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Low success rate of closed reductions when treating dislocations after reverse shoulder arthroplasty: a study by the ASES Complications of RSA Multicenter Research Group

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Background: Postoperative dislocation is a known complication following reverse shoulder arthroplasty (RSA), but treatment patterns and outcomes remain unclear. The purpose of this study was to identify treatment patterns, rate of successful closed reductions, and factors associated with unsuccessful closed reductions for dislocations after RSA in a large multicenter patient cohort.

Methods: A multicenter retrospective review was performed for patients receiving primary or revision RSA from June 2013 to May 2019 across 15 institutions in the United States. Patients who sustained a postoperative shoulder dislocation (defined as complete loss of articulation between the humeral component and glenosphere confirmed on imaging) with a minimum of 3-month follow-up were included. The time from surgery to dislocation, nature of the dislocation, complications associated with the dislocation, initial treatment, success of closed reduction, recurrent dislocations, and subsequent treatments including revision procedures, were recorded. Univariate analysis was performed to identify patient factors associated with failure of an initial closed reduction attempt.

Results: A cumulative postoperative dislocation incidence of 2.1% (n = 138) was observed in the 6621 patients undergoing RSA. The median time to dislocation was 7 weeks (interquartile range = 33 weeks), with 61.6% (n = 85) occurring within the first 90 days after surgery. Initial treatment consisted of closed reduction (n = 87; 63.0%), open reduction (n = 1; 0.7%), revision arthroplasty (n = 43; 31.2%), or benign neglect (n = 7; 5.1%). Those treated without an initial closed reduction had higher incidence of associated complications (45.1% vs. 14.9%). Among patients initially treated with a closed reduction, 27 (31.0%) were successful (required no further interventions), 15 (17.2%) subsequently required a revision procedure, and 43 (49.4%) sustained an additional dislocation. The only patient or surgical factor associated with an unsuccessful closed reduction was increased body mass index (BMI; 31.8 ± 6 vs. 28.9 ± 5.2, $P = .02$). Of the 43 patients who sustained an additional dislocation, 10 received another closed reduction and 30 received revision surgery. Among the 10 patients who received a second closed reduction, 5 remained stable (50.0%). Overall, 92 patients (66.7%) required a revision arthroplasty procedure during the study period, whereas 22 (22.5%) required multiple revision procedures. Ultimately, 18 patients (13.0%) remained unstable (benign neglect) at final follow-up.

Conclusion: In this large multicenter series of postoperative dislocations following RSA, a closed reduction was initially attempted in the majority of patients, but only about one-third were successful and required no further intervention. Unsuccessful closed reductions were associated with higher patient BMI. Revision surgery for dislocations was complicated by a high rate of recurrent dislocations and rerevision surgery.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Dislocation; instability; reverse shoulder arthroplasty; treatment; closed reduction; risk factors; multicenter; Delphi method

Despite increasing enthusiasm and use of reverse total shoulder arthroplasty (RSA), postoperative dislocation remains a prevalent complication.[6,10,11,16,18] It has been estimated that the incidence of dislocations after RSA ranges from 1.5% to 31%.[6,7,10,15,17,18,25,28] Various patient and surgical factors have been associated with instability after RSA, including a patient-reported history of subluxations before dislocation, male sex, obesity, prior shoulder surgery, no subscapularis repair at the index surgery,[6] a primary diagnosis of rotator cuff disease, revision

RSA, baseplate positioning, inadequate soft tissue tensioning, surgical approach, and prior proximal humerus fracture.[1,14,18,19,21,24] Despite the growing understanding of risk factors for dislocation, the etiology of each case is often multifactorial and in many cases is challenging to elucidate.[1,3,6,17]

Current evidence is varied regarding the appropriate sequence and relative success of the available treatment options for a dislocation after RSA. Although a closed reduction attempt is often performed in the setting of a first-time dislocation, published success rates range between 20% and 100%.[7-9,13,23,27,28] As a result, prior studies have recommended varying treatment algorithms for a first-time dislocation after RSA: some support revision surgery in early dislocations (<90 days from surgery), whereas others recommend a closed reduction attempt regardless of the timing of the dislocation.[8,12,17,27] Furthermore, some authors have recommended reserving closed reduction attempts only for cases in which a definable trauma occurred, and the etiology of dislocation is thought to be potentially reversible.[17] In addition to the variability in recommended surgical indications, the nature of reported revision procedures are heterogenous given the many possible predisposing factors to dislocations after RSA.[1,4,6,17] In some cases, a simple open reduction with implant retention may be performed, whereas in others all components may be exchanged. Given the variability in existing recommendations and limited available evidence, a consensus on a standardized treatment protocol for dislocations after RSA does not currently exist.[8]

Prior studies reporting the treatment patterns and outcomes of dislocations after RSA have been limited to single institutes with small sample sizes, thus limiting the generalizability of their results.[7-9,13,27,28] Specifically, information regarding the success of closed reduction attempts, as well as an understanding of which patients may ultimately require revision surgery is unclear. As such, the purpose of this study was to identify treatment patterns, rate of successful closed reductions, and factors associated with unsuccessful closed reduction for dislocations after RSA in a large multicenter patient cohort.

Materials and methods

Study design

In this multicenter retrospective study, data for primary and revision RSAs performed between June 2013 and May 2019 across 15 institutions was collected and examined. A total of 21 surgeon members of the American Shoulder and Elbow Surgeons (ASES) contributed cases. Patients who underwent either primary or revision RSA with a minimum of 3-month follow-up were eligible for inclusion. Patients who sustained a postoperative dislocation, defined as complete loss of articulation between the humeral component and glenosphere confirmed on radiograph or computed tomography, were identified, and the timing of the dislocation relative to the date of surgery was recorded. Suspected dislocations required radiographic confirmation to be classified as such.

The nature of the dislocation event was recorded as (1) traumatic, (2) atraumatic, or (3) other. Complications directly associated with the dislocation (eg, humeral stem loosening, baseplate loosening, glenosphere disassociation, polyethylene dissociation, acromial stress fracture, humerus fracture, nerve injury, and infection) were recorded. Initial treatment of each dislocation was recorded as (1) closed reduction, (2) open reduction, (3) revision surgery, or (4) left dislocated (benign neglect). Successful closed reductions, defined as the absence of recurrent dislocations or subsequent revision surgery, were recorded. If initial treatment failed, the subsequent treatments were recorded as (1) additional closed reductions (for a recurrent dislocation), (2) open reduction, (3) single revision, (4) multiple revisions, or (5) unknown. The type of revision procedure was also recorded as (1) humeral component only, (2) glenoid component only, (3) both humeral and glenoid components, (4) conversion to hemiarthroplasty, (5) explant/resection, or (6) spacer.

The final disposition of each patient was recorded as (1) stable, (2) unstable, or (3) unknown. Additional patient demographic and surgical factors were recorded, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) class, osteoporosis, rheumatoid arthritis, diabetes mellitus, smoking history, subjective history of subluxations prior to dislocation, primary diagnosis associated with the index procedure, presence of subscapularis repair at the index procedure, humeral component design (onlay vs. inlay), constrained polyethylene liner, glenosphere size, glenosphere lateralization, glenoid baseplate augments, and combined lateral offset of glenoid components (mm). Combined lateral offset of the glenoid components was obtained from the implant data in the operative report.

Delphi method

The Delphi process was used to reach group consensus regarding all key term definitions, data collection factors (demographic factors, comorbidities, etc), and study design components (study period, minimum follow-up required, etc), as previously published.[18,20] This process began with an iterative survey regarding study methodology, distributed among the 24 participating ASES surgeons, with items containing both open and closed responses. Consensus was established as ≥75% agreement among the surgeons on each item on the survey. Sequential rounds of surveys were distributed until consensus was reached for each survey item. In order to minimize bias, survey responses were anonymous. Responses were recorded in each round, and written responses from participants were further included in iterative rounds. Results were presented to the entire group following iterative rounds. There was no respondent attrition between rounds.

Statistical analysis

Descriptive statistics are reported as mean and standard deviation or number of patients and percentages for continuous and categorical variables, respectively. A flow diagram was constructed to visually present the sequence of treatments, ultimate outcomes, and relative incidences at each branch point (Fig. 1). Patient demographic and surgical factors were compared on univariate

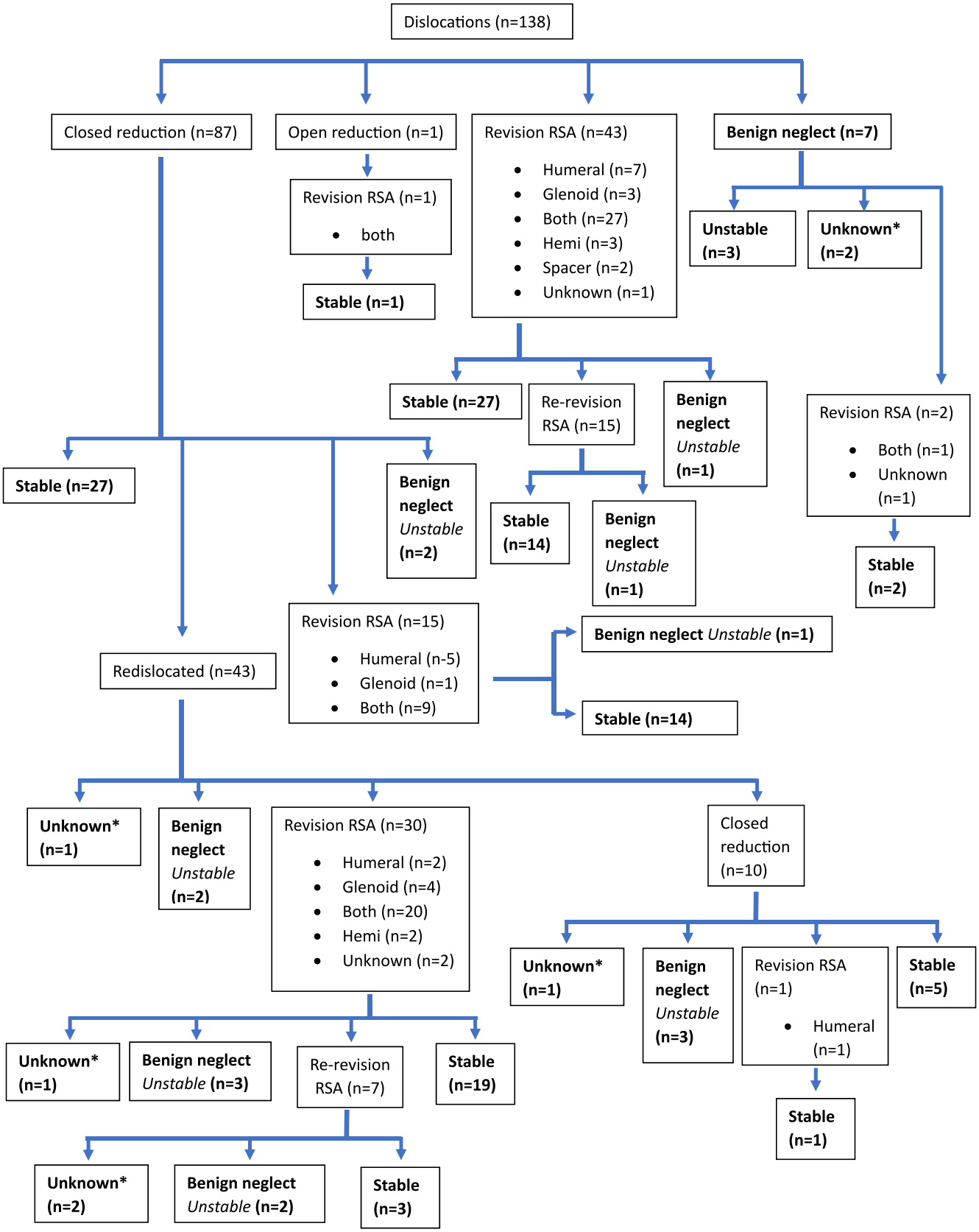

Figure 1 Flow diagram demonstrating the treatment and final outcomes of dislocations after reverse shoulder arthroplasty (RSA).

analysis between patients who were successfully treated with closed reduction and those who failed closed reduction, which was defined as recurrent dislocations or subsequent revision surgery. Categorical variables were analyzed using Pearson χ^2 tests and continuous variables were assessed by Student t tests or Fisher exact tests, as indicated. The level of significance was defined as $P < .05$. Statistical analysis was performed using SPSS statistical software (IBM, Armonk, NY, USA).

Results

Among the 6621 patients who were included for analysis, 138 (2.1%) sustained a postoperative dislocation. The dislocation rate was 6.5% (59/601) among revision RSAs and 1.6% for primary RSAs ($P < .001$). Average follow-up was 19.4 months (3-84 months) and did not significantly differ between those who did and did not dislocate ($P = .25$). The median time to dislocation was 7 weeks after surgery (IQR = 33 weeks), and 61.6% (n = 85) occurred within the first 90 days after surgery. Traumatic dislocations occurred in 22.5% (n = 31) of patients, 58% (n = 18) of which occurred after 90 days from surgery (late dislocation). Atraumatic dislocations occurred in 98 patients (71%), 67 (68.4%) of which happened within 90 days of surgery (early dislocation). Of the remaining patients, 1 dislocated in the setting of a postoperative hematoma (INR of 12), 1 dislocated in the ICU postoperatively (details unknown), 1 dislocated during physical therapy where postoperative restrictions were breached, and 6 patients had an unknown mechanism.

Among the 138 patients who sustained a dislocation, a closed reduction attempt was the initial treatment in 87 patients (63.0%). Of the remaining patients, the initial treatment consisted of revision arthroplasty in 43 (31.2%), open reduction without implant revision in 1 (0.7%), and benign neglect (joint left dislocated) in 7 patients (5.1%), 2 of which subsequently received a revision arthroplasty procedure (Fig. 1). The rate of dislocation varied across institutions, ranging from 0.6% to 5.1%, and the initial treatment approaches also differed among these institutions (Table I). Among the 87 patients initially treated with a closed reduction attempt, 27 (31.0%) were successful and required no further intervention, 15 (17.2%) required a revision arthroplasty procedure (2 for humeral loosening, 1 for acromial stress fracture, 1 for periprosthetic fracture, 9 others at the discretion of the treating surgeon), and 43 (49.4%) sustained an additional dislocation following the closed reduction (Fig. 1). Of the 43 patients sustaining an additional dislocation, 10 underwent another closed reduction and 30 underwent revision surgery. Among the 10 patients who underwent an additional closed reduction after a second dislocation (redislocation after prior closed reduction), 5 (50.0%) remained stable.

Regarding the distinguishing features of the dislocation event between those who received an initial closed reduction attempt vs. other initial treatment (revision arthroplasty, open reduction, or benign neglect), there were no significant differences in the proportion of traumatic dislocations (23.0% vs. 21.6%, $P = .75$) or early dislocations (64.4% vs. 56.9%, $P = .34$). However, those who received other treatment in lieu of an initial closed reduction attempt had a significantly higher incidence of complications associated with the dislocation (45.1% vs. 14.9%, $P < .001$): 11 implant dissociations, 4 implant loosening, 9 periprosthetic fractures, and 1 infection (Table II).

On univariate analysis, increased BMI was significantly associated with an initial failed closed reduction attempt (31.8 ± 6 vs. 28.9 ± 5.2, $P = .02$). All other patient and implant factors, including revision RSA, age, sex, history of subluxations prior to dislocation, no subscapularis repair at the index procedure, early dislocation, atraumatic dislocation, primary diagnosis of rotator cuff disease or fracture sequalae, and prior shoulder surgery, were not significantly associated with an initial failed closed reduction attempt (Table III).

Overall, 92 patients (66.7%) required a revision arthroplasty procedure during the study period; 15 (16.3%) isolated humeral component revisions, 8 (8.7%) isolated glenoid component revisions, 58 (63%) both component revisions, 5 (5.4%) conversions to hemiarthroplasty, 2 (2.2%) explants with placement of spacers, and 4 (4.4%) unknowns. Among the 92 revision RSAs, 22 (22.2%) required additional revision RSA procedures and 8 (8.7%) ultimately failed to achieve stability and were treated with benign neglect. Among all patients, 18 patients (13.0%) were unable to achieve stability or were treated with benign neglect and remained dislocated at final follow-up.

Discussion

This multicenter retrospective series demonstrated that dislocations after RSA occur at a rate of 2.1% and require revision surgery to achieve stability in the majority of patients (66.7%). Specifically, we found that although the majority of patients undergo an initial closed reduction attempt (63.0%), only about one-third of these patients ultimately remained stable and required no further intervention. Furthermore, the only patient variable associated with the failure of a closed reduction (eg, additional instability episodes) was higher BMI. The results of this study may aid in counseling patients of the expected outcomes of this challenging complication after RSA.

Despite the growing body of literature on RSA and its associated complications, the optimal initial management after postoperative dislocations remains debated.[3,6,8,12,17,27] Several prior studies have reported success rates of closed reduction ranging from 20% to 100%.[7-9,13,23,27,28] The majority of these studies have been small series of <20

Table I Dislocation incidence and initial treatment by institution

Institution*	n	Dislocation	Initial treatment of dislocation			
			Closed reduction	Revision RSA	Benign neglect†	Open reduction
1	288	2.8 (8)	—	75 (6)	12.5 (1)	12.5 (1)
2	175	2.3 (4)	25 (1)	75 (3)	—	—
3	676	2.4 (16)	37.5 (6)	50 (8)	12.5 (2)	—
4	309	3.6 (11)	45.4 (5)	45.4 (5)	9.1 (1)	—
5	515	3.3 (17)	47.1 (8)	47.1 (8)	5.9 (1)	—
6	78	5.1 (4)	50 (2)	50 (2)	—	—
7	535	1.1 (6)	50 (3)	50 (3)	—	—
8	789	2.0 (16)	62.5 (10)	31.3 (5)	6.3 (1)	—
9	811	0.6 (5)	80 (4)	20 (1)	—	—
10	680	1.5 (10)	90 (9)	10 (1)	—	—
11	424	2.4 (10)	90 (9)	10 (1)	—	—
12	610	2.8 (17)	94.1 (16)	5.9 (1)	—	—
13	435	2.1 (9)	100 (9)	—	—	—
14	92	1.1 (1)	100 (1)	—	—	—
15	204	2.0 (4)	100 (4)	—	—	—
Combined	6621	2.1 (138)	63.0 (87)	31.2 (43)	5.8 (8)	0.7 (1)

RSA, reverse shoulder arthroplasty.
Data formatted as % (n) represents frequency and count.
* Institutions listed in order of increasing utilization of a closed reduction.
† Benign neglect defined as remaining unstable at final follow-up.

Table II Comparison of dislocation event details between patients initially treated with closed reduction vs. other treatment

Parameter	Initial closed reduction (n = 87)	Other initial treatment* (n = 51)	*P* value
Timing of dislocation relative to surgery, weeks†	39.6 (113.4)	61.1 (105.9)	.27
Early dislocation (within 90 d)	56 (64.4)	29 (56.9)	.34
Nature of dislocation			
Traumatic	20 (23.0)	11 (21.6)	
Atraumatic	61 (70.1)	37 (72.5)	.75
Other	6 (6.9)	3 (5.9)	
No. of patients with complications associated with dislocation‡	13 (14.9)	23 (45.1)	<.001§
Humeral loosening	2 (2.3)	2 (3.9)	.63
Baseplate loosening	1 (1.2)	2 (3.9)	.56
Glenosphere dissociation	0 (0)	8 (15.7)	.003§
Polyethylene dissociation	0 (0)	3 (5.9)	.05
Periprosthetic fracture	3 (3.5)	9 (17.7)	.005§
Nerve injury	2 (2.3)	0 (0)	.53
Infection	2 (2.3)	1 (2.0)	.99
Acromial stress fracture	4 (4.6)	0	.30

RSA, reverse shoulder arthroplasty.
* Other initial treatments include open reduction (n = 1), revision RSA (N = 43), and benign neglect (n = 7).
† Continuous variables reported as mean (standard deviation).
‡ Multiple complications occurred in some patients; therefore, the sum of the individual complications does not equal the number of patients with complications.
§ Statistical significance with alpha risk at .05.

patients who sustained dislocations.[7,9,13,23,27,28] The largest published series by Cronin et al[8] included 50 dislocations and reported a successful closed reduction rate of 20%. Prior evidence also suggests that even in the absence of recurrent dislocation or need for revision surgery, patients successfully treated with a closed reduction report subjective outcomes that are inferior to what would otherwise be anticipated after RSA. The average American Shoulder and

Table III Univariate analysis comparing patients with successful and unsuccessful closed reductions as initial treatment following dislocation

Parameter	Successful closed reduction (n = 27)	Unsuccessful closed reduction (n = 60)	*P* value
Revision arthroplasty	4 (14.8)	15 (25)	.27
Age*, yr	70.6 ± 7.1	68.4 ± 7.4	.22
Male sex	16 (59.3)	34 (56.7)	.89
BMI*	28.6 ± 5.0	31.8 ± 6.1	.02†
ASA class			
1	2 (7.7)	2 (3.3)	
2	12 (46.2)	26 (43.3)	.41
3	12 (46.2)	29 (48.3)	
Subluxated before dislocation	3 (11.1)	18 (30)	.06
No subscapular repair	11 (40.7)	23 (38.3)	.22
Early dislocation (within 90 d)	19 (70.4)	37 (61.7)	.49
Nature of dislocation			
Traumatic	6 (22.2)	14 (23.7)	
Atraumatic	17 (63)	43 (72.9)	.89
Other	4 (14.8)	3 (5)	
Primary diagnosis			
GHOA	2 (7.4)	5 (8.5)	
CTA	19 (70.4)	34 (57.6)	.16
Fracture sequelae	0 (0)	7 (11.9)	
Other	6 (22.2)	14 (23.3)	
Prior surgery	9 (33.3)	26 (43.3)	.35
Osteoporosis	4 (14.8)	9 (15)	.96
RA	2 (7.4)	11 (18.3)	.21
DM	3 (11.5)	9 (15)	.75
Smoking status			
Never	13 (54.2)	28 (52.8)	
Previous	10 (41.7)	22 (41.5)	.96
Current	1 (4.2)	3 (5.7)	
Onlay humeral design	9 (34.6)	17 (28.3)	.66
Constrained polyethylene liner	2 (7.4)	11 (18.3)	.21
Augmented glenoid baseplate	3 (11.5)	6 (10)	.63
Glenosphere size >36 mm	9 (34.6)	25 (41.7)	.46
Lateralized glenosphere	18 (69.2)	40 (66.7)	.90
Glenoid component lateral offset >5 mm	12 (46.2)	30 (50)	.69
Combined lateral offset, mm*	9.6 ± 7.2	9.7 ± 6.5	.94

BMI, body mass index; *ASA*, American Society of Anesthesiologists class; *GHOA*, glenohumeral osteoarthritis; *CTA*, cuff tear arthropathy (includes massive rotator cuff tear); *RA*, rheumatoid arthritis; *DM*, diabetes mellitus.

* Continuous variables reported as mean and standard deviation.

† Statistical significance with alpha risk at .05.

Elbow Surgeons Standardized Shoulder Assessment Form (ASES) score in such patients is reported to range from 67.2 to 68,[8,27] compared with 79-80 in uncomplicated primary RSAs according to recent meta-analyses.[11,16] This highlights that postoperative dislocations are not a benign complication even when stability is achieved and revision surgery is avoided.

There is little existing evidence that identifies risk factors for failed closed reductions to treat dislocations after RSA. Cronin et al previously reported a history of prior shoulder surgery as the only variable significantly associated with the need for revision surgery to treat a dislocation after RSA.[8] This is in contrast to our study, which identified increased BMI as the sole factor associated with failure of closed reduction. Interestingly, none of the risk factors for dislocation identified in a prior study using the same patient cohort as the current study (subluxations prior to dislocation, primary diagnosis of fracture nonunion or rotator cuff disease, revision arthroplasty, male sex, and no subscapularis repair) were identified as being risk factors for a failed closed reduction attempt.[18] It is plausible that such risks may be mitigated with postreduction immobilization and

rehabilitation protocols that allow for scarring and improve muscle imbalance and fatigue which positively impact compression forces in the early postoperative period.[5,7] It has previously been suggested that atraumatic dislocations require revision surgery to address improper implant positioning or soft tissue tensioning.[17] Although the majority of atraumatic dislocations did fail treatment with closed reduction in our study, this did not occur at a significantly different rate than for traumatic dislocations (71.7% vs. 70%, $P = .89$). Additionally, the timing of the dislocation relative to the surgery did not have an impact on the success of a closed reduction attempt, which corroborates the findings of prior studies.[8,17,27] This is in contrast to the conjecture by Gerber et al[12] that closed reduction attempts within the first 90 days of surgery are unlikely to be successful as they are likely the consequence of patient factors or surgical error. Although it is clear that some patients are not candidates for a trial of closed reduction, such as in the setting of baseplate failure or component disassociation, our results suggest that a trial of closed reduction is a reasonable initial treatment option for most patients. However, careful evaluation of the etiology of dislocation is necessary to appropriately guide subsequent treatments.

Previous authors have created classification schemes to describe the etiology of dislocation after RSA in order to aid in treatment decision making in cases requiring revision surgery. Abdelfattah et al[1] categorized etiologies of RSA dislocation requiring revision surgery as (1) loss of compression, (2) loss of containment, or (3) impingement. They suggested correcting loss of compression by upsizing the glenosphere. Loss of containment was recommended to be addressed with revised components or exchange to a semiconstrained polyethylene for component failure and eccentric wear, respectively. For impingement, their suggested treatment was component revision or tissue excision for prosthesis malalignment and tissue impingement, respectively. In contrast, Kohan et al[17] described only 2 distinct etiologies of dislocation, including (1) inadequate soft tissue tensioning and/or axillary nerve palsy and (2) dislocation due to adduction impingement or liner failure. Boileau et al[3] and Chae et al[6] previously developed algorithms to guide management of the unstable RSA requiring revision surgery, with focus on humeral medialization and humeral shortening as the primary causes. They report humeral shortening <15 mm as being amenable to exchange for thicker humeral polyethylene component, whereas shortening >15 mm requires humeral stem revision. In the setting of humeral medialization, a larger glenosphere with or without increased lateral offset can be used. Although helpful in establishing a general treatment framework, prospective studies evaluating such criteria are currently lacking. Additionally, it is challenging to describe the technicalities of each RSA procedure and the unique properties of each patient, thus limiting the ability to categorize cases into distinct etiologic groups.

The outcomes of revision RSA for postoperative dislocations are reported to be inferior to expected scores after an uncomplicated primary procedure, and recurrent dislocations are common. Cronin et al[8] reported a mean postoperative ASES score of 66.7 among 40 revisions for dislocations. Among those revision cases, 42.5% proceeded to sustain additional dislocations, 35% required an additional rerevision procedure, and stability was ultimately never achieved in 14%. Melbourne et al[22] reported on 36 revision RSA procedures for postoperative dislocations and found that a higher percentage of patients who underwent multiple revisions had persistent dislocations compared with patients receiving a revision after a failed primary procedure (27% vs. 7%). In that study, 11% of patients never achieved stability. Among patients they reported had achieved stability at final follow-up, the average ASES score was 62.[22] The results of our current study are within range of these prior reports, with a 22.2% incidence of rerevision surgery for recurrent dislocation after a failed revision and 13% overall incidence of patients who ultimately failed to achieve stability.

The strengths of this study include the 6621 multicenter patient cohort, including 138 patients who sustained dislocations after RSA, which is the largest analysis on this topic to the authors' knowledge. However, this study is not without limitations. Its retrospective nature limited our ability to generalize individual cases of dislocations into distinct etiologic groups that have previously been suggested by other authors.[1,3,6,17] Although implant factors such as humeral design and lateralization were not found to significantly impact the success rate of initial closed reduction attempts, we did not analyze radiographic parameters of implant positioning such as lateralization and distalization. Consequently, we cannot comment on the impact such variables have on treatment patterns and outcomes. However, our analysis did include several patient and surgical factors that were deemed relevant for determining a patient's likelihood of experiencing a successful closed reduction. Additionally, we did not perform a multivariable analysis to further assess the relationship between BMI and risk of failed initial closed reduction attempts, as our event rate ($n = 27$) limited our available degrees of freedom for such analysis. Furthermore, we did not report subjective patient-reported outcome scores or objective range of motion measurements, as the focus of this study was on the treatment patterns and attainment of stability. Another limitation is that we did not use an adjusted P value to correct for multiple comparisons, as is done with the Bonferroni correction method. However, given that our study is retrospective without a priori–defined analyses and is purely exploratory rather than confirmatory for final decision making, we felt that it was not necessary to perform such corrections.[2,26] Doing so can increase the chance for type 2 errors and be diminutive to the power of an analysis.[26] Nonetheless, it remains

possible that some of our significant results may be due to chance, and this exploratory work should serve as a pilot for future studies. Finally, the minimum follow-up for this study was 3 months, which may have introduced a selection bias, resulting in a possible misrepresentation of the overall incidence of dislocations as well as possible misrepresentation of the final disposition of some patients. However, the number of dispositions effected by short follow-up is likely small, given our average follow-up length of 19.4 months. Additionally, the minimal follow-up was determined by the Delphi process to maximize the number of patients included in our cohort.

Conclusion

In this large multicenter series of postoperative dislocations following RSA, a closed reduction was initially attempted in the majority of patients, but only about one-third were successful and required no further intervention. Unsuccessful closed reductions were associated with higher patient BMI. Revision surgery for dislocations was complicated by a high rate of recurrent dislocations and rerevision surgery.

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