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The diagnostic value of arthrography and plain radiography in rotator cuff tears

In 26 patients with surgically verified rotator cuff tears, the findings at radiography and arthrography were analysed. Plain anteroposterior radiograms were of no value in diagnosis. In plain groove-films, the slope of the medial wall and the depth of the intertubercular groove correlated with dislocations of the biceps tendon.

In arthrography, leakage of the contrast medium into the subacromial or subdeltoid bursa was a reliable sign of a full-thickness tear. There was no correlation between the size of the tear measured at arthrography and at surgery. In cases where the biceps tendon sheath was visualised, the appearance was in agreement with the surgical findings.

Key words: shoulder joint; tendon injuries

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A subacromial or subdeltoid bursa filled with contrast medium has been unanimously accepted as an arthrographic sign of a full-thickness rotator cuff tear (Lindblom 1939, Kernwein et al. 1957, Samilson et al. 1961, Killoran et al. 1968, Ghelman & Goldman 1977, Neviaser 1980, Resnick 1981). It may be difficult, however, to assess the extent of such a tear. Although DePalma (1973) proposed that the size could be measured in single contrast arthrography, double contrast studies give a better image of the extent of the tear (Ghelman & Goldman 1977). Few reports have dealt with the problems involved in imaging the extent of a tear.

In fresh traumas plain radiographs have been used to exclude fractures as a cause of pain. If pain is chronic, plain films may reveal calcification in tendons and bursae, but the changes observed in connection with rotator cuff tears have been minimal.

The purpose of this study was to analyse the predictive value of arthrography and plain radiography in rotator cuff tears and associated lesions in patients over 40 years of age. The diagnoses were confirmed by arthrotomies of the glenohumeral joints.

Patients and methods

During the 2-year period from 1980 to 1982, a total of 65 arthrotomies were carried out for chronic shoulder pain. Forty-two patients 40 years of age or older were selected for this study. In 26 cases, the peroperative finding confirmed the diagnosis of a tear of the rotator cuff. The ages of these patients ranged from 42 to 75 years. Sixteen patients with an intact rotator cuff served as a control group. The peroperative diagnoses of these patients are shown in Table 1. The ages of the controls ranged from 42 to 67 years.

40° posterior oblique views with the humerus rotated inwards and outwards were taken with the patients in the upright position. The central X-ray of the beam was 15° above the horizontal. The focus-film distance was 100 cm, and the X-ray beam was centred on the middle of the shoulder joint. Axillary views

Table 1. Surgical findings in 16 patients without a tear of the rotator cuff

Surgical finding	Number of patients
Biceps tendinitis	7
Rotator cuff degeneration	5
Rotator cuff degeneration and biceps tendon dislocation	1
Rotator cuff degeneration and acromioclavicular osteoarthritis	1
Anterior glenohumeral subluxation	2

were taken with the patients in the supine position. Groove views were taken with the patients in the supine position by the technique presented by Ahovuo (1983).

At arthrography, the shoulder joint was punctured anteriorly using the technique presented by Killoran et al. (1968). Natrium metrizoate, iodine content 200 mg/ml, was used as contrast medium. Dye was injected into the joint under fluoroscopic control until the patient reported a feeling of fullness in the shoulder joint. No anaesthetic was used in the contrast medium. Additional oxygen was used in 14 double contrast arthrographies (seven with and seven without a rupture of the rotator cuff). The shoulder joint was not exercised after the injection. Anteroposterior views with the humerus inwardly and then slightly and maximally outwardly rotated were taken with the patients in the upright position. The central X-ray of the beam was 15° above the horizontal (Neviaser 1980). Axillary and groove radiographs were taken with the patients in the supine position.

The appearances in arthrography and plain radiography were compared with the surgical observations made during arthrotomy. The significance of any differences was determined by the chi-square and *t*-tests, and by correlation analysis.

Results

During arthrotomy of the glenohumeral joint, a complete full-thickness rupture of the rotator cuff was verified in 25 cases. In one further case there was a partial, onion-skin-like degeneration of the supraspinatus tendon, but not a full-thickness tear of the tendinous attachment to the humeral head.

In all the cases the rupture comprised at least the facet of the tuberosity attaching the supraspinatus muscle. According to the classification presented by Post et al. (1983), 12 tears were large, eight moderate, and five small. The length of the ruptured tendon facet of the rotator cuff, measured on the circumference of the humeral head, varied from 3 to 40 mm.

In two cases, the rotator cuff tear was associated with a rupture of the tendon of the long head of the biceps brachii muscle. In eight cases medial dislocation of the biceps tendon could be verified, with a rupture extending into the medial attachment of the coracohumeral ligament.

The distance between the acromion and the humeral head was not significantly smaller in the cases with a rotator cuff tear than in the controls ($P > 0.05$, *t*-test).

Minor degenerative changes in the bone structure of the humeral head were not significantly more frequent in patients with rotator cuff tears than in those without ($P > 0.05$, chi-square test).

In those cases with a rotator cuff tear, neither the width or depth of the intertubercular groove nor the slope of the medial wall differed significantly from the values for the controls ($P > 0.05$, *t*-test).

Interestingly, the inclination of the medial wall and the depth of the groove were significantly less in those rotator cuff tears with a dislocation of the biceps tendon than in those without a tendon dislocation ($P < 0.001$, *t*-test). In the cases with a dislocated biceps tendon, the inclination was less than 42°, and the depth of the groove less than 3.6 mm (Figure 1).

At arthrography, the subacromial or subdeltoid bursa was filled with contrast medium in all the patients with a full-thickness rotator cuff tear. In the patient who was found at surgery to have a partial tear, the arthrogram showed irregular delineation of the inner surface of the rotator cuff and stripes of contrast medium in the inner part of the tendinous cuff (Figure 2).

In all full-thickness tears, arthrography showed a lesion of the supraspinatus tendon (Figure 3). The size of a tear measured in arthrography did not correlate with that measured peroperatively ($P > 0.05$, $r = -0.15$). Arthrographic measurements presented diffi-

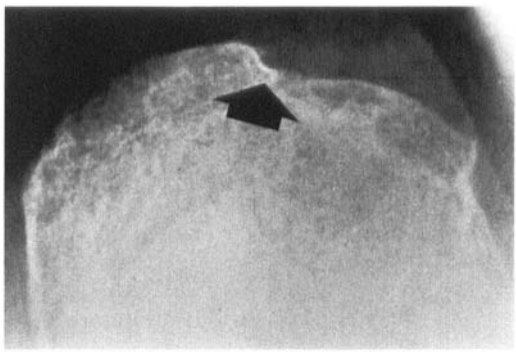

Figure 1. Groove radiograph in a rotator cuff tear with medial dislocation of the biceps tendon. The groove is largely obliterated. Note the shallow sulcus and decreased inclination of the medial wall of the groove.

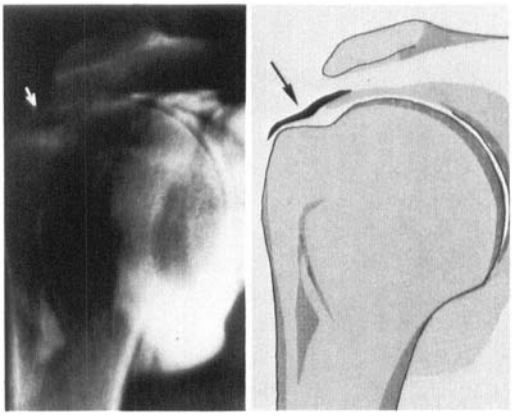

Figure 2. Parial rotator cuff tear. Note stripes of contrast medium near the inner surface of the tendinous cuff (arrows). Neither the subacromial nor the subdeltoid bursa is filled with contrast medium.

culties if the thickness of the rotator cuff was 2.0 mm or less. The thickness of the rotator cuff measured in arthrography did not correlate with the extent of a surgical tear ($P > 0.05$, r = –0.27).

In three of the control patients, arthrography showed filling of the bursa above the rotator cuff.

The biceps tendon sheath was filled with contrast medium in 17 patients with a rotator cuff tear, and in 14 control patients. In five patients with a rotator cuff tear and in one of the controls the biceps tendon was medially displaced both in arthrography and at surgery. In two patients with a rotator cuff tear the sheath was visualised in anteroposterior views, but could not be imaged in the groove view. In both these patients a medial dislocation of the biceps tendon

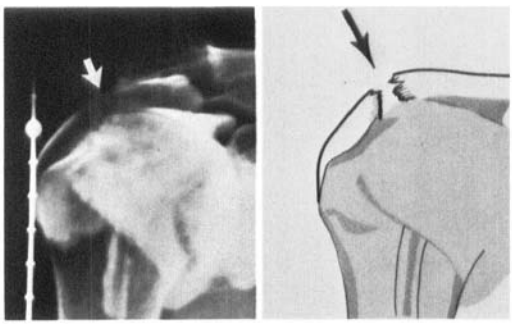

Figure 3. Full-thickness rotator cuff tear. Note contrast medium in both the subacromial and subdeltoid bursa. The edges of the tear are seen (arrows). The sheath of the biceps tendon is clearly visualised.

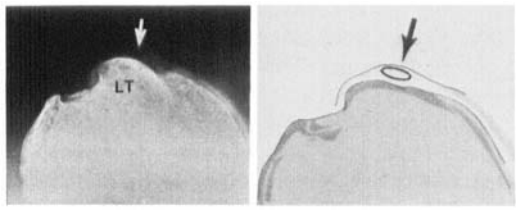

Figure 4. Medial dislocation of the biceps tendon. The groove view of arthrography. The biceps tendon is riding on the lesser tuberosity (LT) (arrows).

was found peroperatively. In one further patient the sheath was not visualised, but the biceps tendon was medially displaced at surgery. One of the controls had a medial biceps tendon dislocation in arthrography and at surgery without a full-thickness tear of the rotator cuff (Figure 4).

Discussion

In this study, the arthrographic sign with contrast medium in the subacromial or subdeltoid bursa correlated well with the surgical observations if the cuff was injured. Three control patients, however, fulfilled the arthrographic criteria of a full-thickness tear, although this was not found at surgery. This means that the above-mentioned arthrographic sign is too sensitive in detecting a tear and it may depend on the low viscosity of the contrast medium used (1.6 cP at 37°C) with easy penetration of the dye between the tendon fibres. Furthermore, patients had to wait up to 4 months from arthrography to operation, so that minimal tears might have healed during the observation period.

A rotator cuff tear is most common in the area of the supraspinatus tendon, but in large tears the rupture may extend into additional tendon facets (DePalma 1973). To be imaged, the X-ray beam must be tangential to the tear. Therefore, several views were taken for more accurate localisation of the tears. In the present study the site of the arthrographically verified tears correlated with the surgical observations when the supraspinatus tendon was injured. In the axillary view the anterior border of these tears may sometimes be seen near the coracohumeral ligament when the biceps tendon is in profile. In this view the posterior border of the

supraspinatus tendon lesion may not be imaged.

The size of rotator cuff tears measured in arthrography did not correlate with the extent observed surgically. In arthrography, only the intratendinous part of the tears could be measured accurately because contrast medium may obscure the superficial parts of the tears, especially when too much contrast medium is used.

Rotator cuff tears are to be regarded as the end result of tendinous degeneration which often worsens after the age of 40 years (DePalma 1973). This leads to thinning of the rotator cuff. No correlation could be seen, however, between the extent of a rotator cuff tear and the thickness of the cuff. Apparently the extent of the tear depends more on the violence of the trauma than on the degree of degeneration.

In this study concomitant biceps tendon lesions were seen in eight of the 26 patients with a rotator cuff tear, supporting the view that biceps changes are associated with rotator cuff tears (DePalma 1973, Neer 1983). This might be due to wear of the medial part of the coracohumeral ligament, the portion of the rotator cuff that prevents medial displacement of the biceps tendon (Slätis & Aalto 1979).

When arthrography gave a clear image of the biceps sheath in the groove view, the site of the tendon was easy to determine. Occasionally, in rotator cuff tears with a filled bursa system, contrast medium obscured the groove silhouette, making the displacement of the biceps tendon difficult to diagnose. Indirectly, displacement of the tendon may be suspected if the groove is empty but the sheath can be imaged in the anteroposterior views.

The value of anteroposterior plain films was only to exclude fractures in fresh traumas as a cause of shoulder pain. On the other hand, groove radiographs may be useful for detecting alterations in the walls of the sulcus, because pathological changes in the sulcus are found in rotator cuff tears. Therefore, when painful shoulders are examined, the programme of the projections in plain radiography should routinely include the groove view.

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