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Case Report

Intra and extramedullary fat globules as an MRI marker for osteomyelitis

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ABSTRACT

Magnetic resonance imaging (MRI) findings of acute osteomyelitis vary from non-specific bone marrow edema to more reliable signs such as bone destruction, periosteal reaction, and sequestrum. In some cases, imaging features could overlap with other conditions such as trauma and bone tumors. Intra and extramedullary fat globules are a helpful MRI marker for osteomyelitis, as shown in the following case report. We report the MRI findings of a 15-year-old young man with distal femur osteomyelitis, associated with intra and extramedullary fat globules. We present the MRI features of the case and emphasize the importance of noting additional signs of osteomyelitis to make a precise diagnosis.

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Background

Osteomyelitis is an infectious disease that often presents as pain, fever, and soft tissue infection. An early and precise diagnosis leads to antibiotic treatment and may avoid surgical procedures and complications. Imaging studies are helpful to identify bone involvement in cases of suspected osteomyelitis. Magnetic resonance imaging (MRI) is able to access bone and soft tissues and determine the precise location and extension of the inflammatory process [1–3].

MRI sensitivity for osteomyelitis is high (82%–100%), but the specificity is reported as low (38%–100%) [3,4]. Other bone disorders may have MRI findings similar to osteomyelitis, such as post-trauma edema, medullary infarction, tumors, or metabolic disorders, especially in children [4–6]. However, current reports have described MRI findings that could be more osteomyelitis-specific such as intramedullary and extramedullary fat globules [6–8]. In this case report, we describe the radiographic and MR (magnetic resonance) images of a femoral osteomyelitis in a young male. We also highlight the presence of medullary bone edema, intramedullary, and

Abbreviations: MRI, magnetic resonance imaging; BMI, body mass index.

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Fig. 1 – AP (a) and lateral (b) radiograph of the right knee presenting a moth-eaten and permeative pattern of bone destruction in the distal femur metaphysis (white arrows).

extramedullary fat globules to exclude other causes of lower limb pain.

Case presentation

A 15-year-old young man presented with intense pain in the right lower limb, mainly in the thigh, that began 2 weeks after seeking medical attention. The pain was associated with edema and reduced range of motion. A physical examination showed mild fever, reduction of passive, and active right thigh movement, with increased temperature of the limb, close to the knee joint. The patient's medical history was collected with his father and did not include neoplastic disease or prior surgery of the lower extremities, although the patient was from an Indian tribe from the southeast of Brazil and provided limited information as he was not fluent in Portuguese. The patient had a body mass index of 14.9 and did not report recent lower limb trauma. Laboratory tests were performed during the same period as the imaging studies and were considered normal.

Radiographs of the right knee were performed 2 weeks after the onset of symptoms and showed heterogeneous bone texture of the distal femoral shaft and metaphysis with a permeative and moth-eaten pattern, without a fracture line or periosteal bone formation (Fig. 1). At that time, the patient was presumed to have a bone tumor or intramedullary infectious or metabolic disease. An MRI of the right knee was performed 2 weeks after the onset of symptoms (Figs. 2–4). The MR images of the right knee showed extensive bone marrow edema throughout the distal right femur medullary cavity, with

subperiosteal fluid in the distal femoral shaft. In addition to marrow edema, there were multiple intramedullary fat globules, especially in the distal femoral metaphysis (Fig. 2). Furthermore, there were extramedullary fat globules in soft tissues on the posteromedial margin of the distal femoral metaphysis and intense regional soft tissue edema (Figs. 3 and 4).

The MRI and radiograph findings were interpreted as femoral osteomyelitis and a surgical approach was chosen, including medial knee arthrotomy, synovectomy, articular inspection. The culture of the synovial fluid confirmed an *Enterococcus* infection. He received parenteral antibiotics and dietary supplementation to increase caloric intake.

Discussion

Osteomyelitis usually affects the long bones of the extremities due to their vascular anatomy. In children, adolescents, and young adults areas with slow blood flow, such as the metaphysis of long bones, may increase the propensity for infection [4]. The main bacterial agent of acute osteomyelitis is *Staphylococcus aureus*, accounting for 80%–90% of all cases [9]. Other bacterial agents, such as *Enterococcus* are responsible for fewer cases, and occur especially in patients with malnutrition, or even those with renal or intestinal infections [9]. In cases of acute osteomyelitis, the medullary involvement is characterized by vascular engorgement, edema, cellular infiltration, and abscess formation [9]. The inflammatory process increases intramedullary pressure and facilitates



Fig. 2 – Sagittal T2-weighted fat-suppressed (a) and sagittal T1-weighted MR (b) images of the right knee show intramedullary fat globules (black arrows) and subperiosteal fluid on distal femoral shaft (white arrows).



Fig. 3 – Coronal (a) and axial (b) T2-weighted fat-suppressed MR images of the right knee demonstrate intense bone marrow edema of the distal femur, with intramedullary fat globules (black arrows) and extramedullary fat globules (white arrows).

the spread to cortical bone via Haversian and Volkmann's channels. When the infection reaches the periosteum it may result in cortical breach and extraosseous involvement [10]. Bone marrow necrosis due to infection results in the release of free fatty globules [9]. Those fat globules may be liberated to extraosseous compartments through cortical breaches [10].

Imaging studies are helpful to identify the bone involvement of osteomyelitis, although soft-tissue edema and ab-

cess formation might be visible before osseous destruction on radiographs, especially in children [10]. Permeative and moth-eaten patterns of bone destruction are common in acute osteomyelitis and cortical destruction or periosteal reaction can be seen [3,10,11]. MRI is a sensitive method for osteomyelitis detection. A low signal intensity is seen in the bone marrow on T1-weighted sequences and fluid and inflammatory cell infiltration results in high signal inten-



Fig. 4 – Sagittal T2-weighted fat-suppressed (a) and sagittal T1-weighted MR (b) images of the right knee show extramedullary fat globules (white arrows).

sity on T2-weighted and other fluid sensitive MRI sequences [3,11,12]. Fat saturation sequences are useful to differentiate bone marrow edema from the fatty tissue of bone marrow and subcutaneous tissue [10]. Other imaging signs that may help in the diagnosis of osteomyelitis include focal bone destruction, periosteal reaction, and sequestrum [7]. Additionally, intramedullary and extramedullary fat globules are also signs that can improve MR specificity, since they are secondary to fat released by medullary lipocytes after necrosis [8]. In a study with 100 osteomyelitis subjects, Davies et al. reported that in patients ranging from 9 to 42 years old, 70% (12 out of 17 patients) had MRI findings of intramedullary or extramedullary fat globules.

Our case report includes a patient with osteomyelitis with intramedullary fat globules within the age range of puberty. Recent studies suggest that osteomyelitis patients in puberty or past that age range are more likely to demonstrate the signs of bone infection [6,8]. The increased percentage of yellow marrow in young adolescents when compared with children may be responsible for differences in the signs of osteomyelitis. Although, intramedullary and extramedullary fat are not pathognomonic of osteomyelitis, as they have been seen in cases of medullary infarction, trauma, and Gaucher disease [8,13], in the clinical context of infection they could play an important role in diagnosis. When present, the fat globules are an MRI marker of increased intramedullary pressure of the affected bone, probably due to rapid progression of the inflammatory process, and should be promptly reported to the attending physician to avoid a delay of treatment or misdiagnosis.

Conclusion

Imaging findings of osteomyelitis are often restricted to non-specific bone marrow findings on MRI along with soft tissue edema. Intramedullary and extramedullary fat globules have previously been described as a helpful and specific sign of osteomyelitis. In this report, osteomyelitis in the distal femur is clearly demonstrated using MRI with the presence of intramedullary and extramedullary fat globules in a teenager. Although, the described fat globules are infrequent in MRI examinations when there is a suspicion of bone infection, they could be a helpful biomarker for osteomyelitis.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

IG provided the clinical data included in the text. IG wrote the manuscript draft. IG and LPN revised it critically and approved the modified text. IG, TCR, LPN and AS and approved the final version of the manuscript. All the authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

A written informed consent was obtained from the patient for publication of this case report and any accompanying images.

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