MRI, ultrasound offer hope to arthritis patients

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MRI and ultrasound can be useful tools in evaluating patients with early rheumatoid arthritis. Both techniques can detect pre-erosive synovial inflammation. They can also identify early bone damage before it becomes apparent on x-rays.

Rheumatoid arthritis is characterized by chronic synovial inflammation, resulting in bone erosion and joint destruction. Diagnosis is based on clinical, laboratory, and radiologic findings. Conventional radiography has been the mainstay for diagnosis of joint damage and subsequent follow-up. X-rays can provide only indirect information on synovitis, however, and the modality is insensitive to early bone damage. Until recently, the absence of effective treatment to prevent joint destruction limited the need for more sensitive imaging modalities. This situation changed following the introduction of disease-modifying antirheumatic drugs. Availability of these powerful and expensive drugs has created new demands on radiologists to identify patients with aggressive rheumatoid arthritis at an early stage. Treatment decisions can then be taken to prevent joint destruction.

MRI and ultrasound can be useful tools in evaluating patients with early rheumatoid arthritis. Both techniques can detect pre-erosive synovial inflammation. They can also identify early bone damage before it becomes apparent on x-rays. MRI can be used to predict future bone damage. It also has a high negative predictive value in patients with clinical suspicion of early rheumatoid arthritis when no evidence of synovial inflammation or bone abnormality is observed.

The wrist and the metacarpophalangeal (MCP) and metatarsophalangeal (MTP) joints are among the first areas to be affected in rheumatoid arthritis. The most symptomatic extremity, the dominant extremity, or both may be studied with MRI and ultrasound. Abnormalities in early rheumatoid arthritis include synovitis, tenosynovitis, bone erosions, bone marrow edema, and bursitis. Synovitis (rheumatoid pannus) is the earliest pathologic abnormality in rheumatoid arthritis, and it is secondarily responsible for bone and joint damage. It is usually, but not exclusively, bilateral. MRI demonstrates synovitis as synovial enhancement on fat-suppressed gadolinium-enhanced T1-weighted images (Figure 1A), whereas ultrasound detects synovial hyperemia with color or power Doppler imaging (Figure 1B). The degree of hyperemia, and so the importance of the Doppler signal, correlates histologically with the amount of vascularization in the knee. Both MRI and ultrasound are more sensitive than clinical assessment in detecting synovitis.

Conventional radiography, on the other hand, is unable to diagnose synovitis unless there is fusiform soft-tissue swelling at the joints. This swelling is often seen at the proximal interphalangeal joints and, to a lesser extent, at the MCP joints. Assessment is subjective and highly dependent on technique. Tenosynovitis is a common finding in patients with early rheumatoid arthritis. Although any tendon may be affected, the flexor digitorum, extensor digitorum, and extensor carpi ulnaris are frequently involved. Tenosynovitis is usually, but not exclusively, bilateral. MRI reveals thickening of the synovial sheath with marked enhancement on fat-suppressed Gd-enhanced T1-weighted images. Ultrasound shows similar findings: hypoechoic thickening of the synovial sheath with hyperemia on color or power Doppler imaging (Figure 2).

A small amount of fluid may be associated with tenosynovitis. This will show high signal intensity on T2-weighted MRI and low signal intensity on fat-suppressed Gd-enhanced T1-weighted MRI. The fluid appears anechoic on ultrasound, with no evidence of flow on color or power Doppler imaging, and can be expelled from the region by compression with the ultrasound transducer. Affected tendons may appear heterogeneous on both modalities in some patients with early rheumatoid arthritis. This finding is suggestive of incipient tendinitis. The tendinous changes are seen best with ultrasound. Both MRI and ultrasound are more sensitive than clinical assessment in detecting tenosynovitis and outclass conventional radiography, which cannot diagnose the condition at all.
Bone erosions result from synovitis. These are best detected on MRI by fat-suppressed Gd-enhanced T1-weighted imaging, especially thin-partition 3D gradient-echo sequences. Bone erosions are less frequently bilateral than synovitis or tenosynovitis. They are best detected on ultrasound at the radial aspect of the second MCP joint, the ulnar aspect of the fifth MCP joint, and the lateral aspect of the fifth MTP joint.

Compared with MRI, however, ultrasound is limited in the evaluation of the other MCP and MTP joints, owing to adjacent fingers and toes and the carpal bones.

The radial aspect of the second and third metacarpal bones (Figure 3) and the lateral aspect of the fifth metatarsal bone (Figure 4) are more frequently involved with bone erosions. The latter appear as sharply marginated areas of trabecular bone loss with a cortical defect, often associated with synovitis. The bone erosions are filled with hypervascular pannus and exhibit a high signal on color and power Doppler imaging. MRI is more sensitive than conventional radiography for diagnosing bone erosions. The same is true of ultrasound for the MCP and MTP joints.

Bone marrow edema reportedly precedes the development of bone erosions and can be used to predict medium-term functional disability. It is detectable with STIR T2-weighted MRI or fat-suppressed T2-weighted sequences (Figure 4). Bone marrow edema appears as a lesion with ill-defined margins and high signal intensity. It can occur alone, or it may surround a bone erosion. Ultrasound provides no information on it.

EARLY FINDINGS

Bursitis is a common finding in patients with early rheumatoid arthritis and will be located between or beneath the metatarsal heads. Intermetatarsal bursitis is more frequent in the second and third web spaces. Intermetatarsal and submetatarsal bursitis show significant enhancement on MRI after contrast injection due to inflammation (Figure 5). They appear on ultrasound as heterogeneous (hypo- and hyperechoic) collections, which can be well or ill defined. Significant hyperemia of the synovial lining is seen on color and power Doppler imaging.

MRI and ultrasound are both useful in assessing early rheumatoid arthritis. Modern drug therapies have reportedly decreased synovial proliferation and bone marrow edema and prevented development of bone erosions. MRI and ultrasound can both quantify synovial inflammation.

Differential diagnoses

Diagnosis of early rheumatoid arthritis is based primarily on inflammatory polyarthralgia of the hands. Clinicians sometimes struggle to differentiate early rheumatoid arthritis from psoriatic arthritis or systemic lupus erythematosus, especially when conventional radiography demonstrates no abnormality. MRI may show extensive signal intensity changes within the bone marrow on STIR T2-weighted, fat-suppressed T2-weighted, or fat-suppressed Gd-enhanced T1-weighted sequences for patients with psoriatic arthritis. These changes may sometimes be seen within soft tissues as well.

Bone marrow changes due to psoriatic arthritis are not related to the joint capsule (Figure 6) and can extend far beyond the joint capsule. The same is true for bone marrow changes associated with inflammatory enthesitis. Changes related to early rheumatoid arthritis remain localized within the joint capsule.

MRI of patients with systemic lupus may exhibit abnormalities similar to those of patients with early rheumatoid arthritis (for instance, synovitis, tenosynovitis, and bone erosions). It can be impossible to differentiate patients with early rheumatoid arthritis from those with lupus on MRI.

MRI and ultrasound have opened up new horizons in the detection of early joint damage, assessment of inflammation, and management of patients with rheumatoid arthritis. Although the precise role of these imaging modalities remains to be defined, radiologists and clinicians should be aware of their growing usefulness in delivering better patient care.

Disclosures:

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