

# Instability After Reverse Total Shoulder Arthroplasty: Which Patients Dislocate?

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## Abstract

Given the increasing use of reverse total shoulder arthroplasty (RTSA), it is important to study the complications associated with this procedure.

We conducted a study of the incidence, predisposing factors, and treatment of RTSA dislocations. Using our institutional database, we retrospectively searched for RTSAs performed between September 27, 2010 and December 31, 2013 and identified postoperative dislocations.

Four hundred eighty-seven patients underwent 510 RTSAs (393 primary, 117 revision). Fourteen patients had 15 dislocations (5 in primary RTSAs, 10 in revision RTSAs). Mean time from surgery to diagnosis was 58.2 days (range, 0-319 days). One dislocation occurred immediately after surgery, 2 after falls, 4 from low-energy mechanisms of injury, and 8 without known inciting events. Logistic regression

analysis revealed revision RTSA (odds ratio [OR] = 7.515;  $P = .042$ ) and higher body mass index (BMI) (OR = 1.09;  $P = .047$ ) to be independent risk factors. The diagnosis of primary cuff tear arthropathy (CTA) was independently associated with a lower rate of dislocation (OR = 0.025;  $P = .008$ ); dislocation occurred in only 1 (0.35%) of 285 patients with CTA. All dislocations were treated in the operating room; no dislocation was successfully treated with simple closed reduction in the clinic.

Although dislocation after RTSA is uncommon, the risk is higher for patients with higher BMI and for revision patients. Patients may benefit from lifestyle modifications, preoperative counseling, intraoperative considerations, and rehabilitation modifications. Patients who undergo RTSA for primary CTA can be reassured that the likelihood of dislocation is low.

**R**isk factors for dislocation after reverse total shoulder arthroplasty (RTSA) are not clearly defined. Prosthetic dislocation can result in poor patient satisfaction, worse functional outcomes, and return to the operating room.<sup>1-3</sup> As a result, identification of modifiable risk factors for complications represents an important research initiative for shoulder surgeons.

There is a paucity of literature devoted to the

study of dislocation after RTSA. Chalmers and colleagues<sup>4</sup> found a 2.9% (11/385) incidence of early dislocation within 3 months after index surgery—an improvement over the 15.8% reported for early instability over the period 2004–2006.<sup>5</sup> As prosthesis design has improved and surgeons have become more comfortable with the RTSA prosthesis, surgical indications have expanded,<sup>6,7</sup> and dislocation rates appear to have decreased.

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Although the most common indication for RTSA continues to be cuff tear arthropathy (CTA),<sup>6</sup> there has been increased use in rheumatoid arthritis<sup>8-10</sup>; proximal humerus fractures, especially in cases of poor bone quality and unreliable fixation of tuberosities<sup>11-13</sup>; and failed previous shoulder reconstruction.<sup>14,15</sup> As RTSA is performed more often, limiting the complications will become more important for both patient care and economics.

We conducted a study to analyze dislocation rates at our institution and to identify both modifiable and nonmodifiable risk factors for dislocation after RTSA. By identifying risk factors for dislocation, we will be able to implement additional perioperative clinical measures to reduce the incidence of dislocation.

## Materials and Methods

This retrospective study of dislocation after RTSA was conducted at the Rothman Institute of Orthopedics and Methodist Hospital (Thomas Jefferson University Hospitals, Philadelphia, PA). After obtaining Institutional Review Board approval for the study, we searched our institution's electronic database of shoulder arthroplasties to identify all RTSAs performed at our 2 large-volume urban institutions between September 27, 2010 and December 31, 2013. For the record search, *International Classification of Diseases, Ninth Revision (ICD-9)* codes were used (**Table 1**). These unique procedure codes are used by the hospital system for billing, but are not always specific to assigned procedures. Therefore, the individual operative reports identified were reviewed to identify the patients who actually underwent RTSA. From this database, all patients who underwent RTSA were selected. Using the subpopulation of patients who underwent RTSA, we searched individual medical records to identify patients who had a dislocation after RTSA. This information was cross-referenced with *ICD-9* codes for shoulder dislocation (831.0, 831.01, 831.02, 831.03) to ensure that all patients were identified.

The medical records of each patient were used to identify independent variables that could be associated with dislocation rate. Demographic variables included sex, age, and race. Preoperative clinical data included body mass index (BMI), etiology of shoulder disease leading to RTSA, individual comorbidities, and Charlson Comorbidity Index (CCI)<sup>16</sup> modified to be used with *ICD-9* codes.<sup>17</sup> In addition, prior shoulder surgery history and arthroplasty type (primary or revision) were determined.

**Table 1. ICD-9 Codes Searched in Our Institutional Database to Identify All Reverse Total Shoulder Arthroplasties Performed**

ICD-9 Code	Case Description
79.31	Open reduction and internal fixation of fracture of humerus
80.01	Arthrotomy for removal of prosthesis without replacement
81.80	Total shoulder arthroplasty
81.81	Shoulder hemiarthroplasty
81.82	Repair of recurrent dislocation of shoulder
81.83	Other repair of shoulder, arthroplasty
81.88	Reverse total shoulder arthroplasty
81.97	Revision joint replacement upper extremity

Abbreviation: ICD-9, *International Classification of Diseases, Ninth Revision*.

Postoperative considerations were time to dislocation, mechanism of dislocation, and intervention(s) needed for dislocation. Although the institutional database did not include operative variables such as prosthesis type and surgical approach, all 6 surgeons in this study were using a standard deltopectoral approach in beach-chair position with a Grammont style prosthesis for RTSA cases.

Descriptive statistics for RTSA patients and the dislocation subpopulation were compiled. Bivariate analysis was used to evaluate which of the previously described variables influenced dislocation rates. Last, multivariate logistic regression analysis was performed to evaluate which factors were independent predictors of dislocation. We included demographic variables (age, sex, ethnicity), clinical variables (BMI, individual comorbidities, CCI), and surgical variables (primary vs revision, diagnosis at time of surgery). All statistical analyses were performed with Excel 2013 (Microsoft) and SPSS Statistics Version 20.0 (SPSS Inc.).

## Results

From the database, we identified 487 patients who underwent 510 RTSAs during the study period. These surgeries were performed by 6 shoulder and elbow fellowship-trained surgeons. Of the 510 RTSAs, 393 (77.1%) were primary cases, and 117 (22.9%) were revision cases.

Of the 510 shoulders that underwent RTSA, 15 (2.9%; 14 patients) dislocated. Of these 15 cases, 5 were primary (1.3% of all primary cases) and 10 were revision (8.5% of all revision cases). Mean time from index surgery to diagnosis of dislocation

Table 2. Surgical Variables for All Dislocations

Sex	Age, y	Diagnosis	Arthroplasty Revision	Previous Open Surgery	Glensphere Size, mm	Polyethylene Size, mm	Retentive Polyethylene	Subscapularis Treatment	Intervention
F	74.4	Periprosthetic joint infection/spacer	Yes	Yes	36	3	Yes	Irreparable	Polyethylene exchange to 6
M	79.9	Periprosthetic joint infection/spacer	Yes	Yes	38	3	No	Irreparable	Open reduction
F	74.6	Posttraumatic arthritis	No	Yes	36	6	No	Irreparable	Polyethylene exchange to 9
M	53.5	Dislocated primary arthroplasty	Yes	Yes	42	6	No	Irreparable	1. Hematoma aspiration, closed reduction 2. Polyethylene exchange to 9
F	67.0	Periprosthetic joint infection/spacer	Yes	Yes	38	6	No	Irreparable	1. Closed reduction 2. Glensphere exchange to 42, liner exchange to 9
M	66.2	Cuff tear after arthroplasty	Yes	Yes	40	3	Yes	Irreparable	1. Revision of humeral component, liner exchange to 6 2. Revision of humeral component, liner exchange to 3
M	76.8	Primary cuff tear arthroplasty	No	No	42	9	No	Primary repair	Polyethylene exchange to 6
M	66.7	Cuff tear after arthroplasty	Yes	Yes	36	3	No	Primary repair	Retentive polyethylene (3) placement, subscapularis repair
M	67.6	Periprosthetic malunion	Yes	Yes	36	3	No	Primary repair	Glensphere exchange to 40, polyethylene exchange to 3
F	65.2	Chronic glenohumeral dislocation	No	No	36	6	No	Taken down without repair	Polyethylene exchange to 6
M	57.8	Periprosthetic joint infection/spacer	Yes	Yes	42	12	No	Primary repair	Closed reduction
F	63.3	Cuff tear after arthroplasty	Yes	Yes	36	6	No	Primary repair	Humeral augment (9), retentive polyethylene (6) placement
M	53.4	Proximal humerus avascular necrosis	No	No	42	12	No	Taken down without repair	Retentive polyethylene (12) placement
M	78.2	Posttraumatic arthritis	No	No	38	3	No	Primary repair	Polyethylene exchange to 9
F	79.9	Periprosthetic joint infection/spacer	Yes	Yes	36	6	No	Irreparable	Humeral augment (6), polyethylene exchange to 6

was 58.2 days (range, 0-319 days). One dislocation occurred immediately after surgery, 2 after falls, 4 from patient-identified low-energy mechanisms of injury, and 8 without known inciting events. Nine dislocations (60%) did not have a subscapularis repair (7 were irreparable, 2 underwent subscapularis peel without repair), and the other 6 were repaired primarily (Table 2). In addition, 11 dislocations (73.3%) previously underwent open or arthroscopic shoulder surgery. All patients who had a dislocation after RTSA returned to the operating room at least once; no dislocation was successfully treated with closed reduction in the clinic. The 15 dislocations underwent 17 surgeries: 7 isolated polyethylene exchanges, 2 isolated closed reductions, 1 hematoma aspiration with closed reduction, 1 open reduction, 2 humeral component revisions with polyethylene exchange, 1 humeral augmentation with polyethylene exchange, 2 glenosphere exchanges with polyethylene exchange, and 1 polyethylene exchange with concurrent subscapularis repair.

Male patients accounted for 32.2% of the study population but 60.0% of the dislocations ( $P = .019$ ) (Table 3). In addition, mean BMI was 33.2 for patients with dislocation and 29.5 for patients without dislocation ( $P = .039$ ) (Table 3). Revision arthroplasty was found to be a risk factor for dislocation in univariate analysis: 66.7% of the dislocations occurred after revision RTSA, and only 21.6% of nondislocated shoulders were revision cases ( $P < .001$ ) (Table 4). Patients who underwent RTSA for CTA had a very low incidence of dislocation (0.35%, 1/285), accounting for 6.7% of the dislocated group and 57.6% of the nondislocated group ( $P < .001$ ) (Table 4). The 1 patient with a dislocation after primary RTSA for CTA had an indolent infection at time of surgery after dislocation.

Multivariate logistic regression analysis revealed revision arthroplasty (OR = 7.515;  $P = .042$ ) and increased BMI (OR = 1.09;  $P = .047$ ) to be independent risk factors for dislocation after RTSA. Analysis also found a diagnosis of primary CTA to be independently associated with lower risk of dislocation after RTSA (OR = 0.025;  $P = .008$ ). Last, the previously described risk factor of male sex was found not to be a significant independent risk

Table 3. Patient Variables Across Groups

Variable	All RTSAs	Dislocated	
	(N = 510)	Yes (n = 15)	No (n = 495)
Male sex, n (%)	164 (32.2%)	9 (60.0%)	155 (31.3%)
Mean age, y (range)	71.7 (22.3-94.1)	68.3 (53.4-79.9)	71.8 (22.3-94.1)
Caucasian, n (%)	476 (93.3%)	14 (93.3%)	462 (93.3%)
Body mass index (range)	29.6 (16.0-62.8)	33.2 (22.1-47.9)	29.5 (16.0-62.8)
Age-adjusted CCI (range)	4.52 (1-10)	4.27 (1-5)	4.53 (1-10)
Revision, n (%)	117 (22.9%)	10 (66.7%)	107 (21.6%)

Abbreviations: CCI, Charlson Comorbidity Index; RTSA, reverse total shoulder arthroplasty.

Table 4. Univariate Analysis of Clinical Variables

Variable	t	z	P
Male sex <sup>a</sup>	—	2.34	.019
Mean age, y <sup>b</sup>	-1.43	—	.152
Caucasian <sup>a</sup>	—	0.00	1.00
Body mass index <sup>b</sup>	2.06	—	.039
Age-adjusted CCI <sup>b</sup>	-0.69	—	.493
Diagnosis for primary <sup>a</sup>			
Cuff tear arthropathy	—	-3.90	<.001
Revision	—	4.09	<.001
Posttraumatic arthritis	—	1.14	.254
Acute trauma	—	-1.02	.308
Inflammatory arthritis	—	-0.79	.430

Abbreviation: CCI, Charlson Comorbidity Index.

<sup>a</sup>Comparison of proportions (reported as z statistic).

<sup>b</sup>Paired comparison of sample means (reported as t statistic).

factor, though it did trend positively (OR = 3.011;  $P = .071$ ).

### Discussion

With more RTSAs being performed, evaluation of their common complications becomes increasingly important.<sup>18</sup> We found a 3.0% rate of dislocation after RTSA, which is consistent with the most recently reported incidence<sup>4</sup> and falls within the previously described range of 0% to 8.6%.<sup>19-26</sup> Of the clinical risk factors identified in this study, those previously described were prior surgery, subscapularis insufficiency, higher BMI, and male sex.<sup>4</sup> However, our finding of lower risk of dislocation after RTSA for primary rotator cuff pathology was not previously described. Although Chalmers and colleagues<sup>4</sup> did not report this lower risk, 3

(27.3%) of their 11 patients with dislocation had primary CTA, compared with 1 (6.7%) of 15 patients in the present study.<sup>4</sup> Our literature review did not identify any studies that independently reported the dislocation rate in patients who underwent RTSA for rotator cuff failure.

The risk factors of subscapularis irreparability and revision surgery suggest the importance of the soft-tissue envelope and bony anatomy in dislocation prevention. Previous analyses have suggested implant malpositioning,<sup>27,28</sup> poor subscapularis quality,<sup>29</sup> and inadequate muscle tensioning<sup>5,30-32</sup> as risk factors for RTSA. Patients with an irreparable subscapularis tendon have often had multiple surgeries with compromise to the muscle/soft-tissue envelope or bony anatomy of the shoulder. A biomechanical study by Gutiérrez and colleagues<sup>31</sup> found the compressive forces of the soft tissue at the glenohumeral joint to be the most important contributor to stability in the RTSA prosthesis. In clinical studies, the role of the subscapularis in preventing instability after RTSA remains unclear. Edwards and colleagues<sup>29</sup> prospectively compared dislocation rates in patients with reparable and irreparable subscapularis tendons during RTSA and found a higher rate of dislocation in the irreparable subscapularis group. Of note, patients in the irreparable subscapularis group also had more complex diagnoses, including proximal humeral nonunion, fixed glenohumeral dislocation, and failed prior arthroplasty. Clark and colleagues<sup>33</sup> retrospectively analyzed subscapularis repair in 2 RTSA groups and found no appreciable effect on complication rate, dislocation events, range-of-motion gains, or pain relief.

Our finding that higher BMI is an independent risk factor was previously described.<sup>4</sup> The association is unclear but could be related to implant positioning, difficulty in intraoperative assessment of muscle tensioning, or body habitus that may generate a lever arm for impingement and dislocation when the arm is in adduction. Last, our finding that male sex is a risk factor for dislocation approached significance, and this relationship was previously reported.<sup>4</sup> This could be attributable to a higher rate of activity or of indolent infection in male patients.<sup>34,35</sup>

Besides studying risk factors for dislocation after RTSA, we investigated treatment. None of our patients were treated successfully and definitively with closed reduction in the clinic. This finding diverges from findings in studies by Teusink and colleagues<sup>2</sup> and Chalmers and colleagues,<sup>4</sup> who respectively reported 62% and 44% rates of

success with closed reduction. Our cohort of 14 patients with 15 dislocations required a total of 17 trips to the operating room after dislocation. This significantly higher rate of return to the operating room suggests that dislocation after RTSA may be a more costly and morbid problem than has been previously described.

This study had several weaknesses. Despite its large consecutive series of patients, the study was retrospective, and several variables that would be documented and controlled in a prospective study could not be measured here. Specifically, neither preoperative physical examination nor patient-specific assessments of pain or function were consistently obtained. Similarly, postoperative patient-specific instruments of outcomes evaluation were not obtained consistently, so results of patients with dislocation could not be compared with those of a control group. In addition, preoperative and postoperative radiographs were not consistently present in our electronic medical records, so the influence of preoperative bony anatomy, intraoperative limb lengthening, and any implant malpositioning could not be determined. Furthermore, operative details, such as reparability of the subscapularis, were not fully available for the control group and could not be included in statistical analysis. In addition, that the known dislocation risk factor of male sex<sup>4</sup> was identified here but was not significant in multivariate regression analysis suggests that this study may not have been adequately powered to identify a significant difference in dislocation rate between the sexes. Last, though our results suggested associations between the aforementioned variables and dislocation after RTSA, a truly causative relationship could not be confirmed with this study design or analysis. Therefore, our study findings are hypothesis-generating and may indicate a benefit to greater deltoid tensioning, use of retentive liners, or more conservative rehabilitation protocols for high-risk patients.

## Conclusion

Dislocation after RTSA is an uncommon complication that often requires a return to the operating room. This study identified a modifiable risk factor (higher BMI) and 3 nonmodifiable risk factors (male sex, subscapularis insufficiency, revision surgery) for dislocation after RTSA. In contrast, patients who undergo RTSA for primary rotator cuff pathology are unlikely to dislocate after surgery. This low risk of dislocation after RTSA for primary cuff

pathology was not previously described. Patients in the higher risk category may benefit from preoperative lifestyle modification, intraoperative techniques for increasing stability, and more conservative therapy after surgery. In addition, unlike previous investigations, this study did not find closed reduction in the clinic alone to be successful in definitively treating this patient population.

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*This paper will be judged for the Resident Writer's Award.*