



Morbid obesity in total shoulder arthroplasty: risk, outcomes, and cost analysis

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Background: A rate of obesity in the US population and the rate of total shoulder arthroplasty (TSA) has increased over the past decade. Little information exists concerning the number of morbidly obese patients undergoing TSA or how these patients compare with their non-obese counterparts. The goal of this study was to determine whether morbidly obese patients exhibit greater rates of postoperative in-hospital complications, mortality, or utilization of resources.

Methods: We used the Nationwide Inpatient Sample to analyze 31,924 patients undergoing TSA between 1998 and 2008. Multivariate analysis with logistic regression modeling was used to compare patients based on body mass index for various outcomes.

Results: Among morbidly obese patients, predictors of death included age (odds ratio, 1.06; 95% confidence interval, 1.01-1.11) and Deyo score. A comparison of hospital costs among patients showed that increased patient body mass index led to increased hospital charges independent of physician charges (\$38,103.88 in morbidly obese patients vs \$33,521.66 in non-obese patients, $P = .0001$). An increased length of stay was observed in morbidly obese patients (2.84 days vs 2.52 days in obese patients and 2.56 days in non-obese patients, $P = .003$). Respiratory dysfunction occurred more commonly in morbidly obese patients than in non-obese patients (1.2% vs 0.7%; odds ratio, 1.61; $P < .01$).

Conclusions: Obese patients tend to have longer hospital stays, an increased risk of postoperative respiratory complications, and higher costs. Although there was a trend toward an increased early postoperative mortality rate, obesity was not associated with an increased incidence of most complications. These findings should be supplemented with further research to assist patient counseling and risk adjustment for obese patients undergoing TSA.

Level of evidence: Level III, Retrospective Cohort Study, Treatment Study.

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Keywords: Shoulder arthroplasty; morbid obesity; complications; length of stay; cost analysis

This study was exempt from institutional review board ethical committee approval. Research involving only the analysis of data from public datasets does not require University of Virginia Institutional Review Board approval or a determination of exempt status. Researchers may conduct this research without submitting an application or other materials to the Human Subjects Division.

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Obesity has become a major public health concern within the United States and across the globe. The incidence of obesity and specifically morbid obesity continues to rise.^{7,11} In addition to the increased incidence, the number of morbidly obese patients seeking elective joint surgery is on the rise.^{6,10,12,13} Approximately 33% of American men and 36% of American women are considered obese.⁵ Obesity is currently the fifth leading cause of

death, and morbid obesity is associated with greater mortality rates.⁵ Moreover, obesity accounts for a great deal of expenditures within health care. A body mass index (BMI) of 35 to 40 kg/m² is associated with an increase in healthcare expenditures when compared with non-obese patients.¹³

Furthermore, obesity has been identified as a risk factor in patients undergoing elective joint arthroplasty.^{2,3,12,14} Total shoulder arthroplasty (TSA) is common and on the rise, with nearly 27,000 TSAs and 20,000 hemiarthroplasties being performed in North America per year.⁸ The frequency of TSA has increased exponentially, with an ever-rising demand.⁸ Previous studies have documented increased complexity within postoperative care and lack of patient satisfaction within the morbidly obese population,¹⁰ as well as increased operative time after TSA procedures.⁹ Preoperative screening of patients for various perioperative and postoperative risk factors has become routine in many centers and may contribute to better patient selection and improved outcomes. Identifying expected outcomes is becoming more important as centers move toward pay-for-performance and value-based health care.

The objective of our study was to compare obese and non-obese patients undergoing TSA with regard to risk of in-hospital postoperative death, length of stay, complications, and postoperative charges on a large scale.

Methods

The Nationwide Inpatient Sample (NIS) is a survey of hospitals conducted by the federal Healthcare Cost and Utilization Project, which has been deemed statistically valid.¹ On the basis of a random inclusion of 20% of the nation's hospitals, the numbers from these hospitals are then weighted or extrapolated to produce national estimates. We used the NIS to identify a total cohort of 39,924 patients who underwent TSA in the United States between January 1, 1998, and December 31, 2008.

All intake and discharge data for the patients were recorded in the database. *International Classification of Diseases, Ninth Revision, Clinical Modification* codes were used to identify the procedure performed, namely TSA. Among the overall patient sample, 583 patients (1.8%) had a BMI of 40 kg/m² or greater and were classified as morbidly obese, 1,805 (5.7%) had a BMI between 30 kg/m² and 39 kg/m² and were classified as obese, and 29,536 (92.5%) had a BMI of 29 kg/m² or less. The mean patient age was 68.7 years, and 56% were female.

Postoperative complications were also identified using *International Classification of Diseases, Ninth Revision* codes as noted in Table I. From the database, the length of stay, as well as charges resulting from the inpatient stay, were calculated and compared. Data analysis was performed with SPSS software, version 19 (IBM, Armonk, NY, USA). The database includes in-hospital data only, and no preoperative data aside from diagnoses were available.

Logarithmic transformation within multivariate analysis by use of SPSS modeling was used to compare the risk-adjusted association between morbidly obese patients undergoing shoulder arthroplasty and those without the diagnosis of obstructive

sleep apnea (OSA). Each multivariate model used was adjusted for age, gender, and comorbidities by use of the Deyo score and reported as the odds ratio with respect to the 95% confidence interval.⁴ The Deyo score is a method of controlling for comorbidity within large populations. Independent *t* tests were performed between the likelihood of postoperative morbid events and mortality. Statistical significance was set at the $P < .01$ level.

Results

The mean age of patients undergoing shoulder arthroplasty was 68.8 years. This investigation highlights that among inpatients in the United States, the percentage of obese patients undergoing TSA was 7.5%, with 1.8% being classified as morbidly obese. Patients who were morbidly obese tended to seek shoulder replacement on average 4 years earlier (mean age, 64.9 years; SD for age, 9.1 years; $P = .0001$). Female patients made up 55% of patients within the 29,536 non-obese patients, whereas approximately 68.8% of the 583 morbidly obese patients were female ($P = .0001$). The percentage of black patients undergoing TSA was 10% in the morbidly obese group as compared with 2.6% in the obese group. The diagnosis of OSA was present in 5.1% of patients undergoing TSA in the overall cohort; however, OSA was present in 27% of morbidly obese patients as compared with 4% of patients in the non-obese group ($P = .0001$).

Patients who were morbidly obese (BMI ≥ 40 kg/m²) had an increased in-hospital mortality rate (0.2%) compared with both obese and non-obese patients (0.1%), but this did not reach statistical significance and is likely not clinically significant ($P = .680$). Overall mortality data were analyzed by use of regression analysis, and predictors of death with this model in the analyzed population included age (odds ratio, 1.06; 95% confidence interval, 1.01-1.11) and Deyo score (odds ratio, 1.32; 95% confidence interval, 1.15-1.51). The Deyo score is a method of controlling for comorbidity within large populations and confounders (Table I).

Data available within the NIS database include total charges for all patients regardless of payer status. Analysis of hospital charges was performed among groups of patients undergoing TSA. An increased patient BMI was noted to lead to increased hospital charges regardless of individual physician charges (\$38,103.88 in morbidly obese patients vs \$36,437.79 in obese patients and \$33,521.66 in non-obese patients, $P = .0001$) (Table I).

The length of stay increased linearly with increasing patient BMI. Patients who underwent TSA and were morbidly obese stayed in the hospital for a mean of 2.84 days compared with 2.52 days for obese patients and 2.56 days for non-obese patients undergoing TSA ($P = .003$). The number of in-hospital procedures was similar among groups (Table I).

An analysis of complications among the various patient groups showed several distinct differences in the number of in-hospital complications in morbidly obese patients.

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