

Comparison of Clinical and Structural Outcomes of Open and Arthroscopic Repair for Massive Rotator Cuff Tear

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Background: Management of massive rotator cuff tears can be challenging because of the less satisfactory results and a higher retear rate regardless of the use of open or arthroscopic repair technique.

Methods: We retrospectively analyzed 102 cases of massive rotator cuff tear treated with either open or arthroscopic repair. Open repair was performed in 38 patients; and arthroscopic repair, in 64 patients. The mean age at the time of surgery was 59.7 years in the open group and 57.6 years in the arthroscopic group.

Results: The Constant score increased from the preoperative mean of 55.9 to 73.2 at the last follow-up in the open repair group and from 53.8 to 67.6 in the arthroscopic repair group ($p < 0.001$ and < 0.001 , respectively). The University of California at Los Angeles (UCLA) score increased from a preoperative mean of 17.7 to 30.8 at the last follow-up in the open group and from 17.5 to 28.7 in the arthroscopic group ($p < 0.001$ and < 0.001 , respectively). No statistically significant difference in the Constant and UCLA scores was observed between the two groups at the last follow-up ($p = 0.128$ and 0.087 , respectively). Retear was found in 14 patients (36.8%) in the open group and 39 patients (60.9%) in the arthroscopic group ($p = 0.024$).

Conclusions: Open and arthroscopic repairs of massive rotator cuff tears may provide satisfactory clinical results with no significant difference. However, a significantly lower retear rate was observed for the open repair group compared with the arthroscopic repair group. (Clin Shoulder Elbow 2016;19(2):60-66)

Key Words: Shoulder; Rotator cuff; Tendon injuries; Massive; Open; Arthroscopy

Introduction

Recently, arthroscopic repair has been widely accepted with evolving instrumental development and wide surgical experience for treatment of rotator cuff tears.^{1,2)} Most symptomatic large to massive rotator cuff tears can be managed successfully using an arthroscopic approach and some favorable outcomes have been reported.¹⁻³⁾

Many studies¹⁻³⁾ have reported good clinical outcomes of arthroscopic repair for large to massive rotator cuff tears; however retear of the repaired tendon remains a significant clinical issue. Previous studies have reported retear rates ranging from 47% to 94% after arthroscopic repair of large to massive rotator cuff

tears at 1- and 2-year follow-up.^{4,5)} Although not synonymous with clinical failure, a retear is associated with poorer clinical outcomes than repairs that achieve structural healing. Many studies have reported that a healed rotator cuff resulted in a superior clinical outcome.⁵⁻⁷⁾

However, tendon retraction, adhesions, and poor tissue quality, which are common in large to massive rotator cuff tears, make repair one of the most technically complex procedures in the shoulder.⁸⁾ In cases involving less mobile and severely retracted large to massive tears, complete repair of a torn cuff to the native footprint may be difficult using only arthroscopic technique. Arthroscopic repair of severely retracted large to massive rotator cuff tears has a less satisfactory result with a high rate

Received May 4, 2015. Revised July 15, 2015. Accepted August 16, 2015.

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Financial support: This research was supported by the Sports Scientification of Convergent R&D Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (NRF-2014M3C1B1033319). **Conflict of interests:** None.

of retears.^{9,10} Therefore, open technique can be more effective for these kinds of tears. Some surgeons prefer an open approach for management of severely retracted large and massive tears. However, relatively few studies have evaluated the clinical and structural outcomes of open and arthroscopic repairs for massive rotator cuff tears.

The purpose of this study was to evaluate and compare the clinical and structural outcomes of open and arthroscopic repairs for massive rotator cuff tears and to correlate the clinical outcomes of the respective repair techniques with respect to rotator cuff integrity. We hypothesized that there would be no significant differences in postoperative clinical outcomes and in the retear rate between the open and arthroscopic repair group.

Methods

This study was retrospective in nature and final approval of exemption by the Institutional Review Board was obtained (IRB Approval No.: KMC IRB 1404-04).

Patient Selection

A total of 102 patients (102 shoulders) who underwent surgical repair of a massive rotator cuff tear and routine follow-up magnetic resonance imaging (MRI) at least 6 months after surgery from February 2006 to January 2010 were enrolled in this study. Patients with partial or small, medium, and large-sized rotator cuff tears, acromioclavicular arthritis requiring distal clavicle resection, advanced glenohumeral arthritis, or rotator cuff tears and a worker's compensation claim were excluded from the study. Patients who had undergone revision procedures were also excluded. According to the repair methods, 38 shoulders were treated using the open technique; and 64 shoulders, using the arthroscopic technique. The mean age of patients at the time of the operation was 59.7 years (range, 44–79 years) in the open repair group and 57.6 years (range, 40–75 years) in the arthroscopic repair group. The mean postoperative follow-

up periods were 26.2 months (range, 18–40 months) and 28.1 months (range, 19–38 months), respectively. According to the classification of DeOrio and Cofield,¹¹ the extent of the tear was determined intraoperatively under direct arthroscopic visualization after debridement of the degenerated tendon edges. The tear size was measured in the anteroposterior dimension using a calibrated probe introduced through the posterior portal while viewing from the lateral portal. No significant differences in demographic data were found between the two groups (Table 1).

Preoperative and Postoperative Evaluations

We performed a retrospective analysis of the prospectively collected patient data. All patients underwent a physical examination 1 day before the operation. Postoperative evaluation was performed regularly on an outpatient basis (at 3 weeks, 6 weeks, 3 months, 6 months, 9 months, and 12 months postoperatively and at the last follow-up visit), and the results of the last follow-up examination were analyzed. Preoperative and postoperative subjective pain scores were measured using the visual analog scale (VAS). For shoulder range of motion (ROM), forward flexion, external rotation at the side, and internal rotation to the posterior were assessed before and after the operation. Quantitative measurement of muscle strength of the rotator cuff was performed using a portable, handheld Nottingham Mecmesin Myometer (Mecmesin Co., Nottingham, UK). Elevation strength was tested with the patient in the seated position, with the arm flexed to 90° in the scapular plane. External and internal rotations were tested with the shoulder in a neutral position and the elbow in 90° flexion. The Constant score¹² and shoulder rating scale of the University of California at Los Angeles (UCLA)¹³ were used for clinical assessment.

Operative Techniques

Open repair tended to be performed in more severe cases with less mobile and severely retracted massive tears where a sufficient repair is difficult using arthroscopic technique. In some cases, arthroscopic repair was attempted, and then abandoned for an open approach. And, in some cases, we proceeded directly with open surgery without an attempt at arthroscopic repair based on preoperative radiologic findings.

1) Open repair

All procedures were performed by the senior author with the patient in a 30° beach chair position under general anesthesia. A superolateral approach with a 6 to 8 cm incision extended from just lateral to the coracoid process over the anterolateral corner of the acromion was used for the open procedures. Once the raphe which demarcates the anatomic division between anterior and middle deltoid was identified, the muscle was split between its anterior and lateral portions, parallel to its muscle fibers. Blunt dissectors were then used to separate the muscle fibers parallel to their orientation beginning at the anterolateral corner of the

Table 1. Patient Demographics

Variable	Open repair group	Arthroscopic repair group
No. of patient	38	64
Sex (male/female)	23/15	38/26
Right/left	25/13	33/31
Mean age (yr)	59.7 (44–79)	57.6 (40–75)
Dominant/nondominant	24/14	36/28
Mean follow-up period (mo)	26.2 (18–40)	28.1 (19–38)
Mean postoperative MRI time (mo)	6.4 (6–12)	7.1 (6–12)

Values are presented as number only or median (range).
 MRI: magnetic resonance imaging.

acromion and extending the muscle-splitting incision inferiorly for approximately 5 cm. Once adequate exposure had been obtained, the size and location of the rotator cuff tear and the degree of degeneration of the biceps tendon were evaluated, which was followed by a subacromial decompression with or without acromioplasty, as indicated. Traction sutures were applied to the rotator cuff edges to improve visualization of the tear. After debridement of the footprint, the tear was repaired by Mason-Allen sutures to the greater tuberosity using transosseous tunnels. Tenotomy or tenodesis was performed in cases where pathology of the long head of the biceps tendon was detected. Mason-Allen sutures with No. 2 Ethibond sutures (Ethicon, Somerville, NJ, USA) were used to repair the elevated anterior deltoid muscle to the anterior acromion through bone tunnels. The split in the deltoid was sutured using No. 1 Vicryl sutures (Ethicon).

2) Arthroscopic repair

All operations were performed by the same surgeon who performed the open repairs with the patient in a beach chair position with the back of the bed flexed to 70°. A posterior viewing portal and an anterior working portal were used in assessment of the glenohumeral joint. After performance of diagnostic arthroscopy through the posterior portal, the arthroscope was inserted through the posterior portal to the subacromial space, and a lateral portal was created. After performance of subacromial bursectomy through this portal, the pattern of the rotator cuff tear in the subacromial space was observed. If severe fibrillation was observed inferior to the acromion, except when the acromion was seen as being flat on the preoperative radiographs, the patient was young, or the rotator cuff tear was caused by a definite trauma, acromioplasty was performed based on the plain radiographs and arthroscopic findings. For subacromial viewing and rotator cuff repair, addition of a portal providing a Grand Canyon view¹⁴⁾ near the posterolateral corner of the acromion was established. Using the Banana Suture Lasso (Arthrex, Naples, FL, USA) through the 'Three Sister' portals (anterior subclavian portal, modified Neviaser portal, and posterior infraspinous portal),¹⁵⁾ one end of each fiber wire pair was shuttled through the torn cuff edge, and standard arthroscopic rotator cuff repair was performed.

Postoperative Rehabilitation

All patients followed a standard postoperative rehabilitation program. From the day of the operation, passive exercises including pendulum exercise, passive forward flexion, and external rotation exercises were performed in a tolerable range. Active exercises were not allowed until 6 weeks postoperatively or until regaining full passive ROM. Active-assisted exercises were started at 6 weeks postoperatively and muscle strengthening exercises were gradually introduced thereafter. Return to heavy demand activity or manual labor was delayed until 6 months.

Assessment of Tendon Healing

For assessment of tendon healing, anatomical evaluation of the cuff repair was performed using MRI as the imaging modality, as it provides multiplanar imaging of the postoperative shoulder. All 102 patients underwent routine MRI at least 6 months after surgery for assessment of tendon integrity. All studies were obtained using a 1.5-T scanner (Signa; GE Medical Systems, Milwaukee, WI, USA) using routine pulse sequences. The images were reviewed by an experienced senior radiologist who was informed that the patients had undergone surgery for rotator cuff repair but was blinded to the size and location of the tear that had been repaired. Continuity and retear of the tendon were assessed on MRIs according to established criteria.¹⁶⁾ A diagnosis of full-thickness retear (i.e., anatomic failure of healing) was made when a fluid-equivalent signal was found or when the supraspinatus, infraspinatus, or subscapularis tendon was not visible on at least one T2- or proton density-weighted image.

Statistical Analysis

An independent t-test was used for comparison of the UCLA, Constant, and VAS scores and the deltoid muscle thickness between the open and arthroscopic repair groups. A paired t-test was used for comparison of the preoperative and postoperative UCLA, Constant, and VAS scores between the two groups. Significance was set at $\alpha=0.05$, with 95% confidence intervals. The statistical package for the social sciences (SPSS) ver. 17.0 software package (SPSS Inc., Chicago, IL, USA) was used for statistical analyses.

Results

Pain

In the open repair group the subjective VAS at rest decreased from the preoperative mean of 1.8 ± 0.7 to 0.2 ± 0.1 at the last follow-up examination ($p<0.001$). The mean VAS score during motion declined to 1.7 ± 1.1 from the preoperative value of 5.6 ± 1.7 ($p<0.001$). In the arthroscopic repair group, the mean VAS scores at rest and during motion, respectively, improved from the preoperative values of 1.1 ± 0.3 and 5.7 ± 2.0 to 0.3 ± 0.1 and 2.2 ± 1.7 at the last follow-up examination ($p<0.001$ and <0.001 , respectively). At the last follow-up, the two groups did not show statistically significant differences in VAS scores at rest and during motion ($p=0.194$ and 0.145 , respectively) (Table 2).

Range of Motion

In the open repair group, the mean active ROM for forward flexion changed from 156.6° (range, 120° – 170°) preoperatively to 161.9° (range, 150° – 180°) at the last follow-up examination; external rotation at the side, from 53.6° (range, 15° – 80°) to 50.9° (range, 30° – 80°); and internal rotation to the posterior,

Table 2. Comparison of Postoperative Results between the Open and Arthroscopic Repair Groups

Variable	Open repair group (n=38)	Arthroscopic repair group (n=64)	p-value
VAS (pain at rest)	0.2 ± 0.1	0.3 ± 0.1	0.194
VAS (pain during motions)	1.7 ± 1.1	2.2 ± 1.7	0.145
ROM			
FF (°)	161.9 (150–180)	160.3 (140–180)	0.702
ERs (°)	50.9 (30–80)	55.3 (20–90)	0.333
IRp (level)	T10.0 (T3–T12)	T10.6 (T3–L3)	0.321
Muscle strength (kg)			
FF	5.1	4.2	0.063
ER	6.7	6.0	0.234
IR	9.3	8.5	0.250
Constant score	73.2 ± 12.8	67.6 ± 17.6	0.128
UCLA score	30.8 ± 3.2	28.7 ± 6.4	0.087

Values are presented as mean ± standard deviation, median (range), or mean only. VAS: visual analog scale, ROM: range of motion, FF: forward flexion, ERs: external rotation at the side, IRp: internal rotation to the posterior, ER: external rotation, IR: internal rotation, UCLA: the University of California at Los Angeles.

from T10.9 (range, T5–L1) to T10.0 (range, T3–T12). In the arthroscopic group, the mean preoperative ROM for forward flexion, external rotation at the side, and internal rotation to the posterior were measured at 143.6° (range, 130°–170°), 55.5° (range, 20°–80°), and T11.3 (range, T5–L4), respectively. At the last follow-up examination, the results were 160.3° (range, 140°–180°), 55.3° (range, 20°–90°), and T10.6 (range, T3–L3), respectively. Compared with the preoperative measurements, the postoperative values for all motions did not differ significantly between the two groups. In the evaluation of ROM at the last follow-up examination, no statistically significant difference was observed between the two groups ($p=0.702$, 0.333 , and 0.321 , respectively) (Table 2).

Muscle Strength

In the open repair group, the muscle strength for forward flexion, external rotation, and internal rotation increased from the preoperative mean of 5.8, 7.1, and 8.6 kg, respectively, to 5.1, 6.7, and 9.3 kg, respectively, at the last follow-up examination, but no statistically significant differences were observed when compared with the preoperative strengths ($p=0.246$, 0.372 , and 0.445 , respectively). In the arthroscopic repair group, the preoperative muscle strength was 5.6 kg during forward flexion, 7.0 kg during external rotation, and 8.2 kg during internal rotation. At the last follow-up examination, the muscle strength had changed to 4.2, 6.0, and 8.5 kg, respectively, but the differences were not statistically significant compared with the

Table 3. Comparison of Anatomic Results between the Open and Arthroscopic Repair Groups

Variable	Open repair group (n=38)	Arthroscopic repair group (n=64)	p-value
Healing	24 (63.2)	25 (39.1)	-
Retear	14 (36.8)	39 (60.9)	0.024
Partial tear	5 (13.1)	11 (17.2)	
Complete tear	9 (23.7)	28 (43.7)	

Values are presented as number (%).

preoperative results ($p=0.221$, 0.814 , and 0.981 , respectively). No statistically significant differences in the muscle strengths at the last follow-up examination were observed between the two groups ($p=0.063$, 0.234 , and 0.250 , respectively) (Table 2).

Clinical Assessment

In the open repair group the Constant scores increased from the preoperative mean of 55.9 to 73.2 at the last follow-up examination ($p<0.001$). The corresponding figures in the arthroscopic group improved from 53.8 to 67.6 ($p<0.001$). The preoperative UCLA score was 17.7 in the open repair group and 17.5 in the arthroscopic group. The UCLA score at the last follow-up examination was 30.8 in the open repair group and 28.7 in the arthroscopic group (Table 2).

The open repair group had 10 excellent (26.3%), 24 good (63.2%), and 4 fair results (10.5%). The arthroscopic repair group had 12 excellent (18.8%), 42 good (65.6%), 7 fair (10.9%), and 3 poor results (4.7%). A statistically significant improvement in the Constant and UCLA scores was observed in both groups, however the difference in the scores between the two groups was not statistically significant ($p=0.128$ and 0.087 , respectively).

Structural Results

In assessment of the repair integrity in both groups on the postoperative MRIs, 14 retears (36.8%) were observed in the open repair group. In the arthroscopic repair group, retears were observed in 39 shoulders (60.9%). The re-tear rate was significantly lower in the open repair group than in the arthroscopic repair group ($p=0.024$) (Table 3).

Functional Outcomes in the Complete Healing and Retear Groups

In the healing group the Constant score increased from the preoperative mean of 54.9 to 70.8 at the last follow-up examination ($p<0.001$). The corresponding figures for the re-tear group improved from 53.4 to 68.5 ($p<0.001$). The UCLA score at the last follow-up was 29.8 in the healing group and 29.1 in the re-tear group. No significant difference in functional outcome was observed between the healing and re-tear groups ($p=0.526$

Table 4. Comparison of Postoperative Results between the Complete Healing and Retear Groups

Variable	Complete healing group (n=49)	Retear group (n=53)	p-value
VAS (pain during motions)	2.2 ± 1.1	1.8 ± 1.7	0.633
ROM			
FF (°)	162.0	159.6	0.554
ERs (°)	53.3	51.9	0.688
IRp (level)	T10.0	T10.6	0.321
Muscle strength (kg)			
FF	4.6	4.4	0.628
ER	6.2	6.1	0.926
IR	7.8	7.7	0.878
Constant score	70.8 ± 14.3	68.5 ± 15.6	0.526
UCLA score	29.8 ± 3.7	29.1 ± 4.4	0.654

Values are presented as mean ± standard deviation or mean only. VAS: visual analog scale, ROM: range of motion, FF: forward flexion, ERs: external rotation at the side, IRp: internal rotation to the posterior, ER: external rotation, IR: internal rotation, UCLA: the University of California at Los Angeles.

and 0.654, respectively) (Table 4).

Discussion

A retear after surgical repair of a massive rotator cuff tear is a common complication. Association of several factors including patient age, preoperative tear size, degree of muscular atrophy, degree of fatty infiltration of the cuff muscle, surgical technique, and inappropriate rehabilitation with tendon retears has been demonstrated.¹⁷⁻¹⁹ In general, when successful repair of a massive rotator cuff tear is achieved, excellent clinical results may be attained and joint degeneration may be halted or at least markedly decelerated.^{20,21} However, with respect to less mobile and severely retracted massive rotator cuff tears, literature comparing and analyzing clinical results and repair integrity between open and arthroscopic repairs is lacking.

Trappey and Gartsman²² insisted that a low-tension environment is critical for rotator cuff healing. Other biomechanical studies have demonstrated that the elements for successful repair of a rotator cuff tear are strong fixation,^{23,24} a high interface pressure and a wide interface area between the tendon and bone,²⁵ and minimization of stress concentration inside the tendon.²⁶ In cases of arthroscopic repair of a massive rotator cuff tear, effective anatomical repair is difficult because the repair construct is under inevitably undue tension even after sufficient release. Therefore, the retear rate of massive rotator cuff tears is generally higher than that of smaller rotator cuff tears. Recent studies have reported postoperative healing rates after arthroscopic repair of

massive rotator cuff tears of 47% to 94%.^{4,17,27} In this study, the retear rate was 60.9% after arthroscopic repair of massive rotator cuff tears, which is within a similar range with that reported in other relevant literature; however, the retear rate was 36.8% for open repair, which was a statistically significant lower retear rate than that for arthroscopic repair.

There are several explanations for the favorable clinical and anatomical results of open rotator cuff repair in this study. First, the authors used the deltoid splitting technique for the approach to repair of the torn rotator cuff and minimized postoperative dehiscence of the deltoid using the Mason–Allen stitch to reattach and strongly fix the coracoacromial ligament and the deltoid detached from the anterior acromion. Second, for sufficient release of a less mobile and severely retracted torn cuff, a small Darrach retractor was used for release in the anterior, superior, and posterior directions to minimize tension and repair at the anatomical footprint. In addition, the Mason–Allen and conventional transosseous techniques were used for firm fixation.

Liu and Baker²⁸ initially reported no significant clinical differences in evaluation of patients with intact or torn rotator cuffs using arthrography 2 years after surgery. In contrast to these results, Gazielly et al.¹⁷ and Harryman et al.⁶ reported superior clinical outcomes in patients with intact repairs regardless of initial tear size. Zumstein et al.²⁹ reported significantly increased Constant scores and abduction strength with preserved repair integrity after massive rotator cuff repairs. Galatz et al.⁵ reported excellent early clinical results despite loss of repair integrity, which appeared to deteriorate over time. Although structural failure of repair of massive tears can and does occur, it does not necessarily imply a poor clinical outcome.^{5,6} In our study, despite structural failures, excellent pain relief and improvement in the ability to perform activities of daily living were demonstrated during the >24-month follow-up period. This result, combined with those of multiple studies documenting frequent progression of rotator cuff tears over time, suggests that early improvement despite retear may be attributable to partial restoration of shoulder force couples that deteriorate with the described natural history of tear progression.³⁰ Other possible explanations for the clinical improvement despite loss of repair integrity include the potential beneficial effects of bursectomy and the postoperative rehabilitation protocols associated with rotator cuff repair surgery.²⁹

Our study had a few limitations. First, as it was retrospective in nature, our study had limitations similar to those of other retrospective studies. Second, the two techniques were not randomized, thus selection bias could be an issue. However, open repair tended to be performed in more severe cases. Nevertheless, if the open repair group showed more favorable results, open repair may be considered to have stronger advantages. The strength of this study was that reliable and validated MRIs were used to measure the postoperative structural outcome. Another strength is that this study is a rare and noteworthy piece of

literature comparing and analyzing clinical results and repair integrity after open and arthroscopic repairs of less mobile and severely retracted massive rotator cuff tears. The growing number of advantages of recent arthroscopic repair has led to decreasing attention to open repair; however this study showed that open repair results in more-favorable structural outcomes for massive rotator cuff tears; therefore, in cases of a less mobile and severely retracted tendon, open repair is recommended instead of stressing arthroscopic repair.

Conclusion

Open and arthroscopic repairs of massive rotator cuff tears provided satisfactory clinical results with no significant difference. However, a significantly lower retear rate was observed for the open repair group compared with the arthroscopic repair group. Open repair may be recommended for appropriately selected patients with less mobile and severely retracted massive rotator cuff tears.

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