Magnetic resonance imaging of the shoulder in early rheumatoid arthritis

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Learning objectives

• to describe magnetic resonance imaging (MRI) features of early rheumatoid arthritis (RA) affecting the shoulder joint in a series of 31 patients
• to evaluate the sites of inflammatory process in the shoulders of patients with early RA
• to depict both early soft-tissue and bone changes in the shoulder in those patients
• to discuss the differential diagnosis of shoulder changes observed on MRI
Background

RA is characterized by a chronic inflammatory process that targets the articular cartilage, the bone at the joint margins, and the periarticular tissues. The shoulder joint becomes involved later than the peripheral joints in RA and the onset of the disease in the shoulder joint is often insidious because shoulder joint is deeply seated, and synovial tissue swelling often escapes notice as it is difficult to detect unless suspected [1, 2].

At the time when the clinical examination or plain radiographs are still quite normal, MRI may already detect bone and soft tissue changes [3], because radiographs do not show changes in synovial tissue and bone marrow [4], which occur months to years before an erosion develops [5, 6].

Early diagnosis is of high priority in the initial workup of the patients with suspected RA. The need for a change in imaging strategy is supported by the recent introduction of new biological treatments such as antitumor necrosis-factor alpha (TNF-#) antagonist. These drugs allow suppression of disease activity in patients failing conventional DMARD therapy [7, 8], but as the biologics are very expensive, sensitive methods to assess the early inflammatory treatment response, and to predict the course of the disease, are warranted.
Imaging findings OR Procedure details

Figure 1 on page 6 shows the MRI of the shoulder of a healthy volunteer.

Pathological changes related to RA begin with synovial inflammation followed by bone marrow edema and, finally, by osseous erosions [9].

Early changes in RA shoulder were characterized by joint effusion, synovitis, cartilage disease, bone marrow edema, bone erosions, bursitis, and tenosynovitis. The mean disease duration was 16.1 months (range, 1-24 months).

Although, the shoulder joint becomes involved later in RA, during the first two years of rheumatoid history, 18 (58.1%) patients experienced shoulder pain what is in concordance with previously reported research [2].

Normal synovial fluid is not visible on MRI; when it is abnormal (pannus formation) it has low signal intensity on T1 weighted images and high signal intensity on T2 weighted images [10, 11]. Joint effusion was found in 10 (32.3%) patients (Figure 2 on page 6).

Synovitis is defined by increased volume of the edematous synovium, and increased enhancement after intravenous injection of contrast agent which is an important finding because it correlates with development of future erosions [12, 13]. Glenohumeral synovitis was present in 9 (29.0%) patients (Figure 3 on page 7), while subacromial/subdeltoid bursitis was found in 8 (27.6%) patients (Figure 4 on page 8).

Normal hyaline articular cartilage has intermediate signal intensity on T1 and T2 weighted images. Cartilage disease was diagnosed when the articular cartilage had thinned focally or diffusely (Figure 5 on page 9).

Bone marrow edema is defined as a lesion within the trabecular bone, with ill-defined margins and signal characteristics consistent with increased water content [14]. Bone marrow edema is seen as an increased T2 signal on MRI that results from increased water content in the bone marrow, which is probably related to inflammatory response (Figure 6 on page 9). Bone marrow is a strong predictor of future erosions [15] and predicts erosive progression in early RA during the first 2 years of the disease [16].

The MRI criteria of erosions are defined as a sharply marginated bone lesion with correct juxta-articular localization and high signal intensity in T2 weighted images and low signal intensity in T1 weighted images [17] (Figure 7 on page 10). Only focal lesions that demonstrate contrast enhancement should be classified as erosions (Figure 8 on page 11), otherwise they can represent subchondral cysts. MRI detected bone erosions on the humeral head in 24 (77.4%) patients. Most of the erosions were found on the lateral aspect of the humeral head, i.e. on the greater tuberosity.
Synovial inflammation causes rotator cuff lesions (Figure 9 on page 11) [18]. Although there are usually no tears, cuff function is severely impaired [19] (Figure 10 on page 12). Biceps tenosynovitis was found in 8 (25.8%) patients (Figure 11 on page 13).

Apart from glenohumeral joint, in patients with RA acromioclavicular joint is involved in about one third of the cases [20, 21]. RA in acromioclavicular joints frequently causes joint space widening (Figure 12 on page 14) due to the erosive destruction [22].

Enlarged lymph nodes were common findings in patients with early RA (Figure 13 on page 15).

Other inflammatory arthritides must be considered in the differential diagnosis: septic arthritis, gout or pseudogout, polymialgia rhuematica, psoriatic arthritis, and osteoarthritis. Other conditions, such as osteoarthritis and chondrocalcinosis, may produce cysts or defects in trabecular bone similar to those in RA [3].
Fig. 0: Coronal T1 weighted image of normal right shoulder - 1 = humeral head; 2 = acromion; 3 = clavicle; 4 = glenoid cavity; 5 = supraspinatus muscle; 6 = supraspinatus tendon; 7 = deltoid muscle; 8 = acromioclavicular joint.

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**Fig. 0:** Coronal FSE T2 weighted image with fat saturation - small amount of glenohumeral fluid collection (arrowhead) appears as an area of high signal intensity in the joint space. Edema of suprasinatus tendon is shown (arrow).

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**Fig. 0:** Axial FSE T2 weighted image with fat saturation delineates synovitis defined by increased volume of the edematous synovium.

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**Fig. 0:** Coronal FSE T2 weighted image with fat saturation (a), axial T1 weighted image with fat saturation before (b) and after intravenous application of gadolinium-DPTA (c) showing moderate subacromial/subdeltoid bursitis. Highly vascular inflamed synovium shows bright enhancement.

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**Fig. 0:** Coronal T2* weighted gradient echo (GRE) sequence - normal hyaline articular cartilage (a) and diffusely thinned articular cartilage of glenohumeral joint.

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**Fig. 0:** Coronal FSE T2 weighted image with fat saturation demonstrates bone marrow edema (arrow) caused by synovitis and followed by osseous erosions. Erosions of greater tuberosity.

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**Fig. 0:** Coronal T1 (a) and FSE T2 weighted image with fat saturation (b) shows large circumscribed erosion on the lateral aspect of the humeral head.

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**Fig. 0:** Axial T1 weighted image with fat saturation before (a) and after (b) intravenous application of gadolinium-DPTA and axial FSE T2 weighted image with fat saturation (c) demonstrate humeral head erosions that are defined as a sharply marginated bone lesion with high signal intensity on T2 weighted image (c) and low signal intensity on T1 weighted image (b) demonstrating contrast enhancement (c)

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Fig. 0: Coronal FSE T2 weighted image with fat saturation delineates edema (a) and complete rupture (b) of supraspinatus tendon in patients with early RA.

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Fig. 0: Coronal T1 weighted image with fat saturation demonstrates elevation of the humeral head and narrowing of the space between the humeral head and acromion as a consequence of synovial inflammation that cause rotator cuff atrophy or tear.

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Fig. 0: Axial FSE T2 weighted image with fat saturation - long-head biceps tenosynovitis.

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**Fig. 0:** Coronal FSE T2 weighted image with fat saturation shows joint space widening in rheumatoid acromioclavicular joint. Integral joint space is 10 mm.

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Fig. 0: Enlarged axillary lymph nodes are common finding in patients with early RA.

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Conclusion

MRI is the modality of choice in early diagnosis and management of RA since MRI is more sensitive in detection of early changes in shoulder than clinical examination. As a result of this study we can conclude that damage of the shoulder joint is already present even in the early stage of RA (Figure 1 on page 18). Bone erosions are predominant part of the inflammatory process of the early RA. MRI has high sensitivity and it is the only imaging modality capable to detect bone marrow edema, which is a predictor of future bone erosions [12, 16, 23, 24]. MRI became an important tool for evaluation the response of synovium to therapy because the disease is now being treated early before significant bone and joint destruction have occurred (Figure 2 on page 18) [25].
Fig. 0: Coronal FSE T2 weighted image with fat saturation demonstrates bone marrow edema (arrow) caused by synovitis and followed by osseous erosions. Erosions of greater tuberosity.

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Fig. 0: Axial FSE T2 weighted image with fat saturation shows severe cartilage and bone loss of the humeral head and glenoid followed by bursitis and synovitis.

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