Surgical Results in Rotator Cuff Tears with Shoulder Stiffness


Background/Purpose: Little has been mentioned about the treatment of rotator cuff tears and associated shoulder stiffness. We prospectively treated a series of patients with rotator cuff tears associated with shoulder stiffness concomitantly and reported the outcomes.

Methods: A combined procedure of manipulation, lysis of adhesions, anterior acromioplasty and repair of rotator cuff was performed on 43 patients (47 shoulders) who were available for follow-up for a minimum of 2 years. Ten patients (11 shoulders) had diabetes mellitus and 33 patients (36 shoulders) were non-diabetic. Partial tear of the rotator cuff was noted in 27 shoulders, complete tears in 15 shoulders and massive tears in five shoulders. A functional score of Constant and Murley was used to evaluate the overall outcomes, the results between patients with and without diabetes mellitus and the results among different types of rotator cuff tears.

Results: At a mean (±SD) of 48.61 ± 18.0 months (range, 24–85 months) after the operation, each patient showed a significant improvement in subjective score, objective score and strength score as well as in the total score of Constant and Murley. There was no statistical difference in postoperative total Constant scores between patients with and without diabetes mellitus (p = 0.123). Comparison of the scores among the three types of rotator cuff tears revealed that all had a significant improvement in the total scores of Constant and Murley (44.6 ± 7.7 vs. 91.7 ± 4.9, p < 0.001 for a partial cuff tear; 42.9 ± 11.3 vs. 86.0 ± 9.6, p = 0.001 for a complete tear; and 44.2 ± 4.8 vs. 82.0 ± 12.1, p = 0.043 for a large tear), but patients with partial tears of the rotator cuff had significantly better total scores than did those with complete tears (92.6 ± 4.8 vs. 82.0 ± 12.1, p = 0.018) or large tears (92.6 ± 4.8 vs. 86.1 ± 9.7, p = 0.041).

Conclusion: A combined procedure of manipulation, lysis of adhesions, acromioplasty and repair of rotator cuff is a satisfactory procedure for patients with rotator cuff tears and associated shoulder stiffness.


Key Words: acromioplasty, rotator cuff repair, rotator cuff tear, shoulder stiffness

The surgical results of rotator cuff tears have been satisfactory either by open method or through arthroscopy.1–6 However, there are few reports regarding the management of shoulder stiffness.7–9 If the patient has a rotator cuff tear and secondary shoulder stiffness, some authors7,9 suggest that the shoulder stiffness should be managed initially because a rotator cuff repair is a "shoulder-tightening" procedure and may increase stiffness postoperatively. However, patients usually need to wait a significant length of time for improvement in shoulder motion before the rotator cuff tears
can be repaired. In addition, the symptoms of shoulder stiffness may not be relieved, especially in the presence of rotator cuff lesions. It thus becomes a challenging task when the orthopedic doctors face patients who have rotator cuff tears and shoulder stiffness. Tauro\textsuperscript{9} first reported surgical results of arthroscopic cuff repair without release for rotator cuff tears and stiffness. He found that patients with severe shoulder stiffness might not do well with cuff repair alone and recommended combined cuff repair and capsular release for these patients. Based on previous satisfactory results on similar patients,\textsuperscript{10} we prospectively treated a series of patients with rotator cuff tears and shoulder stiffness concomitantly and report the surgical results here.

**Materials and Methods**

Four hundred and twenty-four shoulders were operated on consecutively for rotator cuff tears during a period of 5 years and 7 months. Among them, associated shoulder stiffness was noted in 48 patients (52 shoulders) who received treatment for rotator cuff tears and associated shoulder stiffness concomitantly. This treatment protocol was based on our previous satisfactory results on similar patients.\textsuperscript{10} Forty-three patients (47 shoulders) were available for follow-up for a minimum of 2 years and were included in this study. Institutional review board approval and informed consent of all patients to participate in the study were obtained. Patients who had previous operations or had traumatic fracture on the involved shoulder were excluded from the study.

Preoperative data involving chief complaints, duration of symptoms, trauma history, sports activity, profession and other past medical diseases, especially diabetes mellitus, were collected. Initial treatment was nonoperative, including non-steroidal anti-inflammatory drugs, avoidance of causative activity and rehabilitation. Patients who had functional improvement after nonoperative management continued to receive conservative treatment. All patients had a positive impingement sign and some patients with partial tear had temporary improvement of the symptoms after injection of steroid and xylocain into the subacromial bursa (positive impingement test) at least 3 months before surgery. Magnetic resonance imaging (MRI) or glenohumeral arthrography were performed in addition to routine AP and outlet radiographs if the symptoms of impingement persisted for more than 3 months. All enrolled patients had progressive restricted range of motion despite rehabilitation. The surgical indications included radiographic or MRI findings suggestive of a partial or complete tear and shoulder stiffness of more than 3 months despite a supervised physical therapy program. The criteria for shoulder stiffness were active and passive limitation of motion of equal to or more than half the normal range for at least 3 months. The ranges of motion were flexion $\leq 90^\circ$, abduction $\leq 90^\circ$, external rotation $\leq 25^\circ$ and internal rotation $\leq$ sacral level. The mean duration of shoulder stiffness was $6.00 \pm 2.55$ months (range, 3–14 months). The range of motion including flexion, abduction, external rotation, internal rotation and the function score of Constant and Murley\textsuperscript{12} were recorded just before the operation and at follow-ups.

**Surgical procedure**

The surgical procedure included gentle manipulation under anesthesia, anterior acromioplasty, lysis of adhesions and partial bursectomy, followed by rotator cuff repair.

Under general anesthesia, the patients are placed in a beach chair position. The involved shoulder is sterilized and draped to allow free access to the arm. Gentle manipulation is performed first so that motion of the shoulder (flexion, abduction, external rotation and internal rotation) can be regained as much as possible. A constant controlled force is applied to the proximal humerus while holding the scapula stable. Sudden force causes greater risk to normal structures and should be avoided. Abduction force is applied first, followed by flexion, external rotation and internal rotation. A crepitant disruptive release of the articular capsule to some extent is
noted. The manipulation is stopped if the crepitant release does not ensue under constantly applied force. Arthroscopic release is performed to treat postoperative or post-fracture shoulder stiffness but not in this series. We have found that the release of the contractive rotator interval, coracohumeral ligament and the adhesions between rotator cuff and deltoid (extra-articular pericuff adhesions) and the repair of the rotator cuff are easily performed through the open method.

During open acromioplasty, a saber-shaped incision is made along the Langer line, extending from a point just lateral to the acromioclavicular joint to a point one finger breadth lateral to the coracoid. The deltoid muscle is split beginning at the lateral side of the acromioclavicular joint (but medial to the lateral acromion) and extending distally 2 cm. We find that this approach affords limited dissection of the soft tissue and gives good surgical results. A flap of deltoid muscle about 1.5 cm long is dissected off the anterior aspect of the acromion to expose the coracoacromial ligament. Incisions are made along the medial and lateral sides of the coracoacromial ligament at its acromial insertion. With traction of the arm, a flat elevator is placed under the acromion and a thin osteotome is used to remove only that amount of acromion that protrudes anterior to the clavicle. One centimeter of the coracromial ligament is excised. The pathologic features of the rotator cuff are observed and recorded. The diagnosis of bursal side cuff tears and complete rotator cuff tears is made after opening the subacromial bursa. The existence of articular side cuff tears is suspected from the MRI findings and the puckering of the tendon on elevation of the involved arm intraoperatively. A cleft is then made on the critical portion of the supraspinatus tendon. The articular side of the rotator cuff is inspected directly through the cleft to confirm the diagnosis of an articular side tear.

Next, extensive surgical lysis of the adhesive tissue is performed. This includes resection of the contractive coracohumeral ligament, partial bursectomy, and lysis of the rotator interval and the extra-articular peritrotator cuff adhesions. During lysis of the pericuff adhesions, adhesions between the acromion and the superior aspect of the rotator cuff are released first. Any bursal tissue between the acromion and the superior aspect of the cuff should be excised to leave the subacromial space free of the humeral head and rotator cuff muscles. In order to free up the anterior adhesions between the deltoid and the subscapularis, finger lysis or blunt dissection of the adhesion is performed down to the axillary pouch. The interval between the subscapularis and the conjoined tendon and coracoid is also dissected. Then the lysis and dissection are proceeded laterally and posteriorly between the planes of the lateral and posterior aspects of the deltoid and the lateral and posterior aspects of the rotator cuff. Myofibroblasts are noted in the adhesive bursal tissue and may contribute to the development of shoulder stiffness.

The intra-articular distension and irrigation of the glenohumeral joint is performed through the cleft on the rotator cuff interval or through the ruptured tendon. At this time, the joint capsule–rotator cuff complex becomes quite elastic and loose. The rotator cuff is mobilized and repaired with number-2 braided nonabsorbable polyester sutures and a tendon-to-bone suturing technique (Figure 1). Revo screws are used if the tendon cannot be sutured directly through the bone. For the massive irreparable tears, a partial thickness flap of the anterolateral side of the deltoid is created. The deltoid flap is sutured to the trimmed edges of the rotator cuff tear. The detached deltoid is sutured back on the acromion and the skin wound is closed. A triangular bandage is applied for immobilization.

**Aftercare**

Postoperative analgesia included patient-controlled analgesia, intramuscular methedrine injection and non-steroidal anti-inflammatory drugs. Postoperative rehabilitation should be aggressive and include pendulous exercise and passive elevation from the second postoperative day. The patients progress with active-assisted exercises including elevation, external rotation and internal rotation from 3 to 4 days postoperatively. The patient is
then discharged. Active exercise is started when the patient can tolerate it, usually 7–10 days after surgery. For patients with massive tear of the rotator cuff, the shoulder is immobilized in a Velpeau bandage for 3 days. Pendulous exercise and passive elevation are started 3–4 days postoperatively, followed by active-assisted exercises 10 days later. Because the postoperative pain of patients with shoulder stiffness is usually more severe than that of patients without it, encouragement is necessary especially during the first 2–3 weeks after surgery.

Regular follow-up checks were made every 2 weeks for the first 2 months; at monthly intervals for half a year; every 3 months for the first year; and then annually after surgery. The follow-ups included more of rehabilitation training, emotional support during recovery, oral analgesics and muscle relaxant, and functional score of Constant and Murley. The Constant scoring system includes four parameters: pain—none to severe (15 points); activities of daily living—work, recreation and sleep (10 points); level of use of hand—waist to about head (10 points); range of motion (40 points); and power (25 points). The Constant scores were further divided into a subjective score for pain, daily activity and level of use of hand (35 points), an objective score (40 points), a strength score (25 points) and total score in this series. The pre- and postoperative data were analyzed with Wilcoxon signed rank tests. A data comparison of patients with and without diabetes mellitus and the results of different types of rotator cuff tears were analyzed with the Mann–Whitney U test.

Results

The patients’ data and clinical results are shown in Table 1. There were 30 females (33 shoulders) and 13 males (14 shoulders). The right shoulder was involved in 21, and the left shoulder in 26. The mean (±SD) age at surgery was 54 ± 9 years and the mean (±SD) duration of follow-up was 48.6 ± 18.0 months. The mean duration of shoulder stiffness before surgery was 6.0 ± 2.6 months (range, 3–14 months). Articular side cuff tears were noted in 13 patients (13 shoulders), bursal side cuff tears in 11 patients (13 shoulders), both articular side and bursal side cuff tears in one patient (one shoulder), complete tears involving supraspinatus tendon in 14 patients (15 shoulders), and massive tears involving more than two tendons or larger than 5 cm in five patients (five shoulders). The subjective scores of Constant and Murley improved from 11.7 ± 3.9 preoperatively to 29.5 ± 4.3 points postoperatively (p < 0.001). The objective scores improved from 14.6 ± 4.2 to 36.3 ± 3.0 points (p < 0.001); the strength score improved from 18.9 ± 2.3 to 23.6 ± 2.5 points (p < 0.001); flexion improved from 78.3 ± 12.6° to 165.9 ± 14.0° (p < 0.001); abduction improved from 67.7 ± 15.1° to 158.2 ± 15.5° (p < 0.001);
and external rotation improved from 7.3° ± 9.0° to 34.3° ± 11.6° (p < 0.001). Internal rotation improved a mean of 6.8 ± 2.8 spinous-process levels (range, 0–12 levels). In total, 19 patients (20 shoulders) regained flexion of more than 160° within half a year postoperatively. The total scores of Constant and Murley improved from 45.1 ± 8.8 to 89.4 ± 8.4 points (p < 0.001).

Diabetes mellitus was noted in 10 patients (11 shoulders). There was no statistical difference in postoperative total Constant scores between patients with and without diabetes mellitus (93.00 ± 5.31 points vs. 88.33 ± 8.86 points; p = 0.123). When these two groups of patients were compared, patient age was greater in the diabetic group (59 ± 6 years vs. 52 ± 9 years; p = 0.015). The diabetic patients had higher postoperative subjective scores (p = 0.014), preoperative external rotation (p = 0.083) and preoperative total scores (p = 0.048). Two patients had insulin-dependent diabetes. One received an arthroscopic capsular release half a year after the index surgery due to poor improvement in the function and motion of the shoulder. The latest total Constant scores were 91 and 87 points for these two patients, respectively.

The patients’ data with different types of rotator cuff tears are shown in Table 2. Partial tear of the rotator cuff was noted in 27 shoulders, complete tears in 15 shoulders, and massive tears in five shoulders. A comparison of the scores among the three types of rotator cuff tears revealed that all had a significant improvement in the total scores of Constant and Murley (p < 0.001 for a partial cuff tear, p = 0.001 for a complete tear, p = 0.043 for a massive tear), but patients with partial tears of the rotator cuff had significantly better total scores than did those with complete tears (p = 0.018) or massive tears (p = 0.041). However, there was no difference in total scores between patients with complete cuff tears and massive cuff tears (p = 0.401). When parameters in patients with partial tears and complete tears were compared, better scores were noted in patients with partial cuff tears in the postoperative subjective score (p = 0.047) and the preoperative and postoperative strength score (p = 0.026 and p = 0.011, respectively). There was also a significant difference in age between patients with complete tears and massive tears (p < 0.001). There were no differences in the degree of preoperative or postoperative flexion, abduction or external rotation among patients with different types of rotator cuff tear. No deterioration in functional score was noted except in one patient during the follow-ups. This patient

| Table 1. Surgical results in different types of rotator cuff tears (based on Wilcoxon signed rank tests) |
|-----------------------------------------------|-------|-------|-------|-------|
| Partial tear (n = 27)                        | Complete tear (n = 15) | Massive tear (n = 5) |
| Mean ± SD | p    | Mean ± SD | p    | Mean ± SD | p    |
| Flexion (°) Pre-op | 78.5 ± 12.2 | 75.7 ± 14.5 | 85.0 ± 6.1 | 0.043 |
| F/U | 169.1 ± 10.8 | 164.0 ± 12.7 | 154.0 ± 25.8 |
| Abduction (°) Pre-op | 65.9 ± 15.5 | 67.3 ± 15.8 | 78.0 ± 5.7 | 0.043 |
| F/U | 162.2 ± 12.6 | 155.7 ± 13.3 | 144.0 ± 27.0 |
| ER (°) Pre-op | 8.3 ± 8.5 | 5.3 ± 9.9 | 7.0 ± 5.7 | 0.039 |
| F/U | 36.3 ± 10.3 | 30.7 ± 14.3 | 33.0 ± 9.1 |
| Constant score Pre-op | 44.6 ± 7.7 | 42.9 ± 11.3 | 44.2 ± 7.3 | 0.043 |
| F/U | 91.7 ± 4.9 | 86.0 ± 9.6 | 82.0 ± 12.1 |

SD = standard deviation; Pre-op = preoperatively; F/U = follow-up; ER = external rotation.
was the only person who had a tear involving three tendons and underwent repair with a deltoid flap in this series. Functional improvement was noted up to the 4th year of follow-up but deteriorated gradually up to the latest follow-up.

Ten patients had bilateral shoulder surgeries. Four patients had surgeries on rotator cuff tears and associated shoulder stiffness of both shoulders in the period of the study. Six patients had a surgery on the opposite shoulders: three were without shoulder stiffness and three had shoulder stiffness but did not undergo surgery in the period of the study.

At the latest follow-up, Constant scores of more than 90 points were obtained in 26 patients (30 shoulders) and more than 80 points in 12 patients (12 shoulders). Satisfactory results were obtained in 42 out of 47 shoulders (89.4%) (Figure 2). Five patients (five shoulders) had an unsatisfactory result of less than 80 points of Constant score. Medical disorders other than diabetes mellitus were noted in five patients and included rectal carcinoma in two patients, and thalassemia, hypertension, and cervical carcinoma and bronchiectasis in one each. There were no neurovascular damage, wound infections, or recurrence of shoulder stiffness at the latest follow-up in this study. One patient with a massive rotator cuff tear had symptoms of reflex sympathetic dystrophy after surgery. Although the symptoms resolved after rehabilitation, the latest Constant score was 71 points. The other patient (insulin-dependent diabetic) had arthroscopic debridement half a year after the index operation due to persistent discomfort and poor improvement in shoulder motion.

Discussion

Most papers concerning the management of shoulder stiffness are on the treatment of primary shoulder stiffness. The treatments that are suggested for shoulder stiffness consist of: (1) supportive treatment including ultrasound, transcutaneous electrical nerve stimulation, massage, stretching, or traction; (2) systemic or local medications,
(3) injections of fluid, arthrographic dye, or medications for the purpose of joint distension to release capsular contracture;22 (4) manipulative therapy with or without anesthesia to release adhesions or contracted structures;23 and (5) surgical release of adhesions or contractive structures by open or arthroscopic means.23–25 Little has been mentioned about the treatment of rotator cuff tears and associated shoulder stiffness.8,9 Warner and Greis9 mentioned that stiffness with a tear of the repaired rotator cuff was a particularly challenging situation to manage. They said that if there was marked loss of passive motion and extensive scarring, it might be best to release the adhesions without revising the repaired rotator cuff at the same time, as the combination of both operations might increase the likelihood of subsequent shoulder stiffness. Harryman et al7 also suggested that shoulder stiffness be treated as the primary problem before considering a rotator cuff repair. A rotator cuff repair is often a "shoulder-tightening" procedure that might result in increased stiffness postoperatively. However, patients usually need to wait a significant length of time for shoulder movement to improve before the rotator cuff tears can be repaired. In addition, the symptoms of shoulder stiffness may not be relieved especially in the presence of rotator cuff lesions. Twelve percent of our patients (52 out of 424 shoulders) exhibited such symptoms during the 5 years and 7 months of our surgical experience. Thus, facing a patient with rotator cuff

Figure 2. Clinical photographs show: (A) stiffness of the right shoulder preoperatively. (B) Aggressive rehabilitation was started from the second postoperative day. The patient progressed with active-assisted exercises 3 days postoperatively. (C, D) The patient had good motion of the right shoulder 9 months postoperatively.
lesions and associated shoulder stiffness is a challenging but not uncommon issue. Tauro first reported surgical results of arthroscopic cuff repair without release for rotator cuff tears and stiffness. He found that patients with severe shoulder stiffness might not do well with cuff repair alone and recommended combined cuff repair and capsular release for these patients. From our previous experience, we noticed that it is possible to treat rotator cuff lesions and associated shoulder stiffness concomitantly with good results.

We found that the release of contracture and adhesions in the rotator interval and extra-articular components and the repair of rotator cuff tears were easily achieved through the open method. This is in agreement with the comment by Warner et al who stated that their technique of arthroscopic release was only for capsular lesions and it would be difficult to improve motion in patients who have an extra-articular component. Satisfactory results were obtained in 89.4% of our patients (42 out of 47 shoulders). The reasons for successful outcomes from our procedure include: (1) gentle manipulation, intra-articular distension and extensive lysis of extra-articular adhesions of the rotator interval, coracohumeral ligament, rotator cuff–deltoid interface and (2) adequate decompression and rotator cuff repair. Itoi and Tabata reported surgical results of open repair in 38 shoulders with partial-thickness rotator cuff tears. The overall results were satisfactory in 31 shoulders (82%) at 4.9 years follow-up. Fukuda et al reported on acromioplasty and open repair in 63 patients with partial-thickness tears of the rotator cuff. Satisfactory results were obtained in 62 patients (94%) with an average follow-up of 32 months. In the current series, satisfactory results of more than 80 points Constant score were obtained in 26 (96%) patients. This result is comparable to those of other reports with partial tear of the rotator cuff, and our recent report on partial tear of the rotator cuff without stiffness. Fuchs et al reported on open repair of an isolated one-tendon tear of the rotator cuff and found that the mean overall subjective shoulder value was 82.8% of the value of a normal shoulder with significant improvement in the Constant score postoperatively. The treatment of massive rotator cuff tear is especially challenging. Cofield et al reported a 13-year follow-up of patients with rotator cuff tears treated with an open technique. Patient satisfaction was significantly affected by the size of the tear with an 85% satisfaction rate for medium sized tears compared with a 27% rate for massive tears. Lam and Mok reported on open repair of massive rotator cuff tears in patients aged ≥65 years. The outcome was excellent or good in 44% and the patient satisfaction rate was 84%. They suggested that patients with massive rotator cuff tear can be expected to have a good outcome after repair. Vandenbussche et al reported on massive tears of the rotator cuff treated with a deltoid flap. Patient satisfaction was 89% with a significant gain of 80% of preoperative Constant score. There were five patients with massive tears in our series. Three (60%) had a satisfactory result. Limited soft tissue dissection, adequate debridement and decompression, avoidance of distal clavicle resection, and rotator cuff repair with tendon-to-bone technique or a deltoid flap might contribute to the satisfactory results. Tissue contracture in response to cytokines, inflammatory cell products, and platelet-derived growth factor has been proposed as a pathogenic mechanism for primary frozen shoulder. We believe that a similar mechanism may be involved in the development of secondary shoulder stiffness associated with rotator cuff tears. Through our method of extensive lysis of the adhesions and treatment of rotator cuff tears, the cascade pathway of cytokines inducing fibroplasia and adhesion may be blocked because the long-term results are good, with no recurrence in our series.

Harryman et al stated that stiffness was commonly seen with partial cuff tears but was much less frequently associated with full-thickness tears. In our series, a partial tear of the rotator cuff was noted in only 57% (27 out of 47) of shoulders. This implied that most shoulder stiffness accompanying a partial tear of the rotator cuff might improve after nonoperative treatment. On the other hand, a partial tear might progress to a complete
tear of the rotator cuff. On the whole, the so-called “shoulder-tightening” effect after cuff repair did not have a detrimental influence on our surgical results. Extensive lysis of the adhesions and excision of the myofibroblast-containing bursa might play an important role in achieving good results. The relatively poor results in patients with complete and massive rotator cuff tears were thought to be due to the poor status of the rotator cuff. We therefore suggest that a partial tear of the rotator cuff be treated early, even with associated shoulder stiffness.

Patients with diabetes mellitus are reported to be at much greater risk for developing limited joint motion. Fortunately, we found that diabetes mellitus did not have a negative effect on the outcome of surgical treatment of rotator cuff tears and associated shoulder stiffness. This agreed with Ogilvie-Harris et al who reported that patients with diabetes did worse initially after arthroscopic release for resistant frozen shoulder, but the outcome was similar to patients without diabetes. However, two of our patients who had insulin-dependent diabetes mellitus had more contracture tendency during postoperative rehabilitation. Fortunately, one patient required an arthroscopic release and manipulation 6 months after the index operation. He received the same procedure on the contralateral shoulder 7 years later and was satisfied with the index operation.

All our patients with or without diabetes mellitus received nonoperative treatment for shoulder stiffness for at least 3 months as is usually suggested. On the other hand, early intervention has been considered appropriate to prevent progressive disability because of the refractory nature of shoulder stiffness in the long-term insulin-dependent diabetic. Neviaser and Neviaser also reported that if in the first few months, a patient is unable to raise his arm above 90° and has shown no progress, more aggressive manipulation should be considered. Further communication with doctors in the rehabilitation department highlighted a negative tendency for shoulder stiffness improvement if the patients did not improve within 2 months after rehabilitation. Therefore, it is advisable that rotator cuff tears associated with shoulder stiffness be treated early. Early surgical intervention can resolve the patients’ complaints early and is a cost-effective procedure.

In summary, gentle manipulation, extensive lysis of the adhesions, excision of myofibroblast-containing bursa, and acromioplasty with rotator cuff repair is a satisfactory procedure for patients with rotator cuff tears and associated shoulder stiffness. Because patients with a partial tear of the rotator cuff have significantly better total Constant scores than those with complete tears or massive tears, early surgical intervention is suggested.

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References