Clinical note

Discordance between MRI and bone scan findings in a child with acute complicated osteomyelitis: Scintigraphic features that contribute to the early diagnosis

V. Mpalaris\textsuperscript{a,*}, G. Arsos\textsuperscript{a}, I. Iakovou\textsuperscript{a}, E. Dalpa\textsuperscript{b} y N. Karatzas\textsuperscript{a}

\textsuperscript{a} 3rd Department of Nuclear Medicine of the Aristotle University of Thessaloniki, Papageorgiou General Hospital, Thessaloniki, Greece

\textsuperscript{b} 4th Pediatrics Clinic of the Aristotle University of Thessaloniki, Papageorgiou General Hospital, Thessaloniki, Greece

ABSTRACT

Early diagnosis and prompt treatment of acute osteomyelitis are of paramount importance in children because they can prevent irreversible bone damage. Magnetic resonance imaging (MRI) with its superior spatial resolution and lack of ionizing radiation is routinely preferred over bone scan for this purpose. Increased blood flow, hyperemia and focally increased tracer uptake shown by “three phase” bone scan are the typical scintigraphic findings of acute osteomyelitis. In addition, diffuse uptake along the shaft of long bones and focal “cold” lesions are two special features that may be highly suggestive of infective periostitis, soft tissue sepsis and subperiosteal abscess formation, due to the loose attachment of periosteum to bone during childhood. We present a case of complicated osteomyelitis in a child with inconclusive MRI correctly diagnosed on the basis of these special scintigraphic findings resulting in treatment change from double i.v. Vancomycin – Ceftriaxone scheme to surgical intervention.

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Discordancia entre los hallazgos de resonancia magnética y gammagrafía ósea en niño con osteomielitis aguda complicada: aportación de patrones gammagráficos característicos en el diagnóstico precoz

RESUMEN

El diagnóstico precoz y el tratamiento adecuado de la osteomielitis aguda es de suma importancia en los niños, ya que pueden prevenir el daño irreversible del hueso. La resonancia magnética (RM) por su superior resolución espacial y ausencia de radiación ionizante es la técnica utilizada en la práctica habitual antes que la gammagrafía ósea. El aumento de flujo sanguíneo y el incremento de captación focal del radiotrazador mostrado en la gammagrafía ósea de tres fases son los hallazgos gammagráficos típicos de osteomielitis aguda. Además, la captación difusa en la diafisis de huesos largos y una lesión focal “fría” son dos características especiales muy sugerente de periostitis, sepsis en tejidos blandos y formación de un absceso subperióstico, debido a la pérdida de unión del periostio al hueso durante la infancia. Presentamos un caso de osteomielitis complicada en un niño con RM no concluyente correctamente diagnosticada sobre la base de los hallazgos gammagráficos característicos originando el cambio de tratamiento de doble esquema de Vancomicina – ceftriaxona iv a intervención quirúrgica.

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Introduction

Early diagnosis of acute osteomyelitis is critical in children because prompt antibiotic therapy may prevent bone damage. The diagnosis is primarily clinical, although clinical manifestations may be non-specific. As delayed or inadequate diagnosis may significantly diminish cure rate and increase the frequency of complications, imaging is essential to confirm the presumed clinical diagnosis and to provide localization and extent data crucial for the selection between primarily medical or surgical treatment.

Magnetic resonance imaging (MRI) with its ability to demonstrate changes in the water content of bone marrow combined with its excellent structural definition and spatial resolution is the most sensitive and most specific imaging modality for the detection of osteomyelitis. It provides fine anatomic detail and more accurate information on the extent of the infectious process and soft tissues involvement.

Disadvantages of MRI are its inability to distinguish infectious from reactive inflammation – as in our case – and its difficulty in imaging sites with metallic implants, such as joint prostheses or fixation devices. Nuclear medicine with three-phase bone scan can provide additional information in such cases contributing to correct diagnosis and treatment.

Case report

A 10-year-old girl presented with high grade fever followed by painful swelling of the right ankle 24 h later. Apart from a right
ankle strain one year ago, medical history was negligible. As both clinical manifestations and laboratory tests were highly suggestive of osteomyelitis (white-blood cells [WBC] 15.84 × 1000/μL, neutrophils [NEUT] 83.2%, C-reactive protein [CRP] 18.2 mg/dl, eritrosedimentation rate [ESR] 105 mm) a double intravenous vancomycin–ceftriaxone scheme was started.

MRI (Fig. 1) performed three days after the onset of symptoms showed diffuse heterogeneity of the marrow of the distal tibia signal and to a lesser degree of the other bones of the foot with no contrast enhancement. The findings were interpreted as not being consistent with bone marrow edema or bone abscess. A periosteal reaction of the distal metaphysis of the tibia with edema of the adjacent soft tissues and fat, was attributed to inflammation. Overall, the findings were interpreted as consistent with hematological disease but not with acute osteomyelitis.

Because of the disagreement between MRI suggestions and clinical impression a bone scan was requested. A three-phase study (Fig. 2A) performed the next day revealed increased blood flow and hyperemia of the right leg, diffusely increased uptake in the right tibia and foot with intense focal uptake in the distal tibial metaphysis. In both the blood pool (Fig. 2B) and skeletal (Fig. 2C) phases a well delineated photopenic diaphyseal area adjacent to the hypermetabolic tibial metaphysis was evident. Tracer uptake was normal throughout the rest of the skeleton. The diagnosis of acute osteomyelitis of the distal metaphysis of the right tibia with possible subperiosteal abscess/necrosis was reported leading to prompt surgical intervention.

During surgery under general anesthesia, pus discharge was evident on the incision of the elevated periosteum. Drilling of the cortical bone was also followed by flow of small quantity of pus. No cavity was found in the metaphyseal area. The subperiosteal pus collection was also extending within adjacent soft tissue. Material for culture and histology was obtained. Finally, bone window was created. Histological diagnosis was that of osteomyelitis with no signs of malignancy and methycylon-resistant staphylococcus aureus was isolated from culture.

After surgery there was a fast resolution of fever and drop of WBC counts (6.4 × 1000/μL, NEUT 67.4%), ESR (58 mm) and CRP (5.48 mg/dl).

Fig. 1. MRI of the right tibia with findings of marrow edema of the distal tibia and to a lesser degree of the other bones of the foot.

Fig. 2. Bone scan. Three phase bone scan (2A) reveals increased blood flow and hyperemia of the right leg, diffusely increased uptake in the right tibia and foot with intense focal uptake in the distal tibial metaphysis. In both the blood pool (2B) and skeletal (2C) phases a well delineated photopenic diaphyseal area adjacent to the hypermetabolic tibial metaphysis was evident.
Discussion

The term osteomyelitis refers to infection of both bone and bone marrow, tending to affect long bones in children and vertebrae in adults. Microorganisms can enter bone by the hematogenous route, directly from a contiguous focus of infection, or by a penetrating wound. Trauma, ischemia, and foreign bodies enhance the susceptibility of bone to microbial invasion. Children account for 80% of all cases of osteomyelitis with two peaks in incidence; one under 1 year of age and a second between 9 and 11 years. Blood supply at the ends of long bones changes with age. In the infant diaphyseal and metaphyseal vessel may perforate the growth plate to reach and supply the epiphysis. During childhood and adolescence (1–16 years) as the growth plate is gradually ossified there is progressive involution of these vessels till none penetrates the plate and anastomotic channels are then established from the metaphysis to epiphysis. The pathological process starts with an inflammatory reaction (myelitis) leading to alterations in pH and capillary permeability that contribute to regional edema, cytokine release, tissue breakdown, leukocyte recruitment, decreased oxygen tension, increased local pressure, small-vessel thrombosis, and bone metabolism deterioration. The increasing exudative pressure within the marrow cavity can compromise blood flow.

If the exudate penetrates the endosteum it may then enter the haversian and lacunar systems of the cortical bone (osteitis) and then spread to periosteum (periostitis). At this level of children in the periosteum, due to its loose attachment to bone, can be lifted away leading to disruption of blood supply and development of subperiosteal abscess.

MRI is considered the most useful imaging technique to evaluate suspected osteomyelitis. It is highly sensitive for detecting osteomyelitis as early as 3 to 5 days after the onset of infection.

The MRI findings vary depending on the pulse sequences used and on the disease stage. Initial MRI screening usually includes T1-weighted and T2-weighted spin-echo pulse sequences. The earliest finding of acute osteomyelitis on MRI is an alteration of the normal bone marrow signal intensity, which can be appreciated as early as 1–2 days after the onset of infection; the edema and exudates within the medullary space produce an ill-defined low-signal intensity on the T1-weighted images and a high signal on T2-weighted and STIR or fat-suppressed sequences.

The characteristic pattern of acute osteomyelitis in “three phase bone scan” consists of increased arterial blood flow (flow phase), hyperemia (blood pool phase) and focal intense uptake in the delayed phase within 48–72 h of the onset. Special scintigraphic findings correlating with the complications of osteomyelitis described above have been reported. Elevated tissue pressure secondary to the inflammatory response can lead to ischemic injury to the bone and reduce the delivery of radiopharmaceutical. Furthermore, if the exudates lift the periosteum then cortical blood flow may be disrupted, again reducing the delivery of radiopharmaceutical. A “cold” lesion may then result or a mixed pattern with a “cold” lesion adjacent to the increased uptake site as in our case. This pattern has been attributed to subperiosteal abscess formation by several authors and was an indication for urgent surgical decompression in 25 of 35 cases reviewed by Rehm and Aaron.7

Another special scintigraphic pattern of “extended” uptake has been reported in both childhood and adult osteomyelitis, and has been attributed to infective periostitis, severe soft tissue sepsis adjacent to bone and with hyperemia secondary to focal osseous sepsis.8

In our case there were both extended uptake along the shaft of tibia and a photopenic area, raising suspicion of complicated osteomyelitis requiring invasive treatment. The main MRI finding was bone marrow signal heterogeneity with no contrast enhancement—probably due to ischemic injury of bone corresponding to the photopenic area on bone scan— and the overall impression was that of hematological disease.

The presented case showed that in the era of high resolution imaging modalities, bone scintigraphy can still provide unique informations at early stages of acute osteomyelitis leading to change in patient’s management.5,10

Conflicts of interest

The authors have no conflicts of interest to declare.

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