Self-Assessment Examination

CPI PET/CT Special Edition 2014

IMAGE-RELATED QUESTIONS

1. You are shown positron emission tomography/computed tomography (PET/CT) images of a 29-year-old man with a history of testicular cancer who underwent right-sided orchiectomy 10 months previously, followed by chemotherapy. He now presents with a right-sided groin mass. Which one of the following is the MOST likely diagnosis?
   A. Non-Hodgkin lymphoma
   B. Metastatic testicular carcinoma
   C. Postoperative urinoma
   D. Groin abscesses

Fig 1-1. Chest/abdomen/pelvis. Fluorodeoxyglucose positron emission tomography/computed tomography (PET/CT). Maximum intensity projection. Frontal view.

Fig 1-2. Pelvis. CT. Contrast enhancement. Axial plane.

Fig 1-3. Pelvis. Fused PET/CT. Axial plane.
2. You are shown maximum intensity projection (Figures 2-1 and 2-2) and axial fused images from an $^{18}$F-fluorodeoxyglucose PET/CT (Figures 2-3 and 2-4) and corresponding contrast-enhanced CT images (Figures 2-5 and 2-6) of a 36-year-old woman who presents with chronic lower abdominal pain. Which one of the following is the **BEST** interpretation of the etiology for the FDG-avid lesions seen in the pelvis?

A. Bladder diverticulum  
B. Bladder carcinoma  
C. Cervical carcinoma  
D. Cystic ovarian neoplasm
Fig 2-3. Pelvis. Fused $^{18}$F-fluorodeoxyglucose (FDG) PET/CT. Axial plane. Level of femoral heads.

Fig 2-4. Pelvis. CT. Contrast enhancement. Axial plane. Level of femoral heads.

Fig 2-5. Pelvis. Fused $^{18}$F-FDG PET/CT. Axial plane. Somewhat higher level than Figure 2-3, through iliac bones.

Fig 2-6. Pelvis. CT. Contrast enhancement. Axial plane. Somewhat higher level than Figure 2-4, through iliac bones.
3. An $^{18}$F-FDG PET/CT scan was performed in a 2-year-old girl with a history of neuroblastoma. Based on the findings in Figure 3-1, which one of the following is the MOST likely diagnosis?

A. Diaphragmatic metastases
B. Peritoneal metastases
C. Physiologic uptake
D. Adrenal metastases

*Fig 3-1. Chest/abdomen. FDG PET/CT. a) MIP. Coronal plane. b) MIP. Magnified image of abdomen. c) CT. Coronal plane. d) Fused PET/CT. Frontal view.*
40. Which one of the following types of lymphomas is the LEAST likely to be $^{18}$F-FDG-avid?
   A. Diffuse large B cell
   B. Follicular
   C. Marginal zone/mucosa-associated lymphoid tissue
   D. Hodgkin

41. PET/CT is NOT an appropriate indication for which one of the following lymphoma subtypes?
   A. Hodgkin lymphoma, initial staging
   B. Diffuse large B-cell lymphoma, initial staging
   C. Indolent non-Hodgkin lymphoma, initial staging
   D. Indolent non-Hodgkin lymphoma when transformation is suspected

42. Which one of the following statements regarding cardiac activity noted on an oncologic PET/CT scan using $^{18}$F-FDG is CORRECT?
   A. The interatrial septum, apex of the left ventricle, and right atrial appendage are common sites of normal variant focal cardiac FDG uptake.
   B. An FDG-avid mass in the wall of the left ventricle is most likely due to a benign or malignant primary cardiac neoplasm rather than a metastasis.
   C. Intense activity in the left ventricular wall is commonly seen in patients who have undergone a prolonged fasting of greater than 12 hours.
   D. Of the major cancer types imaged with PET/CT, lung cancer is the least common to metastasize to the heart.

43. Which one of the following is TRUE regarding $^{18}$F-FDG PET/CT after radiation treatment for lung cancer?
   A. Post radiation inflammatory changes in the lungs rarely last more than 6 months.
   B. Focally increased activity in the radiation port 3 months after completion of radiation is always indicative of residual or recurrent malignancy.
   C. Inflammatory changes from radiation can mask residual or recurrent malignancy and serial PET/CT scans may be necessary before malignancy can be excluded.
   D. Radiation-induced esophagitis rarely occurs in patients with radiation to the mediastinum or spine.
   E. It is recommended to wait at least 1 year before performing the first restaging PET/CT scan to avoid false-positive results.
ANSWER KEY
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1. B
2. C
3. C
4. A
5. C
6. D
7. C
8. C
9. D
10. C
11. A
12. B
13. D
14. C
15. D
16. D
17. C
18. C
19. C
20. B
21. C
22. A
23. B
24. A
25. B
26. A
27. D
28. D
29. B
30. C
31. B
32. B
33. C
34. D
35. B
36. A
37. C
38. A
39. C
40. C
41. C
42. A
43. C
44. E
45. A
46. A
47. D
48. D
49. D
50. D
**RATIONALS AND REFERENCES**

**Answer 1 is B.**
Metastatic testicular carcinoma is the correct answer. The hypermetabolic lesions shown in Figures 1-1 through 1-5 correspond to right inguinal and right external iliac nodal metastases on the side of prior orchiectomy, a typical pattern of spread for testicular carcinoma.

*Option A is not correct.*
Option A is incorrect since a second primary malignancy solely on the right side is less probable than metastatic disease.

*Option C is not correct.*
Option C is incorrect since none of the foci of increased uptake correspond to fluid density lesions on the corresponding CT scan.

*Option D is not correct.*
Option D is incorrect since no secondary signs of abscess, such as loculated fluid, air, or fat stranding are seen around the groin mass.

**Reference:**

**Answer 2 is C.**
Of the given choices, the most likely explanation for the findings of a hypermetabolic heterogeneously enhancing mass posterior to the bladder (Figure 2-3) and a hypermetabolic right external iliac node (Figure 2-4), is cervical cancer with right external iliac nodal metastasis.

*Option A is not correct.*
The mass is located posterior to the urinary bladder and does not communicate with the bladder itself, excluding a bladder diverticulum as the explanation for the image findings.

*Option B is not correct.*
The mass is located posterior to the bladder and does not involve the bladder itself, making bladder cancer an unlikely explanation.

*Option D is not correct.*
The mass is located in the midline posterior to the bladder and does not have cystic features on the contrast-enhanced CT scan, making a cystic ovarian neoplasm an unlikely explanation.

**Reference:**
**Answer 3 is C.**

Crying infants and children can demonstrate high $^{18}$F-FDG uptake in muscles of respiration, including diaphragms, abdominal oblique muscles, and intercostal muscles.

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**Option A is not correct.**

High uptake in the diaphragmatic crura (single arrows on Figure 3-1, annotated) can be mistaken for retroperitoneal lymphadenopathy or adrenal metastases. Correlation with fused PET/CT images can assist in localizing the diffusely increased FDG uptake to the diaphragmatic musculature and excluding metastatic lesions.

**Option B is not correct.**

Peritoneal metastases typically have corresponding soft tissue density abnormalities seen on CT and have $^{18}$F-FDG uptake that is more irregular, asymmetric, and nodular than would be seen with diffuse physiologic diaphragmatic FDG uptake as shown in the test case.

**Option D is not correct.**

High uptake in the diaphragmatic crura can be mistaken for adrenal metastases. Correlation with fused PET/CT images can assist in localizing the high FDG uptake to the diaphragmatic musculature and exclude adrenal pathology. Respiratory motion artifact can prevent accurate co-registration of PET and CT images.
Answer 4 is A.
The tumor in the left distal femur shows interval increase in the intensity and extent of $^{18}$F-FDG uptake on the follow-up PET scan (Figure 4-2), indicating tumor progression and poor response to therapy. Enlargement of the tumor was subsequently confirmed by MRI.

Option B is not correct.
Response to treatment would demonstrate an interval decrease in intensity and extent of $^{18}$F-FDG uptake in the primary tumor.

Option C is not correct.
There is new low-level diffuse uptake in the metaphyses of the left tibia, which is due to increasing hyperemia of the left lower extremity, and is unlikely due to metastatic disease.

Option D is not correct.
The PET images show no metabolic abnormality in the lungs. Even if all PET images show normal activity throughout the lungs, the corresponding CT scan should be carefully inspected as small pulmonary metastases due to sarcoma may be below the metabolic resolution of PET.

References:


Answer 5 is C.
With the exception of the left femur, Figure 5-1 shows normal sodium $^{18}$F-fluoride ($^{18}$F-fluoride) tracer uptake in all other regions of the skeleton. The symmetric intense tracer uptake seen in the costochondral junctions of all ribs and in the growth plates of the upper and lower extremities represents normal costochondral and normal growth plate activity in a young child.

Option A is not correct.
Osteogenic sarcoma, such as Ewing sarcoma or osteosarcoma, typically has a high degree of uptake on $^{18}$F-fluoride PET scan.

Option B is not correct.
Recent fractures typically have a high degree of focal tracer uptake on an $^{18}$F-fluoride PET scan. The patient described in this question was being evaluated for possible nonaccidental trauma and plain radiographs showed a left femur fracture. The $^{18}$F-fluoride PET scan was performed to exclude other sites of possible fracture.
Option D is not correct.

\(^{18}\)F-fluoride PET is more sensitive than skeletal radiographs in the diagnosis of spinous process fractures.

Reference:

Answer 40 is C.

Most subtypes of newly diagnosed lymphomas have reliably high \(^{18}\)F-FDG avidity, including Hodgkin disease, diffuse large B-cell lymphoma, and follicular lymphoma. Studies have shown that marginal zone/mucosa-associated lymphoid tissue (MALT) lymphoma and small lymphocytic lymphoma, however, have lower \(^{18}\)F-FDG avidity.

Option A is not correct.
Diffuse large B-cell lymphoma has high \(^{18}\)F-FDG avidity.

Option B is not correct.
Follicular lymphoma has high \(^{18}\)F-FDG avidity.

Option D is not correct.
Hodgkin lymphoma has high \(^{18}\)F-FDG avidity.

Reference:

Answer 41 is C.

Initial staging PET/CT is usually not indicated in the indolent lymphomas as those are usually considered incurable, with the main goal aimed to treat the clinical manifestations of the disease.

Option A is not correct.
Initial staging PET/CT is an appropriate indication for all curable lymphomas, such as Hodgkin and diffuse large B-cell lymphoma.

Option B is not correct.
Baseline PET/CT is an appropriate indication for diffuse large B-cell lymphoma.

Option D is not correct.
PET/CT is an appropriate indication for evaluation of low-grade, indolent lymphoma when Richter transformation is suspected. PET/CT is helpful to confirm the suspected transformation to a higher grade lymphoma and also helps guide a suitable biopsy site.

References:
Answer 42 is A.

Normal variant physiologic cardiac activity can be seen in all chambers of the heart, typically with a diffuse or heterogeneous uptake pattern. Figure 42-1 shows 2 common patterns of normal variant physiologic cardiac activity.

Focal cardiac activity can be seen as a normal variant in the interatrial septum, the apex of the left ventricle, and in the atrial appendages. If focal activity is seen in the heart, and not in a location of a normal physiologic variant, further evaluation with MRI may be necessary to exclude cardiac malignancy.

Option B is not correct.

An FDG-avid mass in the wall of the lateral ventricle is not usually due to a primary cardiac neoplasm. Metastases to the heart are much more common than primary cardiac neoplasms (both benign and malignant). Metastases to the heart were found in 1.23% of 12,485 consecutive autopsies, compared with a 0.056% prevalence of primary cardiac neoplasms.
Option C is not correct.
There is variable myocardial FDG uptake in the left ventricle depending on whether the heart is primarily utilizing glucose or free fatty acids for its source of energy. With a prolonged fast of greater than 12 hours, one would expect the heart will be primarily utilizing free fatty acids for metabolism and, therefore, have a relatively low level of FDG uptake.

Option D is not correct.
Lung cancer and lymphoma are the 2 most common tumors to metastasize to the heart.

References:


Answer 43 is C.
Post radiation inflammatory changes from radiation-induced thermal injury can last 18 months or longer. Radiation fibrosis starts to develop within 6–12 months after completion of radiation therapy and can progress for up to 2 years before stability occurs. Post radiation inflammatory changes can result in focally increased uptake on PET/CT which can be difficult to differentiate from residual and recurrent malignancy. Serial PET/CT or CT scans may be necessary to differentiate inflammatory changes from malignancy.

Option A is not correct.
Post radiation inflammatory changes in the lungs from radiation-induced thermal injury can last 18 months or longer. Radiation fibrosis starts to develop within 6–12 months after completion of radiation therapy and can progress for up to 2 years before stability occurs.

Option B is not correct.
Post radiation inflammatory changes from radiation-induced thermal injury can last 18 months or longer. Post radiation inflammatory changes can result in focally increased uptake on PET/CT which can be difficult to differentiate from residual and recurrent malignancy. Serial PET/CT or CT scans may be necessary to differentiate inflammatory changes from malignancy.

Option D is not correct.
Radiation-induced esophagitis is a relatively common side effect in patients who receive radiation therapy to the mediastinum or spine for lymphoma or lung, esophageal or other cancers. The severity of radiation-induced esophagitis can vary from mild esophagitis lasting a few days to weeks to severe esophagitis with severe pain and dysphagia lasting months. The longer duration and the greater intensity of the radiation treatment, the greater the risk of radiation-induced esophagitis.

Option E is not correct.
It is generally recommended to wait at least 3–6 months before performing the initial restaging PET/CT scan to avoid false-positive results from post radiation inflammatory changes. Serial follow-up imaging with PET/CT or CT may still be necessary before residual or recurrent tumor can be excluded.
References:


**Answer 44 is E.**

Even though there is no CT correlate, a focus of intense FDG uptake in the colon has a high likelihood of representing a premalignant or malignant colonic neoplasm. Colonoscopy should be considered for further evaluation.

In one of the largest series addressing this issue in a database of 6,000 patients, focal colonic uptake was reported in 64 patients; 48 of whom underwent colonoscopy for further evaluation. At colonoscopy, a malignant or premalignant lesion was proven in 65% of the patients – 25% had a malignant and 45% a premalignant histology.

*Option A is not correct.*

Even though there is no CT correlate, a focus of intense FDG uptake in the colon has a high likelihood of representing a premalignant or malignant colonic neoplasm. Colonoscopy should be considered for further evaluation.

*Option B is not correct.*

As no additional sites of abnormal activity are seen, isolated metastatic disease as the etiology of the focus of activity is unlikely.

*Option C is not correct.*

Even though there is no CT correlate, a focus of intense FDG uptake in the colon should be considered suspicious for a premalignant or malignant colonic neoplasm. Focal colonic inflammation or focal physiologic colonic activity are also possible explanations for this finding. Colonoscopy should be considered for further evaluation.

*Option D is not correct.*

Metformin administration has been reported to cause diffusely increased FDG uptake in both the large and small bowel. The mechanism of action for intestinal FDG uptake in humans is not well understood. Metformin use is not associated with an isolated focal area of increased bowel activity.

References:
