Atrophy of the rotator cuff muscles and site of cuff tears

Togo Shimizu[1], Eiji Itoi[1], Hiroshi Minagawa[2], Rabindra L Pradhan[1], Ikuko Wakabayashi[1] and Kozo Sato[1]

Departments of Orthopedic Surgery, [1]Akita University School of Medicine, 1-1-1 Hondo, Akita 010-8543, Japan, and [2]Ugo Municipal Hospital. Correspondence: Dr. Eiji Itoi. E-mail: itoi@med.akita-u.ac.jp
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ABSTRACT – We determined the relationship between the site of rotator cuff tears and atrophy of the cuff muscles. 28 shoulders (28 patients) had rotator cuff tears: 19 isolated tears of the supraspinatus tendon (isolated-tear group) and 9 combined tears of the supraspinatus and infraspinatus tendons (combined-tear group). The cross-sectional area of the subscapularis, supraspinatus, the infraspinatus and teres minor muscles in the coronal oblique MR images were measured before and after surgery. Although we found no difference in tear size, the cross-sectional areas of the muscles were smaller in the combined-tear group than in the isolated-tear group. We conclude that atrophy of the supraspinatus and infraspinatus muscles also depends on the site of the tear.

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The supraspinatus tendon is the most commonly involved tendon in rotator cuff tears (Codman 1984, Harryman et al. 1986). Since the posterior half of the supraspinatus tendon is covered by the infraspinatus tendon (Minagawa et al. 1998), a tear located in that half of the tendon involves part of the infraspinatus tendon. We hypothesized that infraspinatus muscle atrophy would be worse in patients with tears in the posterior half of the supraspinatus tendon than the anterior half, even if they were of the same size. We therefore studied 1) how the site of rotator cuff tears affects atrophy of the rotator cuff muscles and 2) whether recovery from atrophy after cuff repair differs with the site of the tear.

Patients and methods

Between January 1994 and December 1997, 28 shoulders of 28 patients with rotator cuff tears underwent surgical repair of the cuff by a shoulder surgeon (EI). 25 were men and 3 women with an average age of 53 (42–68) years at the time of surgery. In all patients, the repair was done by suturing the rotator cuff tendon in a bony trough. Both the size and site of the tear were determined during surgery. The size was calculated from the maximum width and length of the tear. The width of the remnant of the anterior supraspinatus tendon and the relationship between the tear and the facets of the greater tuberosity were carefully examined to assess the involvement of the infraspinatus tendon (Minagawa et al. 1998).

The shoulders were divided into two groups according to the site of the tear: 19 shoulders with an isolated tear of the supraspinatus tendon (isolated-tear group) and 9 shoulders with a combined tear of the supraspinatus and infraspinatus tendons (combined-tear group). The tear's size was 2.19 (SD 1.42) cm^2 in the isolated-tear group and 2.64 (SD 1.29) cm^2 in the combined-tear group, which was not significant ($p = 0.6$). The average duration of symptoms was 5.7 (SD 2.6) months in the isolated-tear group and 5.9 (SD 3.6) months in the combined-tear group.

We used a 1.5-T whole-body MR imager (Signa, GE Medical Systems, Milwaukee, WI), T1-weighted images (TR/TE = 600/23 msec) in the oblique sagittal plane to obtain 3-mm gapless slices with a 10-cm field-of-view and a 256 × 128 matrix size. The cross-sectional area (CSA) of the

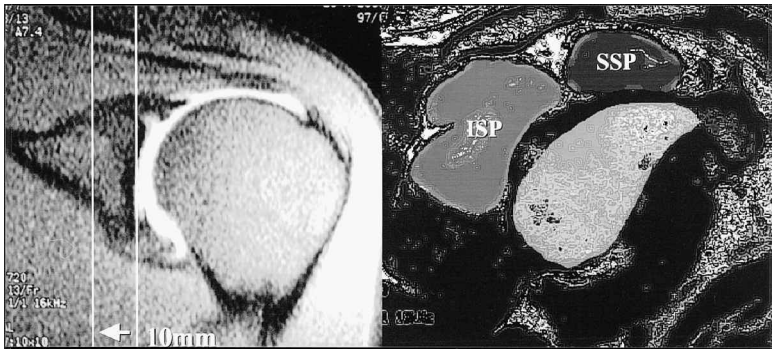

Figure 1. Cross-sectional area (CSA) of the supraspinatus and infraspinatus muscles on T1-weighted MR images in the oblique sagittal plane, 10 mm proximal to the glenoid surface.

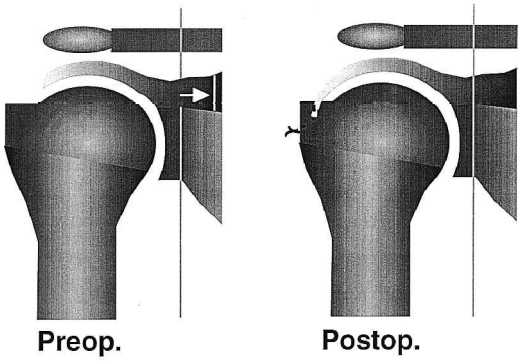

Figure 2. Retraction of the cuff in rotator cuff tears.

supraspinatus and infraspinatus muscles on these images, at the slice level 10 mm medial to the glenoid surface, was measured using image-processing software, NIH Image (National Institutes of Health, Bethesda, MD, USA). CSA measurements were normalized by comparing the CSA of the corresponding muscle of the contralateral shoulder (Figure 1).

MR images were taken once before and twice after surgery (2 and 12 months). Preoperative images were used to assess the relationship between the tear site and muscle atrophy, and postoperative images to determine the effect of cuff repair on the CSA of the muscles. The images at 2 months rather than the preoperative served as a baseline for comparison with the images at 12 months because cuff tension may change postoperatively and affect the CSA of the muscles (Figure 2).

In all statistical analyses, we used a two-sample t-test to compare the isolated-tear and combined tear-groups. The CSAs before and after surgery were compared using a paired t-test. Statistical significance was set at the 5% level.

Results

Relationship between the tear site and muscle atrophy (Table)

In the isolated-tear group, the CSAs of the supraspinatus and infraspinatus muscles were 94% and 95% of the uninvolved side at 2 months after surgery, respectively. In the combined-tear group, the CSAs of the supraspinatus and infraspinatus muscles were 61% and 75% of the uninvolved side at 2 months after surgery. The CSAs of both the supraspinatus and infraspinatus muscles were therefore smaller in the combined-tear group than in the isolated-tear group ($p = 0.002$, $p < 0.001$). We found no significant difference in the CSAs of the subscapularis and teres minor muscles between the isolated-tear and combined-tear groups ($p = 0.2$, $p = 0.5$).

Normalized CSAs of SSP and ISP in isolated—and combined—tear groups. Percent, mean (SD)

	Postop 2 months			Postop 12 months		
	Isolated group	Combined group	P-value	Isolated group	Combined group	P-value
SSP	94 (4)	61 (18)	0.002	94 (6)	61 (19)	0.01
ISP	95 (5)	75 (17)	< 0.001	97 (3)	74 (16)	0.03
Sum of SSP and ISP	94 (5)	68 (19)	0.001	95 (5)	67 (19)	0.02

Change in muscle atrophy after cuff repair

Likewise, we found no significant difference in the CSAs of the supraspinatus and infraspinatus muscles between 2 and 12 months after surgery in the isolated-tear or in the combined-tear group ($p = 0.7$, $p = 0.6$). Therefore, after 12 months of surgery, the CSAs of the supraspinatus and infraspinatus muscles were still larger in the isolated-tear group (98%, 97%) than in the combined-tear group (61%, 74%) ($p = 0.01$, $p = 0.03$).

Discussion

Identification of torn tendons

In 1994, Goutallier et al. stated that the infraspinatus muscle undergoes atrophy even in isolated tears of the supraspinatus tendon. However, they did not mention any anatomical landmarks to identify the supraspinatus and infraspinatus tendons. These tendons overlap at the superior half of the middle facet of the greater tuberosity (Minagawa 1998) and are covered by bursal tissue and fibers of the coracohumeral ligament (Clark and Harryman 1992), which makes it difficult to identify the border between them during surgery. We recommended that the facets of the greater tuberosity be used to identify them during surgery (Minagawa et al. 1998). We have found that the relationship between the tear and the facets helps us to determine which tendons are involved in the tear: when the tear only involves the superior facet, it is an isolated tear of the supraspinatus tendon, but if it affects the superior half of the middle facet, both tendons are involved.

Tear can start at the posterior cuff

It is generally believed that degenerative lesions of the cuff tendons typically start at the deep surface of the anterior insertion of the supraspinatus near the long head of the biceps (Codman 1984). Our study, however, showed that rotator cuff tears sometimes occurred at the posterior site as well.

Why less atrophy in the isolated-tear group?

The isolated tear of the supraspinatus tendon includes the anterior tendinous band—i.e., the anterior third of the supraspinatus tendon. It is composed of thick fibers and plays an important role in stabilizing the humeral head (Figure 3) (Itoi et al. 1997). An isolated tear in the supraspinatus tendon is located at the site where impingement against the acromion tends to occur (Neer 1972). Therefore, shoulders with such a tear seem to lose an important function and the patients may develop symptoms early and have to consult a doctor. This may explain why hardly any atrophy was found in the cuff muscles of the isolated-tear group. Although the duration of symptoms was not statistically significant, it was shorter in the isolated-tear group. On the other hand, a combined tear of the supraspinatus and infraspinatus tendons does not affect the anterior tendinous band. It is located more posteriorly, where impingement against the acromion seldom occurs and therefore little reduction in function or pain seems to ensure. By the time the patients consult a doctor, muscle atrophy may have already become advanced.

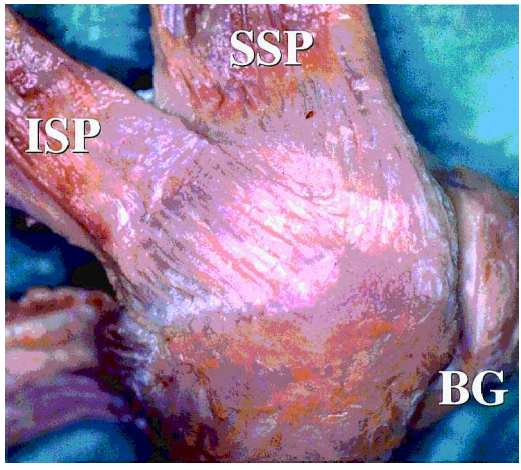

Figure 3. Anterior tendinous band—i.e., the anterior third of the supraspinatus. The supraspinatus tendon is covered by the infraspinatus tendon at its posterior half. SSP—supraspinatus tendon. ISP—infraspinatus tendon. BG—biceps groove.

Recovery of muscle atrophy

We found that advanced muscle atrophy in shoulders with combined tears had not improved 1 year after cuff repair. Goutallier et al. (1994) showed that advanced fatty degeneration of the cuff muscles is irreversible. Although we did not assess fatty degeneration, advanced atrophy seems to indicate a poor prognosis.

Classification

Rotator cuff tears are usually classified on the basis of size or depth of the tear (Post et al. 1983). However, this study showed that muscle atrophy was advanced in both the supraspinatus and infraspinatus muscles when a tear was located posteriorly rather than anteriorly. This suggests that morphological changes and therefore functional disability of the shoulder with rotator cuff tears may depend on the site of this tear, which may explain why some tears cause more disability than others. A classification that takes into account not only the size and extent of th tear, but also its location may be of value in assessing the shoulder with rotator cuff tears.

Limitations

Our study has several limitations. First, the difficulty in identifying the space between various muscles on MR images may affect measurements of the CSA, especially between the infraspinatus and teres minor muscles. Secondly, the method of surgical repair and postoperative immobilization can also influence the recovery of the muscles, and therefore the CSA. We did not correlate the biomechanical dysfunction of the shoulder joints with tears at various sites, which may have changed the muscle volume before and after surgery.

We conclude that the site of rotator cuff tears affects atrophy and recovery of the cuff muscles. Our study supports the view that the classification of rotator cuff tears should take into account the site of the tear since it may help physicians predict the outcome of the disease more precisely.

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