Clinical and structural results of arthroscopic repair of bursal-side partial-thickness rotator cuff tears

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**Background:** There have been few studies using magnetic resonance imaging (MRI) to evaluate the clinical outcomes and structural results after arthroscopic repair of bursal-side partial-thickness rotator cuff tears (PTRCTs).

**Methods:** From 2009 to 2012, 73 consecutive patients with bursal-side PTRCTs underwent arthroscopic repair. Fifty-nine of them were retrospectively evaluated as Ellman classification grade 2 (group A, n = 11) or grade 3 (group B, n = 48). All repairs were performed with a technique that preserved the intact articular fibers and repaired the avulsed bursal flap. The University of California–Los Angeles (UCLA) score and Constant score were assessed before the operation and at the final follow-up. Postoperative cuff integrity was determined with MRI following Sugaya’s classification.

**Results:** At the 2-year follow-up, the average UCLA score increased from 17.3 ± 3.7 to 33.3 ± 2.2, and the Constant score increased from 65.3 ± 12.9 to 93.9 ± 5.1 (P < .001). Forty-nine patients received follow-up MRI examinations at an average of 10.3 months after surgery. Of these 49 patients, 41 patients (83.7%) had a healed tendon and 8 patients had partial tears. Neither the clinical scores nor the retear rates on follow-up MRI were significantly different between the 2 groups.

**Conclusions:** Arthroscopic repair of bursal-side PTRCTs achieved good functional and structural outcomes at a minimum of 2 years after surgery.

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

**Keywords:** Shoulder; rotator cuff; partial-thickness tear; bursal-side tear; arthroscopic repair; preservation of intact tissue

Partial-thickness rotator cuff tears (PTRCTs) are a common source of shoulder pain and dysfunction and can be classified as bursal-side, articular-side, or intratendinous tears. Compared with articular-side tears, fewer studies examining functional and structural outcomes of bursal-side tears have been reported.

There is no real consensus in the literature on the threshold of tendon injuries that require repair or on the best treatment approach for bursal-side PTRCTs. Several different surgical approaches have been reported, including tear completion followed by repair and repair while preserving the normal articular-side tendon.

The purpose of this study was to evaluate the functional outcomes and structural results after arthroscopic repair of...
bursal-side PTRCTs while preserving the normal articular-side tendon and suturing the bursal flap.

Materials and methods

Patient selection

For this retrospective case study, 84 consecutive patients (84 shoulders) with bursal-side PTRCTs underwent arthroscopic treatment between August 2009 and February 2012. The inclusion criteria were (1) symptoms lasting more than 3 months with proper conservative treatment, (2) tears of >25% of the tendon thickness (or 3 mm) confirmed during surgery, and (3) no major associated disease that needed to be addressed at the time of arthroscopic surgery, such as frozen shoulder or Bankart lesion. Six patients with tear <3 mm, who underwent arthroscopic débridement, as well as 5 patients with frozen shoulder were excluded from this study. Of the 73 patients who met the inclusion criteria, 1 patient died of an unrelated disease and 13 patients did not participate in follow-up for 2 years. Consequently, 59 patients were included in this study. There were 30 men and 29 women. The mean age at the time of surgery was 48.9 years (range, 27-81 years); 43 patients (73%) had repair of the dominant shoulder.

Preoperative clinical features

All patients had shoulder pain, and 26 patients had a history of acute trauma to the shoulder. The duration of pain ranged from 3 months to 15 years with an average of 24.9 months, and 25 patients experienced consistent pain including night pain, 22 patients complained of pain during light activities, 10 patients felt pain during strenuous exercises, and 2 patients felt light pain or discomfort occasionally. All patients had positive Neer or Hawkins impingement signs. The active range of motion was 149° (range, 60°-180°) in flexion, 141° (range, 40°-180°) in abduction, and 41° (range, 10°-50°) in external rotation; the active internal rotation was L5 (range, T10 to the gluteus).

Preoperative imaging

All of the patients received preoperative bilateral radiographs of the anteroposterior and supraspinatus outlet views and magnetic resonance imaging (MRI) scans. The acromial morphology was divided into 3 categories according to the Bigliani classification. The preoperative diagnoses were based mainly on the oblique coronal T2-weighted fat-suppressed MRI scans. The diagnostic signs included a defect on the bursal side of the cuff and fluid signal intensity within the tendon that connected to the bursal surface of the tendon.

Surgical technique

All of the procedures were performed with the patient under general anesthesia in the beach chair position. Diagnostic arthroscopy was performed, and a variety of intra-articular pathologic processes, such as superior labrum anterior-posterior (SLAP) lesions, partial rupture of the long head of the biceps tendon, and partial tears of the subscapularis tendon, were treated appropriately. The arthroscope was then redirected into the subacromial space, and the hypertrophic bursal tissue was removed. Formal acromioplasty was performed on all of the patients.

After confirmation of the tear, the degenerative tissue of the tendon was removed until normal articular-side tendon fibers inserting into the greater tuberosity could be identified (Fig. 1). The thickness of the tear was measured with a calibrated probe. The classification of Ellman based on the depth of the tear (grade 1, <3 mm; grade 2, 3-6 mm; and grade 3, >6 mm) was used. The greater tuberosity was prepared by removal of a thin layer of cortical bone with a power burr to promote healing of the reattached cuff. Only the detached layer was reattached to the greater tuberosity. Thirty patients received a single-row repair (Fig. 2), whereas 29 patients were treated by the suture bridge technique (Fig. 3).

Rehabilitation

Postoperatively, the arm was maintained in a sling at 15° of abduction and neutral rotation for 6 weeks. Gentle pendulum exercises and passive external rotation were started on the first postoperative day. An ice bag was used to reduce swelling and pain. Passive range of motion exercises were initiated with minor loads across the repair for weeks 1 to 6. After 6 weeks, active range of motion exercises that applied progressive loading to the repair construct were allowed. Strengthening exercises that focused on restoring power and endurance to the healing rotator cuff muscles were started after 3 months and continued until 4 to 6 months postoperatively. Six months after surgery, patients were allowed to gradually return to their full sports activities.

Clinical evaluation

The University of California–Los Angeles (UCLA) and Constant-Murley scoring systems were adopted before the operation and at the final evaluation.

MRI evaluation

Forty-nine patients received postoperative MRI scans, which were performed at a mean of 10.3 months after surgery (6-42 months),
and 10 patients refused MRI examinations. Tendon healing was classified into 5 types according to Sugaya’s criteria as type I, sufficient thickness compared to normal cuff with homogeneously low intensity on each image; type II, sufficient thickness compared to normal cuff with partial high-intensity area; type III, insufficient thickness with less than half the normal thickness without discontinuity, suggesting a partial-thickness delaminated tear; type IV, presence of a minor discontinuity in only 1 or 2 slices on both the oblique coronal and sagittal images, suggesting a small full-thickness tear; and type V, presence of a major discontinuity observed in more than 2 slices on both the oblique coronal and sagittal images, suggesting a medium or large full-thickness tear.

**Statistical analysis**

Preoperative and postoperative clinical scores were compared by paired \( t \) test. Postoperative clinical scores between group A and group B were compared by independent \( t \) test. Postoperative MRI results between the 2 groups were compared by \( \chi^2 \) test. \( P < .05 \) was considered to be statistically significant.

**Results**

**Preoperative imaging**

Preoperative plain radiographs showed type II acromion in 48 patients and type III acromion in 11 patients.

Of the 59 oblique coronal T2-weighted fat-suppressed magnetic resonance images, 50 patients showed defect on the bursal side of the cuff, supporting the diagnoses of bursal-side tears (Fig. 4). Three patients showed small tendon defects, 1 showed high signal on the articular surface of the tendon, 3 showed high signal intensities within the insertion of the supraspinatus tendon, and 2 showed nearly normal tendons. These results were interpreted as 3 full-thickness tears, 1 articular-side partial tear, 3 intratendinous tears, and 2 normal tendons.

**Intraoperative findings**

Bursal-side tears were confirmed during the operation in all of the patients. According to Ellman’s classification, group A included 11 patients and group B included 48 patients. The coracoacromial ligament surface was fibrillated or rough in all of the patients, indicating the existence of subacromial impingement.

Several intra-articular lesions were defined and treated, including 5 repairs of type II SLAP lesions, 4 débridement procedures of type I SLAP lesions, 1 tenodesis and 2 débridement procedures of partial ruptures of the long head of the biceps tendon, 5 débridement procedures of partial tears of the subscapularis tendon, and 3 débridement procedures of anterior labrum lesions.
Clinical outcomes

The mean follow-up was 37.6 months (range, 24-54 months). At the final follow-up, 38 patients had no pain, 19 patients felt light pain or discomfort occasionally, and 2 patients felt pain during strenuous exercises. The active range of motion was 179° (range, 160°-180°) in flexion, 170° (range, 160°-180°) in abduction, and 44° (range, 40°-50°) in external rotation; the active internal rotation was T12 (range, T7 to L3).

Both scoring systems indicated significant improvement in the status of the shoulder when the preoperative scores were compared with those at the final follow-up (Table I). The mean UCLA score improved significantly from 17.3 ± 3.7 to 33.3 ± 2.2 (P < .001). The Constant score increased significantly from 65.3 ± 12.9 to 93.9 ± 5.1 (P < .001). No significant difference in either postoperative score was found between the two groups (UCLA, P = .792; Constant, P = .977) (Table II).

MRI analysis

Postoperative MRI revealed 6 type I (12.2%; Fig. 5, A), 35 type II (71.4%; Fig. 5, B), and 8 type III (16.3%; Fig. 5, C). In this study, we did not find any type IV or type V retears. Overall, there were 41 intact repaired cuff tendons (Sugaya type I or II) and 8 partial tears (Sugaya type III). In group A, 9 patients (82%) received the follow-up MRI, and 1 of them (11%) had a retear. In group B, 40 patients (83%) underwent the follow-up MRI, and 7 of them (18%) had a retear. There was no significant difference in the retear rate between the two groups (P = .639).

Discussion

To the best of our knowledge, this is the largest study yet reported on the clinical and anatomic results of bursal-side PTRCTs after arthroscopic repair. The data presented here demonstrated that the combination of subacromial decompression and repair while preserving as much of the intact articular-side tendon fiber as possible yields satisfactory clinical outcomes. Postoperative MRI also demonstrated a high healing rate of repaired tendons in our cohort of patients.

Although the pathogenesis of bursal-side tears can involve both intrinsic and extrinsic causes, there may be a greater association with extrinsic factors, such as impingement with an acromial spur.7,15,21 Fukuda7 suggested that subacromial impingement may be the main cause of bursal-side tears. Ozaki et al15 reported in a cadaver study that pathologic and structural changes on the acromion undersurface were associated with bursal-side tears. Ogawa et al13 indicated that the incidence of spurs was highest in bursal-side tears. Kim et al11 found in a comparative study that a protruded spur as well as signs of attrition on the acromion undersurface was significantly related to bursal-side tears. In the present study, all patients presented with impingement signs and subacromial bursitis and had type II or III acromion, which suggests that subacromial impingement may be the important cause of bursal-side tears. Our experience supports cuff repair with acromioplasty for bursal-side tears.

There is no consensus in the literature on the best treatment method for bursal-side PTRCTs, although the classification system devised by Ellman is used by most authors and remains helpful for intraoperative decision making.3,4,8-12,14,16,20-22 Although the current theory is to débride tears that are <50% of the tendon thickness (Ellman grade 2 or less) and to repair higher grade tears (Ellman grade 3), the data to support any particular management approach are variable and limited. For Ellman grade 3 tears, 2 biomechanical studies17,22 found that the strain in the remaining intact articular-side tendon was significantly increased. As a result, partial tears will likely propagate deeper and become full-thickness tears.17 Débrèdement and acromioplasty alone cannot promote the healing of the tear, and pain will continue after débrèdement and subacromial decompression.3,20 In his study, Weber20 concluded that grade 3 tears should be repaired.
On the contrary, debate continues on the best management of grade 2 tears. Some authors\textsuperscript{16,18} have reported that pain relief and functional recovery were excellent or good after débridement and subacromial decompression. In other reports with longer follow-up, however, patients with grade 2 tears had a much higher rate of unsatisfactory outcomes than did patients with articular-side tears.\textsuperscript{3,9} In a study by Kartus et al.,\textsuperscript{9} 35% of the patients had developed a full-thickness tear despite having undergone an acromioplasty a minimum of 5 years earlier. Cordasco et al.\textsuperscript{3} reported that patients with bursal-side tears fared poorly after acromioplasty without repair after a follow-up period of 53 months. On the basis of these data, several authors\textsuperscript{9,21} advocated that grade 2 bursal-side tears should be repaired and began to do just that. In the present study, we have lowered the threshold for repair, treating all tears that are >25% of the tendon thickness. The clinical scores for the 2 groups increased significantly.

Currently, controversy remains on the suturing method for bursal-side tears. Some authors\textsuperscript{4,8,10} proposed that such lesions should be completed to full-thickness tears and then repaired. They reported good clinical results and a high rate of tendon healing. However, this method leads to additional damage on the remaining normal articular-side tissue. In addition, removal of the remaining intact tissue can alter the normal footprint of the rotator cuff and possibly cause mismatch between the tension and length of the repaired rotator cuff. Other authors\textsuperscript{11-12,14,21} have suggested that the normal articular-side tissue should be preserved because it can protect the repaired bursal-side tendon and offer a good opportunity for healing of the repaired tendon.

Two different techniques for preserving the intact articular-side rotator cuff fibers during treatment of bursal-side PTRCTs have been reported. Certain authors\textsuperscript{12,21} reported performing full-layer repair, whereas others\textsuperscript{11,14} preferred to repair the avulsed outer layer only. Kim et al.\textsuperscript{11} described satisfactory functional outcomes and structural integrity (89% healing rate) by magnetic resonance arthrography examination after a simple repair of the detached lateral cuff tissue. Oh et al.\textsuperscript{14} also reported good clinical results and structural outcomes (89.5% healing rate) on computed tomography arthrography or ultrasound examination after in situ repair or conversion to full-thickness tears. In the present study, we considered that a full-layer repair would possibly lateralize the normal articular-side tendon and increase the tension on the repaired rotator cuff. We also believed that repairing the outer torn bursal layer would accurately restore the intact footprint of the rotator cuff. Therefore, during the surgery, we preserved as much of the healthy articular-sided tendon as possible and repaired the avulsed bursal flap into the footprint. The good clinical results obtained show that our technique was effective for these bursal-side tears.

Postoperative MRI was valuable in this study for showing tendon integrity and state of healing. Although 8 of the 49 shoulders were classified as retears, 83% of the repaired tendons were intact according to the Sugaya classification. As far as we know, there have been only 5 articles\textsuperscript{8,10,12,14} that reported the structural outcomes after arthroscopic repair of bursal-side PTRCTs. Using various postoperative techniques, they reported a satisfactory...
healing rate ranging from 77.8% to 90.5%. Our rate for tendon healing of 83.7%, which was not different between the 2 groups, is consistent with these studies. To promote the tendon healing, as much of the unhealthy tissues on the edge of the tear must be debrided as possible, and the remaining tendon tissue on the greater tuberosity must be completely removed. The bone trough should be decorticated to create a bleeding bed for the repaired tendon.

This study had several limitations that should be discussed. First, the retrospective instead of comparative nature of the study and relatively short follow-up times prevented us from obtaining a clear understanding of the requirements for treatment of bursal-side PTRCTs. Second, several concomitant procedures, such as acromioplasty, tenodesis, and SLAP repairs, were performed along with the rotator cuff repairs, which may have influenced the clinical results. Third, postoperative MRI scans were taken at various times between 6 months and 3 years after the surgery instead of being taken at a specific time point. Thus, the structural integrity reported here may not match the clinical outcomes at the final follow-up.

Conclusions

In this study, 59 patients with bursal-side PTRCTs were assessed at least 2 years after arthroscopic repair. The average UCLA and Constant scores increased to 33.3 ± 2.2 and 93.9 ± 5.1, respectively. Postoperative MRI revealed that 41 patients (83%) had intact repaired cuff tendons and 8 patients had partial tears. Both the postoperative clinical scores and retear rates were similar between the Ellman grade 2 and grade 3 groups. The arthroscopic repair of bursal-side PTRCTs while preserving the normal articular-side tendon and suturing the bursal flap could achieve improved functional and structural outcomes at a minimum of 2 years after surgery.

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