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Total Knee Arthroplasty for Posttraumatic Osteoarthritis: Is it Time for a New Classification?

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ABSTRACT

Background: Total knee arthroplasty (TKA) is often the best answer for end-stage, posttraumatic osteoarthritis after intra-articular and periarticular fractures about the knee. Although TKA in this setting is often considered more technically demanding, outcomes are typically worse for patients. This study examines the intraoperative differences and 30-day outcomes in posttraumatic vs primary TKA cohorts.
Methods: Patients undergoing TKA were selected from the National Surgical Quality Improvement Program database from 2010 to 2013. Patients were stratified on the basis of concurrent procedures and administrative codes indicating posttraumatic diagnoses. Thirty-day complications were recorded, and multivariate analyses were performed to determine whether posttraumatic arthritis was a risk factor for poor outcomes.
Results: A total of 67,675 primary and 674 posttraumatic TKAs were identified. Posttraumatic TKA patients were on average younger and healthier than the primary TKA population. The posttraumatic TKA group had higher rates of superficial surgical site infections and bleeding requiring transfusion. History of posttraumatic knee osteoarthritis was found to be an independent risk factor for prolonged operative time, increased length of hospital stay, and 30-day hospital readmission.
Conclusion: We have demonstrated increased intraoperative times, heightened transfusion requirements and surgical site infections, and higher readmission rates after conversion TKA in the posttraumatic cohort. In contrast to total hip arthroplasty, current diagnosis and reimbursement schemes do not differentiate posttraumatic patients from primary osteoarthritis groups undergoing TKA. We believe that classification reform would improve medical documentation and improve patient care.

Distal femur and proximal tibia fractures account for a significant proportion of orthopedic trauma [1,2]. Considering the multitude of operative and nonoperative management options, these injuries also have a wide range of outcomes [3,4]. As high as 75% of patients with intra-articular and periarticular knee fractures can be expected to develop posttraumatic osteoarthritis of the knee [5-7], and end-stage osteoarthritis typically develops within 7 years of the sentinel injury [8,9]. Sequela including nonunion, malalignment, and inadequate reduction or fixation are a few of the risk factors for accelerated arthritic change [10-12]. One option for the definitive treatment of end-stage, posttraumatic osteoarthritis is total knee arthroplasty (TKA).

TKA on the posttraumatic knee presents a number of technical considerations [13-15]. Residual malalignment, scar tissue, stiffness and reduced range of motion, a compromised soft tissue envelope secondary to the initial trauma, retained hardware, and secondary osseous deficiency represent a few of the technical challenges encountered while performing TKA on a posttraumatic knee [16-18]. Although the operation may be protracted because of difficult exposures and concurrent procedures, multiple peer-reviewed studies have demonstrated higher complication rates and worse outcomes in this setting [13,17,19]. However, in contrast to conversion total hip arthroplasty, current procedural classifications do not differentiate complex posttraumatic cases from primary TKA [20,21]. Irrespective of procedural risk, such cases are

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coded and bundled as primary TKA although the complexities, outcomes, and resource utilization may more closely resemble revision rather than primary arthroplasty.

Multiple single-institution studies have evaluated complications of TKA in the posttraumatic knee [13-15,19,22,23], and a recent study evaluated Medicare administrative data for the same purpose [24]. However, no study has used a large multi-institutional, patient-specific data set to analyze intraoperative variables, risk-adjusted outcomes, or 30-day hospital readmissions. The primary purpose of this study was to use the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) to assess these factors. Specifically, we aim to (1) compare the preoperative and intraoperative differences and (2) analyze the 30-day postoperative outcomes of TKA on posttraumatic knees. In addition, we aim to (3) determine whether the posttraumatic knee is an independent risk factor for medical and surgical complications in this patient group.

Methods

Data Source

Patients participating in the ACS NSQIP were examined [25]. The structure of the ACS NSQIP has been described previously [25-29]. In short, the program prospectively collects detailed data regarding patient demographics, preoperative comorbidities, laboratory values, and specific operative variables. Patients are then followed for 30 days after the index operation, and postoperative complications are collected regardless of whether the patient is an inpatient, has been discharged to their home or other facility, or has been readmitted to another hospital. Data are abstracted at each site by surgical certified reviewers using clinical records, physician charts, and by contacting patients directly. Surgical certified reviewers are intensively trained with continuing education courses to standardize data collection. Data definitions are rigorous and standardized across all participating institutions. Data consistency and reliability are assessed at each hospital through an on-site interrater reliability audit program [28].

Patient Selection and Exclusion

Patients who underwent primary TKA were identified using Current Procedural Terminology (CPT) codes from January 1, 2010, to December 31, 2013 (CPT 27447, Arthroplasty, knee, condyle and plateau; medial and lateral compartments with or without patellar resurfacing). Posttraumatic patients were further identified according to International Classification of Disease 9 diagnostic groups and concurrent CPT coding (Appendix A). All cases with "prior operations in the last 30 days" were deleted to evaluate complications only associated with the primary procedure. Any cases with missing or "null" preoperative variables were also excluded. In addition, cases involving unicompartmental arthroplasty, revision arthroplasty, unspecified site of concurrent operations, pathologic fractures, inflammatory arthropathies, and osteogenesis imperfecta were excluded (Appendix B).

Preoperative Variables

Preoperative demographics, comorbidities, and 30-day complications were compared between the 2 data sets. Demographics included age, gender, height, weight, and body mass index (BMI). Comorbidities included history of myocardial infarction, smoking, diabetes, dyspnea, ventilator requirement, history of severe chronic obstructive pulmonary disease, congestive heart failure, dialysis, disseminated cancer, chronic steroid use, >10% weight loss 6 months before surgery, bleeding disorders, hypertension requiring antihypertensive medications, preoperative sepsis, and American Society of Anesthesiologists physical status classification.

Outcomes

Postoperative variables included operative time, anesthesia time, hospital length of stay, and 30-day reoperation and readmission rates. Postoperative complications encompassed major medical complications, minor medical complications, and surgical site complications. Major medical complications were defined as death, sepsis, ventilator use >48 hours, unplanned reintubation, deep venous thrombosis, pulmonary embolism, and myocardial infarction. Minor medical complications included bleeding requiring transfusion, pneumonia, renal insufficiency, and urinary tract infection. Surgical site complications included prosthesis failure, superficial surgical site infection (SSI), open wound/wound infection, deep SSI, organ-space infection, and wound disruption. Postoperative transfusion involved bleeding that required at least 1 unit of transfusion. All variables were used as defined in the ACS NSQIP user guide [30].

Statistical Methods

SPSS Statistics version 22 (IBM, Armonk, NY) was used to perform all analyses in this study. In all cases, a P value of $\leq$.05 was deemed statistically significant. Univariate analysis with Fisher's exact test was used to compare categorical preoperative variables. The independent-samples t test assuming equal variances was used to compare continuous operative details between the 2 procedures. To demonstrate whether prior intra-articular fracture or posttraumatic arthritis was independently associated with higher risk of complications, multivariate regression analyses were performed. Candidate preoperative variables for each regression were screened from those with $P < .2$ and at least 5 incidences in each of the cohorts from our previous univariate analysis [31]. Hosmer-Lemeshow and c-statistics were calculated to assess the calibration and goodness of fit of the model, respectively [32].

Results

Out of 67,675 TKAs performed during the study period, 674 (1.0%) were posttraumatic cases. There were significant differences in the demographics and preoperative characteristics between the posttraumatic and control groups (Table 1). The posttraumatic group included a higher percentage of male patients ($P < .001$), was younger ($P < .001$), and had a lower BMI ($P < .001$) than the baseline TKA group. In addition, the posttraumatic group had fewer comorbidities including a lower percentage of patients with insulin-dependent diabetes mellitus ($P = .026$), hypertension requiring medications ($P < .001$), and American Society of Anesthesiologist class >3 ($P < .001$), despite having a slightly higher rate of patients on hemodialysis ($P = .015$).

Postoperative complications were different between study groups (Tables 2-3). There was no statistically significant difference in major medical complications ($P = .942$), but minor medical complications were more common after TKA on posttraumatic knees ($P < .001$). The only significant complication was bleeding requiring transfusion ($P < .001$). Surgical site complications were overall increased ($P = .004$). Superficial SSIs ($P = .009$) were more common in the posttraumatic group, although deep SSIs and wound disruptions were equivalent. Notably, there were marked differences in perioperative variables between posttraumatic TKA and standard primary TKA groups. Average operative times were longer by 26.7 minutes ($P < .001$), anesthesia times were longer by