Focal Increased Tc-99m MDP Uptake in the Nutrient Foramen of the Femoral Diaphysis on Bone SPECT/CT

Hwajin Cha¹ · Soo Bin Park² · Hyun-joo Kim¹

Received: 19 April 2017 / Revised: 25 May 2017 / Accepted: 21 July 2017 / Published online: 11 August 2017
© Korean Society of Nuclear Medicine 2017

Abstract We present images of an 83-year-old female with a history of osteoporosis and bilateral total knee replacement arthroplasty, referred for bone scintigraphy and single-photon emission computed tomography (SPECT)/computed tomography (CT), owing to left knee pain. No trauma to, or intense exercise of, the knee was reported. The bone scan and SPECT/CT revealed a focally increased Tc-99m methylene diphosphonate (MDP) uptake in the medial cortex of the left femoral diaphysis with matched linear

radiolucency on CT images. This was misinterpreted as atypical femoral stress fracture; however, focal stress reaction injury to the nutrient foramen was confirmed on contrast-enhanced magnetic resonance imaging.

Keywords Tc-99m MDP · Bone scan · SPECT · SPECT/CT · Nutrient foramen

✉ Soo Bin Park
soobin.park@schmc.ac.kr

¹ Department of Radiology, Soonchunhyang University Hospital, Seoul, Republic of Korea

² Department of Nuclear Medicine, Soonchunhyang University Hospital, 59 Daesagwan-ro, Yongsan-gu Seoul 04401, Republic of Korea

Fig. 1 An 83-year-old female with osteoporosis visited our hospital for examination of left knee pain from 2 weeks prior, without a previous history of trauma or excessive exercise. She had undergone bilateral total knee replacement arthroplasty surgery at another institute 3 years ago. Bone scintigraphy and single-photon emission computed tomography/computed tomography (SPECT/CT) were performed on a hybrid SPECT/CT scanner (Symbia Intevo, Siemens Medical Solutions, IL), 3 h after injection of 925 MBq Tc-99m methylene diphosphonate (MDP). CT was performed using a 16-slice helical CT scanner with 110 KV and 30 mA in the AutomA mode. Attenuation-corrected SPECT images were reconstructed by Flash 3D algorithms (8 subsets and 3 iterations; Gaussian filter of 8.4). Bone scintigraphy and SPECT/CT revealed

focally increased MDP uptake in the left femoral lateral condyle, which was possibly due to prosthesis loosening. Furthermore, there was a focally increased uptake in the medial cortex of the mid-shaft of left femur with matched linear radiolucency on CT images of SPECT/CT (arrow) (a: bone scan; b: axial CT, SPECT, and fusion SPECT/CT; c: coronal CT, SPECT, and fusion SPECT/CT). Based on the typical location, the classical bone scan findings of stress fracture (e.g., focal intense and fusiform cortical uptake), the concurrent CT abnormality on SPECT/CT, and the patient's history of osteoporosis, atypical left femoral stress fracture was suspected (1–4). Plain radiography, thin-section non-enhanced CT, and contrast-enhanced magnetic resonance imaging (MRI) of the left femur were requested for confirmation

Fig. 2 On plain radiography, subtle focal radiolucency was noted in the medial cortex of the mid-shaft of the left femur (**a**). Conventional CT showed a permeative bony osteolytic change on the mid-shaft of left femur (**b**), which was confirmed on the MRI as a nutrient foramen with nutrient vessels rather than a fracture line. Additionally, on the fat-suppressed T2-weighted MRI (**c**), it was accompanied by focal cortical signal change and fluid collection along the periosteum, suggesting a stress reaction of a possibly impending fracture. Long bones are supplied by nutrient arteries that enter individual bones through the nutrient foramen (5). Previous studies have described the association of the nutrient foramen and longitudinal stress fractures (6–8). The nutrient foramen

may be a potentially weak area, and a stress fracture can initiate from the nutrient foramen or its vicinity. Rawson et al. reported a focal radioactive uptake at the nutrient foramen of the tibia in a 13-year-old male, with a presumed stress response or stress fracture (8). Impending fracture is the destruction of bone mass before the appearance of a radiographic abnormality, and it stimulates the bone-remodeling processes to repair the microfracture (9). Hence, a focally increased MDP uptake at the nutrient foramen of the left femur in this patient may be due to a stress response to a possible impending fracture with new bone formation (10). In this rare case, the focal increased MDP uptake at the nutrient foramen mimicked an atypical femoral stress fracture

Compliance with Ethical Standards

Conflict of Interest This work was supported by the Soonchunhyang University Research Fund. Hwajin Cha, Soo Bin Park, and Hyun-joo Kim declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent The institutional review board of our institute approved this retrospective study, and the requirement to obtain informed consent was waived.

References

1. Shane E, Burr D, Ebeling PR, et al. Atypical subtrochanteric and diaphyseal femoral fractures: report of a task force of the American Society for Bone and Mineral Research. *J Bone Miner Res.* 2010;24:2267–94.

2. Lenart BA, Lorich DG, Lane JM. Atypical fractures of the femoral diaphysis in postmenopausal women taking alendronate. *N Engl J Med*. 2008;358:1304–6.
3. Papandrianos N, Alexiou S, Xouria X, et al. Atypical bilateral stress fractures of the femoral shaft diagnosed by bone scintigraphy in a woman with osteoporosis. *Clin Nucl Med*. 2013;38:910–2.
4. Tins BJ, Garton M, Cassar-Pullicino VN, et al. Stress fracture of the pelvis and lower limbs including atypical femoral fractures-a review. *Insights Imaging*. 2015;6:97–110.
5. Kizilkanata E, Boyana N, Ozsahina ET, et al. Location, number and clinical significance of nutrient foramina in human long bones. *Ann Anat*. 2007;189:87–95.
6. Prashanth KU, Murlimanju BV, Prabhu LV, et al. Morphological and topographical anatomy of nutrient foramina in the lower limb long bones and its clinical importance. *Australas Med J*. 2011;4: 530–7.
7. Craig JG, Widman D, Holsbeeck M. Longitudinal stress fracture: patterns of edema and the importance of the nutrient foramen. *Skelet Radiol*. 2003;32:22–7.
8. Rawson C, Robinson J. Rare anterior nutrient foramen of the tibia in an adolescent with shin pain. *Radiology Case Reports*. 2015;10(2):1018.
9. Sutter PM, Regazzoni P. Impending pathological fracture. *Swiss Surg*. 2002;8(2):81–7.
10. Love C, Din AS, Tomas MB, et al. Radionuclide bone imaging: an illustrative review. *Radiographics*. 2003;23:341–58.