

# Comparison of Functional Outcomes After Arthroscopic Rotator Cuff Repair Between Patients With Traumatic and Atraumatic Tears

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**Background:** The role of tear etiology in outcomes after rotator cuff repair is not well understood.

**Purpose/Hypothesis:** The purpose of this study was to determine the difference in outcomes after rotator cuff repair based on tear etiology. We hypothesized that traumatic rotator cuff tears will have greater improvements in functional outcome measures and range of motion (ROM) than atraumatic tears.

**Study Design:** Cohort study; Level of evidence, 3.

**Methods:** We conducted a chart review of 221 consecutive patients who underwent arthroscopic rotator cuff repair; prospectively collected preoperative and minimum 2-year postoperative data were evaluated. Shoulder ROM, strength, and standard shoulder physical examination findings were recorded pre- and postoperatively. Outcome measures included visual analog scale for pain, Subjective Shoulder Value (SSV), 10-item Patient-Reported Outcomes Measurement Information System (PROMIS-10; physical and mental components), and American Shoulder and Elbow Surgeons (ASES) form.

**Results:** Of the 221 patients, 73 had traumatic tears and 148 had atraumatic/degenerative tears. There were no differences in age, body mass index, or Charlson Comorbidity Index between groups. Patients in the atraumatic cohort had significantly longer duration of symptoms before presentation (18 vs 7 months;  $P < .01$ ). Preoperatively, the traumatic cohort had less motion to forward flexion (mean  $\pm$  SD;  $138^\circ \pm 43.7^\circ$  vs  $152^\circ \pm 29.8^\circ$ ;  $P = .02$ ). Postoperatively, both groups experienced significant improvements in visual analog scale and SSV scores ( $P < .001$  each). However, only the traumatic cohort demonstrated improvements in ASES and PROMIS-10 physical component scores. Patients with traumatic rotator cuff tears had lower preoperative SSV and less motion than those with atraumatic tears, but they had greater improvements in SSV ( $40.6\% \pm 39.0\%$  vs  $29.2\% \pm 39.7\%$ ;  $P = .005$ ) and forward flexion ( $21.6^\circ \pm 48.6^\circ$  vs  $2.3^\circ \pm 48.2^\circ$ ;  $P < .001$ ), as well as strength in forward flexion, external rotation, and internal rotation ( $P < .001$ ,  $P = .003$ , and  $P = .002$ , respectively).

**Conclusion:** Patients with traumatic rotator cuff tears have worse preoperative symptoms and more functional deficits but experience greater improvements in ROM, strength, and perceived shoulder function than those with degenerative/atraumatic tears.

**Keywords:** rotator cuff; rotator cuff repair; shoulder trauma

Symptomatic rotator cuff tears are a common cause of shoulder pain and disability and can be generally classified as traumatic or degenerative in nature. Traumatic tears usually occur in younger patients after a fall or trauma to an abducted and externally rotated arm, whereas chronic or degenerative tears (atraumatic) are thought to develop in part because of age-related tendon degeneration with subsequent progression from tendinopathy to partial- and full-thickness tears.<sup>17,24</sup> Studies have demonstrated that

surgical rotator cuff repair leads to improvement in shoulder pain and function, with the best functional outcomes corresponding with repairs that remain intact.<sup>7-9,13</sup> Tear size, number of tendons involved, tear chronicity, and amount of fatty infiltration and muscle atrophy have been investigated as significant predictors of functional outcome and repair integrity.<sup>5,9,10,15,18,24,32</sup> Tear etiology (traumatic vs atraumatic) may also play an important role in predicting functional outcomes, although there is limited research exploring this notion.

Atraumatic rotator cuff tears have been postulated to have impaired healing in comparison with acute traumatic rotator cuff tears after surgical repair. While rotator cuff

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healing has not been shown to correlate with pain outcomes, better functional outcomes have been demonstrated with repairs that remain intact.<sup>7,13</sup> Research has failed to identify a clinical difference in healing rates after surgery for traumatic versus atraumatic rotator cuff tears and has found no significant difference in retear rates.<sup>36</sup> However, studies have shown that larger and more chronic rotator cuff tears are more likely to have fatty infiltration and muscle atrophy as compared with smaller and more acute tears, which suggests that repair of degenerative tears may have poorer outcomes, as these characteristics have been independently predictive of worse functional outcomes after repair.<sup>8,9,27</sup>

The aim of this study was to examine if repairs of traumatic rotator cuff tears differ in functional and clinical outcomes from their atraumatic counterparts. We hypothesized that traumatic rotator cuff tears would have greater improvements in outcome measures and range of motion (ROM). Elucidation of the effect of tear etiology on outcomes after rotator cuff repair can help with preoperative counseling and shared clinical decision making.

## METHODS

After obtaining approval from the institutional review board, we reviewed the prospectively collected data of all patients who underwent arthroscopic rotator cuff repair at a single institution between 2013 and 2018. All procedures were performed by one of the senior fellowship-trained orthopaedic sports medicine surgeons at our institution (A.L. and B.P.L.). Inclusion criteria consisted of documentation of whether the rotator cuff tear was due to a traumatic event, preoperative magnetic resonance imaging (MRI) available for review, and clinical follow-up of 2 years. Revision rotator cuff repairs were excluded.

Basic descriptive data were obtained via chart review and included patient sex, extremity involved, hand dominance, age at presentation and surgery, body mass index, tobacco use, diabetes mellitus status, and Charlson Comorbidity Index. Clinical notes were reviewed at preoperative presentation and final clinical follow-up to obtain visual analog scale scores for pain, Subjective Shoulder Value (SSV) scores, presence or absence of nighttime pain, and shoulder ROM of forward flexion (FF) in the scapular plane and external rotation (ER) at the side, as well as rotator cuff strength in FE, ER, and internal rotation. ROM was assessed with the patient's active motion only; passive motion was excluded given the intent to measure the

functioning rotator cuff. FE and ER were chosen to isolate the function of the supraspinatus and infraspinatus tendon/muscle. Rotator cuff strength was assessed by the examining fellowship-trained orthopaedic sports medicine surgeon using the standard subjective scale from 0 to 5.

Patient outcome scores were recorded pre- and postoperatively and included the 10-item Patient-Reported Outcomes Measurement Information System (PROMIS-10; physical and mental components) and the American Shoulder and Elbow Surgeons (ASES) form. Postoperative complications were also recorded: retear of the repaired rotator cuff tendon confirmed via MRI, subsequent revision rotator cuff repair, postoperative stiffness necessitating manipulation under anesthesia, infection requiring operative irrigation and debridement, and conversion to reverse total shoulder arthroplasty.

Preoperative radiographs were reviewed to determine critical shoulder angle, Hamada classification, and presence of osteoarthritis.<sup>14,25,35</sup> Preoperative MRI scans were reviewed to determine rotator cuff muscle involvement and muscle quality based on the Goutallier classification of fatty infiltration.<sup>2,33,34</sup> Operative reports were reviewed for operative time, which rotator cuff tendons were repaired, and concomitant procedures performed, such as acromioplasty or if the long head of the biceps tendon was addressed.

## Study Cohorts

Patients were divided into 2 cohorts: those with a traumatic cause of rotator cuff tear and those with atraumatic/degenerative etiology. Delineation of traumatic versus degenerative tear was based on patient history of traumatic event and muscular edema on MRI scans.<sup>23,31</sup> To be considered traumatic in nature, patients had to report a specific trauma related to the onset of correlating symptoms, with an adequate injury mechanism. Acute traumatic tears were confirmed via the presence of muscle edema on MRI scans. Preoperative measurements were compared with postoperative values at final follow-up within each cohort, as well as between cohorts. Changes from pre- to postoperative values were also calculated and compared within and between cohorts.

## Statistical Analysis

All deidentified patient information was compiled into a secured Excel spreadsheet (Microsoft). Descriptive data included mean and standard deviation for continuous

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Ethical approval for this study was waived by the University of Pittsburgh.

TABLE 1  
Characteristics of the Study Cohorts<sup>a</sup>

	Traumatic (n = 73; 33%)	Atraumatic (n = 148; 67%)	P Value
Sex			<b>.002</b>
Male	46 (63.0)	61 (41.2)	
Female	27 (37.0)	87 (58.8)	
Involved side			.51
Right	37 (50.7)	82 (55.4)	
Left	36 (49.3)	55 (44.6)	
Dominant arm affected			<b>.02</b>
Yes	28 (38.4)	82 (55.4)	
No	45 (61.6)	66 (44.6)	
Age, y			
At presentation	56.5 ± 12.8	58.7 ± 10.9	.43
At time of surgery	56.7 ± 12.9	59.4 ± 10.8	.28
Time from injury to surgery, d	57 ± 34.4	93 ± 143	<b>&lt;.001</b>
Body mass index	30.2 ± 6.7	30.5 ± 7.2	.72
Diabetes	8 (11.0)	22 (14.9)	.4
Tobacco use	10 (13.7)	21 (14.2)	.89
Charlson Comorbidity Index score	1.2	1.1	.54

<sup>a</sup>Values are presented as No. (%) or mean ± SD unless indicated otherwise. Bold *P* values indicate statistically significant difference between groups (*P* < .05).

variables and number and percentages for continuous variables to describe patient baseline characteristics and surgical procedures. Fisher exact test and Student *t* test were used to compare categorical and continuous data, respectively. *P* < .05 was considered statistically significant. Data normality was assessed using the Jarque-Bera test.

An a priori power analysis, with a power of 80% and alpha of .05, demonstrated that 33 patients were needed in each cohort to achieve sufficient power to detect a significant difference in ASES score based on the minimal clinically important difference.<sup>37</sup>

## RESULTS

Overall, 221 patients met the study criteria: 73 (33%) with traumatic rotator cuff tears and 148 (67%) with atraumatic tears. The mean follow-up was 27 months (traumatic, 28 months; atraumatic, 27 months; *P* = .56). Patients with traumatic rotator cuff tears were more often male (*P* < .01), with tears that affected the nondominant arm (*P* = .02) (Table 1). On average, patients with traumatic rotator cuff tears sought care sooner after the onset of symptoms (mean ± SD; 6.5 ± 10.8 vs 17.9 ± 29.3 months, respectively; *P* < .01). The Jarque-Bera test determined that the data were normally distributed.

Preoperative imaging revealed no differences between traumatic and atraumatic rotator cuff tears with respect to critical shoulder angle (33.3° vs 32.5°, respectively; *P* = .10), mean Hamada classification (1.9 vs 1.8; *P* = .62), or prevalence of osteoarthritis (*P* = .11). Each rotator cuff muscle was classified according to the Goutallier classification to determine muscle quality via degree of fatty infiltration, and there was no difference between the cohorts for any of the muscles (Table 2). There was no difference between the groups regarding imaging abnormalities of the

TABLE 2  
Mean Goutallier Classification

	Traumatic	Atraumatic	P Value
Supraspinatus	0.71	0.80	.58
Infraspinatus	0.53	0.57	.78
Teres minor	0.27	0.17	.37
Subscapularis	0.48	0.34	.38

long head of biceps tendon (eg, absence, tendinitis, tearing) (65.7% vs 60.1%; *P* = .61).

The time from presentation to surgery was significantly less in those with traumatic rotator cuff tears versus their atraumatic counterparts (56.6 ± 34.4 vs 92.9 ± 143 days; *P* < .01). Traumatic rotator cuff tears had significantly longer operative times than their atraumatic counterparts (106 ± 40 vs 86 ± 29 minutes; *P* < .01). There were no differences in rates of biceps tenotomy versus tenodesis versus no biceps surgery between the cohorts (*P* = .43). Additionally, there was no difference between the cohorts in the proportion of patients undergoing acromioplasty (*P* = .27). Table 3 presents data for the rotator cuff tendons repaired in each cohort.

Preoperatively, patients with traumatic rotator cuff tears had significantly less forward flexion (FF) and were weaker with FF (*P* = .02 and .002, respectively). There were no differences preoperatively in outcome scores, except for lower PROMIS-10 physical component scores in the traumatic cohort (*P* = .004). Postoperatively there were no differences between the cohorts in any of the assessed outcomes except FF, which was greater in those with traumatic tears (*P* = .04). Both cohorts saw significant improvements in visual analog scale and SSV scores, as well as FF and ER strength; however, only those with

TABLE 3  
Rotator Cuff Tendons Repaired<sup>a</sup>

	Traumatic	Atraumatic	P Value
1 tendon	36 (49.3)	80 (54.1)	.51
Supraspinatus	33 (45.2)	76 (51.4)	.39
Subscapularis	3 (4.1)	4 (2.7)	.60
2 tendons	31 (42.5)	57 (38.5)	.58
Supraspinatus and infraspinatus	17 (23.3)	23 (15.6)	.18
Supraspinatus and subscapularis	14 (19.2)	34 (23.0)	.51
3 tendons: supraspinatus, infraspinatus, and subscapularis	6 (8.2)	11 (7.4)	.84

<sup>a</sup>Values are presented as No. (% of group).

TABLE 4  
Pre- and Postoperative Outcome Measures<sup>a</sup>

	Preoperative			Postoperative			Change, Pre- to Postoperative				
	Traumatic	Atraumatic	P Value	Traumatic	Atraumatic	P Value	Traumatic	P Value <sup>b</sup>	Atraumatic	P Value <sup>b</sup>	P Value <sup>c</sup>
VAS	6.9 ± 2.1	7.1 ± 2.2	.52	1.4 ± 2.4	2.1 ± 2.9	.08	-5.5 ± 3.2	<b>&lt;.001</b>	-5.0 ± 3.2	<b>&lt;.001</b>	.37
SSV	46.1 ± 22.8	53.1 ± 23.0	.06	86.6 ± 15.2	82.4 ± 19.5	.15	40.6 ± 39.0	<b>&lt;.001</b>	29.2 ± 39.7	<b>&lt;.001</b>	<b>.005</b>
PROMIS-10											
Mental	12.5 ± 0.7	14.4 ± 3.2	.09	14.2 ± 3.5	15.4 ± 2.9	.09	1.7 ± 4.2	.08	1.0 ± 6.6	.31	.67
Physical	10.0 ± 0.0	13.0 ± 3.0	<b>.004</b>	14.5 ± 3.0	14.3 ± 2.4	.74	4.5 ± 4.1	<b>&lt;.001</b>	1.3 ± 5.8	.07	.08
ASES	28.3 ± 9.4	50.8 ± 20.8	.08	65.4 ± 24.4	64.5 ± 22.5	.88	37.1 ± 27.1	<b>.04</b>	13.7 ± 27.1	.4	.33
ROM, deg											
FF	138 ± 43.7	152 ± 29.8	<b>.02</b>	160 ± 14.6	154 ± 25.4	<b>.04</b>	21.6 ± 48.6	<b>&lt;.001</b>	2.3 ± 48.2	.48	<b>&lt;.001</b>
ER	46.2 ± 15.1	49.8 ± 13.9	.09	49.4 ± 11.1	49.5 ± 11.8	.93	3.1 ± 18.7	.13	-0.3 ± 20.8	.87	.09
Strength											
FF	4.0 ± 0.7	4.3 ± 0.5	<b>.002</b>	4.8 ± 0.4	4.8 ± 0.5	.71	0.81 ± 0.75	<b>&lt;.001</b>	0.49 ± 1.1	<b>&lt;.001</b>	<b>&lt;.001</b>
ER	4.4 ± 0.6	4.5 ± 0.5	.41	4.9 ± 0.3	4.8 ± 0.5	.14	0.45 ± 0.61	<b>&lt;.001</b>	0.31 ± 1.3	<b>&lt;.001</b>	<b>.003</b>
IR	4.7 ± 0.5	4.9 ± 0.4	<b>.04</b>	5.0 ± 0.2	4.9 ± 0.3	.39	0.27 ± 0.55	<b>.002</b>	0.10 ± 1.0	.22	<b>.002</b>

<sup>a</sup>Values are presented as mean ± SD. Bold *P* values indicate statistically significant difference between groups (*P* < .05). ASES, American Shoulder and Elbow Surgeons; ER, external rotation; FF, forward flexion; IR, internal rotation; PROMIS-10, 10-Item Patient-Reported Outcomes Measurement Information System; ROM, range of motion; SSV, Subjective Shoulder Value; VAS, visual analog scale rated from 0-10.

<sup>b</sup>Pre- vs postoperative.

<sup>c</sup>Traumatic vs atraumatic.

traumatic tears saw improvements in PROMIS-10 physical component and ASES scores and in FF motion. As seen in Table 4, the traumatic rotator cuff tear cohort had greater improvements in SSV score; FF motion; and strength in FF, ER, and internal rotation when compared with the atraumatic cohort. There was no difference in the postoperative complications of retear, need for revision rotator cuff repair, need for manipulation under anesthesia, or conversion to reverse total shoulder arthroplasty (Table 5).

## DISCUSSION

This study demonstrated that patients with traumatic rotator cuff tears had increased disability preoperatively but experienced greater improvements in ROM, shoulder strength, and perceived shoulder function than those with atraumatic tears at a minimum 2-year follow-up. The groups had similar improvements in pain postoperatively.

TABLE 5  
Complications<sup>a</sup>

	Traumatic	Atraumatic	P Value
Retear	9 (12.3)	14 (9.5)	.6
Revision rotator cuff repair	7 (9.6)	5 (3.4)	.11
Manipulation under anesthesia	1 (1.4)	3 (2.0)	.71
Infection requiring I&D	1 (1.4)	0 (0.0)	.32
Conversion to RTSA	2 (2.7)	3 (2.0)	.76

<sup>a</sup>Values are presented as No. (%). I&D, irrigation and debridement; RTSA, reverse total shoulder arthroplasty.

Rotator cuff tears affect a substantial proportion of patients, and their incidence will continue to increase as the population ages and continues to remain active. Rotator cuff repair can improve pain and function, with the largest improvements shown in patients with the least amount of fatty infiltration and muscle atrophy preoperatively.<sup>8</sup> While the degree of fatty infiltration has been shown to

have the greatest effect on functional outcomes after repair, these muscular changes have been shown to take years to develop, and a large number of symptomatic rotator cuff tears do not show a severe degree of fatty infiltration or muscular atrophy.<sup>8,27</sup> As shown in Table 2, the patients in this study had minimal fatty infiltration.

Numerous studies have evaluated clinical and functional outcomes with regard to tear size, number of tendons involved, tear chronicity, and amount of fatty infiltration and muscle atrophy.<sup>5,9,10,15,18,24,29,32</sup> The goal of this study was to evaluate the effect of tear etiology on functional outcomes after arthroscopic rotator cuff repair. Our results demonstrate good and equal clinical and functional outcomes in both groups after repair, with the greatest improvements seen in patients with traumatic tear etiology similar to what has been observed in the literature.<sup>1,3,19</sup> Braune et al<sup>3</sup> evaluated postoperative outcomes in 46 patients who underwent surgical rotator cuff repair between 1993 and 1998 and reported improved outcomes in younger patients and those with traumatic ruptures. Notably, this study was limited by a relatively small sample size, and the results were potentially confounded by patient age; the mean age was 34.2 years in patients with traumatic rupture versus 54.1 years in those with atraumatic tears.

More recently, Kukkonen et al<sup>19</sup> performed a registry study that evaluated the outcomes of 306 patients who underwent arthroscopic rotator cuff repair for traumatic versus nontraumatic tears. In this study, the mean patient age was not significantly different between the groups (58 vs 57 years in traumatic vs atraumatic tears, respectively). This study found no difference in postoperative Constant score or patient satisfaction between cohorts. However, this study was limited, as it was a registry study; therefore, operative technique may have varied significantly among patients, and there was no review of preoperative MRI scans. Additionally, follow-up was limited to 1 year, which is short for clinical outcomes after rotator cuff repair.

Abechain et al<sup>1</sup> in 2017 compared postoperative muscle strength and outcomes using the modified UCLA score (University of California, Los Angeles) between 35 patients with traumatic rotator cuff tears and 52 with atraumatic tears who underwent arthroscopic rotator cuff repair. There was no significant difference in patient age between the groups (59.5 vs 59 years in the traumatic vs atraumatic groups, respectively). This study found no difference in mean modified UCLA scores or strength difference between groups. This study was limited by its relatively small sample size (87 patients), lack of preoperative data, measurement of strength in only 1 direction (FF), and absence of imaging data including tendon involvement and muscle integrity (Goutallier classification); it also failed to report complications.

In our study, traumatic rupture was more common in men, which is consistent with what has been reported in the literature.<sup>1,3,22,24</sup> Patient age did not differ significantly between traumatic and degenerative tears (57 vs 59 years, respectively). There was no difference in the number of tendons repaired at the time of rotator cuff repair (Table 3).

Duration of symptoms before surgery was significantly shorter in patients with traumatic tears (6.5 vs 17.9 months for atraumatic). This difference in symptom duration before treatment is greater than that previously reported in the literature.<sup>19,36</sup> Tan et al<sup>36</sup> noted that patients with traumatic tears had repair on average 4 months sooner than those with atraumatic tears (6 vs 10 months), and Kukkonen et al<sup>19</sup> cited a 6-month difference in symptom duration before repair (12.4 vs 18.8 months). It is unclear if these differences in surgical timing may affect study outcomes in patients with traumatic or atraumatic tear.<sup>24,36</sup> The improved functional results after cuff repair in traumatic tears in our study may be in part attributable to this faster time to treatment in conjunction with the likely improved biological healing environment in the acute phase of injury. While numerous studies have demonstrated worse clinical outcomes for patients with a longer interval between symptom onset and repair in the traumatic tear setting, there is no clear consensus on the effect of treatment timing in the atraumatic setting.<sup>6,11,12,21,28,30,36</sup>

The patients in our study with traumatic rotator cuff tears sought care sooner (6.5 vs 17.9 months;  $P < .01$ ) and underwent operative intervention sooner (57 vs 93 days;  $P < .01$ ) (Table 1) when compared with those with atraumatic tears. However, this length of symptoms before presentation raises the question of whether a portion of the acute tears were actually acute on chronic, with some degree of prior rotator cuff damage. Jeong et al<sup>16</sup> presented a retrospective review comparing acute-on-chronic rotator cuff tears and chronic tears. Similar to the findings in our study, they found patients with acute-on-chronic tears to have worse preoperative function and pain, but these patients experienced greater improvement in function, outcome measures, and pain than those with traumatic tears.

Our study did not demonstrate a significant difference in fatty infiltration and muscle atrophy between cohorts, which is expected given that the duration of symptoms for both groups was less than what has been reported for development of significant muscular changes.<sup>27</sup> Studies have shown that moderate fatty infiltration develops around 3 to 4 years after onset of cuff tear symptoms, with a greater degree of infiltration found in older patients, those with longer delay to diagnosis, and those with larger tears and with faster progression of infiltration in patients with  $>1$  torn tendon.<sup>4,17,20,26,27</sup>

## Limitations

The results of this study should be interpreted with consideration of certain limitations. This was a retrospective review of prospectively collected data and is therefore prone to inherent biases. Our classification of rotator cuff tears as traumatic versus atraumatic was based on history of trauma and muscular edema in the rotator cuff muscles seen on MRI scans. In addition, the measurement of tear size was not available for this study, although clinical significance was estimated by the number of tendons involved and repaired. While statistically significant functional outcomes were greater in the traumatic tear cohort for most measures of ROM and strength, these differences may not

be clinically significant. This study did not routinely obtain postoperative MRI scans to evaluate radiographic integrity of the rotator cuff repair or any potential differences in repair integrity between groups. Yet, postoperative MRI scans were obtained when clinically indicated. Another limitation of this study is that we did not evaluate the effect of tear etiology independent of other possibly confounding variables, such as tear size, amount of tendon retraction, which tendons were involved, preoperative imaging variables, and duration between symptom onset and repair, although the 2 study cohorts did not differ significantly in these variables. Additionally, given that these potentially confounding variables are possibly associated with tear etiology and therefore can be difficult to tease apart in clinical practice, the results of the study may be more clinically relevant.

## CONCLUSION

This study demonstrates that arthroscopic repair of traumatic and atraumatic rotator cuff tears can lead to significant subjective and functional improvements. This study found that those with traumatic rotator cuff tears have worse preoperative symptoms and more functional deficits but experience a greater improvement as compared with those with an atraumatic tear etiology. This information can help guide preoperative discussions about expectations and functional outcomes in patients based on tear etiology and can be used in conjunction with other preoperative predictors to provide a more comprehensive understanding of surgical outcomes.

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