiomas with associated hemiatrophy and calvarial thickening. Cortical-subcortical calcifications are seen as areas of susceptibility effect on the gradient echo image. These findings in an individual with seizures are characteristic of Sturge-Weber syndrome.

Reference:

A Spectrum of Unusual Neuroimaging Findings in Patients with Suspected Sturge-Weber Syndrome. M.E. Adams, S.E. Aylett, W. Squier and W. Chong; American Journal of Neuroradiology February 2009, 30 (2) 276-281.

5. An elderly man becomes paralyzed after minor trauma. Based on the CT image, what is the MOST likely cause of paralysis?



- A. Ossification of the posterior longitudinal ligament
- B. Disk-osteophyte complex
- C. Acute fracture
- D. Ligamentum flavum ossification

Key: A

Rationale:

A: Correct. Prominent ossification of the posterior longitudinal ligament results in significant spinal canal stenosis.

B: Incorrect. The calcification/ossification follows the expected course of the PLL, not the disk space.

C: Incorrect: No fracture is evident on this image.

D: Incorrect. The PLL is ossified, not the ligamentum flavum.

Reference:

Ryuichiro Sato, Kenzo Uchida, Shigeru Kobayashi, Takafumi Yayama, Yasuo Kokubo, Hideaki Nakajima, Takaharu Takamura, Alexander Bangirana, Hiroshi Itoh, Hisatoshi Baba, Ossification of the posterior longitudinal ligament of the cervical spine: histopathological findings around the calcification and ossification front *Journal of Neurosurgery: Spine*, August 2007 / Vol. 7 / No. 2: Pages 174-183.

6. Based upon the sagittal T2 image of the cervical spine in a child, what is the diagnosis?



- A. Diskitis osteomyelitis complex
- B. Langerhans cell histiocytosis
- C. Limbus vertebra
- D. Klippel-Feil anomaly

Key: B

Rationale:

A: Incorrect. Although the C3 vertebral body collapse could be caused by underlying infection, the disk spaces appear normal, so diskitis osteomyelitis complex would be unlikely.

B: Correct. This is a common cause for vertebral plana deformity in a child.

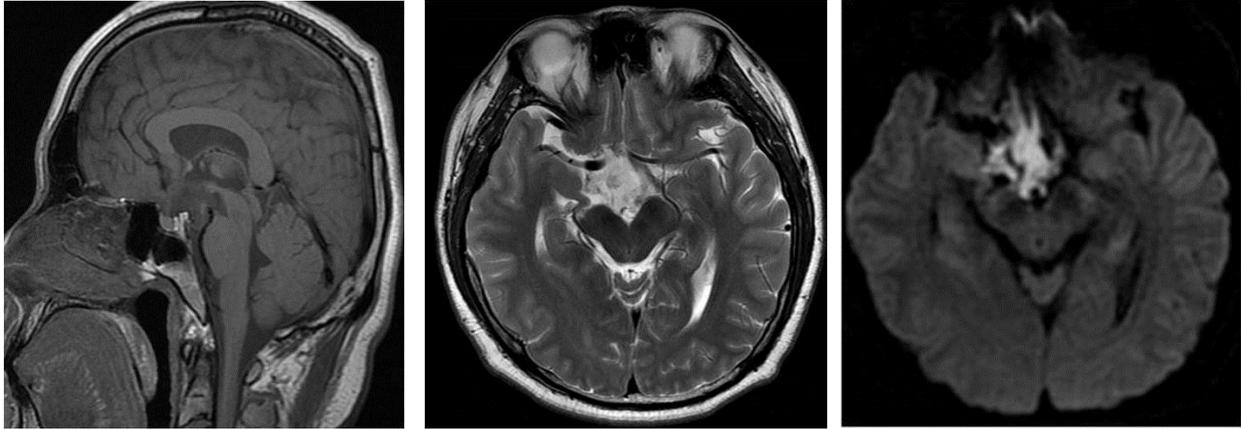
C: Incorrect. A limbus vertebra would show a well corticated bony fragment at the anterior superior vertebral margin.

D: Incorrect. The Klippel-Feil anomaly would demonstrate a small and/or fused disk and vertebral body narrowing. This disc spaces are normal here.

Reference:

Roche CJ, O'keeffe DP, Lee WK et-al. Selections from the buffet of food signs in radiology. Radiographics. 22 (6): 1369-84.

7. You are shown sagittal contrast-enhanced T1, axial T2 spin-echo, and axial diffusion weighted images of a 36-year-old female with progressive visual disturbance. What is the MOST likely diagnosis?



- A. Pituitary macroadenoma
- B. Epidermoid cyst
- C. Craniopharyngioma
- D. Arachnoid cyst

Key: B

Rationale:

A: Incorrect: The images show a nonenhancing suprasellar mass. Pituitary macroadenomas typically enhance and at least peripheral enhancement should be found in an adenoma. A normal sized enhancing pituitary gland is seen in the sella. Consequently, pituitary macroadenoma is an unlikely diagnosis.

B: Correct: The imaging findings show a suprasellar T1 hypointense, T2 hyperintense nonenhancing mass that has restricted diffusion. The mass is hyperintense relative to cerebrospinal fluid on the T2 weighted FLAIR image. The imaging findings are most consistent with a suprasellar epidermoid. Restricted diffusion is characteristically found in epidermoids.

C: Incorrect: Craniopharyngioma is a diagnostic consideration for this cystic appearing mass though these often have increased T1 signal. Also, the absence of an enhancing solid or peripheral component and diffuse diffusion restriction makes this an unlikely diagnosis.

D: Incorrect: The suprasellar mass shown has signal characteristics on the T1 and T2 weighted images similar cerebrospinal fluid as expected for an arachnoid cyst though it is hyperintense compared to cerebrospinal fluid on the T2 weighted FLAIR image, which is not expected for an arachnoid cyst. Diffusion restriction is also not found in an arachnoid cyst.

Reference:

Osborn AG, Preece MT. Intracranial cysts: radiologic-pathologic correlation and imaging approach. *Radiology*. 2006; 239 (3): 650-64.

8. Which of the following techniques helps to minimize susceptibility artifacts from spinal fixation hardware on MRI?
- A. Decrease bandwidth
 - B. Gradient echo sequence
 - C. Fast spin echo (SE) sequence
 - D. Increased field strength

Key: C

Rationale:

A: Incorrect: Susceptibility artifact from metallic fixation hardware can result in geometric distortions. The size of this geometric distortion is inversely related to receiver bandwidth. Therefore, to reduce susceptibility artifact, increase the receiver bandwidth.

B: Incorrect: Susceptibility artifacts are more pronounced with gradient-echo imaging compared to spin echo imaging. Protons dephase in the transverse plane because of local magnetic field differences. When metal is present in the field, this dephasing can cause significant signal loss. This can be reduced with a 180° refocusing pulse, as in spin echo imaging, which allows rephasing of the protons.

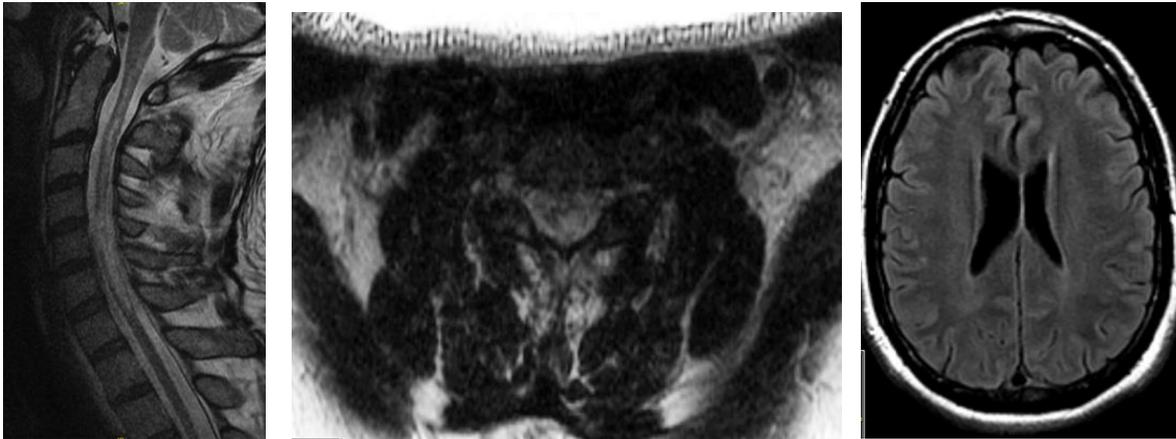
C: Correct: In contrast to GRE sequences, spin-echo (SE) sequences use a 180° refocusing radiofrequency pulse that corrects for magnetic field inhomogeneities such as those caused by fixation hardware. The 180° refocusing pulses used in spin echo and fast spin echo (FSE) pulse sequences result in a reduction in intravoxel signal loss from dephasing and therefore reduced susceptibility artifact.

D: Incorrect: Susceptibility artifact increases with increasing field strength. Therefore, a 1.5T scanner will result in less artifact than scanning at 3T.

Reference:

Mi-Jung Lee, MD, Sungjun Kim, MD, Sung-Ah Lee, MD, Ho-Taek Song, MD, Yong-Min Huh, MD, Dae-Hong Kim, PhD, Seung Hwan Han, MD, and Jin-Suck Suh, MD: Overcoming Artifacts from Metallic Orthopedic Implants at High-Field-Strength MR Imaging and Multi-detector CT. *Radiographics*: May-June 2007. Volume 27, Issue 3.

9. A 45-year-old male presents with weakness in the upper and lower extremities and inability to urinate progressing over 2 weeks. You are shown sagittal and axial imaging of the cervical spine and FLAIR imaging of the brain. What is the MOST LIKELY diagnosis?



- A. Multiple sclerosis
- B. Neuromyelitis optica (NMO, Devic disease)
- C. Subacute combined degeneration
- D. Spinal cord infarction

Key: B

Rationale:

A: Incorrect: Multiple sclerosis commonly affects the cervical spinal cord and may present with solitary or multifocal T2 hyperintense lesions extending for less than 2 vertebral segments in length. These lesions are typically wedge-shaped with their axis directed centrally and involve the dorsolateral, rather than central, cord.

B: Correct: Neuromyelitis optica (NMO, Devic disease) is characterized by acute myelitis and optic neuritis. Spinal cord lesions characteristically extend over 3 or more vertebral segments, involve the central cord with associated cord swelling and expansion. Brain imaging is usually normal and does not fulfill criteria for multiple sclerosis (MS) at diagnosis.

C: Incorrect: Subacute combined degeneration results from vitamin B12 deficiency and results in selective degeneration of the dorsolateral columns in the spinal cord giving rise to the classic inverted “V” or inverted “rabbit ears” appearance on axial T2 weighted MRI.

D: Incorrect: Spinal cord infarction is typically due to occlusion of a radicular branch from the aorta (thoracic and lumbar) or vertebral artery (cervical). Spinal cord infarction usually involves greater than one vertebral body segment, involves central gray matter, gray plus white matter or the cross section of the cord. DWI may show restricted diffusion. In contrast to NMO, symptom onset is usually sudden with rapid progression to maximal impairment within a few hours.

Reference:

Sarbu N, Shih RY, Jones RV et-al. White Matter Diseases with Radiologic-Pathologic Correlation. Radiographics. 2016; 36 (5): 1426-47.

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



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Released July 2017

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1. Regarding Mo-99/Tc-99m generator systems and the NRC (Nuclear Regulatory Commission), which of the following QC maneuvers must be performed after each elution?
 - A. Mo-99 breakthrough test
 - B. Colorimetric test
 - C. Uniformity test
 - D. Aluminum breakthrough test

Key: A

Rationale:

A: Correct. NRC requires this testing as a patient safety issue, to prevent long-lived, high energy radioactive contaminants from being administered to patients.

B: Incorrect. Selective passage of high energy (740 and 780 keV) photons unique to moly-99 through a calibrated lead container (pig) are assayed in a dose calibrator. There is a colorimetric test for Mo-99 breakthrough, but it is much less commonly used.

C: Incorrect. Uniformity test is for gamma camera quality control.

D: Incorrect. Chemical contamination by aluminum is routinely detected by a colorimetric spot test.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

2. Which of the following structures will typically show hypometabolism in dementia with Lewy bodies?
- A. Basal ganglia
 - B. Visual cortex
 - C. Caudate nuclei
 - D. Frontal lobe

Key: B

Rationale:

A: Incorrect. The basal ganglia are not affected in dementia with Lewy bodies.

B: Correct. This is a hallmark finding for dementia with Lewy bodies.

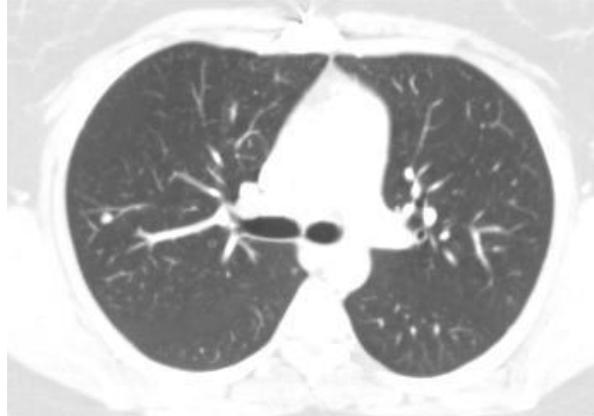
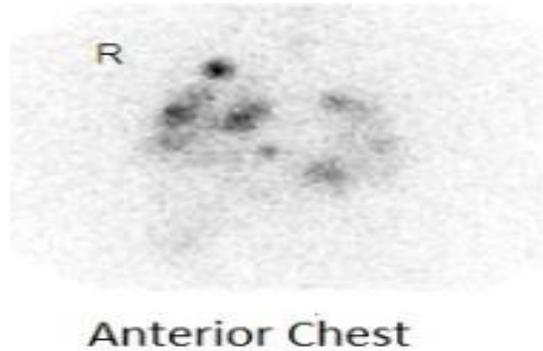
C: Incorrect. This is typically seen with Parkinson disease.

D: Incorrect. Frontal lobe involvement is typically seen with frontotemporal dementia.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

3. You are shown an anterior spot image of the chest and a CT image obtained in a 29-year-old female 7 days following radioiodine therapy for thyroid carcinoma. What was the MOST likely administered dose of I-131?



- A. 30 mCi
- B. 50 mCi
- C. 100 mCi
- D. 175 mCi

Key: D

Rationale:

A: Incorrect. Radioiodine therapy for metastatic thyroid disease varies by local institutions. 30 mCi dose is typical for empiric treatment of Plummer disease (autonomously functioning thyroid nodule) or multinodular goiter.

B: Incorrect. This is not a typical dose for radioactive ablation for thyroid cancer.

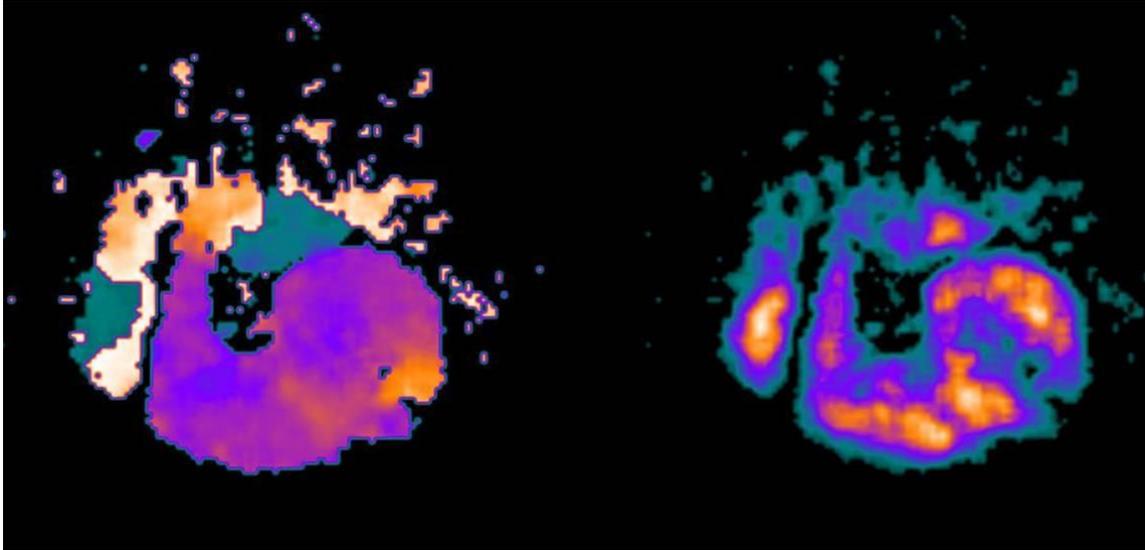
C: Incorrect. Typical doses for regional neck metastasis can range from 100-150 mCi of I-131.

D: Correct. Typical doses for lung and bone metastasis is 175-200 mCi of I-131.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

4. Based upon these anterior phase (left) and amplitude (right) images from a radionuclide multigated acquisition cardiac blood pool (MUGA) study, which of the following findings is demonstrated?



- A. Normal wall motion
- B. Hypokinesis
- C. Akinesis
- D. Dyskinesis

Key: C

Rationale:

A: Incorrect. These images demonstrate abnormal wall motion in the region of the cardiac apex, with both abnormal phase and amplitude demonstrated.

B: Incorrect. There is demonstration of abnormal wall motion at the apex, with nearly zero amplitude, more consistent with akinesis, rather than hypokinesis.

C: Correct. Akinetic wall segments demonstrate absence of wall motion on amplitude images and abnormality in phase as well.

D: Incorrect. The apical wall motion is not 180 degrees out of phase with the remainder of the ventricle (i.e., not equivalent to the atrial phase angle).

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

5. What is the mechanism of localization of F18-FDG?
- A. Mitochondrial membrane binding
 - B. Binding of intracellular phosphorylated glucose
 - C. Uptake via surface transport receptors
 - D. Chemisorption

Key: C

Rationale:

A: Incorrect. This is the mechanism for Tc-99m sestamibi.

B: Incorrect. Both glucose and F-18 FDG are phosphorylated by hexokinase; this reaction traps them inside the cell.

C: Correct. Because phosphorylated F-18 FDG cannot be further metabolized via the glycolytic pathway, it is trapped in the cell and continues to accumulate proportionally to the glucose uptake by the cell.

D: Incorrect. This is the mechanism for Tc-99m HDP/MDP.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

6. What percent of bleeding Meckel diverticula have ectopic gastric mucosa?

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

Key: D

Rationale:

A: Incorrect.

B: Incorrect.

C: Incorrect.

D: Correct. Of symptomatic patients, ~50-60% have ectopic gastric mucosa within the diverticulum. However, greater 90% of Meckel's diverticula in patients presenting with gastrointestinal bleeding contain ectopic gastric mucosa.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

7. Which of the following is the primary rationale for the routine use of a 60 minute sincalide (CCK analog) infusion during hepatobiliary imaging?
- A. Decrease intestinal cramping
 - B. Decrease gallbladder ejection fraction variability
 - C. Increase sensitivity for chronic cholecystitis
 - D. Decrease gallbladder contractility

Key: B

Rationale:

A: Incorrect.

B: Correct. Sincalide is used to obtain a gallbladder ejection fraction. The best-validated reference dataset with the greatest number of healthy volunteers points to an infusion of 0.02 mg/kg over 60 min. This results in the least variability of reference values and may be considered the method of choice. The reference GBEF with this methodology should be 38% or greater. Shorter infusions showed a number of healthy subjects with very low GBEFs that would be commonly reported as pathologic raising a false positive test result.

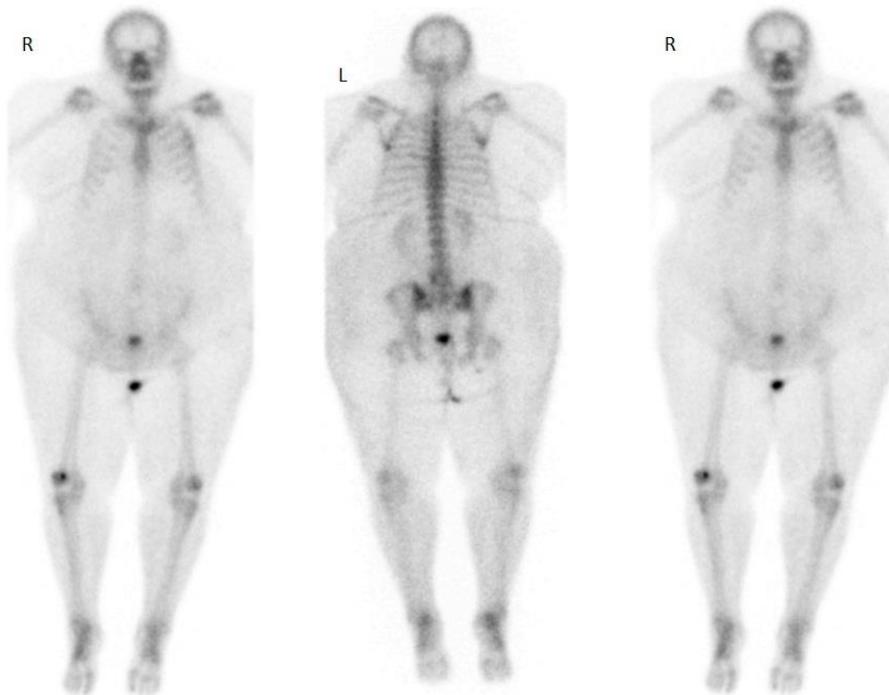
C: Incorrect.

D: Incorrect.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

8. A 61-year-old female undergoes the following study. What is the best explanation of the chest wall findings?



- A. Healing rib fractures
- B. Post-operative change
- C. Photomultiplier tube artifact
- D. Edge packing

Key: B

Rationale:

A: Incorrect. No fractures are present. Left ribs are better seen due to less soft tissue attenuation from prior left mastectomy.

B: Correct. Left ribs are better seen due to less soft tissue attenuation from prior left mastectomy.

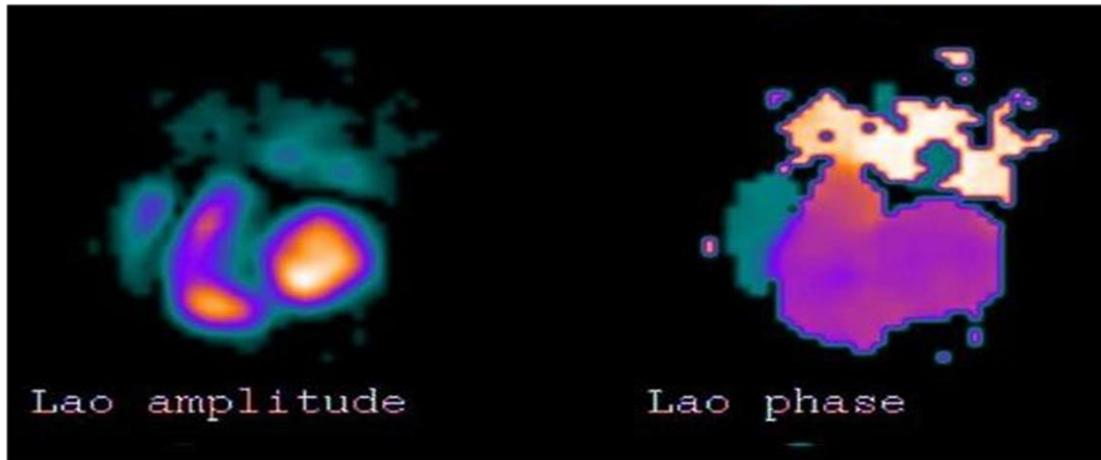
C: Incorrect. This quality control problem would general cause a focal geometric defect.

D: Incorrect. This would be a bright ring around the edge of the image which appears as a characteristic non-uniformity in the image. This artifact results from a somewhat greater light collection efficiency for events near the edge when compared to central regions of the detector crystal. It occurs as a result of internal reflections of scintillation light from the sides of the detector back into the photomultiplier tubes near the edge.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

9. You are shown images from a study obtained in a 42-year-old female on chemotherapy for breast carcinoma. Which one of the following is the maximum acceptable percent of aberrant beats permitting accurate assessment of regional wall motion and left ventricular ejection fraction?



- A. 5
- B. 10
- C. 15
- D. 20

Key: B

Rationale:

A: Incorrect.

B: Correct. Data distortion caused by arrhythmias is in part related to aberrant cardiac beats of which < 10% can be tolerated.

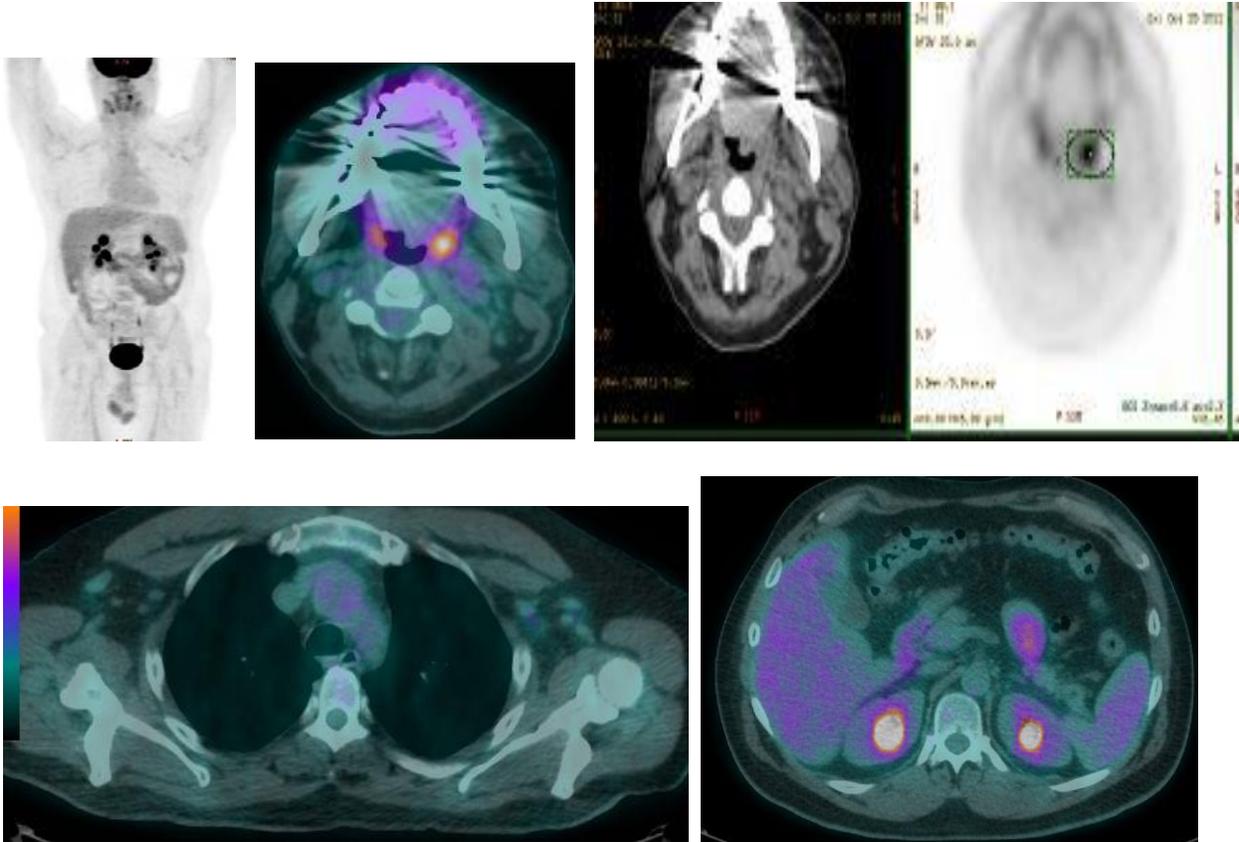
C: Incorrect.

D: Incorrect.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

10. A 55-year-old patient with Hodgkin Lymphoma presents after 2 cycles of chemotherapy. He complains of persistent neck fullness and mild fatigue. He has had no febrile episodes or recent procedure on the neck or chest. Based on this history and the images presented, what is this patient's stage of disease?



- A. IA
- B. IAE
- C. IIA
- D. IIAE

Key: C

Rationale:

A: Incorrect.

B: Incorrect.

C: Correct. Neck AND Axillary uptake. No uptake below the hemidiaphragm. Testicular uptake is normal.

D: Incorrect.

Reference:

Bennett, P and Oza, U. Diagnostic Imaging: Nuclear Medicine 2nd edition. Philadelphia: Elsevier, 2016.

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



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1. A 5-month-old child presents with skin nodules and abdominal distension. Based on the CT image shown, which of the following is the MOST likely diagnosis?



- A. Adrenal hemorrhage
- B. Metastatic Wilms tumor
- C. TORCH infection
- D. Neuroblastoma

Key: D

Findings: Calcification in the left adrenal gland, and extensive, diffuse liver lesions altering parenchymal architecture.

Rationale:

A: Incorrect. Adrenal hemorrhage is a differential consideration when there is isolated adrenal calcification present. However, there are also multiple liver lesions present which makes adrenal hemorrhage a less likely consideration based on the available choices.

B: Incorrect. Although Wilms tumor can metastasize to the liver, adrenal calcifications are not associated with Wilms tumor; furthermore, there is no evidence of renal tumor.

C: Incorrect. Liver lesions and adrenal calcifications in the setting of a TORCH infection would be an unusual presentation. Of the available choices, TORCH infection is considered a less likely consideration based on the available choices.

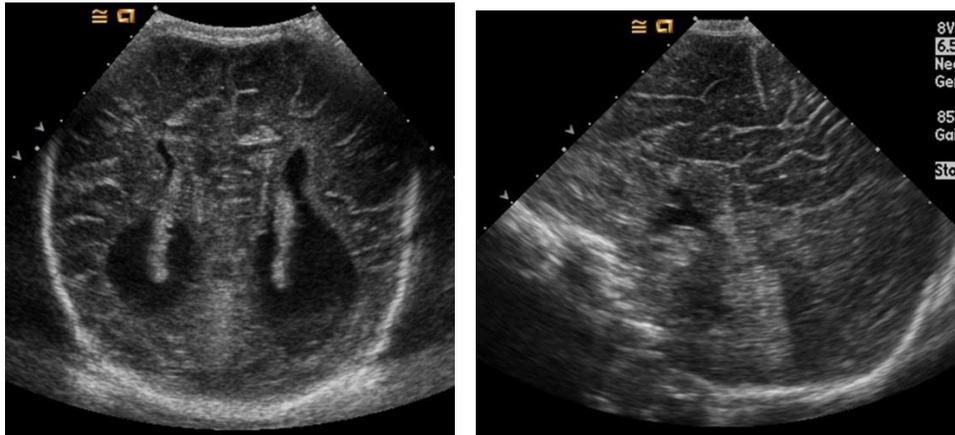
D: Correct. There is a left adrenal calcified mass as well as multiple masses seen throughout the liver. Stage 4-S neuroblastoma includes metastatic disease confined to liver, skin, and/or bone marrow in a child under one year of age, and this is the most likely diagnosis.

References:

Chu, C.M., et al. Clinical presentations and imaging findings of neuroblastoma beyond abdominal mass and a review of imaging algorithm. *Br J Radiol*, 2011. 84(997): p. 81-91.

2. Kembhavi, S.A., et al. Imaging in neuroblastoma: An update. *Indian J Radiol Imaging*, 2015. 25(2): p. 129-36.

2. A 2-day-old infant presents with seizures. What is the MOST likely diagnosis?



- A. Aqueductal stenosis
- B. Semilobar holoprosencephaly
- C. Dandy Walker malformation
- D. Agenesis of the corpus callosum

Key: D

Findings: Dilatation of the occipital lobes of the lateral ventricles (colpocephaly), parallel lateral ventricles, absent corpus callosum on midline sagittal image, with sulci radiating from third ventricle.

Rationale:

A: Incorrect. There is enlargement of the occipital horns as part of the malformation, not due to obstructive hydrocephalus. There is typical parallel orientation of the lateral ventricles, and the corpus callosum is absent.

B: Incorrect. In holoprosencephaly there is absence of the corpus callosum because of failure of cleavage of the prosencephalic vesicle into two hemispheres. This is not true in this case, in which there are two hemispheres.

C: Incorrect. In Dandy Walker, there is absence/hypoplasia of the cerebellar vermis, with obstruction at the foramina of Luschka and Magendie, resulting in a large posterior fossa cyst and lambdoid-torcular inversion. Although agenesis of the corpus callosum may be associated with Dandy Walker malformation, the latter is not present here.

D: Correct. The findings enumerated are classic findings in agenesis of the corpus callosum.

References:

Curnes, J.T., et al. MRI of corpus callosal syndromes. *AJNR Am J Neuroradiol*, 1986. 7(4): p. 617-22.

Hernanz-Schulman, M., et al. Sonographic appearance of callosal agenesis: correlation with radiologic and pathologic findings. *AJNR Am J Neuroradiol*, 1985. 6(3): p. 361-8.

3. A 4-month-old child with a cough and abnormal chest radiograph has a CT scan performed. Based on the provided axial image, what is the MOST likely diagnosis?



- A. Neuroblastoma
- B. Teratoma
- C. Bronchogenic cyst
- D. Round pneumonia
- E.

Key: C

Findings: There is a rounded, sharply marginated, low attenuation middle mediastinal mass at the level of the aortic arch.

Rationale:

A: Incorrect. The mass is paratracheal, retrocaval and is of homogeneous fluid attenuation. Neuroblastoma would present with a solid mass arising in the posterior mediastinum. Furthermore, there is no evidence of intra-spinal extension, a finding that, while not always present, would favor neuroblastoma.

B: Incorrect. A teratoma would arise in the anterior mediastinum. Although teratomas can be predominantly cystic, the presence of fatty and/or calcific densities, which are not seen here, would more strongly favor the diagnosis of teratoma.

C: Correct. Bronchogenic cysts typically occur in the middle mediastinum just above the carina (but can be seen from the suprasternal level to below the diaphragm). The sharply marginated, rounded configuration of this lesion is very compatible with a bronchogenic cyst. Bronchogenic cysts are typically fluid or soft tissue attenuation (although proteinaceous fluid can have higher attenuation).

D: Incorrect. While round pneumonias can occur in the perihilar region, the lesion in this case is centered in the mediastinum rather than the parenchyma of the lung. Also, the attenuation would be expected to be higher in a case of round pneumonia.

References:

Jeung, M.Y., et al. Imaging of cystic masses of the mediastinum. *Radiographics*, 2002. 22 Spec No: p. S79-93.

Juanpere, S., et al. A diagnostic approach to the mediastinal masses. *Insights Imaging*, 2013. 4(1): p. 29-52.

4. A 6-month-old cyanotic child undergoes a chest radiograph. What is the MOST likely diagnosis?



- A. Ebstein anomaly
- B. Ventriculoseptal defect
- C. Type III total anomalous pulmonary venous return
- D. Tetralogy of Fallot

Key: D

Findings: The heart is moderately enlarged. Pulmonary vascularity is moderately decreased, and there is a right-sided aortic arch, with concavity of the main pulmonary segment and elevation of the cardiac apex, resembling a “sabot”.

Rationale:

A: Incorrect. Cardiomegaly is typically severe in patients with Ebstein anomaly, and pulmonary vascularity is usually more diminished. Further, a right aortic arch is not typically seen in patients with Ebstein anomaly

B: Incorrect. Pulmonary vascularity is usually increased in patients with ventriculoseptal defect (VSD). Furthermore, patients with isolated VSD would not be expected to have cyanosis.

C: Incorrect. Patients with total anomalous pulmonary venous return (TAPVR) can have supra-diaphragmatic or infra-diaphragmatic anomalous pulmonary venous return. In the former (Types I and II), the pulmonary vasculature is typically increased due to a left-to-right shunt, which is not the case here. In the latter (Type III), the heart is typically normal or small in size, and there is pulmonary venous congestion rather than shunt vascularity due to the severe obstruction in the common pulmonary vein. These findings are not present here.

D: Correct. A right aortic arch as in this patient is a finding in 20-30% of patients with TOF. The upturned cardiac apex seen on this chest radiograph is a common finding in patients with TOF. The combination of a right arch and an upturned cardiac apex in a patient with cyanosis suggests that TOF is the most likely diagnosis in this case.

Reference:

Downing, T.E. and Y.Y. Kim, *Tetralogy of Fallot: General Principles of Management*. *Cardiol Clin*, 2015. 33(4): p. 531-41, vii-viii.

5. A 14-month-old-child with respiratory distress undergoes a chest radiograph. What is the appropriate next step?



- A. Follow-up radiographs in 3-4 weeks
- B. Computed tomography
- C. Bilateral decubitus radiographs
- D. MRI

Key: C

Findings: Unilateral air trapping in the right lung.

Rationale:

A: Incorrect. Delayed radiographs would delay the diagnosis, and this answer is incorrect.

B: Incorrect. CT scan would not dynamically evaluate the airway to demonstrate persistent air trapping in the right lung, and would ordinarily involve more radiation exposure than decubitus radiographs, or brief chest fluoroscopy.

C: Correct. A common cause of unilateral air-trapping in this age group is aspirated foreign-body, which may have an indolent presentation. Bilateral decubitus radiographs will demonstrate a lack of the obligatory volume loss in the dependent lung if it is obstructed by an endobronchial foreign body. Fluoroscopy of the chest likewise would demonstrate inability of the partially obstructed lung to deflate.

D: Incorrect. MRI in this age group would need sedation and only delay the diagnosis, which is easily and rapidly made with decubitus radiographs or fluoroscopy. Once diagnosed, these are removed bronchoscopically to prevent complications such as chronic bronchiectasis.

Reference:

Rotta, A.T. and B. Wiryawan, *Respiratory emergencies in children*. *Respir Care*, 2003. 48(3): p. 248-58; discussion 258-60.

6. Newborn infant with abdominal distension and history of oligohydramnios. Which of the following is MOST LIKELY to be associated with these sonographic findings?



- A. Pulmonary hypoplasia
- B. Autosomal dominant inheritance pattern
- C. Congenital biliary atresia
- D. Posterior urethral valves

Key: A

Findings: Bilaterally markedly enlarged, hyperechoic kidneys.

Rationale:

A: Correct. By far the most common cause of bilaterally enlarged cystic kidneys in an infant is autosomal recessive polycystic kidney disease (ARPKD). The echogenic kidneys are caused by dilated collecting tubules and finding is always bilateral. Patients with ARPKD who present in the neonatal have oligohydramnios and pulmonary hypoplasia. Some, but not all, patients with ARPKD have dilated biliary ducts, although all have congenital hepatic fibrosis (ductal plate malformation). Rarely, autosomal dominant polycystic kidney disease can present in neonates but a few round cysts are noted. Patients with ADPKD may have hepatic cysts but these are not associated with ARPKD.

B: Incorrect. ARPKD is inherited as an autosomal recessive, as the name indicates.

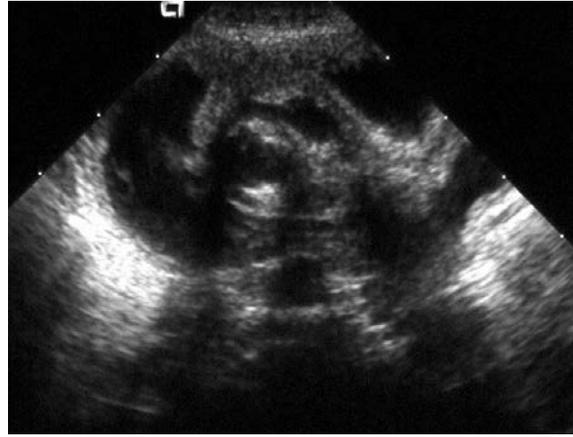
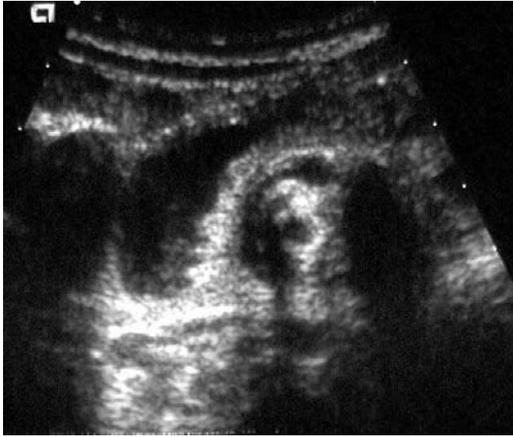
C: Incorrect. All patients with ARPKD have congenital hepatic fibrosis (ductal plate malformation) and some, but not all, have dilated biliary ducts (Caroli disease). Biliary atresia is not part of the syndrome.

D: Incorrect. Renal cystic dysplasia can be seen in association with posterior urethral valves. However, the findings in the kidneys of the test case are not those of cystic renal dysplasia which presents normal size kidneys which are hyperechoic with scattered macroscopic cysts of varying size; instead, they are classic of autosomal recessive polycystic kidney disease, which is not associated with posterior urethral valves.

Reference:

Chung, E.M., et al., From the radiologic pathology archives: pediatric polycystic kidney disease and other ciliopathies: radiologic-pathologic correlation. *Radiographics*, 2014. 34(1): p. 155-78.

7. A 7-day-old infant with vomiting has abdominal ultrasound performed. What is the MOST likely diagnosis?



- A. Midgut volvulus
- B. Pyloric stenosis
- C. Pancreatic hemangioma
- D. Duodenal duplication

Key: A

Findings: The sonographic findings denote a twist of the duodenum and mesenteric veins about the axis of the superior mesenteric artery

Rationale:

A. Correct. The findings are diagnostic findings of midgut volvulus.

B: Incorrect. Ultrasound findings of pyloric stenosis are those of thickening of the muscle and mucosa of the antropylic portion of the stomach. These findings are not present in the test case.

C: Incorrect. Pancreatic hemangiomas are very rare, and tend to present with jaundice rather than vomiting. Ultrasound would demonstrate a mass in the head of the pancreas, without the classic whirlpool abnormality seen on the test case.

D: Incorrect. Duodenal duplication presents as a simple or complex cyst with bowel signature, medial to the duodenum. Such findings are not present here.

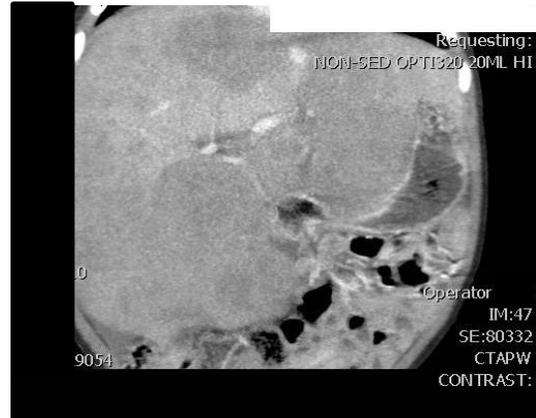
References:

Hernanz-Schulman, M., Imaging of neonatal gastrointestinal obstruction. *Radiol Clin North Am*, 1999. 37(6): p. 1163-86, vi-vii.

Hernanz-Schulman, M., Infantile hypertrophic pyloric stenosis. *Radiology*, 2003. 227(2): p. 319-31.

Hernanz-Schulman, M. The Duodenum and Small Intestine. *Congenital and Neonatal Abnormalities*. Chapter 103 *Caffeys Pediatric Diagnostic Imaging*, 12th Ed, Elsevier Volume 2.

8. A 5-month-old previously healthy boy presents with abdominal distension and skin nodules. What is the MOST likely diagnosis?



- A. Neuroblastoma
- B. Hepatoblastoma
- C. Cirrhosis
- D. Liver abscesses

Key: A

Findings: A small left adrenal mass with calcifications is seen on the non-contrasted scan. The liver is enlarged with multiple hypodense metastatic foci throughout both lobes.

Rationale:

A: Correct. The child was previously healthy. The skin nodules also represent metastatic foci. Neuroblastoma is the most common extracranial solid tumor during infancy. 15% metastasize to the liver. This presentation with skin nodules is characteristic of Stage IV-S, which is defined as tumor in an infant less than 1 year of age with metastases restricted to the liver, skin, and bone marrow (< 10% tumor) in whom the primary tumor is localized (INSS 1 or 2), that is, there is no infiltration across the midline or contralateral lymph node involvement.

B: Incorrect. Hepatoblastoma may be a consideration but would not explain the calcified adrenal mass in this previously healthy patient. Average age at presentation is 18 months.

C: Incorrect. Cirrhosis in infancy is almost always associated with history of chronic liver disease such as biliary atresia, chronic hepatitis or underlying metabolic disorders. No history of jaundice is given and the child is previously healthy. There is no splenomegaly.

D: Incorrect. Infections would present with fever, leukocytosis – a history of which is not provided. No history to indicate systemic infection is given. Further, this would not explain the adrenal mass.

References:

Chu, C.M., et al, Clinical presentations and imaging findings of neuroblastoma beyond abdominal mass and a review of imaging algorithm. *Br J Radiol*, 2011. 84(997): p. 81-91.2.

Kembhavi, S.A., et al. Imaging in neuroblastoma: An update. *Indian J Radiol Imaging*, 2015. 25(2): p. 129-36.

9. Based on this portable chest and abdomen radiograph in a newborn infant, what is the most likely diagnosis?



- A. Congenital high airway obstruction syndrome
- B. Thanatophoric dysplasia
- C. Surfactant deficiency disease
- D. Total anomalous pulmonary venous connection

Key: A

Findings: The lungs are enlarged with flattened or inverted hemidiaphragms. The airway distal to the obstruction is dilated; there is dilatation of the central bronchi bilaterally. The abdomen and flanks are distended, most likely with ascites secondary to hydrops. Although the chest appears small in this case, this is an illusion due to the more pronounced abdominal distention from severe ascites. The lungs are actually hyperexpanded as evidenced by the inverted hemidiaphragms. There is dilation of the central bronchi bilaterally. There is chest and abdominal wall edema.

Rationale:

A: Correct. Congenital high airway obstruction syndrome (CHAOS) is caused by in-utero high airway obstruction due to laryngeal atresia, laryngeal cyst, tracheal atresia or incomplete airway obstruction due to a laryngeal or tracheal web. The findings in the test case are typical of this condition.

B: Incorrect. There is no shortening of the ribs or the long bones and there is no evidence of flattening of the vertebral bodies as would be expected in thanatophoric dysplasia.

C: Incorrect. Although the lungs are hazy with a ground glass appearance as can be seen in surfactant deficiency disease (SDD), the appearance is not typical for that diagnosis. The lung volumes are usually decreased in SDD. While the lung volumes can be normal or even increased in patients with SDD after intubation and treatment with positive pressure ventilation, the hemidiaphragms would not be inverted and the central bronchi would not be dilated, as they are in this case. The abdominal distention due to ascites is also not part of SDD.

D: Incorrect. Patients with total anomalous pulmonary venous connections (TAPVC) have cardiomegaly and increased pulmonary vascularity due to left-to-right shunting if of the supradiaphragmatic type. In infradiaphragmatic TAPVC, there can be an interstitial edema pattern in the lungs (with a similar hazy appearance as seen in this case) with a normal or small heart size (as in this patient). However, the abdominal distention, the hemidiaphragm inversion, and the dilated central bronchi would not be expected findings in infradiaphragmatic TAPVC.

References:

Berrocal, T., et al. Congenital anomalies of the tracheobronchial tree, lung, and mediastinum: embryology, radiology, and pathology. *Radiographics*, 2004. 24(1): p. e17.

Dillman, J.R., S.G. Yarram, and R.J. Hernandez, Imaging of pulmonary venous developmental anomalies. *AJR Am J Roentgenol*, 2009. 192(5): p. 1272-85.

10. In this fetus referred for evaluation of a chest mass, what is the MOST likely diagnosis?



- A. Pulmonary blastoma
- B. Sequestration
- C. Bronchogenic cyst
- D. Congenital lobar overinflation

Key: C

Findings: Round cystic lesion at the left lung base

Rationale:

A: Incorrect. Pulmonary or pleuropulmonary blastoma is an extremely rare malignant tumor in children that can be cystic or solid. Retrospective reports have identified prenatal cysts in some of these patients. However, lesions are typically multicystic, and the diagnosis is so uncommon that it would not be the most likely choice.

B: Incorrect. Sequestrations typically are not round purely cystic lesions, and a large systemic vascular supply is present.

C: Correct. Bronchogenic cysts are classically isolated lesions that can be either central, adjacent to the mediastinum (including subcarinal), or in the pulmonary parenchyma. When central, they can cause an appearance of more distal airway obstruction due to mass effect.

D: Incorrect. CLO results from an obstruction, either mechanical or physiologic, of the bronchus, most often to the upper or the middle lobes. In utero, this results in lung fluid trapped in the obstructed lobe, with overdistension and mass effect including mediastinal shift. These findings are not present in the test case.

Reference: Rios, L.T., et al. Prenatal diagnosis and postnatal findings of bronchogenic cyst. Case Rep Pulmonol, 2013. 2013: p. 483864.

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



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Committee on Residency Training in Diagnostic Radiology*

1. Which radionuclide would require the use of a medium energy collimator to image a patient on a gamma camera?
- A. Co-57
 - B. Ga-67
 - C. F-18
 - D. Tc-99m

Key: B

Rationale:

A: Incorrect. Co-57 has a 122 keV gamma ray and is imaged using a low-energy collimator.

B: Correct. Ga-67 has 3 primary gamma rays, with gamma ray energies of 93, 184 and 300 keV.

C: Incorrect F-18 is used in PET imaging. Although in the past some gamma cameras were used for F-18 imaging, the 511 keV photon energy is too high for a medium energy collimator.

D: Incorrect. Tc-99m has a 140 keV gamma ray, and is used with a low-energy collimator.

Reference:

The Essential Physics of Medical Imaging, JT Bushberg, JA Seibert, EM Leidholdt, Jr., JM Boone, 3rd edition (2012), page 679.

2. A chief advantage of digital radiography systems over screen film systems is:
- A. wider exposure latitude.
 - B. superior spatial resolution.
 - C. immunity to quantum mottle.
 - D. better x-ray energy discrimination.

Key: A

Rationale:

A: Correct. Digital detector devices have the characteristics of separating the detection, display and archiving functions that are provided “all-in-one” for a screen-film receptor. In order to achieve appropriate image contrast for a radiograph, the film must convert the variations in exposure into variations in optical density over the “linear” portion of the characteristic curve with a high gradient (slope), with a typical value of 3 or more. On either side of the linear portion are the toe (underexposed area) and the shoulder (overexposed area) of the film, where the gradient is low and the radiographic contrast is correspondingly poor. Digital detectors can capture the exposure variations linearly (with a gradient = 1) over the full dynamic range, and depend upon subsequent image processing to render the radiographic contrast appropriately for the diagnostic task.

B: Incorrect. Most, if not all digital detectors have poorer spatial resolution than the corresponding screen-film detector.

C: Incorrect. Quantum mottle is determined by the amount of exposure incident on the detector. Neither system is immune to quantum mottle, but digital systems in particular can achieve an appropriate brightness and contrast in the output image despite the incident exposure to the detector. However, the underexposed images will readily manifest quantum mottle, and the overexposed images will have reduced quantum mottle that doesn't improve the diagnostic usefulness of the image, and therefore inflicts an unnecessary exposure to the patient.

D: Incorrect. Neither screen-film nor current digital radiography detectors have energy discrimination capabilities. They are both energy integrators.

Reference:

The Essential Physics of Medical Imaging, JT Bushberg, JA Seibert, EM Leidholdt, Jr., JM Boone, 3rd edition (2012), Chapter 7.

3. Which of the following BEST represents the acquisition time for a standard spin-echo pulse sequence?

- A. $TR \times TE \times \# \text{ averages}$
- B. $TR \times TI \times \# \text{ averages}$
- C. $TR \times \# \text{ phase encode steps} \times \# \text{ averages}$
- D. $TE \times \# \text{ phase encode steps} \times \# \text{ averages}$

Key: C

Rationale:

A: Incorrect. Acquisition time is determined by the time required to fill the requisite number of lines in k-space, which in turn is determined by the repetition time, the number of phase encode steps determine the specific row of k-space to be filled, and the number of averages (or excitations) per row.

B: Incorrect. TI, inversion time, is not a variable for standard spin-echo imaging.

C: Correct. See Rationale A (above).

D: Incorrect. The TE occurs over a much shorter time than the TR.

Reference:

The Essential Physics of Medical Imaging, JT Bushberg, JA Seibert, EM Leidholdt, Jr., JM Boone, 3rd edition (2012), pages 450-451.

4. What is the annual permissible effective dose equivalent for the general public in the United States, in the context of shielding a medical radiation facility?
- A. 1 mSv (0.1 rem)
 - B. 5 mSv (0.5 rem)
 - C. 10 mSv (1 rem)
 - D. 50 mSv (5 rem)

Key: A

Rationale:

A: Correct. According to NCRP 116, the annual effective dose equivalent for the general public is 1 mSv. This is described as the limit for continuous or frequent exposures, and NCRP 147 (Structural Shielding Design for Medical X-Ray Imaging Facilities, p. 5) refers to NCRP 116 and states that the 1 mSv annual limit applies to shielding design.

B: Incorrect. 5 mSv is not the limit used in shielding design, for annual public dose. However, there are situations related to infrequent exposure where 5 mSv is allowed, such as exposure to a patient administered a radionuclide and cannot be released from the hospital. (see 10 CFR 20.1301).

C: Incorrect. See explanation for A and B.

D: Incorrect. 50 mSv is the annual occupational dose limit.

Reference:

NCRP 116, NCRP 147, and NRC regulation 10 CFR 20.1301.

5. During the preimplantation stage of pregnancy, what is the most likely adverse effect due to a radiation exposure of 200 mGy (20 rads)?
- A. Embryonic death
 - B. Gross malformation
 - C. Growth retardation
 - D. Low birth weight

Key: A

Rationale:

A: Correct. The fetus is sensitive to radiation during the pre-implantation stage animal data suggests fetal death is possible after 200 mGy. If the fetus survives, it will most likely develop normally, therefore this stage is sometimes referred to as the period of “all or none” effect from radiation

B: Incorrect. This effect is possible during the organogenesis stage, but not during the pre-implantation stage.

C: Incorrect. This effect is possible during the organogenesis or fetal stage, but not during the pre-implantation stage.

D: Incorrect. During the preimplantation stage sufficient radiation may cause fetal death, if not, the fetus will develop normally.

References:

ACR-SPR Practice Guidelines for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation, 2013.

The Essential Physics of Medical Imaging, JT Bushberg, JA Seibert, EM Leidholdt, Jr., JM Boone, 3rd edition (2012), pages 823-832.

6. What is the average annual natural background radiation level in the United States?

- A. 0.031 mSv/yr
- B. 0.31 mSv/yr
- C. 3.1 mSv/yr
- D. 31 mSv/yr

Key: C

Rationale:

A: Incorrect. The correct number is 3.1 mSv/year.

B: Incorrect. The correct number is 3.1 mSv/year.

C: Correct. According to NCRP Report 160, average annual natural background radiation in the United States is 3.1 mSv/year.

D: Incorrect. The correct number is 3.1 mSv/year.

Reference: NCRP Report 160, pages 2-4.

7. Portable radiographs taken with a film-screen system utilizing a fixed radiographic grid tend to have less contrast than radiographs taken in radiography rooms because of which of the following?
- A. Use of lower kVp
 - B. Use of higher mAs
 - C. Use of lower grid ratio radiographic grid
 - D. Use of higher speed film-screen system

Key: C

Rationale:

A: Incorrect. Lower kVp would increase contrast.

B: Incorrect. Higher mAs would darken film, but not change contrast.

C: Correct. Lower grid ratio radiographic grid is used to minimize cutoff from poor alignment, however the lower grid ratio yields less cleanup of the scatter radiation.

D: Incorrect. Higher speed film-screen does not necessarily reduce contrast.

Reference: www.sprawls.org/ppmi2/SCATRAD/.

8. As exemplified in the Image Gently® website, all of the following are appropriate to lowering radiation dose in pediatric CT, EXCEPT:
- A. Reduce mAs
 - B. Reduce kVp
 - C. Reduce pitch
 - D. Reduce gantry rotation time

Key: C

Rationale:

A: Incorrect. The product of the tube current and exposure time, referred to as the mAs, determines the number of x-rays produced during the scan. Lowering the mAs reduces the dose, however, it will increase the noise in the images.

B: Incorrect. A lower kVp will reduce patient dose, although it will increase noise if everything else remains the same.

C: Correct. Reducing pitch to a smaller value will increase radiation dose.

D: Incorrect. Reducing gantry rotation time reduces the mAs, by reducing the exposure time. The number of x-rays produced during the scan is decreased.

Reference: American Journal of Roentgenology. 2010; 194:868-873.

9. Which of the following recommendations should be given to a nursing/lactating mother prior to the I-131 therapy?
- A. Cease breast-feeding and discard breast milk for one week post administration
 - B. Cease breast-feeding for 48 hours and discard breast milk during that time
 - C. Cessation of breast feeding 48 hours before therapy, then resume after therapy
 - D. Complete cessation of breast-feeding for this child, ideally ceasing 4-6 weeks before therapy

Key: D

Rationale:

A: Incorrect. This would present a significant radiation dose to the breast and one week is not enough time for elimination of I-131 and protect the child.

B: Incorrect. This would present a significant radiation dose to the breast and 48 hours is not enough time for elimination of I-131 and protect the child.

C: Incorrect. This would present a significant radiation dose to the breast and to the child.

D: Correct. This will provide the lowest radiation dose to the mother and child. Ceasing breastfeeding 4-6 weeks before the therapy allows time for lactating to stop before administration of I-131 and minimizes breast dose.

Reference:

The SNM Practice Guideline for Therapy of Thyroid Disease with I-131 3.0, Silberstein et al. 2012, available on SNMMI website.

10. Regarding MRI, which weighting generates the highest signal intensity in a conventional spin-echo pulse sequence?

- A. Proton-density
- B. T2
- C. T1
- D. Magnetization transfer contrast

Key: A

Rationale:

A: Correct. Proton density weighting is acquired with a long TR and a short TE. The long TR allows the tissues to develop a large signal as there is extended time for remagnetization of the tissues (MZ) prior to the next pulse. The short TE does not allow any significant decay of the transverse signal caused by spin-spin interactions.

B: Incorrect. Although T2 weighting requires a long TR, it also requires a long TE which diminishes the overall signal (although the T2 contrast differences are increased).

C: Incorrect. T1 weighting uses a relatively short TR, with significant partial saturation of the tissues and lower signal.

D: Incorrect. Magnetization transfer contrast uses off-resonance pulses to cause the partial saturation of protons associated with macromolecules, which diminishes the signals in the vicinity.

Reference:

The Essential Physics of Medical Imaging, JT Bushberg, JA Seibert, EM Leidholdt, Jr., JM Boone, 3rd edition (2012), pages 422-427, 473-474.

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



QUALITY IS OUR IMAGE

Released July 2017

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1. When does a corpus luteal cyst of pregnancy typically resolve or regress?
 - A. After ovulation
 - B. After implantation of embryo into endometrium
 - C. By 14 weeks
 - D. Typically maintained throughout pregnancy until term

Key: C

Rationale:

A: Incorrect. After ovulation. The corpus luteal cyst is formed from the dominant follicle after ovulation.

B: Incorrect. After implantation of embryo into endometrium. Implantation of the embryo typically occurs 6-12 days following ovulation. A corpus luteal cyst of pregnancy will not resolve or regress until 14 weeks.

C: Correct. By 14 weeks. A corpus luteal cyst of pregnancy typically resolves or regresses by 14 weeks. If a pregnancy does not develop, the corpus luteum typically begins to regress after 14 days.

D: Incorrect. Typically maintained throughout pregnancy until term. A corpus luteal cyst of pregnancy typically resolves or regresses by 14 weeks.

Reference:

Hertzberg BS and Middleton WD. Ultrasound: The Requisites, 3rd Edition. 2016 Elsevier, Adnexa.

2. In a stable patient with ultrasound findings concerning for cervical ectopic pregnancy versus incomplete abortion, which of the following would be the best management?
- A. Follow up with MRI
 - B. Dilatation and curettage
 - C. Repeat Ultrasound in 24 hours
 - D. Methotrexate or KCL injection

Key: C

Rationale:

A: Incorrect. Follow up with MRI. While some studies have shown MRI may be helpful in complicated cases, follow up with Ultrasound and HCG levels in 24 hours is first line management for a stable patient with suspected cervical pregnancy versus incomplete abortion.

B: Incorrect. Dilatation and curettage. Dilatation and curettage, the standard treatment for failed intrauterine pregnancy can potentially lead to catastrophic hemorrhage in patients with cervical ectopic pregnancy. Surgical intervention is reserved for unstable patients.

C: Correct. Repeat Ultrasound in 24 hours. If the patient is clinically stable, a repeat ultrasound and quantitative serum HCG levels can help differentiate cervical pregnancy from incomplete abortion. In patients undergoing an incomplete abortion, the gestational sac will be gone or will have changed in size and HCG level will decrease. By contrast, the appearance of the gestational sac and the HCG levels will be more stable in cervical ectopic pregnancy.

D: Incorrect. Methotrexate or KCL injection. For a stable patient with the diagnosis of cervical ectopic versus incomplete abortion in question, the next best step in management is repeat US and HCG in 24 hours. There is no consensus for the best management of diagnosed cervical ectopic however medical therapies such as Methotrexate or KCL injection are preferred over surgical interventions due to risk of bleeding associated with the later.

Reference:

EH Dibble and AP Lourenco. Imaging unusual pregnancy implantations: rare ectopic pregnancies and more. AJR 2016; 207:1380-1392.

3. A well-defined unilocular or multilocular cystic mass with diffuse low-level internal echoes describes which one of the following adnexal lesions?
- A. Hemorrhagic cyst
 - B. Dermoid
 - C. Endometrioma
 - D. Serous cystadenoma

Key: C

Rationale:

A: Incorrect. Hemorrhagic cyst. The most common appearance of a hemorrhagic cyst is a cyst with a fine reticular or “lace-like” internal echo pattern.

B: Incorrect. Dermoid. Characteristic sonographic signs of a dermoid include an echogenic, shadowing “dermoid plug” and interlacing hyperechoic linear and punctate echoes or “dermoid mesh.” The “tip of the iceberg” sign is used when only a small, superficial portion of the lesion is identified sonographically and the majority of the mass is obscured by acoustic shadowing. Fat fluid levels and intracystic floating fat lobules can also be identified sonographically.

C: Correct. Endometrioma. The characteristic sonographic appearance of an endometrioma is that of a well-defined unilocular or multilocular cystic mass with diffuse low-level internal echoes.

D: Incorrect. Serous cystadenoma. Serous cystadenomas are cystic lesions of the ovary which tend to be unilocular and typically 5-10 cm in size. They may have thin septations, and occasionally papillary projections.

Reference:

Hertzberg BS and Middleton WD. Ultrasound: The Requisites, 3rd Edition. 2016 Elsevier. Adnexa.

4. Which one of the following is a sonographic feature of hepatic hydatid disease?

- A. Cyst with peripheral hypervascularity
- B. Complex cyst with solid internal components
- C. Cyst with detached, floating endocysts
- D. Cyst with small central echogenic focus

Key: C

Rationale:

A: Incorrect. Cyst with peripheral hypervascularity. Peripheral calcifications may be seen in hepatic hydatid cysts.

B: Incorrect. Complex cyst with solid internal components. Hydatid cysts may have internal daughter cysts or debris.

C: Correct. Cyst with detached, floating endocysts. Sonographically hydatid cysts may appear as relatively simple cysts, cysts with multiple internal daughter cysts, cysts with detached floating endocystic membranes, cysts with internal debris and may contain internal or peripheral calcifications.

D: Incorrect. Cyst with small central echogenic focus. This is a sonographic feature of a fungal microabscess.

Reference:

Hertzberg BS and Middleton WD. Ultrasound: The Requisites, 3rd Edition. 2016 Elsevier, Liver.

5. In Budd-Chiari syndrome, the caudate lobe is:
- A. Spared and relatively enlarged
 - B. Spared and relatively small
 - C. Not involved
 - D. Similarly involved as the rest of the liver

Key: A

Rationale:

A: Correct. Spared and relatively enlarged. Budd-Chiari syndrome (BCS) is caused by obstruction of the hepatic veins. The caudate lobe is typically spared because the segmental veins which drain the caudate extend directly into the IVC at a lower level than the main hepatic veins. Over time the caudate will undergo compensatory hypertrophy while affected portions of the liver will atrophy.

B: Incorrect. Spared and relatively small. The caudate lobe is spared as described above. Over time the involved segments of liver will atrophy and the caudate will undergo compensatory hypertrophy causing it to appear relatively enlarged.

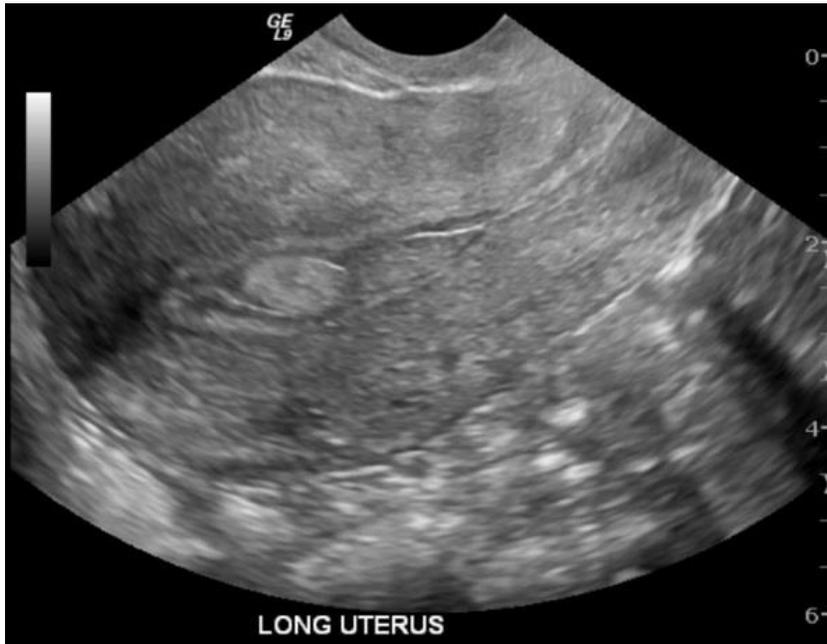
C: Incorrect. Not involved. While the caudate lobe is spared the initial insult, over time it will hypertrophy.

D: Incorrect. Similarly involved as the rest of the liver. The caudate lobe is typically spared because the segmental veins which drain the caudate extend directly into the IVC at a lower level than the main hepatic veins.

Reference:

Faraoun SA, et al. Budd-Chiari syndrome: an update on imaging features. *Clinical Imaging* 2016; 40(4): 637-646.

6. What would be the MOST appropriate next imaging study in this pre-menopausal female presenting with dysfunctional bleeding?



- A. Repeat ultrasound in 8 weeks
- B. Saline infusion sonohysterography
- C. Contrast-enhanced CT pelvis
- D. Biopsy

Key: B

Rationale:

A: Incorrect. Repeat ultrasound in 8 weeks. The endometrium is irregular and focally thickened in this patient. This is unlikely to represent a transient finding that will resolve over the course of two menstrual cycles.

B: Correct. Saline infusion sonohysterography. Further evaluation with saline infusion sonohysterography (SIS) is warranted in cases of endometrial thickening in the setting of dysfunctional uterine bleeding (DUB). SIS differentiates diffuse endometrial thickening, which could be blindly biopsied in a gynecology office, from either endometrial polyps or submucosal fibroids which should be biopsied/removed under hysteroscopic visualization.

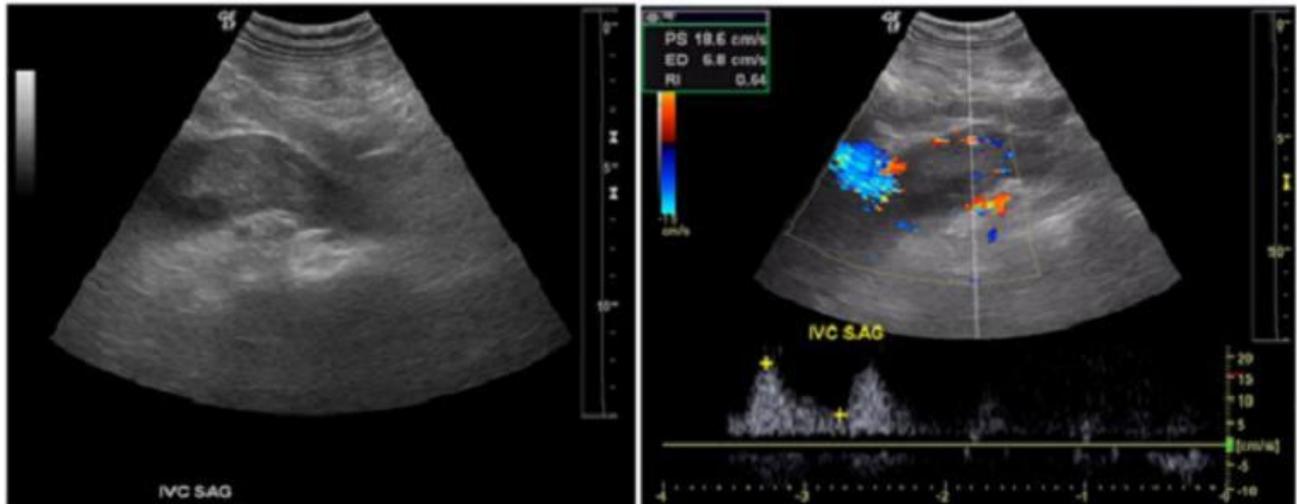
C: Incorrect. Contrast-enhanced CT pelvis. Ultrasound is preferred over CT when imaging the endometrium.

D: Incorrect. Biopsy. Additional imaging with SIS is preferred prior to biopsy. SIS can differentiate diffuse endometrial thickening, which could be blindly biopsied in a gynecology office, from either endometrial polyps or submucosal fibroids which would require hysteroscopic visualization for biopsy / removal.

Reference:

Goldstein SR. Modern evaluation of the endometrium. *Obstetrics & Gynecology* 2010; 116:168-175.

7. A 74-year-old male presents with bilateral lower extremity swelling. You are shown two sagittal images of the IVC, one grayscale, and the other color with spectral Doppler. Which one of the following is the MOST likely diagnosis?



- A. Bland thrombus
- B. Tumor thrombus
- C. AV fistula
- D. Pseudolesion

Key: B

Rationale:

A: Incorrect. Bland thrombus. The images show an echogenic mass distending the IVC. Color and spectral Doppler imaging shows arterial flow within this mass. Bland thrombus does not have internal arterial flow.

B: Correct. Tumor thrombus. The images demonstrate thrombus within the IVC with internal arterial vascularity consistent with tumor thrombus. The kidney is the most likely site of origin.

C: Incorrect. AV fistula. The waveform shown on the spectral Doppler image is arterial and is not consistent with an AVF.

D: Incorrect. Pseudolesion. In obese patients a pseudolesion may be seen as a B-mode artifact. Color Doppler analysis is helpful in confirming vessel patency.

Reference:

Smillie RP, Shetty M, Boyer AC et-al. Imaging evaluation of the inferior vena cava. Radiographics. 2015; 35 (2): 578-92.

8. A 38-year-old female was found to have an incidental 4 mm gallbladder polyp on an abdominal ultrasound. Which of the following is the recommended follow-up?
- A. No follow-up
 - B. Follow-up ultrasound in 1 year
 - C. Follow-up CT scan in 1 year
 - D. Cholecystectomy

Key: A

Rationale:

A: Correct. No follow-up. If a gallbladder polyp is less than 5mm, no further follow up is recommended as these are thought to be benign cholesterol polyps.

B: Incorrect. Follow-up ultrasound in 1 year. If a gallbladder polyp is less than 5mm, no further follow up is recommended as these are thought to be benign cholesterol polyps.

C: Incorrect. Follow-up CT scan in 1 year. CT is not recommended for evaluation of gallbladder polyp.

D: Incorrect. Cholecystectomy. If a gallbladder polyp is 10 mm or larger, then surgical removal is indicated because of the increased risk for a carcinoma.

References:

Sunit Sebastian, Cyrillo Araujo, Jeffrey D. Neitlich, Lincoln L. Berland. White paper: Managing incidental findings on abdominal/pelvic CT and MRI, Part 4: Gallbladder and biliary findings, JACR December 2013; 10(12):953-956.

Corwin MR, Siewert B, Sheiman RG and Kane RA. Incidentally detected gallbladder polyps: Is follow-up necessary? Long-term clinical and US analysis of 346 patient. Radiology 2011; 256:277-282.

9. A patient presents with swelling in the groin following a recent procedure. You are shown color Doppler images of the groin with and without spectral Doppler. Which of the following is the MOST likely diagnosis?



- A. AV fistula
- B. Pseudoaneurysm
- C. Arterial stenosis
- D. Partially occlusive thrombus

Key: B

Rationale:

A: Incorrect. In a peripheral artery, an AVF is seen as an area of persistent intra-arterial flow throughout the cardiac cycle. This can be best seen in diastole when normal arterial flow should stop. In addition, normal triphasic flow is lost.

B: Correct. A pseudoaneurysm is a collection of blood outside the vessel wall that communicates with an artery via a neck. This results in a swirling flow within the mass with a characteristic appearance on color and spectral Doppler. Pseudoaneurysms can be caused iatrogenically, or post traumatic. On color Doppler, there is a circular flow, "ying-yang", within the pseudoaneurysm itself, and on spectral Doppler of the neck there is a characteristic "to and fro" The Doppler waveform finding in the neck of a "to-and-fro" flow is a characteristic finding of a pseudoaneurysm. The "to" component is due to expansion of the cavity of pseudoaneurysm as blood enters during systole. The "fro" component is seen during diastole as the blood stored in the pseudoaneurysm is ejected back into the artery.

C: Incorrect. In a hemodynamically significant stenotic segment of an artery, the peak systolic velocity will be markedly increased and peak velocity distal to the stenosis will be decreased. Flow distal to a significant stenosis may also have an abnormal tardus parvus waveform.

D: Incorrect. Partially occlusive thrombus in an artery will be seen as a hypoechoic focus within the lumen with partial filling of the lumen.

10. In acute pyelonephritis, which of the following is the most common finding on ultrasound?

- A. Renal enlargement
- B. Normal appearing kidneys
- C. Focal, hypoechoic renal mass
- D. Loss of corticomedullary differentiation

Key: B

Rationale:

A: Incorrect. Renal enlargement. In the majority of patients with acute pyelonephritis the kidneys will appear normal. Renal enlargement is one of the findings that can be seen on sonography in acute pyelonephritis, though not the most common.

B: Correct. Normal appearing kidneys. The majority of kidneys with acute pyelonephritis will appear normal. If abnormalities are present they can include: renal enlargement, compression of renal sinus, abnormal echotexture, loss of corticomedullary differentiation, poorly marginated mass or masses, and gas within the renal parenchyma.

C: Incorrect. Focal, hypoechoic renal mass. The majority of kidneys with acute pyelonephritis will appear normal on sonography. If the pyelonephritis is focal, then a poorly marginated mass may be seen which can be hypoechoic, mixed echogenicity, or more commonly echogenic.

D: Incorrect. Loss of corticomedullary differentiation. The majority of kidneys will appear normal on sonography in acute pyelonephritis. Loss of corticomedullary differentiation is one of the findings that can be seen in acute pyelonephritis, though not the most common.

Reference:

Craig WD, Wagner BJ, Travis MD. From the archives of the afip pyelonephritis: radiologi-pathologic review. Radiographics 2008; 28:255-276.