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Complications of Morbid Obesity in Total Joint Arthroplasty: Risk Stratification Based on BMI

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ABSTRACT

This study stratifies complication risk in primary total joint arthroplasty (TJA) based on body mass index (BMI). Demographics, co-morbidities, perioperative variables, and complications were reviewed for 22,808 patients. Chi-squared, one-way ANOVA, univariate and multivariable regression analysis were performed. Increasing BMI led to an increase ($P < 0.05$) in combined complications, acute kidney injury (AKI), cardiac arrest (CA), reintubation, reoperation, and superficial infection (SI). Univariate analysis for BMI > 40 revealed an increase in combined complications (15.21-vs-17.40%), AKI (1.93-vs-3.87%), CA (0.22-vs-0.57%), reintubation (0.47-vs-0.95%), reoperation (2.36-vs-3.37%), and SI (0.82-vs-1.65%). Multivariable regression showed BMI > 40 as an independent predictor for combined complications (OR = 1.18), AKI (OR = 1.79), CA (OR = 3.94), reintubation (OR = 2.56), reoperation (OR = 1.44), and SI (OR = 2.11). Morbid obesity confers increased risk for complications in TJA.

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Obesity is a major epidemiologic health crisis for the United States and one of the most significant health challenges facing providers today. Over one third of adults and 17% of children in the United States were obese as of 2010, representing an exponential increase in the last two decades [1,2]. The effect of obesity on the spectrum of orthopedic disease is far-reaching, but most profound in osteoarthritis. The number of obese patients requiring total joint arthroplasty is increasing rapidly, patients are undergoing procedures at a younger age, and the burden of disease in the obese population presents orthopedic surgeons with unique challenges [3–5]. Outcomes in these patients have been consistently shown to be as good as in non-obese patients, however postoperative complications are of serious concern [6–18]. Within the changing healthcare landscape and an emphasis on cost-effective care it is imperative to determine the risk obesity confers with regard to surgical complications to best determine which patients are most appropriate to receive total joint arthroplasty and how to medically optimize and council these patients as they undergo surgery. Previous literature has found conflicting results regarding postoperative complications in obese patient undergoing total joint arthroplasty and there have been no large studies that stratify risk by obesity level [14,15,19–26]. The purpose of this paper is to risk stratify patients by degree of obesity using a large patient population from a comprehensive database.

Methods

The Veterans Affairs Surgical Quality Improvement Program (VASQIP) database was utilized after IRB approval was obtained (IRB #10-00859). The VASQIP is a national database using full-time specially trained nursing staff to extract precise information from VA medical charts. This database was chosen due to its accuracy and comprehensive record keeping related to quality control as well as its validity and verified applicability to the general population [27,28]. We examined all primary total joint arthroplasty patients in the Veterans Affairs Database from 2006 to 2009. Inclusion criteria were patients undergoing primary total hip (THA) and knee (TKA) arthroplasty for any reason. We excluded patients under 18 years of age and revision surgery. BMI was calculated using the standard formula of weight in kilograms divided by the square of height in meters. We removed patients for whom we did not have height and/or weight to calculate BMI. We examined our data and removed patients whose BMI was at such an extreme as to indicate a coding or reporting error based on outlier values which were patients with a BMI <13 and >66.

We recorded basic demographic variables including gender, age, and race. We examined intraoperative variables including operative time, transfusion rate, type of anesthesia (spinal or epidural versus general) and postoperative variables included hospital length of stay (LOS), location of discharge (discharged home or to another facility), and complications. Postoperative complications included, major acute kidney injury (Cr > 200% of normal), cardiac arrest, myocardial Infarction, stroke, death within one year, joint infection, sepsis, pneumonia, pulmonary embolism, need for reintubation, reoperation for any reason, superficial wound infection, urinary tract infection, and deep vein

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thrombosis. All complications were recorded up to 30 days from surgery (with the exception of death within one year). We examined co-morbidities and age > 75 for multivariable regression analysis. Co-morbidities included congestive heart failure, history of cerebrovascular accident, hyperbilirubinemia, chronic obstructive pulmonary disease, renal failure requiring dialysis, alcohol consumption > 2 drinks/day, ascites, hypertension requiring medication, American Society of Anesthesiologists (ASA) Score 3 or 4, orally controlled diabetes, insulin controlled diabetes, coronary artery disease, history of bleeding disorder, current smoker, current steroid use, low preoperative albumin, history of peripheral vascular disease, and preoperative leukocytosis [29].

We examined all preoperative, intraoperative, and postoperative variables stratified by obesity level by BMI in accordance with World Health Organization criteria. This was done using Chi-squared analysis for mean values and one-way ANOVA for continuous values. We then re-stratified the data in several ways including comparing obese and non-obese, as well as obesity levels via linear order by BMI divisions of 5. We then calculated a Youden's coefficient to confirm the best cutoff to optimize sensitivity and specificity and re-examined our data in a univariate analysis using this cutoff (BMI > 40). We examined this data with and without patients who were underweight (BMI < 18.5) due to the high complication rate observed in these patients. Re-calculation of the Youden's coefficient and final analysis was done excluding underweight patients in order to eliminate this group as a confounding factor. Univariate analysis was done using Student's t-test. Multivariable regression analysis was done using BMI > 40 and patient co-morbidities as well as age > 75. We also calculated a receiver operator characteristic curve for BMI and compared it to age and the Charlson Comorbidity Index [30]. STATA was used for all data analysis (StatCorp, College Station, TX 2011).

Results

After exclusions the database yielded 22,808 primary total joint arthroplasty patients for review. This included 7360 (32.3%) total hip arthroplasties and 15,448 (67.7%) total knee arthroplasties. There were relatively few women (n = 1139, 4.99%) in our population as was expected given the data source. Overall there were 12,148 (53.22%) patients with a BMI > 30. This included 5066 patients with a BMI > 40 (22.19%). Only 76 patients (0.33%) had a BMI < 18.5. Patients receiving TKAs tended to be slightly heavier.

Examining patients by age at time of surgery we found a significantly younger age at time of surgery for both TKA patients and THA patients as BMI increased. Although the difference was larger for TKA patients with age decreasing as BMI increased, overall TKA patients were slightly older than THA patients in every category. We found a significant increase in operative time for both THA and TKA patients. This difference was much larger for THA than for TKA with the overall average difference between normal weight and the morbidly obese patients constituting 32 minutes for THA patients and only 7 minutes for TKA patients. There was no difference in type of anesthesia between BMI groups. Less than 1% of any TKA patients received an intraoperative transfusion and there was no trend toward increasing transfusion rates with increasing BMI for TKA patients. There was a slight trend toward increased intraoperative transfusions for THA patients however the rate for any group was low (<2%). There was no significant difference in length of stay as BMI increased, however there was a trend for patients to be discharged to another facility instead of home as their BMI increased and this was particularly true for TKA patients.

When all complications were combined there was a statistically significant increase in complications as BMI increased ($P = 0.047$). The overall increase in complication rates between the normal weight and obese groups in any category was relatively small (less than 3% for any group) until the BMI was over 50 (Fig. 1). Examining individual complications by BMI we found significant trends for major acute kidney injury ($P = 0.000$), cardiac arrest ($P = 0.001$), reintubation ($P = 0.006$), reoperation ($P = 0.043$), superficial infection ($P = 0.026$), and death within one year ($P = 0.000$) as seen in Fig. 2. There was no trend for joint infection, pulmonary embolism, myocardial infarction, readmission, pneumonia, sepsis, stroke, deep vein thrombosis, or urinary tract infections.

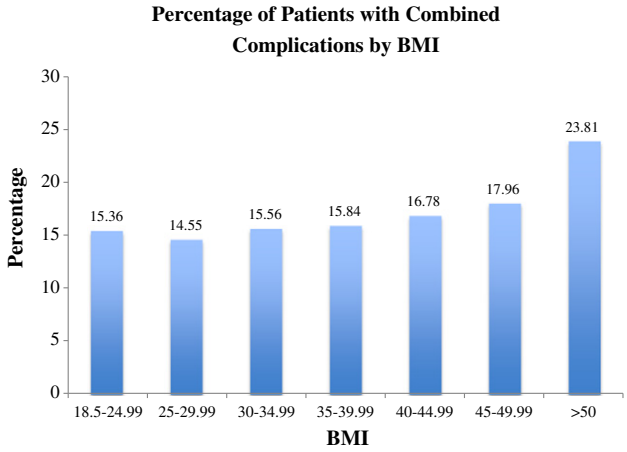

Fig. 1. Percentage of patients with all combined complications as stratified by BMI in categories of 5.

Univariate analysis comparing patients with BMI 18.5 to 40 and patients with a BMI > 40, for all combined complications and mortality revealed a 2.19% increase for patients with a BMI > 40 (17.4% versus 15.21%) and this difference was statistically significant ($P = 0.021$). Univariate analysis by all individual complications revealed significant differences with increased complications for patients with a BMI > 40 for major acute kidney injury (1.93% vs 3.87%, $P = 0.000$), cardiac arrest (0.22% vs 0.57%, $P = 0.007$), death within one year (0.41% vs 0.83%, $P = 0.017$), need for reintubation (0.47% vs 0.95% $P = 0.009$), reoperation (2.36% vs 3.37%, $P = 0.013$), and superficial infection (0.82% vs 1.65%, $P = 0.001$) as seen in Fig. 3. There was no significant difference for joint infection, stroke, myocardial infarction, pulmonary embolism, deep vein thrombosis, pneumonia, systemic sepsis, readmission or urinary tract infections.

Multivariable regression analysis showed BMI > 40 to be an independent predictor for combined complications (OR 1.18, CI 1.02 to 1.36), major acute kidney injury (OR 1.79, CI 1.27 to 2.53), cardiac arrest (OR 3.94, CI 1.87 to 8.3), death within one year (OR 2.46, CI 1.34 to 4.52), reintubation (OR 2.56, CI 1.44 to 4.56), reoperation (OR 1.44, CI 1.07 to 1.93), and superficial infection (OR 2.11, CI 1.39 to 3.21). Many other comorbidities examined were also independent predictors of complications, often with higher odds ratios than a BMI > 40 as shown in Fig. 4. Calculating a receiver operator curve for BMI revealed the area under the curve to be 0.53. This was lower than age (0.55) or the Charlson Index (0.62).

Discussion

Obesity has become a major issue for orthopedic surgeons, particularly for procedures related to osteoarthritis. While we conclude that there is no specific cutoff for BMI and safe surgery for total joint arthroplasty, it is important to recognize that there is an increased rate of complications as BMI increases and that morbid obesity is an independent predictor of complications. It is also equally important to recognize, given that obese and morbidly obese patients can have excellent outcomes after TJA, that the absolute risk difference for complications is relatively low as is the odds ratio for independent risk.

A great deal of literature has been published attempting to determine outcomes and complications in the obese patients. In general, outcomes are good, even for the morbidly obese. McCalden, et al, noted WOMAC, HHS, and SF-12 scores actually improved the most in this group for 3290 patients undergoing primary THA with an average