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Sacral insufficiency fracture detected by FDG-PET/CT: Report of 2 cases

Tatsuro TSUCHIDA, Nobuyuki KOSAKA, Katsuya SUGIMOTO and Harumi ITOH

Department of Radiology, Faculty of Medicine, University of Fukui

We report 2 cases of sacral insufficient fracture detected by FDG-PET/CT. In case 1, a 79-year-old female patient with malignant lymphoma, who had recent lumbago, received FDG-PET/CT examination. Vertical linear FDG uptake medial to bilateral sacro-iliac joint was observed on FDG-PET and a fracture line corresponding to FDG uptake was observed in bone window of CT images. In case 2, an 81-year-old male patient with colon cancer, who also complained of lumbago, received FDG-PET/CT examination. Vertical linear FDG uptake medial to bilateral sacro-iliac joint and horizontal uptake which connects vertical line (H-shaped) was demonstrated and CT also demonstrated a fracture line corresponding to FDG uptake. H-shaped high intensity area corresponding to FDG uptake was observed on T2-weighted image of MRI. On bone scintigraphy, H-shaped uptake was also observed. Like bone scintigraphy, typical H-shaped FDG uptake may be diagnostic in sacral insufficiency fracture. Adding CT information to FDG-PET, that is, assessing SIF with FDG-PET/CT may be useful when atypical findings are observed.

Key words: FDG-PET, PET/CT, sacral insufficiency fracture, H-sign

INTRODUCTION

SACRAL INSUFFICIENCY FRACTURE (SIF) is a kind of stress fracture, which is frequently detected on bone scintigraphy. The typical pattern of SIF in bone scintigraphy is recognized as H-sign or Honda-sign in sacrum. We experienced 2 cases of SIF which demonstrated H-sign and FDG uptake medial to bilateral sacro-iliac (S-I) joint on FDG-PET/CT and report them.

METHODS

FDG-PET/CT examination was performed with a PET/CT camera (Discovery LS, General Electric Medical Systems, Milwaukee, WI). FDG-PET images were obtained 50 min after the intravenous injection of 185 MBq of FDG, and CT-based attenuation correction was performed. Acquisition and reconstruction parameters of FDG-PET were 2 min emission/bed, 7 bed positions, and iterative reconstruction (subsets 14, number of iterations 2). Scanning parameters of CT were Auto mA (upper limit; 40 mA, Noise index 20), 140 kV, 5-mm section thickness, 15-mm table feed, and pitch of 4. Reconstructed images were converted to standardized uptake value (SUV) image with patient's body weight and injected dose of FDG.

Case 1

A 79-year-old woman was admitted to our hospital for the treatment of malignant lymphoma. On FDG-PET before chemotherapy, multiple intense FDG uptake in lymph nodes and bone marrow was observed (Fig. 1A, *left*). She received 6 courses of chemotherapy and thereafter almost all abnormal FDG uptake disappeared (Fig. 1A, *right*). Three months after the second FDG-PET examination, she received FDG-PET/CT as a follow-up study. One week before this examination, she had complained of lumbago. On FDG-PET, no apparent sign of recurrence was observed. But vertical FDG uptake medial to bilateral S-I joint was observed (SUVmax = 3.72, Fig. 1B). The anatomical localization of FDG uptake was confirmed by the co-registration between FDG-PET and CT. A transaxial CT image in bone window demonstrated a fracture line

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For reprint contact: Tatsuro Tsuchida, M.D., Department of Radiology, Faculty of Medicine, University of Fukui, 23–3 Matsuokashimoaizuki, Eiheiji-cho, Yoshida-gun, Fukui 910–1193, JAPAN.

E-mail: tsucchy@fmsrsa.fukui-med.ac.jp

which corresponding to FDG uptake (Fig. 1C).

Case 2

An 81-year-old man who had undergone surgery for ascending colon cancer 2 years previously received FDG-PET/CT examination as a follow up study. He also complained of low back pain 1 month before this examination, and bone metastasis was suspected. On FDG-PET, H-shaped FDG uptake, vertical uptake medial to bilateral S-I joint and horizontal line which connects the vertical uptake, were observed (SUVmax = 3.45, Fig. 2A). Also in this case, the anatomical localization of FDG uptake was confirmed by the co-registration between FDG-PET and CT. On CT, a fracture line was observed medial to S-I joint (Fig. 2B). MRI showed an H-shaped high intensity area on T2-weighted image (Fig. 2C), and bone scintigraphy also showed H-shaped uptake in sacrum although an asymmetrical uptake of vertical line was observed (Fig. 2D).

DISCUSSION

SIF is a kind of stress fracture which occurs due to the effect of normal or physiological stress on weakened bone with decreased elastic resistance.[1,2] Although SIF is recognized as a significant cause of low back, buttock, and groin pain, the diagnosis is sometimes difficult as there is usually no significant history of trauma and plain radiographs of the sacrum do not demonstrate them adequately.

For the diagnosis of SIF, several imaging modalities are proposed. As for the morphological imaging modalities, computed tomography (CT) is one of the most useful modalities for the detection of SIF. The bone window of CT can exhibit the fracture lines directly with the cross-sectional images which are sometimes uncertain on plain radiographs. Magnetic resonance imaging (MRI) can also detect SIF as hypointense lines or fissures on T1- and T2-weighted images. Besides the hypointense fissures, there were areas of hyperintensity on T2-weighted images adjacent to these hypointense fissures in active fractures. The hyperintensity area in T2-weighted images is thought to be caused by bone marrow edema or inflammation adjacent to active insufficiency fractures.[3] As for the functional imaging modalities, bone scintigraphy is one of the most sensitive technique for detecting SIF, with the H-shaped or butterfly pattern of uptake regarded as being diagnostic.[4–6]

Positron emission tomography with fluorine-18 labeled deoxyglucose (FDG-PET) is recognized as a useful modality in nuclear oncology for the differential diagnosis between benign and malignant lesions, staging, detection of recurrence, and origin, etc. But FDG accumulates in inflammatory cells as well as neoplastic cells,[7] and the interpretation of bone FDG uptake is sometimes confusing as to whether it indicates a benign lesion or bone metastasis when the patient has a past history of malignancy. There some reports of FDG uptake in insufficient or compression fractures.[8–12] However, it is controversial and little is known regarding FDG accumulation in the various stages of fracture. Kato et al.[11] reported that FDG uptake in benign fracture is significantly lower than that in malignant fracture even in the acute or subacute phase although they include a false-positive case. They speculated that there are numerous factors which affect FDG uptake in fracture; the site and timing of a fracture, stability of the fracture site, age of the patient, and any drug therapies received by the patient. The mechanism of increased FDG uptake in the fracture site is thought to be the migration of activated inflammatory cells.[13] Therefore, FDG uptake in benign fracture in the acute or subacute phase cannot be completely excluded even if we encounter high bone FDG uptake.

In our cases, the patients complained of lumbago 1 week or 1 month before the FDG-PET/CT examination, and an H-shaped high intensity area was present on T2-weighted image of MRI or H-shaped uptake in bone scintigraphy in case 2. Moreover, there were no bone destruction or lytic changes, strongly suggesting that the FDG uptake was caused by SIF.

In case 2, we refer to the different appearance of H-sign between FDG-PET and bone scintigraphy. On FDG-PET, vertical line of H-sign was shown symmetrically while asymmetrical uptake was observed on bone scintigraphy. This discordant finding is thought to result from the different uptake mechanisms of the two tracers. The uptake mechanism of a bone imaging tracer depends on its affinity for hydroxyapatite and is different from that of FDG mentioned above. Therefore, it is not surprising to note varying temporal patterns of activity using these two imaging modalities.

As for the SUV in SIF site, Fayad et al.[8] reported SUVmax of 2.2–3.6, Ravenel et al.[9] reported SUV of 8.9, and Schmitz et al.[10] reported SUVmax of 1.1–2.9. In our cases, SUVmax of 3.72 and 3.45 were observed. From these reports, SIF site has various SUV and it seems to be impossible to distinguish SIF from bone metastasis with a certain cut-off level of SUV.

The advantage of FDG-PET/CT is the simultaneous assessment of the target lesions. When H-shaped FDG uptake is observed, it may be diagnostic. But the incidence of such typical findings may not be high. In bone scintigraphy, the incidence of H-sign is reported to be only about 50%.[14–16] Although FDG-PET alone cannot rule out bone metastasis in atypical cases, CT images acquired in a battery of examinations will aid the diagnosis.

CONCLUSION

We reported 2 cases of SIF revealed by FDG-PET/CT. Adding CT information to FDG-PET, that is, assessing SIF with FDG-PET/CT may be useful when atypical findings are observed.

Fig. 1

A

B

C

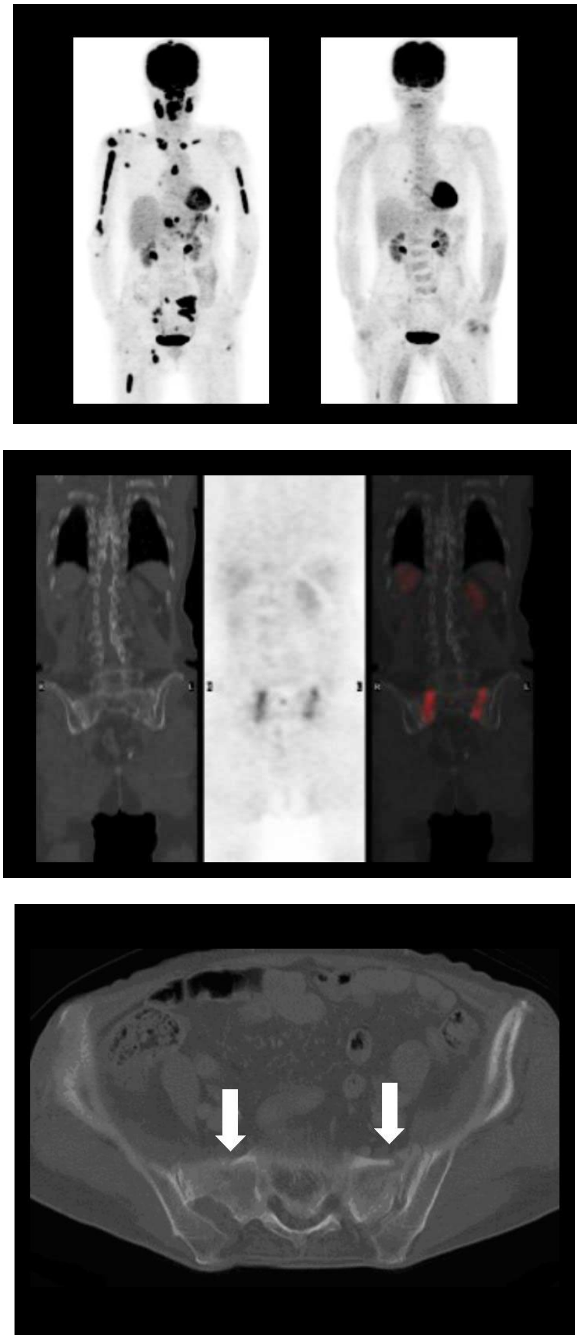

Fig. 2

A

B

C

D

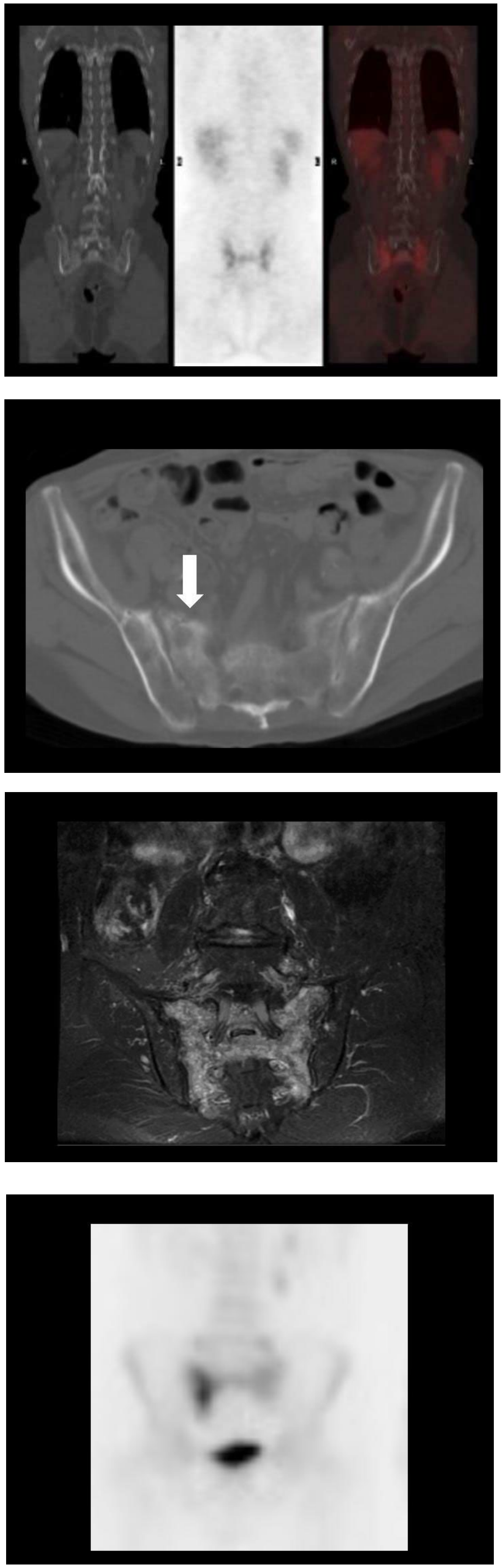

Fig. 1 A 79-year-old woman with malignant lymphoma. A. Maximum intensity projection (MIP) image of FDG-PET (*left*; before chemotherapy, *right*; after chemotherapy). B. Coronal FDG-PET/CT images in sacral insufficient fracture. CT (*left*), FDG-PET (*center*), and fused image (*right*). Vertical FDG uptake medail to bilateral sacro-iliac joint is demonstrated. C. A transaxial CT image in bone window. Fracture lines (*white arrow*) are demonstrated.

Fig. 2 An 81-year-old man with history of colon cancer who underwent surgery. A. Coronal FDG-PET/CT images in sacral insufficient fracture. CT (*left*), FDG-PET (*center*), and fused image (*right*). An H-shaped FDG uptake is observed. B. A transaxial CT image in bone window. Fracture line (*white arrow*) is demonstrated. C. A coronal T2-weighted MRI image. An H-shaped hyperintensity area is demonstrated. D. Bone scintigraphy. H-sign is observed.

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