A 34-year-old male presented with symptoms of irregular heartbeat and tremor. Thyroid function tests revealed an elevated serum T3, normal T4 and reduced TSH. The 24 hour I-123 thyroid uptake was <1%. Based on these results and the accompanying I-123 thyroid images (Figure 1A: anterior image of neck with radioactive markers around the chin and at the sternal notch, and Figure 1B: anterior image of the neck without markers), which one of the following is the MOST likely diagnosis?

A. Graves' disease
B. Acute bacterial thyroiditis
C. Plummer's disease
D. Painless thyroiditis
E. Recent iodinated contrast administration
Section IX – Nuclear Radiology

Question #366

Findings: There is near-complete non-visualization of the thyroid on I-123 imaging (Figures 1A & 1B), with only faint visualization of the gland, which appears grossly normal in size. Thyroid morphology cannot accurately be assessed.

Rationales:

A) Incorrect. While the patient's symptoms and laboratory findings are consistent with hyperthyroidism, the markedly reduced I-123 thyroid uptake and near-non-visualization of the thyroid on I-123 imaging are not consistent with Graves' disease, in which an elevated uptake and an enlarged thyroid with diffusely increased uptake on thyroid imaging would be expected.

B) Incorrect. Acute bacterial thyroiditis presents with fever, elevated white blood cell count and focal tenderness over a portion of the gland. The thyroid uptake is variable, and thyroid imaging would most likely demonstrate a focal hypofunctioning (“cold”) nodule, with normal visualization of the remainder of the gland.

C) Incorrect. Plummer's disease is toxic nodular goiter. The thyroid uptake may be normal or mildly increased in this disorder, but would not be decreased. I-123 thyroid imaging in Plummer's disease demonstrates one or more focal areas of increased tracer uptake, with associated areas of suppression of uptake in other parts of the gland, findings which are not present in this case.

D) Correct. Subacute or painless thyroiditis is the most likely etiology for these findings. In this viral disorder, there is diffuse or focal inflammation of the gland, with release of pre-formed thyroid hormone into the circulation during the acute phase, resulting in signs and symptoms of hyperthyroidism and elevated thyroid function tests, as in this case. There is markedly reduced synthesis of new thyroid hormone by the gland, with associated decreased thyroid uptake and poor visualization of the thyroid on I-123 or Tc-99m pertechnetate thyroid imaging. These findings may also be seen in thyrotoxicosis factitia (intake of exogenous thyroid hormone) or in patients with ectopic thyroid hormone production (eg. struma ovarii), but these conditions were not listed as possible answers.

E) Incorrect. Recent iodinated contrast administration may result in a falsely low I-123 thyroid uptake measurement, secondary to flooding of the extracellular iodine pool with non-radioactive iodine. In turn, poor visualization or non-visualization of the thyroid on thyroid scintigraphy may result. However, in most cases, these findings would not be associated with clinical evidence of hyperthyroidism, as is present in this case.

Citations:


367. A 57-year-old male presented with a 4 cm right upper lobe pulmonary mass on an outside chest radiograph and chest CT scan. The CT study demonstrated no evidence of mediastinal or hilar adenopathy. You are shown representative coronal, transaxial and sagittal images from an F-18 fluorodeoxyglucose (FDG) PET scan (Figure 2A) and the complete series of coronal images (Figures 2B and 2C). The lesion demonstrated a standardized uptake value (SUV) of 7.2. Based upon these findings, which one of the following is the MOST likely diagnosis?

A. Stage IIIA squamous cell bronchogenic carcinoma  
B. Stage IB squamous cell bronchogenic carcinoma  
C. MALT (mucosa-associated lymphoid tissue) lymphoma  
D. Hamartoma  
E. Bronchoalveolar carcinoma
Section IX – Nuclear Radiology

Question #367

Findings: There is a large focal area of markedly increased FDG uptake in the right upper lobe, corresponding to the site of the patient's known pulmonary nodule on prior imaging studies. There is no evidence of mediastinal or hilar lymphadenopathy. No additional pulmonary nodules are identified. The remaining areas of FDG uptake (eg. liver, heart, bowel, kidneys, bone marrow) represent normal sites of uptake.

Rationales:

A) Incorrect. The right upper lobe lesion is highly suspicious for bronchogenic carcinoma, especially in light of the SUV value of 7.2. However, in the absence of mediastinal or hilar adenopathy, this lesion is not consistent with Stage IIIA disease, which includes patients with primary lesions of any size, but only those with ipsilateral mediastinal or hilar adenopathy.

B) Correct. On the basis of this PET scan, this patient has a T2 N0 M0 lesion, which is consistent with Stage 1B involvement. Despite its 4 cm size, only a primary lesion with evidence of invasion of the mediastinum, heart, great vessels, trachea, esophagus, vertebral body, carina or lesions associated with additional tumor nodules or malignant pleural effusions can be placed into the category of Stage III disease without evidence of adenopathy.

C) Incorrect. Lymphomas are in general very FDG-avid. However, the MALT type lesion has been shown to be much less FDG-avid than other cell types, and FDG PET imaging is not recommended for patients with this disorder. Furthermore, a large focal lung nodule would represent an unusual manifestation of lymphoma in any case, even for FDG-avid cell types.

D) Incorrect. Mildly increased FDG uptake may occur in infectious and granulomatous processes, including histoplasmosis, tuberculosis and others. Such occurrences may result in false positive PET scans for bronchogenic carcinoma. However, FDG uptake in such lesions is usually mild, typically with SUV values <2.5, and in any event, such a diagnosis is much less likely than bronchogenic carcinoma, given the findings in this case.

E) Incorrect. Bronchoalveolar carcinoma demonstrates variable FDG uptake, and has been reported to be a common cause of a false negative FDG PET scan in bronchogenic carcinoma. The presentation of a solitary, large focal pulmonary nodule is not the most common appearance for bronchoalveolar carcinoma. Furthermore, it is less common than other cell types of bronchogenic carcinoma, and this diagnosis would therefore be less likely than other cells types of non-small cell or small cell carcinoma.

Citations:


368. A 43-year-old female with a history of ovarian carcinoma presented with shortness of breath and low-grade fever following a long airplane ride. You are shown posterior Xe-133 ventilation images (Figure 3A), Tc-99m MAA perfusion images (Figure 3B) and a concurrent PA and lateral chest radiograph (Figures 3C and 3D). Which one of the following BEST characterizes the overall findings in this case?

A. High probability for pulmonary embolism
B. Intermediate probability for pulmonary embolism
C. Low probability for pulmonary embolism
D. Normal study
E. Lymphangitic carcinomatosis
Section IX – Nuclear Radiology

Question #368
Findings: The Xe-133 ventilation study (Figure 3A) demonstrates only mild xenon retention bilaterally, most striking at the lung bases. The Tc-99m MAA perfusion images (Figure 3B) demonstrate a single moderate subsegmental perfusion defect in the lateral basal segment of the left lower lobe, which does not correspond to a focal ventilatory defect on the ventilation study. The chest radiograph demonstrates no focal infiltrates or pleural effusions.

Rationales:
A) Incorrect. The V/Q scan findings of a single moderate ventilation-perfusion mismatch are not consistent with a high probability for pulmonary embolism, using any of the commonly employed criteria for interpretation of these studies. Both the modified PIOPED criteria and modified Biello criteria categorize such cases as intermediate probability for pulmonary embolism.

B) Correct. As discussed in item A above, a single moderate V/Q mismatch is consistent with an intermediate probability for pulmonary embolism using the two most prevalent sets of diagnostic criteria currently in use. In published retrospective and prospective studies, approximately one-third of such cases have been associated with pulmonary embolism on pulmonary angiography.

C) Incorrect. Again, a single moderate subsegmental V/Q matching defect is consistent with an intermediate probability for pulmonary embolism, both in the modified PIOPED and modified Biello diagnostic criteria. The original PIOPED study incorrectly classified these cases as low probability, an error which was corrected when the criteria were subsequently modified following the study.

D) Incorrect. This ventilation-perfusion lung scan demonstrates abnormalities on both the ventilation and perfusion portions of the exam. It is not a normal study.

E) Incorrect. The pattern of perfusion abnormality in this case is not suggestive of lymphangitic carcinomatosis. In that entity, the perfusion images typically produce a diffuse pattern of irregularity, with numerous small subsegmental perfusion defects, corresponding to the interlobular septae. This pattern of abnormality has been termed “contour mapping”. It is not present in this case, nor is there an interstitial pattern of pulmonary parenchymal abnormality on the chest radiography to suggest this entity.

Citations:
369. A 15-year-old female volleyball player presented with low back pain, without a specific incident of trauma. You are presented with AP and lateral radiographs of the lumbar spine (Figures 4A and 4B), anterior and posterior planar spot images (Figure 4C) and coronal, transaxial and sagittal SPECT images from a Tc-99m MDP radionuclide bone scan (Figures 4D - 4F). No other lesions were present elsewhere in the skeleton. Which one of the following is the MOST likely diagnosis?

A. Stress fracture of the pars interarticularis
B. Osteoid osteoma
C. Ewing's sarcoma
D. Vertebral osteomyelitis
E. Ankylosing spondylitis
Section IX – Nuclear Radiology

Question #369

Findings: The AP and lateral radiographs of the lumbar spine (Figures 4A and 4B) demonstrate very mild scoliosis of the lower lumbar spine, possibly positional. Anterior and posterior planar Tc-99m MDP bone images (Figure 4C) demonstrate a focal area of increased tracer uptake at L5 on the left, best seen on the posterior image. The coronal, transaxial and sagittal SPECT images (Figures 4D-4F) localize this finding to the region of the lamina, in the expected location of the pars interarticularis.

Rationales:

A) Correct. The findings described above are typical for a stress fracture of the left pars interarticularis of L5, a common injury occurring in children involved in athletic activities, such as gymnastics, volleyball, etc. Radiographs may or may not demonstrate a pars defect, and in the case of bilateral pars defects, spondylolysis may also be present. SPECT imaging is useful in detecting subtle lesions not evident on planar views, as well as localizing the lesion to the region of the pars. Increased bone turnover in the site of the lesion suggests that it is the etiology for the patient's symptoms of localized back pain.

B) Incorrect. Osteoid osteoma can occur in the spine, and may be associated with focal areas of increased uptake on bone scintigraphy. However, it is less likely to be associated with normal radiographs, usually presenting with a focal area of sclerosis, sometimes with a visible central radiolucent nidus. It commonly presents with rigid, painful scoliosis, and may have the classic presentation of pain, worse at night and relieved by aspirin. It is less common than a stress fracture of the pars, especially in the present clinical setting.

C) Incorrect. Ewing's sarcoma is uncommon relative to stress fractures, and the vertebral column is an uncommon site of involvement. When arising in the vertebral column, the sacrum is the most common site. It is often associated with a long history of pain, a soft tissue mass and in many cases, associated systemic symptoms. Vertebral involvement most often involves the vertebral bodies primarily, may be associated with vertebral collapse, and is not usually associated with normal radiographic findings. Ewing's sarcoma is associated with markedly increased uptake of Tc-99m MDP, although usually the lesion is much larger at presentation.

D) Incorrect. Vertebral osteomyelitis is usually located in the vertebral bodies, and may also spread to the intervertebral disc spaces. Radiographic findings include areas of bone destruction and/or sclerosis, similar to the findings of osteomyelitis in other regions of the skeleton. Fever, leukocytosis and systemic symptoms are often present. Vertebral osteomyelitis is less common than stress fractures, and does not fit the present clinical setting well. Again, normal radiographic findings would not be expected with vertebral osteomyelitis.

E) Incorrect. Findings that may be seen in ankylosing spondylitis include increased uptake in the sacro-iliac joints, focal areas of increased uptake in the apophyseal joints, increased uptake in the intervertebral disc spaces and other sites of arthritic involvement in the peripheral joints and costovertebral and sternoclavicular joints. These findings are not present in this case. While this patient is at the lower end of the typical age range for this disorder, ankylosing spondylitis is more common in males, and is far less common than post-traumatic injuries.

Citations:


Section IX – Nuclear Radiology

370. A 46-year-old female underwent a living-related donor renal transplant placed in the left iliac fossa, and presented 5 days post-operatively with the acute onset of markedly reduced urine output and elevated serum creatinine. You are presented with an anterior flow study (Figure 5A) and serial static anterior images of the abdomen and pelvis (Figure 5B) from a Tc-99m MAG-3 renal scan. Which one of the following is the BEST interpretation for these findings?

A. Post-operative acute tubular necrosis (ATN)
B. Renal artery stenosis
C. Immunosuppressive drug toxicity
D. Ureteral obstruction
E. Accelerated rejection
Section IX – Nuclear Radiology

Question #370

Findings: The flow study (Figure 5A) demonstrates no evidence of perfusion to the transplanted kidney in the left iliac fossa. The delayed static images (Figure 5B) demonstrate increased background activity and photopenic areas in the configuration of bowel loops, without visualization of the renal transplant.

Rationales:

A) Incorrect. Post-operative ATN is present immediately after transplantation, and a 5 day delay before the onset of symptoms would not be expected. In addition, ATN is usually associated with disproportionate impairment of renal tubular function, with relatively preserved perfusion, which is not present in this case. It is also usually less striking in the case of living-related donor transplantation, in which cases the ischemic time of the donor kidney is minimized.

B) Incorrect. Renal artery stenosis is a later complication of transplantation, and would not be expected within the first post-operative week. The high-grade degree of impaired perfusion in this case is also not typical for renal artery stenosis.

C) Incorrect. Immunosuppressive drug toxicity, similar to ATN, is most often associated with a disproportionate impairment of renal tubular function relative to perfusion, which is not the case in this instance. Complete lack of perfusion to the renal transplant is not an expected finding with drug toxicity.

D) Incorrect. Complete obstruction of the transplanted kidney could conceivably produce these findings. However, it would be unusual to see complete non-perfusion and non-function of the transplant, as is present in this case. Acute rejection is a more likely etiology for these findings.

E) Correct. Severe acute or accelerated rejection, is the most likely explanation for these findings. Rejection is typically associated with impairment both of perfusion and tubular function of the transplanted kidney, and is consistent with the time course in this case. While much less common in living-related donor transplants, it can occur even in this setting. The most likely differential diagnostic possibility would be acute occlusion or disruption of the renal vessels, which is not one of the options listed.

Citations: