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**Self Assessment Module on Nuclear Medicine  
and PET/CT Case Review**

**FDG PET/CT IN MALIGNANCIES OF THORAX  
(LUNG, BREAST, ESOPHAGUS)**

**Submitted by:**

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**Cases 14 - 26**

**Case 14: Which of the following is incorrect:**

- a) The intense right lung nodule is strongly suspicious for neoplastic etiology per FDG PET/CT
- b) Patient has T1,N0,M0 disease per FDG PET/CT
- c) Visual and SUV analyses are comparable in accuracy of interpretation
- d) All lung lesions with intense FDG uptake are malignant

**Answer: D**

**Rationale:** A is correct as an intense non-calcified lung nodule has a high probability of being malignant. Although there are false positive results; the specificity is adequately high (about 85%).

B is correct as there are no abnormal nodal or extra-thoracic foci to indicate nodal or distant metastases per FDG PET/CT

C is correct as it has been documented in the literature that visual and SUV analyses of FDG PET images have comparable accuracy for interpretation.

D is incorrect as not all lung lesions with intense FDG uptake are malignant as several active inflammatory/granulomatous/infectious lesions can also show intense FDG uptake (e.g., active TB lesions, sarcoid nodules, active infectious lesions, etc).

**References:**

1. Kim SK, Allen-Auerbach M, Goldin J, et al. Accuracy of PET/CT in characterization of solitary pulmonary lesions. J Nucl Med. 2007 Feb;48(2):214-20.

2. Lowe VJ, Fletcher JW, Gobar L, Lawson M, Kirchner P, Valk P, *et al* . Prospective investigation of positron emission tomography in lung nodules. J Clin Oncol 1998;16:1075-84.
3. Shim SS, Lee KS, Kim BT, *et al*. Focal parenchymal lung lesions showing a potential of false-positive and false-negative interpretations on integrated PET/CT. Am J Roentgenol. 2006 Mar;186(3):639-48.

**Case 15: Which of the following is true:**

- a) FDG PET/CT has only limited role in evaluating nodal and distant metastases in NSCLC
- b) Whole body FDG PET/CT scan is adequate to assess for brain metastases as well
- c) Compared with bone scan, FDG PET/CT is equal or greater in sensitivity & more specific for bone marrow metastases
- d) Addition of FDG PET/CT to conventional workup is not cost effective in NSLC

**Answer: C**

**Rationale:** A is false as PET is superior to CT for mediastinal and especially supraclavicular disease and will detect unsuspected distant metastases in about 12% of patients.

B is false as FDG PET/CT is clearly suboptimal for detecting brain metastases. The yield is only around 50-60% as the inherent high grey matter FDG uptake in the brain decreases sensitivity.

C is true. FDG PET has high sensitivity and specificity (92% & 99% respectively) for bone marrow metastases and in lung cancer patients, is better than bone scans as in these patients, the bone lesions often tend to be lytic.

D is false as FDG PET/CT is now a standard modality for staging NSCLC and can help make the diagnostic and staging workup of NSCLC more efficient and cost-effective.

**References:**

1. Hellwig D, Ukena D, Paulsen F, Bamberg M, Kirsch CM; Onko-PET der Deutschen Gesellschaft für Nuklearmedizin. Meta-analysis of the efficacy of positron emission tomography with F-18-fluorodeoxyglucose in lung tumors: Basis for discussion of the German Consensus Conference on PET in Oncology 2000. Pneumologie 2001;55:367-77.
2. Marom EM, McAdams HP, Erasmus JJ, *et al*. Staging non-small cell lung cancer with whole-body PET. Radiology. 1999 Sep;212(3):803-9.

**Case 16: Which of the following are not affected with malignant/metastatic disease:**

- a) Pleura
- b) Adrenals
- c) Right Kidney
- d) A & B

**Answer: D**

**Rationale:** A. is not completely correct, as although the pleura is not affected, there is a better answer.

B is also not completely correct, as although the adrenals are not affected, there is a better answer.

C is incorrect as there is an FDG avid right renal lesion that is suspicious for metastatic disease. Although it is difficult to assess metastatic renal lesions on FDG PET, sometimes such lesions may be picked on FDG PET/CT imaging.

D is the best correct choice as both pleura and adrenals are not affected with metastatic disease as per FDG PET imaging.

**Reference:**

Kaneta T, Hakamatsuka T, Yamada T, et al. FDG PET in solitary metastatic/secondary tumor of the kidney: a report of three cases and a review of the relevant literature. *Ann Nucl Med.* 2006 Jan;20(1):79-82. Review.

**Case 17: Which of the following is false:**

- a) The patient has a malignant right lung SPN, until proven otherwise
- b) The colonic uptake in this patient is a normal variation
- c) Lack of significant cardiac FDG uptake on oncologic FDG PET/CT scans is a normal variation
- d) The scan quality of this study is adequate with maintained normal biodistribution of FDG

**Answer: B**

**Rationale:** A is true as the SPN is intense and most likely on a malignant basis.

B is false as the colonic uptake does not appear normal. Although colonic uptake can be highly variable, for it to be physiologic/normal variant, it generally should not have any gross focal intense lesions. The differential for such focal intense lesions is inflammatory or adenomatous polypoid lesions, diverticular disease or conceivably colon carcinoma and in the appropriate age group, colonoscopic correlation is warranted.

C is true as cardiac uptake on oncologic FDG PET scans tends to be highly variable ranging from none to maximal intensity, and generally depends on the hormonal milieu during the FDG uptake period.

D is true as there is normal biodistribution of FDG on this scan with maximal brain grey matter uptake and lesser uptake in various parenchymal organs and soft tissue sites.

**Reference:**

Takalkar AM, El-Haddad G, Lilien DL. PET/CT: FDG-PET AND PET/CT - Part I. *Indian Journal of Radiology and Imaging,* 2007; 17(3):169-180.

**Case 18: Which of the following is true:**

- a) Sensitivity of FDG PET/CT for detecting malignant breast lesions is highly dependent on tumor size and grade
- b) FDG PET/CT cannot replace sentinel node biopsy but positive axillary nodal uptake has high specificity
- c) FDG PET/CT is most valuable in distant metastases staging in specific circumstances
- d) All of the above

**Answer:** D is the most appropriate answer.

**Rationale:** A is true as small size and low grade tumors are detected with low sensitivity with FDG PET but the sensitivity increases significantly for larger tumors ( $\geq T2$  disease). B is also true as FDG PET has low sensitivity for axillary nodal metastases. But when positive, it has a high specificity for axillary nodal metastases and one can potentially go for axillary nodal dissection without a sentinel node biopsy in this setting. C is also true as in clinically suspected higher stage disease, PET helps detect internal mammary nodal involvement and even unsuspected distant metastases. D is the most correct answer as A, B & C all are correct.

**References:**

1. Avril N, Rosé CA, Schelling M, et al. Breast imaging with positron emission tomography and fluorine-18 fluorodeoxyglucose: use and limitations. *J Clin Oncol.* 2000 Oct 15;18(20):3495-502.
2. Kumar R, Zhuang H, Schnall M, et al. FDG PET positive lymph nodes are highly predictive of metastasis in breast cancer. *Nucl Med Commun.* 2006 Mar;27(3):231-6.
3. Wahl RL. Current status of PET in breast cancer imaging, staging and therapy. *Semin Roentgenol.* 2001;36(3): 250-260.

**Case 19: The focus in the left cerebellum is:**

- a) Artfactual and can be ignored
- b) Physiologic variation
- c) Suspicious for metastasis & warrants brain MRI
- d) A benign entity

**Answer:** C

**Rationale:** A is incorrect. The focus is intense, unilateral and localized; hence unlikely to be artifactual and should not be ignored as non-specific. B is incorrect as although there is lot of physiologic variation in the various areas in the brain, this focus is unilateral and quite intense. C is correct as this focus warrants further evaluation with brain MRI which subsequently showed 4 brain metastatic lesions. D is incorrect as benign lesions of the brain do not tend to be hypermetabolic.

**Reference:**

Stubbs E, Kraas J, Morton KA, et al. Brain abnormalities detected on whole-body 18F-FDG PET in cancer patients: spectrum of findings. Am J Roentgenol. 2007 Mar;188(3):866-73.

**Case 20: The subtle left hepatic focus is:**

- a) Suspicious for early hepatic metastasis
- b) Non-specific heterogeneity in hepatic FDG uptake
- c) Unrelated benign liver lesion
- d) Artifactual related to noise

**Answer:** A

**Rationale:** A is the correct answer. Although PET may be suboptimal in detecting smaller lesions, it does have the ability for early detection of abnormal tumor metabolism prior to the appearance of anatomic changes, and localization of tumor in unsuspected sites. The lesion appears to be new and there can be differential response to treatment. It progressed significantly within the next few months as shown by the follow-up PET scan.

B is incorrect. Although there can be non-specific heterogeneity in hepatic FDG uptake, this focus appears small but real.

C is incorrect as small benign liver lesions generally tend to show no increased FDG uptake.

D is incorrect. Although when scanned with arms down, there may be more noise and beam hardening artifact, especially in the plane across the liver, this focus appears slightly away from that plane.

**Reference:**

Choi J. Imaging of Hepatic Metastases. Cancer Control. Jan 2006; 13(1): 6-12.

**Case 21: The mediastinal nodal abnormalities are most likely to represent:**

- a) Metastatic disease from breast cancer
- b) Inflammatory/Granulomatous etiology like Sarcoidosis
- c) Lymphoma
- d) None of the above

**Answer:** B

**Rationale:** A is incorrect as metastatic breast cancer is unlikely to affect mediastinal and hilar nodes only without any internal mammary, supraclavicular and deltopectoral nodal groups.

B is correct as the pattern of uptake in bilateral hilar and mediastinal nodes is very indicative of an inflammatory/granulomatous etiology like sarcoidosis. Subsequent mediastinal nodal sampling confirmed this and patient had similar pattern of uptake on subsequent scans.

C is incorrect as given the pattern of bilateral hilar and mediastinal uptake, an inflammatory/granulomatous etiology like sarcoidosis would be favored over Lymphoma. D is incorrect as B is the correct answer as described above.

**Reference:**

Prabhakar HB, Rabinowitz CB, Gibbons FK, O'Donnell et al. Imaging features of sarcoidosis on MDCT, FDG PET, and PET/CT. Am J Roentgenol. 2008 Mar;190(3 Suppl):S1-6.

**Case 22: Scan findings indicate:**

- a) Recurrent metastatic breast cancer
- b) Normal scan with physiologic tracer activity in the visualized regions
- c) Increased uptake in the chest wall and mediastinal nodes, most likely on an infectious/inflammatory basis
- d) Prosthesis rupture

**Answer: C**

**Rationale:** A is incorrect as the uptake in the chest was is more at muscle insertions and the nodal uptake is not quite striking  
B is incorrect as although the uptake in the chest wall and nodes is not likely malignant, it is still not normal.  
C is the correct answer. Due to the breast implants, patient had sheer stress on the muscle insertions leading to inflammation and injury and causing chest pain. The moderately FDG-avid nodes are also probably inflammatory related to this process. This was proven on subsequent surgery to remove the implants and nodal sampling wherein no malignancy was found on pathology. Patient has costosternal chondrodynia, a rare variant of Teitze's Syndrome with chest pain after breast reconstruction surgery.  
D is incorrect as there is no definite evidence for prosthesis rupture.

**Reference:**

Mathew AS, El-Haddad G, Lilien DL, et al. Costosternal chondrodynia simulating recurrent breast cancer unveiled by FDG PET. Clin Nucl Med. 2008 May;33(5):330-2.

**Case 23: In esophageal cancer, FDG PET/CT is most valuable for:**

- a) Assessing local extent (T-stage)
- b) Assessing nodal disease (N-stage)
- c) Assessing distant metastases (M-stage)
- d) All of the above

**Answer: C**

**Rationale:** A is incorrect as PET is suboptimal for T-staging and is especially limited in assessing small volume, low grade and superficial disease.

B is incorrect as PET has lower sensitivity compared to CT and EUS for nodal disease.  
C is correct as PET is most valuable in detecting distant metastases.  
D is incorrect as only C is correct.

**References:**

1. Kato H, Miyazaki T, Nakajima M, et al. The incremental effect of positron emission tomography on diagnostic accuracy in the initial staging of esophageal carcinoma. *Cancer*. 2005 Jan 1;103(1):148-56.
2. van Westreenen HL, Westerterp M, Bossuyt PM, et al. Systematic review of the staging performance of 18F-fluorodeoxyglucose positron emission tomography in esophageal cancer. *J Clin Oncol*. 2004 Sep 15;22(18):3805-12.

**Case 24: Which of the following is true:**

- a) Combination of FDG PET/CT and EUS can be the most cost-effective method for staging esophageal cancer
- b) FDG PET/CT is better than EGD for assessing local extent of disease as well as local residual/recurrent disease
- c) CT/EUS is inferior to FDG PET/CT for assessing locoregional disease
- d) All of the above

**Answer:** A

**Rationale:** A is true as EUS is very effective for locoregional staging of esophageal cancer and PET is most valuable for detecting distant metastases and together, their combination is the most cost-effective method for staging esophageal cancer.

B is false as EGD with direct visualization is better than FDG PET/CT for assessing local disease status.

C is also false as CT/EUS is superior to FDG PET/CT for assessing locoregional disease in esophageal cancer.

D is false as only A is true.

**Reference:**

Wallace MB, Nietert PJ, Earle C, Krasna MJ, et al. An analysis of multiple staging management strategies for carcinoma of the esophagus: computed tomography, endoscopic ultrasound, positron emission tomography, and thoracoscopy/laparoscopy. *Ann Thorac Surg*. 2002 Oct;74(4):1026-32.

**Case 25: Which of the following is the most likely underlying etiology:**

- a) Lymphoma
- b) An inflammatory etiology like peri-aortitis or fibrosing mediastinitis
- c) Aortic arch dissection. Call surgery STAT!
- d) None of the above

**Answer: B**

**Rationale:** A is incorrect as although periaortic lymphoma may present like this, it is quite rare and the soft tissue abnormality does not favor Lymphoma as the primary differential. B is correct as the pattern of findings (peri-aortic soft tissue mass, non-nodal appearance, encasement of aortic arch, location in mediastinum, intense FDG uptake) favors an active inflammatory process with fibrosing mediastinitis being the primary differential. This was confirmed by thoracotomy and tissue sampling. C is incorrect as there is no evidence for aortic arch dissection. D is incorrect as B is the correct answer.

**Reference:**

Takalkar AM, Bruno GL, Makanjoula AJ, et al. A Potential Role for F-18 FDG PET/CT in Evaluation and Management of Fibrosing Mediastinitis. Clin Nucl Med. 2007 Sep;32(9):703-6.

**Case 26: Which of the following is true:**

- a) Scan findings indicate recurrent lymphoma in mediastinum, left groin and bone marrow
- b) Scan findings indicate metastatic renal cell carcinoma
- c) There is metastatic disease in the neck and supraclavicular regions
- d) Focus in right sided mediastinum is related to tip of porta cath and on a non-malignant basis

**Answer: D**

**Rationale:** A is incorrect as the bone marrow activity appears to be related to hematopoietic stimulation; the left groin focus is associated with a superficial dermal/subdermal lesion suggesting an infectious/inflammatory etiology (rather than nodal disease) and the right sided mediastinal focus is right at the tip of the porta cath catheter and not nodal. B is incorrect as metastatic renal cell carcinoma lesions tend to be only modestly FDG avid and the lesions on this study are not in typical locations for metastatic renal cancer. C is incorrect as the modest foci in the neck and supraclavicular regions are not nodal but localize to fat and represent benign brown fat uptake. D is the correct answer. The focus in the right sided mediastinum is associated with the tip of the porta cath and could represent a clot/thrombus (especially if the technologist withdrew blood when injecting FDG through the port) or may represent residual/retained tracer at that site if the subsequent flush was not optimal.

**Reference:**

Siösteen A, Celsing F, Jacobsson H. FDG Uptake in a Catheter-Related Thrombus Simulating Relapse of Lymphoma. Clin Nucl Med. 2005 May;30(5):338-9.

