J Shoulder Elbow Surg (2024) ■, 1–6

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Judicious use of corticosteroid injections prior to shoulder arthroplasty does not compromise outcomes at a minimum of 2 years following surgery

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Background: The use of total shoulder arthroplasty is continuing to rise with its expanding indications. For patients with chronic conditions, such as glenohumeral arthritis and rotator cuff arthropathy, nonoperative treatment is typically done prior to arthroplasty and often includes corticosteroid injections (CSIs). Recent studies in the shoulder arthroplasty literature as well as applied from the hip and knee literature have focused on the risk of periprosthetic infection. Literature is lacking as to whether the judicious use of corticosteroids in the year prior to arthroplasty influences patient-reported outcomes (PROs). The purpose of this study was to determine if preoperative CSIs prior to shoulder arthroplasty affected 2-year PROs.

Methods: Retrospective review of anatomic and reverse total shoulder arthroplasty (RSA) patients (n = 230) was performed at a single institution including multiple surgeons. Patients were included if they had preoperative and a minimum of 2-year postoperative PROs, including: American Shoulder and Elbow Surgeons (ASES), visual analog scale, Single Assessment Numeric Evaluation, Veteran's RAND 12 Physical Component Score, and Veteran's RAND 12 Mental Component Score. Patients were included in the injection group if they had received an injection, either glenohumeral or subacromial, within 12 months prior to arthroplasty (inject = 134). Subgroup analysis included anatomic (total shoulder arthroplasty [TSA] = 92) and RSA (RSA = 138) as well as those with no injection within 12 months prior to surgery. An analysis of variance was used to compare outcomes between patients who received an injection and those who did not prior to TSA and RSA.

Results: There were 230 patients included with 134 patients in the injection group and 96 in the no injection group. Patients who received an injection in the year prior to arthroplasty displayed a significantly higher ASES (82 [16.23 standard deviation] vs. 76 [19.43 standard deviation], $P < .01$) and Single Assessment Numeric Evaluation (70 [24.49 standard deviation] vs. 63 [29.22 standard deviation], $P < .01$) scores vs. those who had not received injection. There was no difference when comparing preoperative injection vs. no injection in patients undergoing TSA. Those patients undergoing RSA displayed significantly higher ASES scores ($P < .01$). There

Institutional review board approval for this project was received from Prisma Health (Pro00040469).

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https://doi.org/10.1016/j.jse.2024.03.006

were no significant differences in visual analog scale, Veteran's RAND 12 Physical Component Score, and Veteran's RAND 12 Mental Component Score among any analysis ($P > .05$), and the minimal clinically important difference in ASES was not different between groups (P.09).

Conclusion: CSIs within 12 months prior to anatomic and RSA do not compromise PROs during a minimum of 2-year follow-up. Although more complications occurred in the injection group, it did not reach statistical significance and warrants further study in a larger population.

Level of evidence: Level III; Retrospective Cohort Comparison; Prognosis Study

Keywords: Shoulder arthroplasty; corticosteroid; injection; glenohumeral arthritis; rotator cuff arthropathy; outcomes

Shoulder arthroplasty is becoming a more commonly performed surgical procedure, particularly reverse shoulder arthroplasty with its expanding indications. Regardless of indication for surgery, nonoperative treatment often includes corticosteroid injection (CSI) prior to surgery.[9,10] Corticosteroid medications can be injected to relieve symptoms into many areas of the shoulder, including the subacromial space, bicipital groove, glenohumeral joint, or acromioclavicular joint.

Due to the catabolic and immunosuppressive qualities of the medications, the treating providers must consider timing and quantity when planning for surgical intervention. Many studies report on the risk of CSI prior to rotator cuff surgery.[7,11,12] Although not directly related to shoulder arthroplasty, patient outcomes after shoulder arthroplasty may be influenced by rotator cuff healing, particularly with regards to subscapularis healing after anatomic total shoulder arthroplasty. Previous literature has also advised waiting at least 3 months after CSI of the hip and knee prior to arthroplasty to minimize the risk of periprosthetic joint infection and revision surgery.[1] Recent studies have been reproduced showing similar trends in patients undergoing shoulder arthroplasty.[2,10]

The effect of preoperative shoulder CSI on outcomes of shoulder arthroplasty has not been previously studied. The purpose of this study was to determine if preoperative CSI prior to shoulder arthroplasty affected 2-year patient-reported outcomes (PROs). The secondary aims were to determine if the number of injections influenced outcomes and whether CSI was associated with an increase in complications. We hypothesized that preoperative CSI would not cause any significant reduction in PROs, irrespective of number of injections, and that CSI would not result in any increase in complications.

Methods

All patients who underwent primary anatomic or reverse total shoulder arthroplasty (RSA) and had minimum 2-year PROs during the study period of 2015-2020 were enrolled. Retrospective chart review was done to determine whether a preoperative CSI had been given. It is standard practice by the treating surgeons to offer a CSI to all patients prior to shoulder arthroplasty barring no contraindications, such as allergy to the medicine or uncontrolled diabetes mellitus. Patients undergoing TSA had primary osteoarthritis, and an intra-articular (glenohumeral) injection was given. Patients undergoing RSA had either cuff tear arthropathy or irreparable rotator cuff tears, and these patients received subacromial injections. If the patient has a positive response, a repeat injection is typically offered with a minimum interval of 3 months between injections. The injections are often part of a more comprehensive nonoperative treatment course, also consisting of Non-steroidal anti-inflammatory drugs (NSAIDs), physical therapy, and avoidance of strenuous activities. The corticosteroid used was 40 mg of triamcinolone in all cases. A variable amount of local anesthetic, 1% plain lidocaine and/or 0.25% bupivacaine, was added based on surgeon preference to constitute a total volume of 5-8 cc.

All surgeons were fellowship trained and core faculty at a large academic center. Four different implant systems were used based on surgeon preference (Arthrex, Naples, FL, USA; ExacTech, Gainesville, FL, USA; Enovis, Austin, TX, USA; Stryker, Mahwah, NJ, USA). An abduction sling and standardized physical therapy program was followed for all patients. After RSA, patients were allowed early gentle active range of motion out of the sling; whereas, active elevation and external rotation beyond neutral was delayed for 6 weeks in patients after TSA to allow for subscapularis healing. Strengthening was initiated at 6 weeks postoperative for all patients with a supervised physical therapy (PT) program.

A cut-off period of 1 year prior surgery was used to be considered a preoperative injection, as CSI given prior 1 year were considered too remote to be relevant. Demographic data were collected, including: sex, age, Charlson index, and postoperative complications. The complications collected included infection, periprosthetic fracture, acromial stress fracture, instability, component loosening, rotator cuff failure, stiffness, and persistent pain. PROs data were obtained preoperatively and at a minimum of 2 years postoperatively and included American Shoulder and Elbow Surgeons (ASES), visual analog scale (VAS), Single Assessment Numeric Evaluation (SANE), and VR12-physical and mental health component summary scores (VR12 PCS and VR12 MCS).

A linear regression analysis was done at 26 weeks, 1 year, 2 years, and 3 years to determine the association between number of injections and outcomes. For each analysis, an unstandardized beta, a t-score, and a standardized beta coefficient were evaluated, along with a P value to determine statistical significance. The effect of baseline outcome scores and Charlson index score were controlled for each outcome. Standardized beta coefficient

Table I Patient demographics

	Injection n = 134	No injection n = 96	*P* value
Age	68.9 [Std 7.7]	66.0 [Std 8.7]	.018
Sex			
Male	57	51	.112
Female	77	45	
Anatomic vs. reverse			
TSA	52	40	.660
RSA	82	56	
Complications			
Total	8	2	.435
	6.0%	2.1%	
Infections	2	2	
Instability	4	0	
Other	2	0	
Reoperations	4	1	
Number of injections (within 1 yr of surgery)	1.7 [Std 0.9] Range 1-4		
Days from last injection to surgery	140 [Std 81] Range 27-361		

Std, standard deviation; *TSA*, total shoulder arthroplasty; *RSA*, reverse total shoulder arthroplasty.
Repeated measure linear modeling.

parameters generally span between −1 to 0 to 1 with higher absolute values suggesting a stronger association. Standardized beta coefficients are of particular importance since the values are somewhat transferrable across analyses.

A repeated measures analysis of covariance was used to measure the between-groups differences between TSA with and without injection and RSA with and without injection independently and combined. Similar to the linear regression analysis, the effect of baseline outcome scores and Charlson index score were controlled for each outcome. A between-groups P value and partial eta squared was calculated. A boundary value for partial eta squared ($\eta 2$-an effect measure) are 0.01 (small effect), 0.06 (medium effect), and 0.14 (large effect). The complication and reoperation rates were compared using Fisher exact 2-sided tests.

Results

There were 230 patients included with 134 patients in the injection group and 96 patients in the no injection group. Patients had a mean follow-up of 23.74 months +/− 3.1 months (range of 21.9 months-38 months). Patients in the injection group were slightly older than the no injection group (68.9 vs. 66.0 years, $P = .018$). No other demographic differences were found (Table I). The distribution of anatomic and RSA was similar between groups. Patients in the injection group received an average of 1.7 injections (SD ± 0.9, range 1-4) in the year prior to surgery. The average time from last injection to surgery was 140 days (SD ± 81, range 27-361 days).

The postoperative complication rate was not statistically significantly different between groups ($P = .14$). There were 8 complications in the injection group out of 134 patients (6.0%): 4 patients with instability (2 of whom required revision surgery), 2 infections (1 of whom required reoperation), 1 acromial stress fracture (no reoperation), and 1 patient with unexplained continued pain and dysfunction. Two complications were found in the no injection group out of 96 patients (2.1%). Both patients had an infection and one required reoperation. The rates of reoperation were not statistically different between the injection group (2.2%) and the no injection group (1.0%), $P = .4$.

At final follow-up, the ASES score was higher in the injection group than the no injection group (82 vs. 76, $P < .01$, Table II). Using an minimal clinically important difference (MCID) score of 16.7 for ASES based on a previous study,[6] 116 out of 134 patients in the injection group (87%) met MCID and 75 out of 96 patients in the no injection group met MCID. The difference in percentage of patients achieving MCID between groups was not significant, $P = .09$. The SANE score was also higher in the injection group (70 vs. 63, $P < .01$). Both ASES and SANE demonstrated $\eta 2$ measures yielding a small effect. There were no statistically significant differences found between all other PROs (VAS, VR12 PCS, and VR12 MCS).

No significant between-group differences were found in any PROs in patients who had TSA. Significant between-groups differences were found for ASES score ($P < .05$) and SANE ($P < .05$) in patients who had RSA. In both measures, RSA with no injection provided the lowest overall values, with $\eta 2$ measures yielding a moderate effect. There were no other statistically significant differences in other PROs (VAS, VR12 PCS, and VR12 MCS) in patients who had RSA.

Table II Injection vs. no injection

Variable	Injection	26 weeks Mean (SD)	1 year Mean (SD)	2 years Mean (SD)	3 years Mean (SD)	*P* value	Partial eta squared (effect size)
ASES score	No	66.84 (28.55)	70.13 (27.53)	76.81 (20.22)	76.42 (19.43)	**<.01**	0.04
	Yes	75.46 (22.14)	73.13 (27.79)	82.49 (17.41)	82.08 (16.23)		
VAS	No	1.68 (1.57)	1.78 (2.37)	1.75 (2.09)	1.51 (1.76)	.08	0.01
	Yes	1.54 (1.32)	1.42 (2.11)	1.19 (1.97)	1.37 (1.73)		
SANE	No	51.28 (33.51)	61.61 (31.57)	65.92 (28.87)	62.92 (29.22)	**<.01**	0.03
	Yes	56.72 (33.19)	67.10 (30.25)	74.07 (25.25)	69.73 (24.49)		
VR12 PCS	No	40.47 (12.49)	39.14 (13.41)	43.68 (7.74)	41.64 (9.66)	.71	0.00
	Yes	38.37 (15.34)	40.37 (14.62)	44.44 (8.59)	43.79 (8.02)		
VR12 MCS	No	49.08 (15.31)	48.54 (16.71)	51.88 (11.23)	52.01 (10.70)	.08	0.01
	Yes	51.70 (15.03)	50.74 (17.08)	53.77 (9.07)	54.01 (7.07)		

ASES, American Shoulder and Elbow Surgeons; *VAS*, visual analog scale; *SANE*, Single Assessment Numeric Evaluation; *VR12 PCS*, Veteran's RAND 12 Physical Component Score; *VR 12 MCS*, Veteran's RAND 12 Mental Component Score; *SD*, standard deviation.
Repeated measure linear modeling.
All analysis include control for the baseline variable of interest and Charlson index score. Partial eta squared ($\eta 2$) = 0.01 indicates a small effect; $\eta 2 = 0.06$ indicates a medium effect; $\eta 2 = 0.14$ indicates a large effect.
Bold value indicates statistical significance.

When analyzing between TSA and RSA (Table III), significant between-groups differences were identified for ASES ($P < .01$) and SANE ($P < .01$). In both measures, RSA with no injection provided the lowest overall values, with $\eta 2$ measures yielding a moderate effect. No other measures met statistical significance.

When considering number of injections, predictive analysis demonstrated a weak relationship between number of injections and SANE at 3 years, with more injections associated with slightly improved SANE. No significant associations were found with preoperative CSI and all other PROs (ASES, VAS, VR12 PCS, and VR12 MCS).

Discussion

The main finding of the study is that preoperative injections given within 1 year prior to shoulder arthroplasty do not seem to portend a negative influence on outcomes. Injections were typically avoided within 3 months of surgery in this cohort, but timing of the injection beyond 3 months did not influence outcomes. The ASES and SANE were higher in the injection group than the no injection group; however, it yielded a small effect likely making its clinical relevance insignificant as they did not reach the previous published MCID of 9 points for ASES and 14.9 for SANE.[5,13]

The sample size was too small to draw conclusions on complications. More complications were found in the injection group (n = 6) than the no injection group (n = 2), but this was not statistically significant. Large database studies are required to examine complication rates, such as infection or revision, due to their low incidences. No conclusions can be drawn with regards to how close to surgery a CSI is safe, since the standard practice of the treating physicians is to avoid injections in the immediate preoperative period. However, the increased number of complications in the injection group warrants further study.

The primary outcome of the current study was differences in 2-year PROs based on preoperative CSI. Previous literature has focused on postoperative complications of giving preoperative CSI. High rates of revisions have been found in patients receiving preoperative CSI prior to rotator cuff repair surgery.[7,11,12] Infection risk after other shoulder arthroscopy procedures has also shown to be increased with preoperative CSI.[3,8] Stadecker et al[10] found that among the 38.4% of patients who received a CSI prior to shoulder arthroplasty, the patients who got the injection within 3 months of surgery had an odds ratio of 2.61 for risk of all-cause revision surgery.[10] Baksh et al similarly found an increased risk of periprosthetic joint infection (PJI) with injections given within 4 weeks of shoulder arthroplasty.[2] Cancienne et al reported a significant risk of infection with CSI administered to patients with previous arthroplasty.[3,4] Based on this literature, the surgeons in the current study do not offer injections close to surgery, typically within 3 months, and the risk of giving CSI within this time period is beyond the scope of the paper.

Limitations of the study include the inadequate number of subjects to provide statistical power on the risk of complications from CSI. The primary aim of the study was 2-year PROs, but complications were added as a secondary measure to ensure that the immunosuppressive effect was not causing a noticeable difference between groups. Larger database studies are better suited to study CSI effect on infections, complications, and revisions. In addition, since the author's standard of practice is to delay arthroplasty for at least 3 months after injection, the use of CSI within 3 months of surgery is beyond the scope of this study and should be avoided based on the results of larger database studies. The retrospective nature of the study introduces possible

Table III Four-group comparison of TSA plus injection (TSA yes), vs. TSA no injection (TSA no) vs. RSA plus injection (RSA yes) vs. RSA no injection (RSA no)

Variable	TSA vs. RSA	26 weeks Mean (SD)	1 year Mean (SD)	2 years Mean (SD)	3 years Mean (SD)	*P* value	Partial eta squared (effect size)
ASES score	TSA yes	78.00 (21.85)	74.02 (32.78)	87.50 (16.36)	84.91 (16.86)	**<.01**	0.09
	TSA no	74.54 (26.18)	74.29 (28.88)	81.00 (18.02)	82.02 (17.76)		
	RSA yes	73.87 (22.30)	72.98 (24.39)	79.37 (17.41)	80.32 (15.67)		
	RSA no	60.00 (29.10)	66.44 (26.03)	73.09 (20.91)	71.45 (19.69)		
VAS	TSA yes	1.59 (1.45)	1.00 (1.63)	0.98 (1.87)	1.32 (1.87)	.06	0.03
	TSA no	1.52 (1.51)	1.34 (2.04)	1.58 (2.08)	1.24 (1.63)		
	RSA yes	1.51 (1.24)	1.67 (2.33)	1.33 (2.04)	1.41 (1.64)		
	RSA no	1.82 (1.63)	2.17 (2.58)	1.90 (2.11)	1.75 (1.84)		
SANE	TSA yes	51.41 (33.09)	69.16 (33.04)	80.41 (24.94)	73.28 (26.83)	**<.01**	0.10
	TSA no	58.97 (34.14)	66.22 (31.31)	69.05 (30.06)	76.85 (23.21)		
	RSA yes	60.03 (33.02)	65.81 (28.51)	70.14 (24.78)	67.54 (22.81)		
	RSA no	44.45 (31.77)	57.41 (31.58)	63.14 (27.81)	50.55 (28.63)		
VR12 PCS	TSA yes	39.12 (15.87)	39.76 (17.25)	47.41 (6.76)	45.57 (8.34)	.26	0.02
	TSA no	41.89 (10.95)	39.31 (14.43)	44.75 (7.05)	44.57 (7.93)		
	RSA yes	37.90 (15.08)	40.74 (12.83)	42.59 (9.11)	42.46 (7.57)		
	RSA no	39.20 (13.71)	38.99 (12.60)	42.74 (8.26)	39.03 (10.38)		
VR12 MCS	TSA yes	53.93 (12.23)	48.65 (21.02)	54.99 (9.49)	54.53 (8.20)	.30	0.02
	TSA no	49.85 (15.49)	48.56 (18.89)	50.98 (13.24)	52.51 (11.56)		
	RSA yes	50.31 (16.45)	52.05 (14.08)	53.01 (8.77)	53.69 (6.29)		
	RSA no	48.38 (15.29)	48.52 (14.73)	52.69 (9.17)	51.57 (9.99)		

ASES, American Shoulder and Elbow Surgeons; *RSA*, reverse total shoulder arthroplasty; *TSA*, total shoulder arthroplasty; *VAS*, visual analog scale; *SANE*, Single Assessment Numeric Evaluation; *VR12 PCS*, Veteran's RAND 12 Physical Component Score; *VR 12 MCS*; Veteran's RAND 12 Mental Component Score; *SD*, standard deviation.

Repeated measure linear modeling.

All analysis include control for the baseline variable of interest and Charlson index score. Partial eta squared ($\eta 2$) = 0.01 indicates a small effect; $\eta 2$ = 0.06 indicates a medium effect; $\eta 2$ = 0.14 indicates a large effect.

Bold value indicates statistical significance.

selection bias, as patients considered higher risk for surgery may have been given more CSI in attempts to avoid surgery. The difference in baseline health status may contribute to the increased number of complications in the injection group. However, the effect of Charlson comorbidity was controlled for in the linear regression analysis in all outcome measures. Lastly, although demographics between the 2 groups in this study were similar, patients in the injection group were on average 3.9 years older than the no injection group. This reflects the authors' practice of administering more injections in older and more sedentary patients. However, the difference in average age was likely too small to contribute any meaningful effect on the outcomes.

Conclusion

CSIs are a common adjunct to conservative management for patients with shoulder arthritis and rotator cuff arthropathy. The injections can reduce symptoms as patients progress through physical therapy, and the need for surgery may be delayed or avoided. CSIs within 12 months prior to anatomic and RSA did not compromise PROs during a minimum of 2-year follow-up. Although more complications occurred in the injection group, it did not reach statistical significance and warrants further study in a larger population.

Disclaimers:

Funding: No funding was disclosed by the authors.

Conflicts of interest: The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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