Clinical Outcomes of Single-row Arthroscopic Revision Rotator Cuff Repair

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abstract

This article reports the authors’ experience with single-row arthroscopic revision rotator cuff repairs and analyzes the variables associated with a poorer long-term outcome. A retrospective review was performed of patients who had undergone an all-arthroscopic, single-row revision rotator cuff repair for pain with a documented re-tear over a 13-year period. After exclusionary criterion was applied, 32 shoulders in 30 patients were available for follow-up. A thorough shoulder examination was performed to record postoperative motion and functional outcomes, including the University of California Los Angeles (UCLA) score, American Shoulder and Elbow Surgeons (ASES) score, and visual analog scale (VAS) pain score, and was compared with the patient’s preoperative data. Analysis of variables, including patient demographics, surgical history, and functional outcomes, was performed to determine whether there was any association with a UCLA score less than 28 or an ASES score less than 65. At final follow-up, 20 men and 10 women had a mean age of 69.3 years (range, 55.1-84.1) at a mean follow-up of 70.3 months after final revision surgery. Mean UCLA score improved from 15.5±3.9 preoperatively to 29.8±4.6 postoperatively (P<.001); mean modified ASES score improved from 53.4±12.5 preoperatively to 86.7±12.7 postoperatively (P<.001); and mean VAS pain score improved from 4.6±1.1 preoperatively to .91±1.1 postoperatively (P<.001). A poorer functional outcome (defined as a UCLA score greater than 28) was found in 25% of patients. This was associated with female gender, age older than 70 years, dominant-arm revision, and preoperative external rotation less than 35°. In addition, preoperative active range of motion in forward flexion less than 140° (P=.039) and active range of motion in external rotation less than 35° (P=.025) were also associated with poorer ASES scores (<65). The authors believe that patients can have reliable improvements in shoulder pain and function after a revision procedure using a single-row arthroscopic technique and that patient factors can lead to poorer results with this technique.
Painful recurrent tears of the rotator cuff are not uncommon after arthroscopic or open primary surgical repair. Tendon re-tear and an impaired healing response after surgical repair are likely multifactorial but often include biologic factors (ie, patient age, tear size, tendon quality), quality of surgical repair, trauma, and inappropriate postoperative rehabilitation.\(^1\)\(^-\)\(^5\) Reported re-tear rates vary in the literature but have ranged anywhere from 7\% to 69\% depending on the initial tear size and primary method of repair.\(^6\) Although many patients continue to achieve good pain relief and function despite rotator cuff re-tear after primary repair,\(^7\)\(^-\)\(^10\) some evidence indicates that those that maintain structural integrity of the repaired tendons may do better with more strength than those that re-tear or never heal.\(^11\) Those that have unacceptable return of function and strength may require revision rotator cuff repair, commonly due to persistent pain.

Several outcome studies in the literature have found high levels of long-term patient satisfaction after primary arthroscopic rotator cuff repair.\(^12\)\(^-\)\(^14\) The existing literature on long-term outcomes for revision arthroscopic rotator cuff repair is less abundant. A systematic review by Ladermann et al\(^15\) identified only 4 articles (2 articles contained the same patient population) in the current literature that discussed the outcomes of revision arthroscopic rotator cuff repair incorporating data using various repair techniques. It is controversial whether a double-row repair is clinically superior to a single-row repair in primary rotator cuff repairs. Little literature exists to explore this concept in revision cases. The purpose of the authors’ current study was to report on the functional outcomes after single-row arthroscopic revision rotator cuff repair. The authors hypothesize that with the evolution of techniques in arthroscopic rotator cuff surgery, a good result can be obtained in the revision setting with just a single-row repair. The secondary purpose was to evaluate any factors that may relate to a poorer surgical outcome as defined by a University of California Los Angeles (UCLA) score\(^16\) less than 28 or an American Shoulder and Elbow Surgeons (ASES) score less than 65.\(^17\)\(^,\)\(^18\)

**Materials and Methods**

A retrospective database review of all patients who had undergone arthroscopic rotator cuff repair from April 1999 to April 2012 at the authors’ institution by a single surgeon (W.M.N.) was conducted and revealed 1230 cases in 843 patients. Of these, 58 cases were determined to be all-arthroscopic revision rotator cuff repairs. The surgeon used only a single-row repair technique in his revision rotator cuff cases, which was verified in the operative reports of the 58 cases. Institutional review board approval was obtained prior to the review of the surgical cases and contact of the patients for participation in the study. All patients underwent an informed consent process prior to enrollment and subsequent inclusion in the study.

Inclusion criteria were patients who had failed conservative treatment of previous open or arthroscopic rotator cuff repair with documented re-tear seen on magnetic resonance imaging and a persistently painful shoulder. A minimum follow-up of 1 year after revision arthroscopic single-row repair was also required for inclusion. Both partial and complete repairs at the time of revision surgery were included. Exclusion criteria included any revision repair that was converted to an open procedure, irreparable rotator cuff defects in which no repair was attempted, or revision repair that was completed with biologic tissue grafting.

The medical records of all patients were reviewed to obtain baseline demographic data (age, gender, hand-dominance, side of surgery), number of previous revision rotator cuff repairs, detailed clinical/surgical history and examination findings, and available preoperative visual analog scale (VAS) pain scores, UCLA scores, and modified ASES scores. The standard ASES patient self-reported evaluation consists of a pain scale component and 10 functional activities of daily living component questions (both equally weighted 50 points each) for a total score of 100 points. Omitting the last question item on the standard ASES evaluation form (ability to “do usual sport”) allowed for calculation of the “modified ASES” score by weighing the total score calculated from a total of 95 points instead of 100. The authors chose to perform a modified ASES score because the initially standard ASES functional outcome scores were not being used for preoperative data collection by the senior author (W.M.N.); however, a similar patient self-reported functional outcome scoring system that used all of the same components of the current ASES score except for the last question item was being used. Thus, the authors used the modified ASES score to allow for direct comparison between pre- and postoperative function.

All patients deemed eligible for the study were contacted and evaluated by the sports medicine fellow (J.J.). Functional outcomes were determined with patient-completed validated clinical outcome scoring systems, including UCLA scores, modified ASES scores, and VAS pain scores. Patients also underwent a clinical examination by the fellow, independent of the surgeon, to determine active range of motion (AROM) in forward flexion and external rotation with the arm at the side. All AROM measures were performed 3 times and averaged to the nearest whole number. Medical records and operative reports were analyzed by the sports medicine fellow, who was not involved in any of the revision surgical procedures.

All arthroscopic revision rotator cuff repairs were performed by the senior author. With the patient in the lateral decubitus position and the arm in balanced suspension (7 lb), a diagnostic arthroscopy of the shoulder is performed. The rotator cuff is inspected from the subacromial
space laterally after subacromial bursectomy, and a determination of tear size is performed prior to any cuff debridement. Tear size is classified as small (<1 cm), medium (1-3 cm), large (3-5 cm), or massive (>5 cm), based on the work of DeOrio and Cofield. The tear pattern, mobility, and reducibility to the footprint are then determined. Biceps tenotomy and incorporation into the repair or release were performed in all cases with significant (over 50%) biceps tendon involvement or any subluxation. Subacromial decompensation was not routinely performed in the revision cases, leaving the coracoacromial ligament and arch intact at a minimum. Subscapularis tendon tears were repaired when encountered. The surgeon performed a thorough capsular and coracohumeral ligament release in all cases.

Although interval slides can be helpful to gain additional mobility, in this case series anterior interval slide was used in less than 5%, and only in cases where the goal was to translate the rotator cuff laterally 1 to 1.5 cm to reach the greater tuberosity. Double and posterior interval slides were not performed due to the risk of vascular compromise to the cuff. Margin convergence using a side-to-side technique was routinely performed to “shrink” the tear and bring it to the greater tuberosity. Once the tear was converged near the greater tuberosity, a single-row repair was performed with anchors next to the articular margin. The authors do not routinely perform transosseous equivalent repairs or lateral row suplementation. Although the goal of the repair was to establish a complete anatomic tension-free repair, depending on the degree of tissue loss and tension, the surgeon will perform a partial repair to reestablish the force couples if complete repair over-tensions the construct.

Postoperatively, patients are routinely placed in a sling immobilizer with an abduction pillow for the first 6 weeks postoperatively and are started on pendulum and gentle passive range of motion exercises immediately. Active range of motion is allowed at 6 weeks postoperatively, with progression to strengthening starting at 3 months postoperatively. Return to full activity is generally allowed at 1 year.

Statistical calculations were performed with Excel 2007 software (Microsoft, Redmond, Washington). Continuous data were described by mean, standard deviation, and ranges. Paired t tests were performed to compare preoperative and postoperative measurement variable data including AROM, VAS pain scores, UCLA scores, and modified ASES scores. Fisher exact test was used to conduct univariate analysis of nominal variables, such as patient factors (eg, age, gender, arm dominance, tobacco use, workers’ compensation status, postoperative AROM) or surgical factors (eg, number of previous revisions, time of last repair to final revision, complete vs partial repair) that may be prognostic of poorer outcomes (UCLA score ≤28 and ASES <65). A cutoff UCLA score of ≤28 was chosen based on the categories described by Ellman et al. of excellent (34-35 points), good (28-33 points), fair (21-27 points), and poor (0-20 points). An ASES score of ≤65 was chosen based on the work of Tashjian et al., where a 12- to 17-point change in the ASES score was found to be the minimally clinically important change. Because the authors’ average preoperative ASES score and modified ASES score were 50.7 and 53.4, respectively, the addition of 15 or 12 points to each (both in the described range of 12 to 17) gives a minimally acceptable score of 65. P values less than .05 were considered to be statistically significant.

RESULTS

Office database review revealed 58 surgical cases of single-row arthroscopic revision rotator cuff repairs in 56 patients who met the study inclusion criteria. All eligible patients were contacted for study recruitment. Of the 56 patients available for review, 26 patients refused to participate or could not be reached for this study. This left 32 surgical cases of 30 patients who participated in examination for this study.

Demographic data of the 30 patients (Table 1) revealed a mean age of 69.3±7.9 years (range, 55-84 years) with a mean follow-up of 70.3±45 months (range, 13-165 months). Twenty (66.7%) men and 10 (33.3%) women, with 20 (62.5%) right shoulder and 12 (37.5%) left shoulder surgeries, participated. The dominant arm was involved in 27 (90%) cases. Mean age at time of last revision arthroscopic rotator cuff repair was 63.9±8.5 years (range, 45.7-77.6 years), with a mean time from primary repair to last revision of 62.9±61.6 months.

A mean of 1.2±.45 prior rotator cuff repair procedures were reported in the ipsilateral shoulder prior to the final arthroscopic revision rotator cuff repair; with 28 (87.5%) patients having 1 previously attempted rotator cuff repair, 3 (9.4%) having 2 previously attempted repairs, and 1 (3.1%) having 3 previous attempted repairs before the final arthroscopic revision rotator cuff repair. The previous procedures also included subacromial decompression in 18 (56.3%) cases, distal clavicle excision in 5 (15.6%), biceps tenotomy or tenodesis in 1 (3.1%), superior labral tear anterior-posterior repair in 1 (3.1%), and concomitant anterior stabilization in 1 (3.1%). Of the 37 prior attempted repairs, 19 (51.4%) were through an open approach and 18 (48.6%) were attempted arthroscopically.

At the time of final revision surgery, 19 massive (59.4%), 6 large (18.8%), and 7 medium (21.8%) rotator cuff tears were reported. Complete repairs with single-row fixation were performed in 26 (81.2%) patients, whereas only partial repairs were obtained in 6 (18.8%) patients. One anterior interval slide (3.6%) was performed; no posterior or double interval slides were performed. Margin convergence sutures were used in 18 (56.3%) cases. All repairs in this cohort were per-
formed with single-row technique using a mean of 1.8±.63 anchors (range, 1-4). Additional procedures at the time of final revision surgery included a modified acromioplasty in 17 (53.1%) cases, biceps tenotomy or tenodesis in 8 (25%), subscapularis repair in 2 (6.3%), and anterior stabilization in 2 (6.3%).

Clinical outcomes after last arthroscopic revision rotator cuff repair at final follow-up are listed in Table 2. A clinically significant improvement was seen from a mean of 4.6±1.1 preoperatively to a mean of 0.9±1.1 postoperatively (P<.001). The mean active forward flexion trended from 146.4°±37.3° preoperatively to 155.7°±16.5° postoperatively but did not reach statistical significance (P=.140). The authors did not find a significant difference in external rotation motion (P=.211).

To the authors’ knowledge, no patients required repeat surgery or revision rotator cuff repair. Univariate analysis of prognostic factors associated with poor results is shown in Table 3. A poor or fair functional result, defined as a UCLA score less than 28, was found in 8 (25%) of 32 procedures. These cases were associated with age at last revision surgery greater than 70 years (P=.012), female gender (P=.005), the dominant arm being the surgical side (P=.038), and preoperative AROM external rotation less than 35°. A poorer clinical results, defined as a ASES score less than 65, was associated with a preoperative AROM of forward flexion less than 140° (P=.039) and an AROM of external rotation less than 35° (P=.025).

**DISCUSSION**

Although primary arthroscopic rotator cuff repair has shown predictably good outcomes at both short- and long-term follow-up,12-13,24-28 the initial outcomes reported after revision repair were mainly on open surgery and revealed minimal functional gains despite overall significant pain relief.19,29-31 The existing literature evaluating outcomes after revision arthroscopic rotator cuff repair is limited. The recent systematic review by Ladermann et al.15 identified only 4 studies and found significant improvements in postoperative motion and functional scores. The review found poorer results associated with female patients, retears after the revision repair, preoperative active forward flexion less than 135°, and a VAS pain score greater than 5. Some disagreement has occurred as to whether patient age or the number of prior surgeries is prognostic.15

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**Table 1**

<table>
<thead>
<tr>
<th>Demographic Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SD age at final follow-up, y</td>
<td>69.3±7.9</td>
</tr>
<tr>
<td>Gender, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20 (66.7)</td>
</tr>
<tr>
<td>Female</td>
<td>10 (33.3)</td>
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<tr>
<td>Dominant arm, No. (%)</td>
<td>19 (59.4)</td>
</tr>
<tr>
<td>Tobacco, No. (%)</td>
<td>4 (13.3)</td>
</tr>
<tr>
<td>Diabetes mellitus, No. (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Rheumatoid arthritis, No. (%)</td>
<td>1 (3.1)</td>
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<tr>
<td>Workers’ compensation, No. (%)</td>
<td>4 (12.5)</td>
</tr>
<tr>
<td>Mean±SD age at last revision (y)</td>
<td>63.9±8.5</td>
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<tr>
<td>Mean±SD time from primary repair to last revision, mo</td>
<td>62.9±61.6</td>
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<tr>
<td>Mean±SD No. of previous surgeries</td>
<td>1.2±45</td>
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<tr>
<td>Type of previous repair, No. (%)</td>
<td></td>
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<tr>
<td>Arthroscopic</td>
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</tr>
<tr>
<td>Open</td>
<td>19 (51.4)</td>
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<tr>
<td>Tear size, No. (%)</td>
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<tr>
<td>Massive</td>
<td>19 (59.4)</td>
</tr>
<tr>
<td>Large</td>
<td>6 (18.8)</td>
</tr>
<tr>
<td>Medium</td>
<td>7 (21.8)</td>
</tr>
<tr>
<td>Revision repair type, No. (%)</td>
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<tr>
<td>Complete</td>
<td>26 (81.2)</td>
</tr>
<tr>
<td>Partial</td>
<td>6 (18.8)</td>
</tr>
<tr>
<td>Margin convergence</td>
<td>18 (56.3)</td>
</tr>
<tr>
<td>Mean±SD No. of anchors used</td>
<td>1.8±63</td>
</tr>
<tr>
<td>Associated procedures performed, No. (%)</td>
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<tr>
<td>Modified subacromial decompression</td>
<td>17 (53.1)</td>
</tr>
<tr>
<td>Biceps tenotomy or tenodesis</td>
<td>8 (25)</td>
</tr>
<tr>
<td>Stabilization</td>
<td>2 (6.3)</td>
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</table>
The only other series to report the results of arthroscopic single-row revision rotator cuff repair was Lo and Burkhart\textsuperscript{32} in 2004. They reported on the outcomes of 14 patients with a mean age of 57.9 years with a mean follow-up of 23.4 months. Overall patient satisfaction was excellent (13 of 14 patients), with the mean UCLA score increasing from 13.1 preoperatively to 28.6 at last follow-up. The mean shoulder active forward elevation increased from 120.7° to 153.6° and external rotation increased from 26.1° to 44.3° postoperatively.\textsuperscript{32}

Keener et al.\textsuperscript{33} also reported their results using various repair techniques on 21 patients (10 single-tendon tears and 11 supraspinatus/infraspinatus tears) with a mean age of 55.6 years at a mean follow-up of 33 months. Their study group showed significant improvements in all outcome measures, which included VAS pain scores (6 preoperatively to 3 postoperatively), Simple Shoulder Test (5 preoperatively to 9 postoperatively), ASES scores (40 preoperatively to 73 postoperatively), and postoperative range of motion assessments ($P<.05$). They also included postoperative ultrasound to evaluate the integrity of the repair at a mean follow-up of 25 months, and found that 10 (48%) of the 21 shoulders still had an intact repair. They found a greater number of intact repairs in those with an average age of 51.9 years compared with those with recurrent tears with an average age of 59.1 years. They also found a significantly higher re-tear rate in those patients with tears involving both the supraspinatus and infraspinatus vs single-tendon tears (73% vs 30%).\textsuperscript{33}

Piasecki et al\textsuperscript{34} found similar results with 54 arthroscopic single- and double-row repairs at a mean follow-up of 31.1 months. Average age was 54.9 years. Significant improvements were noted in ASES scores (43.8 preoperatively to 68.1 postoperatively), Simple Shoulder Test (3.6 preoperatively to 7.5 postoperatively), VAS pain scores (5.2 preoperatively to 2.6 postoperatively), and active forward elevation (121° preoperatively to 136° postoperatively). They found that female patients and a preoperative abduction less
than 90° was associated with clinical failure, which they defined as an ASES score less than 50.34

Finally, in the largest study to date, Ladermann et al15 reported on the midterm outcome of mixed single- and double-row repairs of 21 nonmassive tears and 53 massive tears with a mean follow-up of 63 months. Overall patient satisfaction was 78%, with both groups showing significant improvements in active forward flexion (136° preoperatively to 152° postoperatively), VAS pain scores (5 preoperatively to 2 postoperatively), and UCLA (17 preoperatively to 26 postoperatively) and ASES scores (47.1 preoperatively to 75 postoperatively). No significant difference was found between the nonmassive and massive tear groups regarding functional outcome scores or the need for revision surgery.35

The authors’ current study revealed similar clinical improvements to the aforementioned studies; however, without a direct comparison group of double-row repairs, the authors cannot draw any conclusions concerning superiority. The patients experienced significantly improved VAS pain scores from 4.6 to 0.9, UCLA scores from 15.7 to 29.7, and modified ASES scores from 53.4 to 86.7 at a mean follow-up of 70.3 months. This supports the authors’ belief that correctly performed single-row arthroscopic revision can provide good to excellent clinical results in 75% of patients based on improvements in pain and function scores. The authors believe they can improve on this rate in the future by excluding patients according to the prognostic factors elicited in this study. The authors also performed complete repairs in 81.2% of the patients, yet their partial repair patients showed similar improvements in clinical outcomes, perhaps reinforcing the importance of restoring the force couple in the shoulder. Although the authors found a trend of improved active forward flexion (146.4° preoperatively to 155.7° postoperatively), this did not reach statistical significance (P=.140). Active external rotation seemed to decrease with time (50.8° preoperatively to 46.4° postoperatively; P=.221). This is most likely due to their selection criteria for revision surgery, which is persistent shoulder pain, not loss of motion.

Previous authors have noted poorer postoperative outcomes associated with patients with recurrent tears after revision repair,33 female patients, and preoperative active forward elevation less than 136°, as well as preoperative VAS score less than 5.34,35 Similarly to these studies, the current study found a poorer outcome for female patients and those with a preoperative active forward flexion less than 140°. The authors also found that age older than 70 years at the time of last revision surgery, revision involving the dominant arm, and preoperative active external rotation less than 35° were associated with a poorer clinical result. Although these factors may be associated with poorer outcomes, the authors believe they should be used as a guide rather than an absolute contraindication when deciding on whom to perform revision arthroscopic rotator cuff repair.

The major limitation of the authors’ current study is the low follow-up rate of 55%, most likely due to the authors’ retrospective study design, the long follow-up period (up to 165 months), and an older patient population (average age, 69.3 years). The authors had a small cohort of 32 cases; however, conversely, this is the largest series studying single-row arthroscopic revision rotator cuff repair reported in the literature. In addition, the inherent weaknesses of the functional outcomes scoring systems themselves (UCLA and ASES scores) have been described,17 which may be reflected in the inability to determine true relationships between factors associated with a poorer result. Follow-up imaging (magnetic resonance image or ultrasound) was not performed as has been done in other studies due to limitations of resources.33 The authors are aware that the re-tear rates are as high as 69% in single-row primary rotator cuff repairs (tears >5 cm); however, outcomes do not correlate to this high failure rate.6 Thus, the authors’ measure for postoperative success was symptomatic relief of pain and improvement of function. In addition, a comparison of outcomes between single- and double-row constructs would help to more clearly define the clinical advantage of each technique. However, the surgeon does not perform double-row techniques for his revision cuff repairs; thus a direct comparison cannot be made.

Despite these limitations, the current study provides the longest follow-up (70.3 months) on arthroscopic revision rotator cuff repairs of any kind in the literature. In addition, this is the second and largest case series describing the clinical outcomes of arthroscopic single-row revision repairs. Furthermore, these data are based on the clinical experience of a single surgeon using the same surgical techniques over a span of 12 years. More research on this topic should be performed in the future; however, currently a clear deficiency exists in the literature concerning this application of single-row repairs.

CONCLUSION

The authors’ findings support arthroscopic single-row revision rotator cuff repair as a viable option for those individuals who present with symptomatic re-tears after primary repair. Their study has shown significant improvement in pain scores and functional scores at a mean follow-up of 70 months after revision surgery. In addition, the authors described preoperative factors that make certain patients more likely to fail using the single-row arthroscopic technique.

REFERENCES

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