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Impact of prior anterior instability on shoulder arthroplasty outcomes: a systematic review

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Background: Anterior shoulder instability (ASI) is a frequently encountered pathology. Patients with a history of ASI have an increased rate of developing glenohumeral osteoarthritis and becoming candidates for shoulder arthroplasty. This systematic review aims to synthesize outcomes for patients undergoing shoulder arthroplasty with a history of ASI.

Methods: A comprehensive literature review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) using PubMed, Embase, OVID Medline, Scopus, CINAHL, Web of Science, and Cochrane databases for studies evaluating the impact of prior ASI on total shoulder arthroplasty (TSA), reverse TSA, and/or hemiarthroplasty outcomes, with a minimum follow-up of 12 months. Studies were graded by level of evidence and data concerning patient demographics and outcomes were extracted.

Results: Sixteen articles met the inclusion criteria, including 596 patients (413 male, 181 female). The average age of the control and prior ASI groups were 57.5 and 57.0 years, respectively. Overall, 251 patients were treated operatively, 132 nonoperatively, and 213 were controls without a history of prior ASI. Shoulder arthroplasty techniques included TSA (436 shoulders), reverse TSA (130 shoulders), and hemiarthroplasty (14 shoulders). Prior anterior stabilization management included soft tissue repair, bony augmentation, and nonoperative treatment. Almost all studies reported no significant difference in subjective and functional arthroplasty outcomes between control and prior ASI groups, or between patients with prior ASI treated nonoperatively vs. surgically.

Conclusion: Shoulder arthroplasty in the setting of prior ASI results in improved subjective and functional outcome scores that are comparable to patients without a history of instability.

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Anterior shoulder instability (ASI) is a frequently encountered pathology in orthopedics[31,33] and is often the result of trauma when the shoulder is subjected to an anterior force with the shoulder abducted and externally rotated.[11] While ASI is relatively common in the general population,[22] it is even more common in active subgroups such as military personnel and contact athletes, with the highest rates being found in football, wrestling, and ice hockey.[24,30,32] ASI can be managed with either nonoperative therapy or a variety of operative stabilization techniques.[36] However, given that recurrent instability rates have been documented as high as 77% with nonoperative management[16,23,38] and a recent study demonstrating a 7-fold decrease in recurrent instability following arthroscopic Bankart repair compared to nonoperative management,[19] the number of patients undergoing operative stabilization is likely to rise. Regardless of whether patients undergo nonoperative or operative management, patients with a history of ASI have an increased rate of developing glenohumeral osteoarthritis (GHOA).[4,6,12,18,25,35]

First described by Neer et al in 1982 and subsequently defined as "dislocation arthropathy" by Samilson and Prieto a year later,

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arthritis following glenohumeral joint dislocation is a well described phenomenon.[6,13,17,28,39] Marx et al reported the risk of developing arthrosis requiring total shoulder arthroplasty (TSA) following shoulder dislocation to be 19.3 times greater than those without a prior dislocation[25] and radiographic evidence of GHOA has been reported to be as high as 69% in patients who underwent arthroscopic Bankart repair.[35] As these patients' arthritis naturally progresses, they become candidates for shoulder arthroplasty which can be technically challenging due to distorted anatomy, existing hardware, young age, bone loss, and potential subscapularis deficiency.[5,20,21] Prior studies have documented variable shoulder arthroplasty outcomes in the setting of prior stabilization procedures, indicating the need for a current systematic review of the literature.[21,34,40,42]

This systematic review aims to synthesize subjective and functional outcomes for patients undergoing shoulder arthroplasty with a history of anterior instability management (nonoperative or operative).

We hypothesize that patients with a history of prior anterior instability who undergo shoulder arthroplasty will have inferior subjective and functional outcomes compared to those who have no prior history of anterior instability.

Methods

Information sources

Databases used in this systematic review included PubMed Medline, Embase, OVID Medline, Cochrane Database of Systematic Reviews (via OVID), Cochrane Central Register of Controlled Trials (via OVID), CINAHL, and Web of Science from inception up to August 30, 2021.

Literature search

A search strategy was created using a combination of keywords and database-specific headings related to each concept, including TSA and prior anterior stabilization surgery; MeSH terms were utilized where appropriate/allowed by the database. Please refer to the supplementary data (Supplementary Table S1) for complete and reproducible search strategies. Non-English and nonhuman studies were excluded from the search through the database searches. Duplicates were removed using ProQuest RefWorks (Ex Libris, Jerusalem, Israel).

Eligibility criteria

For studies to meet the inclusion criteria, they had to include patients undergoing a primary shoulder arthroplasty that had undergone previous anterior stabilization management (nonoperative or operative). For this review, studies that treated patients with prior anterior stabilization management (nonoperative or operative) using an anatomic TSA, reverse TSA (rTSA), and/or hemiarthroplasty (HA) were included. Studies that meet the inclusion criteria had to state in their methods that the included patients had undergone prior stabilization and discuss the use of prior open and/or arthroscopic procedures or nonoperative management techniques. Postoperative follow-up was limited to a minimum of 12 months.

Publication year limit was set within each database search from January 2000 to August 2021. Studies were only included if published in the English language. Studies that focused on revision shoulder arthroplasty, shoulder resurfacing, or rTSA as management of proximal humerus fractures were not included in the review. If there was no discussion of the impact of prior stabilization procedures on postoperative outcomes, studies were excluded. Studies which focused on shoulder arthroplasty in the setting of fracture fixation were not included. Cadaveric and animal studies were excluded as well. Additional studies excluded from this review included addresses, abstracts, conference posters, comments, editorials, case reports, and narrative review (ie, Level V evidence).

Data collection process

The data collection process consisted of multiple, tiered reviews. All reviews were conducted using Rayyan QCRI (Doha, Qatar). The first review consisted of two blinded reviewers screening title and abstract. Studies were included if the title or abstract indicated a focus on a patient population that had previously undergone anterior stabilization procedures. The articles marked for inclusion in the first round of screening were subjected to a full-text screening, again by two blinded, independent reviewers to ensure that they met the inclusion criteria listed above (SP and MM).

Once each article had been screened by two reviewers, a third, independent reviewer resolved any conflicts that were present with regards to inclusion (AP). Once the full-text screening was complete, the included articles were collated in Rayyan, including the full-text PDFs of each study. The level of evidence of each article was graded by two, blinded reviewers (SP and MM). Any conflicts regarding the level of evidence were resolved by a third, independent reviewer (AP). Relevant data from each study were then extracted.

Summary of measures and results

Assignment of levels of evidence was done in a systematic approach. Level I was assigned to all randomized controlled trials and meta-analysis/systematic reviews. Cohort studies were considered level II. All case-control studies were considered level III. Level IV studies were case series.

Data were then extracted from the articles included after the full-text review. For each study analyzed, the following data were extracted: number of patients, number of shoulders, sex of patients, mean age, study design, inclusion criteria, exclusion criteria, mean follow-up time, surgical technique (including arthroplasty type), prior surgical procedures, preoperative and postoperative functional scales, preoperative and postoperative range of motion (ROM) measurements, patient satisfaction, complications, revisions, and conclusions (Table I).

Risk of bias

The search procedure was standardized across all databases using homogenous search strings to ensure minimal bias. Each level of screening was performed by two reviewers in a blinded fashion to avoid interobserver bias. Conflict resolution was an inherently unblinded step, which does introduce the possibility of interobserver bias at this stage. Similarly, grading of levels of evidence was done in a blinded fashion to minimize bias. Levels I through IV were only included in the review, to reduce bias from studies of lesser quality. The greatest risk of bias comes from the limited number of studies on the subject of the impact of prior anterior stabilization procedures on shoulder arthroplasty outcomes.

Table I
Summary of individual studies.

Article no	Reference	LoE	No. patients (male:female)	Implant type	Mean age (y)	Study design	Inclusion criteria	Exclusion criteria	Mean follow-up	Prior surgery	Conclusion
1	Anatomic total shoulder arthroplasty vs. reverse total shoulder arthroplasty for post-capsulorrhaphy arthropathy[10]	3	39 (38:1)	19 TSA* v. 20 rTSA*	67.5 ± 4.1 (TSA) 68.1 ± 3.4 (RTSA)	Retrospective cohort study	Each of the patients had undergone at least one open stabilization procedure to treat a previously unstable shoulder that had a dislocation history	Preoperative or intraoperative identification of full thickness cuff tear	TSA: 24-110 mo, rTSA: 24-72 mo	Prior open surgical stabilization on shoulder with history of dislocation and/or subluxation	Both TSA and rTSA had significant improvement in PROs and ROM pre to post. Prior open ant instability surgery may alter subscap and capsule, leading to instability after TSA. rTSA is safe and effective.
2	Arthroplasty for glenohumeral arthritis in shoulders with a previous Bristow or Latarjet procedure[42]	4	30 (17:13)	14 *TSA, 11 *rTSA, 5 *HA	50.7 ± 12.8	Prospective case series	GHOA with prior coracoid transfer procedure; severe pain and loss of function 2/2 GHOA	Minimum 2-year follow-up not reached	4.9 ± 4.8 y	Prior coracoid transfer procedure	Athroplasty for patients with prior coracoid transfer provides increased ROM and pain relief. However, complications rates are high, particularly with HA and TSA.
3	Clinical characteristics and patient-reported outcomes of total shoulder arthroplasty after anterior stabilization: a retrospective matched control study[29,†]	3	40 (30:10)	20 TSA* vs. 20 TSA †Control	TSA: 59.6 ± 8.7 Control: 58.4 ± 10.4	Retrospective cohort study	Any patient who underwent shoulder arthroplasty performed by 1 of 8 senior fellowship-trained sports medicine and shoulder surgeons at designated institution	Patients with a history of inflammatory arthropathy and those who underwent reverse shoulder arthroplasty	-	Open stabilization for 11 (1 coracoid transfer, 10 open ant soft tissue plication, 6 of which involved Putti-Platt), arthroscopic stabilization in 9	No difference between control and prior stability group at 2 y, but at 5 y, significantly worse SF-12, ASES, and shoulder activity score. No significant difference between open vs arthroscopic prior surgery. Prior surg group still had significant improvement in PROs at 2 y.
4	Comparison of shoulder replacement to treat osteoarthritis secondary to instability surgery and primary osteoarthritis: a retrospective controlled study of patient outcomes[27]	3	49 (30:19)	19 TSA/HA* vs. 30 TSA †Control	Study: 44.5 ± 12.4 Control: 48.2	Prospective cohort study	Preoperative diagnosis of shoulder arthritis + prior instability repair/ primary OA + 2-year follow-up	-	Study: 52.6 ± 18 mo Control: 41.6 ± 12 mo	Putti-platt (5), open capsulorrhaphy (8), arthroscopic capsulorrhaphy (5), Latarjet (1),	Significant improvements among both arthroplasty and control groups from preoperative to postoperative (PRO and ROM). Results are largely comparable.
5	Early complication rates following total shoulder arthroplasty for instability arthropathy with prior coracoid transfer procedure[3]	3	56 (52:4)	14 TSA* vs. 42 TSA †Control	Study: 56.7 ± 4.2 Control: 57.1 ± 5.0	Retrospective matched cohort study	Prior coracoid transfer and subsequent TSA	Rotator cuff tears, fixed dislocations, post shoulder instability, prior glenoid bone grafting from sources other than coracoid, HA, rTSA	Study:58 ± 35 mo Control: 42 ± 28 mo	-	No significant difference in complications rates between study and control group; All patients significantly increased functional and PROs.
6	Intermediate and long-term follow-up of total shoulder arthroplasty for the management of postcapsulorrhaphy arthropathy[7]	3	44 (45 shoulders) (34:9)	25 TSA* vs. 19 TSA †Control	Study: 55 ± 13 Control: 58 ± 12	Retrospective matched cohort study	Patients with post-CA treated with TSA	-	Study: (24-136) mo Control: (24-72) mo	Postcapsulorrhaphy	TSA after CA helps with pain and function but have worse outcomes compared to TSA for OA.

7	Outcomes of primary reverse shoulder arthroplasty for dislocation arthropathy[8]	4	24 (14:10)	rTSA*	70[§]	Retrospective case series	History of prior glenohumeral dislocation	Proximal humerus fracture, dislocation, less than 2-year follow-up	40 mo (range 24-72)	-	rTSA produces significant improvements to ER and FE. However, results are lessened by a complete subscapularis deficiency.
8	Reverse arthroplasty for osteoarthritis and rotator cuff deficiency after previous surgery for recurrent anterior shoulder instability[37]	4	13 (8:5)	rTSA*	70 (range 48-82)	Retrospective case series	1. OA and RC deficiency following a prior surgery for anterior stability. 2. treatment with same rTSA. 3. minimum 2-year follow-up	-	3.5 y (range 2-8)	Patients with only 1 prior surgery: 5 Trillat procedure: 2 Latarjet :3 Bankart and capsular shift: 1 Eden-Hybinette :2 Operations Latajet after failed Bankart: 1 Latarjet after failed Trillat: 1, Patients had recurrent ant. sublux ation after Trillat: 3	rTSA had significant improvements to FF and IR but not ER following prior surgeries to treat ant. instability. Furthermore, rTSA had significant improvements in strength, activity, pain, and mobility.
9	Reverse shoulder arthroplasty for instability arthropathy[9]	4	19 (9:10)	rTSA*	69.9[§]	Retrospective case series	1. Previous history of shoulder instability with prior surgery 2. Previous multiple closed reduction	Chronic locked dislocations or dislocations	79.2 mo[§]	80% had prior surgery 7 had Latarjet or Bristow rest had capsular surgery remaining 20% had closed reduction in history	rTSA improved objective and subjective scores in patients with prior instability.
10	Reverse shoulder arthroplasty in the treatment of glenohumeral instability[15]	3	33 (14:19)	11 rTSA* vs. 22 rTSA [†]Control	Study: 70[§]	Retrospective case series	Recurrent instability after failed operation or associated with major bone loss −another stabilization procedure was not considered an option, traumatic dislocation	-	Study: (22-171) mo Control: 23-172 mo	Study: 3 shoulder had prior surgeries (2 Bankart, 2 Latarjets) Control: 7 had RCR or débridement before index surgical procedure	Pain score, SSV after rTSA improves outcomes for case group (recurrent instability) and has similar outcomes when compared to rTSA for cuff deficiency.
11	Shoulder arthroplasty after prior anterior stabilization procedures: do reverses have better outcomes?[34]	3	45 (21:24)	15 *TSA vs. 10 *rTSA vs. 30 [†]Control	TSA: 54.9 rTSA: 65.4 Control: 64.5	Prospective cohort study	Primary TSA or rTSA, history of anterior stabilization surgery, minimum 2-year follow-up	Prior shoulder infection, prior shoulder athroplasty, and/or less than 2 y follow-up	TSA: 48 mo, rTSA: 39.6 mo, Control 33.6 mo	TSA: Bristow (4), anterior labral repair (7), open anterior capsular recon (4) rTSA: Bristow (3), Glenoid osteotomy (1), open anterior labral repairs (3), arthroscopic labral repair (2), thermal capsulorrhaphy + RCR (1)	rTSA had better PROs than TSA group; all groups had significant improvements in ROM and PROs postop - only nonsignifiant improvement was IR after rTSA. Relative to control rTSA, those with prior surgery + rTSA had similar preoperative ROM/PROs and there were no significant postoperative differences.
12	Shoulder arthroplasty for advanced glenohumeral arthritis after anterior instability repair[14]	4	19 (11:8)	19 *TSA or HA	45 (range, 32-69)	Retrospective case series	Surgical procedure to treat anterior glenohumeral instability	-	62 mo (range, 24-167)	4 Bristow, 4 Putti-Platt, 4 Magnuson-Stack, 2 Bankart, 5 other types of anterior capsulorrhaphy	TSA produced increased FF, ER, IR; no significant improvement; FF and ER had better strength while IR had some decreases (most of which were a result of subscapularis lengthening).

(continued on next page)

Table I (*continued*)

Article no	Reference	LoE	No. patients (male:female)	Implant type	Mean age (y)	Study design	Inclusion criteria	Exclusion criteria	Mean follow-up	Prior surgery	Conclusion
13	Shoulder arthroplasty in patients with a prior anterior shoulder dislocation[26]	3	55 (31:24)	27 *TSA vs. 28 TSA †Control	Study: 31.6 Control: 43.1	Prospective cohort study	Study: Patients treated with TSA with history of prior anterior dislocation that had been reduced; Control: GHOA treated with TSA	Fixed anterior dislocation	45 mo (range, 24-87)	Coracoid transfer (17), soft tissue reconstruction (9), Putti platt + coracoid (1)	No significant differences between prior ant instability procedure and control group. All patients had significant improvement pre to postop.
14	Total shoulder arthroplasty in dislocation arthropathy[21]	4	45 (30:15)	45 *TSA or HA	55.8 (range 32-76)	Retrospective case series	OA of glenohumeral joint; history of shoulder instability and underwent prosthetic replacement	-	44 mo (range, 12-101)	21 prior stabilizations (3 arthroscopic stabilization, 9 Eden-Hybbinette, 9 open Bankart) each patient had only 1 procedure	TSA produces significant increased FE, ER, IR, and abduction. Increased abduction strength but not significant. Significant improvements in levels of pain, active ROM, and activities of daily living.
15	Shoulder arthroplasty for arthritis after instability surgery[40]	4	31 (25:6)	31 *TSA or HA	46 (range, 22-70)	Prospective case series	GHOA treated with total shoulder with prior surgery	-	7 y (range, 0.7 to 21)	Open anterior capsule repair (13), Bristow (8), putti-platt (4), magnuson-stack (2), arthroscopic anterior repair (2), bone block (1)	Significant improvement in ER and abduction preoperative to postoperative. arthroplasty is tenable in patients with previous anterior instability surgery but is accompanied by a higher risk of complications.
16	Outcomes of total shoulder arthroplatsy for instability arthropathy with a prior coracoid transfer procedure: a retrospective review and matched cohort[2]	3	44 (40:4)	11 *TSA vs. 31 TSA *Control	Study: 58 Control: 47	Prospective matched cohort	Prior coracoid transfer, anatomic TSA, 2-year follow-up	Fixed dislocations, posterior shoulder instability, prior glenoid bone grafting not from coracoid, HA/rTSA, coracoid transfer + TSA at once, lack of follow-up	Study: 58 Control: 47	Bristow (8), Latarjet (3)	Significant difference in ASES and pain for prior surgery patients (higher in prior surgery). Significant improvement for all preoperative to postoperative outcomes in both groups.

TSA, total shoulder arthroplasty; *rTSA*, reverse total shoulder arthroplasty; *HA*, hemiarthroplasty; *GHOA*, glenohumeral osteoarthritis; *PRO*, patient-reported outcome; *ASES*, American Shoulder and Elbow Surgeons shoulder score; *SF-12*, 12-item short form survey; *OA*, osteoarthritis; *ROM*, range of motion; *CA*, capsulorrhaphy arthropathy; *FF*, forward flexion; *IR*, internal rotation; *ER*, external rotation; *RC*, rotator cuff; *SSV*, subjective shoulder value score; *RCR*, rotator cuff repair; *FE*, forward elevation.

*patients who underwent shoulder arthroplasty procedure with a history of prior anterior instability management (conservative or operative).

†patients who underwent shoulder arthroplasty procedure without a history of prior anterior instability.

‡study performed a sub-group analysis by type of prior anterior instability management (conservative, open, arthroscopic).

§only median value provided.

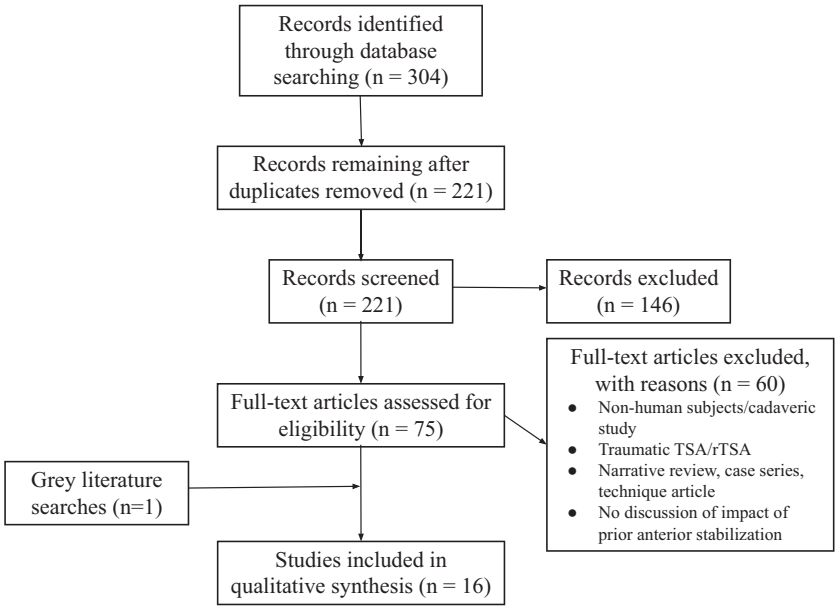

Figure 1 Flow diagram displaying the systematic review of search strategy.

Results

Study selection

From the initial database search, 304 articles were identified. After duplicates were removed, 221 articles remained and were subjected to screening. 146 articles were removed based on title and abstract screening using the criteria above. The remaining 75 articles underwent a full-text screening. A total of 15 articles were included at the end of full-text screening; an additional article was found through grey literature searches and was included based on meeting the above criteria (Fig. 1). Of the included studies, 9 were considered level of evidence III,[2,3,7,10,15,26,27,29,34] with the remaining 7 being level of evidence IV.[8,9,14,21,37,40,42]

Demographic and surgical factors

Overall, there were a total of 596 patients (597 shoulders) included in the studies. Of these 596 patients, 213 patients (214 shoulders) served as controls that did not have a history of prior anterior instability. Of the remaining 383 patients who underwent management for anterior instability, 132 patients were treated nonoperatively. There were 413 male patients (149 controls) and 181 female patients (65 controls) included. The mean age of the patients who had a history of prior anterior instability was 57.0 years old (unable to give standard deviation or range because lack of consistency in variance reportings), while the mean age of the controls was 57.5 years old. The minimum follow-up for all included studies was 24 months, with an average follow-up of 50.7 months after arthroplasty.

Of the included studies, 5 studies utilized an anatomic implant,[2,3,7,26,29] 4 studies utilized an rTSA implant,[8,9,15,37] 4 studies utilized either a HA or an anatomic TSA implant,[14,21,27,40] 2 utilized either a rTSA or an anatomic TSA implant,[10,34] and 1 study utilized all 3 implant types (TSA, rTSA, and HA).[42] Twelve studies specifically commented on their surgical approach, with 9 using a deltopectoral approach.[2,3,10,14,21,27,34,37,42] The other 3 studies utilized a combination of anterosuperior or anteromedial approaches, with the majority of cases still being done through a deltopectoral approach.[7,9,40] Ten studies discussed handling of the subscapularis, which was either repaired or tenotomized in all studies, except in cases of tendon ruptures/tears.[2,3,7,10,14,15,21,34,37,42] Number of subscapularis repairs vs. tenotomies were not specified in any of the included studies. Indications for anatomic TSA included capsulorrhaphy arthropathy and degenerative GHOA, while indications for rTSA included an irreparable, massive tear of the rotator cuff, rupture of the subscapularis tendon, or an isolated fatty infiltration of the subscapularis muscle, following failed prior instability management (operative or nonoperative).[1,2,3,7,8,9,10,14,15,21,26,27,29,34,37,40,42]

There were a wide variety of prior surgeries that were included in these studies—coracoid transfers (Latarjet, Bristow, Trillat, Eden-Hybinette), and soft tissue procedures (Putti-Platt, capsulorrhaphy, Bankart, anterior labral repair, anterior capsular reconstruction, Magnuson-Stack).[2,3,7,9,14,15,21,26,27,29,34,37,40,42] Only 2 studies did not specify the type of prior surgery.[8,10] While none of the included studies performed sub-group analyses on shoulder arthroplasty outcomes based on the specific type of prior stabilization procedure (soft tissue vs. bony procedure), 3 studies[8,21,26] performed a sub-analysis by type of anterior stabilization management (nonoperative or operative).

In general, studies found that a history of prior ASI did not affect postoperative subjective outcomes following shoulder arthroplasty.[3,7,10,15,27,29,34] Moreover, among the studies that performed a sub-group analysis by type of prior anterior stabilization management,[8,21,26] none found a significant difference in postoperative subjective outcomes between nonoperative and operative intervention following shoulder arthroplasty. All studies recorded significant increase in patient-reported outcomes preoperatively to postoperatively in patients with a history of anterior instability, among the most commonly reported were the American Shoulder and Elbow Surgeons (ASES) and Constant Score.[3,7,9,10,21,27,29,34,37,42] For patients who underwent rTSA, improvement in ASES scores ranged from Δ 41.0 to Δ 51.1,[10,34] while improvement in those who underwent TSA ranged from Δ 24.8 to Δ 45.0 (Fig. 2).[3,7,10,29,34]

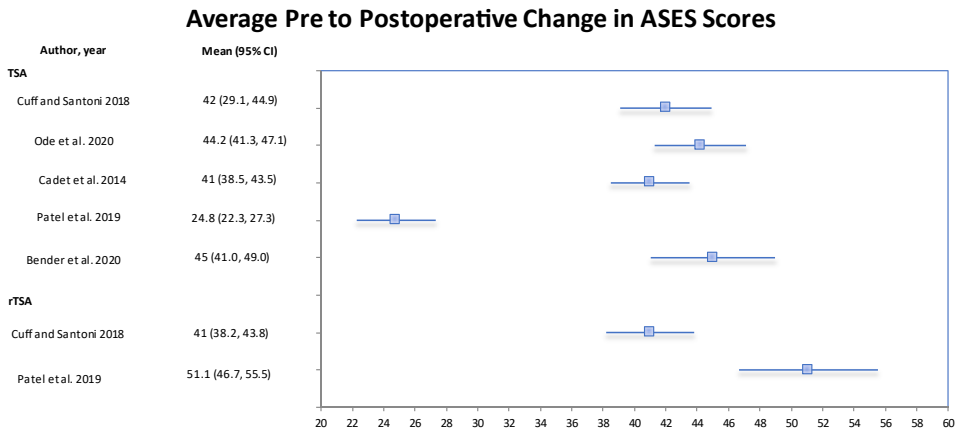

Figure 2 Forest plot of mean preoperative to postoperative reported ASES scores with 95% confidence intervals in patients with a history of prior anterior instability, by type of arthroplasty. Significant improvement in ASES was reported in all seven cases. Patel et al found that patients with prior anterior instability who underwent rTSA had notably better (trending toward significance) postoperative ASES scores than those who underwent TSA ($P = .085$). *ASES*, American Shoulder and Elbow Surgeons; *TSA*, total shoulder arthroplasty; *rTSA*, reverse total shoulder arthroplasty.

Improvement in preoperative to postoperative Constant Scores was more variable between arthroplasty techniques, however, both rTSA (Δ 22.0-Δ 59.9)[9,15,34,37] and TSA (Δ 24.8-Δ 43.5)[21,26,27,34] cohorts significantly improved (Fig. 3). While most of the reviewed studies reported no significant differences in postoperative outcomes between arthroplasty techniques,[10,14,27,42] Patel et al was a notable outlier, reporting that rTSA patients with prior anterior stabilization surgery had better (trending toward significance) mean postoperative outcomes for ASES, Simple Shoulder Test, and Constant Scores, and significantly better postoperative SPADI-130 scores ($P = .049$) than the TSA group.[34] None of the included studies that used HA stratified postoperative subjective outcomes in their results, and therefore, could not be reported in the current review.[14,21,27,40,42]

While the reviewed studies found that a history of prior ASI generally does not affect postoperative ROM following shoulder arthroplasty,[3,10,15,21,27,29,34,40] the effect of specific arthroplasty technique on postoperative function remains less definitive. All studies recorded significant increase in preoperative to postoperative ROM, among the most commonly reported were forward elevation (FE) and external rotation (ER).[7,9,10,14,15,21,26,27,34,37,40] For patients who underwent rTSA with prior ASI, improvement in FE ranged from Δ 19.0° to Δ 69.0°,[9,10,15,34,37] while improvement in those who underwent TSA ranged from Δ 19.0° to Δ 57.0° (Fig. 4).[7,10,14,21,26,27,34] Improvement in preoperative to postoperative ER was considerably more variable between arthroplasty techniques. However, for patients treated with TSA, ER improvement ranged from Δ 13.0° to Δ 42.5°,[7,10,14,21,26,27,34] while those with rTSA improved by only Δ 0°-Δ 29.0° (Fig. 5).[9,10,15,34,37] Interestingly, Cadet et al found that patients who had not had prior surgery had greater postoperative FE and ER ($P = .36$, $P = .04$, respectively) than patients with prior anterior stabilization, although both groups improved significantly preoperatively to postoperatively.[7] Willemont et al[42] was the only study that stratified ROM outcomes for patients treated with HA. Preoperative to postoperative increase in FE (Δ 52.5°, $P = .03$) and ER (Δ 15.0°, $P > .05$) was observed in patients who underwent HA with prior ASI. None of the literature reported significant differences in outcomes between HA and other arthroplasty techniques,[14,27] or differences between HA outcomes in patients with and without prior ASI.[40,21,27]

With regards to the altered anatomy that a surgeon might encounter and the theoretical increased risk of complications after shoulder arthroplasty, Bender et al did not show a significant difference in complications rates.[2] However, Sperling et al did remark that there was a higher risk of failure in patients who underwent TSA with prior anterior instability surgery (including open capsulolabral repair, the Bristow procedure, the Putti-Platt procedure, the Magnuson-Stack procedure, arthroscopic capsulolabral repair, and bone-block procedures).[40] The authors proposed that high failure rates, which were due to posterior instability in all patients (n = 3), were likely a result of inadequate anterior soft tissue flexibility which forced the humeral head posteriorly.[40] Cuff et al, in their comparison of TSA and rTSA, did show that the alteration of the subscapularis and capsule leads to greater instances of instability after TSA compared to rTSA.[10]

Overall, the included studies found that shoulder arthroplasty in the setting of prior anterior instability procedures resulted in improvement in patient-reported outcomes and increased ROM. However, careful soft tissue balancing and adequate tissue release, which are fundamental for shoulder arthroplasty in general, are critical for successful arthroplasty among patients who have had previous stabilization procedures.[40]

Discussion

Evaluation of the literature

Current available literature reports the impact of prior ASI on shoulder arthroplasty outcomes to be highly variable. This is likely due to shoulder arthroplasty being a comparatively new procedure, and the lack of well-powered, prospective cohort studies that evaluate specific anterior stabilization management both nonoperatively and operatively as a predictive factor. Despite the paucity of appropriately powered literature, the available studies suggest that shoulder arthroplasty in the setting of prior anterior instability yields improved subjective and functional outcome scores that are comparable to patients without a history of instability. Moreover, while a majority of the included literature did not report significant differences in outcomes between arthroplasty techniques, the current review suggests variability in postoperative outcomes between TSA and

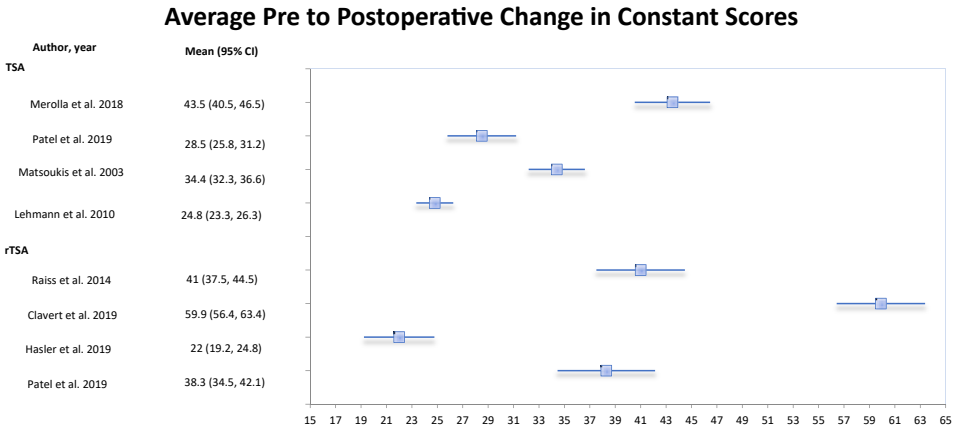

Figure 3 Forest plot of mean preoperative to postoperative reported Constant Scores with 95% confidence intervals in patients with a history of prior anterior instability, by type of arthroplasty. Significant improvement in Constant was reported in all eight cases. Patel et al found that in patients with prior anterior instability who underwent rTSA, the groups' mean Constant Scores were above the minimal clinically important differences in comparison with the TSA groups' scores. *TSA*, total shoulder arthroplasty; *rTSA*, reverse total shoulder arthroplasty.

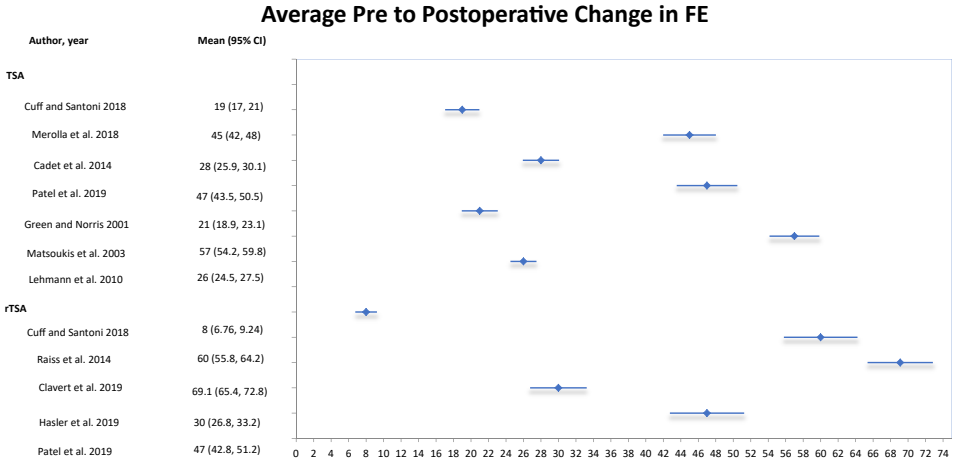

Figure 4 Forest plot of mean preoperative to postoperative reported forward elevation (FE) with 95% confidence intervals in patients with a history of prior anterior instability, by type of arthroplasty. Significant improvement in FE was reported in all eight cases. Cuff et al found that patients treated with a TSA had significantly greater FE postoperatively compared to those treated with rTSA (153 vs. 139, $P = .010$), although both groups showed significant improvement in all planes of motion preoperatively to postoperatively. *TSA*, total shoulder arthroplasty; *rTSA*, reverse total shoulder arthroplasty.

rTSA procedures in patients with a history of prior ASI. Future studies and discussion regarding the effect of specific prior anterior instability management on shoulder arthroplasty outcomes require more stringent evaluation.

The absence of literature that stratifies shoulder arthroplasty outcomes by specific type prior stabilization procedure highlights an existing gap in our current understanding of how prior operative management techniques, and their associated risk factors, may guide treatment algorithms for failed shoulder stabilization or recurrent ASI. Prior open surgical management of recurrent ASI often requires a degree of violation of the subscapularis and/or anterior capsule to prevent recurrent instability. This is often performed by tightening the shoulder joint anteriorly. Operations such as the Putti-Platt or Magnuson-Stack procedures disrupt native anatomy through either shortening or transferring the subscapularis muscle and tendon. Many other open procedures that do not directly address the subscapularis, such as an open Bankart or capsulorrhaphy, still require a take down or repair of the subscapularis. In such cases, the residual subscapularis is relied upon to heal and provide stability.[10] Sperling et al illustrate the potential consequences of prior subscapularis violation in their retrospective case series, observing that all cases of failure after anatomic TSA were due to inadequate anterior soft tissue flexibility from prior stabilization procedures which forced the humeral head posteriorly. [40] Alternatively, Patel et al reported that rTSA patients with prior anterior stabilization surgery had better (trending toward significance) mean postoperative outcomes for ASES, Simple Shoulder Test, and Constant Scores, and significantly better postoperative Shoulder Pain and Disability Index (SPADI)-130 scores than the TSA group.[34] Among patients who undergo subsequent TSA, a procedure which relies heavily on a complex soft tissue repair of the rotator cuff, there is a reasonable concern for the viability or strength of the residual musculature that must be considered. In instances of prior anterior stabilization surgeries in which the subscapularis integrity is altered, management with rTSA, where the reverse ball-and-socket structure utilizes the

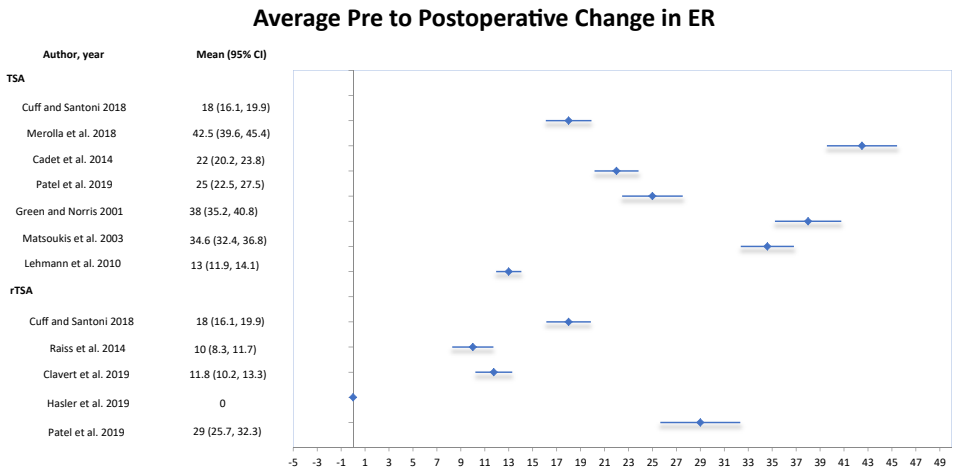

Figure 5 Forest plot of mean preoperative to postoperative reported external rotation (ER) with 95% confidence intervals in patients with a history of prior anterior instability, by type of arthroplasty. Significant improvement in ER was reported in seven of the eight cases. Raiss et al did not find significant improvement in ER ($P = .55$).

deltoid more than the rotator cuff for stability, may be more amenable.[41] The findings from this review, along with our current understandings of shoulder arthroplasty mechanics, emphasize the importance of a thorough evaluation of prior operative reports and a careful review of preoperative imaging. This will allow surgeons to recognize frequently distorted anatomy and facilitate management strategies.

Prior ASI management with bony augmentation procedures, such as the Latarjet, may also serve as a fundamental determinant of appropriate shoulder arthroplasty technique. Coracoid graft malpositioning in the setting of Bristow and Latarjet procedures is believed to play an important role in the development of postoperative osteoarthritis.[42] In their retrospective case series, Willemot et al found that postoperative shoulder instability in patients with a previous Bristow or Latarjet procedure that underwent a TSA or HA was significantly more common than in rTSA patients.[42] The authors determined that graft malpositioning in TSA and HA patients was a driving cause for failure and was avoided in patients treated with rTSA, a technique which does not rely on correct anatomical alignment of the native glenoid against the humeral head. In Bender et al's retrospective cohort study, however, the universal use of rTSA for instability arthropathy following coracoid transfer was challenged.[3] The authors found no significant difference in complication rates between patients who underwent TSA with a history of prior coracoid transfer and the control group. Discrepancies in the current literature regarding appropriate management of instability arthropathy following coracoid transfer, a pathology that primarily presents at a younger mean age (40s to 50s years), warrant further investigation to determine the adequacy of anatomic TSA as an alternative to rTSA in younger patient populations.[3]

Limitations

There are several notable limitations of the current review. Systematic reviews are inherently limited by the relevant data reported in the literature. While shoulder arthroplasty procedures are increasing in popularity, few well-powered, prospective cohort studies exist that evaluate particular anterior stabilization management both nonoperatively and operatively as a predictive factor in shoulder arthroplasty. Most of the included studies did not breakdown outcomes by type of prior stabilization (nonoperative, soft tissue, bony stabilization), and therefore did not allow for a comprehensive evaluation. Additionally, there were many different types of implant designs used among the included studies; for example, lateralization of the implant, either on the humeral or glenosphere component can alter the biomechanics of the implant and the relative impact that each muscle has on ROM, and therefore patient satisfaction with a procedure and its outcomes. These factors impact the strength of conclusions that we can draw from this review.

Conclusion

Shoulder arthroplasty in the setting of prior ASI results in improved subjective and functional outcome scores that are comparable to patients without a history of instability.

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Supplementary Data

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