Applications of PET/CT and PET/MR Imaging in Primary Bone Malignancies

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KEYWORDS

• PET/CT • PET/MRI • Primary bone malignancies

KEY POINTS

- The hybrid modalities of FDG PET/CT and PET/MRI have improved oncologic imaging that combine the sensitivity of metabolic imaging with the specificity of anatomic imaging.
- PET/CT is a valuable modality in the diagnosis, staging, and assessment of therapeutic response to treatment of several primary musculoskeletal malignancies.
- PET/MRI is promising modality, which allowed detailed local staging and tissue characterization, all while reducing patient's exposure to radiation.

INTRODUCTION

Diagnostic imaging plays a central role in the evaluation and management of oncologic disease involving the musculoskeletal system (**Figs. 1–5**). Standard imaging modalities used in current practice include conventional radiography, computed tomography (CT) scanning, Magnetic resonance imaging (MRI), and skeletal scintigraphy.[1,2] In recent years, PET imaging has also emerged as a complementary modality in musculoskeletal imaging, using various radiopharmaceutical agents to improve detection and characterization of the pathophysiology of disease.[3] Fusion of PET-acquired images with CT scans or MRI has significantly improved the overall diagnostic accuracy.[4] The objective of this article is to review the current role of PET/CT scans and PET/MRI hybrid imaging in the evaluation of primary malignancies of the skeletal system, with an emphasis on clinical usefulness, imaging findings, and current limitations.

ROLE OF HYBRID IMAGING IN BONE MALIGNANCY

Viable malignant primary bone tumors are usually 18F-fluorodeoxyglucose (FDG) avid.[4,5] PET

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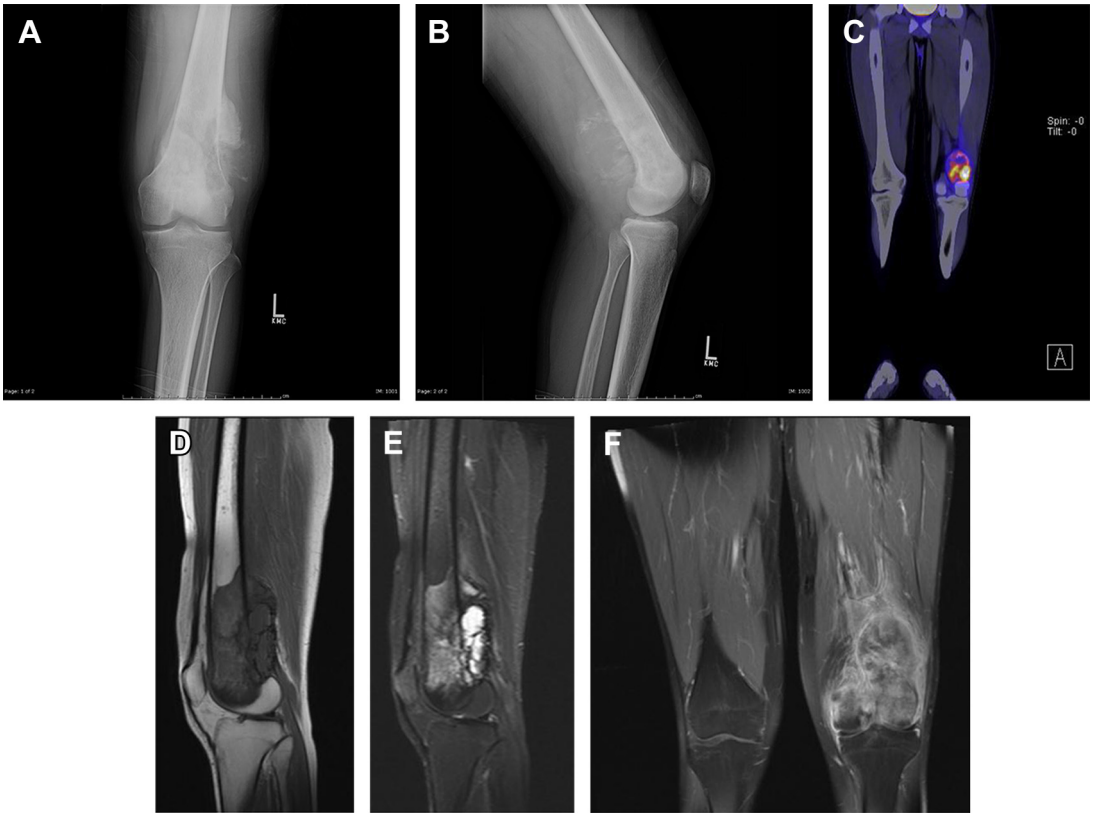

Fig. 1. A 19-year-old man presented with left knee pain for 1 month. The radiograph (*A*, *B*) shows aggressive osteolytic lesion of the distal left femur with sunburst periosteal reaction. The lesion demonstrates heterogeneous increased metabolic activity on PET/CT with fludeoxyglucose F 18 (FDG) with a maximum standardized uptake value of 8.8 (*C*). On MRI, the lesion demonstrates heterogeneous intermediate signal intensity on T1-weighted imaging (*D*), hypersignal on short tau inversion recovery imaging (*E*), and heterogeneous postcontrast enhancement (*F*) with cortical breakthrough, aggressive periosteal reaction, and associated soft tissue mass. Histopathologic evaluation confirmed osteosarcoma.

imaging using FDG produces images that allow for the diagnosis of these neoplasms, initial staging, selection of biopsy sites, evaluation of treatment response, and assessment for tumor recurrence.[3,4,6,7] When CT images are contemporaneously acquired, the PET and CT data are spatially co-registered, allowing for significantly improved localization of metabolic abnormalities. Integrated PET/CT devices allow for reduced scanning time and improved PET image quality and quantitation using CT attenuation correction reconstruction techniques.[6]

In the FDG PET component of these studies, lesions are assessed primarily based on their maximum standardized uptake value (SUV_{max}) and graded accordingly.[8] As methods evolve, metabolic activity will become a useful marker for differentiating between benign and malignant lesions. Moreover, dual time point imaging, which involves measuring the SUV_{max} at multiple sequential intervals after radiotracer injection, may also be beneficial in differentiating benign lesions from malignant processes.[9–11]

Recently, interest in hybrid PET/MRI has grown, particularly in evaluation of the musculoskeletal system. This new modality couples the physiologic information acquired from PET with the unparalleled soft tissue resolution and contrast of MRI to provide more accurate diagnoses.[12] In addition, MRI can be used to provide additional functional information using perfusion techniques and diffusion-weighted imaging.[13–15] With hybrid PET/MRI, a patient's oncologic disease can potentially be fully characterized and staged in a single imaging session.[14]

The morphologic characteristics of tumors are critical in making the correct diagnosis.[2,7,16] The MRI and CT components of hybrid imaging provide important morphologic information that PET scans alone cannot provide and, therefore, it is