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ORIGINAL ARTICLE

Complications in total shoulder and reverse total shoulder arthroplasty by body mass index

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Introduction: The purpose of this study was to identify the effects of body mass index (BMI) on long-term outcomes (revision rate, 1-year mortality rate, 3-year surgical site infection rate, and 90-day inpatient all-cause readmission rate) after total shoulder arthroplasty (TSA) and reverse TSA (RTSA).

Methods: A large shoulder arthroplasty registry was used to review outcomes after TSA and RTSA. The registry monitors patient's revision, mortality, infection, and readmission rates. The exposure of interest was the patient's BMI at the time of the surgery, which was stratified by 5 kg/m^2 increments.

Results: Selected for this study were 4630 patients who underwent TSA and RTSA between 2007 and 2013, of which 3483 (75.2%) were TSA and 1147 (24.8%) were RTSA. The overall combined (TSA and RTSA) revision rate was 1.7%. After adjusting for confounders in the overall models (TSA and RTSA combined), higher BMI was not associated with higher risk of aseptic revision, 1-year mortality, or 3-year deep infection. In TSA-specific models, every 5 kg/m^2 increase in BMI was marginally associated with a 16% increase in the likelihood of 90-day readmission. This association was not observed in the RTSA model. In RTSA-specific models, every 5 kg/m^2 increase in BMI was marginally associated with higher risk of 3-year deep infection. This association was not observed in the TSA model.

Conclusion: Shoulder arthroplasty in obese patients is not associated with higher risk of aseptic revision. The BMI has different effects on TSA and RSA. The surgeon should anticipate increased risk of readmission after TSA and infection after RSA.

Level of evidence: Level III; Retrospective Cohort Comparison using Large Database; Treatment Study

Keywords: Total shoulder arthroplasty; reverse shoulder arthroplasty; obesity; complications; infection; revision shoulder arthroplasty

Total shoulder arthroplasty (TSA) provides a reliable improvement in pain relief and function in a subgroup of patients with end-stage glenohumeral osteoarthritis and an intact rotator cuff.[7,12,29,42] In addition, with the introduction of the Grammont prosthesis in the 1980s, the popularity and acceptance of reverse TSA (RTSA) for the treatment of rotator cuff tear

The Kaiser Permanente Institutional Review Board Study approved this study (No. 5527).

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arthropathy has continued to increase.[4,11,27,31] The indications for RTSA have continued to grow and expand, and these implants are now commonly used for 3-part and 4-part proximal humeral fractures, patients with rheumatoid arthritis, pseudoparalysis, and in the setting of revision of failed TSA.[5,6,14,48] With the rapidly growing elderly population, there has been an exponential increase in the total number of shoulder arthroplasties performed in the United States.

As the incidence of shoulder arthritis and the need for shoulder arthroplasty continues to grow, so does the obesity epidemic in the United States. Obesity, defined as a body mass index (BMI) >30 kg/m^2 by the World Health Organization, has an estimated prevalence of 36% in the United States population.[13] The obesity epidemic is even more pronounced in the elderly population, where more than 70% of the elderly (age >60 years) are estimated to be overweight or obese.[32] Because the elderly population represents the bulk of patients undergoing elective TSA and RTSA, an understanding of the influence of obesity on the success, longevity, and safety of shoulder arthroplasty is critical.

There is ample evidence from the orthopedic hip and knee arthroplasty literature to suggest that obesity and increasing BMI have a deleterious effect on perioperative complications, infections, and revision rates.[1,20,21,30] In the last several years, interest has been growing in studying the effect of obesity and increased body habitus on the outcomes of shoulder arthroplasty. Several studies have evaluated predictors of early and late complications of shoulder arthroplasty in an attempt to determine whether certain comorbidities and patient characteristics predispose patients to early complications and failure.[7,16,35,37,45] Others have studied the outcomes of TSA and RTSA in patients with varying bone mass indices to determine whether the trends observed in the hip and knee arthroplasty literature can be extrapolated to patients undergoing shoulder arthroplasty.[2,17,22,23,26,33,38,46]

Although some studies have shown that severely obese (BMI >35 kg/m^2), morbidly obese (BMI >40 kg/m^2), and superobese (BMI >50 kg/m^2) patients have increased rates of complications and unsatisfactory results, others have shown contradictory results, concluding that TSA and RTSA are both safe and effective in the obese population. Recent shoulder arthroplasty literature attempting to determine the effect of obesity and BMI on outcomes and complications of TSA and RTSA is quite heterogeneous in its study design, patient cohort size, and specific outcome measures. Furthermore, most of the published studies focus on short-term complications occurring within 30 days of surgery, including acute blood loss anemia requiring transfusion, rate of atelectasis, acute renal insufficiency, dislocation rate in the early postoperative period, increased operative time, postoperative length of stay, and rate of discharge to home. Only a few studies have looked at long-term outcomes.

Given the lack of consensus in the current literature concerning the effect of patient size on complications and outcomes of shoulder arthroplasty, the purpose of this study was to identify the effects of BMI on long-term outcomes after TSA and RTSA in a large patient cohort recorded in our comprehensive shoulder registry. The primary outcome evaluated by 5 stratified BMI subgroups was the rate of revision, which was defined as any aseptic incidence of operation after a primary TSA or RTSA requiring replacement of any implant components. The secondary outcome measures assessed were (1) the 1-year mortality rate, (2) the 3-year deep surgical site infection (SSI) rate, and (3) the 90-day inpatient all-cause readmission rate. Potential confounders were considered to be (1) procedure type (TSA vs. TRSA), (2) patient age at the time of surgery (from 45 to 84 years), (3) gender, (4) prevalence of diabetes, and (5) American Society of Anesthesiologists (ASA) Physical Status Classification (I to IV), and were adjusted for in the overall outcome models.

Materials and methods

Study design, setting, and inclusion criteria

A prospective study was conducted in a large United States integrated health care system. The study included patients with a primary diagnosis of osteoarthritis, rotator cuff arthropathy, or rotator cuff tear who had undergone an elective TSA or RTSA between January 2007 and December 2013,. Patient age was limited to 45 to 85 years. Patients with fracture were excluded, as were patients with a concurrent diagnosis of malunion, nonunion, dislocation, failed open reduction and internal fixation, glenoid fracture, and postfracture arthritis.

Data source

The data for this study were provided by the shoulder arthroplasty registry from a large health care system with more than 9 million members. This registry was established in 2005 with a mission to track and improve the clinical practice and the quality of care for patients within the health system. The data extraction methods, quality control, and surgeon participation have been described.[34] Our shoulder arthroplasty registry used electronic operative forms to collect surgical and implant related data for all patients who underwent shoulder arthroplasty. The registry monitors the revision, mortality, infection, readmission, and other postoperative complications for each registered patient. Revisions and infections were further validated by specially trained clinical associates.

Exposure of interest, outcomes of interest, and confounders

The exposure of interest for this study was patients' BMI at the time of the surgery. BMI was calculated using the median of the patient's height and weight collected during each of the medical visits up to 1 year before the surgery. Two separate analyses were performed: a continuous variable model based on 5 kg/m^2 increments and a categoric model with the BMI grouped into 5 categories: <25 kg/m^2, 26-29 kg/m^2, 30-34 kg/m^2, 35-39 kg/m^2, and ≥40 kg/m^2.

The main outcome of interest was revision, which was defined as any aseptic incidence of operation after a primary TSA or RTSA that required replacement of any implant components. The secondary outcomes of interests were 1-year mortality, 3-year deep SSI,