Prediction of primary reparability of massive tears of the rotator cuff on preoperative magnetic resonance imaging

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We studied magnetic resonance images of rotator cuff tears to determine whether it was possible to establish preoperatively the feasibility or infeasibility of primary repair. The study comprised 27 shoulders in 26 patients who underwent magnetic resonance imaging before surgery because of complete tears of the rotator cuff and who were treated with primary repair or by the patch graft technique because primary repair was not feasible. The length and width of each tear, the thickness of the supraspinatus muscle at the superior margin of the glenoid, and the presence or absence of a high signal intensity in the infraspinatus muscle were statistically analyzed. Primary repair was often not feasible when both the length and width of the tear exceeded 40 mm on a preoperative magnetic resonance image, when the supraspinatus muscle was thin at the superior margin of the glenoid, and when a high signal intensity was observed in the infraspinatus muscle. (J Shoulder Elbow Surg 2003;12:222-5.)

Because primary repair of a rotator cuff tear is sometimes not feasible in the case of a massive tear, surgical treatment is sometimes necessary in the form of patch graft reconstruction or muscle transfer. It is very important to determine preoperatively the feasibility or infeasibility of primary repair, not only for the selection of an adequate operative procedure but also for giving a satisfactory explanation to the patient. We studied magnetic resonance (MR) images of rotator cuff tears to determine whether it was possible to establish preoperatively the feasibility or infeasibility of primary repair, and the results obtained are reported.

METHODS

The study comprised 27 shoulders in 26 patients who underwent magnetic resonance imaging (MRI) before surgery between 1996 and 2001 because of complete tears of the rotator cuff and who were treated with primary repair or by the patch graft technique because primary repair was not feasible. There were 17 shoulders in 17 men and 10 shoulders in 9 women, including 17 right shoulders, 8 left shoulders, and 1 bilateral case. The patients were aged 24 to 72 years with a mean of 57 years.

The subjects were divided into a group in which surgical treatment was performed by patch graft technique because of the infeasibility of primary repair (patched group) and a group in which primary repair could be performed (primary repair group). When the mobilized cuff could reach the greater tuberosity with the arm at the side, primary repair (via the McLaughlin procedure) was performed. A trough was created in the sulcus just lateral to the articular surface. When the mobilized cuff could not reach the greater tuberosity with the arm at the side, a patch graft was performed. Similarly, a trough was created in the sulcus just lateral to the articular surface, and the distal end of the graft was sutured to it.

The patched group contained 12 shoulders, including 8 in men and 4 in women and 8 right and 4 left shoulders. The patients in this group were aged 51 to 72 years with a mean of 61 years. The femoral fascia and the coracoacromial ligament were used to prepare patches for 10 and 2 shoulders, respectively.

The primary repair group contained 15 shoulders, including 9 in men and 6 in women and 10 right and 5 left shoulders. The patients ranged from 24 to 69 years of age with a mean of 54 years.

T2-weighted MR images were obtained preoperatively in the oblique coronal, sagittal oblique, and axial views with a Philips 0.5-T MR system (Gyroscan TS-NT, Best, Holland). The length of each tear (oblique coronal plane) (Figure 1), the width of the tear (sagittal oblique plane) (Figure 2), the thickness of the supraspinatus muscle at the superior margin of the glenoid (the oblique coronal plane of a slice passing the center of the glenoid) (Figure 3), and the presence or absence of a high signal intensity in the infraspinatus muscle (axial plane) (Figure 4) were statistically analyzed (by unpaired t test, Mann-Whitney U test, and χ2 test).

In addition, tissue was collected from the infraspinatus muscle during surgery. The obtained specimens, stained with hematoxylin-eosin, were examined under light micros-
copy to determine the relationship between histopathologic findings and signal intensity patterns on MR images.

RESULTS

The mean length of the tears was $42.0 \pm 10.5$ mm in the patched group and $22.0 \pm 8.6$ mm in the primary repair group, revealing significantly longer tears in the patched group ($P < .01$, unpaired $t$ test) (Figure 5). The mean width of the tears was $46.8 \pm 16.4$ mm in the patched group and $23.3 \pm 11.0$ mm in the primary repair group, revealing significantly wider tears in the patched group ($P < .01$, unpaired $t$ test) (Figure 6).

In the patched group, both the length and width of the tear were $40$ mm or more in 7 cases and less than $40$ mm in 5 cases. In the primary repair group, both the length and width of tears were $40$ mm or more in 1 case and less than $40$ mm in 14 cases. Thus, tears of $40$ mm or more in both length and width were characteristic of the patched group ($P < .01$, Fisher exact test).

The mean thickness of the supraspinatus muscle at the superior margin of the glenoid was $4.8 \pm 0.9$ mm in the patched group and $8.7 \pm 2.4$ mm in the primary repair group, revealing a significantly thinner muscle in the patched group ($P < .01$, Mann-Whitney $U$ test) (Figures 7 and 8).

A high signal intensity of the infraspinatus muscle was observed in 11 cases in the patched group, whereas such a high intensity was observed in only 1 case in the primary repair group and was not observed in the remaining 14 cases. The presence or absence of a high signal intensity of the infraspinatus muscle was significantly different between the two groups, and this signal change was characteristic of the patched group ($P < .01$, $\chi^2$ test) (Figure 9).

When the infraspinatus muscle showed a high signal intensity on MR images, it was examined histopathologically in 5 cases; tendon fibers were stained light red with hematoxylin-eosin, and the disappearance of the undulating structure of tendon fibers and the appearance of hyalinization were observed (Figure 10).

DISCUSSION

Many reports have described the use of MRI to determine the diagnosis of complete tears of the rotator cuff, and the sensitivity, specificity, and accuracy of this diagnostic modality have been reported to be over 90% in most cases. MRI can be used to...
determine the presence or absence of rotator cuff tears. However, because MRI of massive tears of the rotator cuff that cannot be treated with primary repair has been reported rarely, we often encounter difficulty in determining preoperatively the feasibility of primary repair in the treatment of such massive tears.

The results of our study revealed the likelihood of performing patch graft reconstruction because of infeasibility of primary repair if, on preoperative MRI, both the length and width of the tear exceed 40 mm, the supraspinatus muscle is thin at the superior margin of the glenoid, and a high signal intensity is observed in the infraspinatus muscle.

Changes in the supraspinatus muscle by massive tears of the rotator cuff on MR images have been sporadically reported. It has been reported that a high signal intensity, suggesting fatty degeneration, was observed in the supraspinatus muscle on T1-weighted images in cases in which primary repair was not feasible. On the other hand, it has been reported that the severity of the involution of anterior fibers of the supraspinatus muscle strongly affected the feasibility or infeasibility of primary repair, rather than fatty degeneration of the supraspinatus muscle. In our present study, it was revealed that primary repair was not feasible when the supraspinatus muscle was thin at the superior margin of the glenoid, frequently requiring patch graft reconstruction. This seemed to be explained by thinning of the supraspinatus muscle in the region where the supraspinatus muscle retracts proximally, bringing the torn end closer to the superior margin of the glenoid.
Changes in signal intensity of the infraspinatus muscle have been reported rarely. In our study, it was likely that primary repair was not feasible when a high signal intensity of the infraspinatus muscle was observed. With regard to the histopathologic features of the infraspinatus muscle in cases in which this muscle showed high signal intensity, tendon fibers were stained pale red, differing from the usual crimson, and the undulating structure of tendon fibers disappeared whereas hyalinization appeared. It has been reported that such histopathologic features as tendon fibers stained pale red and the disappearance of the undulating structure indicate degeneration. Thus, a high signal intensity of the infraspinatus seems to reflect hyalinization of the muscle.

REFERENCES
