Accuracy of CT arthrography in the assessment of tears of the rotator cuff

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CT arthrography and arthroscopy were used to assess tears of the rotator cuff in 259 shoulders. Tear size was determined in the frontal and sagittal planes according to the classification of the French Arthroscopy Society.

CT arthrography had a sensitivity of 99% and a specificity of 100% for the diagnosis of tears of supraspinatus. For infraspinatus these figures were 97.44% and 99.52%, respectively and, for subscapularis, 64.71% and 98.17%. For lesions of the long head of the biceps, the sensitivity was 45.76% and the specificity was 99.57%.

Our study showed an excellent correlation between CT arthrography and arthroscopy when assessing the extent of a rotator cuff tear. CT arthrography should, therefore, be an indispensable part of pre-operative assessment. It allows determination of whether a tear is reparable (retraction of the tendon and fatty degeneration of the corresponding muscle) and whether this is possible by arthroscopy (degree of tendon retraction and extension to subscapularis).

Various imaging methods are available for the assessment of the rotator cuff. High-definition ultrasound examination of full-thickness tears of the rotator cuff gives a sensitivity of 100% and a specificity of 85% according to Teefey et al, but such accuracy relies on an experienced examiner. MRI provides the same rates of sensitivity and specificity, but with recognised difficulties in the assessment of partial lesions and ruptures of subscapularis. CT arthrography is an invasive examination with comparable levels of sensitivity and specificity.

Effective pre-operative planning ideally requires additional information to be available including the extent of retraction of the tendons in the frontal plane and the size, shape and degree of sagittal extension of any tear. Many reports describe only the presence or absence of a full-thickness tear.

We have, therefore, compared CT arthrography with arthroscopy in 259 shoulders in order to establish their ability to determine the existence of a tear as well as its size and extent in the two directions according to the classification of the French Arthroscopy Society.

Patients and Methods

Between January 2001 and December 2002, a senior radiologist (LB) experienced in musculoskeletal radiology and an orthopaedic surgeon (CC) who had specialised in arthroscopic repair of tears of the rotator cuff compared pre-operative CT arthrography data with arthroscopic analysis in 259 patients with a mean age of 42 years (21 to 69). It was not possible for the surgeon to be blinded for ethical reasons.

The arthroscopic examination diagnosed the lesions as follows: 126 full-thickness and 15 partial-thickness tears of supraspinatus, 29 cases of shoulder instability, nine cases of adhesive capsulitis and 80 cases of calcific tendinitis. The mean interval between CT arthrography and arthroscopy was 87.7 days (5 to 182).

The CT arthrography procedure involved entering the glenohumeral joint with a 22-gauge spinal needle through an anterior approach and with fluoroscopic guidance. The spinal needle was coupled by connective tubing to a syringe filled with contrast material. A 20-ml solution composed of 10 ml of non-ionic iodinated contrast material (Iohexol, lopamiron; 320 mg/ml; Guerbet, France) and 10 ml of 0.5% lidocaine (Abbott Laboratories, North Chicago, Illinois) was injected. There were no complications with this procedure. Radiographs were obtained in all patients after gentle movement once the shoulder was internally and externally rotated. The patients then underwent CT arthrography without further movement of the joint.

All patients underwent CT arthrography (GE Medical Systems, Milwaukee, Wisconsin)
with the humerus in internal rotation, using helical acquisition (15 cm field of view, 1 mm section thickness, 0 to 0.5 mm intersection gap) followed by reformatting in the oblique-coronal and oblique-sagittal planes. The procedure was then repeated in external rotation with sequential acquisition (15 cm field of view, 1 mm section thickness, 3 mm intersection gap).

In accordance with the practice of the French Arthroscopy Society, a concise anatomical description of tears of the rotator cuff was produced, based upon the framework common to both CT arthrography and arthroscopy (Figs 1 and 2).

For each of the tendons of the cuff (supraspinatus, infraspinatus and subscapularis) the frontal and sagittal extent of the tear was assessed. In the frontal plane (Fig. 1), the tendon was either retracted, intermediate or distal, as described by Thomazeau et al.12 It was distal when the retraction did not extend beyond the upper edge of the anatomical neck of the humerus, retracted when it retracted within the lower edge of the anatomical neck and intermediate when it was situated between these two extremes.

In the sagittal plane (Fig. 2), three types of tear of supraspinatus could be identified (anterior, posterior or complete), depending on whether they affected, respectively, the anterior half, posterior half or the whole tendon. For infraspinatus or subscapularis, tears were either limited to cleavage, the upper third (upper-third tears) or affected more than this (complete tears).

In the long head of biceps, four conditions have been identified, (intact, hypertrophied, frayed or ruptured). The stability and cover of the biceps tendon were also assessed, according to whether the tendon lay within its groove, had subluxed across the lesser tuberosity, had dislocated medially or was absent.

Arthroscopy was regarded as the definitive assessment and comparisons were made with CT arthrography. In
order to correlate the results for frontal and sagittal extension of lesions, the global value of the test was calculated by establishing a relationship between the number of concordant results for both techniques and the total number of results.

**Results**

Details of the results are given in Tables I to X.

**Supraspinatus.** Comparison of the analyses by CT arthrography and arthroscopy gave a sensitivity of 99%, a specificity of 100% and a negative predictive value of 98.33% (Tables I, V and X). Of 15 partial lesions only the 13 deep lesions could be analysed since the two superficial lesions could not be identified by the CT scanner.

Analysis of frontal and sagittal extension produced excellent results with global values of 78.62% and 81.52%, respectively. Frontal analysis of distal and retracted conditions showed the greatest correlation, with the intermediate frontal extension proving more difficult to assess. Correlation for a posterior sagittal extension was more difficult with a global value of 50%, probably because of infrequency of this type of lesion (Table X).

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**Infraspinatus.** The sensitivity of CT arthrography was 97.44%, but the specificity only 88.18% because of longitudinal intratendinous cleavages which are not often detectable by arthroscopy (Tables II, VI and X). If the cleavages were excluded from the statistical analysis (36 cases),
the sensitivity rose to 100%, the specificity to 99.40%, the positive predictive value to 96.67% and the negative predictive value to 100%.

Frontal analysis had a global value of 71.62%, with only 54.55% for intermediate retraction, the results being identical to those for lesions of supraspinatus. Sagittal analysis produced a better result with a global value of 83.15% and a greater rate of detection of upper-third lesions with a global value of 91.30% (Table X).

Subscapularis. The sensitivity of CT arthrography was 64.71%, but the specificity was 98.17% with a positive predictive value of 84.62% and a negative predictive value of 94.69% (Tables III, VII and X). Agreement of results in the sagittal plane was poor with a global value of only 35% for cleavage or upper-third lesions and 37.5% for lesions beyond the upper third. For complete tears there was a much greater agreement with a global value of 80% (Table X).

Long head of biceps. The sensitivity of CT arthrography was poor (45.76%); but specificity was excellent (99.57%) with a positive predictive value of 96.43% and a negative predictive value of 87.83% (Tables VIII to X). Analysis of the correlation for the precise condition of the tendon produced only a mediocre result with a global value of 67.40%.

The dynamic study of the biceps was unimpressive (global value 63.49%) and analysis of dislocation of the biceps produced a very poor result (global value 18.18%). Analysis of biceps cover was excellent (global value 85.71%).

Discussion

Our study confirms the value of CT arthrography for the diagnosis of tears of the rotator cuff, with considerable sensitivity and specificity for tears of supraspinatus and infraspinatus. The sensitivity of this type of examination is practically identical to that of recent studies which compared ultrasound with arthroscopy and MRI with arthroscopy.

Our specificity of 100% was better than any of these other studies. Callaghan et al. reported similar results as early as 1988 when they compared CT arthrography with arthroscopy, but the sensitivity was only 50%. More recently, Farin et al. obtained a sensitivity of 95%.

As regards to tendon retraction, our study is the first to show an excellent correlation between CT arthrography and arthroscopy, with a correlation of 78% for retraction in the frontal plane for supraspinatus and of 71% for infraspinatus.

Retraction in the frontal plane is one of the main criteria for assessing the feasibility of repair of the cuff and these results confirm that pre-operative data obtained from CT arthrography are reliable.

The significance of this finding is enhanced by the fact that recent studies have shown equally good results for
arthroscopic repair of distal tears of supraspinatus and for repairs by convenient methods. CT arthrography can be useful in the pre-operative assessment of the feasibility of arthroscopic repair. However, our results are based on unblinded arthroscopic evaluation which is open to bias and will be influenced by the experience of the arthroscopic surgeon. Gartsman, showed in his study than an experienced surgeon can produce reliable results.

Deep partial lesions showed good correlation but superficial lesions were not detected by CT arthrography unlike MRI and ultrasound. To our knowledge, no study has ever compared MRI arthrography and CT arthrography in the evaluation of lesions of the rotator cuff. For the tendon of subscapularis, CT arthrography has been shown to have excellent specificity. Injection of contrast material appears to be important in the assessment of this tendon, as has been confirmed by Bennett and Pfiirrmann et al with MRI arthrography.

In our study, the sensitivity appears to be unimpressive because we included partial lesions or upper-edge cleavages which do not show up clearly in imaging tests. This is especially important in the pre-operative assessment of a tear of the rotator cuff since it is now known that lesions affecting the upper edge of subscapularis can be treated by arthroscopy, whereas those affecting more than the upper third should be managed by conventional surgery.

The pathology of biceps is not accurately assessed by CT arthrography, and ultrasound or MRI give better results. Fatty muscle degeneration in the rotator cuff is reported to be an important predictor of reparability of the tendon. At present this is best assessed by CT.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References