J Shoulder Elbow Surg (2011) 20, 557-563

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Factors predicting complication rates after primary shoulder arthroplasty

Eugene Farng, MD, David Zingmond, MD, Lucie Krenek, MD, Nelson F. SooHoo, MD*

Department of Orthopaedic Surgery, University of California-Los Angeles, Los Angeles, CA, USA

Hypothesis: Shoulder arthroplasty is an effective treatment for arthritic conditions and intraarticular fractures of the proximal humerus. Treatment options include total and hemiarthroplasty of the shoulder. They hypothesis of this study was that a mandatory statewide discharge database could identify the epidemiology of primary shoulder arthroplasty, 90 day complication rates, implant survival rates, and patient and hospital characteristics associated with complications.

Materials and methods: We identified patients undergoing primary total shoulder replacement and hemiarthroplasty between 1995 and 2005. We report rates of complications within 90 days of surgery and performed survival analysis using revision surgery as the endpoint. Logistic and proportional hazard regression models were used to estimate the effect of patient and provider factors in predicting the rates of adverse outcomes.

Results: During the study period, 15,288 patients underwent shoulder arthroplasty. Patients undergoing total shoulder arthroplasty and hemiarthroplasty had no statistically significant difference in the aggregate risk of 90-day complications or the risk of implant failure within the study period. Fracture patients were shown to have a higher risk of short-term complications (odds ratio, 3.2; $P < .001$). Implant failure rates were lower in patients with fracture, rheumatoid arthritis, increased comorbidity, and advanced age.

Conclusion: This study reports similar rates of short-term complications and implant failure in patients undergoing total or hemiarthroplasty, an overall mortality rate of 1.3%, and a pulmonary embolism rate of 0.6%. The findings of our study indicate that the risk of short-term complications is highest in patients undergoing total or hemiarthroplasty for a fracture compared with nonfracture indications. Our results also indicate that longer-term, implant survival is largely driven by factors associated with increased activity, such as age. In patients undergoing surgery for arthritis of the shoulder, we found no difference in implant survival rates between total and hemiarthroplasty of the shoulder.

Level of evidence: Level II, Retrospective Design, Prognostic Study.

Keywords: Shoulder arthroplasty; database; complication failure

An estimated 7000 total shoulder replacements and 11,000 hemiarthroplasty procedures were performed annually in the United States from 1996 to 2002.[3,10] The most common indications for shoulder arthroplasty are chronic arthritic conditions or acute fractures of the proximal humerus. Debilitating shoulder pain from end-stage

This work was approved by the California Committee for the Protection of Human Subjects (Project #08-10-51.) Owing to the nature of the secondary data analyses in this study, waiver of patient consent was granted.

*Reprint requests: Nelson F. SooHoo, MD, 10945 Le Conte Ave. #3355, Los Angeles, CA 90095.

E-mail address: nsoohoo@mednet.ucla.edu (N.F. SooHoo).

1058-2746/$ - see front matter © 2011 Journal of Shoulder and Elbow Surgery Board of Trustees.
doi:10.1016/j.jse.2010.11.005

osteoarthritis, inflammatory arthritis, avascular necrosis of the humeral head, or other degenerative conditions are frequent indications for surgery.[21] Patients with significant trauma to the proximal humerus, including head-splitting fractures, and fractures in patients with significant osteoporosis, often are considered for arthroplasty.[14,15] In patients with intact articular glenoid cartilage, the surgical decision making may be controversial, because some advocate total shoulder arthroplasty whereas others prefer concentric reaming of the glenoid without an implant.

It is often impossible to evaluate rare but serious complications of surgery because the number of cases needed to adequately characterize the complication can exceed the experience of any single surgeon or institution. In this situation, it is helpful to use large databases. Although no significant joint registry for shoulder arthroplasty currently exists, many administrative databases have been collecting useful information. This study used a mandatory statewide database to identify short-term (90-day) complication rates after primary total shoulder arthroplasty and hemiarthroplasty as well as to identify patient and hospital characteristics associated with these complications. We also sought to evaluate device failure rates for total shoulder arthroplasty and hemiarthroplasty during an 11-year period. In addition, we sought to identify patient and hospital characteristics associated with higher risks of implant failure, with a specific focus on identifying differences between total and hemiarthroplasty of the shoulder.

Materials and methods

Data source

Data for all hospital discharges within the state in the years 1995 through 2005 were obtained from the California Office of Statewide Health Planning and Development (OSHPD) through a patient discharge database. This mandatory database is compiled annually by the state, and all nonfederal acute care hospitals within California are required to submit discharge abstracts electronically for every inpatient admission, regardless of insurance type. Auditing rules are in place to identify potentially erroneous batches of records, and a sample of the records is also audited for accuracy. Independently funded institutions, which include only the Shriner's system of hospitals, are exempt from submitting data.

Each discharge abstract includes codes for up to 20 inpatient procedures and 24 diagnoses per hospitalization, with flags to separately identify diagnosis codes that existed before the specific hospital admission. All procedures and diagnoses are coded using the *International Classification of Disease, 9th Revision, Clinical Modification* (ICD-9-CM). Also included are patient demographic information (race, Hispanic ethnicity, gender, age, and ZIP code of residence), outcomes (in-hospital mortality), and site of hospitalization (unique hospital identifier and ZIP code).[24]

Postdischarge mortality was identified from the state death file. This file provides mortality information for all deaths within the state and also for all state residents who die within other states in the United States. These data are collected by the Office of Vital Statistics and augmented by out-of-state deaths provided by the National Death Index, with validated linkages performed by the OSHPD.[26]

Inclusion and exclusion criteria

The sample consisted of patients undergoing primary total or hemiarthroplasty of the shoulder during the study period. A concurrent diagnosis of proximal humeral fracture or an appropriate nonfracture diagnosis (osteoarthritis, rheumatoid arthritis, other inflammatory arthropathy, or avascular necrosis of the humeral head) was required for inclusion. The study excluded patients with other trauma of the upper extremity, prior shoulder dislocation, malignancy, prior infection of the shoulder, prior surgery such as hardware removal, arthrodesis, or internal fixation. The specific ICD-9-CM procedure codes used to identify the cohort sample are listed in Appendix 1. Patients with ZIP codes of residence outside California were excluded because they were more likely to be readmitted outside of the state during the observation period. The unit of analysis was hospital discharge for each individual patient.

Outcomes studied: Dependent variables

Once arthroplasty patients were identified, all future admissions for the patient during the study period were flagged. These admissions were evaluated for outcomes of interest as dependent variables, including readmission rates for specific complications (eg, pulmonary embolus, revision arthroplasty) and death. The 90-day outcomes included infection, dislocation, mechanical complication of the shoulder prosthesis, thromboembolic disease (pulmonary embolism or deep venous thrombosis), neurovascular injury, revision surgery, amputation, and fusion.

To analyze implant failure (see Statistical Analysis), all subsequent admissions for revision arthroplasty or fusion were identified, and the time to revision was noted. The coding algorithm requires the assumption that the repeat code is for the same extremity because laterality is not recorded in the database. Mortality was identified using the state's Vital Statistics Registry Database. The specific ICD-9-CM codes used to identify readmission for these complications are listed in Appendix 1.

Predictors (independent variables)

The predictive variables of interest included the procedure type (total shoulder replacement or hemiarthroplasty) and patient demographics, such as age, gender, race, and socioeconomic status (using ZIP code as a proxy). We also included the indication for surgery, defined as fracture or nonfracture. Specific medical conditions, such as diabetes, rheumatic disease, and peripheral vascular disease were also identified. A modified Charlson index was calculated for all patients, with corrections for terms already accounted for elsewhere. A high Charlson index was defined as a modified Charlson index >1. Hospital characteristics such as teaching status, rural status, and hospital volume were identified. Hospitals were grouped into three categories based on average annual volume—top 20%, 40% to 80%, and 0% to 40%—for shoulder arthroplasty.