

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



QUALITY IS OUR IMAGE

March, 2012

Sponsored by:

Commission on Education

Committee on Residency Training in Diagnostic Radiology

© 2012 by American College of Radiology. All rights reserved.

1891 Preston White Drive -- Reston, VA 20191-4326 -- 703/648-8900 -- www.acr.org

1. Based the on PLOPED II criteria for the interpretation of ventilation-perfusion scintigraphy studies in suspected pulmonary embolism, the presence of a "stripe sign" is best categorized as which ONE of the following?
 - A. **Very Low Probability**
 - B. Low Probability
 - C. Intermediate Probability
 - D. High Probability

Rationale:

- A. Correct. Based on the PLOPED II study, the positive predictive value of a perfusion defect with a stripe sign is 7%, which is categorized as very low probability, i.e., PPV is less than 10%. The stripe sign, which consists of the finding of an intact stripe of perfused tissue distal to the perfusion defect, is not typical of embolic defects, are associated with occlusion of the end-arterial supply, and therefore typically extend to the periphery of the lung.
- B. Incorrect. The stripe sign is usually associated with non-embolic defects, with a positive predictive value for PE of only 7% in the PLOPED II trial. Thus, this finding is most consistent with a very low probability for pulmonary embolism.
- C. Incorrect. The stripe sign is usually associated with non-embolic defects, with a positive predictive value for PE of only 7% in the PLOPED II trial. Thus, this finding is most consistent with a very low probability for pulmonary embolism.
- D. Incorrect. The stripe sign is usually associated with non-embolic defects, with a positive predictive value for PE of only 7% in the PLOPED II trial. Thus, this finding is most consistent with a very low probability for pulmonary embolism.

Reference:

Mettler, FA, Guiberteau, MJ Essentials of Nuclear Medicine Imaging Philadelphia, Elsevier 5th edition 2006, pp 178-183.

2. Which of the following organs is NOT normally visualized 20-30 minutes after intravenous administration of Tc-99m pertechnetate?
- A. Salivary gland
 - B. Thyroid
 - C. **Pulmonary parenchyma**
 - D. Choroid plexus

Rationale:

- A. Free pertechnetate is not really 'free' at all. When a molybdenum/pertechnetate generator is eluted with NaCl solution, the pertechnetate comes off the alumina column(Al_2O_3) and enters the eluate, while the Mo-99 remains adherent to the column. Saline elutes Tc-99m in the form of sodium pertechnetate ($NaTc-99mO_4$) from the column, while Mo-99 remains attached to it.
- B. Visualized organs/structures of the body after pertechnetate administration include: choroid plexus, thyroid gland, salivary glands, gastric mucosa (stomach/meckels diverticulum), renal/bladder, mucous membranes and sweat glands. Pertechnetate can be used as a vascular flow agent and it can be used routinely in scrotal scintigraphy as well as salivary gland imaging.
- C. See above
- D. See above

Reference:

Lyle J. Goodin, BSc, MRT(N), ACNM **Nuclear Medicine Technology Resource WebSite**
Comments:<http://www3.sympatico.ca/lgoodin/rp-1-0.htm>

Scott Williams MD et al **General Nuclear Medicine**
Comments:<http://www.auntminnie.com>

Sandler MP, Coleman RE et al **Diagnostic Nuclear Medicine, Fourth Edition** 2003. Fourth Edition

3. Which of the following characteristics of F-18 FDG (fluorodeoxyglucose) PET imaging is most responsible for its efficacy in oncology imaging?
- A. **Non-specific tracer uptake due to increased glucose metabolism.**
 - B. Size criteria for malignancy.
 - C. The fact that FDG undergoes glycolysis, like glucose.
 - D. Ability to definitively differentiate tumor from inflammation.

Rationale:

- A. Correct. This is the rationale for imaging tumors with FDG, as most tumors exhibit increased glucose metabolism, particularly those with higher metabolic rates and those which are less well-differentiated.
- B. Incorrect. This is the method used by CT and other anatomic imaging modalities used for tumor imaging.
- C. Incorrect. F-18 FDG is phosphorylated by hexokinase, like glucose, but is not able to participate further in the metabolic pathway, and does not undergo glycolysis, instead remaining trapped within cells. This is the principle involved in the persistent localization of FDG within malignant tumors.
- D. Incorrect. In general, the greater the FDG uptake, the more likely the presence of neoplastic involvement. However, some inflammatory conditions, such as sarcoidosis, can demonstrate markedly increased uptake, which can overlap with the degree of uptake in neoplastic processes.

Reference:

Ziessman, O'Malley and Thrall **Nuclear Medicine The Requisites third edition** 2006
Mettler and Guiberteau **Essentials of Nuclear Medicine Imaging** 2006

4. You are shown transaxial, sagittal and coronal Tc-99m RBC SPECT images obtained in a patient with a solitary right hepatic lobe mass with indeterminate enhancement characteristics on CT (not shown). Based on the images provided (Figure 1.A), which ONE of the following statements is correct?
- A. The findings are most consistent with a hepatic abscess.
 - B. **The findings are most consistent with a cavernous hemangioma.**
 - C. MRI is the next procedure of choice to further characterize the lesion.
 - D. CT-guided biopsy is indicated to exclude malignancy.

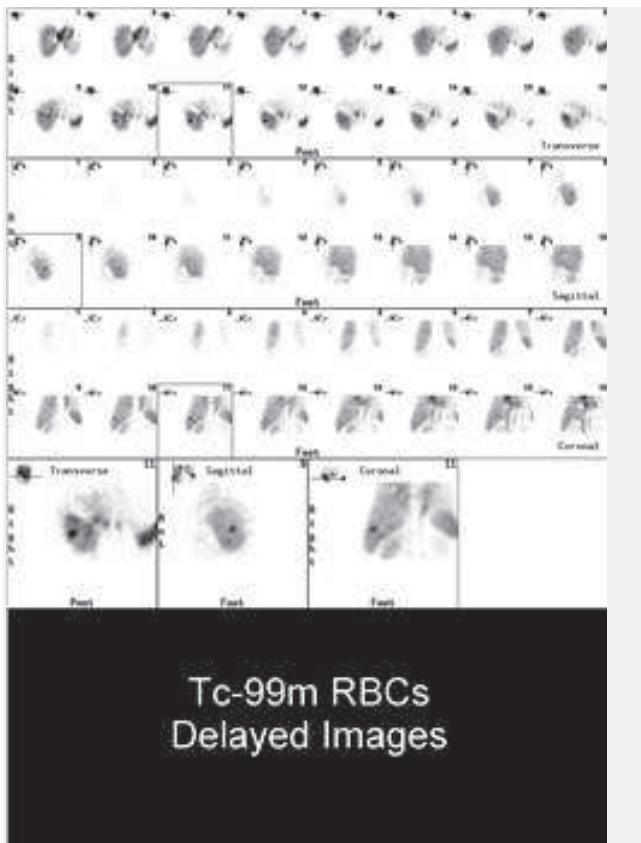


Figure 1.A Text: SPECT images obtained 1 hour after injection of labelled RBCs

Rationale:

- A. Incorrect. An abscess would have no internal blood pool activity and would be photopenic in appearance, rather than demonstrating the diffusely increased tracer uptake present in this case.
- B. Correct. The delayed hyperintense blood pool activity is characteristic for a benign cavernous hemangioma. The positive predictive value of this finding for cavernous hemangioma is nearly 100%, and generally does not require further confirmation.

C. Incorrect. MRI would be unlikely to add any additional information in this case. The scintigraphic findings are characteristic for a cavernous hepatic hemangioma.

D. Incorrect. The lesion is consistent with a cavernous hemangioma, and biopsy is unnecessary, and would additionally present an unnecessary risk of significant hemorrhage.

Reference:

Zeissman HA, O-Malley JP, Thrall JH Nuclear Medicine: The Requisites, 3rd Ed. Mosby/Elsevier 2006, pp. 190-195.

5. You are shown stress and rest vertical long-axis images (Figure 5) from a SPECT myocardial perfusion scan in a 50-year-old woman with chest discomfort. During treadmill exercise, the patient achieved 70% of the maximum predicted heart rate. What is the MOST likely explanation of the findings?
- A. Normal study
 - B. Diaphragmatic attenuation artifact
 - C. **Inferior wall ischemia**
 - D. Non-diagnostic study due to inadequate heart rate response

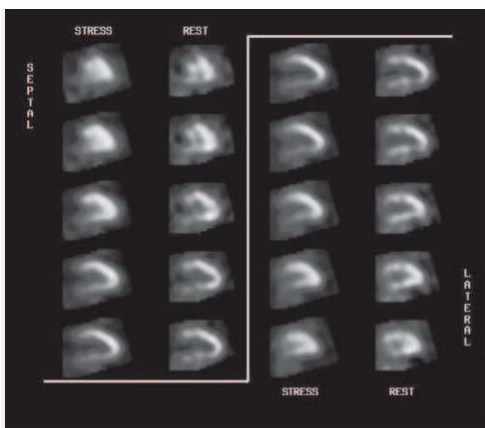


Figure 5

Rationale:

- A. Incorrect. There is a moderate reversible defect of mild severity noted in the inferior wall. This is not a normal study.
- B. Incorrect. Diaphragmatic attenuation can produce artifactual defects in the inferior wall region. Typically, diaphragmatic attenuation affects both the stress and resting studies, producing fixed defects, unless there is significant patient motion between the two sets of images. Diaphragmatic attenuation is more commonly seen in male patients. Therefore, while plausible, diaphragmatic attenuation artifact is not the most likely diagnosis in this case.
- C. Correct. The best explanation for the findings in this case is exercise-induced ischemia involving the inferior wall, corresponding to the right coronary artery territory.
- D. Incorrect. The patient achieved only 70% of maximum predicted heart rate during treadmill exercise. The usual target for exercise studies is 85% of maximum predicted heart rate (based on maximum predicted heart rate = $220 / \text{age}$). A submaximal exercise test reduces the sensitivity of the study. However, if the patient demonstrates ischemia despite failure to achieve the target heart rate, then the findings are still valid, although it should be noted that the degree or extent of exercise-induced ischemia may be underestimated.

Reference:

None

6. What factor is MOST important in identifying sentinel lymph nodes on breast lymphoscintigraphy studies?
- A. Nodal size
 - B. Proximity to the injection site
 - C. Intensity of uptake
 - D. **Timing of visualization**

Rationale:

- A. Incorrect. Nodal size is not a factor considered in identifying sentinel lymph nodes. The sentinel node(s) may or may not be the largest ones visualized, but are correctly identified as being the first node(s) visualized.
- B. Incorrect. The sentinel node(s) are often located close to the site of injection, and are usually closer to the injection site than other visualized nodes. However, as a result of the variability of lymphatic pathways, it is possible for the sentinel node to be located farther from the site of injection than other nodes that visualize later.
- C. Incorrect. The sentinel node may or may not be the "hottest" node seen on imaging. This factor is irrelevant in the identification of the sentinel node(s).
- D. Correct. The essential element in the identification of the sentinel node(s), whether single or multiple, is the fact that they are visualized prior to any other nodes seen.

Reference:

None

7. Concerning the presence of multiple focal "hot spots" on a Tc-99m macroaggregated albumin (MAA) scan, which one of the following is CORRECT?
- A. **The study may need to be repeated on another day.**
 - B. The patient is at risk for the development of acute hypoxemia.
 - C. A false positive study will result.
 - D. The patient has multiple arteriovenous malformations (AVMs).

Rationale:

- A. Correct. The finding of focal "hot spots" on a Tc-99m MAA scan indicates the aggregation of the radiopharmaceutical into larger particles, which lodge in the pulmonary vascular bed. This artifact may be produced by drawing blood back into the syringe during injection or by failing to resuspend the particles prior to injection, in the event the dose is left sitting for a prolonged time after being drawn up. While it is not associated with any adverse effects in the patient, these foci of increased activity may obscure portions of the underlying lungs, resulting in the need to repeat the study after significant radioactive decay has occurred.
- B. Incorrect. While technically these foci do represent small, iatrogenic pulmonary emboli, they are virtually never associated with any clinically demonstrable adverse effects. In general, pulmonary perfusion imaging with Tc-99m MAA is associated with transient occlusion of less than 0.1% of the pulmonary capillary bed. Thus, this occurrence is unlikely to produce acute hypoxemia.
- C. Incorrect. While these "hot spots" may obscure underlying detail in evaluating pulmonary perfusion, they are not associated with artifactual perfusion defects that would produce a false positive study.
- D. Incorrect. Pulmonary AVMs are associated with right to left shunting, permitting Tc-99m MAA particles to bypass the pulmonary capillary bed. Thus, AVMs would tend to produce focal perfusion defects, rather than focal areas of increased tracer localization.

Reference:

None

8. Concerning radionuclide myocardial perfusion imaging, which one of the following is NOT associated with an inferior wall perfusion defect on a stress Tc-99m sestamibi SPECT study?
- A. Inferior wall exercise-induced ischemia
 - B. Prior inferior wall myocardial infarction
 - C. **Left bundle branch block**
 - D. Diaphragmatic attenuation artifact

Rationale:

A. Incorrect. Inferior wall ischemia characteristically produces a perfusion defect in this region on stress myocardial perfusion images. In the case of reversible ischemia, the defect would be expected to resolve on a resting study.

B. Incorrect. An area of prior myocardial infarction typically produces a "fixed" perfusion defect, which would be visible both on stress and resting images. Thus, from evaluation of stress images alone, it cannot be differentiated from a defect due to exercise-induced ischemia, as in item A.

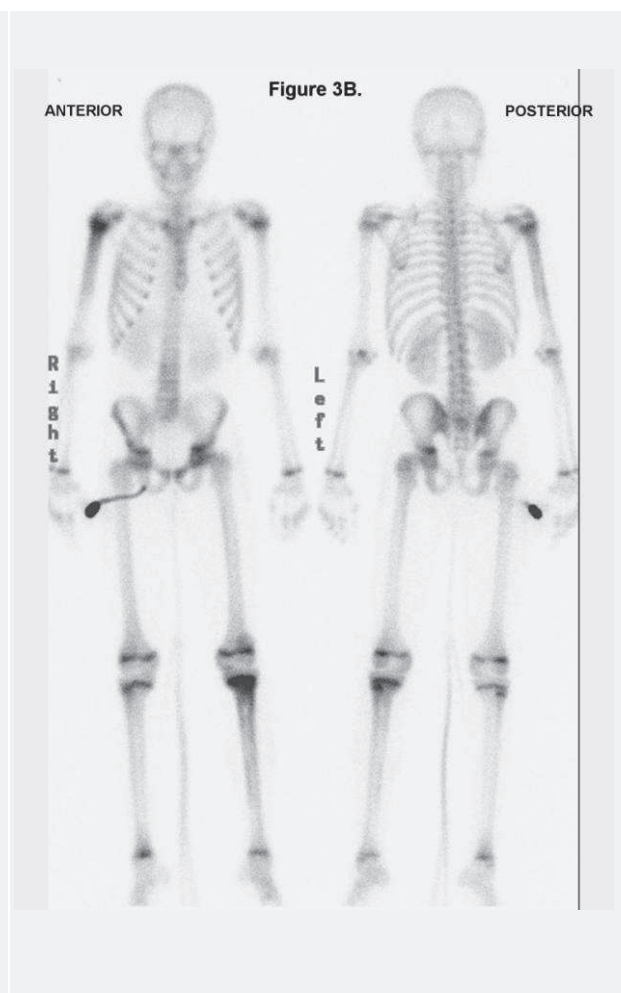
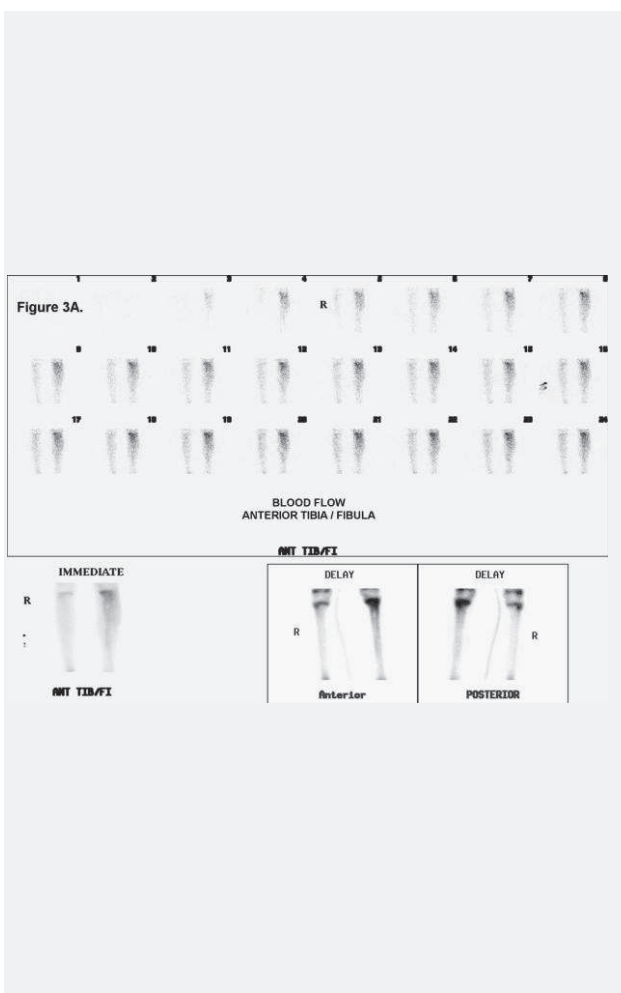
C. Correct. Left bundle branch block may be the result of myocardial ischemia or infarction, or may be an incidental finding. It may produce perfusion abnormalities on myocardial perfusion scintigraphy in the absence of coronary artery disease. When it produces abnormalities, the most common finding is a reversible perfusion defect in the interventricular septum, not in the inferior wall. In patients with known left bundle branch block, it is preferable to perform a pharmacologic stress test, using dipyridamole or adenosine, rather than treadmill exercise in conjunction with the imaging, since this artifact is more commonly associated with the latter procedure.

D. Incorrect. Diaphragmatic attenuation artifact commonly produces apparent defects in the inferior wall. These defects may or may not be present both on stress and resting images, and may be suspected by inspection of planar rotating images from the raw data set. This artifact most often occurs in male patients, and is more common in obese patients as well.

Reference:

Mettler FA and Guiberteau MJ: Essentials of Nuclear Medicine Imaging, 4th edition

9. You are shown flow, immediate and delayed static spot images and delayed whole body images from a three-phase Tc-99m MDP (methylene diphosphonate) bone scan in a previously healthy 11 year-old boy, presenting with worsening knee pain and fever. Which of the following diagnoses is MOST consistent with the imaging findings?
- A. Tibial stress fracture
 - B. Reflex sympathetic dystrophy
 - C. Metastatic neuroblastoma
 - D. **Osteomyelitis**



Rationale:

- A. Incorrect. The extent of the lesion is greater than typically seen with a stress fracture. In addition, there is also abnormal uptake at the right shoulder and left hip, indicating a multifocal process.
- B. Incorrect. Again, this is a multifocal process, and the distribution of the abnormality is not typical of reflex sympathetic dystrophy (RSD), which classically produces a "glove and stocking" peripheral distribution.
- C. Incorrect. Neuroblastoma can certainly metastasize to bone, and would typically involve the region of the physes (as in this case). However, osteomyelitis is a more likely diagnosis in an 11-year-old child.
- D. Correct. Although not specific, the findings in this case are consistent with multifocal osteomyelitis, which is the most likely diagnosis of the options listed.

Reference:

Comments: Taylor A, Datz. Clinical Practice of Nuclear Medicine. Churchill Livingstone. 1991. Zeissman HA, O'Malley JP, Thrall JH: Nuclear Medicine-The Requisites. 3rd ed. Mosby. 2006.

10. You are shown serial 3 minute posterior static images and renogram curves from a Tc-99m mercaptoacetyltriglycine (MAG3) renal scan (Figures 4A and 4B) performed in an adult with left hydronephrosis. Repeat images and curves obtained after intravenous administration of 40mg of furosemide (LasixR) are also shown (Figures 4C and 4D). Which one of the following statements is CORRECT?
- There is left ureteropelvic junction obstruction.
 - There is no evidence of anatomic obstruction.**
 - The study is non-diagnostic because of renal insufficiency.
 - 24 hour delayed images are necessary for a definitive diagnosis.



Figure 4.A

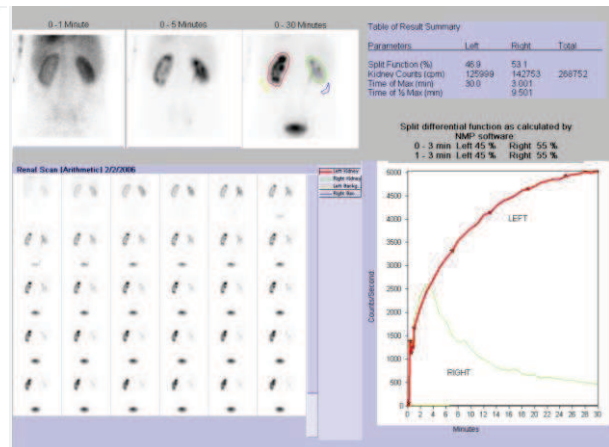


Figure 4.B

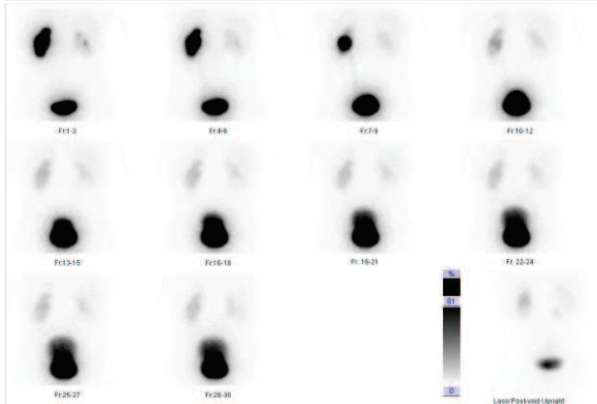


Figure 4.C

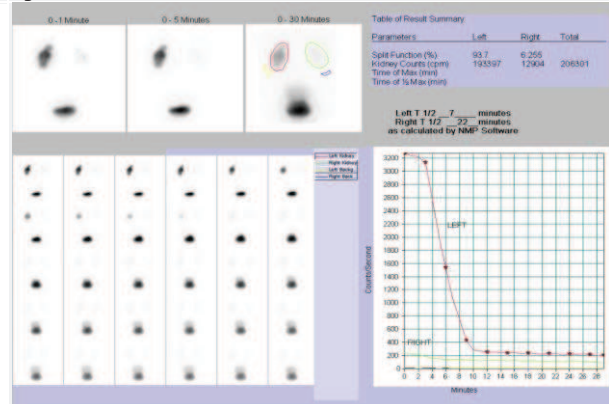


Figure 4.D

Rationale:

A. Incorrect. The baseline study is consistent with high-grade left ureteropelvic (UPJ) obstruction. However, on the diuretic portion of the study, there is prompt clearance of activity from the left renal calyces and renal pelvis, with a clearance half-time of 7 minutes, which is normal (normal < 10 minutes). Based on these results, there is no evidence of significant anatomic obstruction, and the findings are consistent with dilatation of the left renal collecting system without obstruction.

B. Correct. See discussion in A above.

C. Incorrect. If there is renal insufficiency, then the diuretic study may produce a false-positive result for obstruction, because the affected kidney(s) may be unable to respond to the loop-acting diuretic. Renal insufficiency would not produce a false negative result (ie. apparent non-obstruction in the face of significant anatomic obstruction). Furthermore, there is only mild impairment in left renal function, with normal right renal function in this case, thus this option is not a plausible explanation for the findings demonstrated.

D. Incorrect. The diagnosis of a dilated, non-obstructed left renal collecting system can be made on the basis of the available images alone, as discussed above, without the need for further delayed views, which would add nothing to the diagnosis in this case.

Reference:

None