Osteomyelitis - What radiologists should know

Poster No.: C-3086
Congress: ECR 2018
Type: Educational Exhibit
Authors: B. S. D. Flor de Lima, E. F. M. P. Negrao, C. Sousa, J. Rebelo, M. J. Leite, F. Duarte, J. N. C. Lobo, M. Pimenta; Porto/PT
Keywords: Infection, Diagnostic procedure, MR, CT, Conventional radiography, Musculoskeletal bone, Management
DOI: 10.1594/ecr2018/C-3086

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys’ fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

To review the spectrum of imaging findings of osteomyelitis in different radiologic modalities and correlate them with surgical findings.

To discuss the differential diagnosis and invasive treatment options available for osteomyelitis, also showing their radiologic features.
Background

Osteomyelitis is defined as bone inflammation, usually caused by pyogenic infection. It is often a difficult-to-treat condition, associated with considerable morbidity and important health care costs. Osteomyelitis can occur in every age, although it has a two-peak incidence, one infantile, in children before 5 years of age and, another, in adults older than 50 years of age. Its incidence is increasing in developing countries, since the incidence of predisposal conditions such as diabetes mellitus is also raising.

*Staphylococcus aureus* is the most common causative agent, both in children and adults. Other agents are common in specific groups, such as *Salmonella* spp., frequent in patients with sickle-cell disease, and *Pseudomonas* spp., in endovenous-drug users.

Osteomyelitis can be typically classified according to its duration as acute, subacute or chronic, although there is no consensus on the duration criteria to define each phase. Chronic osteomyelitis is more common in adults than in children.

Pathogenic agents may reach the bone by three main routes. Hematogenous dissemination is most common in children and affects most frequently the metaphysis of long bones, the most susceptible part of the bone, due to its high vascularization. Hematogenous spread is less common in adults and may typically affect vertebral bodies, but also long bones, pelvis and clavicles. Osteomyelitis may as well be caused by contiguous spread of infection from adjacent tissues, frequently in diabetic patients, and by direct inoculation, due to previous trauma or surgery.

After bacterial proliferation, bone undergo important inflammatory reactions that lead to local edema and increased medullary pressure. This raised pressure induce infection spreading to subperiosteal bone, periosteum and lastly to contiguous soft tissues. In chronic stages of the disease, there can be a separated necrotic bone fragment, called sequestrum. If this sequestrum is present, its detection is crucial because it can perpetuate the infection and it needs surgical removal. As infections progress, the pus needs to exit the medullary cavity, and the cloaca is formed, which is a cortical defect that drains the pus to adjacent tissues. New bone is formed and deposited, covering the necrotic bone, as an involucrum.

Imaging exams play a crucial role on the diagnosis of osteomyelitis because its associated symptoms are varied and non-specific and, additionally, some patients may have normal serum inflammatory markers. However, the diagnosis can be sometimes challenging, as imaging features vary according to the duration of the inflammatory process and many conditions may mimic osteomyelitis.
Findings and procedure details

- Imaging findings of osteomyelitis

- Conventional radiography

Conventional radiography should be the first imaging exam requested since it may show some osteomyelitis features and can also exclude other diagnosis such as fractures or bone tumors. However, it has low sensitivity and radiologic findings only appear one to three weeks after the beginning of the infection.

Initially, the imaging features are subtle. Then radiography may show a wide-range of findings, such as soft-tissue edema, osteopenia, impaired trabecular arrangement, lytic lesions, endosteal scalloping, perosteal reaction and new bone apposition. In sub-acute stage, an intraosseous abscess called Brodie Abscess may be seen mainly the in extremity of tubular bones, typically tibia and femur (Fig. 1 on page 20). It appears as a well-defined lytic lesion, with a sclerotic halo, ranging from 1 to 4 cm.

Fig. 1: Brodie abscesses in three different patients appearing as a lytic lesion with a sclerotic rim. A- AP knee x-ray shows an abscess on the proximal tibial metaphysis. B- Left ankle x-ray shows an abscess on the distal tibial metaphysis. C- AP knee x-ray shows two abscesses, one in distal femur and the other on the proximal extremity of the tibia.
In chronic phases, radiographs may show sequestrum, appearing as sclerotic calcified bone within lucent bone. Osteoid osteoma, eosinophilic granuloma and lymphoma are some conditions that may mimic the sequestrum. Radiographs may also show the involucrum, ill-defined lytic lesions and cortical destruction (Fig. 2 on page 20).

**Fig. 2**: Osteomyelitis. Right AP foot x-ray (magnified on the right) shows ill-defined lytic lesions and cortical destruction in the distal phalange of the hallux.

**References**: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**-Computed tomography (CT)**

On CT, osteomyelitis findings are similar to those shown by radiography (Fig. 3 on page 21), but they can be detected on an earlier phase.
Fig. 3: Brodie abscesses. Right knee CT coronal (A) and axial (B, C) images, from the same patient as Figure 1-C, show two lytic lesions in a child presenting with fever and pain, representing Brodie abscesses: one in the distal femoral metaphysis (A, B) and the second on the proximal metaphysis of the tibia (A, C).

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
CT is better than MRI to identify sequestrum, cloaca (Fig. 4 on page 22), involucrum and intra-osseous gas, a rare sign of osteomyelitis.
**Fig. 4:** Ankle CT sagittal (A) and axial (B) images show a lytic lesion on the calcaneum, containing a bone fragment inside, consistent with a Brodie abscess with a sequestrum (circles). On the axial image (B), a cortical defect representing the cloaca (arrow) is seen. MRI was also performed to exclude osteoid osteoma.

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

CT allows guidance for intervention radiology procedures, although it uses ionizing radiation. Not to forget that it is inferior to MRI in the study of soft-tissues, as it does not show bone marrow edema, an important finding in the earlier stages of osteomyelitis. Its accuracy may be limited in the presence of metallic prosthesis causing beam-hardening artifacts.

- **Ultrasound (US)**

US has an important role in the pediatric population, as it is easily accessed, gives real time information, does not use ionizing radiation and is a relatively low-cost technique. Like CT, it also allows guidance for intervention radiology procedures.

US may show elevated periosteum by hypoechoic purulent material (periosteal abscesses) ([Fig. 5](#) on page 23), adjacent soft tissue involvement with collections ([Fig. 6](#) on page 23) or fistulas, cortical erosions, concomitant septic arthritis, soft tissue edema and foreign bodies.
Fig. 5: Gray-scale US images show a subperiosteal abscess, seen as irregularity of the tibial periosteum with hyperechoic material extending towards soft-tissue, in a child with osteomyelitis.

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

Fig. 6: Chest wall gray-scale US images in transverse (A) and longitudinal (B) plans show a fluid collection (C) representing a soft-tissue abscess in a child with rib (b) osteomyelitis. Periosteum irregularity can also be seen on both images.

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

-Magnetic resonance imaging (MRI)

MRI is the gold standard in the diagnosis of osteomyelitis, due to its high sensitivity, specificity and its good spatial resolution. Imaging findings are best seen on T1-weighted
and fluid sensitive sequences. Whenever an abscess or sinus tract is suspected to be present, T1-weighted sequences with fat saturation after gadolinium injection should also be acquired.

The key feature of osteomyelitis is **bone marrow edema**, which is seen as a low signal on T1-weighted and high signal on T2-weighted and short tau inversion recovery (STIR) images. It is the first imaging sign and appears as early as in 24 to 48 hours. (Fig. 7 on page 24)

**Fig. 7**: Acute osteomyelitis. Left hip x-ray (A) of a boy presenting with left hip pain and fever. No clearly lesions are seen. MR images show abnormal marrow signal on the left acetabulum, seen as low-signal on Fat-saturated (FS) T1 (B and D) and T1 (C). After gadolinium injection (D), the bone marrow enhances.

**References**: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

Abscesses are hypointense on T1-weighted images and hyperintense on fluid sensitive sequences. After the administration of gadolinium, the granulation tissue enhances but the central cavity does not, representing the "penumbra sign" (Fig. 8 on page 24).
Fig. 8: Penumbra sign. Sagittal MRI FS T1-weighted image with contrast show a round hypointense area with peripheral enhancement (circle), representing an intra-osseous abscess. Anteriorly, a cutaneous ulcer is seen as subcutaneous tissue thinning. Also, in the most distal part of the tibia, bone avascular necrosis is seen (arrow).

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

Sequestrum is seen on MRI as an area of low signal, surrounded by granulation tissue, which has low to intermediate signal on T1-weighted and high signal on fluid sensitive sequences. After contrast, granulation tissue enhances, but central dead bone don’t (Fig. 9 on page 25 and Fig. 10 on page 26). Sinus tracts and fistulas may appear as a fluid-linear structure draining to skin surface.
Fig. 9: Sequestrum. Axial MRI images in a patient with osteomyelitis of the right tibia show a round area (inside circles) of low-signal on T2-weighted (A) and FS T1-weighted sequences (B), that exhibits peripheral enhancement on the FS T1 with contrast image (C), representing a sequestrum with outlying enhancing granulation tissue.

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
**Fig. 10:** AP leg x-ray (A) shows an ill-defined lytic lesion (arrow) on the proximal metaphysis of the tibia. MRI fat-sat T1-weighted images with gadolinium on coronal (B) and sagittal (C) planes show an abscess (arrows) on the proximal metaphysis of the tibia with peripheral enhancement - penumbra sign. In the most distal part of the tibia, an area of bone avascular necrosis is also seen (circles). Axial MRI FS PD with contrast image (D) show a small cortical defect representing the cloaca (*). The patient was submitted to abscess drainage as seen on the intraoperative photograph (E).

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

MRI is also important to determinate the extent of the inflammatory process to contiguous tissues (**Fig. 11** on page 27), to detect acute inflammatory activity in chronic osteomyelitis and to help on planning surgical treatment.

**Fig. 11:** Sagittal fluid-sensitive sequence MRI image shows a sub-periosteal abscess (circle) in a patient with acute osteomyelitis and associated soft-tissue involvement. Two days after, the patient developed a compartment syndrome and fasciotomy was performed, as seen on the intra-operative photograph (B). Five days after this surgery, MRI show muscles edema due to fasciitis and a defect on the subcutaneous tissue related to the surgical procedure performed (arrow). An intramuscular abscess is also seen (*).

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

On the other hand, MRI has the disadvantage of requiring sedation or general anaesthesia in children.
• **Differential diagnosis**

Several conditions with different etiologies may mimic osteomyelitis.

**Stress injuries**

Stress fractures may be a diagnostic challenge. They occur more frequently in weight-bearing bones of the lower limb and present with insidious pain that gets more frequent over time. The first radiographs may be normal. MRI plays a major role on the diagnosis of these fractures, showing a fracture line surrounded by abnormal bone marrow signal (Fig. 12 on page 27). Like in osteomyelitis, periosteal reaction may be seen, but no soft tissue affection is expected to be present.

![Fig. 12: Stress fracture in a adolescent presenting with night pain. Technetium 99m bone scan (A) show increased uptake in the right medial malleolus. Coronal MRI FS PD image (B) show abnormal marrow signal on the distal tibia and a small hypointense cortical interruption representing the fracture line (arrow). Sagittal MRI images show surrounding bone marrow edema, seen as low signal on T1-weighted (C) and high signal on STIR images (D).](image)

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**Primary bone neoplasms**
Some primary bone tumors may mimic osteomyelitis, such as multiple myeloma, Ewing sarcoma and osteosarcoma. To differentiate them, the age of the patient must be considered and also his clinical history, as tumors tend to have a slower growth when compared to osteomyelitis.

Multiple myeloma is the most prevalent primary bone tumor in adults. Its imaging features range from multiple "punched-out" lytic lesions involving predominantly the axial skeletal, to diffuse osteopenia or a single expansive lesion (plasmocytoma). MRI has a good sensitivity to detect bone marrow infiltration.

Osteosarcoma is the most common bone tumor in childhood. It may be classified as primary or secondary. Primary osteosarcomas are more common in males between the ages of 10 to 20 years. They usually affect the metaphysis of long bones, most frequently around the knee. On radiographs, a bone-destroying lesion is seen, usually associated with aggressive periosteal reaction and with a soft-tissue mass. On MRI, a mass with heterogeneous signal is seen, which reflects the mixed tumoral matrix composed by both mineralized and non-mineralized parts.

Ewing sarcoma is the second most prevalent bone tumor in children, after osteosarcoma. It also has a male-predominance and is more common in adolescents and young adults. Radiographs typically show a poorly-defined permeative lytic lesion located on the metaphysis/diaphysis of long bones that may have associated prominent soft-tissue mass. On MRI, the tumoral lesion has low signal on T1 and high signal on T2-weighted sequences (Fig. 13 on page 28). The abnormal marrow signal tends to be well-defined, unlike what is seen in osteomyelitis.
**Fig. 13:** Ewing sarcoma. AP x-ray of the right elbow (A) shows an expansive lesion, predominantly lytic, on the proximal extremity of the humerus. MRI coronal STIR image (B) shows abnormal marrow signal depicted by hyperintensity on the meta-diaphysis of the humerus.

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

---

**-Bone metastasis**

Many tumors can invade bone, but skeletal metastasis are more frequently found in association with lung, renal cell, breast and prostate cancers. Bone metastasis are usually present in well irrigated parts of the skeleton such as skull, vertebral bodies, proximal femur and humerus and pelvis. They can have a lytic (Fig. 14 on page 29), sclerotic or mixed appearance. Periosteal reaction may be seen, generally less exuberant than what is seen in primary tumors.

**Fig. 14:** Bone metastasis in a patient with breast cancer. Right hip x-ray shows a permeative pattern on the right femoral neck. Coronal CT scan shows lytic lesions on this location. Technetium 99m bone scan (C) shows increased uptake in the proximal femur and in D11 vertebral body, consistent with metastatic disease.

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

---

**-Charcot Joint/Neuropathic arthropathy**
Charcot Joint is a degenerative disorder that affects patients with loss of sensation, most commonly caused by diabetes mellitus neuropathy. This arthropathy leads to the destruction of weight-bearing joints and has two main forms: atrophic and hypertrophic. It usually affects multiple bones with a juxta-articular distribution, mainly in the midfoot (Fig. 15 on page 30), whereas osteomyelitis is more common in a single weight-bearing bone, in the forefoot or hindfoot. MRI is an important tool to differentiate Charcot from osteomyelitis, but also to identify a superimposed osteomyelitis on a Charcot foot.

Charcot is the most likely diagnosis if, beside abnormal bone marrow signal, there are no other associated features such as soft-tissue inflammatory changes, cutaneous ulcers or sinus tracts.

**Fig. 15:** Charcot joint in a diabetic patient. Oblique foot x-ray (A) shows deformity of the mid-foot with associated subchondral sclerosis. Sagittal MRI STIR (B) and T1-weighted (C) images show diffuse mid-foot bone marrow edema with some extension to the calcaneum. No skin ulcer was seen.

**References:** Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

-Langerhans cell histiocytosis (LCH)

LCH is a rare systemic disease caused by abnormal proliferation of Langerhans cells. Patients may present with a wide-range of symptoms, which vary according to the body part that is involved. The musculoskeletal system is the most affected one, mainly in young males.
Imaging exams may show a wide range of findings, such as single or multiple "punched-out" lytic lesions (Fig. 16 on page 30), vertebra plana or floating tooth. In long bones, perosteal reaction and endosteal scalloping may be seen, like in osteomyelitis. However, in LCH, diaphysis are more frequently affected, rather than metaphysis.

![Image](image_url)

**Fig. 16**: Bone involvement in Langerhans cell histiocytosis. Skull x-ray (A) and axial CT image (B) show an isolated right parietal lytic lesion (arrows).

**References**: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**- Chronic recurrent multifocal osteomyelitis (CRMO)**

CRMO is an idiopathic condition that affects most frequently female children or adolescents. It presents with chronic, multifocal and typically symmetric pain, with a relapsing and remitting pattern. Lesions are most commonly located on lower extremities, committing metaphysis of long bones, with possible associated physis involvement. Medial clavicles and spine may also be affected. Unlike osteomyelitis, in CRMO inflammatory markers are usually low.

Radiographs initially show lytic lesions with a sclerotic halo. Over time, these lesions can get progressively sclerotic. MRI is more sensitive to detect CRMO, showing abnormal marrow signal, periostitis and soft-tissue edema (Fig. 17 on page 31). Abscesses, fistulas or sequestrum are not present on CRMO, distinguishing it from osteomyelitis.
Fig. 17: CRMO in a patient presenting with left hip pain. Pelvis x-ray (A) show mild sclerosis on the proximal femur metaphysis, but also on the right iliac bone. MRI coronal FS-T1 with contrast image (B) shows abnormal bone marrow signal on both locations, associated with periosteal reaction and adjacent soft-tissue inflammatory changes.

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

- **Osteomyelitis treatment**

Promptly treatment of osteomyelitis is important to prevent bone necrosis, thus decreasing complications and morbidity rates. The mainstay of acute osteomyelitis treatment is optimal long-term antibiotic therapy.

Surgery is most likely to be necessary in adults, rather than in children with acute osteomyelitis. Surgery may be necessary in some situations, for example: if a sequestrum is present, in patients with infected orthopedic devices or if there's no response to antibiotics. In some cases a multi-step approach is preferred, including multiple procedures such as sequestrum removal, dead space management with bone grafting or tissue flaps and local therapy with antibiotic-impregnated material. Especially in diabetic patients, minor or major amputations are sometimes necessary due to bad outcomes with antibiotic therapy only. Imaging findings of some surgical procedures are seen on Fig. 18 on page 32.
Fig. 18: Imaging findings of some surgical procedures. A- Right foot AP x-ray of a diabetic patient submitted to transmetatarsal amputation of the first toe. B- Side knee x-ray shows a lateral cortical window (arrow) on the femur, made for bone abscess drainage. Also, signs of knee osteoarthritis may be seen.

References: Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 1: Brodie abscesses in three different patients appearing as a lytic lesion with a sclerotic rim. A- AP knee x-ray shows an abscess on the proximal tibial metaphysis. B- Left ankle x-ray shows an abscess on the distal tibial metaphysis. C- AP knee x-ray shows two abscesses, one in distal femur and the other on the proximal extremity of the tibia.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 2: Osteomyelitis. Right AP foot x-ray (magnified on the right) shows ill-defined lytic lesions and cortical destruction in the distal phalange of the hallux.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 3: Brodie abscesses. Right knee CT coronal (A) and axial (B, C) images, from the same patient as Figure 1-C, show two lytic lesions in a child presenting with fever and pain, representing Brodie abscesses: one in the distal femoral metaphysis (A, B) and the second on the proximal metaphysis of the tibia (A, C).

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
**Fig. 4:** Ankle CT sagittal (A) and axial (B) images show a lytic lesion on the calcaneum, containing a bone fragment inside, consistent with a Brodie abscess with a sequestrum (circles). On the axial image (B), a cortical defect representing the cloaca (arrow) is seen. MRI was also performed to exclude osteoid osteoma.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**Fig. 5:** Gray-scale US images show a subperiosteal abscess, seen as irregularity of the tibial periosteum with hyperechoic material extending towards soft-tissue, in a child with osteomyelitis.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
**Fig. 6:** Chest wall gray-scale US images in transverse (A) and longitudinal (B) plans show a fluid collection (C) representing a soft-tissue abscess in a child with rib (b) osteomyelitis. Periosteum irregularity can also be seen on both images.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**Fig. 7:** Acute osteomyelitis. Left hip x-ray (A) of a boy presenting with left hip pain and fever. No clearly lesions are seen. MR images show abnormal marrow signal on the left acetabulum, seen as low-signal on Fat-saturated (FS) T1 (B and D) and T1 (C). After gadolinium injection (D), the bone marrow enhances.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
**Fig. 8:** Penumbra sign. Sagittal MRI FS T1-weighted image with contrast show a round hypointense area with peripheral enhancement (circle), representing an intra-osseous abscess. Anteriorly, a cutaneous ulcer is seen as subcutaneous tissue thinning. Also, in the most distal part of the tibia, bone avascular necrosis is seen (arrow).

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 9: Sequestrum. Axial MRI images in a patient with osteomyelitis of the right tibia show a round area (inside circles) of low-signal on T2-weighted (A) and FS T1-weighted sequences (B), that exhibits peripheral enhancement on the FS T1 with contrast image (C), representing a sequestrum with outlying enhancing granulation tissue.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
**Fig. 10:** AP leg x-ray (A) shows an ill-defined lytic lesion (arrow) on the proximal metaphysis of the tibia. MRI fat-sat T1-weighted images with gadolinium on coronal (B) and sagittal (C) planes show an abscess (arrows) on the proximal metaphysis of the tibia with peripheral enhancement - penumbra sign. In the most distal part of the tibia, an area of bone avascular necrosis is also seen (circles). Axial MRI FS PD with contrast image (D) show a small cortical defect representing the cloaca (*). The patient was submitted to abscess drainage as seen on the intraoperative photograph (E).

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**Fig. 11:** Sagittal fluid-sensitive sequence MRI image shows a sub-periosteal abscess (circle) in a patient with acute osteomyelitis and associated soft-tissue involvement. Two days after, the patient developed a compartment syndrome and fasciotomy was performed, as seen on the intra-operative photograph (B). Five days after this surgery, MRI show muscles edema due to fasciitis and a defect on the subcutaneous tissue related to the surgical procedure performed (arrow). An intramuscular abscess is also seen (*).

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 12: Stress fracture in a adolescent presenting with night pain. Technetium 99m bone scan (A) show increased uptake in the right medial malleolus. Coronal MRI FS PD image (B) show abnormal marrow signal on the distal tibia and a small hypointense cortical interruption representing the fracture line (arrow). Sagittal MRI images show surrounding bone marrow edema, seen as low signal on T1-weighted (C) and high signal on STIR images (D).

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 13: Ewing sarcoma. AP x-ray of the right elbow (A) shows an expansive lesion, predominantly lytic, on the proximal extremity of the humerus. MRI coronal STIR image (B) shows abnormal marrow signal depicted by hyperintensity on the meta-diaphysis of the humerus.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
Fig. 14: Bone metastasis in a patient with breast cancer. Right hip x-ray shows a permeative pattern on the right femoral neck. Coronal CT scan shows lytic lesions on this location. Technetium 99m bone scan (C) shows increased uptake in the proximal femur and in D11 vertebral body, consistent with metastatic disease.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

Fig. 15: Charcot joint in a diabetic patient. Oblique foot x-ray (A) shows deformity of the mid-foot with associated subchondral sclerosis. Sagittal MRI STIR (B) and T1-weighted (C) images show diffuse mid-foot bone marrow edema with some extension to the calcaneum. No skin ulcer was seen.

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal
**Fig. 16:** Bone involvement in Langerhans cell histiocytosis. Skull x-ray (A) and axial CT image (D) show an isolated right parietal lytic lesion (arrows).

© Department of Radiology, Centro Hospitalar de São João/Faculdade de Medicina da Universidade do Porto, Portugal

**Fig. 17:** CRMO in a patient presenting with left hip pain. Pelvis x-ray (A) show mild sclerosis on the proximal femur metaphysis, but also on the right iliac bone. MRI coronal FS-T1 with contrast image (B) shows abnormal bone marrow signal on both locations, associated with periosteal reaction and adjacent soft-tissue inflammatory changes.
Fig. 18: Imaging findings of some surgical procedures. A- Right foot AP x-ray of a diabetic patient submitted to transmetatarsal amputation of the first toe. B- Side knee x-ray shows a lateral cortical window (arrow) on the femur, made for bone abscess drainage. Also, signs of knee osteoarthritis may be seen.
Conclusion

Early detection is the key to a successful management of osteomyelitis.

Imaging is of extreme importance in the diagnosis of this condition, so radiologists must be familiarized with its features. MRI is the best technique, by revealing marrow edema, although other modalities are also useful.

However, the diagnosis may be sometimes challenging, as many lesions may mimic osteomyelitis.
References


