Factors associated with clinical and structural outcomes after arthroscopic rotator cuff repair with a suture bridge technique in medium, large, and massive tears

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Background: This study was conducted to evaluate clinical outcomes, maintenance of repair integrity, and retear rate after arthroscopic rotator cuff repair by a suture bridge technique among patients with medium, large, and massive rotator cuff tears.

Methods: We evaluated 147 patients who had undergone arthroscopic rotator cuff repair. Clinical and functional evaluations were performed with the Constant and University of California–Los Angeles scores. All patients were confirmed to have magnetic resonance imaging evidence of tendon healing at least 12 months postoperatively.

Results: The average postoperative time to follow-up magnetic resonance imaging was 23.4 months (range, 12-48 months). A total of 25 (17.0%) retears were observed. All clinical outcome scores were improved significantly at follow-up. Larger intraoperative tear sizes were correlated with higher retear rates. The incidence of retear was also higher in cases in which the preoperative fatty degeneration grade was higher. The incidence of retear increased with age and in the heavy worker group (e.g., farmers, carriers, car mechanics) but was not statistically significant.

Conclusions: Arthroscopic rotator cuff repair by a suture bridge technique yields improvements in clinical outcome measures and a relatively high degree of patient satisfaction despite the fact that repair integrity is not maintained in many cases.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Rotator cuff tear; arthroscopic repair; suture bridge technique; fatty degeneration; tear size; retear
In arthroscopic repair of rotator cuff tears, patient-related factors are likely to exert a strong influence on rotator cuff healing. The factors that influence repair integrity include patient age, tear size, and quality of bone and tendon (retraction, muscle atrophy, and fatty infiltration). Furthermore, social history, especially occupation and smoking, may influence tear size, tendon quality, and repair integrity.

The primary goal of rotator cuff repair is to maximize tendon healing. The suture bridge technique was introduced to maximize the utility of the repair construct and to compress the repaired tendon to the bone. On the basis of biomechanical studies, the suture bridge repair technique resulted in better clinical and structural outcomes compared with other arthroscopic repair techniques.

The aim of this study was to evaluate clinical outcomes, maintenance of repair integrity, and recurrence rate after use of the suture bridge technique in patients with medium, large, and massive rotator cuff tears. Furthermore, we evaluated the retear patterns in cases with structural failure after arthroscopic suture bridge repair with follow-up magnetic resonance imaging (MRI). Finally, we compared the clinical and radiologic outcomes between heavy and light workers.

**Materials and methods**

**Patient selection**

Between May 2008 and September 2010, 258 patients with full-thickness rotator cuff tears underwent arthroscopic double-row rotator cuff repair at Jeju National University Hospital (Jeju, Korea). The inclusion criteria were patients who had a full-thickness rotator cuff tear confirmed by preoperative MRI with failed initial nonoperative treatment and who consequently underwent a complete arthroscopic rotator cuff repair by a suture bridge technique. Patients were excluded if they had labral tears, glenohumeral arthritis, or inflammatory diseases. Patients undergoing revision procedures were also excluded, as were 49 patients with small tears and 19 patients with massive irreparable tears. Patients with small tears were excluded because, in most cases, the functional outcome was acceptable and the possibility of retear was low, making these inappropriate for the objectives of this research. A total of 12 patients were clinically lost to follow-up. An additional 31 patients were excluded because of lack of follow-up MRI after surgery. Subsequently, a retrospective review was performed for the remaining 147 patients (77.4%).

The average patient age at the time of surgery was 62.8 years (range, 46-79 years). The average postoperative follow-up duration was 31.2 months (range, 12-48 months). The sample included 65 men and 82 women, with the repairs being performed on 103 right and 44 left shoulders. The cuff tear was in the dominant arm in 137 cases and in the nondominant arm in 10 cases. A single tendon (supraspinatus) was involved in 109 cases (74.1%), with multiple tendon involvement (supraspinatus, subscapularis, or infraspinatus) in 38 cases (25.9%). All rotator cuff repairs were performed by an arthroscopic suture bridge technique. Patients reported a history of trauma in 46 cases (31.3%).

The patients were divided into 2 occupational groups. The heavy worker group included patients whose occupation required handling and moving objects or physically demanding work (e.g., farmers, carriers, car mechanics). The light worker group included patients whose occupation required relatively lower physical demands (e.g., housewives, office workers).

**Tear evaluation**

During surgery, the rotator cuff tear was measured. We evaluated the repair integrity of cuff muscles with the classification proposed by Sugaya et al through follow-up MRI: type I, sufficient thickness with homogeneous low intensity; type II, sufficient thickness with partial high intensity; type III, insufficient thickness without discontinuity; type IV, presence of a minor discontinuity; type V, presence of a major discontinuity (Fig. 1). We defined types IV and V as retears. We assessed the retear patterns on the basis of the description used by Cho et al: type 1, no repaired cuff tissue remaining on insertion site; type 2, remnant cuff tissue remaining on the greater tuberosity.

We also evaluated individual fatty degeneration and global fatty degeneration (global fatty degeneration index) by the classification of Goutallier et al: grade 0, no fatty deposits; grade 1, some fatty streaks; grade 2, more muscle than fat; grade 3, as much muscle as fat; and grade 4, less muscle than fat. Fatty degeneration of the cuff muscles was evaluated in soft tissue windows on sagittal MRI sections. For each injured shoulder, we evaluated fatty degeneration for individual cuff muscles and for all cuff muscles combined by calculating the global fatty degeneration index as the mean value of the grades for the supraspinatus, infraspinatus, and subscapularis. Tear size and fatty degeneration were examined by preoperative MRI (Achieva 3.0T; Philips, Amsterdam, The Netherlands). The tear sizes were confirmed intraoperatively under arthroscopy with a probe. The size of the rotator cuff tear was based on the greatest dimension of tendon tear as follows: small, <1 cm; medium, 1 to 3 cm; large, 3 to 5 cm; or massive, >5 cm. Repair integrity was evaluated by follow-up MRI studies, which were performed an average of 23.4 months (range, 12-48 months) after the respective rotator cuff repair.

**Clinical evaluation**

Clinical evaluations were performed preoperatively and an average of 31.2 months (range, 24-48 months) postoperatively with the Constant score and the Shoulder Rating Scale of the University of California at Los Angeles (UCLA). The Constant score includes the following four categories: pain, 15 points; activities of daily living, 20 points; range of motion, 40 points; and power, 25 points.

**Surgical technique**

All surgical procedures were performed by the same surgeon. Each operation was performed under general anesthesia, in a semilateral position. Subacromial decompression was performed with a burr in all patients.

Diagnostic glenohumeral arthroscopy was performed, and accompanying intra-articular lesions were identified. After insertion of an arthroscope into the subacromial space, subacromial decompression was performed. Tear size, tendon quality, and presence of delamination were identified at the time of surgery.
For tendon mobilization, any retracted tendon was released from adhesion, and the footprint of the greater tuberosity was debrided. Medial row anchors (3.7 mm and 4.5 mm Bio-Corkscrew suture anchor; Arthrex, Naples, FL, USA) were inserted at the medial edge of the footprint. The selection of anchor size depended on the bone quality of the footprint and anchor stability. Either Scorpion (Arthrex, Naples, FL, USA) or suture hook (Linvatec, Largo, FL, USA) was used to pass the suture through the supraspinatus tendon, near the musculotendinous junction. The knots were tied on the medial row, and the tendon was reduced into the bone. Lateral row anchors (3.5 mm and 4.5 mm Bio-PushLock anchor and SwiveLock; Arthrex) were inserted 5 to 10 mm below the greater tuberosity, after preparing the bone sockets. The number of anchors depended on the tear size (Fig. 2).

**Postoperative rehabilitation**

An abduction brace was used for 4 to 6 weeks postoperatively. The rehabilitation regimen differed on the basis of the extent of the tear and tendon quality. Pendulum exercises began on the day after surgery. Patients with medium or large tears started rehabilitation on the third postoperative day, and patients with

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**Figure 1** (A) Preoperative coronal T2-weighted image showing a full-thickness tear. (B) Postoperative coronal T2-weighted image showing a completely healed state of a repaired rotator cuff (type I by Sugaya classification) at 24 months after surgery.

**Figure 2** (A) Arthroscopic view showing a medium-size full-thickness tear (2 × 2 cm) and (B) a repair configuration after arthroscopic rotator cuff repair by a suture bridge technique. (C) Arthroscopic view showing a large full-thickness tear (3 × 3 cm) and (D) a repair configuration after arthroscopic rotator cuff repair by a suture bridge technique.
massive tears began rehabilitation 1 week postoperatively. Initially, passive forward flexion exercises were performed with a continuous passive movement machine (ORMED GmbH, Freiburg, Germany). Active exercises were not allowed until 6 weeks postoperatively. The patients were educated in the use of the abduction brace for 6 weeks during ambulation except while doing the rehabilitation. For the ensuing 6 weeks, active motion of the shoulder was slightly increased.

Statistical analysis

All statistics were analyzed with the SPSS software package (version 18.0; SPSS Inc, Chicago, IL, USA). The paired t test was performed to assess functional scores between the preoperative and postoperative results. Pearson \( \chi^2 \) test was performed to assess the correlation between repair integrity and other factors. A \( P \) value \(< .05\) was considered to indicate statistical significance. Comparisons of factors that influence retear rate, such as relative risk and multiple logistic regression analysis, were performed.

Results

Arthroscopic findings demonstrated medium tears in 94 cases (63.9%), large tears in 38 cases (25.9%), and massive tears in 15 cases (10.2%). The mean UCLA score increased from a preoperative mean of 14.0 points (range, 5-24) to 30.4 points (range, 9-35) at last follow-up (\( P < .001\)). Furthermore, the Constant score improved from a preoperative mean of 53.3 points (range, 26-67) to 84.3 points (range, 46-98) at last follow-up (\( P < .001\)). The 18 patients (72%) who experienced retears were satisfied with their outcome on the basis of the UCLA score (Table I).

By the Sugaya classification to assess repair integrity with MRI, type I healing was observed in 33 cases (22.4%), type II in 76 cases (51.7%), type III in 13 cases (8.8%), type IV in 9 cases (6.1%), and type V in 16 cases (10.9%). The overall number of retears (types IV and V) was 25 cases (17.0%). The retear rate was 10.6% (10 of 94) in medium tears, 18.4% (7 of 38) in large tears, and 53.3% (8 of 15) in massive tears. A larger intraoperative tear size was associated with higher rate of retear (\( P < .001\)), which was statistically significant (Fig. 3). We also found 5 type I retears (20.0%) and 20 type II retears (80.0%).

Regarding preoperative fatty degeneration, there was no retear observed among the 29 grade 1 cases, with 7 retears (10.4%) among the 67 grade 2 cases. A retear was found in 18 (35.3%) of 51 grade 3 and grade 4 cases. Higher preoperative fatty degeneration grades were associated with increased incidence of retear (\( P < .001\)) (Fig. 4).

The patients were subdivided into 2 age groups for assessment of tendon healing. A retear was observed in 11 (13.6%) of 81 patients younger than 65 years. Among the

<table>
<thead>
<tr>
<th>Intraoperative tear size</th>
<th>UCLA score</th>
<th></th>
<th>Constant score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium (n = 94)</td>
<td>14.3 (5-27)</td>
<td>30.4 (15-35)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Large (n = 38)</td>
<td>13.8 (9-29)</td>
<td>31.4 (13-35)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Massive (n = 15)</td>
<td>12.2 (3-20)</td>
<td>28.8 (4-35)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Overall (n = 147)</td>
<td>14.0 (3-29)</td>
<td>30.4 (4-35)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

UCLA, University of California–Los Angeles.

Figure 3  Correlation between preoperative tear size and repair integrity.

1678 S. Choi et al.
66 patients older than 65 years, 14 (21.2%) experienced a retear. The incidence of retear tended to be higher for patients older than 65 years, but this difference was not statistically significant ($P = .229$).

Retear rates were also evaluated according to workload. A retear was observed in 14 (18.7%) of the 75 patients in the heavy worker group, whereas 11 (15.3%) patients had a retear in the light worker group. Although the heavy worker group experienced a higher rate of retear, this difference did not reach statistical significance ($P = .341$) (Table II). The heavy workers returned to work at an average of 3.2 months (range, 2-6 months), and their retear rate was 18.7% (14 cases). There were 2 factors that significantly influenced retear rate, as analyzed by multiple logistic regression analysis (Table III). We analyzed several factors for potential association with retear rates and found tear size and fatty degeneration grade to be associated with retear rate.

### Discussion

Arthroscopic rotator cuff repair is associated with significant improvements in shoulder pain, function, and motion. Advances have been made in arthroscopic rotator cuff repair, and many recent studies demonstrate good clinical results. In this study, we confirmed that retear rates are higher in cases of larger intraoperative tear size and higher preoperative fatty degeneration grade.

Our study, using a double-row construct, showed healing rates comparable to those reported by Harryman et al. and we would recommend its use for treating rotator cuff tears.

The integrity of rotator cuff repair correlates with clinical improvement. Therefore, it is important to maintain this integrity until complete healing is achieved. However, previous studies of the single-row repair technique have shown an anatomic failure rate ranging from 22% to 25%. The causes of retears are variable and included poor-quality tendon tissue, pullout of suture anchor, suture breakage, and inappropriate rehabilitation. Recent studies have shown structural healing after double-row rotator cuff repair to have biomechanical characteristics and reconstruction of the rotator cuff footprint superior to those of a single-row repair, with higher rates of intact tendon healing.

### Table II

<table>
<thead>
<tr>
<th>Retear rate increase by age and workload</th>
<th>Retear</th>
<th>$P$ value</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 65 years (n = 81)</td>
<td>11 (13.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age ≥ 65 years (n = 66)</td>
<td>14 (21.2%)</td>
<td>.229</td>
<td>1.713</td>
<td>0.720-4.079</td>
</tr>
<tr>
<td>Light worker (n = 72)</td>
<td>11 (15.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy worker (n = 75)</td>
<td>14 (18.7%)</td>
<td>.341</td>
<td>1.273</td>
<td>0.535-3.025</td>
</tr>
</tbody>
</table>

Odds ratio by age and extent of work.

### Table III

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>$P$ value</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant score</td>
<td>–6.236</td>
<td>.001</td>
<td>4.103</td>
</tr>
<tr>
<td>Intraoperative size</td>
<td>.653</td>
<td>.058</td>
<td>1.273</td>
</tr>
<tr>
<td>Global fatty degeneration index</td>
<td>1.412</td>
<td>.001</td>
<td>1.921</td>
</tr>
</tbody>
</table>

Factors associated after rotator cuff repair
Preoperative fatty degeneration is known to be an important factor affecting the integrity of a repaired rotator cuff. According to Goutallier et al, severe fatty degeneration was correlated with unsatisfactory surgical outcomes and a high retear rate.\textsuperscript{14} Similarly, retear rates and preoperative fatty degeneration were also significantly correlated in our study. Furthermore, a retear was found in 18 (35.3\%) of the 51 cases of grade 3 and grade 4 fatty degeneration.

Boileau et al\textsuperscript{2} found that patients older than 65 years had only a 43\% chance of tendon healing and suggested that age is a negative factor associated with poor healing. However, Charousset et al\textsuperscript{7} have suggested that age itself is not associated with poor repair rates. Our results show that an older age ($P = .229$) is not significantly correlated with a poor healing rate.

In our study, a large proportion of the patients had either a large or massive tear resulting in an overall retear rate of 17.0\% (25 cases). Among the 38 large tear cases, there were 7 (18.4\%) retears; among the 15 massive tear cases, 8 (53.3\%) experienced a retear. Cho et al\textsuperscript{9} reported a retear rate of 33.3\% with the suture bridge technique; the proportion of patients with large to massive tears in that study was 43.1\%.

Recently, Cho et al\textsuperscript{9} found a frequent retear pattern of “medial cuff failure” in patients who had undergone arthroscopic repair with the suture bridge technique. This may be associated with the possibility of strangulation and relatively quick necrosis of the repaired tendon at the medial row. Similarly, we also found that 20 cases (80\%) of the 25 retears occurred at the musculotendinous junction.

In the 25 retear cases, we found that the Constant score improved from 55.4 to 79.5 and that the UCLA score improved from 13.1 to 28.3, both of which were statistically significant. In terms of the UCLA score, 18 patients (72\%) were satisfied with the outcome of surgery. All patients were asked to avoid the overuse of their shoulders in their daily life measures at an average follow-up of 1 year. The majority of retears were at the musculotendinous junction, and the retear rate was statistically correlated with preoperative fatty degeneration and tear size only. Interestingly, most of the patients who experienced retears were satisfied with the results of surgery, even though repair integrity was not maintained. This suggests that structural healing and clinical outcome do not always correlate.

**Conclusions**

Rotator cuff repair by an arthroscopic suture bridge technique resulted in improvement in clinical outcome measures at an average follow-up of 1 year. The majority of retears were at the musculotendinous junction, and the retear rate was statistically correlated with preoperative fatty degeneration and tear size only. Interestingly, most of the patients who experienced retears were satisfied with the results of surgery, even though repair integrity was not maintained. This suggests that structural healing and clinical outcome do not always correlate.

**Disclaimer**

The authors, their immediate families, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

**References**