Predictors of Hospital Readmission After Total Shoulder Arthroplasty

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abstract

The study was conducted to determine the incidence rate, risk factors, and postoperative conditions associated with 30-day readmission after total shoulder arthroplasty (TSA). A total of 3547 patients who underwent primary TSA were identified from the 2011–2013 American College of Surgeons National Surgical Quality Improvement Program. The 30-day readmission rate was 2.9%. The only preoperative predictors of hospital readmission were American Society of Anesthesiologists classification of 3 or greater (odds ratio, 2.16; 95% confidence interval, 1.30-3.61) and a history of cardiac disease (odds ratio, 2.13; 95% confidence interval, 1.05-4.31). Of patients with any perioperative complications, 42 (34%) were readmitted, and the presence of any complication increased the risk of readmission (odds ratio, 28.95; 95% confidence interval, 18.44-45.46). Periprosthetic joint infection, myocardial infarction, pulmonary embolism, deep venous thrombosis, and pneumonia were significant predictors of hospital readmission after TSA ($P<.0001$). The incidence of hospital readmission after TSA peaked within the first 5 days after discharge, and 26%, 32%, and 55% of all hospital readmissions occurred by postoperative days 5, 7, and 14, respectively. Preoperative medical optimization to reduce the rates of postoperative complications, such as periprosthetic joint infection, myocardial infarction, pulmonary embolism, deep venous thrombosis, pneumonia, and urinary tract infection, are likely to decrease the need for subsequent readmission. Patients should be counseled about these risk factors preoperatively. [*Orthopedics*. 201x; xx(x):exxx-exxx.]

In the era of growing health care expenditures, policymakers are increasingly seeking measures to reduce preventable medical costs and optimize administrative efficiency. Hospital readmissions are a burden on the health care system, contributing as much as $20 billion in costs per year.[1-9] In response to this issue, the Patient Protection and Affordable Care Act established the Hospital Readmission Reduction Program to curtail costs incurred as a result of unplanned readmissions.[10-14] Hospital readmission rates have quickly become a metric for

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evaluating hospital performance by the Centers for Medicare & Medicaid Services and the National Quality Forum.[10,14] Financial penalties are imposed for rates exceeding normative values.[15] Among the fields affected by these programs, orthopedic surgery has received significant focus because of its heavy reliance on ambulatory procedures and inpatient surgery.[16]

The use of total shoulder arthroplasty (TSA) in the US health care system has risen dramatically over the past few decades, with a nearly 250% increase to 47,000 TSA procedures performed in 2008.[17] Despite the increasing prevalence of TSA procedures, limited broad-based data are available on their cost and epidemiology.[17-19] As a significant contributor to elective orthopedic surgical hospital readmissions, TSA is likely to become a major contributor to mounting health care expenses. Although factors that affect length of stay after TSA are well delineated,[20] literature on readmission after TSA is limited to either single-institution[21,22] or registry data.[23-26] Readmission rates after TSA have been reported at 4.5% to 6.0% at 90 days,[21,25] and rates are significantly lower than after total knee arthroplasty or total hip arthroplasty.[23] However, pre- and postoperative in-hospital patient characteristics that herald an increased likelihood of readmission are largely unexamined, with only 1 known retrospective, single-state registry exploring variables that predict readmission after TSA.[25]

This study was conducted to identify factors associated with postoperative readmission after TSA. The authors used the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database, with the goal of reducing unplanned readmissions and associated costs. A model for reducing readmissions would provide a basis for early intervention and provide strategies to reduce adverse events and secondary health care costs associated with readmission. To replicate the interval used by existing quality control programs, this study evaluated patient characteristics and surgical variables leading to 30-day postoperative readmission after TSA.

Materials and Methods

This study was exempted from institutional review board approval because it was a publicly available, deidentified database review study. The American College of Surgeons NSQIP database was queried. The NSQIP is a data repository that receives records from 374 participating medical centers across several US health care settings. Patients enrolled in the NSQIP are prospectively followed for 30 days postoperatively and are monitored for hospital readmission, postoperative complications, and mortality. The ACS stringently maintains NSQIP, and it has shown excellent interrater reliability, with a 1.6% disagreement rate for all variables.[27] The use of the NSQIP database and its methods are well documented[28-32] and can be referenced in the program's participant user guide.[33]

The Current Procedural Terminology (CPT) code 23472 for total shoulder arthroplasty was used to identify patients who underwent this procedure and had their data registered with the NSQIP from 2011 to 2013. In the existing classification, CPT code 23472 includes both anatomic TSA and reverse TSA prosthesis. Independent analysis of anatomic TSA and reverse TSA prosthesis was not possible because of the shared CPT code. Patient-specific factors, including demographic data, medical comorbidities, and selected laboratory values, were recorded (**Table 1**). In addition, surgical characteristics were obtained, including total operative time, mode of anesthesia, and postoperative blood transfusion within 72 hours of the procedure.

Systemic and local complications were classified as either major or minor, based on the categories used in previous reports (**Tables 2-3**).[34,35] Major systemic complications were recognized as those requiring complex medical intervention. Major local complications included periprosthetic joint infection, peripheral nerve injury, and implant failure. Periprosthetic joint infections included all deep wound and organ or space surgical site infections. Deep surgical site infections were defined as those occurring within 30 days after the principal operative procedure and involving deep soft tissues as well as either purulent drainage, spontaneous dehiscence with signs or symptoms of infection, or abscess. Hospital readmission within 30 days of the index TSA was the primary outcome measure.

Bivariate logistic regression analysis was used to determine the effect of patient variables, surgical factors, and complications on hospital readmission. Principal patient-based predictors included medical comorbidities, wound classification (clean vs clean contaminated/contaminated/dirty/infected), age (<60 years, 60-69 years, 70-79 years, and ≥80 years), sex, body mass index (≤29.9, 30.0-39.9, and ≥40 kg/m^2), hospital discharge status (admitted from home vs admitted from acute care hospital/nursing home/outside emergency department/other), American Society of Anesthesiologists (ASA) classification (1 or 2 vs 3 or 4), designated preoperative laboratory values, and functional status (independent vs dependent). Patients were determined to have a history of cardiac disease if they had 1 or more of the following: new diagnosis or exacerbation of chronic congestive heart failure within 30 days of surgery, history of angina within 30 days of surgery, history of myocardial infarction within the past 6 months, or any percutaneous cardiac intervention or other history of cardiac surgery. Surgical risk factors incorporated were mode of anesthesia (general vs spinal/epidural/regional), operative time, and blood transfusion within 72 hours postoperatively. Operative time was characterized as being greater or less than the average procedural time plus 1 SD. Surgical outcomes included those specified within

the NSQIP data set by the surgical clinical reviewers and were indexed as mortality, all complications, major systemic complications, major local complications, minor systemic complications, and minor local complications.

For all factors with $P<.2$ and with frequencies greater than 10 on initial bivariate testing, multivariate logistic regression analysis was used.[36,37] To minimize model distortion, any variable that was absent in more than 20% of the cohort was excluded from multivariate analysis. Both odds ratio (OR) and 95% confidence interval (CI) were reported. Significant independent predictor variables were identified as those that maintained $P<.05$ with OR and 95% CI exclusive of 1.0 after multivariate analysis. The C-statistic was used to measure discriminative capacity, and the Hosmer and Lemeshow goodness of fit test was used to assess model calibration.

Results

There were 3547 patients who underwent TSA. Mean age of the entire cohort was 70.1 (±9.9) years (**Table 1**). A substantial number of patients had comorbidities that included ASA classification of 3 or greater (51.8%), diabetes (16.7%), and body mass index of 40 or greater (9.0%). Within the 30-day postoperative period, 8 patients (0.23%) died and 122 (3.4%) had 1 or more complications (**Table 2**). A total of 46 major systemic complications occurred in 44 (1.2%) patients, and 75 minor systemic complications occurred in 70 (2.0%) patients. Of the major systemic complications, 52% were cardiovascular. Pulmonary embolism was the most prevalent (0.4%), followed by myocardial infarction (0.3%). Transfusion was required in 5.4% of patients. Urinary tract infection (1.0%), pneumonia (0.5%), and deep venous thrombosis (0.5%) were the most common minor systemic complications. There were 13 patients (0.4%) who had a major local complication and 11 patients (0.3%) who had a minor local complication. Deep wound infection was the most common major local complication (0.4%). Average length of stay was 2.2 (±2.2) days, and 103 patients (2.9%) were readmitted within 30 days of discharge after TSA.

Of the patients who had any complication, 42 (34%) were readmitted. Perioperative complications were strongly associated with increased risk of readmission (OR, 28.95; 95% CI, 18.44-45.46). Complications with readmission rates that approximated or exceeded 50% included pulmonary embolism, postoperative sepsis, cardiac arrest requiring cardiopulmonary resuscitation, deep venous thrombosis, progressive renal insufficiency, periprosthetic infection, and wound dehiscence (**Table 2**).

Bivariate analysis identified multiple risk factors for readmission, and these were analyzed in multivariate testing (**Table 3**). Multivariate logistic regression analysis showed that ASA classification of 3 or greater (OR, 2.16; 95% CI, 1.30-3.61) and a history of cardiac disease (OR, 2.13; 95% CI, 1.05-4.31) were the only preoperative surgical characteristics that predicted hospital readmission (**Table 4**). Preoperative demographics, including age, sex, body mass index, functional status, and remaining medical comorbidities, as well as surgical variables, such as operative time, type of anesthesia, and need for blood transfusion, were no longer significant. Individual postoperative complications that were significantly associated with hospital readmission included periprosthetic joint infection (OR, 268.93; 95% CI, 57.43-1001.00), myocardial infarction (OR, 29.32; 95% CI, 7.34-117.49), pulmonary embolism (OR, 21.18; 95% CI, 4.85-92.48), deep venous thrombosis (OR, 21.10; 95% CI, 6.41-69.44), pneumonia (OR, 11.99; 95% CI, 3.52-40.80), and urinary tract infection (OR, 6.35; 95% CI, 2.33-17.35). The C-statistic (0.79) for the final regression model indicated good discriminative capacity, and the goodness of fit test showed no statistically significant lack of fit, which indicates good calibration between the model and the source data.

Information on the timing of hospital readmission was available for 71.8% (74 of 103) of cases. The incidence of hospital readmissions after TSA peaked within the first 5 days after discharge, and 26%, 32%, and 55% of all hospital readmissions occurred by postoperative days 5, 7, and 14, respectively.

Discussion

The overall 30-day readmission rate after TSA was 2.9%, which is comparable to the rate of 2.7% for anatomic and reverse TSA reported in the only other study with a similar period of postoperative surveillance.[21] In this previous single-center review of 556 TSA procedures, the readmission rate after TSA increased to 4.5% at 60 days and 5.2% at 90 days postoperatively. In comparison, the overall 30-day readmission rate after total hip arthroplasty or total knee arthroplasty with the NSQIP data set was 3.7% to 4.6%.[30,31] To the authors' knowledge, the current study is the first to evaluate the effect of patient-based variables, surgical risk factors, and postoperative complications on hospital readmission after TSA. Contemporary patients undergoing TSA have significant medical comorbidities, and the current study cohort had an ASA classification of 3 or greater (51.8%), age 70 years or older (54.7%), diabetes (16.7%), and morbid obesity (9.0%). As a result, recognition of pertinent patient-based and surgical risk factors for stratifying individual surgical outcomes and the incidence of hospital readmission is essential. The current study found that ASA classification of 3 or greater (OR, 2.16; 95% CI, 1.30-3.61) and a history of cardiac disease (OR, 2.13; 95% CI, 1.05-4.31) were the only preoperative surgical characteristics that predicted readmission after multivariate analysis. The remaining preoperative demographic and surgical variables identified on univariate analysis were no longer significant on multivariate analysis after

Table 1

Patient Demographics and Preoperative Characteristics

Characteristic	Value	Total No. of Patients	No.	
			No Readmission	Readmission
Age, mean±SD, y	70.1±9.9	3547	3444	103
<60 y, No. (%)	495 (14.0)	-	482	13
60-69 y, No. (%)	1114 (31.4)	-	1093	21
70-79 y, No. (%)	1301 (36.7)	-	1262	39
≥80 y, No. (%)	637 (18.0)	-	607	30
Sex, No. (%)	-	3544	3441	103
Male	1540 (43.4)	-	1492	48
Female	2004 (56.6)	-	1949	55
Body mass index, mean±SD, kg/m^2	30.7±6.7	3536	3433	103
≤29.9 kg/m^2, No. (%)	1841 (52.1)	-	1786	55
30.0-39.9 kg/m^2, No. (%)	1377 (38.9)	-	1338	39
≥40.0 kg/m^2, No. (%)	318 (9.0)	-	309	9
Functional status, No. (%)	-	3513	3411	102
Independent	3415 (97.2)	-	3320	95
Partially or totally dependent	98 (2.8)	-	91	7
Transfer status, No. (%)	-	3545	3443	102
From acute care hospital/inpatient	9 (0.3)	-	8	1
Not transferred (admitted from home)	3505 (98.9)	-	3408	97
Nursing home/chronic care/intermediate care	25 (0.7)	-	22	3
Outside emergency department	4 (0.1)	-	3	1
Transfer from other	2 (0.1)	-	2	0
Wound classification, No. (%)	-	3547	3444	103
Clean	3489 (98.4)	-	3388	101
Clean/contaminated, contaminated, dirty/infected	58 (1.6)	-	56	2
American Society of Anesthesiologists classification, No. (%)	-	3542	3439	103
1-2	1710 (48.3)	-	1680	30
3-4	1832 (51.8)	-	1759	73
Preoperative laboratory values, mean±SD	-			
Hematocrit	40.2%±4.4%	3189	3096	93
Platelets, ×10^3/μL	241.5±69.6	3130	3039	91
Creatinine, mg/dL	1.0±0.6	3130	3034	96
Serum albumin, g/dL	4.0±0.4	1315	1277	38

Table 1 (cont'd)

Patient Demographics and Preoperative Characteristics

Characteristic	Value	Total No. of Patients	No.	
			No Readmission	Readmission
Medical comorbidities, No. (%)	-			
Smoking[a]	337 (9.5)	3547	3444	103
All diabetes[b]	591 (16.7)	3547	3444	103
Dyspnea	244 (6.9)	3547	3444	103
Hypertension	2407 (67.9)	3547	3444	103
Any cardiac issue[c]	154 (4.3)	3547	3444	103
Previous myocardial infarction within 6 mo	2 (0.1)	3547	3444	103
Percutaneous cardiac intervention	86 (2.4)	3547	3444	103
Previous cardiac surgery	71 (2.0)	3547	3444	103
History of revascularization/amputation for peripheral vascular disease/ rest pain/gangrene	7 (0.2)	3547	3444	103
Previous transient ischemic attack/cerebrovascular accident/stroke with neurologic deficit/cerebrovascular accident/stroke without neurologic deficit	76 (2.1)	3547	3444	103
Dialysis use/renal failure	18 (0.5)	3547	3444	103
Systemic sepsis (yes/no)	16 (0.5)	3547	3444	103
Previous operation within 30 d	5 (0.1)	3547	3444	103
Operative time, mean±SD, min	117.4±46.8	3546	3443	103
≤117 min, No. (%)	3080 (86.9)	-	2992	88
>117 min, No. (%)	466 (13.1)	-	451	15
Type of anesthesia, No. (%)		3547	3444	103
General	3408 (96.1)	-	3307	101
All others	139 (3.9)	-	137	2
Occurrence of bleeding transfusions (≥1 unit packed/whole red blood cells given within 72 h postoperatively), No. (%)		3547	3444	103
None	3354 (94.6)	-	3261	93
≥1 unit	193 (5.4)	-	183	10
Time from operation to discharge, mean±SD, d	2.1±2.1	3547	3444	103

[a]*Current smoker within 1 year.*
[b]*Insulin-dependent diabetes/non–insulin-dependent diabetes (yes/no).*
[c]*Next 5 entries.*

Table 2

Complications (Current Procedural Terminology Code 23472)

Characteristic	No. (%)	No.		Readmission <30 Days[a]	*P*
		No Readmission	Readmission		
Overall complications	122 (3.4)	80	42	28.95 (18.44-45.46)	<.0001
Major systemic complications	44 (1.2)	26	18	27.84 (14.71-52.72)	<.0001
Pulmonary embolism	13 (0.4)	7	6	30.37 (10.02-92.07)	<.0001
Unplanned intubation	4 (0.1)	3	1	14.41 (1.68-123.32)	.01
Postoperative sepsis/septic shock	8 (0.2)	2	6	106.41 (21.21-533.86)	<.0001
Stroke/cerebrovascular accident	5 (0.1)	4	1	8.43 (0.93-76.11)	.06
Acute renal failure	1 (0.03)	1	0	-	-
Cardiac arrest requiring cardiopulmonary resuscitation	2 (0.1)	1	1	33.54 (2.08-539.90)	.01
Myocardial infarction	11 (0.3)	7	4	20.74 (6.02-71.44)	<.0001
Coma	0 (0)	0	0	-	-
Minor systemic complications	70 (2.0)	48	22	19.22 (11.08-33.33)	<.0001
Urinary tract infection	37 (1.0)	29	8	9.92 (4.42-22.27)	<.0001
Deep venous thrombosis	16 (0.5)	8	8	36.18 (13.30-98.43)	<.0001
Pneumonia	19 (0.5)	13	6	16.33 (6.08-43.86)	<.0001
Progressive renal insufficiency	3 (0.1)	1	2	68.12 (6.13-757.19)	0
Major local complications	13 (0.4)	3	10	123.33 (33.39-455.52)	<.0001
Deep wound infection/organ or space surgical site infection	12 (0.4)	2	10	185.03 (39.98-856.23)	<.0001
Peripheral nerve injury	1 (0.03)	1	0	-	-
Graft/prosthesis failure	0 (0)	0	0	-	-
Minor local complications	11 (0.3)	6	5	29.24 (8.77-97.42)	<.0001
Superficial wound infection	7 (0.2)	5	2	13.63 (2.61-71.07)	0
Wound disruption	4 (0.1)	1	3	79.83 (9.33-693.33)	<.0001
Mortality or major complication	61 (1.7)	34	27	35.63 (20.48-62.01)	<.0001

[a]*Odds ratio (95% confidence interval).*

controlling for the influence of the remaining risk factors. In contrast, the role of patient factors and surgical characteristics in hospital readmission after TSA in single-state[24-26]or single-institution investigations[21] is limited because these studies did not provide the same level of detail on medical comorbidities, laboratory values, and surgical characteristics as the NSQIP data set. Additionally, the current study found no difference for factors previously shown to predict increased 60- to 90-day readmission rates after TSA, such as age,[25] race,[26] or increasing number of medical comorbidities.[25]

After TSA, 3.4% of patients had a complication that significantly increased the likelihood of readmission (OR, 28.95; 95% CI, 18.44-45.46). Systemic complications accounted for three-fourths of patients with major complications (77%) and minor complications (86%). Multivariate analysis showed that medical complications that were significant risk factors for readmission included myocardial infarction, pulmonary embolism, deep venous thrombosis, pneumonia, and urinary tract infection. Further, periprosthetic joint infection was the strongest predictor of hospital readmission and the only statistically significant local complication. Medical complications rather than surgical complications were responsible for most readmissions after TSA, and this finding corroborates previous studies that showed that 80% to 82% of complications leading to readmission after TSA were medical.[25,26]

The identification of pertinent complications that contribute to hospital re-

Table 3

Univariate and Chi-square Analysis of the Influence of Risk Factors on 30-Day Readmission Rate

Risk Factor[a]	Readmission <30 Days[b]	*P*
Age, y		
Age, continuous	1.03 (1.01-1.06)	.0037
Sex		
Female vs male	1.14 (0.77-1.69)	.5133
Body mass index, mean, kg/m^2		
Body mass index, continuous	0.98 (0.95-1.01)	.2931
Functional status		
Dependent vs independent	2.69 (1.21-5.96)	.0148
Wound classification		
All other vs clean	1.20 (0.29-4.98)	.8035
American Society of Anesthesiologists classification		
≥3 (severe or life-threatening disturbance) vs ≤2 (no or mild disturbance)	2.32 (1.51-3.57)	.0001
Preoperative laboratory values		
Platelets, mean±SD, ×10^3/μL	0.997 (0.993-1.000)	.0403
Serum albumin, mean±SD, g/dL	0.44 (0.22-0.89)	.0213
Prealbumin (≤3.5 g/dL vs >3.5 g/dL)	2.40 (1.12-5.18)	.0251
Medical comorbidities		
Dyspnea	2.39 (1.36-4.21)	.0024
Hypertension	1.88 (1.16-3.05)	.0107

Table 3 (cont'd)

Univariate and Chi-square Analysis of the Influence of Risk Factors on 30-Day Readmission Rate

Risk Factor[a]	Readmission <30 Days[b]	*P*
Any cardiac issue	3.07 (1.64-5.73)	.0004
Percutaneous cardiac intervention	3.11 (1.40-6.91)	.0054
Previous cardiac surgery	3.85 (1.72-8.62)	.001
History of revascularization/amputation for peripheral vascular disease/rest pain/gangrene	7.76 (1.15-52.22)	
Sepsis within 48 h before surgery	4.86 (1.09-21.64)	.0382
Previous surgery <30 d earlier	11.19 (1.47-85.53)	.0199
Comorbidities, total		
3 vs 0	5.02 (2.53-9.96)	.0016
Operative time, min		
Operative time, continuous	1.002 (0.998-1.006)	.3753
Type of anesthesia		
General vs spinal/epidural/regional	2.84 (0.39-20.51)	.3019
Bleeding transfusions		
Yes vs no	1.92 (0.98-3.74)	.0567
Time from operation to discharge	1.03 (0.99-1.08)	.1871
Length of stay (≥5 d vs <5 d)	2.64 (1.34-5.17)	.0049

[a]The word "continuous" means as a continuous variable.
[b]Odds ratio (95% confidence interval).

admission after primary TSA can lead to targeted interventions to mitigate these complications in high-risk patients during the perioperative period. In the absence of reliable evidence, the American Academy of Orthopaedic Surgeons offered a consensus statement advocating for perioperative mechanical or chemical venous thromboembolic prophylaxis for patients undergoing TSA. Although deep venous thrombosis and pulmonary embolism were among the most common and significant complications associated with readmission, few clinical studies have investigated these complications[38-42] and their appropriate treatment. This finding underscores the importance of postoperative surveillance for venous thromboembolic disease and careful consideration of chemoprophylaxis in patients undergoing TSA. Additionally, in patients with a history of cardiac disease, cardiology consultation and medical optimization and moderation of risk factors for postoperative urinary tract infection, such as prolonged catheterization, may decrease readmissions after TSA. Finally, hospitals may be pressured to use evidence-based algorithms that have been shown to improve clinical outcomes and reduce length of stay after total joint arthroplasty, independent of hospital or procedure volume,[43] to recoup financial incentives.[44]

Studies of overall 30-,[21] 60-,[21] and 90-day[21,25,26] TSA readmission rates have not provided a detailed analysis of trends in readmission within the first 30 days. When patients are followed for a 90-day period, the plurality of TSA readmissions occur within the first 30 days after hospital discharge.[21] The current study found that among patients with a known time line for readmission, 26% occurred within 5 days and 55% occurred within

Table 4

Significant Risk Factors for 30-Day Readmission

Risk Factor	Readmission <30 Days[a]	*P*
American Society of Anesthesiologists classification ≥3 (severe or life-threatening disturbance) vs ≤2 (no or mild disturbance)	1.84 (1.14-2.96)	.012
Sepsis within 48 h before surgery	8.99 (2.16-37.48)	.0026
Pulmonary embolism	15.36 (3.45-68.42)	.0003
Myocardial infarction	24.44 (6.17-96.76)	<.0001
Urinary tract infection	7.38 (2.92-18.67)	<.0001
Deep venous thrombosis	20.87 (6.47-67.31)	<.0001
Pneumonia	10.85 (3.36-34.99)	<.0001

[a]*Odds ratio (95% confidence interval).*

14 days. Average length of stay was 2.2 days in the TSA cohort. Most preventable hospital readmissions occur in the days immediately after discharge and are related to coordination of care.[45] These data suggest that efforts to decrease readmissions after TSA should be directed toward patients with ASA classification of 3 or greater or with a history of cardiac disease as well as those with a postoperative complication, including periprosthetic joint infection, myocardial infarction, pulmonary embolism, deep venous thrombosis, pneumonia, and urinary tract infection. Careful preoperative screening and discharge planning, with close postoperative surveillance, may be considered in patients with these risk factors, especially within the first 2 weeks after discharge.

Limitations

The strength of the NSQIP data set is its prospective multi-institutional data collection of patient-based and surgical characteristics as well as postoperative complications among more than 3500 TSA procedures. Within the NSQIP infrastructure, rigid protocols dictate close oversight to limit errors in reporting adverse outcomes and maintain the fidelity of data.[27,32] The study had several methodologic limitations. First, the NSQIP does not include information on potential variables, such as hospital volume, insurance status, discharge destination, and standardized comorbidity scores.[24-26] The study attempted to account for comorbid disease with the use of ASA classification as a proxy risk factor for overall health status.[27] Second, the study did not stratify rates of readmission by operative indication and surgical technique (eg, anatomic TSA and reverse TSA) because these procedures were classified under a common CPT code during the study period. Based on previous studies that showed an increased risk of complications in patients undergoing reverse TSA, the 2.9% readmission rate in the current study may be an overestimate of the TSA readmission rate and an underestimate of the reverse TSA readmission rate. However, more recent prospective case-control studies showed no difference in major complications or revision surgery at 2 years when TSA and reverse TSA were compared.[46] Third, the NSQIP data set relates readmissions and the causative condition. Thus, it was not possible to determine the exact cause of readmission or to determine whether readmission events were directly related to the TSA procedure or to complications of surgery.

Despite these limitations, this investigation offers the most comprehensive evaluation of 30-day readmission rates in a large volume of patients undergoing TSA in the United States. Measures to decrease hospital readmission rates must focus on clinically relevant perioperative variables that inform composite risk stratification and reduce medical costs across the continuum of care.[47] Optimized preoperative and perioperative management of patients undergoing TSA with ASA classification of 3 or greater or a history of cardiac disease may include preoperative screening, in-depth surgical counseling, and referral for medical management. Medical interventions to minimize the potential for postoperative complications, such as periprosthetic joint infection, myocardial infarction, pulmonary embolism, deep venous thrombosis, pneumonia, and urinary tract infection, are likely to decrease the need for hospital readmission.

Conclusion

Risk factors that increase the likelihood of readmission after TSA include ASA classification of 3 or greater and a history of cardiac disease. Preoperative medical optimization to reduce rates of postoperative complications, such as periprosthetic joint infection, myocardial infarction, pulmonary embolism, deep venous thrombosis, pneumonia, and urinary tract infection, are likely to decrease the need for hospital readmission. Patients should be counseled on these risk factors preoperatively.

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