

## Research Article

# Comparison of post-operative outcomes in arthroscopic repair of traumatic and atraumatic rotator cuff tears

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In order to provide individualized care to each patient, he begins by listening to their unique problems and goals. He aims to help patients understand their orthopedic conditions and work with them to choose the best treatment to help them return to their activities. He is passionate about helping people of all ages and backgrounds regain their quality of life and return to the activities they love.

Working at The Ohio State University Wexner Medical Center allows him to provide cutting-edge clinical care to patients. He takes pride in collaborating with a team of sports medicine experts and participating in clinical research that improves treatments for our patients. He also enjoys serving as a team physician for high school, collegiate and professional athletes, including the Columbus Clippers (AAA affiliate of Cleveland Indians).

When he's not at work, he enjoys spending time with my family, as well as running, skiing, baseball, and hiking.

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h Dr. Rauck is an orthopedic surgeon with a subspecialty in sports medicine and shoulder surgery. He takes the time to understand each patient's concerns, goals and expectations while providing a clear explanation of the diagnosis and treatment options, which can range from non-operative solutions to minimally invasive arthroscopic or open surgeries for patients of all ages. He is passionate about helping his patients alleviate their pain and improving their function to get them back to doing the things that they enjoy.

He developed a focus on patient care, research and education while training at the world-renowned Hospital for Special Surgery in New York City. However, as someone who was born and raised in Columbus, The Ohio State University Wexner Medical Center has always been a special place to him. The team-based approach and willingness to address any problem, no matter how complex, set Ohio State apart for providing the best care possible to patients and made it the ideal place to continue his career. He's served as a team physician and taken care of athletes at all levels of competition, including providing care as an assistant team physician with the New York Giants. He also enjoys taking care of the athletes at Ohio State.

His research interests include enhancing our understanding of shoulder instability and available treatment options as well as patient expectations and clinical outcomes for shoulder replacements and rotator cuff repairs.

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### Background

Traumatic or atraumatic etiologies are associated with different pathophysiology, and thus, may lead to different post-operative outcomes after arthroscopic rotator cuff repair (RCR).

### Methods

Institutional records were used to identify patients who underwent arthroscopic RCR in 2019-2020. Retrospective review of medical records was performed to determine mechanism of injury, pre- and post-operative range of motion and strength measures.

### Results

Among 100 RCR patients, 53 sustained a traumatic RC injury. Patients with traumatic rotator cuff tears (TR) presented to the clinic after onset of pain sooner than patients with atraumatic tears (aTR) (TR:  $166 \pm 193$  vs aTR:  $595 \pm 679$  days;  $P < 0.001$ ). Pre-operative measurements were worse among traumatic patients than atraumatic patients: forward elevation (TR:  $130^\circ \pm 48^\circ$  vs aTR:  $152^\circ \pm 25^\circ$ ;  $P = 0.036$ ), external rotation (TR:  $49^\circ \pm 17^\circ$  vs aTR:  $55^\circ \pm 16^\circ$ ;  $P = 0.076$ ), internal rotation (TR: L4 vs aTR: L3;  $P = 0.033$ ), forward elevation strength (TR: 4/5 vs aTR: 5/5;  $P = 0.035$ ), external rotation strength (TR: 5/5 vs aTR: 5/5;  $P = 0.065$ ), and internal rotation strength (TR: 5/5 vs aTR: 5/5;  $P = 0.150$ ). However, there was no significant difference in post-operative measurements between cohorts: forward elevation (TR:  $158^\circ \pm 19^\circ$  vs aTR:  $153^\circ \pm 28^\circ$ ;  $P = 0.433$ ), external rotation (TR:  $53^\circ \pm 16^\circ$  vs aTR:  $50^\circ \pm 15^\circ$ ;  $P = 0.332$ ), internal rotation (TR: L2 vs aTR: L2;  $P = 0.703$ ), forward elevation strength (TR: 5/5 vs aTR: 5/5;  $P = 0.926$ ), external rotation strength (TR: 5/5 vs aTR: 5/5;  $P = 0.920$ ), and internal rotation strength (TR: 5/5 vs aTR: 5/5;  $P = 0.519$ ).

### Conclusion

Traumatic RCR patients had significantly worse functional measurements during pre-operative exam than atraumatic RCR patients, but there was no significant difference in post-operative outcomes.

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### INTRODUCTION

Tears of the rotator cuff (RC) are among the most common causes of shoulder pain and dysfunction, comprising around 50% of all shoulder joint pathologies (Zhao et al. 2021). Surgical rotator cuff repair (RCR) plays a vital role in the treatment of over 250,000 patients in the United States each year, and has been shown to effectively reduce pain and improve shoulder function following symptomatic RC tears (Mather et al. 2013; Narvani et al. 2020; Godshaw et

al. 2022). Within the aging population, it is expected that the prevalence of RC tears will continue to increase annually – thus, an increasing volume of RCRs will be necessary to compensate for the growing burden (Zhao et al. 2021; Karjalainen et al. 2019). Recent advancements in surgical protocols over the last couple decades have allowed RCR to shift from an inpatient approach to an equally effective arthroscopic procedure (Colvin et al. 2012; Charles et al. 2019).

Notably, rotator cuff tears can be classified based on their etiology as either traumatic or atraumatic. Atraumatic

tears are believed to be a consequence of aging, occurring when chronic tendon degeneration progresses into partial- or full-thickness tears of the RC over time (Godshaw et al. 2022; Keener et al. 2019; Codding and Keener 2018). Asymptomatic RC tears are highly prevalent among elderly populations, most specifically identifiable by weakened shoulder abduction strength during physical exam (Kim et al. 2009). Conversely, traumatic tears are the result of high-energy injuries that cause full-thickness tears and acute functional deficits to the shoulder (Godshaw et al. 2022; Abdelwahab et al. 2021; Loew et al. 2015). Several factors that have been shown to be correlated with worse post-operative outcomes following RCR, including patient age, tear size, tear chronicity, and fatty infiltration (Abdelwahab et al. 2021; Gladstone et al. 2007; Gerber, Fuchs, and Hodler 2000; Harryman et al. 1991; Mall et al. 2014; Lahteenmaki et al. 2006). Previous research has examined RCR differences based on mechanism of injury but has provided mixed results. For example, Paul et al. and Braune et al. demonstrated that functional outcomes are better following RCR for traumatic tears (Paul, Yadav, and Goyal 2021; Braune et al. 2003). Conversely, studies by Godshaw et al. and Teratani exhibited no difference in post-operative functional measurements between traumatic and atraumatic cohorts (Godshaw et al. 2022; Teratani 2017).

To date, the effects of traumatic or atraumatic mechanisms of injury on post-operative RCR outcomes remains ill-defined. Thus, the objective of this study is to examine whether or not differences exist in surgical outcomes following traumatic and atraumatic RC tears following arthroscopic RCR. Herein, we analyze pre-operative and post-operative functional range of motion (ROM), strength, and patient satisfaction scores to compare traumatic and atraumatic RCR.

## DATA SOURCE

The institutional electronic health record system was queried for patients who had sustained arthroscopic rotator cuff repair, using Current Procedural Terminology code 29827, between 1/1/2019 and 3/17/2020. Among the identified patients (n=159), 59 were excluded if they had unavailable operative reports, underwent surgery at an outside institution, or had less than the minimum of 1-year follow-up appointments with their provider. This study was approved by the institutional review board at our institution.

## OPERATIVE TECHNIQUE

All rotator cuff repairs were performed under the same institutional protocol: patients were placed in a beach chair position and a double row repair technique was used. Post-operative rehabilitation involved sling immobilization for 6 weeks with full passive range of motion physical therapy beginning at 4 weeks. Physical therapy progressed to assisted active range of motion and active range of motion as tolerated through 6-8 weeks, before finishing with strengthening until return to activity ("Sports Medicine Rehabilitation Protocols" 2023).

## DATA COLLECTION

Patient health records were retrospectively reviewed to determine sex, age at surgery, follow-up time (within the clinic), mechanism of injury, time of onset of pain to intervention, and physical exam measurements: pre-operative and post-operative active ROM (forward elevation, external rotation, and internal rotation with shoulder adducted at the side) and strength testing (forward elevation, external rotation, and internal rotation). Mechanism of injury was classified based on the history of the present illness provided in the initial encounter (examples of traumatic tears include falls, lifting heavy objects, collisions, and motor vehicle crashes; atraumatic tears were most commonly chronic, insidious onsets of pain with no known traumatic event). To ensure consistency, three separate researchers independently classified injuries as traumatic or atraumatic, and reconciled the data for analysis. Procedure failures were defined as those necessitating follow-up surgical intervention following index RCR.

Patients were further contacted by phone in October 2022 to obtain visual analog scale pain score and Single Assessment Numeric Evaluation (SANE) score of affected and contralateral shoulders, at least 2-years after surgery. SANE is a validated and widely-used measurement of patient satisfaction of joint or region of interest functionality, quantified on a scale of 1-100 (Wickman et al. 2020; Cvetanovich et al. 2019).

## STATISTICAL ANALYSIS

Cohorts were compared based on mechanism of injury: traumatic vs atraumatic. Continuous variables were analyzed using the Wilcoxon Rank-Sum test, ordinal variables were analyzed via univariable ordinal logistic regression, and categorical variables were analyzed using the Chi-squared test. Data is reported as mean  $\pm$  standard deviation. Statistical significance was established at  $P < 0.05$  and all statistical tests were conducted as two-sided. Statistical analyses were performed using Stata/SE v17.0 (StataCorp, College Station, TX).

## RESULTS

Among 100 patients who underwent arthroscopic RCR, 53 and 47 were classified as traumatic and atraumatic mechanisms of injury, respectively. Males were more frequently classified as traumatic (TR) injury and less frequently classified as atraumatic (aTR) injury (TR: 34/53, 64% vs aTR: 19/47, 40%;  $P = 0.018$ ). There was no significant difference in age at surgery between the cohorts (TR:  $61 \pm 9$  vs aTR:  $56 \pm 10$  years;  $P = 0.242$ ). Both cohorts had a similar amount of post-operative follow-up time in clinic (TR:  $1.1 \pm 0.7$  vs aTR:  $1.0 \pm 0.7$  years;  $P = 0.681$ ). Notably, patients with traumatic RC tears presented to the clinic after onset of pain markedly sooner than patients with atraumatic tears (TR:  $166 \pm 193$  vs aTR:  $595 \pm 679$  days;  $P < 0.001$ ) (Table 1).

**Table 1. Demographic and clinical characteristics of patients who underwent arthroscopic rotator cuff repair. Changes in sample size are due to missing data.**

|                                 | Traumatic   |             | Atraumatic  |             | P-value          |
|---------------------------------|-------------|-------------|-------------|-------------|------------------|
|                                 | Sample size | Measurement | Sample size | Measurement |                  |
| Male:Female                     | 53          | 34:19       | 47          | 19:28       | <b>0.018</b>     |
| Age at surgery (years)          | 53          | 61 ± 9      | 47          | 56 ± 10     | 0.242            |
| Follow-up time (years)          | 53          | 1.1 ± 0.7   | 47          | 1.0 ± 0.7   | 0.681            |
| Onset of pain to surgery (days) | 40          | 166 ± 193   | 32          | 595 ± 679   | <b>&lt;0.001</b> |

**Table 2. Comparison of traumatic and atraumatic preoperative physical exam shoulder assessments.**

|                            | Traumatic   |             | Atraumatic  |             | P-value      |
|----------------------------|-------------|-------------|-------------|-------------|--------------|
|                            | Sample size | Measurement | Sample size | Measurement |              |
| Forward elevation ROM      | 52          | 130° ± 48°  | 45          | 152° ± 25°  | <b>0.036</b> |
| External rotation ROM      | 52          | 49° ± 17°   | 45          | 55° ± 16°   | 0.076        |
| Internal rotation ROM      | 49          | L4          | 44          | L3          | <b>0.033</b> |
| Forward elevation strength | 51          | 4/5         | 45          | 5/5         | <b>0.035</b> |
| External rotation strength | 51          | 5/5         | 45          | 5/5         | 0.065        |
| Internal rotation strength | 51          | 5/5         | 45          | 5/5         | 0.150        |

ROM: range of motion

Bold text indicates statistical significance.

Pre-operative active ROM and strength measurements were compared between traumatic patients and atraumatic patients. Traumatic RC tear patients presented to the clinic in a generally worse condition than atraumatic RC tear patients, as seen in differences in both ROM and strength measurements: forward elevation (TR: 130°±48° vs aTR: 152°±25°; P=0.036), external rotation (TR: 49°±17° vs aTR: 55°±16°; P=0.076), internal rotation (TR: L4 vs aTR: L3; P=0.033), forward elevation strength (TR: 4/5 vs aTR: 5/5; P=0.035), external rotation strength (TR: 5/5 vs aTR: 5/5; P=0.065), and internal rotation strength (TR: 5/5 vs aTR: 5/5; P=0.150). (Table 2). However, both traumatic and atraumatic patients experienced similar outcomes after RC repair. There was no difference in post-operative measurements when comparing ROM and strength measurements between traumatic and atraumatic patients: forward elevation (TR: 158°±19° vs aTR: 153°±28°; P=0.433), external rotation (TR: 53°±16° vs aTR: 50°±15°, P=0.332), internal rotation (TR: L2 vs aTR: L2; P=0.703), forward elevation strength (TR: 5/5 vs aTR: 5/5; P=0.926), external rotation strength (TR: 5/5 vs aTR: 5/5; P=0.920), and internal rotation strength (TR: 5/5 vs aTR: 5/5; P=0.519). Furthermore, there was no significant difference in SANE scores at least 2-years post-arthroscopic repair (TR: 78±13 vs aTR: 79±11; P=0.780). (Table 3). Of the 100 arthroscopic, only 2 required revision procedures, both due to re-tear of RC.

Rotator cuff pathology is the largest cause of shoulder joint pain, affecting over 4.5 million patients in the United States each year (Zhao et al. 2021; Meislin, Sperling, and Stitik 2005). Likewise, RCR is one of the most common shoulder procedures, accounting for at least 250,000 cases annually (Zhao et al. 2021; Colvin et al. 2012). Medical decision making in the treatment of RC tears can be com-

plex – various demographic factors, chronicity or severity of tear, and physical exam or radiological findings may affect the indication of surgery (Oh et al. 2007; McElvany et al. 2014). Thus, our study is important because recognizing the potential consequences of traumatic or atraumatic etiologies of RC tears can help predict patient outcomes and guide surgical indications or clinical decision making. We found that males were significantly more likely to sustain traumatic RC tears, and that atraumatic tears take over three times longer to receive surgical intervention after onset of pain. Furthermore, despite worse pre-operative functional measurements, there was no significant difference in post-operative outcomes between traumatic and atraumatic RCR. That is, traumatic RCR exhibited greater improvements in functional measurements post-operatively.

In comparing demographic differences between groups, our findings are consistent with existing research, which also indicated that traumatic or symptomatic RC tears, as a whole, are more common in men (Braune et al. 2003; Mall et al. 2013). Furthermore, when accounting for mechanism of injury, women were more likely to receive care for degenerative RC tear and men for traumatic RC tear (Godshaw et al. 2022; Paul, Yadav, and Goyal 2021; Teratani 2017). Additionally, previous studies suggest that delaying RCR by 4-12 months significantly increases the odds of worse outcomes, including longer recovery time, lesser functional improvements, and increased likelihood of revision surgery (Gutman et al. 2021; Hantes et al. 2011; Fu et al. 2020). However, the results of our study contrast these previous findings, suggesting that RCR for both cohorts had comparable outcomes regardless of the broad difference in time-to-surgery (on average, TR: ~6 months vs aTR: ~20 months).

**Table 3. Comparison of traumatic and atraumatic postoperative physical exam shoulder assessments.**

|                            | Traumatic   |             | Atraumatic  |             | P-value |
|----------------------------|-------------|-------------|-------------|-------------|---------|
|                            | Sample size | Measurement | Sample size | Measurement |         |
| Forward elevation ROM      | 51          | 158° ± 19°  | 47          | 153° ± 28°  | 0.433   |
| External rotation ROM      | 51          | 53° ± 16°   | 47          | 50° ± 15°   | 0.332   |
| Internal rotation ROM      | 36          | L2          | 26          | L2          | 0.703   |
| Forward elevation strength | 43          | 5/5         | 39          | 5/5         | 0.926   |
| External rotation strength | 43          | 5/5         | 39          | 5/5         | 0.920   |
| Internal rotation strength | 43          | 5/5         | 39          | 5/5         | 0.519   |
| SANE score                 | 28          | 78 ± 13     | 21          | 79 ± 11     | 0.780   |

ROM: range of motion

SANE: Single Assessment Numeric Evaluation

Bold text indicates statistical significance.

Despite the differences in pre-operative measurements and time to treatment, our study revealed no significant difference in post-operative functional outcomes among traumatic and atraumatic RC tears. Notably, this study included patients of similar ages among traumatic and atraumatic cohorts (61±9 vs 56±10 years). Previous studies which stratified by mechanism of injury and had no difference in age demonstrated similar functional outcomes among traumatic and atraumatic RC tears (Godshaw et al. 2022; Teratani 2017). Conversely, studies that compared traumatic and atraumatic RCR but enrolled patients of significantly different ages (i.e. 34 vs 54 years, respectively, in Braune et al.) had markedly worse post-operative outcomes in the older, atraumatic cohort (Paul, Yadav, and Goyal 2021; Braune et al. 2003). Thus, age could be a stronger predictor of RCR success than mechanism of injury.

While surgery is usually indicated for traumatic RC tears, there is a lack of consensus among orthopedic care teams on the appropriate standard approach for treating degenerative RC tears (Keener et al. 2019; Garibaldi et al. 2021). The decision to use conservative or surgical treatment is multifactorial; physiotherapy may be favored in older patients, who poorly tolerate surgery, and in patients with smaller, partial tears (Narvani et al. 2020). Previous literature suggests that conservative and surgical approaches may be equally viable for restoring function in the short-term, but surgical treatment was superior in lowering long-term pain and disability status (Narvani et al. 2020; Lambers Heerspink et al. 2015). Our study indicates that, despite differences in baseline functional measurements at presentation of traumatic and atraumatic tears, an operative approach had good outcomes regardless of etiology – surgery was successful in improving ROM, strength, and quality of life through restoration of function. Notably, traumatic RCR

patients did experience greater improvements (i.e. lower pre-operative baseline, but similar post-operative status).

The results of this study should be interpreted under consideration of several limitations. The study population was sampled from only a single institution, thus potentially limiting the external generalizability of the study. Additionally, the relatively small sample size limited the statistical analysis to univariate comparisons. A national, multi-center study with a significantly larger sample size would improve the generalizability and allow for more sophisticated multivariable or multivariate analysis. Moreover, as with any study, systematic error may exist within the data – the retrospective study design may produce a selection bias, and inaccuracies during patient chart review may lead to misclassification bias. For example, patients with traumatic aggravation of a pre-existing degenerative and/or previously asymptomatic rotator cuff tears could not be distinguished from those with an acute presentation of a traumatic tear and the size and type of rotator cuff tear (i.e., partial or full) was not distinguished, which may introduce intra-cohort variability in outcomes. Furthermore, there were no predetermined standardized follow-up appointment intervals for inclusion in the study – generally patients returned at 2-week, 1-month, 3-month, 6-month, and annual intervals, but were not excluded for missing appointments or following a different schedule.

In conclusion, despite presenting with significantly worse functional measurements, patients with traumatic RC tears had similar RCR outcomes compared to patients with atraumatic RC tears. Orthopedic care teams should consider arthroscopic RCR as an effective treatment option for patients who are able to tolerate the procedure.

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