

Research Article

Prior Ipsilateral Steroid Injections Do Not Compromise Postoperative Outcomes or Increase Risk for Postoperative Complications or Revisions Surgery After Arthroscopic Rotator Cuff Repair

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Keywords: Rotator Cuff Repair, Corticosteroid Injection, Rotator Cuff Tear, Range of Motion.

<https://doi.org/10.60118/001c.127696>

Journal of Orthopaedic Experience & Innovation

Vol. 6, Issue 1, 2025

Purpose

This study aimed to determine the effect of prior ipsilateral subacromial corticosteroid injection (CSI) on patient outcomes following arthroscopic rotator cuff repair.

Methods

A retrospective review was conducted on patients who underwent primary arthroscopic rotator cuff repair performed by a single fellowship-trained orthopedic surgeon from 2018 to 2019, utilizing single-row techniques for tears smaller than 1.5 cm and double-row techniques for tears larger than 1.5 cm. Patients were divided into two cohorts based on whether they received a preoperative CSI within 12 months of surgery: (1) injection group (IG) and (2) control group (CG). Range of motion (ROM), patient-reported pain and satisfaction, subjective shoulder value (SSV), postoperative complications and reoperations were collected at final follow-up and compared between groups. The impact of the number of preoperative injections on outcomes was assessed by subgroup analysis based on the number of preoperative injections administered: Group 1 included one injection versus Group 2 included two or more injections. The impact of the timing of injections on outcomes was assessed by subgroup analysis based on the timing of their most recent injection: (1) ≤ 3 months before surgery, or (2) > 3 but < 12 months before surgery.

Results

Forty-two patients with preoperative CSIs (mean age, 60.2 years; 54.8% females) were identified and compared against 183 control patients (mean age, 58 years; 39.8% females). No significant differences in demographics between groups were found. The mean follow-up time was 12.6 months (range, 6 – 33.8 months). Preoperatively, the injection group had a significantly greater forward elevation ($p=0.003$), abduction ($p=0.005$), and active external rotation ($p<0.001$). No significant differences in postoperative pain, shoulder function, shoulder strength, ROM, or SSV were appreciated. Postoperative complication and revision rates were similar.

Conclusion

Corticosteroid injections as a conservative treatment prior to rotator cuff repair do not significantly compromise postoperative function and are not associated with adverse postoperative complications or revision surgery compared to control patients.

Level of Evidence: III; Retrospective Cohort Study

INTRODUCTION

Shoulder pathology is the third most common musculoskeletal complaint for primary care providers and, its impact on quality of life makes it a common reason for patients to seek out a shoulder specialist (Bhattacharjee et al. 2019). Rotator cuff pathology specifically is one of the most prevalent conditions affecting approximately 17 million individuals in the United States and it can be a source of significant pain and dysfunction (Shepet, Liechti, and Kuhn 2021). Management of rotator cuff pathology begins conservatively with nonsteroidal anti-inflammatory drugs (NSAIDs), activity modification, and physical therapy. If initial treatment modalities fail, a potential subsequent step is to consider corticosteroid injection (CSI), a med-

ication administered locally that reduces inflammation by downregulating the expression of inflammatory signaling proteins, ultimately decreasing pain perception (Østergaard and Halberg 1998). The suppression of inflammatory signals is transient, and so is the effect in pain reduction and functional improvement. Previous studies have shown that benefits may decrease after one week of administering the injection, with no evidence of benefits after 6.5 months (Jüni, Hari, Rutjes, et al. 2015). A review of multiple studies on the use of CSIs for rotator cuff tears found that pain reduction was successful for up to 3 months but faded shortly thereafter with no further benefit from additional injections (Mohamadi et al. 2017). The molecular effects of CSI and its translation into clinical outcomes have been studied in the broader orthopedic literature, and the relationship

between preoperative joint injections, postoperative outcomes, and complications has shown mixed results (Forlenza et al. 2021; Werner et al. 2016; Wang et al. 2017; Papavasiliou et al. 2006; Cancienne and Werner 2021).

Corticosteroid injections are commonly prescribed for pain relief even in patients considered surgical candidates, despite some of the known adverse effects of CSI, including articular cartilage damage, attenuated immune response, and tendon rupture (Papavasiliou et al. 2006; Gialanella and Prometti 2011). Corticosteroids may interfere with the healing process and cause deteriorated tendons by altering the collagen composition and extracellular matrix (H. J. Lee et al. 2015). Recent studies of shoulder arthroscopy and rotator cuff repair (RCR) patients specifically have added concerns that perioperative injections may be associated with increased rates of postoperative complications and revisions (Bhattacharjee et al. 2019; Werner et al. 2016; Weber, Trasolini, Mayer, et al. 2019; Desai et al. 2019). Specifically, there is evidence that the risk of infection and revision surgery is both time and frequency-dependent, however, there is currently no consensus on what exactly is a safe time interval (Bhattacharjee et al. 2019; Werner et al. 2016; Wang et al. 2017; Desai et al. 2019; W. Lee et al. 2019; Kew et al. 2019; Kunze, Mirzayan, Beletsky, et al. 2020). Specifically, a single shoulder injection within one year prior to arthroscopic RCR has been shown to not have an effect on revision rate, however, two or more injections have been found to significantly increase the risk of revision rotator cuff surgery (Weber, Trasolini, Mayer, et al. 2019; Desai et al. 2019). To date, these investigations have been limited to large database queries, and as such the reason for revision remains unclear and the impact of preoperative injections on postoperative pain and function is still undetermined. Thus, this study aimed to determine the effect of prior ipsilateral subacromial corticosteroid injection on patient outcomes following arthroscopic RCR. The authors hypothesized that patients who received subacromial CSIs prior to arthroscopic RCR would have improved patient outcomes with minimal complications, similar to the control group.

METHODS

STUDY DESIGN

This was an IRB-approved (WCG Clinical, Inc. WO# 1-1657148-1) retrospective review of a prospectively collected database to identify patients undergoing primary arthroscopic RCR between 2018 and 2019 by a single fellowship-trained orthopedic surgeon. The surgeon employed single-row techniques for tears measuring less than 1.5 cm and double-row techniques for tears exceeding 1.5 cm. Patients were divided into two cohorts based on whether they received a preoperative corticosteroid injection within 12 months of the arthroscopic RCR procedure: (1) injection group (IG) and (2) control group (CG). Subacromial CSI's for rotator cuff syndrome are commonly administered with aseptic technique via posterior approach where the needle is inserted inferior to the posterolateral edge of the acromion. Patients were included in the final analysis if

they were aged 18 years or older with a primary arthroscopic RCR. Exclusion criteria consisted of administration of a corticosteroid injection greater than 12 months of RCR, patients less than 18 years of age, patients who underwent revision RCR or other revision arthroscopic procedure, and patients with a history of ipsilateral injections other than corticosteroids (i.e., platelet-rich plasma). The primary endpoints of this study include pre-and postoperative active range of motion (ROM) in degrees, patient-reported pain (0-30) and satisfaction (0-10), subjective shoulder value (SSV), defined as a patient's subjective shoulder assessment as a percentage of an entirely normal shoulder (0-100%), as well as revision rate.

PATIENT EVALUATION AND DATA ANALYSIS

Patient data was collected from electronic medical records and a prospectively collected outcomes database. Patient demographics were collected and included age, body mass index (BMI), sex, race/ethnicity, operative side, comorbidities, preoperative diagnosis, time from injection to surgery, and final follow-up time. Range of motion (ROM) in degrees, patient-reported pain and satisfaction, and SSV, were collected preoperatively and at final follow-up. Internal rotation was calculated based on the highest vertebral level reached by the patient's hand (thigh = 0 pts, greater trochanter = 1 pt, buttocks = 2 pts, sacroiliac joint = 3 pts, L4 to L5 = 4 pts, L1 to L3 = 5 pts, T8 to T12 = 6 pts, $\geq$ T7 = 7 pts). The change (Delta) in outcome scores and ROM were calculated and defined as the difference in preoperative to postoperative measurements. Postoperative complications and revision rates were also recorded.

To analyze the impact of the frequency of injections on outcomes, the injection cohort was subdivided into two groups based on the number of preoperative injections administered: Group 1 included one injection versus Group 2 included two or more injections. To analyze the effect of the timing of injections, the cohort was subdivided into 2 groups based on the timing of their most recent injection: (1) $\leq$ 3 months before surgery, or (2) $>$ 3 but $<$ 12 months before surgery.

STATISTICAL ANALYSIS

Data were checked for normality and appropriate descriptive statistics including medians with interquartile ranges (IQR) or frequencies with percentages (%) were computed for all variables. Mann-Whitney U, Chi-square, and Fisher's exact tests were used to compare demographic, functional, and patient-reported outcomes by injection status. Kruskal-Wallis tests with Dunn's multiple comparisons were used to compare associations between timing and number of injections and patient characteristics. Data were analyzed using SPSS Version 28.0.1.1 (IBM Corp., Armonk, NY, USA). User-defined missing values for dependent variables were treated as missing. Statistics are based on cases with no missing values for any dependent variable or factor used. A priori power analysis was not conducted. All tests were two-tailed and $p < .05$ was considered statistically significant. Differences in pain, function, satisfaction, and re-

vision following RCR based on sex/gender has not been well studied in the literature. Our results were not disaggregated by sex/gender due to small cohort size.

STATEMENT OF HUMAN AND ANIMAL RIGHTS

This study strictly adheres to the principles outlined in the Declaration of Helsinki concerning research involving human subjects. All aspects of this study involving human participants were conducted in accordance with ethical standards and regulations set forth by the Institutional Review Board (IRB) and with the informed consent of all participants or their legally authorized representatives. This study does not involve the use of animals.

RESULTS

PATIENT DEMOGRAPHICS

A total of 239 patients were initially identified from a retrospective chart review. Twelve patients with no documented follow-up and 2 patients who underwent revision surgery were excluded. Forty-two patients with preoperative steroid injections (mean age, 60.2 years; 54.8% females) were included in IG and compared against 183 CG patients (mean age, 58 years; 39.8% females). Fifteen patients received injections < 3 months prior to surgery, with 2 patients receiving injections less than 30 days, and 27 patients received injections between 3 and 12 months of surgery. Thirty-three patients received 1 injection and 9 patients received 2 or more injections. The mean follow-up time was 12.6 months (range, 6 – 33.8 months). No significant differences between the groups were appreciated based on age ($p=0.388$), sex ($p=0.847$), race/ethnicity ($p=0.969$), operative side ($p=0.893$), comorbidities ($p=0.979$), and mean follow-up ($p=0.525$) ([Table 1](#)).

PATIENT OUTCOMES

Preoperatively, the injection group had significantly greater active forward elevation (150° vs 140° ; $p=0.003$), active abduction (140° vs 130° ; $p=0.005$), and active external rotation (70° vs 60° ; $p<0.001$). There are no other noted differences in preoperative variables ([Table 2](#)). At final follow-up, no significant differences between the groups were observed in postoperative pain scores, shoulder function satisfaction scores, ROM, or SSV scores. No significant differences were found in any postoperative patient outcomes based on the timing of injection given (< 3 months vs 3 – 12 months) ([Table 3](#)) or the number of injections given (1 vs >2) ([Table 4](#)).

POSTOPERATIVE RETEAR AND REVISION RATES

In the injection group, one patient (2.4%) had a rotator cuff retear confirmed by MRI at postoperative day 113 and underwent revision rotator cuff repair shortly after. Three patients (1.6%) in the control group had a rotator cuff retear at postoperative days 65, 111, and 344. All patients underwent revision rotator cuff repair. No significant differ-

ence was found in retear or revision rates ($p=0.565$) between groups.

DISCUSSION

The main findings of our study demonstrate that no differences were seen between CSIs administered within 12 months prior to arthroscopic RCR and postoperative outcome scores or revision rates. Although our results did not demonstrate an improvement in postsurgical outcomes, they do support our hypothesized lack of significant complications with the use of CSI preoperatively. However, the injection group demonstrated greater preoperative range of motion, suggesting that corticosteroid injections (CSIs) may provide clinically significant improvements in shoulder function. Alternatively, it could indicate a selection bias, where patients with limited range of motion are less likely to be considered for injections by the treating physician. The primary objective of our study was not to look specifically at timing or correlations with preoperative function. Further investigations are needed to better understand this preoperative relationship and the reasons patients proceed to surgical treatment. Previous literature has found that improvements in activities of daily living are associated with increased quality of life (Brekke et al., n.d.). Given that shoulder flexion, abduction, and external rotation are required for tasks such as reaching overhead shelves, driving, and opening doors, CSI's have the potential to improve patient's quality of life prior to surgery. Numerous studies have demonstrated the effectiveness of CSIs in treating a range of shoulder pathologies, including rotator cuff disease (Lin et al. 2019; Coombes, Bisset, and Vincenzino 2010; Buchbinder, Green, and Youd 2003). In a recent review of 494 shoulders with rotator cuff disease, the authors reported significant improvements in patient-reported outcome scores following corticosteroid injections (Giovannetti De Sanctis et al., n.d.). However, it is worth noting that the improvement in symptoms is most prominent in the short term, which could explain why some patients still proceed to surgery.

In our study, we did not find a significant difference in postoperative outcomes between patients who received CSIs and those who did not, which may support use of subacromial corticosteroid injections as a conservative treatment prior to rotator cuff repair without compromising postoperative function. These findings are similar to a study by Bavrel et al (Feng, Li, Zhong, et al. 2023), which also found no difference in clinical outcome scores between patients who received injections and those who did not, with a mean follow-up of 2.9 years after RCR. Similarly in a study of 93 patients, Feng et al (Feng, Li, Zhong, et al. 2023). observed no significant difference in pain levels, shoulder function scores, or active range of motion at a 3-year follow-up between injected and control patients. There have been studies where patients who received CSIs prior to RCR experienced significant improvement in postoperative outcomes. For example, Donohue et al (Donohue, Prisco, and Grindel 2019). found that patients who received a preoperative CSI (n=92 patients) demonstrated signifi-

Table 1. Patient Demographics

	Control Group (n=183) median (IQR) or n (%)	Injection Group (n=42) median (IQR) or n (%)	p-value
Age, y	58 (54-63)	60.2 (48.8-66.3)	0.388
BMI, kg/m ²	28.1 (24.7-33.2)	27.7 (24.4-35.8)	0.847
Final Follow-up, m	12.1 (6.7-26.8)	14.8 (6-33.8)	0.198
No. of Females	72 (39.3%)	23 (54.8%)	0.077
Race/Ethnicity			0.969
Caucasian	141 (77%)	35 (83.3%)	
Hispanic	1 (0.5%)	0	
African American	21 (11.5%)	5 (11.9%)	
Other	4 (2.2%)	1 (2.4%)	
Operative Side			0.893
Right	120 (65.6%)	28 (66.7%)	
Left	63 (34.4%)	14 (33.3%)	
Total No. of RC tendons torn			0.489
1	86 (47%)	21 (50%)	
2	64 (35%)	17 (40.5%)	
3	33 (18%)	4 (9.5%)	
Comorbidities			
Hypertension	43 (23.5%)	11 (26.2%)	0.605
Hyperlipidemia	3 (1.6%)	0	1.000
Heart Disease	29 (15.8%)	6 (14.3%)	0.883
Diabetes	18 (9.8%)	5 (11.9%)	0.653
Tobacco User	9 (4.9%)	2 (4.8%)	1.000
Cancer	5 (2.7%)	1 (2.4%)	1.000
Cerebrovascular accident	4 (2.2%)	2 (4.8%)	0.295
Atrial fibrillation	18 (9.8%)	4 (9.5%)	1.000
Thyroid Disease	4 (2.2%)	2 (4.8%)	0.295
Asthma/COPD	14 (7.7%)	3 (7.1%)	1.000

Legend: No., number; RC, rotator cuff; COPD, chronic obstructive pulmonary disease

cantly greater improvement in all outcome measures, including ASES, Constant, and VAS pain scores compared to the control group (n=40 patients). Our results although not showing significant improvements also did not see negative effects of steroid use prior to RCR. The duration of the effect of CSIs varies widely, lasting more than 6 months in some patients and less than 3 months in others (Mohamadi et al. 2017). When considering surgery, there is a reluctance to administer injections too close to the procedure due to concerns that they may impair the healing process and increase the risk of infection. These factors, rather than the injection itself, could ultimately contribute to the risk of retear (Donohue, Prisco, and Grindel 2019). The current literature and guidelines lack consensus on the timing and frequency of injections and their impact following RCR. Donohue et al (Donohue, Prisco, and Grindel 2019). reported that patients who received an injection 3 months prior to an RCR, had significantly greater improvement in postoperative ASES and constant scores than patients who received an injection greater than 3 months prior to surgery. In comparison, Lee W et al (W. Lee et al.

2019). found no significant differences in outcome scores and range of motion based on preoperative injection timing in 318 patients. Similarly, our study found no difference in patient-reported pain, shoulder function satisfaction, and SSV scores based on timing or frequency of injection. Although our study did not report on postoperative infections, there have been studies that reported an increase in postoperative infection in patients who received an injection within 3 months prior to shoulder surgery (Werner et al. 2016). Furthermore, Forsythe et al (Forsythe et al. 2019). analyzed 60,823 patients and found that patients who received injections within 1 month of RCR had an increased risk of surgical site infection compared to controls, with no increased risk outside of that time frame.

Several studies have reported a dose- and frequency-dependent increased risk of retear and revision following CSIs in patients undergoing RCR. However, these studies all include limitations associated with “big data” analysis (Cimino, Veazey, McMurtrie, et al. 2020; Sochacki et al. 2018; Dhawan et al. 2018; Rossi, Brand, and Lubowitz 2018). Our study also had a number of limitations.

Table 2. Preoperative and Postoperative Patient Outcomes

	Control Group (n=183) median (IQR) or n (%)	Injection Group (n=42) median (IQR) or n (%)	p-value
PREOPERATIVE			
Pain Score (/30)	19.75 (16-23.25)	18.5 (14-23)	0.554
Shoulder Function Satisfaction	2 (1-4)	2 (1-3)	0.306
SSV	50 (30-63.8)	42.5 (25-59.3)	0.271
Forward Elevation	150° (130°-170°)	140° (100°-150°)	0.003
Abduction	140° (110°-160°)	130° (90°-150°)	0.005
Internal Rotation	3 (3-3)	3 (3-3)	0.312
External Rotation	70 (60°-70°)	60° (50°-70°)	<0.001
POSTOPERATIVE			
Pain Score (/30)	11 (6.5-18)	8.5 (4-14)	0.069
Shoulder Function Satisfaction	5 (3-7)	7 (4-8)	0.094
SSV	70 (50-80)	65 (45-80)	0.806
Forward Elevation	160° (140°-167.5°)	160° (140°-170°)	0.085
Abduction	140° (97.5°-150°)	150° (110°-170°)	0.086
Internal Rotation	3 (1-4)	3 (1-4)	0.623
External Rotation	70° (50°-70°)	60° (50°-70°)	0.503
DELTA			
Delta Shoulder Function Satisfaction	3.8 (3.7)	2.2 (3)	0.025
Delta Pain Score	-7.9 (7.7)	-6.4 (7)	0.311
Delta SSV	23 (36.5)	15 (19)	0.4
Delta Forward Elevation	26.8° (44.2°)	0.6° (31.2°)	0.0015
Delta Abduction	23.1° (50°)	-5.2° (28.4°)	0.0027
Internal rotation	0.2 (1.6)	0.4 (1.7)	0.53
External rotation	6.1° (20°)	-2.5° (16.3°)	0.025

Legend: SSV, subjective shoulder value; IQR, interquartile range

Table 3. Patient Outcomes by Timing of Preoperative Injection

	Control Group (n=183) median (IQR) or n (%)	Injection < 3 mo (n=15) median (IQR) or n (%)	Injection 3 to 12 mo (n=27) median (IQR) or n (%)	p-value
Pain Score (/30)	8.5 (4-14)	12.5 (8-19)	10 (6-18)	0.166
Shoulder Function Satisfaction	7 (4-8)	5 (2.8-8.3)	5 (3.5-7)	0.247
SSV	65 (45-80)	55 (50-80)	77.5 (57.5-81.3)	0.529
Forward Elevation	160° (140°-170°)	160° (100°-167.5°)	160° (140°-167.5°)	0.214
Abduction	150° (110°-170°)	130° (90°-160°)	140° (110°-150°)	0.23
Internal Rotation	3 (1-4)	3 (1.5-3)	3 (1-5)	0.451
External Rotation	60° (50°-70°)	65° (52.5°-70°)	70° (50°-70°)	0.763

Legend: SSV, subjective shoulder value; IQR, interquartile range; SD, standard deviation; mo, month

LIMITATIONS

Although our study did not identify any statistically significant differences in postoperative outcomes between the groups, it is worth considering the potential impact of a Type 2 (beta) error due to our relatively smaller sample size in the injection group sub-analyses. A larger sample size

might provide more power to detect minor discrepancies between the groups if they exist. Additionally, the retrospective design may introduce selection bias, as patients who underwent RCR at our institution may not be representative of the general population. Furthermore, it's important to note that all surgical procedures in this study were performed by a single surgeon who possesses exten-

Table 4. Patient Outcomes by Number of Injections

	Control Group (n=183) <i>median (IQR) or n (%)</i>	1 Injection (n=33) <i>median (IQR) or n (%)</i>	≥ 2 Injections (n=9) <i>median (IQR) or n (%)</i>	p-value
Pain Score (/30)	8.5 (4-14)	10 (6-18)	12 (8.5-16.5)	0.115
Shoulder Function Satisfaction	7 (4-8)	5 (3-7)	5 (3.5-7.5)	0.24
SSV	65 (45-80)	62.5 (50-80)	77.5 (56.3-80)	0.899
Forward Elevation	160° (140°-170°)	160° (140°-170°)	150° (145°-160°)	0.142
Abduction	150° (110°-170°)	140° (95°-155°)	130° (110°-145°)	0.199
Internal Rotation	3 (1-4)	3 (3-4)	2 (1-3.8)	0.359
External Rotation	60° (50°-70°)	70° (50°-70°)	60° (50°-75°)	0.763

Legend: SSV, subjective shoulder value; IQR, interquartile range; SD, standard deviation

sive expertise in shoulder surgery. Consequently, the clinical outcomes observed in this study may not necessarily apply to patients treated by surgeons with varying levels of experience and proficiency in shoulder surgery. Finally, this study was limited by the duration of follow-up (12.6 months) which may not be sufficient to identify the long-term effects of preoperative CSIs on RCR outcomes, so any interpretation of these results with regards to overall safety of CSIs in patients obtaining RCR needs to be viewed through this shorter-term lens.

CONCLUSION

Corticosteroid injections as a conservative treatment prior to rotator cuff repair do not significantly compromise postoperative function and are not associated with adverse postoperative complications or revision surgery compared to control patients.

Submitted: October 01, 2024 EDT. Accepted: December 20, 2024 EDT. Published: May 30, 2025 EDT.



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