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Outcomes, complications, utilization trends, and risk factors for primary and revision total elbow replacement

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Background: Using a validated database, 30-day complications of primary and revision total elbow arthroplasty (TEA) were analyzed to identify risk factors of adverse events.

Methods: Primary and revision TEAs from 2007 to 2013 were identified in the National Surgical Quality Improvement Program database. Bivariate and multivariate analyses of risk factors for 30-day adverse events were assessed using preoperative and intraoperative variables.

Results: The study reviewed 189 primary and 53 revision TEA patients. Fracture (34%), osteoarthritis (24%), and rheumatoid arthritis (23%) were the most common indications for TEA. Adverse event rate was similar in primary and revision TEA (12% vs. 15%; $P = .49$), and infectious complications occurred in 3.2% of primary TEAs and 7.5% of revision TEAs ($P = .23$). Bivariate analysis of risk factors for 30-day adverse events identified dependent functional status in primary TEA ($P = .03$) and age in revision TEA ($P = .02$). Multivariate analysis of primary TEA revealed that adverse events were significantly less likely with rheumatoid arthritis compared with osteoarthritis etiology (odds ratio, 0.15; $P = .02$), and smoking was associated with an increased chance of infection (odds ratio, 6.96; $P = .03$). Revision TEA was not associated with an increased 30-day adverse event or infection rate compared with primary TEA in multivariate analysis. Among primary and revision TEA patients, dependent functional status ($P = .02$) and hypertension ($P = .04$) were independent predictors for adverse events.

Conclusion: Modifiable risk factors should be addressed before TEA to limit postoperative complications as well as cost. The risk of short-term complications after revision TEA is comparable to that of primary TEA.

Level of evidence: Level IV; Case Series Using Large Database; Treatment Study

Keywords: Total elbow arthroplasty; total elbow replacement; risk factors; complications; etiology; utilization trends; revision

Whereas significant improvements in total elbow arthroplasty (TEA) implant longevity and surgical approaches have been made, this procedure has not achieved the level of predictable success of other total joint replacement procedures (such as hip and knee) in terms of complication rates, revision rates, and long-term implant survival.[9] The current

No Institutional Review Board or Ethics Committee approval was required to conduct this study.

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emphasis on quality outcomes and cost-effective treatment mandates an understanding of utilization trends, complication rates, and risk factors for adverse outcomes of TEA.[4]

Several studies describe TEA utilization trends and associated perioperative complication rates. Two studies examining the Norwegian Arthroplasty Register and Scottish Morbidity Record demonstrate a lower prevalence of primary TEA because of fewer TEAs performed for rheumatoid arthritis (RA) and inflammatory arthropathy, respectively, with no change in the prevalence of revision TEA.[4,9] In contrast, studies using the New York Statewide Planning and Research Cooperative System, California discharge database, and National Inpatient Sample (NIS) reported a significant increase in the prevalence of TEA because of more TEAs performed for trauma.[5-7] The statewide studies reported short-term complication rates of 10% to 12% and long-term revision rates of 6% to 8%.[5,7] To date, we are unaware of any studies using a U.S. national database to analyze perioperative complications of TEA.

Although prior literature has described utilization trends and complication rates for primary and revision TEA, there has been very little discussion about risk factors for adverse events for these procedures.[5-7,10,19,21] Two prior studies using the NIS database compared perioperative complication rates in patients with diabetes and RA.[10,21] However, NIS data are limited to the inpatient stay, and significant data quality concerns have been raised.[2]

The objectives of this study were to use the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database to analyze 30-day perioperative complication rates for primary TEA by etiology and for revision TEA and to identify risk factors for complications (including readmission) for primary and revision TEA.

Methods

A retrospective review of the ACS NSQIP database was conducted to identify all patients (≥18 years old) who underwent TEA from 2007 to 2013. The ACS NSQIP is a national surgical database that prospectively collects patient data from more than 370 participating institutions. All data are validated with strict adherence guidelines including routine audits to ensure high-quality data, with an inter-rater reliability of 5% or less and a systematic sampling system involving an 8-day cycle to prevent bias in choosing cases for assessment. Data are collected up to 30 days postoperatively, including after discharge, by trained clinical reviewers from medical records, operative reports, and patient interviews.

Inclusion criteria included patients 18 years or older who underwent primary or revision TEA. Both cohorts were identified using *Current Procedural Terminology* (CPT) codes corresponding to TEA (CPT code 24363) as no specific CPT code existed for revision TEA before 2013. The revision TEA cohort was identified for those patients with an *International Classification of Diseases, Ninth Revision* (ICD-9) diagnosis of mechanical, infectious, or other complication involving a prosthetic device (Appendix Table AI, available on the journal's website at www.jshoulderelbow.org) or separate CPT code corresponding to implant removal (CPT code 24160). The primary TEA cohort was subdivided into 4 groups based on postoperative ICD-9 diagnosis: fracture, osteoarthritis (OA), RA, and other (Appendix Table AII, available on the journal's website at www.jshoulderelbow.org). Patients with incomplete data were removed from the analysis.

Patient demographics including age, sex, race, and functional status were obtained from the ACS NSQIP database. In addition, the NSQIP provides detailed medical comorbidities including diabetes, cardiac, pulmonary, renal, and American Society of Anesthesiologists class among others. Intraoperative variables including wound class (clean, clean-contaminated, contaminated, and dirty-infected), operative time, time to operation, and resident involvement were reviewed.

Adverse events within the first 30 days postoperatively are tracked by the NSQIP and were classified as any, severe, minor, and infectious. Severe adverse events included death, myocardial infarction, cerebrovascular accident, renal failure, pulmonary embolism, venous thromboembolism, sepsis, septic shock, unplanned intubation, peripheral nerve injury, deep wound infection, organ/space infection, and return to operating room. Minor adverse events included superficial wound infection, urinary tract infection, and pneumonia. Infectious complications including deep wound infection, superficial wound infection, organ/space infection, sepsis, and septic shock were also compiled for separate analysis. Readmission data were also analyzed starting in 2011 when the NSQIP began tracking readmission.

Statistical analysis was conducted using SAS (version 9.3; SAS Institute, Cary, NC, USA) with a 2-tailed α of .05. Bivariate analysis comparing demographics, comorbidities, and 30-day outcomes were compared between the primary and revision TEA cohorts. Categorical analysis was conducted with Fisher exact test and χ^2 test where appropriate. Continuous variables were analyzed using Student *t* test or Mann-Whitney *U* test after testing for normality and equal variance. The 30-day outcomes were similarly compared within the primary TEA cohort based on etiology (fracture, OA, RA, and other). Multivariate logistic regression models were built using a stepwise backward elimination approach with an exclusion P value < .20. Likelihood ratio tests confirmed that removed variables were not significant predictors, and all variables were assessed for confounding and interaction where appropriate. Final models were assessed for goodness of fit using the Hosmer-Lemeshow test.

Results

A total of 189 primary TEAs and 53 revision TEAs were identified in the NSQIP database from 2007 to 2013. The most common indication for primary TEA was fracture (34%),