# Magnetic Resonance Imaging of Nontraumatic Musculoskeletal Emergencies

Andrew Kompel, MD*, Akira Murakami, MD,
Ali Guermazi, MD, PhD

**KEYWORDS**

• Osteomyelitis • Osteonecrosis • Stress fracture • Pathologic fracture • Rhabdomyolysis
• Septic arthritis • Compartment syndrome • Necrotizing fasciitis

**KEY POINTS**

- MR imaging is highly sensitive and sometimes specific in the diagnosis of many nontraumatic musculoskeletal emergencies.
- Imaging should not delay the treatment of acute compartment syndrome and necrotizing fasciitis.
- T1-weighted and fat-suppressed fluid-sensitive sequences (T2-weighted or STIR) are the critical MR imaging protocol components.

## BONES

### *Osteomyelitis*

Osteomyelitis is an infection of bone that can involve cortical bone and bone marrow.[1,2] Typical causes include direct extension from overlying soft tissue including ulcers and posttraumatic infections, and hematologic spread.[3] Delay in diagnosis can lead to significant morbidity, making early detection and diagnosis critically important.

Diabetic ulcers and posttraumatic infections are frequent clinical presentations that may lead the clinician to suspect osteomyelitis from direct extension. A physical examination demonstrates cellulitis and soft tissue defects, although imaging is often performed to evaluate for associated abscess and osseous involvement.[4] These additional imaging findings may affect treatment management.

Hematologic spread of bacteria to bone usually presents with fever and lethargy. Depending on which bone is involved, localized soft tissue swelling, decreased range of motion, and focal pain are additional symptoms. These localizing findings provide an indication of field of view coverage for imaging.

#### *Normal anatomy and imaging technique*

MR imaging is useful for suspected cases of osteomyelitis because of its high sensitivity for detection of disease, for evaluating early changes in bone marrow composition, and for determining the extent of the disease[5] (**Fig. 1**). MR imaging has been shown to be capable of detecting changes in bone marrow within 3 days of infection.[6] Protocols include T1-weighted and fluid-sensitive sequences, including T2-weighted fat-suppressed or short-tau inversion recovery (STIR). Precontrast and postcontrast T1-weighted sequences are often performed, although osteomyelitis can be diagnosed without such sequences.[7,8]

Beyond its usefulness for diagnosis, MR imaging can affect how the patient is to be treated.

Drs A. Kompel and A. Murakami have nothing to disclose. Dr A. Guermazi is the President of Boston Imaging Core Lab, LLC, and is a consultant to Merck Serono, Genzyme, TissueGene, and OrthoTrophix.
Section of Musculoskeletal Imaging, Department of Radiology, Boston Medical Center, Boston University School of Medicine, 820 Harrison Ave, FGH Building 3rd Floor, Boston, MA 02118, USA
* Corresponding author.
*E-mail address:* Andrew.Kompel@bmc.org

Magn Reson Imaging Clin N Am 24 (2016) 369–389
http://dx.doi.org/10.1016/j.mric.2015.11.005
1064-9689/16/$ – see front matter 

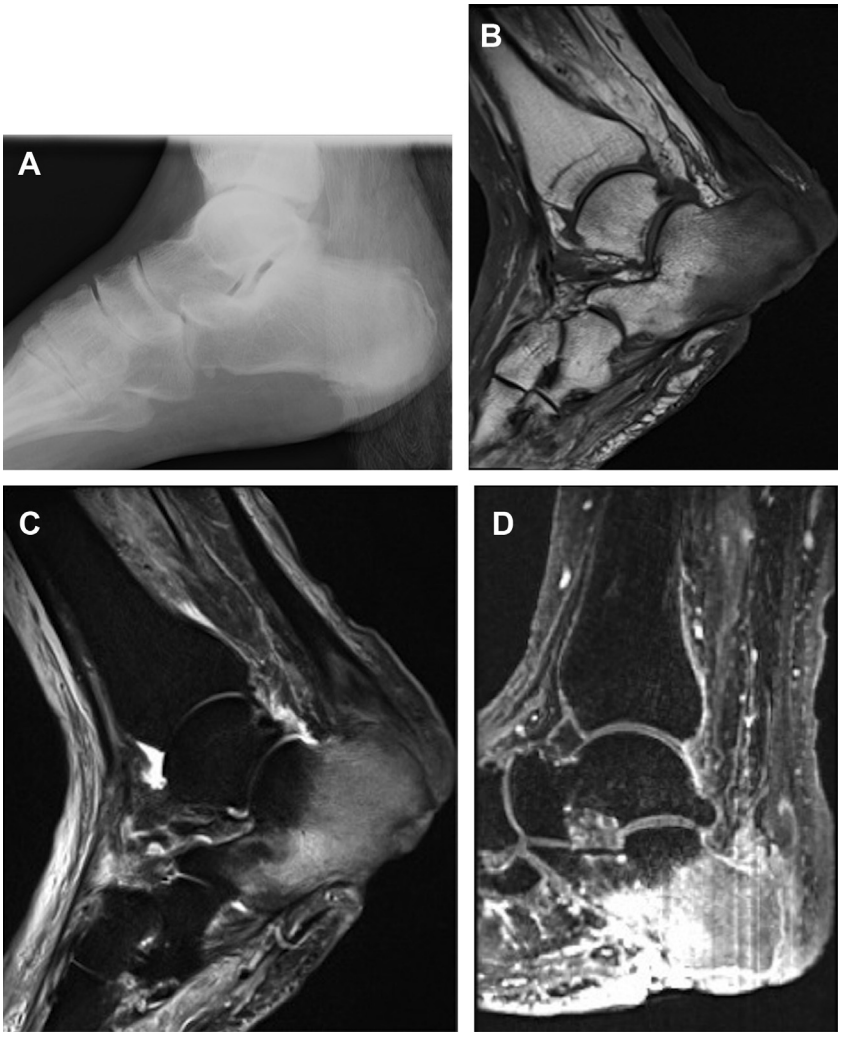


Fig. 1. (*A*) Lateral radiograph shows increased sclerosis in the plantar aspect of the calcaneus. The overlying bandage limits evaluation of the mineralization and soft tissues of the heel. MR imaging clearly shows the soft tissue defect over the heel extending to bone. The adjacent bone demonstrates geographic T1-weighted hypointensity in the marrow and loss of the low signal cortical bone, which is diagnostic of osteomyelitis (*B*). T2-weighted fat-suppressed (*C*) and postcontrast images (*D*) demonstrate edema and enhancement of the calcaneus, which extend beyond the regions of T1-weighted signal abnormality, indicating reactive changes.

Compared with other modalities, the higher sensitivity of MR imaging leads to earlier treatment and potentially improved patient outcomes. If antibiotics fail and surgery is warranted, the amount of devitalized tissue and adjacent critical structures can be identified, modifying the approach accordingly to minimize complications and morbidity.[9] Imaging planes should include a short axis (axial) and at least one long axis (sagittal or coronal).

One particular anatomic consideration should be raised when dealing with hematologic spread in pediatric cases. The metaphyses of long bones are highly vascularized; with an open physis, vessels do not cross the growth plate. The result is slower flow in the metaphysis and more chances for bacterial seeding in this region of bone in the pediatric population[6] (**Fig. 2**).

Imaging Protocols

Primary Protocol

- T1-weighted non-fat-suppressed
- Fluid-sensitive sequence (T2-weighted fat-suppressed or STIR)

Additional Sequences

- Precontrast and postcontrast T1-weighted fat-suppressed

### *Imaging findings and pathology*

The characteristic signal of normal fatty bone marrow is critical for the evaluation of