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CASE REPORT

Jyoti Kumar
Suman Bandhu
Atin Kumar
Shah Alam

Extra-osseous fat fluid level: a specific sign for osteomyelitis

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J. Kumar · S. Bandhu (✉) · A. Kumar
Department of Radiology,
All India Institute of Medical Sciences,
New Delhi, 110018, India
e-mail: suman_bandhu@yahoo.co.in
Tel.: +91-11-26594925
Fax: +91-11-26588663

S. Alam
Department of Orthopedics,
All India Institute of Medical Sciences,
New Delhi, 110018, India

Abstract Osteomyelitis may pose as a diagnostic dilemma on various imaging modalities and may be confused with neoplasms and other pathology. Although a rare finding, extra-osseous fat fluid level, especially when associated with spongy bone destruction, can be considered a specific sign of osteomyelitis. Previously, only two cases of extra-osseous fat fluid level in osteomyelitis have been reported, one on computed tomography (CT) and the other on magnetic resonance imaging (MRI). The former was a case of septic arthritis with intra-articular fat fluid level. A case of osteomyelitis is presented with the demonstration of extra-osseous fat fluid level. Our case is unique in providing exquisite CT and MRI correlation.

Keywords Computed tomography · Extra-osseous · Fat fluid level · Magnetic resonance imaging · Osteomyelitis

Introduction

Hematogenous osteomyelitis is a common occurrence in children and often presents as soft tissue infection. Distinguishing osteomyelitis from soft tissue infection adjacent to bone is of paramount clinical importance. Prompt diagnosis of bone involvement allows early treatment and prevents/reduces the risk of further complications, such as abscess formation.

Imaging investigations, whilst sensitive, frequently lack a specific feature. We present a case of osteomyelitis in which the diagnosis was suggested by magnetic resonance imaging (MRI) and computed tomography (CT) and subsequently confirmed by biopsy. The various CT and MRI signs of bone involvement in osteomyelitis are discussed. In particular, the observation of extramedullary fat fluid level suggesting cortical interruption has been discussed as a specific sign of osteomyelitis in the appropriate clinical setting. A review of the literature reveals only two previously reported cases of extra-osseous fat fluid level in osteomyelitis.

Case report

A 15-year-old girl was admitted with pain and tenderness in the left thigh with fever of four weeks duration. There was no history of trauma/drug abuse.

On examination, her left thigh was swollen and tender. Laboratory findings included white blood cell count of 17,300, erythrocyte sedimentation rate of 68 mm/h, and C-reactive protein (CRP) of 7 mg/dl. The laboratory workup was negative for sickle cell anemia. Blood cultures were positive for Staphylococcus aureus.

The roentgenogram of the left thigh (Fig. 1) showed indistinct areas of bone resorption in the left femoral head and shaft with lamellated periosteal reaction and soft tissue swelling. There was widening of the hip joint space with minimal irregularity of the acetabular margin.

MRI was performed (Figs. 2 and 3). The entire left femur, sparing the distal epiphysis, showed decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted and short tau inversion recovery (STIR) images within the marrow. The surrounding muscle and fascial planes revealed high signal intensity on T2-weighted and STIR images. The femoral head was partially collapsed with altered signal involving the head and the adjacent acetabulum. There was accompanying effusion in the hip joint space. An extra-osseous fat fluid level was seen adjacent to the proximal femoral metadiaphysis. The supernatant fluid component showed persistent hyperintensity on T1- and T2-weighted images with suppression of the signal on fat-saturated images, establishing the diagnosis of a 'fat fluid' level. Several tiny fat globules were also seen, some within the hip joint cavity. No pathological fracture was identified in the femur.

CT (Fig. 3) of the left hip and thigh demonstrated extensive marrow and soft tissue edema, cortical fissuring, and features of septic arthritis. The extramedullary fat fluid level was also well depicted. There was no evidence of fracture.

A bone biopsy confirmed osteomyelitis (Fig. 4).

Fig. 1 Radiograph of the left thigh shows indistinct areas of bone resorption in the left femur with lamellated periosteal reaction and soft tissue swelling. The femoral head is partially collapsed with a widened joint space

Discussion

Primary or hematogenous osteomyelitis is a common occurrence in children. While children present with acute symptoms, the onset in adults is relatively insidious. The infection has a predilection for the metaphyses of the tubular bones of the extremities. This reflects the anatomy of the vascular tree. Eighty to ninety percent (80–90%) of cases of pyogenic osteomyelitis are a result of staphylococcus aureus infection [1].

Radiographic findings are usually not seen before approximately 14 days after the onset of infection. Bone scintigraphic changes are seen much earlier, although false-positive scans are not uncommon due to hyperemia from cellulitis [2].

CT may demonstrate altered bone marrow attenuation in cases of acute hematogenous osteomyelitis. This reflects the inflammatory reaction in the bone marrow. Other causes of increased bone marrow density are neoplasms, hemorrhage, radiation, and stress and healing fractures. Also, CT can demonstrate early the destruction of the spongy bone which may be missed on the radiographs. However, this is, again, a nonspecific finding. CT reveals the presence and extent of bone expansion, and involucrum and cloaca formation, and is especially helpful in the detection of bone sequestra in chronic osteomyelitis [3].

MRI is sensitive in the detection of acute osteomyelitis. It reveals low/intermediate signal in the bone marrow on T1-weighted sequences and high signal intensity on T2-weighted images and STIR sequences. Fat saturation sequences are useful to highlight the fluid within the fatty bone marrow. Surrounding soft tissue also appears hyperintense on T2-weighted images due to edema. However, reactive bone marrow edema can occur in the setting of cellulitis and can mimic osteomyelitis. Also, trauma, infarct, or neoplastic processes may simulate the T1 and T2 signal alterations seen in osteomyelitis. Focal bone destruction and periosteal reaction are the more specific signs that indicate acute osteomyelitis in the appropriate clinical setting [3, 4]. Davies et al. [5] have suggested that intramedullary and extramedullary fat globules on MRI supports the diagnosis of osteomyelitis and may help to exclude the presence of a tumor.

Our case shows typical findings of osteomyelitis along with the demonstration of an extramedullary fat fluid level in the surrounding soft tissues on both CT and MRI. Fat fluid level formation within joints has also been well documented after trauma and suggests an intra-articular fracture. In these cases, shearing of the bone marrow causes the release of fat globules which layer within the joint, causing the formation of lipohemarthrosis. The mechanism

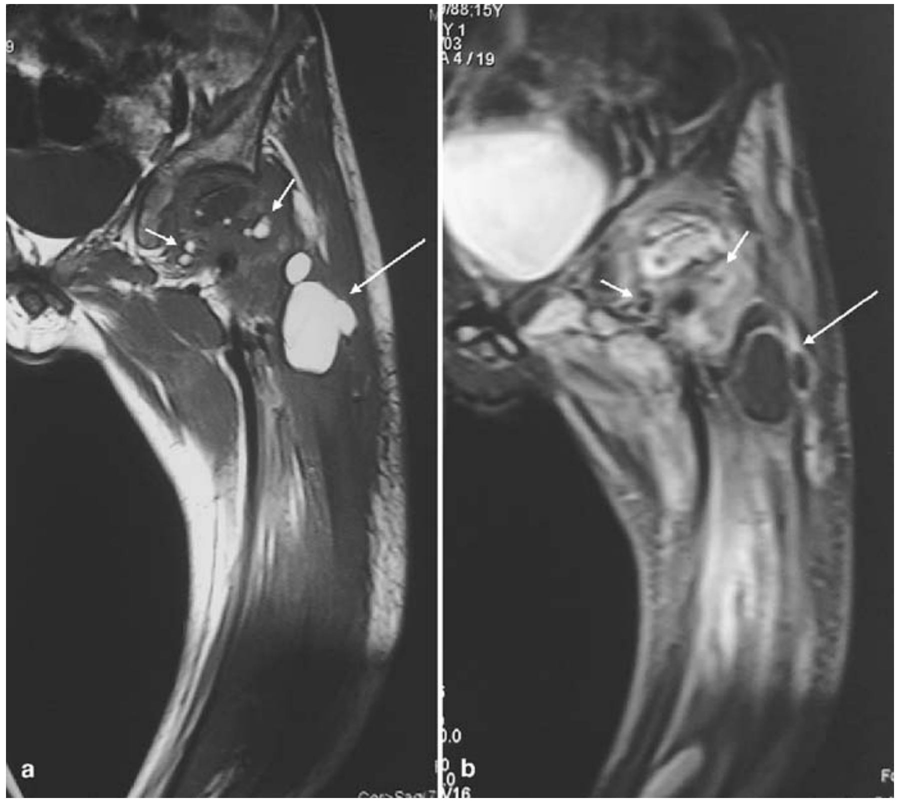

Fig. 2a, b Coronal magnetic resonance imaging (MRI) of the left thigh. **a** T1-weighted image (TR 616, TE 20) shows extra-osseous fat adjacent to the proximal femoral metadiaphysis (*long arrow*). Several small fat globules are also noted in the intra-articular location (*small arrows*). **b** Short tau inversion recovery (STIR) image (TR 4470, TE 67, TI 130) shows suppression of the signal of fat (*large* and *small arrows*)

of formation of fat fluid level in cases of osteomyelitis is, perhaps, similar to that in trauma. Rather than shear injury, it is now septic necrosis of adipose cells in the bone marrow which releases free fatty globules. When associated with cortical breach, these are released into the extra-osseous soft tissues. The layering of this lipid and pus results in the formation of the fat fluid level. This is especially so in the long bones of an adult, where the bone marrow is predominantly fatty [6].

Extra-osseous fat fluid level is seen rarely in osteomyelitis, with only two cases previously reported in the literature: one depicting the level within a joint affected by

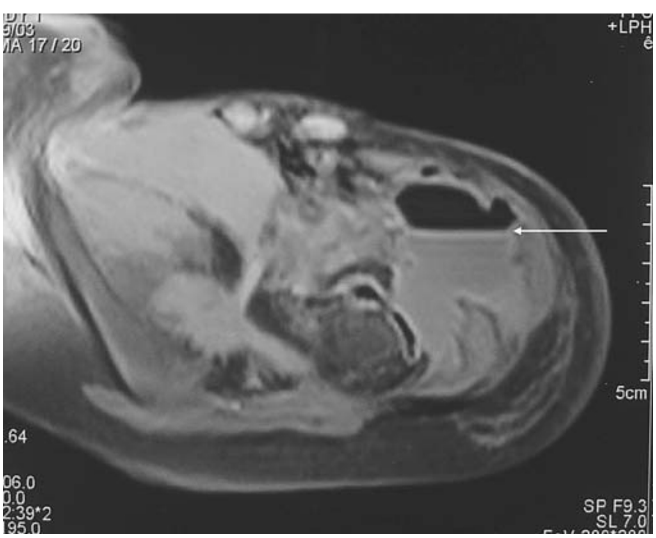

Fig. 3 Axial fat-saturated T1-weighted MRI image (TR 906, TE 10) shows extra-osseous fat fluid level (*arrow*) with suppression of the signal from the supernatant fat component

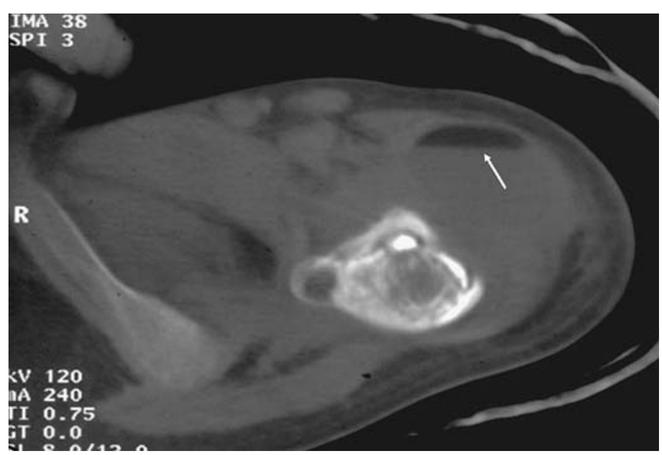

Fig. 4 Axial computed tomography (CT) image (bone window settings) demonstrates the fat fluid level (*arrow*) in the soft tissues adjacent to the femoral shaft. The femur shows irregular destruction with increased marrow density consistent with osteomyelitis

septic arthritis [6] and the other within the surrounding soft tissues [4]. The reason for the rarity of this finding in osteomyelitis is probably the extensive necrosis of bone marrow that needs to occur at a rapid phase for the fat to accumulate. However, it may be useful in the diagnosis of osteomyelitis in cases with otherwise equivocal imaging findings, especially when associated with medullary bone destruction and in the absence of trauma.

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