Length of Stay and Readmission After Total Shoulder Arthroplasty: An Analysis of 1505 Cases

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Abstract

We conducted a study to characterize the risk factors for extended length of stay (LOS) and readmission after primary total shoulder arthroplasty (TSA). Patients who were 60 years or older and underwent TSA between 2011 and 2012 were identified from the American College of Surgeons National Surgical Quality Improvement Program database. Bivariate and multivariate analyses were used to test patient characteristics for association with extended LOS and readmission within 30 days. Extended LOS was defined as LOS of more than 3 days (90th percentile LOS).

Of the 1505 TSA patients identified, 49 (3.3%) were readmitted. Multivariate analysis revealed that extended LOS was independently associated with age 70 years or older and history of diabetes. Readmission was independently associated with history of heart disease and history of hypertension. The identified risk factors may be useful for preoperative discussions, surgical decision-making, and postoperative planning for THA patients.

Use of total shoulder arthroplasty (TSA) and reverse TSA for shoulder conditions has increased dramatically in recent years.[1] Approximately 27,000 standard TSAs were performed in the United States in 2008, and this number is expected to double by 2015.[2] TSA provides excellent pain relief, restoration of function, and patient satisfaction.[3] The evolution of implant design over the past 25 years has contributed to excellent long-term implant survival, with rates comparable to those of total knee and hip arthroplasty.[4] Similarly, compared with previous designs, contemporary designs and techniques have resulted in fewer complications.[5]

Several studies have investigated the long-term complications of TSA. These complications include prosthetic loosening, instability, periprosthetic fracture, rotator cuff tears, nerve injury, and deltoid dysfunction.[6-11] In addition, Waterman and colleagues[11] very recently assessed the influence of risk factors on short-term postoperative complications of TSA. However, none of these studies has assessed the influence of multiple risk factors on postoperative length of stay (LOS) after TSA. Only 1 study, using data from 2005 and earlier, has analyzed the potential effect of multiple patient characteristics on readmission after TSA[12]; other studies have been only descriptive.[13-16]

We conducted a retrospective cohort study to characterize the risk factors for extended LOS and readmission after TSA in a large sample of patients drawn from a national database. We hypothesized that patient factors, including age, sex, and obesity, would be significantly associated with postoperative LOS and readmission after TSA. National databases have been increasingly used in orthopedic research, as they offer particular advantages. Large sample sizes allow for powerful analyses of associations—analyses previously not possible in single-surgeon and single-institution studies. In addition, use of a large, national patient sample allows us to draw generalizable conclusions to better define patients' and physicians' postoperative expectations.

Methods

We conducted a retrospective cohort study using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database. ACS-NSQIP collects 150 patient variables from 374 participating US hospitals.[17] Patients are prospectively identified, and information is collected from operative reports, medical records, and patient interviews by trained clinical reviewers.[17,18] Routine auditing by the program ensures high-quality data, with reported interrater disagreement below 2% for all variables. Data are collected through the 30th postoperative day, including after discharge.

This study was granted an exemption from our institutional review board, as we used a deidentified and publicly available database. Patients who were 60 years or older and underwent TSA between 2011 and 2012 were identified in the ACS-NSQIP database. TSA patients were identified using *Current Procedural Terminology* (CPT) code 23472, which includes TSA and reverse TSA procedures.

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Patients were divided into groups based on surgical indications, which were available as *International Classification of Diseases, Ninth Revision* (ICD-9) diagnosis codes. Patients with postoperative ICD-9 codes 714.0 (rheumatoid arthritis), 715.0-9 (osteoarthritis), 716.61/716.81/716.91 (unspecified arthropathy), 718.01 (articular cartilage disorder), 718.31 (recurrent dislocation of shoulder), 718.81 (other joint derangement of shoulder), 719.41/719.91 (unspecified shoulder pain/disorder), 726.0-2 (disorder of shoulder tendons and bursa), 727.61 (rotator cuff rupture), and 840.3-9 (rotator cuff sprain) were classified as having a nonfracture indication. Patients with postoperative ICD-9 codes 716.11 (traumatic arthropathy), 833.80-89 (malunion/nonunion of fracture), and 812.00-20 (fracture of proximal humerus) were classified as having a fracture-associated indication. Patients with incomplete perioperative data were excluded from the study, leaving 1505 patients for the study (out of an initial 1726).

Patient characteristics, including sex, age, height, weight, and history of smoking, were collected from the ACS-NSQIP database. Body mass index (BMI) was calculated from each patient's height and weight. Information about medical comorbidities was also collected from the ACS-NSQIP database. History of pulmonary disease was defined as a history of dyspnea, severe chronic obstructive pulmonary disease, ventilator-assisted respiration within 48 hours before surgery, or current pneumonia. History of heart disease was defined as a history of congestive heart failure or angina within 1 month before admission, myocardial infarction within 6 months before admission, cardiac surgery, or percutaneous coronary intervention. American Society of Anesthesiologists (ASA) class 3 or higher indicates severe systemic disease. Steroid use was defined as regular administration of corticosteroid medications within 30 days before surgery. Functional status was defined as the ability to perform activities of daily living (ADLs) within 30 days before surgery, with the patient's best functional status during this period recorded. Similar to how other variables were collected from the database, this information was obtained through medical record abstraction and patient interviews by trained personnel. ADLs are defined in the ACS-NSQIP as "activities usually performed in the course of a normal day in a person's life" and include bathing, feeding, dressing, toileting, and mobility. An independent patient does not require assistance for any ADLs, a partially dependent patient requires assistance for some ADLs, and a totally dependent patient requires assistance in completing all ADLs. Partially and totally dependent patients were grouped for analysis. Information about a patient's discharge destination (to home or a facility) was also available in the database.[17]

Table 1. **Patient Characteristics**

Characteristic	N	%
Overall	1505	100.0
Age, y		
60-69	558	37.1
70-79	625	41.5
≥80	322	21.4
Female sex	886	58.9
BMI		
<30	802	53.3
30-35 (class I obesity)	400	26.6
35-40 (class II obesity)	182	12.1
≥40 (class III obesity)	121	8.0
ASA class 3-4	802	53.3
History of:		
Diabetes	266	17.7
Smoking	93	6.2
Pulmonary disease	176	11.7
Heart disease	122	8.1
Hypertension	1092	72.6
Steroid use	80	5.3
Dependent functional status	48	3.2
Indication		
Nonfracture	1445	96.0
Fracture-associated	60	4.0

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.

Extended Length of Stay

Extended LOS was defined as a binary variable that was positive when the postoperative LOS exceeded the 90th percentile LOS. The 90th percentile LOS was chosen as a cutoff to account for normal variations in LOS and differing practices of surgeons while still capturing patients with abnormally extended LOS.

Readmission

Readmission was defined as a binary variable that was positive when a patient had an unplanned readmission 1 or more times after the initial postoperative discharge.

Patient Demographics

Table 1 summarizes the demographics and comorbidities of the 1505 TSA patients who met our study inclusion criteria. Mean age was 72.8 years (range, 60-90 years). Mean BMI was 30.3 kg/m^2 (range, 15.7-63.9 kg/m^2); 46.7% of patients were classified as obese (BMI, ≥30 kg/m^2). The cohort was 58.9% female. Four percent of patients underwent TSA for a fracture-associated indication.

Statistical Analyses

Statistical analyses were performed with Stata 11.2 (StataCorp). Bivariate and multivariate analyses were used to test patient characteristics for association with extended LOS and readmission. Discharge destination and LOS were included in the readmission analysis because this information would be available at time of discharge and would be useful to include in a model that predicts odds of readmission.

Final multivariate models were constructed using a backward stepwise process that initially included all potential variables and sequentially excluded variables with the highest *P* value until only those with $P < .20$ remained. Variables with

.05 < P < .20 were left in the model to control for potential confounding but were not considered significantly associated with the outcome. All tests were 2-tailed, and the statistical difference was established at a 2-sided α level of 0.05 (P < .05).

Results

Median LOS after TSA was 2 days (interquartile range, 1-3 days), and extended LOS was defined as LOS of more than 3 days (90th percentile LOS). The distribution of LOS is depicted in the **Figure**. Results of the bivariate and multivariate analyses are reported in **Table 2** and **Table 3**, respectively. Bivariate analysis revealed an association between extended LOS and increased age, ASA class 3 or higher, and history of diabetes, pulmonary disease, and heart disease. On multivariate analysis, extended LOS was associated with age 70 to 79 years (odds ratio [OR], 1.71; 95% confidence interval [CI], 1.01-2.95; P = .049), age 80 years or older (OR, 3.38; 95% CI, 1.94-5.91; P < .001), and history of diabetes (OR, 2.37; 95% CI, 1.53-3.66; P < .001).

Forty-nine patients (3.3%) were readmitted within the first 30 postoperative days. Bivariate analysis revealed an association between readmission and ASA class 3 or higher, history of heart disease, and history of hypertension. On multivariate analysis, readmission was associated only with history of heart disease (OR, 2.94; 95% CI, 1.45-5.96; P = .003) and history of hypertension (OR, 3.93; 95% CI, 1.40-11.04; P = .010).

Discussion

In the United States, TSA has become increasingly popular because of its favorable outcomes and continued implant development.[1-5] However, there is a shortage of information about risk factors for short-term outcomes after TSA. In this study, we used multivariate analyses to identify patient-related factors associated with extended LOS and readmission after discharge. By identifying these factors, we can improve the preoperative discussion and postoperative planning for this procedure.

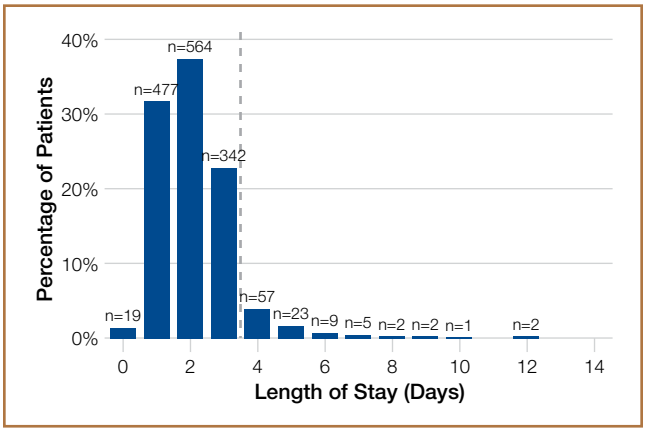

Figure. Postoperative length of stay (LOS) after total shoulder arthroplasty. Extended LOS was defined as LOS above 90th percentile LOS, or 3 days in this cohort. Patients to right of vertical dashed line had extended LOS. Two patients had LOS of more than 14 days (17 days, 26 days) and are not shown here.

In the present study, extended LOS (>3 days) was found to be associated with older age and history of diabetes. The TSA literature has little information that can be used to compare these results, though age over 80 years was previously described as a risk factor for extended LOS after TSA.[19] Uncontrolled diabetes has been identified as a risk factor for extended LOS in hip and knee arthroplasty,[20] and management of diabetes may similarly complicate postoperative care, leading to extended LOS and increased costs in TSA patients. Patients with the identified risk factors for extended LOS should be counseled before surgery. In addition, this is important information for health care organizations and providers.

Readmission within 30 days after TSA was found to be independently associated with history of heart disease and history of hypertension. Similar to factors affecting LOS, patient-related risk factors for readmission are also poorly defined in the TSA literature. In total hip arthroplasty patients, heart disease

Table 2. Results of Bivariate Analyses for Influence of Risk Factors for Extended Length of Stay and Readmission

Outcome/Risk Factor	OR (95% CI)	*P*
Length of stay, >3 days		
Age, y		
70-79 vs 60-69	1.84 (1.08-3.15)	.026
≥80 vs 60-69	3.62 (2.10-6.27)	<.001
ASA, ≥3	2.03 (1.32-3.13)	.001
History of:		
Diabetes	2.37 (1.53-3.66)	<.001
Pulmonary disease	1.79 (1.06-3.03)	.029
Heart disease	1.88 (1.03-3.42)	.037
Readmission		
ASA, ≥3	1.84 (1.01-3.38)	.048
History of:		
Heart disease	3.51 (1.74-7.05)	<.001
Hypertension	4.39 (1.57-12.29)	.005

Abbreviations: ASA, American Society of Anesthesiologists; CI, confidence interval; OR, odds ratio.

Table 3. Results of Multivariate Analyses for Influence of Risk Factors on Extended Length of Stay and Readmission

Outcome/Risk Factor	OR (95% CI)	*P*
Length of stay, >3 days		
Age, y		
70-79 vs 60-69	1.71 (1.01-2.95)	.049
≥80 vs 60-69	3.38 (1.94-5.91)	<.001
History of diabetes	2.37 (1.53-3.66)	<.001
Readmission		
History of:		
Heart disease	2.94 (1.45-5.96)	.003
Hypertension	3.93 (1.40-11.04)	.010

Abbreviations: CI, confidence interval; OR, odds ratio.

has been found to be associated with readmission.[21,22] Hypertension has also been associated with readmission for other orthopedic procedures.[23] Results of the present study indicate these comorbidities may increase the risk for complications after discharge. It is important to note, however, that LOS did not correlate with readmission rates, indicating patients are likely being discharged at the most clinically appropriate time.

Waterman and colleagues[11] very recently identified (in the ACS-NSQIP database) a patient population that underwent TSA between 2006 and 2011 to describe risk factors for postoperative complications within 30 days. They found that comorbid cardiac disease and older age were independently associated with mortality. Interestingly, the present study identified older age as associated with extended LOS, and cardiac disease as associated with readmission. Together with the results from the previous study, age and cardiac disease seem to be important patient factors to consider when planning TSA, as they are associated with a significantly worse postoperative course.

This study had several limitations. First, given the nature of the ACS-NSQIP database, readmissions are recorded only up to 30 days after surgery, including after discharge. Second, though the ACS-NSQIP tries to collect as many patient variables as possible, some information is not captured. Additional variables that could potentially affect LOS and readmission (eg, insurance status, hospital volume) were not available for analysis. However, we think the high-quality data collection process used by the ACS-NSQIP outweighs the lack of certain variables. Third, original operative notes are not available in the ACS-NSQIP database, and the only way to identify operative procedures is to check CPT codes. Unfortunately, CPT code 23472 is used for both TSA and reverse TSA, so these procedures could not be separated for analysis, and the results of this study can be used to comment only on the risks of both procedures. Another limitation is that there were not enough patients to further analyze the data by each indication.

Conclusion

With the increasing popularity of TSA for an expanding set of indications, it is important to understand the factors that can affect the postoperative course. In this study, we found several patient-related risk factors for extended LOS and readmission. Although the identified factors are generally not modifiable, this information can be used to better define the expectations of patients, providers, and organizations for this increasingly common procedure.

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This paper will be judged for the Resident Writer's Award.