Osteonecrosis Mimicking Bone Metastasis in Femoral Head on ^{18}F -FDG PET/CT: A Case Report

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Abstract A 77-year-old woman underwent chemotherapy, radiotherapy, and brachytherapy for cervical cancer 9 years ago. On a follow-up ^{18}F -fluorodeoxyglucose (FDG) PET/CT image, focal FDG uptake was noted in a focal osteolytic lesion in the right femoral head. During magnetic resonance imaging, this lesion showed subchondral dark-signal-intensity rim on T1-weighted image and double line sign on T2-weighted image, suggestive of osteonecrosis. The lesion was pathologically confirmed as osteonecrosis after surgery. This case demonstrates that osteonecrosis of the femoral head may demonstrate focal FDG uptake mimicking bone metastasis.

Keywords Avascular necrosis · Femoral head · Bone metastasis · ^{18}F -fluorodeoxyglucose · Positron emission tomography/computed tomography

Introduction

^{18}F -fluorodeoxyglucose (FDG) PET/CT scan demonstrates FDG accumulation in cancer cells with increased glucose metabolism and is widely used for staging, treatment response evaluation, residual tumor surveillance, and

detection of the recurrence of various malignancies. However, inflammatory diseases are known to show increased FDG uptake as well and can be mistaken for recurrence or metastasis. Focal FDG uptake in bone can readily be mistaken for bone metastasis [1–4]. Over the years, a few cases of osteonecrosis with focal uptake mistaken for bone metastasis or local recurrence have been reported [2, 3, 5]. On the other hand, there have been two studies on the FDG uptake of osteonecrosis [1, 6].

Osteonecrosis of the femoral head is a progressively debilitating lesion that is associated with a number of conditions including trauma, steroid use, alcohol abuse, and hypercholesterolemia; there are some clinical findings such as pain or limited motion [7, 8]. Imaging evaluation of osteonecrosis is usually done with radiography, magnetic resonance imaging (MRI), and bone scintigraphy. MRI continues to be the gold standard in diagnosing osteonecrosis of the femoral head [9].

We describe a case of osteonecrosis presenting as a focal FDG uptake combined with focal osteolytic lesion on corresponding CT images of FDG PET/CT, which mimicked bone metastasis in the femoral head.

Case Report

A 77-year-old woman with cervical cancer who underwent chemotherapy, radiotherapy, and brachytherapy 9 years ago visited our hospital for surveillance and also complained of right hip pain for about 2 months. She had undergone an operation due to fracture in the distal shaft of the right femur 14 years earlier. There was no history of steroid use or alcohol abuse. Laboratory tests were normal. On the FDG PET/CT scan for tumor surveillance, a focally increased FDG uptake area (maximum SUV 2.9) was noted

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in the right femoral head, accompanied by focal osteolytic lesion surrounded by sclerotic rim on the corresponding precontrast bone setting CT images from FDG PET/CT scan. No other bone abnormality was noted in the CT portion (Fig. 1). There was no abnormal FDG uptake suggesting local recurrence or metastasis other than this focal activity on FDG PET/CT scan. On physical examination after FDG PET/CT, limping gate and positive Patrick's test on the right side were noted. Further imaging studies using radiography and MRI were performed to characterize this lesion. The radiographs, including anteroposterior and frog-leg lateral views, showed focal osteolytic lesion with suspicious subchondral fracture in the upper portion of the right femoral head (Fig. 2a). On MR imaging, axial turbo spin echo (TSE) T2-weighted images revealed a well-demarcated lesion surrounded by low-signal-intensity rim with central high signal intensity. Spectral presaturation with inversion recovery (SPIR) images clearly demonstrated an inner high-signal-intensity line within a surrounding rim with dark signal intensity, accompanied by mild bone marrow edema. There was also a crescent-shaped subchondral signal change bounded by a narrow zone with dark signal intensity that was connected to this lesion (Fig. 2b–f). These radiologic findings were consistent with avascular necrosis. A few weeks after the imaging studies, the patient had surgical resection of the right femoral head and total hip replacement arthroplasty. The pathology revealed avascular necrosis of the right femoral head with subchondral fracture (Fig. 3). Following surgery, her right hip pain was relieved, and no evidence of local tumor recurrence or

metastasis due to cervical cancer was found on further follow-up studies for 3 years.

Discussion

Osteonecrosis, also called avascular, ischemic, or aseptic necrosis, is thought to be caused by compromised blood supply secondary to trauma or nontraumatic conditions such as glucocorticoid use, radiation therapy, alcoholism, connective tissue disease, or sickle cell anemia. Osteonecrosis of the femoral head is characterized by variable areas of dead trabecular bone and bone marrow that are accompanied by the separation of the subchondral plate. Once the femoral head has collapsed, most patients experience clinical progression resulting in severe pain and limited range of motion, requiring the need for total hip replacement [6, 10]. Clinical symptoms usually precede radiographic changes [8].

An imaging study for osteonecrosis in the femoral head usually consists of radiography and MRI. Well-known radiographic manifestations of osteonecrosis are irregular discrete rarefactions with fuzzy marginal sclerosis, a mottled pattern of opacity, subchondral fracture, subchondral depression, and subchondral fragmentation [11]. MR images of early osteonecrosis in the femoral head demonstrate a low-signal-intensity band on T1-weighted images and so-called double line sign characterized by the juxtaposition of an inner high-signal-intensity band corresponding to live granulation tissue and an outer low-

Fig. 1a–c ^{18}F -FDG PET/CT scan was done for follow-up of a 77-year-old woman who had been treated for cervical cancer 9 years previously. **a**, **b** Fused coronal and axial FDG PET/CT images showed focally increased FDG uptake (SUV-max: 2.9) in the posterior portion of the right femoral head. **c** On the corresponding CT image from the FDG PET/CT scan, a small well-margined osteolytic lesion surrounded with a sclerotic rim was noted

Fig. 2 **a** Plain X-ray image of the pelvis showed focal osteolytic lesion with subtle subchondral fracture in the right femoral head. **b** Axial turbo spin echo (TSE) T2-weighted MR image (TR 4154/TE 100) demonstrated focal well-margined lesion with central high signal intensity surrounded by dark-signal-intensity rim. **c** Spectral presaturation with inversion recovery (SPIR) revealed a focal well-defined round lesion with dark-signal-intensity rim accompanied by adjacent mild bone marrow edema in the right femoral head. **d** On the magnified image of the lesion, an inner high-signal-intensity line (*arrow*) within an outer parallel rim

with dark signal intensity (*arrowhead*), called the “double line sign,” was nicely demonstrated. **e** Subchondral crescentic lesion also showing the double line sign (*arrowhead*) connected to the focal osteolytic lesion was localized in the top portion of the femoral head on the sagittal SPIR image. This lesion did not show increased FDG uptake on FDG PET/CT scan. **f** Coronal TSE T1-weighted image (TR 500/TE 20) demonstrated the infarcted lesion surrounded by dark-signal-intensity rim in the subchondral region

Fig. 3 A photograph of the vertically divided right femoral head obtained after surgery showed a zone of bone necrosis under the pale brown articular surface characterized by an opaque yellow appearance. Subchondral fracture is noted in the superomedial region of the femoral head (*arrow*). There is a well-defined focal lesion in the lateral aspect that demonstrates increased FDG uptake on FDG PET/CT (*arrowhead*)

signal-intensity band suggestive of peripheral fibrosis or sclerosis on T2-weighted images. The high signal intensity of the affected region on contrast-enhanced T1-weighted images suggests the presence of blood supply [12]. Bone scintigraphy is another tool for imaging diagnosis. Early after the ischemic insult, bone scintigraphy may not show isotope accumulation. Once remodeling has begun, however, a cold spot becomes a hot spot [7, 8].

There have been a few articles on FDG uptake of osteonecrosis, after Grigolon et al. reported a case of a breast cancer patient with focal FDG uptake on the left 5th rib, which was histologically confirmed as osteonecrosis in 2001 [2]. In 2004, Liu et al. reported a case of osteonecrosis mistaken for tumor recurrence in a nasopharyngeal carcinoma patient, which showed locally increased FDG uptake around the right basal skull on FDG PET scan performed about 1 year after successful radiotherapy [3]. Another case of osteonecrosis mimicking bone metastasis in the right proximal femur on FDG PET/CT was reported in 2007 [5]. In addition to these reports, two studies on FDG uptake of osteonecrosis were

performed. In 2005, Talamo et al. failed to detect abnormal FDG uptake in osteonecrosis-positive bones in 21 multiple myeloma patients receiving dexamethasone-containing anti-neoplastic regimens [6]. A study by Catalano et al. in 2006, however, revealed that all four patients treated with bisphosphonates due to multiple myeloma showed increased FDG uptake in the regions affected by osteonecrosis [1].

Increased FDG activity on FDG PET or FDG PET/CT scan is frequently noted in inflammatory or infectious processes because FDG inflammatory cells, such as lymphocytes, neutrophils, and macrophages, with elevated glucose metabolism also accumulate FDG [1–4]. FDG uptake is also increased in osteonecrosis due to the inflammatory process [13]. Therefore, there is always room for mistaking osteonecrosis for bone metastasis during the interpretation of FDG PET/CT scans performed on cancer patients.

In the present case, FDG PET/CT scan showed focal FDG uptake combined with focal osteolytic lesion surrounded by a sclerotic rim in the right femoral head. Because there was no other bony abnormality except for the focal osteolytic lesion on the CT component, bone metastasis was strongly suspected. The CT findings may not have been evident because subchondral fracture was minimal. In this case, the MR findings gave a good idea of the morphologic condition, and surgical specimen verified osteonecrosis. Osteonecrosis was not considered first in this case because FDG uptake was absent in the typical crescentic areas and only the focal osteolytic lesion showed FDG uptake. We think that the subchondral crescentic lesion may represent the chronic area of osteonecrosis, while the focal osteolytic lesion showing FDG uptake corresponds to the active inflammatory process.

In summary, this case demonstrates osteonecrosis of the femoral head mimicking bone metastasis in a cervical cancer patient. When focal FDG uptake is found in the top portion of the femoral head in the FDG PET/CT scan of cancer patients, osteonecrosis should be taken into consideration as well as bone metastasis. Further studies of imaging and clinical correlation are advised for accurate diagnosis.

Conflict of Interest All authors have no conflict of interest to disclose.

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