J Shoulder Elbow Surg (2015) 24, 24-30

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Thirty-day morbidity and mortality after elective total shoulder arthroplasty: patient-based and surgical risk factors

Brian R. Waterman, MD[a,*], John C. Dunn, MD[a], Julia Bader, PhD[b], Luis Urrea, MD[c], Andrew J. Schoenfeld, MD[d], Philip J. Belmont Jr, MD[a]

[a]*Department of Orthopaedic Surgery, William Beaumont Army Medical Center, Texas Tech University Health Sciences Center, El Paso, TX, USA*
[b]*Statistical Consulting Laboratory, University of Texas at El Paso, El Paso, TX, USA*
[c]*El Paso Orthopaedic Surgery Group, Department of Orthopaedic Surgery, Texas Tech University Health Sciences Center, El Paso, TX, USA*
[d]*Department of Orthopaedic Surgery, University of Michigan, Ann Arbor, MI, USA*

Background: Total shoulder arthroplasty (TSA) is an effective treatment for painful glenohumeral arthritis, but its morbidity has not been thoroughly documented.
Methods: The National Surgical Quality Improvement Program database was queried to identify all patients undergoing primary TSA between 2006 and 2011, with extraction of selected patient-based or surgical variables and 30-day clinical course. Postoperative complications were stratified as major systemic, minor systemic, major local, and minor local, and mortality was recorded. Odds ratios (ORs) with 95% confidence intervals (95% CIs) were derived from bivariate and multivariable analysis to express the association between risk factors and clinical outcomes.
Results: Among the 2004 patients identified, the average age was 69 years, and 57% were women. Obesity was present in 46%, and 48% had an American Society of Anesthesiologists classification of $\geq$3. The 30-day mortality and total complication rates were 0.25% and 3.64%, respectively. Comorbid cardiac disease (OR, 85.31; 95% CI, 8.15, 892.84) and increasing chronologic age (OR, 1.19; 95% CI, 1.06, 1.33) were independent predictors of mortality, whereas peripheral vascular disease was associated with statistically significant increase in any complication (OR, 6.25; 95% CI, 1.24, 31.40). Operative time >174 minutes was an independent predictor for development of a major local complication (OR, 4.05; 95% CI, 1.45, 11.30). Obesity was not associated with any specified complication after controlling for other variables.

Brian R. Waterman, John C. Dunn, and Philip J. Belmont Jr. are employees of the U.S. Federal Government and the United States Army. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of William Beaumont Army Medical Center, the Department of Defense, or the United States government.

Andrew J. Schoenfeld is a Robert Wood Johnson Foundation Clinical Scholar. The Robert Wood Johnson Foundation and the Department of Veterans Affairs were not directly involved in study design, data acquisition and interpretation, or manuscript preparation or review. Any opinions expressed herein do not necessarily reflect the opinions of the Robert Wood Johnson Foundation or the Department of Veterans Affairs.
Approval was obtained from the William Beaumont Army Medical Center Institutional Review Board.

*Reprint requests: Brian R. Waterman, MD, Department of Orthopaedic Surgery, William Beaumont Army Medical Center, Texas Tech University Health Sciences Center, 5005 N Piedras St, El Paso, TX 79920, USA.

E-mail address: brian.r.waterman@us.army.mil (B.R. Waterman).

1058-2746/$ - see front matter Published by Elsevier Inc. on behalf of Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2014.05.016

Conclusions: Whereas TSA has low short-term rates of perioperative complications and mortality, careful perioperative medical optimization and efficient surgical technique should be emphasized to decrease morbidity and mortality.
Level of evidence: Level III, Retrospective Cohort Design, Treatment Study.
Published by Elsevier Inc. on behalf of Journal of Shoulder and Elbow Surgery Board of Trustees.
Keywords: Total shoulder arthroplasty; mortality; complications; risk factors; incidence rate

With advances in its design and surgical technique[19] since Neer's early description,[25,26] total shoulder arthroplasty (TSA) has evolved as a reliable option for the treatment of degenerative shoulder disease. TSA effectively provides long-term pain relief and restores upper extremity function,[12] and patient demand has increased dramatically during the past 40 years, with an average increase of 9.4% per year for all cases of TSA.[1,11] Despite the increased surgical volume, postoperative complications still occur in an estimated 1 of 10 individuals undergoing TSA.[7] However, complication rates and profiles may vary considerably according to inclusion criteria, sample composition, and duration of clinical surveillance. Prior reports may not adequately reflect the prevalence of medical comorbidities and other unique perioperative risk factors increasingly present in patients undergoing joint arthroplasty.[6,17,38] Similarly, perioperative mortality and complication rates are thought to be underreported.[35]

This study was designed to quantify the 30-day postoperative morbidity and mortality after TSA in a national sample of patients. A secondary objective of this investigation was to evaluate for specific patient-based and surgical risk factors associated with 30-day postoperative mortality and systemic or local complications after TSA. We hypothesized that the presence of medical comorbidities, such as diabetes and cardiac disease, and advanced patient age would be associated with adverse clinical outcomes after TSA.

Materials and methods

Approval was obtained from our Institutional Review Board, and the National Surgical Quality Improvement Program (NSQIP) database was acquired from the American College of Surgeons for this study. Similar investigations of joint arthroplasty[4] and other orthopedic surgical procedures[3,32] have been conducted with the NSQIP, establishing it as a validated tool for developing prognostic clinical information. The methodology used in conjunction with transmitting NSQIP data from participating centers to the American College of Surgeons has been described in prior publications.[3,4] In brief, the NSQIP entails prospective patient enrollment and random sampling from more than 480 participating hospitals within the United States and offers surveillance of specific clinical outcomes, including perioperative complications and mortality, within the 30-day postoperative window. Surgical clinical reviewers at individual institutions ensure accuracy and completeness of prospective data collection while establishing direct patient contact or independent chart review to ascertain the presence or absence of perioperative complications within this window. Secondary surgeries performed within this period and subsequent patient entries are scrutinized for further relevance to the index procedure, and an anonymous data set is generated with consistent interrater reliability.[33]

For the current study, the NSQIP was queried to isolate all enrolled patients who underwent primary unilateral TSA as identified by *Current Procedural Terminology* (CPT) code 23472, which includes both anatomic and reverse TSA. Any patients with concurrent CPT codes indicating bilateral simultaneous TSA, revision TSA, biologic arthroplasty, and resurfacing or traditional hemiarthroplasty were excluded. Patient-specific factors, including demographics and medical comorbidities, and surgical variables, such as mode of anesthesia and total operative time, were extracted for further analysis (Table I). The presence and type of postoperative complications or mortality within 30 days of surgery were also recorded. For the purposes of this study, complications were considered either systemic or local complications and either major or minor on the basis of widely accepted criteria.[3,5,20,27-29] This resulted in 4 defined categories in which to classify postoperative complications (Tables II and III).

To assess the effect of individual patient-specific and surgical risk factors, bivariate χ^2 analysis was performed relative to the following identified clinical outcomes: patient mortality, presence of one or more complications, and the development of a major or minor systemic or local complication. Specific patient-based risk factors included for analysis were the following: age ($<$60, 60-69, 70-79, and $\geq$80 years old); sex; body mass index ($<$29.9, 30.0-39.9, and $\geq$40 kg/m^2); American Society of Anesthesiologists (ASA) classification (ASA 1 or 2 vs $\geq$3); type of anesthesia; and presence of diabetes mellitus, renal insufficiency, chronic obstructive pulmonary disease, steroid use, peripheral vascular disease, hypertension, or cardiac disease. Comparisons for surgical time were made between those procedures that exceeded the average TSA surgical time by 1 standard deviation compared with those that did not. If a given risk factor achieved a $P < .2$ on initial bivariate analysis, multivariable logistic regression was performed to evaluate its effect on the outcomes of interest while controlling for other predictors. Odds ratios (ORs) with 95% confidence intervals (CIs) were used to quantify risk during both bivariate and multivariable testing. Both a P value $< .05$ and a 95% CI exclusive of 1.0 after multivariable analysis were required for statistical significance.

Results

A total of 2004 patients who underwent TSA at participating hospitals between 2006 and 2011 were extracted from the NSQIP database. The average age of patients at