# Emergency Magnetic Resonance Imaging of Musculoskeletal Trauma

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**KEYWORDS**

• MR imaging • Musculoskeletal trauma • Morel-Lavalléelesion • Internal derangement knee • Fracture • Osteochondral defects • Ligament injury • Tendon injury

**KEY POINTS**

- Magnetic resonance (MR) imaging is a superior modality for assessment of musculoskeletal (MSK) soft tissue injury in both high-velocity and low-velocity trauma.
- Understanding of normal anatomy in the MSK system is critical to interpretation.
- Any increased T2-weighted signal should alert the radiologist to abnormality at that site.
- MR imaging is the most appropriate modality for evaluation of subtle bone injury.
- MR imaging with short, rapid sequences is paramount in the setting of trauma.

## INTRODUCTION

Musculoskeletal (MSK) trauma is commonly encountered in emergency departments. The degree of MSK trauma ranges from trivial injuries to significant life-threatening injuries. Imaging plays an integral role in diagnosis and management of these injuries. The most commonly used modality in the diagnosis of MSK injuries continues to be plain radiographs. For more complex injuries, computed tomography (CT) is still the most commonly available and widely used cross-sectional imaging tool. Although CT has many advantages, the soft tissue detail offered by CT scanning is limited in the evaluation of MSK injuries. Magnetic resonance (MR) imaging produces excellent soft tissue contrast and fine anatomic detail. The availability of MR imaging in emergency centers has gradually increased over the years, and, in major trauma centers, the availability of MR imaging 24 hours a day, 7 days a week, is now standard. A corresponding increase in subspecialist availability in orthopedics and trauma and increased reliance on complex MSK trauma evaluation has further contributed to the increased use of MR imaging in the emergency room (ER) setting. MR imaging provides definitive diagnosis of soft tissue and bony injury both in low-velocity and high-velocity trauma. It acts as an excellent tool in problem solving in repetitive trauma as well as in complex sports injuries.

This article introduces the applications of MR imaging in an emergency setting in the evaluation of MSK trauma. Given the wide range of presenting injuries in MSK trauma in the ER, this article provides an overview of some of the most common injuries, but is not comprehensive. The aim is to educate the reader about recognition of these injuries and mechanisms to avoid pitfalls.

## MAGNETIC RESONANCE IMAGING SEQUENCES AND TECHNIQUE CONSIDERATIONS

MR imaging poses multiple challenges to imaging acutely injured patients. With a simple and robust

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approach to imaging MSK trauma, relevant and clinically useful imaging can be produced. Based on the type of MR imaging magnet, variable sequences can be used. This article presents a brief summary of sequences used in our institution, which can further be generalized in any modern MR imaging magnet.

The standard MSK technique should include multiplanar proton density (PD) fat-saturation (FS) images, a single-plane T1-weighted sequence and a single-plane T2-weighted sequence. Fast-spin echo (FSE) imaging should be used to reduce imaging time while maintaining sufficient image quality and detail. In some cases (eg, injury to a nonjoint extremity) we begin by obtaining a large field of view coronal short-tau inversion recovery sequence (STIR) over the area of interest. Once the area of concern is identified, multiplanar PD axial, T2-weighted FS and T1-weighted images can be obtained. In addition, single-shot imaging could also be performed for rapid acquisition of images in a patient who cannot stay still. Arthrograms and contrast are unnecessary in MSK evaluation in the trauma setting.

## *Occult Scaphoid Fracture*

Scaphoid fractures can present a diagnostic dilemma in the setting of posttraumatic wrist pain and normal radiographs. Up to 65% of scaphoid fractures are radiographically occult immediately following injury.[1] In general, wrist splinting with follow-up radiographs assessing for bony remodeling is the management of choice at most institutions for suspected occult scaphoid fractures. MR imaging has excellent sensitivity for fractures and can be used in the early posttraumatic setting to confidently exclude fracture and avoid unnecessary immobilization.[2–4]

MR imaging has been shown to be both more specific and more sensitive for radiographically occult scaphoid fractures compared with both CT and plain films, with sensitivity and specificity around 100%.[5] Small field of view acquisition using both FS T1-weighted and fat suppressed T2-weighted images of the wrist are sufficient for diagnosis. The coronal plane is the easiest plane in which to detect scaphoid injury because most fractures are oriented transverse or oblique to the long axis of the scaphoid. Coronal planes are preferred using STIR for screening or rapid evaluation. Trabecular disruption in the scaphoid manifests as linear T1 hypointensities and T2 hyperintensities without cortical disruption in nondisplaced fractures. Otherwise, bone edema, trabecular disruption, and cortical disruption may be present on MR imaging in radiographically occult scaphoid fractures (**Fig. 1**).

## *Occult Hip Fracture*

Occult hip fractures in the setting of trauma or falls can be readily appreciated using MR imaging. Up to 46% to 54% of fractures of the hip and/or pelvis

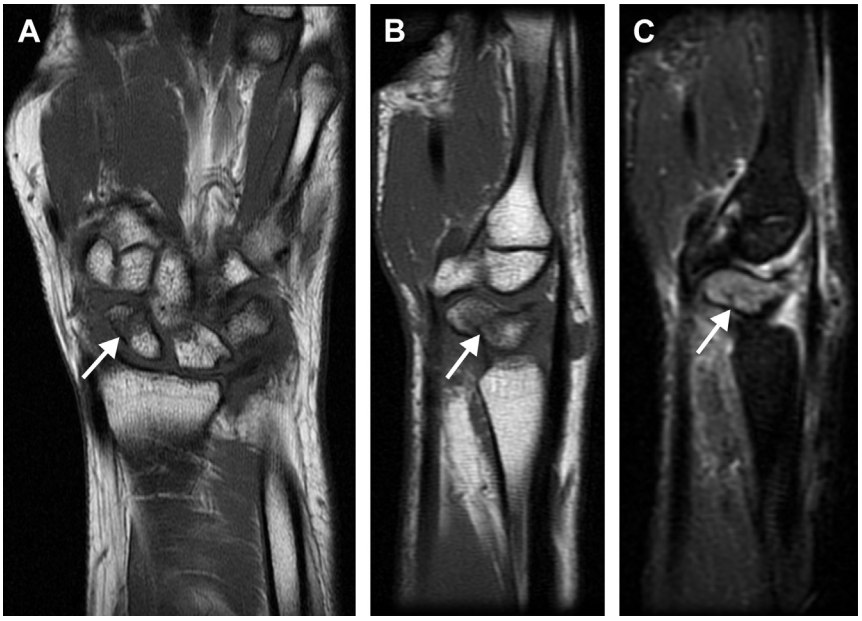


**Fig. 1.** Occult scaphoid fracture. (*A*) Coronal T1-weighted image shows linear hypointense fracture lines in the scaphoid waist. (*B*) In this case the fracture line is better seen on sagittal T1 images. (*C*) Sagittal T2 FS images show diffuse increased signal in the scaphoid consistent with bone edema and surrounding soft tissue edema.