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Clinical note

Comparison of bone scintigraphy and ^{18}F-FDG PET-CT in a prostate cancer patient with osteolytic bone metastases

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ABSTRACT

A 62 year-old male with prostate cancer, recently complaining lumbar pain with elevated PSA level (6.83 ng/ml) was referred for evaluating bone metastases. Bone scintigraphy with ^{99m}Tc-MDP demonstrated intense uptake on third lumbar vertebra. Postoperative biopsy of the lesion on third lumbar vertebra revealed adenocarcinoma metastasis. For evaluating distant metastases and restaging, ^{18}F-FDG PET-CT was performed postoperatively. On PET-CT imaging there were cervical and left parailiac lymph nodes with FDG uptake, destruction on third lumbar vertebra level and intense soft tissue mass FDG uptake on the same area. Additionally, FDG uptake was detected on right iliac crest. On the CT images obtained by integrated PET-CT scanner, this uptake was matching with lytic bone metastases. The superiority of ^{18}F-FDG PET-CT for demonstrating osteolytic bone metastases compared to bone scintigraphy was presented in a case of prostate cancer in a patient with bone and lymph node metastases.

Comparación de la gammagrafía ósea y la ^{18}F-FDG PET-TAC en un paciente con cáncer de próstata con metástasis ósea osteolítica

Palabras clave:
Cáncer de próstata
Gammagrafía ósea
^{18}F-FDG PET-TAC
Metástasis óseas

RESUMEN

Un varón de 62 años de edad con cáncer de próstata recientemente se queja de dolor lumbar con nivel elevado de PSA (6,83 ng/ml) y fue remitido para la evaluación de metástasis ósea. La gammagrafía ósea con ^{99m}Tc-MDP demuestra una captación intensa en la tercera vértebra lumbar. La biopsia postoperatoria de la lesión en la tercera vértebra lumbar demostró una metástasis de adenocarcinoma. Para la evaluación de metástasis a distancia y la reclasificación se realizó ^{18}F-FDG PET-TAC después de la operación. En las imágenes PET-TAC cervical se captaron ganglios linfáticos parailíacos con la captación de FDG, la destrucción de tercer nivel de la vértebra lumbar y una intensa captación de una masa de tejidos blandos FDG en la misma área. Además, la captación de FDG se detectó en la cresta ilíaca derecha. En las imágenes de TAC obtenidas por escáner integrado de PET-TAC, esta captación encajaba con la metástasis ósea lítica. La superioridad de la ^{18}F-FDG PET-TAC para mostrar metástasis óseas osteolíticas en comparación con la gammagrafía ósea se presentó en un caso de cáncer de próstata en un paciente con metástasis en los ganglios linfáticos y los huesos.

Introduction

Bone metastases of solid tumors are common, and about 80% of them occur in patients with breast, lung or prostate cancer. Bone metastases can be suspected clinically and by laboratory tests; however, a final diagnosis relies on radiographic evidence. Bone metastases of prostate cancer usually have osteoblastic characteristics, manifested by pathological bone resorption and formation. Conventional bone scans with ^{99m}Tc-methylene diphosphonate (MDP) are preferred to plain-film radiography for surveillance of the entire skeleton. Radiological diagnosis of bone metastases, particularly in patients with low burden of disease, is difficult because non-cancerous bone lesions that mimic cancer are common. Bone metastases from prostate cancer usually form osteoblastic lesions but may be associated with mixed or osteolytic lesions as well.

Prostate cancer is the most common malignancy among men in the western world. The natural pathway of the disease is often slow. In the United States, median age at diagnosis is 68 years and the overall 5-year relative survival rate is 99%[1]. Most patients are diagnosed with localized prostate cancer, whereas fewer than 10% have metastatic disease[1]. Thus, bone scintigraphy is performed at diagnosis only when high-risk features are present. Conventional bone scanning is still used as the most common procedure to assess bone metastases in prostate cancer which is routinely indicated in patients at high risk. However, it suffers from suboptimal specificity in the accurate differentiation of metastatic from benign processes. In this case report the superiority of ^{18}F-Fluorodeoxyglucose (FDG)

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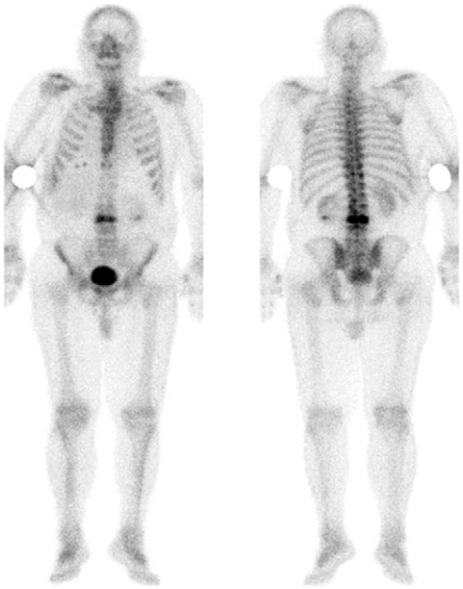

Figure 1. Bone scintigraphy. Intense ^{99m}Tc-MDP uptake and compression fracture on third lumber vertebra (arrow).

Positron Emission Tomography Computed Tomography (PET-CT) for demonstrating osteolytic bone metastases compared to bone scintigraphy was presented in a patient with prostate cancer.

Case report

A 62 year-old male with prostate cancer, recently complaining lumbar pain with elevated prostate-specific antigen level (6.83 ng/ml) was referred for evaluating bone metastases. Bone scintigraphy with ^{99m}Tc-MDP demonstrated intense uptake on third lumbar vertebra because of a compression fracture (fig. 1). On lumbar magnetic resonance imaging (MRI), severe narrowing of spinal channel due to metastatic compresion and solid lesions in neighboring soft tissues at the level of L3 vertebra were detected (fig. 2). Posterior segmental instrumentation and L3 corpectomy and discectomy were performed and biopsy of the lesions revealed postoperatively metastases of an adenocarcinoma. The patient was then referred to Nuclear Medicine Department for evaluation of distant metastases and restaging with FDG PET-CT 11 days after the operation. The interval between preoperative bone scintigraphy and postoperative PET-CT was approximately 1 month. Before PET-CT imaging, he was required to fast for 6 h and avoid exercise for 24 h. Dual-modality PET-CT imaging was

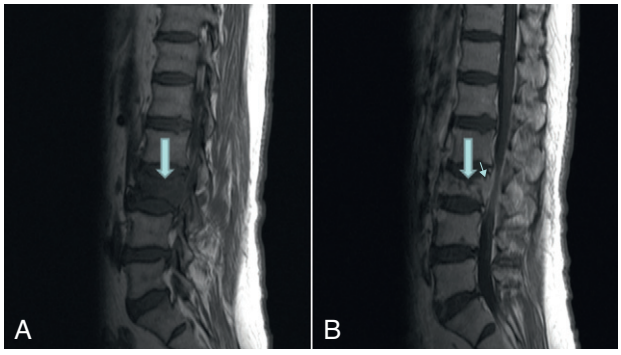

Figure 2. Sagittal T1 weighted (A) and contrast-enhanced T1 weighted MRI demonstrate severe narrowing of spinal channel due to metastatic compresion (thick arrows) and solid lesions in neighboring soft tissues at the level of L3 vertebra (thin arrow) (B).

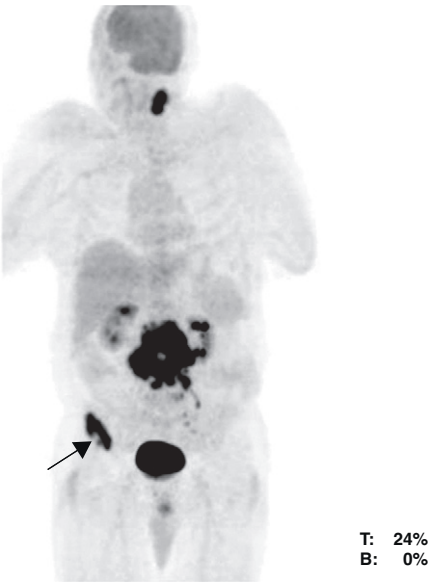

Figure 3. Maximum intensity projection (MIP) PET-CT image demonstrated left cervical lymph nodes, abdominopelvic region and right iliac crest (arrow) FDG uptake.

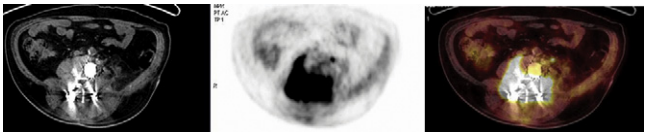

Figure 4. Transaxial PET-CT images show intense soft tissue mass with FDG uptake at operation region (SUVmax: 24.47). Posterior fixators are seen on L1,L2 and L4,L5 vertebrae.

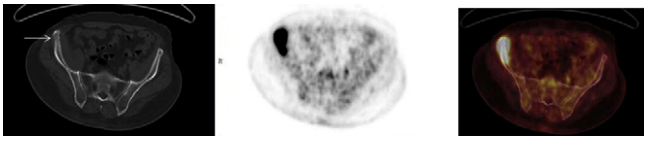

Figure 5. Lytic metastasis on right iliac crest on transaxial ^{18}F-FDG PET-CT imaging.

performed after intravenous injection of 370 MBq (10 mCi) FDG with a PET-CT scanner (Biograph® Siemens) from the top of the head to the feet. On PET/CT imaging there were left cervical lymph node and left parailiac lymph node with FDG uptake (SUVmax: 25.42 and 6.23). Metallic instrumentation and intense soft tissue mass with FDG uptake on third lumbar vertebra level at region of operation primarily influenced by inflammatory changes were seen. Maximum calculated standardized uptake value (SUVmax) of the soft tissue mass lesion was 24.47 (figs. 3 and 4). Additionally, FDG uptake was found on right iliac crest (SUVmax: 16.94) with cortical irregularity. On the CT images obtained by integrated PET-CT scanner, this uptake was matching with lytic bone metastases (fig. 5). The findings of PET-CT was confirmed by clinical follow-up and chemotherapy response. No additional findings were observed on bone scintigraphy at pelvic region (fig. 6).

The superiority of PET-CT for demonstrating osteolytic bone metastases compared to bone scintigraphy was presented in a case of prostate cancer in a patient with bone and lymph node metastases.

Discussion

Bone scintigraphy has been the most widely used method for evaluating skeletal metastases of prostate cancer. However, the

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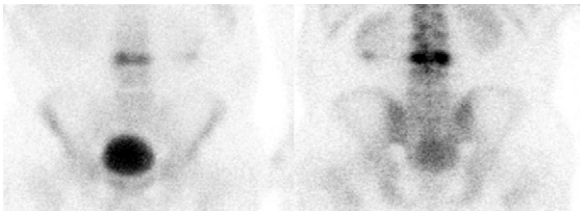

Figure 6. Bone scintigraphy. Anterior (A) and posterior (B) pelvis spot images, right iliac crest was normal.

results of more recent reports have raised doubts whether bone scintigraphy is as effective for confirming metastatic bone disease as was previously perceived[2-4]. The addition of SPECT to planar acquisition can improve the diagnostic accuracy of bone scintigraphy for detecting malignant bone involvement.

Other imaging agents such as radiolabeled antibodies have limited sensitivities. A radiolabeled murine monoclonal antibody to an intracellular domain of the prostate-specific membrane antigen (PSMA), ^{111}In-capromab-pendetide (ProstaScint® Cytogen), has been approved by the Food and Drug Administration since 1996. PSMA expression is normally low but significantly increases in prostate cancer cells. Because of the poor tissue penetration in bone, ^{111}In-capromab-pendetide imaging is suboptimal for detection of bone metastases; it is less sensitive than conventional bone scans[5,6].

MRI is currently of use in intermediate risk patients to examine the extent of the primary tumor. Although it is feasible to use MRI for whole-body scanning for detecting bone metastases, whole-body MRI scanners are not universally available and further investigation is warranted in larger patient populations. In a study by Luboldt et al[7] it is emphasized that diffusion-weighted MRI should be considered for further evaluation and comparisons with PET-CT for comprehensive whole-body staging and restaging in prostate and other cancers.

FDG is generally ineffective in the diagnosis of localized prostate cancer because of the low metabolic glucose activity of prostate cancers. Also the urinary excretion of FDG leading to high bladder activity can mask prostate tumours. The use of FDG for detection of metastatic prostate cancer has also been disappointing. In 1996, Shreve et al found a sensitivity of 65% for the detection of osseous metastases, which was inferior to bone scintigraphy[8]. This finding was confirmed in a study by Yeh et al that noted the uptake of FDG in only 18% of bone metastases[9]. Tracers rather than FDG have also shown promise in the detection of metastases. Another potential PET agents for prostate cancer are ^{11}C-acetate, ^{11}C-methionine and ^{11}C-choline. All of these agents can be used for targeted imaging of prostate cancer. But the short half-life of ^{11}C, which requires that scanning be performed near a cyclotron, is a major limitation for routine clinical application. ^{18}F-fluoride ($^{18}F_2$) is a PET tracer that can be used for bone imaging with the same mechanism of uptake as other bone-seeking agents in conventional nuclear medicine. Tracer uptake depends on regional blood flow and, in particular, on local osteoblastic activity. Although only a few studies comparing ^{18}F-fluoride PET-CT and bone scan with ^{99m}Tc-MDP exist, ^{18}F-fluoride PET-CT seems to be the more sensitive for evaluation of bone metastases. Even-Sapir et al[10] reported superiority of ^{18}F-fluoride PET-CT for detection of bone metastases in patients with high-risk prostate cancer over planar and SPECT bone scintigraphy.

^{18}F-FDG PET is of limited value in prostate cancer due to low FDG avidity of most prostate cancer cells. The primary use of ^{18}F-FDG PET is in recurrent disease with a rising prostate-specific antigen. In detection of bone metastases, conventional bone scintigraphy and ^{18}F-FDG PET-CT imaging provide different mechanisms for lesion detection. While bone scintigraphy shows indirect increased bone mineral changes, FDG PET-CT shows direct metabolic activity of tumour. Comparative diagnostic role of bone scintigraphy and FDG PET-CT for detection of bone metastases is still not established. Sclerotic metastases are smaller due to relative hypocellularity and because of viable tumour volume under the sensitivity limit, it can not be detected by FDG PET-CT system. In osteolytic metastases, the fast and agressive progress of tumor causes inadequate blood flow and hypoxia. Therefore, uptake of FDG increases because of increased glycolysis. Lesion can not be imaged by bone scintigraphy due to inadequate blood flow. Osteolytic bone metastasis was detected only by FDG-PET/CT in our case. Bone scan could not detect it. Prostate cancer is often characterized by sclerotic metastases although, as in our case, lytic metastases can rarely seen. Even if bone scan is normal, the patients screened for bone metastases should be evaluated with FDG-PET/CT in advanced prostate cancer. No single imaging modality is consistently best for the assessment of metastatic bone disease across all tumor types and clinical situations[11]. PET is more likely to detect distant metastases than local recurrence. PET is significantly less sensitive but more specific than bone scan for sclerotic prostate cancer metastases and more sensitive for lytic metastasis.

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