Minimal Effect of Body Mass Index on Total Shoulder Arthroplasty Postoperative Complications: An Electronic Medical Records Database Study

Robert B Campbell, Alton Daley, Daniel Austin, Paul Michael Werth, Robert Brick Campbell

INTRODUCTION: Over the past decade, the volume of total shoulder arthroplasty procedures (TSA) performed annually in the United States has grown significantly, buoyed by the new outpatient designation from Centers for Medicare and Medicaid Services (CMS) beginning in 2024. With this rise in volume, especially in the outpatient setting, the importance of pre-operative risk stratification of patients is ever more important to understand modifiable risk factors. Furthermore, orthopaedic surgery organizational guidelines have referenced the need and importance of large data sets in helping to identify specific risk factors associated with adverse events after TSA. A new large searchable electronic medical records (EMR) database has become available which includes not only hospital based input, but also records of patients in outpatient clinic settings. The current study aims to evaluate the association between BMI and both early (<90-days) and late (<1 year) adverse outcomes in primary, non-traumatic TSA patients across the BMI spectrum using this national EMR system database encompassing both hospital and ambulatory settings.

METHODS: This is a retrospective observational study utilizing data from de-identified electronic health records for all patients undergoing TSA (both anatomic and reverse) between October 2015 and December 2022. Data was extracted from Epic's Cosmos cloud-based, continuously updated, data warehouse representing 300 million patients across >1,700 contributing hospitals and over 40,000 physician clinics. CPT and ICD-10-PCS codes were used to identify the focal population. CPT and ICD-10-CM coding schemes were utilized to identify outcome variables: DVT, PE, Myocardial Infarction (MI), Urinary Tract Infection (UTI), Prosthetic Joint Infection (PJI), Acute Kidney Injury (AKI), Revision, Superficial Surgical Infection (SSI), Dislocation, Periprosthetic Fracture, Mechanical Complications, 90-day Emergency Department (ED) visit, and Stiffness. A continuous treatment of BMI was used as the focal predictor for each outcome in a binary logistic multiple regression model after controlling for: Age, Sex, Race, and Elixhauser Comorbidity. Data missingness was addressed by multiple imputation by chained equations (m=5). For each model BMI had both linear and quadratic (curvilinear) treatments to investigate the potential for non-linear associations with the outcome.

RESULTS: 124,514 TSA patients were identified. BMI was not significantly associated with 1-year revision rates (aOR=0.999, p=0.13). Increased BMI demonstrated a mild protective effect for periprosthetic fracture (aOR=0.983, p=0.006), prosthetic joint infection (aOR=0.972, p=0.002), , myocardial infarction (aOR=0.987, p<0.001), stiffness (curvilinear) (aOR2=0.999, p=0.001), and mechanical complications (aOR=0.990, p=0.024). Conversely, increased BMI demonstrated a harmful effect for dislocation (curvilinear) (aOR=0.990, p=0.006, aOR2=1.001, p=0.001), DVT (aOR=1.013, p<0.001), PE (aOR=1.029, p<0.001), UTI (curvilinear) (aOR=0.995, p=0.009, aOR2=1.001, p<0.001), SSI (aOR=1.015, p=0.002), AKI (curvilinear) (aOR2=1.001, p<0.001), and 90-day ED visit (aOR=0.986, p<0.001, aOR2=1.001, p<0.001).

DISCUSSION AND CONCLUSION:

The current study revealed mixed results on the association between BMI and complications following total shoulder arthroplasty (TSA) in 124,514 patients across the unique Cosmos database. Our results correlate increased BMI with the development of dislocation, DVT, PE, SSI, AKI and UTI. Conversely, increased BMI was shown to be protective in terms of risk of developing a periprosthetic fracture, prosthetic joint infection, stiffness, and mechanical complications. There was no significant association between BMI and 1-year revision rates. It should be noted that the observed associations are relatively small, calling to question the utility of BMI in risk stratifying patients undergoing TSA procedures. These associations may become more important at the extremes of BMI (Figure 1, table 2), however, as BMI levels reach very low (<20) or very high (>50) values, confidence intervals widen as the population study decreases. This work may serve as a comparison for future studies when data is available that captures the increased transition to outpatient TSA procedures.

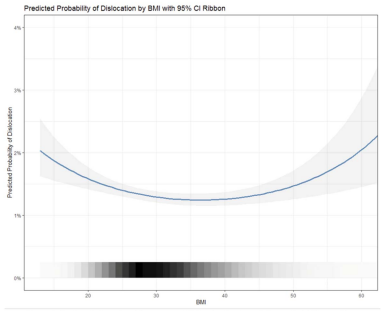

Figure 1: X-axis = Darker-colored bars represent higher density of population studied. Wider confidence intervals are denoted by larger spread of gray band.

Table 1: Patient Demographics and Incidence of Complication

n	124,716
Age (mean(SD))	70.20 (9.06)
Sex = *Male* (%)	53,404 (42.8)
Race (%)	
White/Caucasian	114,456 (92.1)
Black/African American	7,257 (5.8)
Asian	712 (0.6)
Other	1,907 (1.5)
Elixhauser Comorbidity Index (mean(SD))	3.55 (2.43)
Body Mass Index (mean(SD))	30.90 (6.67)
Body Mass Index Categories (%)	
Underweight (<18.5)	848 (0.8)
Healthy Weight (18.5-25)	22,469 (20.0)
Overweight (25-30)	36,660 (32.6)
Class I Obesity (30-35)	28,081 (25.0)
Class II Obesity (35-40)	14,647 (13.0)
Class III Obesity (>40)	9,818 (8.7)
DVT = *Yes* (%)	2,739 (2.2
PE = *Yes* (%)	1,910 (1.5)
UTI = *Yes* (%)	8,174 (6.6)
Superficial Surgical Infection = *Yes* (%)	963 (0.8)
Prosthetic Joint Infection = *Yes* (%)	1,135 (0.9)
AKI = *Yes* (%)	6,194 (5.0)
MI = *Yes* (%)	2,174 (1.7)
Revision = *Yes* (%)	1,968 (1.6)
Mechanical Complication = *Yes* (%)	1,389 (1.1)
Dislocation = *Yes* (%)	2,476 (2.0)
Periprosthetic Fracture = *Yes* (%)	742 (0.6)
Stiffness = Yes (%)	12,497 (10.0)
ED Visit = Yes (%)	35,073 (28.1)

Table 2: BMI ranges and predicted probabilities for dislocation

BMI	Predicted Probabilities (%)	95% Confidence Interval (%)
15	1.97	1.64 - 2.36
20	1.64	1.47 - 1.83
25	1.44	1.34 - 1.54
30	1.31	1.03 - 1.41
35	1.26	1.17 - 1.36
40	1.27	1.16 - 1.38
45	1.33	1.20 - 1.48
50	1.47	1.26 - 1.72
55	1.70	1.35 - 2.14
60	2.06	1.46 - 2.88
65	2.60	1.63 - 4.14
70	3.45	1.84 - 6.35