MRI and Sonography of the Shoulder

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We prospectively evaluated the diagnostic value of sonography and magnetic resonance imaging (MRI) in 24 shoulders in 23 patients with suspected rotator cuff tears using arthrography as gold standard. Sonography demonstrated 14 of 15, MRI 10 of 15 rotator cuff tears, respectively. Sonography diagnosed seven of nine intact rotator cuffs correctly, MRI eight of nine. In a retrospective study we reviewed the diagnostic value of sonography and MRI in other pathologies of the shoulder including intra-articular pathology, humeral head and acromioclavicular joint pathology, and calcification. We conclude that with regard to cost and patient compliance, sonography should be the first radiologic examination in suspected rotator cuff tears if performed by an experienced sonographer. MRI is superior in depicting additional pathology and is less operator dependent. It may thus become the method of choice for the evaluation of the rotator cuff and related pathology in the future. Hodler, J., Terrier, B., von Schulthess, G.K. & Fuchs, W.A. (1991). Clinical Radiology 43, 323–327. MRI and Sonography of the Shoulder

Both sonography and MRI have been introduced into clinical practice in suspected rotator cuff tears over the last 5 years. Their diagnostic value must be compared with arthrography which is still the gold standard although a few false positive and negative results have been reported (Mink et al., 1985). Several publications have proven the diagnostic value of sonography of the rotator cuff (Bretzke et al., 1985; Middleton et al., 1986; Hodler et al., 1988), but the initial good results have not been confirmed by some recent studies (Brandt et al., 1989). One of the important factors is likely to be the experience of the sonographer (Middleton, 1989). In this regard MRI is more reliable and less operator dependent (Burk et al., 1989). In addition MRI can depict early changes in rotator cuff impingement, not visible by sonography (Seeger et al., 1988). The goal of our study was to assess the diagnostic value of sonography and MRI in suspected rotator cuff tears with different pathogenesis. Most previous publications have dealt with rotator cuff tears in degenerative disease (Hodler et al., 1988; Seeger et al., 1988). Little has been published with regard to rheumatoid arthritis (Beltran et al., 1987; Yulissh et al., 1987). In this context the diagnostic value of MRI and sonography in detecting complete rotator cuff tears was evaluated prospectively. Furthermore the diagnostic capabilities of the two methods in different pathologies of the shoulder joint were analysed in a retrospective manner.

CASE MATERIAL

A total of 24 shoulders in 23 patients with chronic shoulder pain were prospectively evaluated by sonography, MRI and arthrography. Thirteen patients were female, 10 male. Their age range was between 39 and 84 years (mean 57.8 years). Twelve shoulders in 11 patients had rheumatoid arthritis, two of them seronegative. One patient was grade II, eight were grade III, one was grade III–IV and one was grade IV (Steinbrocker et al., 1949).

Three patients had chronic pain after trauma, three calcifying tendinitis and six degenerative changes clinically and on plain films.

METHODS OF INVESTIGATION

Sonography

The patients were first examined by sonography. All examinations were done by a radiologist with special skill in sonography (J.H.). A 7.5 MHz phased array transducer (SSA-100 A, Toshiba, Tokyo, Japan) was used. The supraspinatus and infraspinatus tendon were routinely examined longitudinally and transversally with the arm extended and internally rotated. To control this position the patient was asked to put his hand on his back. The biceps tendon sheath and subscapularis tendon were examined in neutral and external rotation. The subacromial bursa and the surface of the humeral head were routinely imaged, but not the acromioclavicular joint and the axillary recess. With the exception of the subacromialis no dynamic study was performed. The criteria used for rotator cuff tears were complete loss of the cuff substance or a focal thinning. Sonographic findings were documented on hard copies in standardized manner. At least one longitudinal and one transverse cut through each supraspinatus, infraspinatus and intertubercular groove, respectively, as well as a longitudinal cut through the subscapularis tendon were documented, thus allowing the review of the sonographic studies.

MRI

MRI was performed with a 1.5T superconductive magnet (S15, Philips, Eindhoven, The Netherlands) and a flexible receive-only surface coil (‘wrap-around-coil’) which was fixed obliquely over the shoulder, passing from the infraspinatus muscle over the acromial edge to the pectoralis major muscle. T1- and T2-weighted coronal oblique spin-echo-sequences were obtained perpendicular to the glenohumeral joint. T1-weighted images were made with a repetition time (TR) of 500–550 and an echo delay (TE) of 20–30 ms. T2-weighted images were made...
with a TR of 1500–2000 and a TE of 60–100 ms. Two measurements were obtained and a 256 × 256 matrix used. Four different radiologists experienced in MRI reported the examinations without knowledge of the sonographic result. There was an upgrading of the hardware (RF-coils) and software (foldover-suppression) during the study, improving image quality.

Arthrography

Arthrography was performed as the final examination. Double contrast arthrography was performed with the injection of 5–8 ml of ioxaglate (320 mg iodine/ml, Hexabrix®) and room air until sufficient distension of the joint capsule was reached under fluoroscopic control. Up to 10 ml of contrast medium but no air was used in inflammatory disease to avoid confusion between air bubbles and synovial hypertrophy. At least one film in each of internal, neutral and external rotation was acquired with the X-ray beam angled craniocaudally under fluoroscopic control in order to visualize the subacromial space.

RESULTS

Plain films showed a diminished distance between the humeral head and the acromion in eight cases (seven of them in inflammatory disease). Acromial spurs were found in 15 (11) cases, sclerosis of the greater tuberosity in six (three) cases. Erosions of the humeral head were found in 12 (11) cases. Fourteen (nine) acromioclavicular joints showed pathologic changes such as erosions, cysts and osteophytes. Osteopenia was found in 10 cases of inflammatory disease. Three rotator cuffs had calcifications.

Arthrography demonstrated a complete tear of the rotator cuff in 15 instances, 10 of them in inflammatory disease, one in post-traumatic shoulder pain and four in degenerative disease. In nine shoulders the arthrographic investigation revealed no pathology of the rotator cuff.

Sonography

Fourteen tears were detected prospectively by sonography, one was missed. In the nine arthrographically intact rotator cuffs sonography was true negative in seven and false positive in two. Eleven tears demonstrated complete loss of the cuff substance (Fig. 1a), three showed focal thinning. The false negative result was due to a complete tear which caused a thinning of the rotator cuff indistinguishable from a partial tear.

Fifteen patients had an increased volume of the subacromial/subdeltoid bursa due to effusion or hypertrophy. The axillary recess, well demonstrated by arthrography, was difficult to image by sonography and was thus not evaluated in this study. Intra-articular disease, as found in 12 cases, was best visible when the volume of the usually communicating biceps tendon sheath was increased (Resnick, 1981). Sonography showed a larger number of bone erosions in the humeral head than did plain films in six of 12 cases, an equal number in five cases and a smaller number in one case, although sonography did not demonstrate the entire humeral head (Fig. 1c).

The acromioclavicular joint was not evaluated sonographically and could thus not be reviewed.

The three cases with calcifying tendinitis had large

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Fig. 1 – Sonography. (a) Normal rotator cuff (arrows: supraspinatus). (b) Small rotator cuff tear (arrows: focal loss of rotator cuff). (c) Rheumatoid arthritis (arrows: large humeral head erosion, arrowheads: synovial hypertrophy within erosion and replacing rotator cuff).
calcification with a maximal diameter of 37, 22, and 8 mm as measured on plain films. Sonography demonstrated these changes adequately.

MRI

MRI detected prospectively 10 of the 15 tears. Eight of the nine intact rotator cuffs were diagnosed correctly, one was false positive. The five false negative results could be explained retrospectively as follows: three complete tears were diagnosed as partial tears, in two cases the false negative diagnosis was due to a reading error. Seven tears appeared predominantly as a hyperintensity on T2-weighted images (Fig. 2a) and eight as a loss of cuff substance (Fig. 2b). The false positive diagnosis was made in a case with a partial tear.

The peribursal fat plane around the subacromial bursa was well depicted by MRI. Its obliteration is considered to be a sign of rotator cuff tear on plain films (Mitchell et al., 1988). Such obliteration appeared in 9 of 10 rotator cuff tears in inflammatory disease and in only one case with a tear in non-inflammatory disease. In intact rotator cuffs there was no obliteration in any case. Three of the rotator cuffs without a tear showed a slight hyperintensity both on T1- and T2-weighted images, possibly corresponding to tendinitis.

As in sonography there was an increased volume of the subacromial and subdeltoid bursa in 15 cases. Intra-articular synovial hypertrophy and/or effusion were present in all 12 shoulders with inflammatory disease. Two had an effusion only, two showed synovial hypertrophy only and eight showed both synovial hypertrophy and effusion. Hypertrophic synovium was usually slightly hyperintense compared to fluid on T1-weighted images and less hyperintense than fluid on T2-weighted images (Fig. 2c). Intra-articular pathology was best visible in the axillary recess. One arthrogrammatically narrow recess was not diagnosed by MRI.

MRI showed more erosions than plain films in five of 12 cases, an equal number in five and a smaller number in two cases. MRI demonstrated erosions, capsular hypertrophy or osteophytosis in inflammatory or degeneration of the acromioclavicular joint in nine cases (Fig. 2d). The two larger calcifications were shown as an increase in volume of the rotator cuff due to a signal free mass (Fig. 2e).

DISCUSSION

Sonography

The diagnostic value of sonography was comparable to previously published results (Mack et al., 1985; Middleton et al., 1986). Initially we were concerned that sonography would not be accurate enough in assessing rotator cuff tears in rheumatoid arthritis because of severe atrophy simulating loss of cuff substance. This has not been confirmed by our study. Recent reports (Soble et al., 1989; Burk et al., 1989) however, include significantly less reliable results of sonography in depicting rotator cuff tears, probably indicating operator dependence. Moreover a large number of different criteria for rotator cuff tears have been published, some of them with questionable diagnostic value (Brandt et al., 1989). In our own experience, only a focal thinning or a loss of the rotator cuff substance were reliable signs in the diagnosis of rotator cuff tears. In the two false positive results the diagnosis was most likely due to an atrophic and a partially ruptured supraspinatus tendon. Hypertrophy of, and effusion within, the subacromial bursa was visible in sonography but may be underestimated (Hodler et al., 1988). The depiction of bone erosions in the humeral head by sonography may not be important because bone pathology will usually be assessed by plain films. Sonographic findings are operator dependent and difficult to compare in a follow-up examination. This is probably true for rotator cuff calcification as well. Small calcifications may be hard to differentiate from the normal internal structure of the rotator cuff or the transversely cut biceps tendon (Middleton et al., 1986).

MRI

MRI is potentially superior to sonography in several regards because it is less operator dependent, shows intraosseous pathology and is superior in depicting the extent of granulation tissue, effusion, erosion, partial tears and tendinitis (Seeger et al., 1987; Zlatkin et al., 1989). However, it is less available, much more expensive and time consuming. Patient compliance is not as good due to claustrophobia and the induction of pain caused by the long duration of the examination with the joint immobilized. In our study MRI was not as successful prospectively as published in the literature (Kneeland et al., 1987; Burk et al., 1989; Zlatkin et al., 1989). Retrospectively, the correct diagnosis could be made in all but one of the MR examinations. This was the false positive one, where signal changes in the supraspinatus tendon were probably due to a partial tear and tendinitis. Similar difficulties in distinguishing partial from complete rotator cuff tears in MRI have been previously described (Zlatkin et al., 1989). The obliteration of the peribursal fat plane was a specific sign of a rotator cuff tear but was observed in most of the patients with inflammatory disease. In our study MRI was superior to sonography in the detection of intra-articular effusion and of granulation tissue. More humeral head erosions were depicted by MRI than on plain films. However, plain films remain the basic examination in this regard, as well as for the detection of osseous changes of the acromioclavicular joint. Capsular hypertrophy of the acromioclavicular joint as a possible pathogenetic factor in impingement syndrome was well depicted on MRI (Seeger et al., 1988).

MRI was not adequate for the evaluation of rotator cuff calculcations, because small calcifications are not visible within the normally hypointense distal tendinous part of the rotator cuff. In our two positive cases the diagnosis was mainly based on the increased volume of the tendon by very large calcifications.

In conclusion, in the radiologicat investigation of patients with a clinical suspicion of rotator cuff tear, sonography performed by an experienced examiner should be the initial examination. MR imaging on the other hand is not operator dependent. Although its results were inferior to other studies, it is potentially superior in depicting and differentiating lesions of the rotator cuff and other structures of the shoulder. After an additional learning process MR imaging may thus become the prime method in non-invasive shoulder imaging.
Fig. 2 – MRI
(a) Small rotator cuff tear. SE 1700/50 coronal oblique image (arrows: hyperintensity within supraspinatus tendon. Arrowheads: intact peribursal fat).
(b) Large rotator cuff tear. SE 520/20 coronal oblique image with completely missing rotator cuff between acromion and humeral head.
(c) Rheumatoid arthritis. SE 2000/80 coronal oblique image (arrows: nodules of synovial hypertrophy within hyperintense effusion).
(d) Rheumatoid arthritis. SE 550/30 axial image at the level of the acromioclavicular joint (arrows: acromial subchondral cyst).
(e) Calcifying tendinitis. SE 550/30 coronal oblique image (arrows: hypointensity and increased volume of the supraspinatus in extensive disease).
REFERENCES


