The Long-Term Outcome of Recurrent Defects After Rotator Cuff Repair

Christopher C. Dodson,*† MD, Alison Kitay,* MD, Nikhil N. Verma,‡ MD, Ronald S. Adler,§ MD, Joseph Nguyen,* MPH, Frank A. Cordasco,* MD, and David W. Altchek,* MD
*From the *Sports Medicine and Shoulder Service, Hospital for Special Surgery, New York, New York, the ‡Department of Orthopaedics, Rush University Medical Center, Chicago, Illinois, and the §Department of Radiology, Hospital for Special Surgery, New York, New York*

Background: Retears of the rotator cuff are not uncommon after arthroscopic and mini-open rotator cuff repairs. In most studies, the clinical results in patients with persistent defects demonstrated significantly less pain and better function and strength compared with their preoperative state at an early follow-up.

Hypothesis: The clinical and structural outcomes of patients with known rotator cuff defects will remain unchanged after a longer period of follow-up.

Study Design: Case series; Level of evidence, 4.

Methods: This study was performed in 15 patients (18 shoulders) from a previous study who had recurrent rotator cuff defects 3.2 years after repair. Each patient completed the American Shoulder and Elbow Surgeons Scoring Survey, the Simple Shoulder Test, the L'Insalata Scoring Survey, and a visual analog scale for pain. Eleven patients (13 shoulders) were clinically reexamined at an average of 7.9 years for range of motion and strength, with targeted ultrasound.

Results: At the 7.9 year follow-up the average scores were 95 (American Shoulder and Elbow Surgeons), 95 (L'Insalata), 11 (Simple Shoulder Test), and 0 (visual analog for pain), which were not statistically significantly different from the scores at 3.2 years. There was no change in the average range of motion; however, there was a statistically significant reduction in forward flexion strength and external rotation strength, as measured by a dynamometer. The average external rotation strength decreased by a mean of 42% and the mean forward flexion strength decreased by a mean of 45% ($P < .001$). Furthermore, there was a statistically significant increase in the mean size of the defect, from 273 mm^2 to 467 mm^2 ($P < .001$). Finally, the size of the defect increased in all patients, and no defects healed structurally.

Conclusion: At an average of 7.9 years, patients with recurrent defects after rotator cuff repair still had an improvement in terms of pain, function, and satisfaction. However, the rotator cuff defect significantly increased in size, and there was a progression of strength deficits. These findings suggest that patients with recurrent defects can remain asymptomatic over the long term but will predictably lose strength in the involved extremity. Furthermore, the study demonstrated that defects after rotator cuff repair increase in size but often remain asymptomatic.

Keywords: rotator cuff repair; recurrent defects; shoulder

Several authors have reported persistent structural defects after open and arthroscopic rotator cuff repairs, with rates between 13% and 94%.[2,6,8-11,15,16,20,29] However, despite the high frequency of recurrent defects, the clinical significance and long-term outcomes of patients with persistent rotator cuff tear remain poorly defined.[6,9,13] A previous study from our institution reported persistent rotator cuff defects in 26% of patients undergoing mini-open or arthroscopic rotator cuff repair.[30] However, in patients with a recurrent defect, follow-up examination revealed significantly less pain, better function, and better strength, as compared with their preoperative state. Furthermore, there was no difference in outcomes between patients with an intact rotator cuff and those with a recurrent defect, with the exception of forward elevation and external rotation strength. No patient in this group required further surgery. Nonetheless, there is concern regarding recurrence of symptoms owing to persistent structural defect with long-term follow-up.

The literature is sparse with studies regarding the long-term follow-up of patients who have known retears at an early follow-up period. This dearth in the research

†Address correspondence to Christopher C. Dodson, MD, Fellow, Sports Medicine and Shoulder Service, Hospital for Special Surgery, New York, NY 10021 (e-mail: dodsonc@hss.edu).

Presented at the interim meeting of the AOSSM, Las Vegas, Nevada, February 2009.

No potential conflict of interest declared.

The American Journal of Sports Medicine, Vol. 38, No. 1
DOI: 10.1177/0363546509341654

is probably in part due to the fact that many of these patients are asymptomatic and doing clinically well despite their retears and, as a result, are lost to follow-up. The clinical significance of determining how these patients do over the long term is important because it may encourage surgeons to surgically intervene at an earlier period if they knew that leaving these defects untreated would result in significant clinical deterioration. The purpose of this study was to determine the clinical and structural outcomes of patients with known recurrent rotator cuff defects at long-term follow-up.

MATERIALS AND METHODS

Approval was obtained from the hospital's institutional review board. Patients were identified from a list of patients enrolled in a previous study with documented persistent full-thickness rotator cuff defect on follow-up ultrasound at an average of 3.2 years after surgery.[30] Fifteen patients were eligible for this study, for a total of 18 shoulders. The patients provided informed consent to participate. The average age at the time of the rotator cuff repair was 62 years (range, 44-73). There were 12 men and 3 women, and 13 patients had involvement of the dominant extremity. Initially, 9 patients had a tear of 1 tendon (supraspinatus) and 6 patients had a tear of 2 tendons (supraspinatus and infraspinatus). The average size of the initial tear was 2.8 cm (273 mm^2 at 3.2 years). Arthroscopic rotator cuff repair had been performed in 7 patients, and mini-open rotator cuff repair was performed in the remaining 8 patients.

All 15 patients (18 shoulders) completed the Simple Shoulder Test, the American Shoulder and Elbow Surgeons Scoring Survey, and the L'Insalata Scoring Survey at both 3.2 years and 7.9 years.[18,21] Patients were also asked to complete a visual analog pain scale (0 to 10) regarding shoulder pain experienced during an average week. Eleven patients (13 shoulders) agreed to a follow-up visit and were reexamined after a mean of 7.9 years (range, 6-9), postoperatively; the remaining 4 patients refused or were unable to return for ultrasound evaluation and physical examination.

Clinical Assessment

Informed consent was obtained at the time of the clinical follow-up visit. All physical examinations were performed by one sports medicine fellow (C.C.D). Active range of motion was recorded for the affected shoulders in forward flexion in the scapular plane, in external rotation with the arm at the side, and in internal rotation behind the back. Rotation was measured 3 times using a goniometer, and the average of the results was calculated. Strength testing was performed with a handheld dynamometer (Lafayette Manual Muscle Test System, Lafayette Instrument Company, Lafayette, Indiana) for forward flexion in the scapular plane and for external rotation with the arm at the side in the affected shoulder. Forward flexion was tested with the patient standing, the elbow extended, and the shoulder forward-flexed to 90° in the scapular plane. The patient was then asked to maximally elevate against the dynamometer and hold for 5 seconds. This measurement was performed 3 times on each shoulder, and the average of the results was calculated. External rotation strength was tested with the arm at the side, the elbow flexed to 90°, and the shoulder in neutral rotation. The patient was then asked to maximally externally rotate against the dynamometer and hold for 5 seconds. Again, the average of 3 measurements was calculated for each shoulder. Finally, the liftoff test was performed to assess the integrity of the subscapularis.

Ultrasound Assessment

Ultrasonographic evaluation was performed on all patients by a single radiologist (R.S.A.) who had 18 years' experience performing musculoskeletal ultrasound and was the same radiologist who interpreted the images at the 3.2-year follow-up evaluation. Targeted examination of the supraspinatus and infraspinatus tendons was performed with the patient seated and the arm placed in internal rotation and extension. Scans were performed with either a Siemens Sonoline Elegra scanner (Siemens Medical, Mountainview, California) with a 7.5-MHz linear transducer or an IU22 scanner (Philips Medical, Bothell, Washington) with a 12.5-MHz linear transducer. Defects were measured for size in 2 dimensions. To maintain consistency with previous tear size measurements, defects were measured with regard to transverse diameter at the greater tuberosity. The radiologist was blinded to the results of the physical examination.

Statistical Analysis

SPSS 14.0 (SPSS Inc, Chicago, Illinois) was used for statistical analysis. The differences in mean values for the standardized shoulder surveys, as well as for clinical and radiographic outcomes, were calculated with paired-samples *t* tests. For all outcome measures, the significance level was set at $P < .05$.

RESULTS

Table 1 presents subjective scoring results and physical examination findings. No statistically significant difference was observed at final follow-up (7.9 years) for all scoring scales (American Shoulder and Elbow Surgeons survey, L'Insalata, Simple Shoulder Test, visual analog pain scale), as compared with the mean values at the 3.2-year follow-up. The range for the American Shoulder and Elbow Surgeons survey is 0-100 points; for the L'Insalata, 17-100 points; for the Simple Shoulder Test, 0-12 points; and for the visual analog pain scale, 0-10. No statistically significant difference was observed at final follow-up with regard to range of motion (forward flexion, external rotation, and internal rotation), when compared with that at the 3.2-year follow-up.

Strength measurements (forward flexion and external rotation) were also compared with the values obtained at the 3.2-year follow-up. The mean forward flexion strength at 7.9 year follow-up was 8.0 lbs (3.6 kg), compared with

TABLE 1
Comparison of Postoperative Survey and Physical Examination Data at 2 Follow-up Times

	Follow-Up (Mean ± SD)		
	3.2 Years	7.9 Years	*P*
Range of motion			
Forward flexion	171.36 ± 8.39	174.09 ± 4.37	.294
External rotation	61.36 ± 20.26	56.36 ± 14.68	.300
Strength, lbs (kg)			
Forward flexion	20.46 ± 6.20 (9.21 ± 2.79)	11.9 ± 4.12 (5.36 ± 1.85)	<.001
External rotation	14.94 ± 5.28 (6.72 ± 2.38)	8.18 ± 6.77 (3.68 ± 3.05)	<.001
Visual analog scale[a]	0.57 ± 1.40	0.36 ± 0.84	.657
American Shoulder and Elbow Surgeons score[b]	96.38 ± 6.17	95.24 ± 4.71	.630
L'Insalata score[c]	94.79 ± 5.13	95.99 ± 3.48	.446
Simple Shoulder Test[d]	11.37 ± 1.04	11.13 ± 1.46	.645
Retraction measurement	15.82 ± 8.69	21.86 ± 9.85	<.001
Width measurement	14.55 ± 7.16	18.59 ± 9.95	.174
Measurement area (mm^2)	273.27 ± 243	467.11 ± 370	.031

[a]Normal range values, 0-10.
[b]Normal range values, 0-100.
[c]Normal range values, 17-100.
[d]Normal range values, 0-12.

14.9 lbs (6.7 kg) at 3.2 years; the mean external rotation strength at 7.9 year follow-up was 11.9 lbs (5.4 kg), compared with 20.0 lbs (9.0 kg) at 3.2 years. These results reflect a decrease of 45% in forward flexion strength and a 42% decrease in external rotation strength and are statistically significant ($P < .001$). There was no significant difference in strength between patients who had a mini-open approach and those who had an all-arthroscopic repair.

According to ultrasound evaluation, none of the previous defects had structurally healed at the time of the most recent follow-up. Furthermore, the overall average size of defects markedly increased from the 3.2-year examination to the 7.9-year follow-up. The average size at the 3.2-year follow-up was 273 mm^2, compared with 467 mm^2 at the latest follow-up ($P < .05$). Again, there was no difference in the average size of progression between patients who had a mini-open approach and those who had an all-arthroscopic repair.

No patient required further treatment for recurrent or persistent shoulder pain since previous follow-up. Furthermore, no patient had undergone further surgery on the affected shoulder since previous follow-up.

DISCUSSION

This study was conducted to investigate the long-term outcome of patients who have known retears after rotator cuff repair. In our experience, patients who develop recurrent defects after rotator cuff repair experience the same clinical improvement after surgery as patients with an intact rotator cuff. Therefore, we have avoided surgical correction of the defect and treated these patients nonoperatively. Our concern was whether these patients maintain their clinical improvement over the long term, which forms the basis of our investigation.

At the 7.9-year follow-up evaluation, patients with known recurrent defects demonstrated no deterioration in clinical outcome with respect to standardized outcome measures (American Shoulder and Elbow Surgeons survey, L'Insalata, Simple Shoulder Test, visual analog pain scale), as well as average range of motion. However, with regard to strength, we did notice a substantial reduction not typically observed in healed repairs.[3,11] We found a decrease of 45% in forward flexion strength and a 42% decrease in external rotation strength, both of which were statistically significant ($P < .001$). Our findings indicate that although patients remain satisfied with their overall shoulder function, they predictably lost shoulder strength over time. Furthermore, progression of strength deficit is consistent with the significant progression in tear size noted on ultrasound. At the time of the most recent follow-up, a recurrent defect was again identified in all 11 patients, as based on the same established ultrasound criteria. In addition, the overall average size of the defects changed significantly from the 3.2-year follow-up to the 7.9-year examination: the average size at the former was 273 mm^2, compared with 467 mm^2 at the latter ($P < .05$). We did not observe healing in any of the 11 patients, and the size of the recurrent defect increased in each.

To our knowledge, there is only one previous study that addressed the long-term clinical and structural outcomes of a series of rotator cuff reruptures. In an elegant study, Jost et al[14] reported on 20 patients at a mean of 7.6 years after open rotator cuff repair in whom a rerupture had been documented at 3.2 years with magnetic resonance imaging (MRI). The researchers noted that at the 7.6-year

follow-up, no clinical deterioration was observed in the 20 patients when compared with their evaluations at 3.2 years. They also reported a mean relative Constant score greater than 80%; significant improvement in terms of pain, activities of daily living, function, and strength (compared with those parameters before the repair); and a high rate of patient satisfaction, with 95% of the patients being very satisfied or satisfied. The data from their series suggest that structural failure of a repair may not have the same prognosis as an untreated tear, because the reruptures did not increase in size over time, whereas untreated tears tend to have a high risk of tear progression.[18,22,26,33] Perhaps the most surprising finding from their study was their observation that some reruptures appeared to heal. They reported that 8 of the 20 reruptures seen at 3.2 years could no longer be identified using the same MRI technique and interpretation by the same radiologists. Although MRI is known to be a validated diagnostic tool for diagnosing rotator cuff tendon lesions,[12] its use in the setting of rotator cuff repair can be challenging.[6,23,34] Some authors have found the specificity of MRI for the diagnosis of rotator cuff rerupture to be only 25%, especially when the size of the rerupture was less than 100 mm^2.[23] In the study by Jost et al,[14] 4 of the 8 patients in the healed group had a tear size less than 100 mm^2.

Our results are more consistent with those of other studies that propose that rotator cuff tears not only fail to heal spontaneously but also have a strong tendency to progress.[5,27,32] However, despite the progression of the tear size, patients remain asymptomatic. This is in contrast to the natural history of untreated tears, which become more symptomatic as they increase in size.[3,7,35] Jost et al[14] reported a similar finding, and it is still unclear what contributes to significant pain relief in the setting of retears. It may be that impingement is a significant source of pain in patients with rotator cuff injury. We routinely perform a debridement and subacromial decompression at the time of the rotator cuff repair; perhaps, patients benefit from the bursectomy and acromioplasty, resulting in adequate pain relief. Furthermore, we prescribe an extensive postoperative rehabilitation protocol, which can also be beneficial in patients who suffer from impingement. Finally, the lack of measurable influence on clinical results in patients with recurrent defects may be due to a still-intact force couple (infraspinatus and subscapularis), which may allow patients to compensate for loss of supraspinatus function.

Note that many of the most commonly used outcome scales do not allocate points for strength measurements. The average age of the population in this study was 62 years; it is possible that patients in this age group are less active and therefore do not notice a significant reduction in strength but focus more on pain relief. As a result, the scoring scale values remain high. Thus, although our results indicate that symptomatic relief can be achieved over the long term despite repair failure, they would have been less promising if our study contained a more significant amount of younger patients, who are particularly focused on restoration of shoulder strength. Furthermore, there is some concern that shoulder function may measurably deteriorate with even longer follow-up, especially in younger patients who remain active.

In this study, ultrasound was selected as the imaging modality to assess rotator cuff integrity (as it was in the previous study). Ultrasound has been described in the literature as an accurate method of evaluating rotator cuff integrity after surgical repair.[1,4,19,25,28,31] There are a couple of advantages in using ultrasound versus another imaging modality, such as MRI. First, the cost of an ultrasound is significantly lower than that of MRI. Second, an ultrasound examination of the shoulder to assess for rotator cuff lesions can be performed in less than 5 minutes. The current study required a voluntary return to our institution for examination; yet, because ultrasound can be performed expeditiously, it helped us to recruit as many patients as possible for follow-up. A recent study from our institution evaluated the ability of ultrasound to detect intact versus defective tendons in the postoperative setting.[24] In that study, using the same radiologist (R.S.A.), the interobserver reliability for ultrasound interpretation of postsurgical rotator cuff tendons demonstrated a high kappa for intact versus defects (0.894) and high interclass correlation scores for defect area (0.906).

A major limitation of this study includes the loss of patients during the follow-up period. Our institution is located in a major metropolitan center, and many of our patients have a migratory pattern that does not allow them to return for follow-up examination. In the cases where patients were unable to return for follow-up, the standardized questionnaires were mailed to them for completion. In addition, the data from the original study were collected retrospectively; repairs were performed by multiple surgeons; and the repairs were not standardized (mini-open versus all-arthroscopic). Last, we did not obtain radiographs at the latest follow-up examination. Therefore, it is possible that some patients developed degenerative changes as a result of their chronic rotator cuff tears, which could affect their clinical outcome. We believe it unlikely that advanced degenerative changes in the shoulder would not be manifested by a decrease in subjective scoring values. However, patients with early degenerative changes secondary to rotator cuff arthropathy can become symptomatic with even longer-term follow-up.

At the time of long-term follow-up, patients with recurrent defects after rotator cuff repair still had significant clinical benefit in terms of pain, function, and range of motion despite an overall increase in the size of the recurrent defects. We did, however, observe a significant reduction in shoulder strength. We conclude that nonoperative treatment can offer pain control in patients with a retear; however, strength cannot be maintained over the long term.

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