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Original Article

The Impact of Metabolic Syndrome on 30-Day Complications Following Total Joint Arthroplasty

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ABSTRACT

Background: The arthroplasty population increasingly presents with comorbid conditions linked to elevated risk of postsurgical complications. Current quality improvement initiatives require providers to more accurately assess and manage risk presurgically. In this investigation, we assess the effect of metabolic syndrome (MetS), as well as the effect of body mass index (BMI) within MetS, on the risk of complication following hip and knee arthroplasty.

Methods: We queried the American College of Surgeons National Surgical Quality Improvement Program database for total hip or knee arthroplasty cases. Thirty-day rates of Centers for Medicare and Medicaid Services (CMS)-reportable complications, wound complications, and readmissions were compared between patients with and without a diagnosis of MetS using multivariate logistic regression. Arthroplasty cases with a diagnosis of MetS were further stratified according to World Health Organization BMI class, and the role of BMI within the context of MetS was assessed.

Results: Of the 107,117 included patients, 11,030 (10.3%) had MetS. MetS was significantly associated with CMS complications (odds ratio [OR] = 1.415; 95% confidence interval [CI], 1.306-1.533; $P < .001$), wound complications (OR = 1.749; 95% CI, 1.482-2.064; $P < .001$), and readmission (OR = 1.451; 95% CI, 1.314-1.602; $P < .001$). When MetS was assessed by individual BMI class, the MetS + BMI >40 group was associated with significantly higher risk of CMS complications, wound complications, and readmission compared to the lower MetS BMI groups.

Conclusion: MetS is an independent risk factor for CMS-reportable complications, wound complications, and readmission following total joint arthroplasty. The risk attributable to MetS exists irrespective of obesity class and increases as BMI increases.

Interest in improving quality and controlling cost in the US health-care sector has led to a push for more accurate understanding of how presurgical conditions impact the results of surgical interventions [1-3]. In the domain of total joint arthroplasty (TJA), efforts have been made to improve outcomes by addressing modifiable risk factors before surgery [4-7]. Obesity and body mass index (BMI) have been among the most intensely scrutinized risk factors, and studies have shown that elevated BMI is an independent risk factor for complications, readmissions, and poor functional outcomes following arthroplasty [8-11]. These findings led a recent workgroup of the American Association of Hip and Knee Surgeons to recommend that surgeons consider delaying arthroplasty for patients with a BMI >40 [12].

A focus on the role of obesity is well founded, as the burden of obesity in the US arthroplasty population is growing at an alarming rate, with a greater than 2.5-fold increase in the rate of obesity among Medicare arthroplasty patients since 1991 [13]. This rise in obesity has been accompanied by a near doubling in the rate of total comorbid conditions [13]. In order to make informed decisions

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regarding risks of surgery, the relative contribution to risk of elevated BMI must be considered in the context of the overall burden of medical illnesses present.

A constellation of medical conditions known as metabolic syndrome (MetS) often arises in obese patients as a result of endocrine dysfunction. Factors germane to a diagnosis of MetS include dyslipidemia, hypertension, abnormal fasting glucose, and visceral obesity [14]. In several surgical conditions, MetS has been shown to contribute significant additional postsurgical risk beyond that attributable to obesity. However, investigations that assess the impact of MetS in arthroplasty have been mostly limited to single-center case series, and little data is available assessing the role of obesity within the context of MetS [15]. Here, we aim to assess the impact of MetS as well as the effect of obesity within MetS on 30-day complication and readmission rates following TJA using the ACS-NSQIP dataset.

Methods

Data Acquisition and Definitions

Data were acquired from the American College of Surgeon's National Surgery Quality Improvement Program (ACS-NSQIP). In brief, the program consists of over 450 surgery centers, ranging from small community practices to urban academic hospitals. Data are collected through clinical nurse reviewers; these are highly trained, independent reporters designated and employed by NSQIP itself. The program provides reliable data that have been validated multiple times and used extensively in orthopedic research [16,17]. Using the Current Procedural Terminology (CPT) codes 27447 (total knee arthroplasty [TKA]) and 27130 (total hip arthroplasty [THA]), all patients who underwent primary TKA or THA were identified from the 2011-2014 NSQIP Participant User Files. Exclusion criteria were as follows: bilateral or concomitant procedures, surgical diagnosis other than osteoarthritis, cases with missing data, and patients designated as American Society of Anesthesiologist (ASA) class 5.

Using the precedent set by Bhayani et al [18], MetS was defined by the presence of all 3 of the following: BMI >30 kg/m^2, hypertension, and diabetes. Patients that met diagnostic criteria for MetS were further stratified based on World Health Organization BMI classes. Thus, patients were divided into 4 categories: no MetS, MetS + BMI 30-35, MetS + BMI 35-40, and MetS + BMI >40.

Outcomes of interest were chosen based on the quality measures in use at the Centers for Medicare and Medicaid Services (CMS) [19]. After hip or knee replacement, CMS mandates the public reporting of complications including myocardial infarction, pneumonia, sepsis/septicemia/shock, surgical site bleeding, pulmonary embolism, death, mechanical complications, and joint/wound infection. Furthermore, CMS requires public reporting of readmission after THA/TKA. Thus, outcomes of interest for this investigation included readmission as well as any reportable complication, specifically myocardial infarction, pneumonia, sepsis/septic shock, bleeding transfusion, pulmonary embolism, death, prosthesis failure, superficial surgical site infection, deep surgical site infection, and wound dehiscence. “Bleeding transfusion” was defined as “at least 1 unit of packed or whole red blood cells given from the surgical start time up to and including 72 hours postoperatively” [20]. Readmission was defined as “any unplanned readmission (to the same or another hospital) for a postoperative occurrence likely related to the principal surgical procedure” [20]. All outcomes were recorded for 30 days after surgery.

Statistical Analysis

Patients were stratified into MetS and no MetS cohorts. The MetS cohort was further stratified into World Health Organization BMI classes. Comparisons were first made between the no MetS cohort and the MetS cohort. Pearson's chi-square (Fisher exact test when appropriate) and analysis of variance tests were used to compare categorical and continuous variables, respectively. Multivariate logistic regression models were generated for each outcome of interest (CMS complications, wound complications, and readmission) and used to control for baseline differences in the cohorts. Wound complications were also examined by procedure type. The following factors were screened for inclusion in each model: age class, gender, race, congestive heart failure in the past 30 days, chronic steroid use, dyspnea, smoking status, kidney disease (preoperative creatinine $\geq$2.0 mg/dL or patients on dialysis), preoperative hematocrit $\leq$33% [21], preoperative platelets <150,000/μL, type of surgery, and mode of anesthesia. Covariates with an association of $P < .2$ and an event occurrence of 10 or more were included in the model [22]. Hosmer-Lemeshow tests were used to assess the goodness of fit of each model. Post hoc pairwise comparisons were then made in similar fashion between the no MetS, MetS + BMI 30-35, MetS + BMI 35-40, and MetS + BMI >40 cohorts. All analyses were run at a type I error rate of 5%; Bonferroni corrections were used to adjust α for post hoc pairwise comparisons. SPSS version 22 (IBM, Armonk, NY) was used to run all statistical tests.

Results

After application of exclusion criteria, 107,117 patients were available for the study. Criteria for MetS were met by 10.3% (11,030) patients. MetS was associated with increased risk of CMS complications (odds ratio [OR] = 1.415; 95% confidence interval [CI], 1.306-1.533; $P < .001$), wound complications (OR = 1.749; 95% CI, 1.482-2.064; $P < .001$), and readmission (OR = 1.451; 95% CI, 1.314-1.602; $P < .001$).

Of those with MetS, 4174 (37.8%) had a BMI of 30-35; 3462 (31.4%) had a BMI 35-40; and 3394 (30.8%) had a BMI 40 or greater. Patient demographics, comorbidities, and laboratory values varied significantly among cohorts (Table 1); only chronic steroid use was not significantly different ($P = .267$). Of note, the ratio of TKA to THA surgery type was higher TKA in patients with MetS than those without MetS (no MetS: 60%; MetS + BMI 30-35: 71%; MetS + BMI 35-40: 74%; MetS + BMI 40+: 79%; $P < .001$).

Rates of any reportable CMS complication (Table 2) were highest in the MetS BMI >40 cohort (MetS + BMI >40: 7.8%; MetS + BMI 35-40: 6.1%; MetS + BMI 30-35: 7.2%; no MetS: 5.0%; $P < .001$). After adjusting for baseline differences between the cohorts (Table 3), MetS + BMI >40 was found to have the strongest independent association with a reportable CMS complication (OR, 1.71; 95% CI, 1.50-1.95). MetS + BMI 30-35 and MetS + BMI 35-40 were also found to be associated with CMS complications (OR, 1.36; 95% CI, 1.20-1.53 and OR, 1.23; 95% CI, 1.06-1.42, respectively). Post hoc pairwise comparisons revealed that the MetS + BMI >40 group had a significantly greater association with CMS complications compared to the MetS + BMI 30-35 group ($P = .009$) and the MetS + BMI 35-40 group ($P = .001$).

Wound complication rates increased with BMI in the MetS cohort (MetS + BMI >40: 2.2%; MetS + BMI 35-40: 1.4%; MetS + BMI 30-35: 1.3%; no MetS: 0.9%; $P < .001$). The adjusted analysis found that patients with MetS + BMI >40 were most strongly associated with wound complications (OR, 2.46; 95% CI, 1.93-3.13). MetS + BMI 30-35 and MetS + BMI 35-40 were also associated with wound complications (OR, 1.38; 95% CI, 1.05-1.83 and OR, 1.51; 95% CI, 1.13-2.03, respectively); however, the association of MetS + BMI 30-35 with wound complications did not reach significance on post hoc pairwise testing when the Bonferroni correction was applied ($P = .023$). Post hoc pairwise comparisons