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Body mass index as a risk factor for dislocation of total shoulder arthroplasty in the first 30 days

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Background: Dislocation of total shoulder arthroplasty has an incidence as high as 31%. Obesity is one of many proposed risk factors, but no consensus exists on this relationship. The purpose of this study was to determine whether there is a relationship between body mass index (BMI) and dislocation of total shoulder arthroplasty.

Methods: The National Surgical Quality Improvement Program database was used to identify patients older than 50 years who underwent anatomic or reverse total shoulder arthroplasty between the years 2012 and 2016 for primary or secondary osteoarthritis, post-traumatic arthritis, or cuff tear arthropathy. Patients requiring reoperation or readmission for dislocation were identified by Current Procedural Terminology code. The relationship between World Health Organization BMI classification and dislocation was assessed.

Results: A total of 9382 patients were identified; 46% were male and 54% female, with an average age of 68.7 years (range 50-90) and average BMI of 31.2 (range 15.1-79.3). There were only 24 dislocation events within the first 30 days after the procedure (0.26%). Ten of 24 (42%) occurred after discharge. Seventy percent of cases (17 of 24) required an open procedure. Underweight patients (BMI < 18.5) experienced the highest dislocation rate (1/50, 2.00%), whereas overweight patients (BMI 25-29.9) experienced the lowest dislocation rate (3/3069, 0.1%).

Conclusion: The rate of dislocation of total shoulder arthroplasty in the acute postoperative period differs across categories of BMI. However, there does not appear to be a linear association between BMI and risk of dislocation of total shoulder arthroplasty. Further studies are required to elucidate the risk factors for total shoulder dislocation.

Total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) are both effective interventions for patients with primary or secondary glenohumeral arthritis. RTSA is also effective for patients with cuff tear arthropathy, proximal humerus fractures, and failed anatomic TSA. Both of these have demonstrated good functional outcomes and long-term survivorship, and their use is becoming more common.[2,5,6,14]

The prevalence of obesity in the United States is 37% and increasing. Obesity is associated with problems such as incorrect implant positioning, component failure, infection, and postoperative medical complications in total knee and total hip arthroplasty. It is therefore reasonable to assume that obesity would pose the same risks in patients undergoing TSA.[10,11,13,18] Whereas some studies have shown increased complications in obese patients,[9,27] others have not.[12,21,26] Complications of shoulder arthroplasty may include infection, failure of the glenoid or humeral component, fracture of the glenoid or humerus, loosening, and dislocation.[23]

Dislocation of TSA has a reported incidence of up to 31%.[15,28] The purpose of this study was to determine whether there is an increased incidence of TSA dislocation within the first 30 days after surgery in overweight or obese patients compared to those of normal BMI and, if so, whether there is a BMI threshold beyond which dislocation is more likely to occur. Our hypothesis was that obese patients would be at increased risk for postoperative dislocation compared to patients of normal BMI.

No IRB approval was required to conduct this study.

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Methods

The National Surgical Quality Improvement Program (NSQIP) database was used as the data source for this study. This validated database is maintained by the American College of Surgeons with the purpose of improving outcomes in surgical patients. The data are collected from a national sample of more than 400 hospitals and include more than 150 variables relating to patient demographics, risk factors and comorbidities, surgical data, and complications within 30 days of discharge. Complete information regarding the database is available at https://www.facs.org/quality-programs/acs-nsqip.

Patients aged 50 years or older who underwent anatomic TSA or RTSA between the years 2012 and 2016 were identified by their primary Current Procedural Terminology (CPT) code (23472, which is the code for both anatomic and reverse total shoulder arthroplasties). Only cases performed for cuff tear arthropathy, primary osteoarthritis, post-traumatic osteoarthritis, or rheumatoid arthritis were included. Cases were excluded if the procedure was performed for acute trauma or if patients had significant comorbidities that would typically preclude surgery, including liver failure with ascites, recent dialysis, transfusion, or were unable to function independently. This left 9382 patients. Patients within this cohort who experienced postoperative complications requiring reoperation or readmission were identified by International Classification of Diseases, Ninth (ICD-9) or Tenth (ICD-10) Revision, code relating to the diagnosis, or by CPT code relating to any relevant secondary procedures performed (Supplementary Tables S1 and S2). Baseline demographics including age, sex, BMI, and other comorbidities were also evaluated. BMI was stratified according to the World Health Organization classification (Table I), and complications were correlated to BMI category.

Analysis was done using SAS statistical software version 9.4 (SAS Institute Inc, Cary, NC, USA). Means and standard deviations were calculated for numeric variables of interest. Cross tabulations were generated between categorical predictor variables and the primary outcomes of interest (ie, reoperation or readmission due to dislocation), and associations were tested using χ^2 tests, or Fisher exact tests when expected cell counts were low.

Results

Of the 9382 patients identified, 4318 (46%) were male and 5064 (54%) were female. Ninety-four percent of patients for whom data regarding race and ethnicity were available were white (8048) (Table II). Average age was 69.7 years (range 50-90, standard deviation 8.6), and average BMI was 31.2 (range 15.1-79.3, standard deviation 6.8). In addition, 16.9% of patients were diabetics and 9.8% were smokers.

Out of the entire cohort of 9382 patients who underwent an anatomic or reverse TSA, 24 (0.26%) experienced a dislocation event after the procedure. Ten (42%) of these occurred after discharge and required readmission. Of these, 22 were recorded as requiring a procedure to treat the dislocation, leaving 2 readmissions that did not undergo a documented procedure. CPT codes accurately documenting a closed or open procedure were available for 20 the 22 patients who had a reoperation. Fourteen (70%) of these patients required an open procedure, and the remaining 30% (10) were treated with closed methods. Treatment occurred an average of 12 days after the index procedure. There was no association between dislocation and age ($P = .75$), sex ($P = .99$) race ($P = .11$), ethnicity ($P = .18$), or smoking status ($P = .73$).

BMI data were available for 9355 patients, which includes the 24 patients discussed above. The distribution of dislocation events across BMI categories was not equal ($P = .039$). Patients in the underweight and class III obesity groups (BMI <18.5 and >40, respectively) experienced the highest dislocation rates (2.00% and 0.52%, respectively) whereas patients in the overweight group had the lowest dislocation rate (0.1%) (Table II).

Table I
World Health Organization classification of obesity

Classification	BMI
Underweight	<18.5
Normal weight	18.5-24.9
Overweight	25.0-29.9
Class I obesity	30.0-34.9
Class II obesity	35.0-39.9
Class III obesity	≥40.0

BMI, body mass index.

Discussion

Our results demonstrate that dislocation of an anatomic or reverse TSA within the first 30 postoperative days is uncommon. There is an unequal distribution of dislocation events across BMI categories in this cohort, with the highest rates occurring in the underweight (BMI <18.5) and in the class III obesity (BMI >40) groups, respectively. However, these data should be used with caution because of the low number of patients in the underweight group.

Several previous studies have examined functional outcomes of TSA and RTSA in the obese population. Linberg et al were the first to publish functional outcome results of anatomic total shoulders in morbidly obese patients (BMI >40) and found that 29% experienced an unsatisfactory result as assessed by the Neer criteria.[16] Li et al compared functional outcome scores after anatomic TSA in 76 total patients of normal, overweight, or obese BMI using the American Shoulder and Elbow Surgeons shoulder score, 36-item Short Form Health Survey, and visual analog sale. All patients experienced significant improvement in American Shoulder and Elbow Surgeons shoulder and visual analog scale scores, but overweight and obese patients did not have any significant improvements in SF-36 scores compared to patients with normal BMI. They found no difference in complication rates.[17] Pappou and Statz both reported good functional outcomes following RSA in morbidly obese patients.[19,24] Others have reported good functional results in both TSA and RSA in obese patients, but one study showed that morbidly obese patients attain less active external rotation and have lower 12-Item Short Form Health Survey scores compared to those who are not morbidly obese.[1,21,25]

Although overweight and obese patients do experience improved functional outcomes after TSA or RTSA, the literature is mixed as to whether they experience higher complication rates. One large database study found that morbidly obese patients undergoing TSA had slightly longer length of stay, total cost of care, and higher rates of respiratory dysfunction, but there was no association with mortality or other complications.[8] Another large database study found that BMI had no correlation with revision for aseptic loosening, 1-year mortality, or deep infection rate at 3 years.[1] Jiang et al found no correlation between BMI and complication rates within 30 days of surgery for patients undergoing anatomic TSA.[12] In a large registry study of 2588 TSA, Singh et al found no correlation between BMI and risk of revision.[22] Similarly, Statz only had 2 revisions among 41 patients with BMI >40. One was for infection and the other for loosening of the humeral component.[24] Other retrospective and prospective studies have found no difference in overall complication rates between patients of high BMI and normal BMI who underwent TSA or RTSA.[21,25]

Table II
Patient characteristics and dislocation rates

	No dislocation, n (%)	Dislocation, n (%)	Total	*P* value
Age, yr				.75
50-59	1196 (99.75)	3 (0.25)	1199	
60-69	3347 (99.76)	8 (0.24)	3355	
70-79	3527 (99.77)	8 (0.23)	3535	
≥80	1288 (99.61)	5 (0.39)	1293	
Total	9358	24	9382	
Sex				.99
Female	5051 (99.74)	13 (0.26)	5064	
Male	4307 (99.75)	11 (0.25)	4318	
Race				.99
Black	403 (99.51)	2 (0.49)	405	
White	8028 (99.75)	20 (0.25)	8048	
Other	93 (98.94)	1 (1.06)	94	
Ethnicity				.18
Hispanic	296 (99.33)	2 (0.67)	298	
Non-Hispanic	8066 (99.75)	20 (0.25)	8086	
BMI				.04
<18.5 underweight	49 (98.00)	1 (2.00)	50	
18.5-24.9 normal weight	1448 (99.72)	4 (0.28)	1452	
25.0-29.9 overweight	3066 (99.90)	3 (0.10)	3069	
30-34.9 Class I obesity	2483 (99.68)	8 (0.32)	2491	
35-39.9 Class II obesity	1328 (99.77)	3 (0.23)	1331	
40+ Class III obesity	957 (99.48)	5 (0.52)	962	
Total	9331	24	9355	
Smoking				.72
No	8445 (99.75)	21 (0.25)	8466	
Yes	915 (99.89)	1 (0.11)	916	
Total	9360	22	9382	

BMI, body mass index.

In contrast, Werner et al studied data from the PearlDiver database of Medicare records and found that patients with a BMI >50 did have significantly higher rates of infection, loosening, dislocation, thromboembolic and medical complications, and revision.[27] Anakwenze studied the Kaiser registry and found that each 5-unit increment in BMI was associated with a 16% increase in the 90-day readmission rate.[1] Similarly, Wagner et al found that the risk of revision increases by 5% per unit of BMI, and that higher BMI was associated with a higher risk of infection.[26] In a retrospective study, Gupta et al found that BMI was associated with complication rates in a bimodal distribution, such that those with BMI <25 and those with BMI >35 experienced a higher complication rate than did patients of normal or overweight BMI (26-34).[9]

Multiple studies have shown dislocation to be a complication after both TSA and RTSA, with rates ranging from 2.4% to 31%.[20] A recent review of the literature indicates that the overall complication rate of TSA and RTSA is about 11%, with instability accounting for 10.1% of TSA complications and 31.3% of RSA complications,[3] but a review of the FDA database indicates that the real numbers may be higher.[23] Dislocation of TSA may occur as a result of improper implant positioning, rotator cuff deficiency, deltoid deficiency, deficient bone stock, subscapularis compromise, or axillary nerve injury. Dislocation of RSA may occur as a result of improper implant positioning, deltoid deficiency, axillary nerve injury, inadequate subscapularis repair, asymmetric liner wear, or impingement.[3,4,7] Impingement has been argued to occur late because of formation of heterotopic ossification and poly wear, whereas early dislocations (prior to 90 days) are due to poor soft tissue tensioning.[15]

A few of the studies correlating BMI with complications in TSA and RTSA included dislocation as an adverse event, but they did not explore the relationship in detail. Vincent et al studied 310 patients with TSA or RTSA (57% and 43%, respectively) and found no relationship between complication rates and BMI.[25] Statz et al reported no dislocations in 41 morbidly obese patients who underwent primary RTSA.[24] Similarly, Gupta et al reviewed 119 patients with primary RTSA and found that BMI was significantly correlated with postoperative complications, but the 4.2% incidence of dislocation did not correlate with BMI.[9] Wagner reviewed 4567 patients who underwent TSA, RTSA, or hemiarthroplasty between 1970 and 2013 and found only 61 dislocation events, with no correlation with BMI. In contrast, Chalmers did find that BMI >30 correlated with dislocation in a retrospective study of 385 patients who underwent RTSA. The incidence of dislocation in their series was 2.9% (11 patients).[4] Werner et al reviewed more than 105,000 TSAs and RTSAs, including 955 in superobese patients (BMI >50), and found that superobesity did correlate with a higher dislocation rate within 1 year of surgery (2.9% vs. 1.7% for nonobese).

Our study does include several limitations. First, it is a review of a large database and is therefore subject to errors or inconsistencies in how data are recorded. The NSQIP is a validated database that ensures accurate data entry by trained nurses, but there may also be variation in how procedures were originally coded. Second, there is only 1 CPT code for both anatomic and reverse TSA, so we could not determine from the data available if there was any difference in dislocation rate according to arthroplasty type. Third, the database only follows patients for 30 days after discharge, but many studies have reported dislocations well beyond 30 days. Finally, the data captured may not represent the true 30-day incidence of dislocation, as a result of sampling methods. Therefore, it is possible that the dislocation rate of 0.26% in this series is underreported.

Conclusion

Dislocation of TSA and RTSA in the early postoperative period is a relatively uncommon complication and does not seem to be directly correlated with patient BMI.

Disclaimer

Matthew J. Teusink reports being a paid consultant for DJO surgical. All the other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jses.2019.07.001.

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