^{18}F-FDG PET/CT and ^{99m}Tc-MDP Imaging of Non–Small Cell Lung Carcinoma Osseous Metastases*

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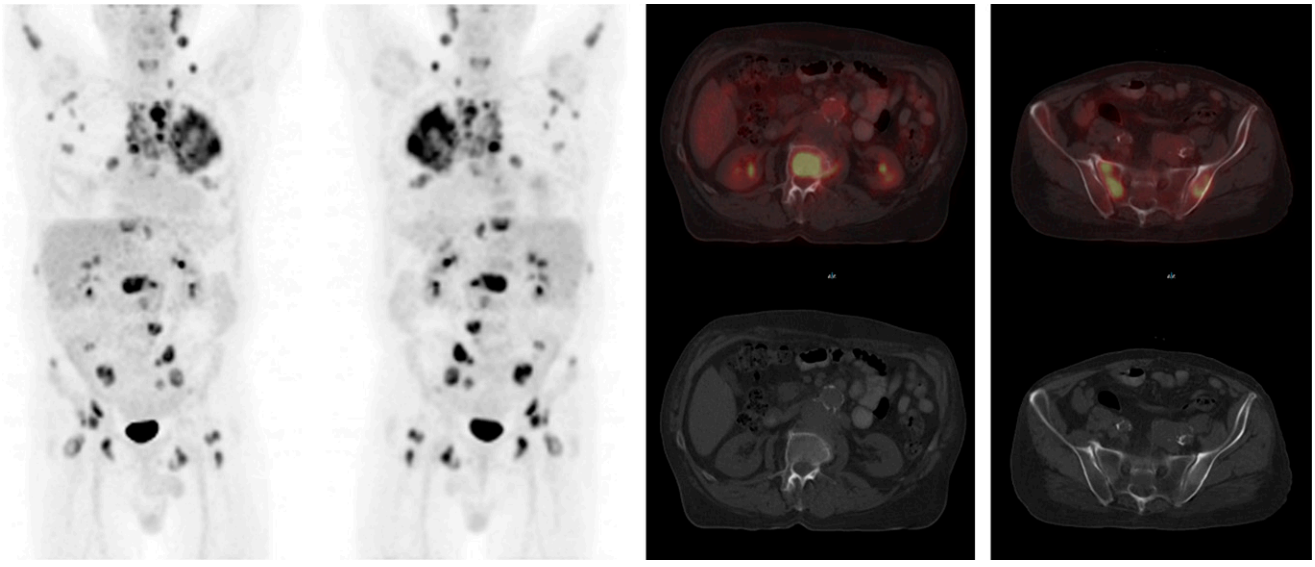
A 74-y-old male smoker presented with hemoptysis and was diagnosed with non–small cell lung cancer causing postobstructive pneumonia. He complained of lower back pain. A PET/CT scan was ordered to stage his disease. Sixty minutes after intravenous administration of 595.7 MBq (16.1 mCi) of ^{18}F-FDG, sequential unenhanced CT and then PET images were acquired:



QUESTION 1

Based on the ^{18}F-FDG PET/CT images, which of the following statements best describes the findings in the skeleton:
A. Multiple traumatic fractures.
B. Multiple metabolically active osseous metastases.
C. Lesions that cannot be characterized and are most likely degenerative disease.
D. Bone marrow stimulation.

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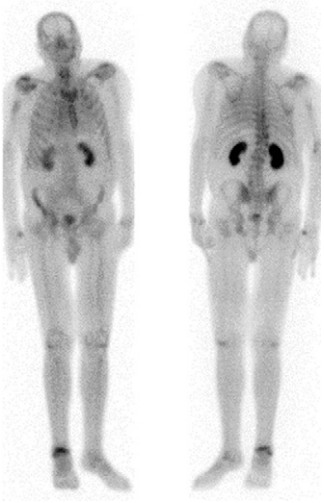
One week later, a bone scan was performed to evaluate if ^{89}Sr could be used to manage the patient's intractable lower back pain. A whole-body bone scan was obtained 2 h after intravenous injection of 925 MBq (25 mCi) of ^{99m}Tc-methyldiphosphonate (^{99m}Tc-MDP):



QUESTION 2

Based on the anterior and posterior whole-body bone scan images, and considering the prior PET/CT scans, which of the following statements is true (Note: there is a history of trauma to the right ankle):

A. The bone scan appearance is expected because ^{18}F-FDG PET is more sensitive than bone scanning for detection of osteoblastic metastases.
B. The discrepancy between the bone scan and ^{18}F-FDG findings is most consistent with a benign process.
C. ^{18}F-FDG PET allows earlier detection of metabolically active metastases in marrow that may not yet have generated an osseous response.
D. Bone scintigraphy is generally an insensitive modality for staging lung cancer skeletal metastases.

CASE DISCUSSION

In this patient with non–small cell lung cancer, ^{18}F-FDG PET and ^{99m}Tc-MDP bone scintigraphy were strikingly discrepant for visualization of skeletal metastases. Although the literature shows varying results, the consensus is that ^{18}F-FDG PET and ^{99m}Tc-MDP bone scintigraphy have equivalent sensitivity (~90%), with ^{18}F-FDG PET having the higher specificity (98% vs. 61% in 1 study).

The 2 agents show different sensitivities in osteoblastic versus osteolytic skeletal metastases, based on the mechanisms of tracer localization. ^{18}F-FDG uptake represents increased glucose metabolism in malignant cells, whereas diphosphonate uptake reflects the remodeling response surrounding the metastatic deposits, which may take longer to develop. ^{18}F-FDG PET thus potentially has an advantage for detection of early bone disease. Several authors have shown that ^{18}F-FDG PET is more sensitive in detecting osteolytic metastases than bone scintigraphy, whereas bone scintigraphy is more sensitive in detecting osteoblastic metastases. This suggests a complementary role for ^{18}F-FDG PET and bone scintigraphy depending on the predominate type of bone metastases expected.

*For the answers, see page 70

Drugs and Introduction to Pharmacology," a section on pharmacology has been added, along with an invaluable table summarizing the uptake mechanism of all commonly used radiopharmaceuticals. The authors made a good call in expanding the former chapter 4, "Instrumentation," to 3 separate chapters: "Math and Radiation Physics Primer," "Instrumentation and Basic Counting Statistics," and "Instrumentation Quality Control." They have also added an entirely new chapter, chapter 7, dedicated to positron CT and CT. Another addition to the text appears in chapter 8, which covers health informatics and introduces research methods. Chapter 10, which centers on specific organ systems and therapy, is similar in layout and title to the third edition. The only changes were minor, with the addition of new imaging studies and therapies in each area.

This textbook continues to be a must-have for anyone preparing to take the NMTCB or ARRT board examination, and I also recommend that those already certified take a look. It gives even the most seasoned technologist a basic overview of some new developments in the field. The authors have done an excellent job of updating this text, following the same format started by their colleague and predecessor, Prof. Steves.

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Answers to the Questions on Pages 66 and 67

Question 1
Answer = B

A. Incorrect. Although traumatic fractures will initially be metabolically active while healing, the distribution is too random to be considered traumatic.
B. Correct. Malignant cells have increased glucose metabolism and will be detected because of uptake and intracellular trapping of ^{18}F-FDG-6-phosphate. The pattern of distribution and the presence of focal bone lesions on the CT scan are most consistent with widespread osseous metastases.
C. Incorrect. Degenerative changes are an unlikely explanation as most of the ^{18}F-FDG bone distribution is clearly nonarticular. The CT scan does not demonstrate significant degenerative changes.
D. Incorrect. Although bone marrow stimulation, commonly seen after chemotherapy or administration of granulocyte colony-stimulating factor, affects the axial and proximal appendicular skeleton, its distribution is usually diffuse.

Question 2
Answer = C

A. Incorrect. Osteoblastic skeletal metastases are usually well detected by ^{99m}Tc-MDP bone scans. By contrast, ^{18}F-FDG PET is reported as being less sensitive in detecting osteoblastic skeletal metastases than bone scintigraphy, such as in prostate carcinoma staging.
B. Incorrect. Widespread ^{18}F-FDG PET bone activity with negative bone scan results is not typical of a benign process.
C. Correct. The best explanation in this patient for avid ^{18}F-FDG bone lesions poorly visualized on ^{99m}Tc-MDP bone scans is that the metabolically active metastases have not yet generated a reactive osseous response detectable with ^{99m}Tc-MDP bone scintigraphy. The CT scan shows slightly hyperdense bone lesions in a medullary rather than cortical distribution. Early metastatic deposits first localize to the marrow.
D. Incorrect: Although non–small cell lung cancer is aggressive and often causes osteolytic metastases, this patient shows no CT evidence of lytic bone lesions.