CHAPTER 42

MAGNETIC RESONANCE EVALUATION OF OSTEOMYELITIS

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An accurate and early diagnosis of osteomyelitis is critical to appropriate treatment of this infectious process. Osteomyelitis may be a challenging diagnosis, especially in the face of systemic complications such as diabetes and its associated neurologic and vascular factors. Plain radiography, computed tomography and various radionuclide imaging techniques have been utilized in the past, with varying degrees of success and indications. Magnetic Resonance Imaging (MRI) provides an excellent adjunct, as well as alternative, due to its excellent soft tissue contrast and high spatial resolution and detail. Due to these characteristics, MRI has excellent diagnostic, surgical planning and treatment assessment capabilities.

Numerous studies have attested to the sensitivity and specificity of MRI for osteomyelitis. Multiple studies have been performed which compare MRI to other diagnostic modalities, and in most cases, superior sensitivity and specificity has been documented. In 1986, Modic et al. documented a 96% sensitivity and 92% specificity for MRI in diagnosing osteomyelitis. Beltran et al., in 1988, found a 93% sensitivity and 88% specificity for osteomyelitis in evaluating bone infection. Nigro et al. in their study confirmed a 100% sensitivity and 95% specificity for MRI in the treatment of osteomyelitis. Multiple studies have been performed which indicate similar results.

MRI PHYSICS

MRI is a non-invasive diagnostic tool which provides a detailed image without ionizing radiation or radioactive isotopes. MRI uses a strong magnetic field of approximately 1000 to 3000 gauss, and relies on the reaction of hydrogen atoms (protons) to the exposure of a strong magnetic field. Because water is composed of a high proportion of protons, MRI measures the water content of body tissues. As the water content increases, so does the intensity of the MRI signal.

Spin echo pulse sequences are the most commonly used MRI techniques although other forms exist which are not the purpose of this discussion. T1 and T2 imaging, short time inversion recovery (STIR), and fat suppression techniques will be discussed as they provide varying degrees of visualization for osteomyelitis. T1-weighted sequence is commonly known as the fat image due to its high intensity signal with lipid tissues. The T2 sequence is known as the water image. Tissue high in water content will have a T2 image with high intensity. Fat suppression techniques, including STIR, eliminate the high intensity signal associated with fat, and enable subtle bone marrow edema changes to be visualized.

MRI FINDINGS IN OSTEOMYELITIS

MRI evaluation for osteomyelitis is based on accepted pathological processes. Classic diagnostic features including soft tissue inflammation, sequestrum, involucrum, cloaca and periosteal elevation, may be observed.

Frequently, T1- and T2-weighted images are obtained. Staging of the osseous infectious process can be assessed, based on signal intensity differences from T1- and T2-weighted images. Early involvement of bone can be evaluated using T1-weighted and T2-weighted techniques or STIR images (Figs. 1A -1C).

Initial changes of osteomyelitis may be seen with MRI much earlier than with conventional radiography. Bone marrow edema is observed on the T1-weighted images as decreased signal intensity, the diminished signal intensity supplanting the normal high signal of fat. In early stages of osteomyelitis, the T2-weighted image may demonstrate some initial increased signal intensity. As progression continues with more medullary involvement, the T1-weighted sequences decrease in signal intensity and an increased signal exists with the T2-weighted image and STIR image (Figs. 2A-2D).

Figure 1A. Plain radiograph changes consistent with osteomyelitis of the fifth metatarsal head.

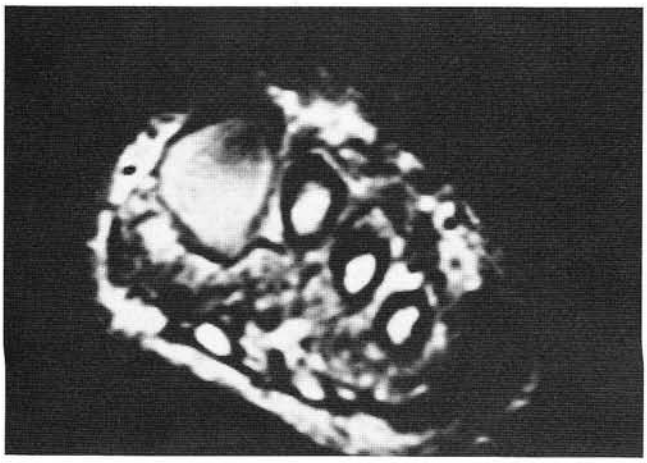

Figure 1B. T1-weighted sequence with decreased signal intensity.

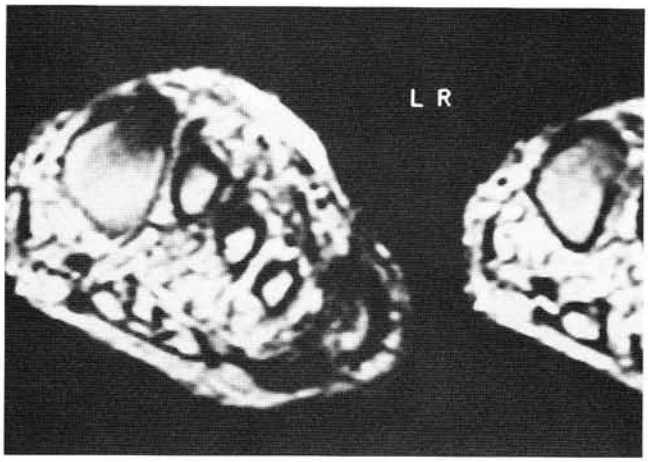

Figure 1C. T2-weighted sequence with increased signal intensity.

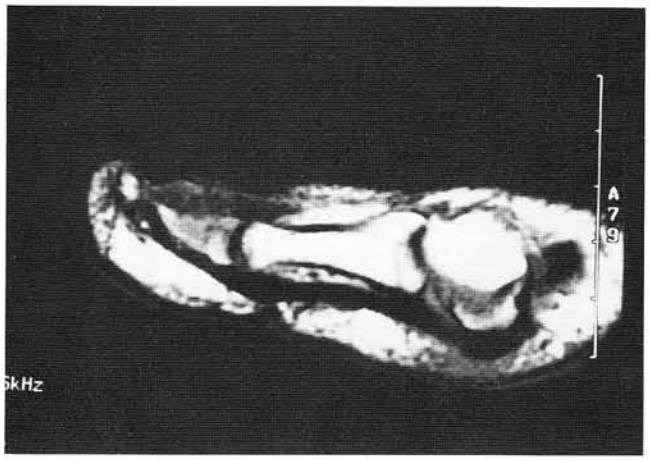

Figure 2A. Sagittal T1-weighted sequence with decreased signal intensity.

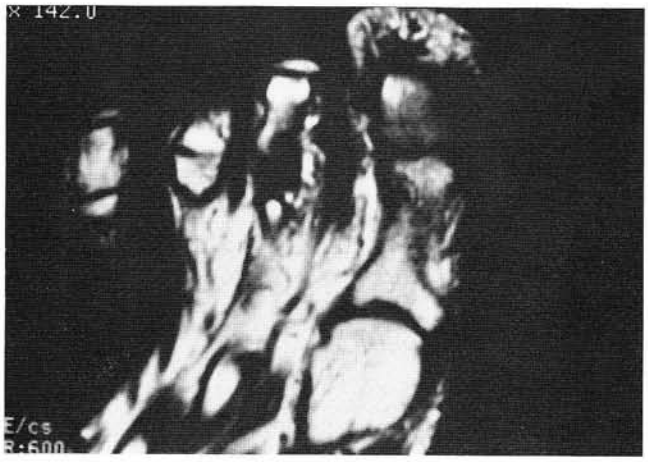

Figure 2B. Axial T1-weighted sequence.

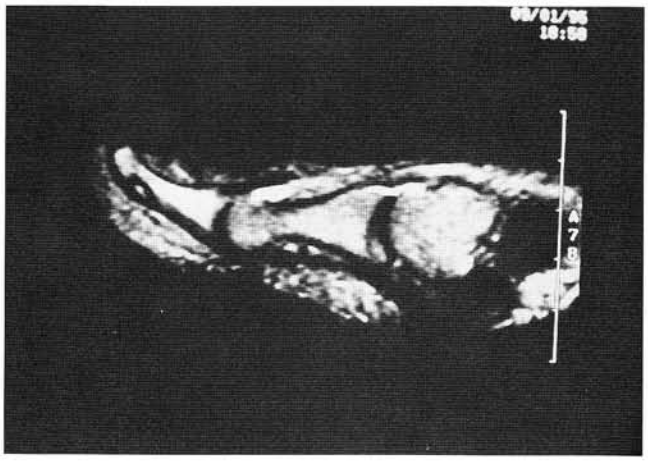

Figure 2C. T2-weighted sequence with increased signal intensity.

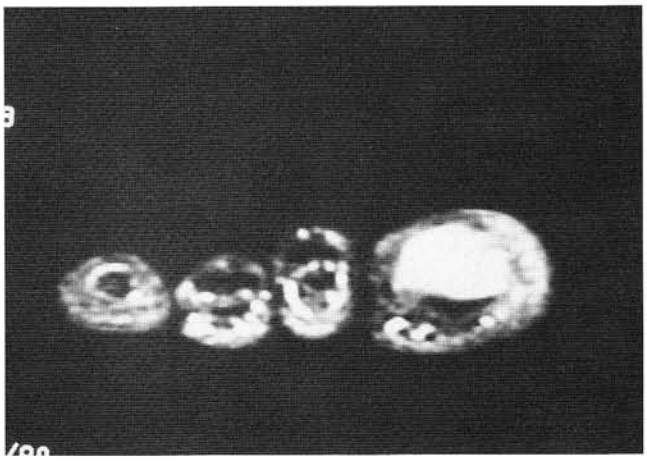

Figure 2D. STIR image. Note the increased signal intensity.

Most authorities indicate the hallmark diagnostic pattern of acute osteomyelitis is the diminished T1-weighted sequence in conjunction with an increased signal on the T2-weighted and STIR image. These MRI changes presumably occur due to the decrease in the normal fat content of bone, and an increase in water associated with edema and purulent exudate. Although STIR images provide excellent contrast due to surrounding fat tissue suppression and are very sensitive, some studies suggest there is a decreased specificity for osteomyelitis with STIR. Accordingly, T1- and T2-sequences should be performed in conjunction with STIR for additional confirmation.

MRI signal changes for osteomyelitis are non-specific and can occur with various other osseous processes. Of particular concern is acute and sub-acute trauma, which may present similar MRI findings as one would see with osteomyelitis. In the diabetic foot, the clinical dilemma involves the differentiation of a non-infectious Charcot arthropathy from osteomyelitis. Several studies suggest non-infectious Charcot arthropathy will reveal low signal intensity T1- and T2-weighted images, versus infected neuropathic joints which demonstrate increased signal strength on the T2-weighted sequence.

SUMMARY

MRI serves a useful clinical and diagnostic role in the initial diagnosis, staging, surgical debridement planning and visualization of treatment progress for osteomyelitis. Past radiographic methods have been highly sensitive, but lack the specificity and spatial resolution which MRI provides. As MRI utilization continues, further experience and diagnostic criteria should become available to further enhance its usefulness and accuracy.

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