Nuclear Radiology
In-Training Test Questions
for Diagnostic Radiology Residents

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Committee on Residency Training in Diagnostic Radiology

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1891 Preston White Drive -- Reston, VA 20191-4326 -- 703/648-8900 -- www.acr.org Item Number: 23
1. You are shown coronal images from an F-18 FDG PET study performed in a 62-year-old man with a history of alcohol abuse, presenting with abdominal pain. What is the MOST LIKELY diagnosis?

A. Hodgkin’s disease  
B. Metastatic colon carcinoma  
C. Hepatocellular carcinoma  
D. Pancreatic carcinoma

Findings:  
Coronal FDG-PET images demonstrate a focal area of markedly increased tracer uptake in the right lower quadrant, in the region of the cecum. There are multiple focal right iliac and paraaortic lymph node metastases and numerous focal hypermetabolic lesions in the liver, consistent with hepatic metastases.

Rationales:  
A. Incorrect. Hodgkin’s disease is usually highly FDG-avid, and commonly involves abdominal and pelvic lymph nodes and the liver. However, the more discrete focal lesion in the right lower quadrant is more typical for a primary lesion within the right colon. In addition, there is no splenomegaly or other sites of lymphadenopathy, which would commonly be seen in association with involvement of the liver and abdominal and pelvic nodes. Extensive involvement of the liver is also more common in non-Hodgkin’s lymphoma. Therefore, while Hodgkin’s disease is a plausible diagnosis, metastatic colon carcinoma is more likely in this case.
B. Correct. The findings in this case are typical for advanced carcinoma of the cecum, with increased FDG uptake noted in the primary lesion, regional lymph nodes, and extensive hepatic metastases visualized. FDG-PET imaging is highly sensitive for the staging and re-staging of colon carcinoma, and is substantially more sensitive and specific than CT for this purpose.

C. Incorrect. Hepatocellular carcinoma demonstrates variable FDG uptake on PET scans. It can be solitary or multifocal. However, it would be unusual to see lymph node metastases remote from the liver, and the larger focal lesion in the right lower quadrant would not constitute a typical site of metastatic involvement.

D. Incorrect. FDG uptake of pancreatic carcinoma is also variable. Multiple hypermetabolic hepatic metastases may occur, and can have the appearance seen in this case. However, adenopathy in the pelvis would be uncommon, and there is also no evidence of increased FDG uptake within a primary lesion in the pancreas. The small foci of increased uptake in the lower epigastric region could conceivably be located within the body of the pancreas, but are not striking, and are relatively inferiorly located. These foci are more consistent with small paraaortic lymph node metastases.

Citations:
2. A 54-year-old diabetic man presents 5 days following renal transplantation with pain at the graft site. You are shown anterior Tc-99m MAG-3 scintigraphic images of the pelvis. What is the MOST likely diagnosis?

A. Urinoma
B. Acute tubular necrosis
C. Lymphocele
D. Acute rejection

Findings:
There is prompt perfusion to the transplanted kidney in the right iliac fossa, with normal tubular transit time and prompt excretion into the collecting system and bladder. In addition, there is progressive accumulation of activity in the right lower quadrant appearing during the excretory phase of the study.
Rationales:
A. Correct. An often-painful surgical complication, urinary extravasation (urinoma) is demonstrated by progressive accumulation of tracer, which persists postvoiding. The current case findings are diagnostic of a urinoma.
B. Incorrect. Acute tubular necrosis (ATN), though common, is typically painless. ATN is associated with relatively preserved perfusion to the transplant with poor tubular function, without extrarenal tracer accumulation. The findings in this case are not consistent with ATN.
C. Incorrect. A common postsurgical complication, lymphoceles typically produce photopenic fluid collections adjacent to the transplant, since they are not in communication with the renal collecting system. In addition, lymphoceles are a later complication, not usually occurring during the first postoperative week.
D. Incorrect. Acute rejection is occasionally painful, and is associated with poor flow and function of the graft, manifested by delayed and reduced uptake and excretion by the transplanted kidney. Neither finding is present in this case. In addition, the progressive accumulation of activity in the right lower quadrant, surrounding the transplant, cannot be explained by acute rejection.

Citations:

3. A 2-month-old male with marked hypertension is referred for captopril renography. You are shown serial 1-minute posterior pre- and post-captopril images. What is the MOST LIKELY diagnosis?
A. Normal study
B. Right renal artery stenosis
C. Left renal artery stenosis
D. Bilateral renal artery stenosis

Findings: The baseline pre-captopril study demonstrates mildly decreased tracer uptake bilaterally, with normal excretion. The post-captopril images demonstrate significant bilateral deterioration in excretion, with marked cortical retention noted bilaterally.

Rationales:
A. Incorrect. Although initial (left) study appears symmetrically normal, there is clearly a bilateral delay in cortical clearance and excretion on the post-captopril study.
B. Incorrect. In unilateral right renal artery stenosis, ACE-inhibitor should create an asymmetric delay in right renal washout, not the bilaterally delayed washout present in this case.
C. Incorrect. In unilateral left renal artery stenosis, ACE-inhibitor should create an asymmetric delay in left renal washout, not the bilaterally delayed washout present in this case.
D. Correct. The post-captopril study fails to demonstrate sequential right and left renal pelvis and bladder activity seen at midpoint of the baseline pre-captopril study. Administration of the ACE inhibitor has produced a symmetric delay in renal cortical clearance, manifested by marked bilateral cortical retention and non-visualization of the renal pelves and bladder. These findings are typical for bilateral ACE-inhibition of compensatory post-glomerular vascular constriction, with resultant delay in transcortical clearance, in this child with bilateral congenital renal artery stenosis.
4. A 28 year-old HIV positive woman presents with headache, papilledema, and a ring-enhancing right thalamic mass on CT (not shown). You are shown a transaxial Tl-201 chloride image of the brain. What is the MOST LIKELY diagnosis?

A. Lymphoma
B. Cytomegalovirus infection
C. Toxoplasmosis infection
D. Normal study

Findings: Transaxial Tl-201 chloride SPECT images of the brain demonstrate a focal area of increased tracer uptake near the midline, in the region of the CT lesion in the basal ganglia.

Rationales:
A. Correct. CNS lymphoma may produce a ring-enhancing lesion on CT and is thallium-avid. These findings are most consistent with CNS lymphoma arising in an immunocompromised host.
B. Incorrect. CMV is not thallium-avid, as is the lesion in this case.
C. Incorrect. Toxoplasmosis can produce cerebral ring-enhancing CT lesion, but it is not thallium-avid, as is the lesion in this case.
D. Incorrect. The focal area of increased tracer uptake in the midline basal ganglia region represents a striking abnormality, which is not attributable to any normal finding. This is not a normal study.

5. Concerning infection imaging with In-111 labeled leukocytes, which one is CORRECT?

A. Uptake is dependent on regional blood flow.
B. It is insensitive for the detection of inflammatory bowel disease.
C. Transient pulmonary uptake clears within 15 minutes post-injection.
D. It is more sensitive than Ga-67 citrate imaging for detection of Pneumocystis carinii pneumonia (PCP).

Rationales:
A. Correct. While not the sole determinant of uptake, the uptake of In-111 labeled leukocytes is dependent upon regional blood flow. For example, a walled-off abscess without a direct blood supply will not accumulate In-111 labeled leukocytes, and may appear as a photopenic defect.
B. Incorrect. In-111 WBC imaging is very sensitive for active inflammatory bowel disease. It has advantages over Ga-67 citrate imaging in this clinical setting, as a result of the absence of normal bowel uptake of the tracer.
C. Incorrect. Transient lung uptake can be seen 4 hours after injection or even longer, sometimes making the diagnosis of pulmonary infection difficult.
D. Incorrect. In-111 WBC’s are less sensitive than Ga-67 citrate for detecting chest infections, such as PCP. As a result, Ga-67 citrate imaging is preferred in the clinical settings of suspected chest infection or in immunocompromised patients presenting with fever of unknown origin.

6. Concerning the presence of hydrolyzed reduced Tc-99m in a dose of Tc-99m MDP (methylene diphosphonate) administered intravenously for a bone scan, which is CORRECT?

A. It results in thyroid visualization.
B. It can be identified using a dose calibrator.
C. It is more likely to occur in the presence of excess stannous ion.
D. It occurs more commonly when multidose vials are used.

Rationales:
A. Incorrect. Hydrolyzed reduced technetium-99m is a colloidal impurity that results in hepatic and reticuloendothelial visualization, not thyroid visualization, which is typical of the presence of free pertechnetate as an impurity.
B. Incorrect. Only chromatography pre-imaging will detect this radiopharmaceutical impurity.
C. Incorrect. On the contrary, Sn(II)ion is a reducing agent protecting MDP from hydrolysis.

D. Correct. The introduction of air into a multidose MDP vial is the most frequent cause of this hydrolyzed technetium-99m contaminant. The more violations of the vial, the more likely air will be introduced.

7. Concerning treatment of intractable pain from widespread metastatic bone lesions with Metastron® (Sr-89) and Quadramet® (Sm-153), which one is CORRECT?

A. Both can be imaged using a gamma camera to assess the biodistribution of the therapeutic dose.
B. The longer half-life of Metastron (50 days) versus Quadramet (1.9 days) provides a superior therapeutic effect.
C. Because of the highly energetic beta particles produced by both agents, a lead syringe shield is employed during dose administration.
D. Recovery from bone marrow toxicity is faster following Quadramet administration.

Rationales:
A. Incorrect. Metastron is a pure beta emitter. The absence of an imagable gamma photon precludes verification of bone lesion uptake. By contrast, Sm-153 has an imagable gamma photon energy of 103 keV, permitting bone scintigraphy to be performed in conjunction with the therapeutic procedure.
B. Incorrect. While it is true that the half-life of Metastron is significantly longer, resulting in more prolonged lesion irradiation, the clinical efficacy of both treatments are quite similar.
C. Incorrect. Due to bremsstrahlung production of high energy photons when high atomic number material (eg. lead) is used for shielding, acrylics are the preferred material for handling of these materials. Materials with lower atomic numbers, such as plastic or acrylics make ideal shields. In addition, bremsstrahlung production is proportional to the atomic number, which is lower for these materials.
D. Correct. The major limitation of both therapies is myelosuppression. Metastron causes 15-30% drops in the platelet and WBC counts from pre-injection values, and Quadramet, 40-50%. However, 8-12 weeks are required for full bone marrow recovery from Metastron, versus only 6-8 weeks for Quadramet.
8. Concerning the biodistribution of Indium-111 ibritumomab tiuxetan (Zevalin®) 48 hours following intravenous administration, which one is CORRECT?

A. Persistent blood pool activity indicates the presence of a human anti-mouse antibody (HAMA) response.
B. Absence of bone marrow activity indicates > 25% marrow infiltration by lymphoma.
C. Renal activity less intense than hepatic is indicative of altered biodistribution.
D. Hepatic activity more intense than bowel uptake is normal.

Rationales:
A. Incorrect. The cardiac blood pool activity gradually decreases with time as Zevalin is distributed to the other organs and a small component is excreted. Persistent but decreased blood pool activity is normal at 48 hours. The development of a HAMA response occurs in < 2% of patients. More rapid clearance of the Zevalin antibody can occur with the development of a HAMA response, and hence, a shorter circulation time.
B. Incorrect. The Zevalin therapeutic regime should not be given to patient’s with greater than or equal to 25% lymphoma marrow involvement. Altered biodistribution is suggested with rapid blood pool clearance and increased marrow uptake.
C. Incorrect. Normal renal activity with Indium-111 Zevalin is generally manifested as faint activity (moderately low to very low activity), which is much less intense than hepatic uptake. Altered renal biodistribution is present if renal activity greater than liver is demonstrated on the posterior images.
D. Correct. Bowel activity is common and normal. However, normal gastrointestinal biodistribution is activity that is less intense than liver and decreases over time (moderately low to very low intensity). Bowel activity more intense than hepatic uptake is indicative of altered biodistribution.

9. Which of the following statements about agreement states is CORRECT?

A. They are states that agree to allow the Nuclear Regulatory Commission (NRC) to regulate radioactive by product material within their boundaries.
B. They are states that agree to regulate radioactive by product material within their borders on behalf of the NRC.
C. They are permitted to have less stringent regulations than the NRC.
D. A state can become an agreement state without prior notification of the NRC.

RATIONALES:
A. Incorrect. Agreement states regulate by-product material within their borders in place of the NRC.
B. Correct
C. Incorrect. Regulations in agreement states must be as stringent as NRC regulations, and can be more stringent.
D. Incorrect. Agreement states must demonstrate to the NRC that they have the capabilities to assume the NRC’s mission within their boundaries, and that the intended regulations are consistent with NRC rules and regulations and are as strict or more so.

References:

10. You are shown serial 5-minute anterior images and final right anterior oblique and right lateral images from a Tc-99m DISIDA hepatobiliary scan performed on a 55-year-old man with abdominal pain, fever and ascites, s/p paracentesis. What is the MOST LIKELY diagnosis?

A. Acute cholecystitis  
B. Bile leak  
C. Common bile duct obstruction  
D. Normal study

Findings:
There is prompt hepatic uptake, with early visualization of activity in the region of the gallbladder fossa. Faint, amorphous activity is noted inferior to the liver on the right, beginning at 10 minutes and better seen thereafter. In addition, there is accumulation of activity throughout the peritoneal cavity, beginning at 15 minutes post-injection, and progressively increasing throughout the study. There is also the appearance of abnormal linear activity along the inferior margin of the left lobe of the liver, beginning at 25-30 minutes into the study and progressively increasing in intensity. The right lateral image demonstrates activity spreading anterior to the liver, also consistent with intraperitoneal biliary leakage. Hepatic clearance is also moderately prolonged.
Rationales:
A. Incorrect. The findings are not consistent with acute cholecystitis. There is prompt visualization of the gallbladder as early as 5-10 minute post-injection, which essentially excludes acute cholecystitis. Furthermore, acute cholecystitis does not explain the presence of biliary leakage present in this case. Perforation of the gallbladder may occur in gangrenous cholecystitis, but that entity is virtually always associated with cystic duct obstruction, which would result in non-visualization of the gallbladder as well.
B. Correct. The findings in this case described above are consistent with a relatively large bile leak, most likely arising in the region of the gallbladder fossa. In this case, the findings may be secondary to trauma from paracentesis.
C. Incorrect. There is prolonged hepatic clearance and non-visualization of the small bowel, both findings that occur in the presence of common bile duct obstruction. However, in common duct obstruction, there is often complete non-visualization of the biliary tree, including the gallbladder, even in the absence of cholecystitis. In addition, common duct obstruction is not usually associated with biliary leakage, which is present in this case.
D. Incorrect. This study is not normal. A significant degree of biliary leakage is demonstrated, as described above. Furthermore, the images also demonstrate prolonged hepatic clearance and nonvisualization of the small bowel, both of which are also abnormal findings.