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Comparison of Perioperative Adverse Event Rates After Total Knee Arthroplasty in Patients With Diabetes: Insulin Dependence Makes a Difference

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ABSTRACT

Background: Total knee arthroplasty (TKA) is an effective treatment option for patients with advanced osteoarthritis and has become one of the most frequently performed orthopedic procedures. With the increasing prevalence of diabetes mellitus (DM), the burden of its sequela and associated surgical complications has also increased. For these reasons, it is important to understand the association between DM and the rates of perioperative adverse events after TKA.

Methods: A retrospective cohort study was conducted using the American College of Surgeons National Surgical Quality Improvement Program database. Patients who underwent TKA between 2005 and 2014 were identified and characterized as having insulin-dependent DM (IDDM), non–insulin-dependent DM (NIDDM), or not having DM. Multivariate Poisson regression was used to control for demographic and comorbid factors and to assess the relative risks of multiple adverse events in the initial 30 postoperative days.

Results: A total of 114,102 patients who underwent TKA were selected (IDDM = 4881 [4.3%]; NIDDM = 15,367 [13.5%]; and no DM = 93,854 [82.2%]). Patients with NIDDM were found to be at greater risk for 2 of 17 adverse events studied relative to patients without DM. However, patients with IDDM were found to be at greater risk for 12 of 17 adverse events studied relative to patients without DM.

Conclusion: In comparison with patients with NIDDM, patients with IDDM are at greater risk for many more perioperative adverse outcomes relative to patients without DM. These findings have important implications for patient selection, preoperative risk stratification, and postoperative expectations.

Total knee arthroplasty (TKA) is one of the most commonly performed orthopedic procedures in the United States (US), and the number of TKAs performed in the US per annum continues to increase [1–4]. Concurrently, the prevalence of diabetes mellitus (DM) in the US is also increasing [5–7], and the effects of DM on surgical outcomes have become a greater focus as surgeons explore all avenues to optimize patient outcomes. In 2009, 20% of the patients in the Nationwide Inpatient Sample had DM [8], and 19% of the patients in the Kaiser Permanente Total Joint Replacement Registry had DM [9].

Patients with DM have been found to have a greater risk of complications than patients without DM following many orthopedic procedures [10–13]. In particular, previous retrospective studies have found that, relative to patients without DM, those patients with DM who underwent TKA had greater rates of mortality [14], surgical site infections [1,15–19], and periprosthetic joint infections [20,21]. Patients with DM were also more likely to be discharged to a location other than home [22] and to be readmitted to hospital [23]. Patients with DM were also more likely to

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experience aseptic loosening [24], persistent pain in the operated joint [25], and revision arthroplasty within 5 years [26]. In addition, patients with DM also had poorer functional outcomes [27] and higher resource utilization following total joint arthroplasty [10].

However, the aforementioned studies have generally categorized patients as either those with DM or those without DM. In doing so, prior studies may not have detected important differences among patients with DM that may be useful as predictors of adverse events. For example, a recent study evaluating the effect of diabetes on outcomes after lumbar fusion found that those with insulin-dependent DM (IDDM) were at a greater risk for many more perioperative adverse events than patients with non–insulin-dependent DM (NIDDM) [11].

The primary purpose of the present study is to use the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database to assess the relative risk (RR) of adverse events after TKA in patients with IDDM and NIDDM in comparison with patients without DM. This information may be useful for patient selection, preoperative risk stratification, and postoperative expectations.

Materials and Methods

Patient Cohort

The NSQIP database gathers patient data from 517 participating hospitals in the US. Trained clinical reviewers collect data during the entire 30-day postoperative period regardless of hospital discharge, and data are deidentified before being shared with participating institutions [28,29]. Our institutional review board granted an exemption for studies using this data set.

Patients who underwent TKA were identified using *Current Procedural Terminology* code 27447. Trauma and revision cases were excluded from this study. Demographic variables available from the NSQIP database include patient age, gender, height, weight, and smoking status (current smoker within 1 year). Body mass index (BMI) was calculated using patients' height and weight.

The NSQIP database records one of 3 possible DM statuses for each case. Patients are either those who require daily insulin therapy to treat their DM (IDDM), those who use noninsulin pharmacologic agents (NIDDM), or patients who do not have DM. Patients who do not have DM either do not have insulin resistance or hyperglycemia or are using diet and/or lifestyle modifications alone to control hyperglycemia.

For each case, a comorbidity score was calculated using a modified version of the Charlson comorbidity index (CCI) [30] that has been adapted to the NSQIP database [31,32]. Studies have demonstrated that such modified CCIs predict similar prognoses as the original CCI [33,34]. The comorbidities used to determine the modified CCI include (followed by their CCI point values) myocardial infarction (MI) within the 6 months before surgery (1), congestive heart failure (1), peripheral vascular disease or rest pain (1), any history of transient ischemic attack or cerebrovascular accident (1), chronic obstructive pulmonary disease (1), diabetes mellitus (1), hemiplegia (2), end-stage renal disease (2), ascites or esophageal varices (3), and disseminated cancer (6). To calculate the CCI for a given case, these point values are summed and an additional point is added for each age decade age >40 years. Although DM is included as a comorbid condition in the original CCI, it was removed from the modified CCI calculation for the present study because DM is the comorbidity that this study investigates.

Perioperative Outcomes and Readmission

The NSQIP database tracks patients for the occurrence of individual adverse events during the first 30 postoperative days [35]. In the present study, pulmonary embolism and deep vein thrombosis were considered together as "thromboembolic event," superficial surgical site infection, deep wound infection, and organ space infection were considered together as a "wound-related infection," and sepsis and septic shock were also considered together.

Postoperative length of stay (LOS) and readmission are also directly reported in the NSQIP database. LOS is defined as the number of days from the operation date until discharge. Readmission is defined as any admission for any reason that occurs after discharge and within 30 days of surgery. Almost most postoperative variables in the NSQIP database are only reported if they occur within the first 30 days, postoperative LOS is reported beyond 30 days. However, to limit the influence of outliers, this study considered patients with postoperative LOS longer than 30 days to have had postoperative LOS equal to 30 days. LOS was considered to be extended if the stay lasted longer than 1 standard deviation (1.8 days) longer than the mean (3.2 days) of all hospital stays in the cohort. For this reason, any LOS longer than 5 days was considered to be extended.

The occurrence of readmission within 30 days of surgery is reported in the NSQIP database for cases that occurred in 2011 or later, but not for earlier cases. Hence, the analysis of readmission includes only 99,508 of 114,102 cases, but this represents 87.2% of all cases included in this study.

Data Analysis

Statistical analyses were performed using STATA, version 13 (StataCorp LP, College Station, TX). Statistical significance was set at a 2-sided alpha level of 0.05, but because the chance of finding one or more spurious significant differences in 17 tests is 58.2%, the level of significance for comparisons of adverse event rate for each of these 17 adverse events was adjusted to 0.003 according to Bonferroni correction [36]. Likewise, instead of reporting 95% confidence intervals (CIs) of these RRs, 99.7% CIs are reported in this study. Demographics were compared among patients with NIDDM, those with IDDM, and those without DM using Pearson chi-squared tests.

Adverse event rates were compared between patients with NIDDM or IDDM relative to those without DM using Poisson regression with robust error variance. These multivariate analyses adjusted for the demographics of age (15-54, 55-64, 65-74, ≥75 years), gender, BMI (18-24, 25-29, 30-34, and ≥35 kg/m^2), CCI, and smoking status to control for potential confounders. Poisson regression with robust error variance was used as an alternative to logistic regression so that the strengths of association could be reported as RRs rather than odds ratios [37,38].

Results

In total, 114,102 patients who underwent TKA between the years 2005 and 2014 were identified in the NSQIP database. Of these, 15,367 patients (13.5%) had NIDDM, 4881 patients (4.3%) had IDDM, and 93,854 patients (82.2%) did not have DM.

Table 1 presents the differences in demographics of patients with NIDDM, patients with IDDM, and patients without DM. Patients with NIDDM, with IDDM, or without DM were different in their distribution of ages ($P < .001$). Patients with NIDDM or IDDM were more likely to be male ($P < .001$). Patients with IDDM were