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Outcomes of total shoulder arthroplasty for instability arthropathy with a prior coracoid transfer procedure: a retrospective review and matched cohort

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Background: Many surgeons are concerned about reports of increased complications, worse outcomes, and early failures in patients undergoing anatomic total shoulder arthroplasty after coracoid transfer. The purpose of this study was to evaluate minimum 2-year outcomes following anatomic total shoulder arthroplasty for instability arthropathy with a prior coracoid transfer procedure and compare them with a matched cohort of patients undergoing total shoulder arthroplasty for primary osteoarthritis.
Methods: We identified 11 primary anatomic total shoulder arthroplasties performed by a single surgeon for instability arthropathy with a prior coracoid transfer procedure with a minimum of 2 years' follow-up (mean, 58 ± 35 months). A matched cohort of 33 patients with a total shoulder arthroplasty for primary osteoarthritis served as the control group. The American Shoulder and Elbow Surgeons (ASES) score, Single Assessment Numeric Evaluation (SANE) score, patient satisfaction, complications, and revisions were evaluated in both cohorts.
Results: The coracoid transfer cohort showed no difference in the final ASES score (88 vs. 82, $P = .166$) or SANE score (85 vs. 67, $P = .120$) vs. the matched cohort. The postoperative ASES pain score (45 vs. 41, $P = .004$) was higher in the coracoid transfer cohort, but the mean improvement from preoperative to postoperative values for the ASES score ($P = .954$), ASES pain score ($P = .183$), and SANE score ($P = .293$) was no different between cohorts. Both cohorts had high patient satisfaction without a statistically significant difference ($P = .784$).
Conclusion: At early- to mid-term follow-up, total shoulder arthroplasty performed after a coracoid transfer demonstrated similar results to total shoulder arthroplasty performed for primary osteoarthritis. Longer follow-up and larger patient cohorts will provide further insights and highlight any potential differences in outcomes or revision rates.

The Texas Orthopedic Hospital's Institutional Review Board approved this study (no. TOH178).

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Instability arthropathy or dislocation arthropathy is a well-described sequela of prior shoulder instability,[3,8,10,13,23] defined as the development of glenohumeral arthritis after nonoperative treatment, capsulolabral reconstruction, or a coracoid transfer procedure (Bristow or Latarjet).[5,21,26] As the number of coracoid transfer procedures performed in the United States has steadily increased,[22] it is expected that glenohumeral osteoarthritis will develop in some of these patients and they will undergo shoulder arthroplasty.[14] Thus, understanding the management and outcomes of these patients is of increasing importance.

Several studies have highlighted the technical challenges of shoulder arthroplasty following a coracoid transfer procedure, including distorted neurovascular anatomy, loss of the coracoid and conjoined tendon as surgical landmarks, scarring, existing hardware, bone loss, and soft-tissue balancing.[2,9,15,16,24] Surgeons are also concerned about whether subscapularis integrity is adequate for anatomic total shoulder arthroplasty (TSA) because it is either split or tenotomized during the coracoid transfer procedure.

There is limited literature regarding the outcomes of anatomic TSA after a prior coracoid transfer procedure. A few studies have addressed TSA in the setting of instability arthropathy; however, many of these studies included patients with prior soft-tissue procedures along with patients following coracoid transfer.[12,16,17,19,24,27] The reported clinical outcomes have been mixed and are not entirely representative of post–coracoid transfer patients because the majority of patients underwent only soft-tissue stabilization procedures. A recent study identified recurrent instability, component loosening, and rotator cuff failure as the main causes of revision after TSA following coracoid transfer.[27] These results have led some surgeons to advocate reverse shoulder arthroplasty (RSA) because of its inherent stability and less reliance on soft-tissue balance. However, the advantages of RSA must be weighed against the limited understanding of its longevity and salvage options, especially in this relatively young patient population.

The purpose of this study was to evaluate minimum 2-year outcomes following anatomic TSA for instability arthropathy with a prior coracoid transfer procedure and compare them with a matched cohort of patients following TSA for primary osteoarthritis. We hypothesized that anatomic TSA would be a safe and reliable option for this condition and would result in similar outcomes to TSA for primary osteoarthritis.

Materials and methods

A retrospective review with a matched cohort was performed using our single-surgeon shoulder arthroplasty registry database. Included data were prospectively collected from December 2004 to February 2018. All patients completed the informed-consent form prior to enrolling in the database.

Inclusion criteria

The inclusion criteria for patient selection were as follows: (1) adults 18 years or older, (2) documentation of a prior coracoid transfer (Bristow or Latarjet procedure) for anterior shoulder instability, (3) primary anatomic TSA performed for instability arthropathy, and (4) minimum of 2 years' follow-up. The exclusion criteria were (1) fixed dislocations, (2) posterior shoulder instability, (3) prior glenoid bone grafting from sources other than the coracoid, (4) hemiarthroplasty (HA) or RSA as the index procedure, (5) coracoid transfer performed simultaneously with the arthroplasty, and (6) lack of adequate follow-up or documentation.

Patient selection

Of the 2887 patients in the database at the time of assessment, 132 who underwent a shoulder arthroplasty for a diagnosis of "instability arthropathy" or "capsulorrhaphy arthropathy" were identified. A review of those patients' clinical notes, operative reports, and radiographs was performed to isolate a subset of 18 patients with a coracoid transfer procedure prior to arthroplasty. Four of those patients underwent an RSA and were therefore excluded. Of the 14 patients with an anatomic TSA after a coracoid transfer procedure, 11 had undergone the procedure at a minimum of 2 years earlier whereas 3 were excluded because of inadequate follow-up. One patient underwent a revision prior to the minimum 2-year follow-up period, so no postoperative outcome measures were available for this patient.

Matched cohort

A matched cohort was created from the database for anatomic TSA performed for primary osteoarthritis to serve as a control group. Each case was matched with 3 control subjects by use of propensity scoring and matched according to age, sex, body mass index, shoulder dominance, and comorbidities with a nearest-neighbor technique used for surgery date to account for changes in surgical technique over time.

Data collection

Patients undergoing shoulder arthroplasty at our institution are asked to undergo follow-up at the following intervals: 1, 2, 5, 7, 10, 15, and 20 years. Validated questionnaires are completed preoperatively and at each of these intervals. Patients who did not have clinical outcome scores documented after the minimum

2-year follow-up period were contacted and asked to return to the clinic for a repeated evaluation and completion of outcome scores. If patients were unable to return, they completed the subjective questionnaires through a standardized phone survey. A detailed chart review was performed in both cohorts to identify any additional complications that may have been missing from the registry data.

Clinical outcomes evaluated preoperatively and at final follow-up in both cohorts included the American Shoulder and Elbow Surgeons (ASES) score, the Single Assessment Numeric Evaluation (SANE) score, a visual analog scale score, and subjective patient satisfaction. Secondary metrics evaluated included complications and the revision rate.

Radiographic data

Radiographic data on glenoid wear pattern and rotator cuff fatty infiltration were documented in the database preoperatively by the primary surgeon. Glenoid wear pattern was assessed on preoperative computed tomography (CT) scans based on the original classification by Walch et al.[25] The grade of fatty infiltration was based on the axial CT slices as described by Goutallier et al.[11] There were insufficient postoperative radiographic data to include in the analysis.

Excluded patients

Of note, of the 18 patients who underwent an arthroplasty after a coracoid transfer, the 4 who underwent an RSA did so for the following reasons: The first patient had an intact cuff but a Walch type B3 glenoid with severe deformity and underwent RSA with posterior glenoid bone grafting. The second patient had recurrent dislocations after the Latarjet procedure with anterior glenoid bone loss and underwent RSA with iliac crest bone grafting. In the third patient, soft-tissue stabilization procedures had failed and the subscapularis ruptured after a recurrence following the Latarjet procedure; the patient underwent an anterior iliac crest bone graft with a pectoralis major transfer prior to later undergoing RSA. The final excluded patient had a fixed anterior dislocation treated with the Latarjet procedure, and a massive cuff tear subsequently developed, requiring RSA.

Coracoid transfer study cohort

The 11 patients consisted of 10 men and 1 woman ranging in age from 47 to 63 years. Of the patients, 8 underwent a prior Bristow procedure whereas 3 underwent a prior Latarjet procedure. Six patients underwent 1 or more soft-tissue surgical procedures prior to coracoid transfer, whereas 3 patients underwent 2 or more. Loose screws were present in 4 patients, and 1 patient had a broken screw. A coracoid nonunion was present following 2 of the Bristow procedures. The average interval from coracoid transfer to anatomic TSA was 28.8 years (range, 2-44 years).

Surgical technique

All 11 cases were performed through a deltopectoral approach, by our published anatomic TSA technique.[6] The absence of the coracoid and conjoined tendon as surgical landmarks was recognized during the approach, as well as anticipation of scarring from prior surgery. There was no routine surgical dissection to expose the axillary or musculocutaneous nerves, although the neurovascular anatomy is known to be distorted following a prior coracoid transfer procedure. The surgical approach was carefully undertaken with an understanding of potential neurovascular changes from the prior operation. The subscapularis was tenotomized along the anatomic neck in all cases. Retained screws were removed if they were loose or interfered with glenoid placement; this was required in 9 of 11 cases. The healed graft was left in place unless it interfered with subscapularis excursion, and the conjoined tendon was not released unless it interfered with soft-tissue tensioning. A cemented all-polyethylene glenoid with a press-fit humeral stem was used in all cases. The humeral components used were Ascend Flex (7), Aequalis (3), and Ascend (1) (Tornier/Wright Medical, Memphis, TN, USA). The glenoid components used were Perform Cortiloc pegged (7), Aequalis pegged (3), and Aequalis keeled (1) (Tornier/Wright Medical).

All 33 TSAs in the matched cohort were performed using a deltopectoral approach with a subscapularis tenotomy. The humeral implants were all press fit and included Aequalis (16), Ascend Flex (11), and Ascend (6). The glenoid components were all cemented all-polyethylene glenoids and included Perform Cortiloc (13), Aequalis keeled (10), and Aequalis pegged (10) glenoids.

Statistical analysis

Baseline subject characteristics between cases and matched controls were evaluated with a matched-linear mixed model or χ^2 test as appropriate. Differences in the ASES score, ASES pain score, and SANE score between groups and times (preoperatively to final follow-up) were also evaluated with matched-linear mixed models. Patient satisfaction was evaluated with the χ^2 test. The P value was set at .05 for statistical significance, and SPSS software (version 24; IBM, Armonk, NY, USA) was used for all analyses.

Results

Demographic characteristics and follow-up

There were no statistically significant differences between the 2 cohorts regarding age, sex, body mass index, and shoulder dominance (Table I). Of note, the mean age of the coracoid transfer cohort was 57 ± 4 years. The mean follow-up periods for the coracoid transfer and matched groups were 58 ± 35 months and 47 ± 28 months, respectively. The glenoid wear pattern (Table II) was not significantly different between the coracoid transfer and matched cohort groups ($P = .844$). Similarly, the grade of fatty infiltration was not significantly different between cohorts ($P = .313$).

Outcome scores

TSA resulted in statistically significant improvements in the ASES score, ASES pain score, and SANE score ($P < .001$

Table I Subject characteristics at baseline

	Coracoid transfer (n = 11)	Matched cohort (n = 33)	*P* value
Age, yr	57 ± 4	57 ± 5	.848
Sex	10 M/1 F	30 M/3 F	>.99
BMI	30 ± 6	30 ± 5	.822
Dominant shoulder, n (%)	6 (55)	19 (58)	>.99
Follow-up, mo	58 ± 35	47 ± 28	.340

M, male; *F*, female; *BMI*, body mass index.

for all) from preoperatively to final follow-up for both study groups (Table III). ASES pain measures were significantly different between the study groups ($P = .004$), but this was largely because of higher levels of reported pain in the matched cohort (osteoarthritis patients) compared with the coracoid transfer group at the preoperative assessment. However, there was no significant preoperative difference between the coracoid transfer and cohort groups for ASES ($P = .166$) or SANE ($P = .120$) scores. Although there were significant improvements in outcome measurements (Figs. 1-3), the magnitude of change between the groups from the preoperative assessment to the final follow-up was nearly identical, as noted by the similar slopes of the lines. The magnitude of change between groups was not statistically significant for ASES ($P = .954$), ASES pain ($P = .183$), and SANE ($P = .293$) scores.

Patient satisfaction

TSA resulted in improved patient satisfaction in both cohorts (Table IV). At final follow-up, 9 of 10 coracoid transfer patients (90%) were "satisfied" or "very satisfied" compared with 27 of 33 patients in the matched cohort (82%) ($P = .784$, Fig. 4).

Complications

In the coracoid transfer cohort, there were a total of 3 complications in 3 different patients, for a total complication rate of 27.2%. Two early complications comprised a stitch abscess and a deep infection at 2 weeks requiring surgical débridement. A third patient in the prior coracoid transfer group was found to have aseptic glenoid loosening and polyethylene wear at 9 years. Of note, there were no nerve injuries, dislocations, or clinically detectable subscapularis failures in the coracoid transfer group.

In the matched cohort, there were 7 complications in 4 patients, for a 21.2% total complication rate. The early complications included 2 neurapraxia injuries, a stitch abscess, and a small intraoperative glenoid fracture that did not require fixation or further treatment. The late complications included 2 cases of aseptic glenoid loosening and a late deep infection. Overall, the total complication rates were 27.2% in the coracoid transfer group and 21.2% in the primary osteoarthritis group.

Table II Preoperative computed tomography results

	Coracoid transfer	Matched cohort	*P* value
Walch classification			
A1	4	11	.844
A2	2	3	
B1	2	5	
B2	3	11	
C	0	2	
Missing		1	
Goutallier grade of subscapularis			
0	7	31	.313
1	1	1	
2	1	0	
3	2	0	
4	0	0	
Missing		1	

Revisions

In the coracoid transfer group, 2 patients had undergone revision at final follow-up, for an 18.2% revision rate. The first case was a revision to RSA at 9.5 months for instability due to subscapularis failure after serial débridement following an acute deep infection at 2 weeks. The second case was a revision to RSA with iliac crest bone grafting at 9 years after TSA for aseptic glenoid loosening.

In the matched cohort, there were 2 revisions at final follow-up, for a 6.1% revision rate. The first case was a 2-stage revision to RSA at 5 years after TSA because of a deep methicillin-resistant *Staphylococcus aureus* infection. The second revision case was treated with RSA at 4 years postoperatively owing to aseptic glenoid loosening.

Discussion

A paucity of literature exists specifically examining patients undergoing arthroplasty after a prior coracoid transfer. Previous studies on arthroplasty after instability procedures have included variety in the type and number of prior surgical treatments for instability, and the majority included only a small percentage of cases with prior coracoid transfer. In addition, most included studies combined the results of HA, TSA, and RSA for instability arthropathy.[2,12,16,17,24,27] The heterogeneity of surgical history and implant type makes it difficult to make recommendations on optimal treatment. One strength of this study is that it presents a small but relatively homogeneous series of 11 patients treated with a single procedure following a coracoid transfer procedure.

Table III Results of matched analysis comparing coracoid transfer and primary osteoarthritis groups

	Coracoid transfer			Matched cohort			*P* value		
	Preoperative	Final follow-up	Change	Preoperative	Final follow-up	Change	Preoperative to final follow-up changes	Group differences	Preoperative to final follow-up changes between groups
ASES	43 ± 20	88 ± 20	45	36 ± 16	82 ± 23	46	<.001	.166	.954
ASES pain	20 ± 14	45 ± 11	25	8 ± 6	41 ± 14	32	<.001	.004	.183
SANE	32 ± 20	85 ± 23	53	28 ± 23	67 ± 35	39	<.001	.120	.293

ASES, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation.

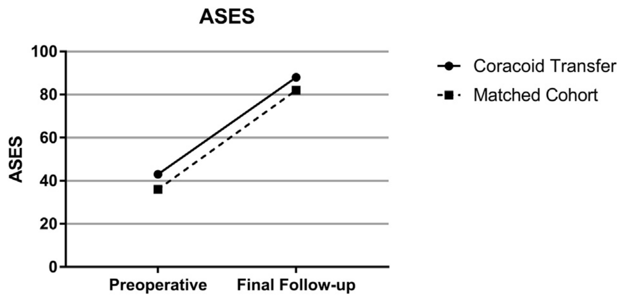

Figure 1 Changes in American Shoulder and Elbow Surgeons *(ASES)* score from preoperative assessment to final follow-up in prior coracoid transfer (—) and matched cohort (---) patients.

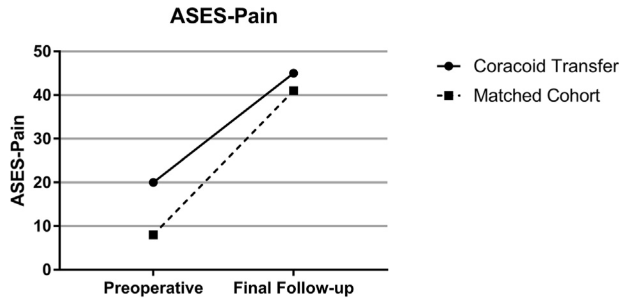

Figure 2 Changes in American Shoulder and Elbow Surgeons *(ASES)* pain score from preoperative assessment to final follow-up in prior coracoid transfer (—) and matched cohort (---) patients.

Freehill et al[9] demonstrated clinically significant alterations in the positions of the musculocutaneous and axillary nerves following coracoid transfer, and prior studies have commented on the challenge of protecting these structures amid extensive scarring in the subdeltoid space and around the conjoined tendon.[2,12,24] In addition, the altered position of the conjoined tendon removes a commonly used landmark. Despite this, there were no injuries to neurovascular structures in our coracoid transfer group or in other reports.[27]

Given the crucial role of a functioning subscapularis in anatomic TSA, multiple authors have examined changes in the function of the subscapularis after being split during coracoid transfer. Performing the procedure with a splitting technique has been found to result in less atrophy and fatty infiltration than an L-tenotomy.[18,20] Caubère et al[4] demonstrated no atrophy or fatty infiltration on MRI at 1 year after coracoid transfer; however, there are differing reports on the effect on strength.[7,20] In a separate study from our institution, we found that 71% of patients (10 of 14) in the coracoid transfer cohort had Goutallier grade 0 changes of the subscapularis on the preoperative CT scan prior to TSA, and this was not significantly different from a primary osteoarthritis cohort ($P = .344$).[1]

Given the technical complexity of performing TSA after coracoid transfer, many authors have expressed concerns about soft-tissue balancing and the potential for increased complications or failures.[2,12,16,24,27] Component revision was required in 2 of 11 coracoid transfer patients (18%) in this study. This finding is similar to that of a previous series including only patients with prior coracoid transfer undergoing TSA in which 3 of 9 (33%) underwent revision at a mean of 4.7 ± 4.4 years.[27] In that series, the indication for revision was related to instability in all 3 cases. In our study, the indications for revision were different in that one was for aseptic glenoid loosening and polyethylene wear at 9 years postoperatively and the other was for subscapularis failure in a patient who underwent multiple débridement procedures for an early deep infection. Moreover, the revision rates between the coracoid transfer and primary osteoarthritis groups were not statistically different in these small cohorts. Thus, the results of this study do not support the notion that coracoid transfer patients will necessarily have a higher revision rate or will have prosthetic instability as a common cause of failure following TSA.

This study also demonstrated similar ASES and SANE scores in the group with instability arthropathy and prior coracoid transfer compared with the matched primary osteoarthritis cohort at early- to mid-term follow-up. In addition, of 10 patients with satisfaction scores, 9 (90%) were satisfied or very satisfied with their outcome. This finding is similar to reported outcomes in the literature. Bigliani et al[2] reported a 77% rate of excellent or satisfactory results at a mean of 2.9 years for TSA or HA in 17 patients with prior instability surgery (2 coracoid

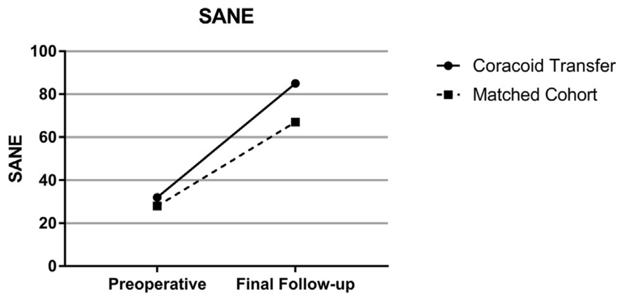

Figure 3 Changes in Single Assessment Numerical Evaluation *(SANE)* score from preoperative assessment to final follow-up in prior coracoid transfer (—) and matched cohort (---) patients.

Table IV Patient satisfaction

	Coracoid transfer, n (%)		Matched cohort, n (%)	
	Preoperative	Final	Preoperative	Final
Very dissatisfied	6 (54.5)	0 (0)	25 (75.8)	1 (3.0)
Dissatisfied	5 (45.5)	1 (10.0)	8 (24.2)	5 (15.2)
Satisfied	0 (0)	1 (10.0)	0 (0)	6 (18.2)
Very satisfied	0 (0)	8 (80.0)	0 (0)	21 (63.6)

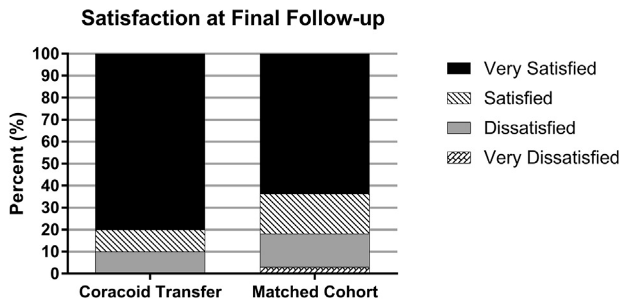

Figure 4 Patient satisfaction at final follow-up.

transfers). Green and Norris[12] retrospectively evaluated 17 patients with TSA or HA following an instability repair (4 Bristow procedures). At a mean of 5.2 years' follow-up, 94% were either "much better" or "better." Matsoukis et al[17] reported good or excellent results in 50 of 55 patients at a mean of 3.8 years' follow-up; 18 patients underwent prior coracoid transfers. There were significant improvements in range of motion and the Constant score, but it was noted that the scores were not as high as those after primary TSA for osteoarthritis reported by the same group.[17]

RSA has been suggested as the most reliable option for these patients given the high rate of instability-related complications in the previously published literature. Willemot et al[27] compared revision rates of 11 RSAs and 19 anatomic arthroplasties (14 TSAs and 5 HAs) after prior coracoid transfer at a mean of 4.9 years' follow-up. No patients undergoing RSA required revision, whereas the rate for the TSA or HA group was 30%. All revisions in the TSA group were related to prosthetic instability.[27] However, the benefits of RSA must be weighed against our limited understanding of its longevity and salvage options. This is especially important in instability arthropathy patients because they typically present at a younger age, with most studies reporting average ages in the 40s and 50s.[2,12,16,17,24,27] It is unclear from the results of our study and the limited literature available whether patients with instability arthropathy after a coracoid transfer would be better treated with RSA. However, the revision rate, types of revisions, and reliable improvements in functional outcomes from TSA in this study suggest that TSA should remain an option at this time for these difficult cases.

There are limitations to our study including the midterm follow-up (mean, 4.8 years) and small sample size (N = 11). Sperling et al[24] evaluated 31 patients with prior instability surgery (8 with prior Bristow procedures) at a mean 7-year follow-up. Their 5-year estimated implant survival rate was similar to ours, at 86%, but dropped to 61% at 10 years. Thus, although the revision rates between the coracoid transfer group (2 of 11 patients, 18%) and primary osteoarthritis group (2 of 33 patients, 6%) in our study were not statistically significant, it is possible that larger cohorts of patients with longer follow-up could show an increased risk of revision. However, it should be noted that the majority of failures in the study by Sperling et al were due to glenoid erosion of HA or failure of metal-backed glenoids, neither of which were used in our cohort.

Other limitations include the retrospective design, somewhat limited applicability of a single surgeon's experience, and lack of adequate radiographic follow-up. Multi-surgeon studies such as the study by Matsoukis et al[17] may represent results that are more generalizable, but the uniformity in indications and surgical technique from our single-surgeon study also provides valuable information. Furthermore, the inclusion of a matched cohort of primary osteoarthritis patients yields additional value; however, we must note that the 2 cohorts are different in that the study group had a diagnosis of instability arthropathy and a prior coracoid transfer whereas the control group had a diagnosis of primary osteoarthritis. An additional limitation is our lack of radiographic follow-up because it is possible that patients showed good function despite radiographic abnormalities. The strengths of this study include a homogeneous series of 11 patients treated with a single procedure following a coracoid transfer procedure, comparable results to TSA for primary osteoarthritis, and a lack of postoperative neurovascular complications despite altered anatomy following a prior coracoid transfer procedure.

As the number of coracoid transfer procedures in the United States increases,[22] larger, multicenter studies with longer follow-up will be crucial to learning how to best manage these patients.

Conclusion

At early- to mid-term follow-up, TSA performed after a coracoid transfer demonstrated similar results to TSA performed for primary osteoarthritis. Longer-term follow-up and larger patient cohorts will provide further insights into this issue and highlight any potential differences in outcomes or revision rates.

Disclaimer

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