Cystic changes of the humeral head on MR imaging

Relation to age and cuff-tears

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We obtained MR images of 140 painful shoulders in 134 patients to determine the relationship between cystic changes of the humeral head and integrity of the rotator cuff. Cystic changes were observed in 49 shoulders (35%) and the commonest site was in the bare bone area of the anatomical neck, and the second commonest site was at the attachment of the supraspinatus tendon. Cystic changes in the bare bone area were observed equally often in shoulders with or without rotator cuff tears (27% and 18%, respectively) and were more frequently observed in the elderly. Cystic changes at the attachment of the supraspinatus and subscapularis tendons were specific to rotator cuff tears: they were observed in 28% of rotator cuff tears, but in none of those with an intact cuff.

We conclude that there are two distinct types of cystic changes: one at the attachment of the supraspinatus and subscapularis tendons, which is closely related to tears of these tendons, and the other in the bare bone area of the anatomical neck, which is related to aging.

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Cystic changes of the greater tuberosity of the humerus are observed in one half to four fifths of shoulders with rotator cuff tears (Cotton and Rideout 1964, Kernwein 1965, Needell et al. 1996). The high incidence suggests a cuff tear as the cause of cyst formation (Codman 1934, Cotton 1964, Kernwein 1965, Kieft et al. 1988, Needell et al. 1996). However, cystic changes are also observed in normal shoulders (Kernwein 1965, Scott 1991, Needell et al. 1996). We hypothesized that the cystic changes detected in rotator cuff tears might differ from those in normal shoulders, in terms of location and/or size. Using MRI, we assessed whether there is a relationship between cystic changes in the humeral head and integrity of the rotator cuff.

Patients and methods

Between January 1994 and August 1996, 140 painful shoulders of 134 consecutive patients were examined with MRI (coronal oblique and sagittal oblique). There were 105 men (110 shoulders) and 29 women (30 shoulders) with an average age of 41 (13–78) years.

Using a 1.5-T whole-body MR imager (Signa, GE Medical Systems, Milwaukee, WI), T1-weighted images (TR/TE = 600/23 msec) and T2-weighted images (TR/TE = 4000/92.2 msec) in the coronal oblique and sagittal oblique planes were obtained in 5-mm gapless slices with a 10-cm field-of-view (FOV) and a 256 × 128 matrix size, using dual phased-array coils (Sashi et al. 1996).

Cystic change on MRI was defined as a round or oval area in the proximal humerus, larger than 2 mm in diameter with low signal-intensity on T1-weighted image, and high signal-intensity on T2-weighted image (Figures 1 and 2). The size of the cystic change was measured, using a caliper, and expressed in millimeters. The location of a cystic change was related to the following anatomical regions: the superior, middle and inferior facets of the greater tuberosity (Figure 3), lesser tuberosity, humeral head and anatomical neck. The three facets of the greater tuberosity were identifiable in the coronal oblique images (Minagawa et al. 1996). Pathology of the rotator cuff tendon was diagnosed on the basis of MRI criteria previously reported (Needell et al. 1996) and were divided into three groups: cuff without tear, partial tear and complete tear.

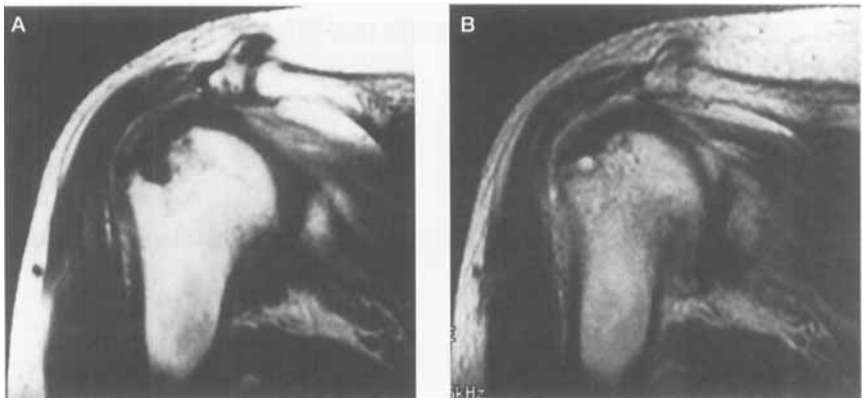

Figure 1. A cystic change in a complete tear of the rotator cuff. Both T1-weighted image (A) and T2-weighted image (B) show a cystic lesion in the middle facet, which corresponds to the location of the tear.

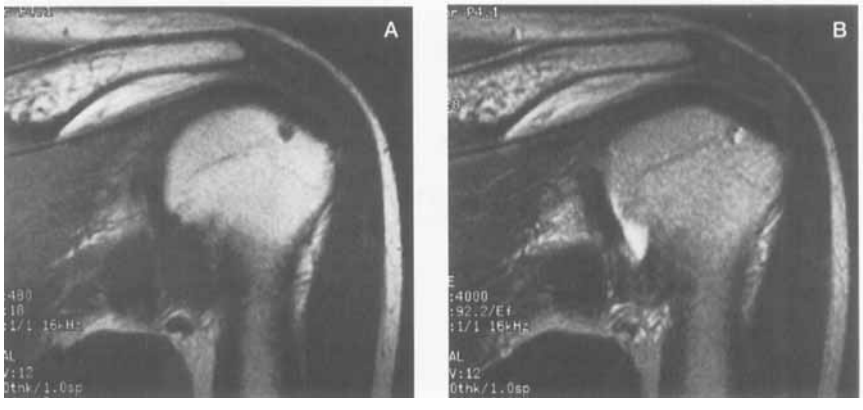

Figure 2. A cystic change in a normal shoulder. T1-weighted image (A) shows a low signal-intensity lesion in the posterior half of the middle facet. The lesion showed high signal-intensity on the T2-weighted image (B).

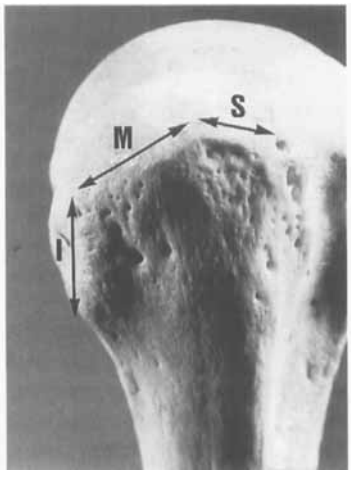

Figure 3. Three facets of the greater tuberosity. The supraspinatus attaches to the superior facet (S) and the anterior half of the middle facet (M). The infraspinatus attaches to the entire length of the middle facet (M) and the teres minor attaches to the inferior facet (I).

The incidence and anatomical location of cystic changes were compared among those with different cuff pathologies, using the chi-square test. The sizes of cystic changes were compared between shoulders with or without cuff tears, using the two-sample t-test and among the different locations using analysis of variance. The statistical significance was set at the 5% level.

Results

There were 66 shoulders without cuff tears and 74 shoulders with cuff tears (34 complete and 40 partial tears). Among the 74 rotator cuff tears, 47 tears involved only the supraspinatus tendon, 19 both the supraspinatus and infraspinatus tendons, and 8 involved all three tendons.

Cystic changes were observed in 49 shoulders (35%), 11/66 shoulders without cuff tears and 38/74

Location of cystic changes, number of cysts

Tear	Superior facet	Middle facet anterior	Middle facet posterior	Lesser tuberosity	Humeral head
None	–	–	11	–	–
Partial	3	6	12	–	1
Complete	6	6	8	5	–

No shoulders had cystic changes in the inferior facet or neck. Cystic changes in the superior facet, anterior half of the middle facet and lesser tuberosity were specific to rotator cuff tears. Cystic changes in shoulders without cuff tears were observed only in the posterior half of the middle facet.

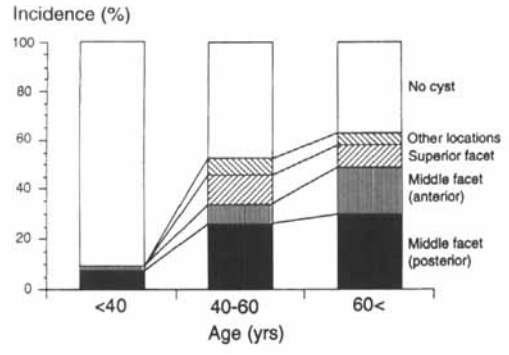

Figure 4. Age and cystic changes. The cystic changes increased with age in the posterior half of the middle facet ($p = 0.0002$), the anterior half of the middle facet ($p = 0.002$), the superior facet ($p = 0.003$) and the other locations ($p = 0.009$).

cuff-tear shoulders: 18 partial tears and 20 complete tears. The commonest location was the posterior half of the middle facet (31 cysts), followed by the anterior half of the middle facet (12 cysts) and the superior facet (9 cysts) (Table). The cystic changes in the posterior half of the middle facet (bare bone area in the anatomical neck) were observed both in rotator cuff tears (20/74 shoulders) and in normal shoulders (11/66 shoulders) ($p = 0.1$). On the other hand, cystic changes of the superior facet and the anterior half of the middle facet (attachment of the supraspinatus tendon) were observed only in rotator cuff tears (18/74 shoulders), all of which involved the supraspinatus tendon. Cystic changes in the lesser tuberosity (attachment of the subscapularis) were all related to massive tears of the rotator cuff, involving all three tendons. In total, the cystic changes in the cuff attachment sites were observed in 21/74 shoulders with rotator cuff tears but in none of those with intact rotator cuff ($p < 0.0001$).

The incidence of cystic changes increased with age, most significantly in the posterior half of the middle facet ($p = 0.0002$), followed by the anterior half of the middle facet ($p = 0.002$), the superior facet ($p = 0.003$) and the other locations ($p = 0.009$) (Figure 4).

The average size of the cysts was 4.5 (2–15) mm. There was no difference in the cyst size between shoulders without cuff tears (4.1, SD 0.2 mm) and those with cuff tears (4.8, SD 0.3 mm) ($p = 0.1$). The size based on the cyst locations did not show differences either ($p = 0.2$).

Discussion

Using conventional radiography, Kernwein (1965) found cystic changes in 21% of subjects with intact rotator cuff and 50% of those with rotator cuff tears detectable by arthrography. The incidence of MR-evident cystic changes in shoulders without cuff tears was slightly lower in our study and also in the study by Needell and colleagues. Because the cuff tear was diagnosed with arthrography in Kernwein's study, it is likely that the intact shoulders included partial tears. On the other hand, the incidence of MR-evident cystic changes in complete tears was slightly higher in Needell's study and in ours. This may be explained by the superiority of MRI to roentgenograms in depicting cystic changes (Sano et al. 1997). MRI gives not only the distinct characteristics of each anatomical element but also sliced images, which probably make it easier to identify bony changes in the humeral head.

Our study clearly showed that cystic changes in the presence of rotator cuff tears and in shoulders without cuff tears were different in location, but not in size. The cystic changes in the superior facet, the anterior half of the middle facet and the lesser tuberosity were observed only in rotator cuff tears. The superior facet and the anterior half of the middle facet are sites of supraspinatus tendon attachment (Minagawa et al. 1998) and the lesser tuberosity is the site of the subscapularis tendon attachment. All shoulders with cystic changes in the supraspinatus tendon attachment had a torn supraspinatus tendon and all shoulders with cystic changes in the lesser tuberosity had a torn subscapularis tendon. This is similar to Cotton and Rideout's (1964) finding that the cysts were situated in the subcortical bone immediately next to the site of detachment of the cuff fibers. The bony structure under the tendon attachment comes into direct contact with the coracoacromial arch, when these tendons are torn. This may cause cystic changes. Absence of physiological tensile force on the bony architecture after tendon disruption may also have played some role in the occurrence of cystic changes. On the other hand, the cystic changes in the posterior half of the middle facet were observed both in shoulders with rotator cuff tears and in those without. This location is close to the

bare bone area of the anatomical neck of the humerus, sometimes called the "sulcus" (Codman 1934). Lack of cartilage coverage, which is known to be a factor predisposing to degenerative changes (Ondrouch 1963), may be related to the pathogenesis of cystic changes. We found that the incidence of cystic changes at this site increased with age, more significantly than at any other locations. Thus, cystic changes in the bare bone area seem to be related to a degenerative aging process, rather than to rotator cuff tears.

There are some limitations to our study. One is that all the diagnoses of cuff tears and cystic changes were made by MRI and not confirmed by surgery. Although MRI resolution has been greatly improved by use of small field-of-view and dual phased-array coils (Sashi et al. 1996) and the diagnostic accuracy for complete tears was 95%, it is less accurate for partial tears. Because of our definition of cystic changes on MRI, we may have missed some cysts filled with fibrous tissues (Cotton and Rideout 1964). As findings of cuff tears and cystic changes were both diagnosed by MRI, the calculation of diagnostic power of one finding for the other would be more influenced by MRI performance. Another limitation is that the same observer made the diagnosis of cuff tears and that of cystic changes. This may have caused some bias in the results.

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