Isolated Subscapularis Repair for Massive Rotator Cuff Tear

LUKE AUSTIN, MD; EDWARD S. CHANG, MD; BENJAMIN ZMISTOWSKI, BS; JASON NYDICK, DO; MARK LAZARUS, MD

abstract

The best surgical treatment for an irreparable rotator cuff tear is controversial. In such cases, partial rotator cuff repair, primarily involving the posterior cuff in most reports, has been shown to be beneficial. The authors retrospectively investigated 41 patients who underwent arthroscopic subscapularis-only repair and greater tuberoplasty between April 2003 and August 2009 for massive 3-tendon cuff tears with irreparable supraspinatus and infraspinatus tendons after 3 months of conservative management was unsuccessful. Twenty-five patients (61%) underwent biceps tenotomy, and the remaining 39% had preexisting biceps tenotomy or rupture. The patients were assessed with American Shoulder and Elbow Surgeons (ASES) and Single Assessment Numeric Evaluation (SANE) scores. Of the 41 patients, 34 (83%) were available for a follow-up telephone questionnaire after a minimum of 12 months (mean, 35 months; range, 12-84 months). Mean ASES and SANE scores were 76% and 63%, respectively. Mean postoperative passive range of motion was 156° of forward flexion and 39° of external rotation. Of the patients queried, 74% (25 of 34) were able to actively raise their arms above shoulder level. For those with a positive belly-press test result preoperatively, 22 of 27 patients had a negative test result postoperatively. A total of 3 complications (7.3%) occurred. Workers’ compensation claim was a strong predictor of lower shoulder scores. Arthroscopic subscapularis-only repair and greater tuberoplasty may offer a promising and safe method for treating massive rotator cuff tears when the supraspinatus and infraspinatus tendons are irreparable. Workers’ compensation claim may predict lower outcome scores.

The authors are from the Rothman Institute, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania.

Dr Chang, Mr Zmistowski, and Dr Nydick have no relevant financial relationships to disclose. Dr Austin is a paid consultant for Tornier and his institution receives grants from Zimmer. Dr Lazarus is a paid consultant for and receives royalties from Tornier.

Correspondence should be addressed to: Mark Lazarus, MD, Rothman Institute, Thomas Jefferson University Hospital, 925 Chestnut St, 5th Fl, Philadelphia, PA 19107 (shoulderd@comcast.net).

Received: October 25, 2013; Accepted: March 4, 2014; Posted: November 6, 2014.

doi: 10.3928/01477447-20141023-51
Massive rotator cuff tears are difficult to treat. When possible, the key elements of treatment include restoration of force couples and anatomic repair of the rotator cuff to its footprint. However, a number of factors (biologic factors and/or characteristics of the tear) can make these goals difficult or impossible to achieve. Fatty infiltration, cuff retraction, and poor tendon compliance are common in patients with massive rotator cuff tears. In these situations, other approaches have been advocated, with varying degrees of success. These include physical therapy, tuberoplasty, partial rotator cuff repair, palliative biceps tenotomy, cuff debridement and subacromial smoothing, muscle transfer, cuff prosthesis, and reverse shoulder arthroplasty.

Few studies have described this difficult problem. Burkhart et al described partial rotator cuff repair in 1994. The authors argued that restoration of the “suspension bridge” may restore force couples and more normal mechanics to the shoulder. In their study of 14 patients with massive rotator cuff tears, mean active elevation was improved from 60° to 150°, strength increased 2.3 grades, and the University of California-Los Angeles (UCLA) Shoulder Scale increased from 9.8 to 27.6. In 2005, Duralde and Bair reported 24 patients who underwent open partial rotator cuff repair for massive irreparable rotator cuff tears. In this series, patients had increased active elevation (range, 114°-154°) and improved American Shoulder and Elbow Surgeons (ASES) scores (range, 41.0-80.1). These studies highlighted the effectiveness of partial rotator cuff repair. However, most of the patients in each series had posterosuperior rotator cuff repairs, and generally worse results were reported for anterosuperior rotator cuff repair.

In 2002, Fenlin et al first reported 20 patients who underwent greater tuberoplasty for irreparable rotator cuff tear. In this series, mean active forward flexion increased from 100° to 162° and the UCLA Shoulder Scale improved from 9.3 to 27.7. Therefore, the authors investigated partial rotator cuff repair of the subscapularis only and greater tuberoplasty for massive 3-tendon cuff tears with irreparable supraspinatus and infraspinatus tendons. The goals of this study were to (1) evaluate ASES and Single Assessment Numeric Evaluation (SANE) scores; (2) identify complications that occur after isolated arthroscopic subscapularis repair with greater tuberoplasty; and (3) investigate patient and surgical factors that affect outcomes.

**MATERIALS AND METHODS**

A retrospective review was undertaken after approval was obtained from the local institutional review board. Inclusion criteria were (1) massive 3-tendon rotator cuff tear; (2) arthroscopic repair of a full-thickness subscapularis tear; and (3) greater tuberoplasty of an irreparable posterosuperior tear. Excluded were patients with (1) full or partial posterosuperior cuff repair or (2) irreparable subscapularis tear. All patients underwent a minimum of 3 months of unsuccessful physical therapy before being offered surgery. This was a review of a continuous cohort of patients with a single treating surgeon (M.L.) between January 2003 and September 2009. The patients were identified by a thorough review of operative reports for all rotator cuff repairs performed by this surgeon during this period. A total of 41 patients met the inclusion criteria during the period in question; they represented 4.2% (41 of 950) of the rotator cuff repairs performed during that time by this surgeon. The patients had a mean age of 61.9 years (range, 45-79 years), and 28 of 41 (68%) were men (Table 1).

All arthroscopies were performed in the beach chair position, and the arm was placed in a McConnell arm holder (McConnell Orthopedic Manufacturing Company, Greenville, Texas). Diagnostic arthroscopy was performed through the standard posterior portal, and the rotator cuff was evaluated. In cases of full-thickness subscapularis tear, a 70° scope was used to see medial to the anterior glenoid. All patients had repairable full-thickness subscapularis tears and irreparable posterosuperior cuff tears. Subscapularis tears varied from partial upper-border tears to complete tears. All patients underwent mobilization and attempted repair of the posterosuperior cuff. In all cases, this was not achieved and a greater tuberoplasty, as described by Fenlin et al., was performed. For subscapularis repair, the posterior portal was used as the viewing portal, an anteroinferior portal was developed as the working portal, and an anterosuperior portal was used as an accessory portal. Using a radiofrequency device, the subscapularis tendon was mobilized and released from adherions, the anterior capsule, the superior glenohumeral ligament, the coracohumeral ligament, and the middle glenohumeral ligament. For complete avulsions, the axillary nerve was identified by dissection with percutaneously placed Metzenbaum scissors, permitting safe mobilization of the inferior subscapularis. The bone on the lesser tuberosity was decorticated with a high-speed burr through the working portal. Depending on the size of the tear, 1 to 3 double-loaded, nonabsorbable suture anchors were placed into the lesser tuberosity. Using a suture-relay system (Spectrum; Linvatec, Utica, New York) through the working portal, a single-row repair was performed. All knots were tied through the working portal. All patients with an intact biceps underwent biceps tenotomy. To preserve the coracoacromial ligament, no subacromial decompressions or distal clavicle excisions were performed. Postoperatively, the arm was placed in a simple sling for 6 weeks. Patients were allowed out of the sling to shower and to perform elbow, wrist, and hand exercises. At 6 weeks, passive range of motion exercises were begun, with external rotation restricted to 40°. Strengthening exercises were started at 3 months, and full activities resumed at 6 months.
Patients were contacted by telephone for outcome scores. Patient-reported outcome was assessed with the ASES and SANE patient questionnaires. Of the 41 patients, 37 (93%) were examined by the treating surgeon in the office, with an average follow-up of 6 months (range, 5-24 months). Passive range of motion and belly-press test (as described by Gerber et al10) results were obtained by the treating surgeon. Of the 41 patients, 25 (61%) underwent a mean delta (postoperative less preoperative) forward flexion of 10° (95% CI, 0° to 22°; range, -70° to 80°) and external rotation of -14° (95% CI, -22° to -5°). Before rotator cuff repair, 27 of 38 (71.1%) of the tested patients had an abnormal belly-press test result. Postoperatively, findings in only 5 of 30 patients (17%) in whom data were available were still abnormal. There was a statistically significant difference between patients’ results on the belly-press test preoperatively vs postoperatively (27 vs 5, P<.001). Two patients with abnormal preoperative belly-press test results were not tested postoperatively.

Postoperative active forward elevation above shoulder level was determined by patient response to question 6 of the ASES questionnaire (“Reach a shelf above your head without bending your elbow”). Of the patients who responded to the questionnaire, 25 of 34 (74%) were able to perform this task. Of the 15 patients with preoperative pseudoparalysis, 8 answered yes to ASES question 6 at final follow-up. Of the 41 patients, 25 (61%) underwent biceps tenotomy. The mean ASES score was 76.89 in patients with a concomitant biceps tenotomy.

Results

The mean ASES score at final follow-up was 76 of 100 (95% confidence interval [CI], 66.9-84.5; range, 15-100). This finding compared with a mean Penn Shoulder Score of 75.3 (95% CI, 63.0-81.6; range, 10.2-100) and a mean SANE score of 63% (95% CI, 51%-74%; range, 5%-100%).

Mean postoperative passive forward flexion was 156° (95% CI, 149°-163°; range, 90°-180°), and mean postoperative passive external rotation was 39° (95% CI, 33.0°-46°; range, 10°-80°). This provided a mean delta (postoperative less preoperative) forward flexion of 10° (95% CI, 0° to 22°; range, -70° to 80°) and external rotation of -14° (95% CI, -22° to -5°). Before rotator cuff repair, 27 of 38 (71.1%) of the tested patients had an abnormal belly-press test result. Postoperatively, findings in only 5 of 30 patients (17%) in whom data were available were still abnormal. There was a statistically significant difference between patients’ results on the belly-press test preoperatively vs postoperatively (27 vs 5, P<.001). Two patients with abnormal preoperative belly-press test results were not tested postoperatively.

Postoperative active forward elevation above shoulder level was determined by patient response to question 6 of the ASES questionnaire (“Reach a shelf above your head without bending your elbow”). Of the patients who responded to the questionnaire, 25 of 34 (74%) were able to perform this task. Of the 15 patients with preoperative pseudoparalysis, 8 answered yes to ASES question 6 at final follow-up. Of the 41 patients, 25 (61%) underwent biceps tenotomy. The mean ASES score was 76.89 in patients with a concomitant biceps procedure vs 70.90 in patients who

### Table 1

Demographics of the Study Cohort (n=41)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y (95% CI)</td>
<td>61.9 (59.1-64.7)</td>
</tr>
<tr>
<td>Female, No./total (%)</td>
<td>13/41 (31.7)</td>
</tr>
<tr>
<td>Chronic tear, No./total (%)</td>
<td>13/41 (31.7)</td>
</tr>
<tr>
<td>Time to surgery, mo (95% CI)</td>
<td>6.71 (4.1-9.4)</td>
</tr>
<tr>
<td>Right shoulder, No./total (%)</td>
<td>30/41 (73.2)</td>
</tr>
<tr>
<td>Revision rotator cuff repair, No./total (%)</td>
<td>5/39 (12.9)</td>
</tr>
<tr>
<td>Anchors used, No. (range)</td>
<td>1.5 (1-3)</td>
</tr>
<tr>
<td>Positive degenerative joint disease, No./total (%)</td>
<td>18/38 (47.3)</td>
</tr>
<tr>
<td>Workers’ compensation claim, No./total (%)</td>
<td>8/39 (20.5)</td>
</tr>
<tr>
<td>Anterosuperior escape, No./total (%)</td>
<td>3/41 (7.3)</td>
</tr>
<tr>
<td>Preoperative pseudoparalysis, No./total (%)</td>
<td>15/38 (39.5)</td>
</tr>
<tr>
<td>Diabetes, No./total (%)</td>
<td>7/41 (17.1)</td>
</tr>
<tr>
<td>Smokers, No./total (%)</td>
<td>8/38 (21.1)</td>
</tr>
<tr>
<td>Preoperative passive forward flexion (95% CI)</td>
<td>147.3° (138.5°-156.1°)</td>
</tr>
<tr>
<td>Preoperative passive external rotation (95% CI)</td>
<td>55.8° (48.2°-63.4°)</td>
</tr>
<tr>
<td>Abnormal preoperative belly-press test result, No./total (%)</td>
<td>27/41 (65.9%)</td>
</tr>
<tr>
<td>Preoperative acromiohumeral interval, mm (95% CI)</td>
<td>7.1 (5.8-8.4)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

Variables investigated as potential predictors of surgical outcome included patient-specific factors (previous rotator cuff repair, preoperative range of motion, mechanism of injury [acute, acute associated with dislocation, or chronic], pre- and postoperative belly-press test results, preoperative pseudoparalysis, degenerative joint disease, age, sex, presence of diabetes, smoking status, dislocation, history of trauma, workers’ compensation claim), and surgery-specific factors (biceps tenotomy and number of anchors used). In addition, pre- and postoperative degree of flexion was obtained from the chart at the last postoperative office visit.

Data were summarized descriptively. Continuous variables were reported with mean and standard deviation. Dichotomous variables were reported with raw numbers and percent of the total. Univariate analysis was performed to identify possible predictors of poor outcome within the study group. Student’s t test was used for continuous variables, and chi-square analysis was used for dichotomous variables. For continuous independent variables with continuous outcomes, Pearson’s correlation coefficient was used.
had a previous tenotomy or biceps rupture ($P=61$). No patients were left with an intact long head of the biceps brachii tendon.

Of the 41 patients, 3 (7.3%) had postoperative complications in association with rotator cuff repair. These included 1 superficial infection, 1 deep infection, and 1 case of carpal tunnel syndrome. The superficial infection was treated successfully with local wound care and oral antibiotics. The second infection required irrigation and debridement in the operating room and 6 weeks of treatment with intravenous antibiotics. The symptoms of carpal tunnel syndrome resolved without surgery.

Patients with pending workers’ compensation claims had lower shoulder scores at final follow-up than patients who did not have pending claims (Figure); the authors identified no other patient or surgical factors that were associated with lower scores. The 6 patients with workers’ compensation claims who had follow-up had mean shoulder outcome scores of 46.5 (ASES) and 17.5% (SANE). Of patients without workers’ compensation claims, 27 had telephone follow-up, with mean outcome scores of 82.0 (ASES; $P<0.001$) and 73.2% (SANE; $P<0.001$). Among the 41 patients, 5 underwent revision, with a mean ASES score of 75.9. Furthermore, delta forward flexion was dependent on preoperative forward flexion ($R=0.80$; $P<0.001$). As with forward flexion, delta external rotation ($R=0.70$; $P<0.001$) and absolute postoperative external rotation ($R=0.38$; $P=0.04$) were dependent on preoperative external rotation. No predictors of sustained abnormal belly-press test results were identified. Postoperative belly-press test results did not correlate with outcome. Predictors of postoperative complications included the number of anchors used during repair ($P=0.02$) and patient sex ($P=0.008$). The 3 patients who had complications required 2.3 anchors vs 1.4 anchors in those who did not. Furthermore, all of the complications (3 of 13; 23.0%) occurred in women. Complications immediately after surgery did not affect the long-term outcome.

**DISCUSSION**

Patients with massive rotator cuff tear are best treated with anatomic repair of the rotator cuff to the footprint and restoration of glenohumeral force couples. When this goal is not achievable, other surgical options exist. $^4$ To the authors’ knowledge, this study is the first report of isolated subscapularis repair and greater tuberoplasty for massive 3-tendon cuff tears with irreparable supraspinatus and infraspinatus tendons. Specifically, the authors evaluated the following: (1) ASES and SANE scores; (2) complications that occurred after isolated arthroscopic subscapularis repair with greater tuberoplasty; and (3) patient and surgical factors that affected outcomes.

The current study was limited by several factors. First, the authors did not have preoperative shoulder scores and could not determine the delta difference in patient outcomes. Because this procedure is rare, the authors determined that a retrospective review was the most feasible method to evaluate the authors’ small patient population. Therefore, the authors used postoperative outcome measures to compare their findings with other studies with similar patient populations. Second, the authors did not have postoperative imaging results to determine the integrity of the subscapularis tendon after repair. However, they had a significant reversal of belly-press test results after repair, indicating functional recovery of the tendon, if not partial healing (although this is not correlated by outcomes). Third, 7 of 41 patients (17%) were lost to follow-up. Fourth, 61% of patients underwent biceps tenotomy. Cotreatment of the biceps tendon is known to be an effective treatment modality, $^6$ further confounding the results. However, in the authors’ cohort, no clear difference was found between patients who were treated with biceps tenotomy (ASES score=76.9) and those who had either previous biceps tenotomy or rupture (ASES score=70.9; $P=0.61$). Fifth, review of medical records showed that only passive forward flexion was recorded. Unfortunately, the authors could not bring all patients back to measure active forward flexion. Therefore, they assessed active forward flexion with the ASES questionnaire, which provided practical, but limited information.
Outcomes after arthroscopic subscapularis repair and greater tuberoplasty were generally good. Scores compared favorably with other treatment options reported in the literature for massive rotator cuff tear (Table 2). Bennett14 performed a prospective cohort study of 37 patients undergoing complete arthroscopic repair of massive rotator cuff tear. This population differed from the current study population because 78% of patients achieved full rotator cuff repair compared with 0% in the current study. In their cohort, which included both anterosuperior and posterosuperior massive rotator cuff tear, mean ASES score at final follow-up was 85. This study represented the best possible results for massive rotator cuff repair, with 78% of patients achieving full anatomic repair of the rotator cuff to the footprint. Duralde and Bair5 reported 24 patients who underwent partial rotator cuff repair for massive rotator cuff tear. The mean ASES score at final follow-up was 80.1. The only poor result in this series was the sole patient with a subscapularis and supraspinatus tear. Gartsman8 evaluated 33 patients with irreparable rotator cuff tear who were treated with operative debridement and subacromial decompression. In this study, the mean ASES score improved from 27 to 55; however, strength and elevation were decreased. The author concluded that patients improve after debridement and decompression, but the results were clearly inferior to those with rotator cuff repair. Furthermore, more invasive options with a higher complication rate are available to treat massive irreparable rotator cuff tear, including pectoralis major transfer and reverse shoulder arthroplasty.12 Therefore, compared with the literature, arthroscopic partial rotator cuff repair (subscapularis only) and greater tuberoplasty may be a promising treatment for massive anterosuperior rotator cuff tear with irreparable supraspinatus and infraspinatus tendons.

Preoperatively, 39% (15 of 38) of patients could not actively lift their arms above shoulder level. At last follow-up, 26% (9 of 34) of patients could not actively lift their arms above shoulder level (answered yes to ASES question 6). Furthermore, 8 of the 15 patients with preoperative pseudoparalysis could actively lift their arms above shoulder level at final follow-up.

Belly-press test results were significantly improved after this procedure. After surgery, 22 of 27 patients converted from a positive belly-press test result to a negative result. Although no postoperative imaging was available, the belly-press test has been shown to be a predictor of subscapularis function and integrity.13,15 Postoperative belly-press test result did not correlate with patient outcomes, and this study further validates the finding of Gerber et al16 that normal or abnormal postoperative belly-press test results are not associated with clinical outcomes.

In this study, 3 complications occurred (7.3%), with a reoperation rate of 2.4%. Overall, this is a safe procedure with a low complication rate. The presence of a workers’ compensation claim was a strong negative predictor of outcome. Delineation among excellent, good, fair, and poor outcome measures showed that all patients with a workers’ compensation claim had poor outcomes, whereas those without a claim had a 71% chance of good to excellent outcomes. The only significant factor predictive of increased delta forward flexion was the etiology of shoulder dislocation. These patients showed an average improvement of 50°. This finding may be attributed to relative poor forward elevation from pain as a result of the acute injury. Furthermore, patients with chronic tears had significantly less external rotation at final follow-up, possibly because of subscapularis retraction and loss of compliance.

**Table 2** Outcomes of Varying Treatment Methods

<table>
<thead>
<tr>
<th>Publication</th>
<th>No. of Patients</th>
<th>Procedure</th>
<th>ASES (Preoperative/Postoperative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current study (2014)</td>
<td>41</td>
<td>Arthroscopic subscapularis repair and tuberoplasty (anterosuperior, 3 tendon tears)</td>
<td>NA/75.7 (no WC=82)</td>
</tr>
<tr>
<td>Bennett4</td>
<td>29</td>
<td>Arthroscopic massive rotator cuff repair (anterosuperior cuff tear)</td>
<td>29/85</td>
</tr>
<tr>
<td>Duralde and Bair5</td>
<td>24</td>
<td>Open partial rotator cuff repair (massive rotator cuff tear)</td>
<td>41/80.1</td>
</tr>
<tr>
<td>Gartsman8</td>
<td>33</td>
<td>Open debridement and subacromial decompression (irreparable, massive rotator cuff tear)</td>
<td>27.2/55.3</td>
</tr>
<tr>
<td>Mulieri et al12</td>
<td>69</td>
<td>Reverse total shoulder arthroplasty (irreparable rotator cuff tear without glenohumeral degenerative joint disease)</td>
<td>33.3/75.4</td>
</tr>
</tbody>
</table>

Abbreviations: ASES, American Shoulder and Elbow Surgeons; NA, not available; WC, workers’ compensation claim.
and SANE scores than those without a claim. Further multicenter, comparative studies are warranted to evaluate this treatment option as a potential alternative for this difficult problem.

REFERENCES


