Risk Factors for Early Readmission After Anatomical or Reverse Total Shoulder Arthroplasty

Shin Xu, MD, Dustin K. Baker, MD, Justin C. Woods, MD, Eugene W. Brabston III, MD, and Brent A. Ponce, MD

Abstract

Hospital readmissions are costly for patients and institutions. We conducted a study to evaluate rates of readmission within 30 days after anatomical total shoulder arthroplasty (ATSA) and reverse total shoulder arthroplasty (RTSA) and to determine independent risk factors for readmission.

We queried the National Surgical Quality Improvement Program database for ATSAs and RTSAs performed between 2011 and 2013 and found a combined total of 3501 cases and an overall readmission rate of 2.7%. Of the readmissions, 67% were for medical complications, and 33% were for surgical complications. Of the medical complications, pneumonia was the most common (11.8%), followed by urinary tract infection (7.8%). Regarding surgical complications, surgical-site infection was the most common (13.7%), followed by prosthetic joint dislocation (9.8%). Hospital-acquired conditions, including surgical-site infection, urinary tract infection, deep vein thrombosis, and pulmonary embolism, accounted for 33% of all 30-day readmissions.

Three independent risk factors for readmission were identified: revision surgery (odds ratio, 2.59), 3 or more comorbidities (odds ratio, 2.02), and extended length of stay (>4.3 days) during the index admission (odds ratio, 2.48). Other factors significantly ($P < .05$) associated with readmission were age over 75 years, dependent functional status, American Society of Anesthesiologists score of 4 or higher, cardiac comorbidity, 2 or more comorbidities, and urinary tract infection before discharge.

Hospital readmissions are undesirable and expensive.[1] The Centers for Medicare & Medicaid Services (CMS) use hospital readmission rates as one measure of healthcare quality and hospital performance.[2] In addition, the Patient Protection and Affordable Care Act of 2010 established a provision that decreases payments to hospitals with above-average readmission rates.[3] Total knee arthroplasties (TKAs) and total hip arthroplasties (THAs) are among the most common surgical procedures leading to readmission and cost almost $20 billion dollars annually in the Medicare population alone.[1] Identifying factors that lead to readmissions after certain popular procedures may be a way to improve healthcare quality and outcomes while decreasing costs.

One such operation is shoulder arthroplasty (SA), which has surged in popularity over the past decade and is projected to increase faster than TKAs and THAs.[4-6] SA is used to treat a variety of shoulder conditions, including osteoarthritis, inflammatory arthritis, severe proximal humeral fracture, avascular necrosis, and rotator cuff tear arthropathy.[7-12] Much as with knee and hip arthroplasty, good outcomes have been reported with SA: decreased pain, improved range of motion, and high patient satisfaction.[10,13] However, there have been few studies of rates of readmission after SA and the associated risk factors.[3,14,15] The reported rates of early readmission after SA have ranged from 5.6% to 7.3%.[3,14,15] These rates are comparable to rates of readmission after TKA

Authors' Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

(4.0%-6.6%) and THA (3.5%-8.4%).[15-17]

Recently, CMS introduced legislation to void payments for hospital-acquired conditions (HACs), preventable medical conditions that patients develop during or as a result of their hospital care and that were not present on admission.[18] Although many factors contribute to readmission, a recent study regarding all-cause readmission during the first 30 days after discharge found that almost 50% of 30-day readmissions after knee and hip replacements were potentially preventable.[19] HACs resulting in readmission after SAs make up 9.3% to 34.5% of all readmissions, after anatomical total shoulder arthroplasties (ATSAs) and reverse total shoulder arthroplasties (RTSAs).[3,14] The most common HACs include retained foreign body after surgery, air embolism, falls and trauma, catheter-associated urinary tract infection (CAUTI), surgical-site infection, deep vein thrombosis (DVT), and pulmonary embolism (PE).[18] Raines and colleagues[16] found that HACs accounted for 41.7% of all complications in knee or hip arthroplasty and that HACs were the greatest predictors of early readmission after both procedures.

We conducted a study to evaluate rates of readmission within 30 days after ATSA and RTSA and to describe the independent risk factors for readmission. We hypothesized that the rate of readmission after SA would be similar to the rate after knee and hip arthroplasty and that readmission risk factors would be similar. Elucidating these rates and associated risk factors may ultimately help to minimize the burden of disability on patients and the burden of financial costs on healthcare institutions.

Materials and Methods

Institutional Review Board approval was not required for this study, and all data used were de-identified to Health Insurance Portability and Accountability Act (HIPAA) standards. We used the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database for this study. The NSQIP was developed in the 1990s to improve surgical quality in the Veterans Health Administration and was later adapted by the ACS.[20] NSQIP follows patients for 30 days after operations and provides clinical data and outcome measures that are closely regulated and internally audited.[21] The program has continued to expand and now includes more than 400 institutions. The NSQIP database has been validated as a reliable source of surgical outcomes data, including outcomes data for orthopedic procedures, and has been used in other studies of readmissions.[17,22]

In the present study, the ACS-NSQIP files for the period 2011-2013 were queried for all total shoulder arthroplasties (TSAs) (*Current Procedural Terminology* [*CPT*] code 23472, which includes ATSA and RTSA). Descriptive analysis was performed to determine the overall readmission rate as well as

Table 1. **Independent Risk Factors for Readmission**

Factor	*P*	OR	95% CI
Revision surgery	.007	2.591	1.305–5.145
≥3 comorbidities	.048	2.019	1.007–4.048
Extended length of stay (>4.3 d), index admission	.02	2.476	1.156–5.307

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

Table 2. **Reasons for Readmission**

Reason	n
Medical	
Pneumonia	6
Urinary tract infection	4
Deep vein thrombosis	3
Pulmonary embolism	3
Progressive renal insufficiency	2
Chest pain, unspecified	2
Sepsis	1
Septic shock	1
Other postoperative infection	1
Intestinal infection caused by other organism	1
Hyposmolality and/or hyponatremia	1
Calculus of gallbladder with acute cholecystitis, with obstruction	1
Altered mental status	1
Nausea with vomiting	1
Myocardial infarction	1
Congestive heart failure	1
Acute gastric ulcer with hemorrhage	1
Acute kidney failure	1
Other alteration of consciousness	1
Poisoning by opium, unspecified	1
Total	**34**
Surgical	
Surgical-site infection	7
Dislocation of prosthetic joint	5
Hematoma complicating a procedure	2
Dislocation of shoulder	1
Closed dislocation of shoulder	1
Contusion of shoulder region	1
Total	**17**

Table 3. **Univariate Analysis of Factors Associated With Readmission**

Factor	*P*	OR	95% CI
Age >75 y	.031	1.593	1.049–2.417
Dependent functional status	.038	2.594	1.104–6.094
ASA score ≥4	.018	3.118	1.320–7.365
Chronic obstructive pulmonary disease	.089	1.780	0.911–3.479
Cardiac comorbidity	.001	3.370	1.797–6.321
Peripheral vascular disease	.178	5.938	0.708–49.812
Central nervous system comorbidity	.156	2.004	0.717–5.604
Bleeding disorder	.128	2.066	0.884–4.830
≥2 comorbidities	.032	1.615	1.054–2.473
≥3 comorbidities	.001	2.979	1.657–5.534
Extended length of stay (>4.3 d), index admission	.014	2.764	1.307–5.845
Transfusion before discharge	.160	1.817	0.779–4.237
Catheter-associated urinary tract infection before discharge	.048	6.538	1.429–29.911
Myocardial infarction before discharge	.178	5.938	0.708–49.812
Revision surgery	.007	2.722	1.383–5.356

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

the percentages of readmissions for medical and surgical complications. Reasons for readmission were collected from 2012 and 2013 (information from 2011 was absent).

The various patient parameters compiled within the database were examined in a review of ATSAs and RTSAs. Demographics, comorbidities, operative characteristics, and predischarge complications were amassed from these data. Demographics included age, sex, race, body mass index, smoking status, preoperative functional health status, and American Society of Anesthesiologists (ASA) score. Comorbidities included diabetes mellitus, hypertension, chronic corticosteroid use, coagulation disorder, peripheral vascular disease, chronic obstructive pulmonary disease (COPD), cardiac comorbidity (including congestive heart failure, history of myocardial infarction, previous coronary intervention or cardiac surgery, and angina), renal comorbidity (including acute renal failure and preoperative dialysis), neurologic comorbidity (including impaired sensorium, hemiplegia, history of transient ischemic attack, and history of cerebrovascular accident with or without residual deficit), and preoperative blood transfusion. Operative characteristics included resident involvement, operative time more than 1 SD from the mean (>164.4 minutes), intraoperative blood transfusion, and revision surgery. Predischarge complications included pneumonia, CAUTI, DVT, PE, postoperative bleeding that required transfusion, cerebrovascular accident, myocardial infarction, and sepsis. Surgical-site infection, CAUTI, DVT, and PE were selected for analysis because these HACs are common in our cohort.

After the data on these characteristics were collected, univariate analysis was performed to determine association with any readmission. Factors with $P < .20$ were then entered into multivariate analysis to determine independent risk factors for readmission. This P value was selected to make the model inclusive of any potentially important predictor. Univariate analysis was performed using the Fisher exact test. Multivariate analysis was performed using backward conditional binary logistic regression. Statistical significance was set at $P < .05$. All analysis was performed with SPSS Version 22.0 (SPSS).

Results

This study included a combined total of 3501 ATSAs and RTSAs performed between 2011 and 2013. The overall readmission rate was 2.7%. The associated diagnosis for readmission was available for 54% of the readmitted patients. Of the known readmission diagnoses, 33% were secondary to HACs. Three independent risk factors for readmission were identified: revision surgery (odds ratio [OR], 2.59), 3 or more comorbidities (OR, 2.02), and extended length of stay (LOS, >4.3 days) during index admission (OR, 2.48). These factors, plus P values and ORs, are listed in **Table 1**.

Of the 51 readmissions, 34 (67%) were for medical complications, and 17 (33%) were for surgical complications. Pneumonia was the most common medical complication (11.8%), followed by UTI (7.8%), DVT (5.9%), PE (5.9%), and renal insufficiency (3.9%). Surgical-site infection was the most

common surgical complication (13.7%), followed by prosthetic joint dislocation (9.8%) and hematoma (3.9%). Of the HACs, 41.2% were surgical-site infections, 23.5% were CAUTIs, 17.6% were DVTs, and 17.6% were PEs (**Table 2**).

Other risk factors significantly ($P < .05$) associated with readmission were age over 75 years, dependent functional status, ASA score of 4 or higher, cardiac comorbidity, 2 or more comorbidities, postoperative CAUTI, extended LOS, and revision surgery (**Table 3**). The most common comorbidities were hypertension (67.8%), diabetes (16.6%), and COPD (6.3%). Readmitted patients were more likely to be female (56.3%) than male (43.6%). The majority of patients were white (86.1%), and 48.1% were obese (body mass index, >30). In addition, 16.9% of readmissions had resident involvement in the operation, and 13.2% of readmissions had an operative time >164.4 minutes. Of readmitted patients, 3.8% required a postoperative blood transfusion (**Table 4**).

Discussion

Hospital readmissions are important because they represent quality of care and play a role in patient outcomes. Arthroplasty research has focused mainly on readmissions after primary knee and hip replacements.[23-25] Given the increasing popularity of SAs, we initiated the present study to quantify short-term rates of readmission after ATSAs and RTSAs and to determine independent risk factors for readmission based on data from a national database. The results identified a 30-day readmission rate of 2.7%. Risk factors for readmission included revision surgery, 3 or more comorbidities, and extended LOS during the index admission.

Historical rates of early readmission after SA[14] are comparable to those found in our study. Previously identified risk factors have included increasing age, Medicaid insurance status, low-volume surgical centers, and SA type.[3] Mahoney and colleagues[14] reported a 90-day readmission rate of 5.9%, but, when they removed hemiarthroplasty replacement from the analysis and shortened the readmission timeline to 30 days, the readmission rate was identical to the 2.7% rate in the present study. In their series from a single high-volume institution, the highest 90-day readmission rate was found for hemiarthroplasty (8.8%), followed by RTSA (6.6%) and ATSA (4.5%). In a study by Schairer and colleagues,[3] the readmission rate was also influenced by replacement type, but their results differed from those of Mahoney and col-

Table 4. **Demographic and Comorbidity Data for Study Population**

Demographics	**n**	**%**
Age, y		
≤65	1042	29.8
66-75	1394	39.8
76-85	914	26.1
>85	123	3.5
Sex		
Male	1526	43.6
Female	1972	56.3
Race		
White	3013	86.1
Minority	488	13.9
Obesity		
Obese (BMI >30)	1684	48.1
Morbidly obese (BMI >40)	319	9.1
Smokes	333	9.5
Dependent functional status	92	2.6
ASA score ≥4	80	2.3
Comorbidities	**n**	**%**
Diabetes	582	16.6
Hypertension	2375	67.8
Chronic steroid use	178	5.1
Bleeding disorder	115	3.3
Peripheral vascular disease	8	0.2
Chronic obstructive pulmonary disease	221	6.3
Any cardiac	155	4.4
Congestive heart failure	11	0.3
Myocardial infarction <6 mo before surgery	3	0.1
Previous percutaneous coronary intervention	89	2.5
Previous cardiac surgery	70	2
Angina	5	0.1
Any renal	18	0.5
Acute renal failure	3	0.1
Preoperative dialysis	16	0.5
Any neurologic	77	2.2
Impaired sensorium	1	0
Hemiplegia	11	0.3
History of transient ischemic attack	39	1.1
Cerebrovascular accident with deficit	22	0.6
Cerebrovascular accident without deficit	21	0.6
Preoperative blood transfusion	4	0.1
≥2 comorbidities	909	26
≥3 comorbidities	203	5.8

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Table 4. **Demographic and Comorbidity Data for Study Population** *(cont)*

Operative Characteristics	**n**	**%**
Resident involvement	590	16.9
Operative time >164.4 min	461	13.2
Intraoperative blood transfusion	48	1.4
Revision surgery	154	4.4
Predischarge Postoperative Complications	**n**	**%**
Extended length of stay (>4.3 d), index admission	118	3.4
Pneumonia	10	0.3
Pulmonary embolism	5	0.1
Deep vein thrombosis	1	<0.1
Blood transfusion	132	3.8
Urinary tract infection	13	0.4
Cerebrovascular accident	2	0.1
Myocardial infarction	7	0.2
Sepsis	1	0

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; d, days; min, minutes; mo, months; y, years.

leagues.[14] Schairer and colleagues[3] analyzed data from 7 state inpatient databases and found that the highest readmission rate was associated with RTSA (11.2%), followed by hemiarthroplasty (8.2%) and ATSA (6.0%). In both series, RTSA readmission rates were higher than ATSA readmission rates—consistent with the complication profiles of these procedures, with RTSA often provided as a surgery of last resort, after failure of other procedures, including ATSA.[26] The lower 30-day readmission rate in the present study may be attributable to the fact that some surgical and medical complications may not have developed within this short time. Nonetheless, the majority of readmissions typically present within the first 30 days after SA.[14,15] Other factors, including hospital volume, surgeon volume, race, and hospital type, may also influence readmission rates but could not be compared between studies.[27,28]

The present study found that revision surgery, 3 or more comorbidities, and extended LOS (>4.3 days) more than doubled the risk of readmission. Published SA revision rates range from 5% to 42%, with most revisions performed for instability, dislocation, infection, and component loosening.[6,29] Complication rates are higher for revision SA than for primary SA, which may explain why revisions predispose patients to readmission.[30] Compared with primary SAs, revision SAs are also more likely to be RTSAs, and these salvage procedures have been found to have high complication rates.[31] In the present study, the most common comorbidities were hypertension, diabetes, and COPD; the literature supports these as some of the most common comorbid medical conditions in patients who undergo ATSA or RTSA.[5,26,32] Furthermore, all 3 of these comorbidities have been shown to be independent predictors of increased postoperative complications in patients who undergo SA, which ultimately would increase the risk of readmission.[3,26,33,34] Last, extended LOS has also been shown to increase the risk of unplanned readmissions after orthopedic procedures.[35] Risk factors associated with increased LOS after ATSA or RTSA include female sex, advanced age, multiple comorbidities, and postoperative complications.[32]

Several other factors must be noted with respect to individual risk for readmission. In the present study, age over 75 years, dependent functional status, ASA score of 4 or higher, and cardiac comorbidity were found to have a significant association with readmission. Increased age is a risk factor for increased postoperative complications, more medical comorbidities, and increased LOS.[34,36] Older people are at higher risk of developing osteoarthritis and rotator cuff tear arthropathy and are more likely to undergo SA.[5,6] Older people also are more likely to be dependent, which itself is a risk factor for readmission.[19] An ASA score of 3 or 4 has been found to be associated with increased LOS and complications after SA, and cardiac comorbidities predispose patients to a variety of complications.[34,36,37]

In studies that have combined surgical and medical factors, rates of complications early after ATSA and RTSA have ranged from 3.6% to 17.8%.[26,38,39] After SAs, medical complications (80%) are more common than surgical complications (20%).[39] In the present cohort, many more readmissions were for medical complications (67%) than for surgical complications (33%). In addition, Schairer and colleagues[3] found medical complications associated with more than 80% of readmissions after SA.[3] Infection was the most common medical reason (pneumonia) and surgical reason (surgical-site infection) for readmission—consistent with findings of other studies.[3,35,40] Infection has accounted for 9.4% to 41.4% of readmissions after ATSA and

RTSA.[3,14] In joint arthroplasty, infection occurs more often in patients with coexisting medical comorbidities, leading to higher mortality and increased LOS.[41] Prosthetic joint dislocation was common as well—similar to findings in other studies.[3,10]

In the present study, 33% of known readmission diagnoses were secondary to HACs. Surgical-site infection was the most common, followed by CAUTI, DVT, and PE. In another study, of knee and hip arthroplasties, HACs accounted for more than 40% of all complications and were the strongest predictor of early readmission.[16] In SA studies, HACs were responsible for 9.3% to 34.5% of readmissions after ATSA and RTSA.[3,14] Our finding (33%) is more in line with Mahoney and colleagues[14] (34.5%) than Schairer and colleagues[3] (9.3%). One explanation for the large discrepancy with Schairer and colleagues[3] is that UTI was not among the medical reasons for readmission in their study, but it was in ours. Another difference is that we used a database that included data from multiple institutions. Last, Schairer and colleagues[3] excluded revision SAs from their analysis (complication rates are higher for revision SAs than for primary SAs[30]). They also excluded cases of SA used for fracture (shown to increase the risk for PE[42]). The US Department of Health and Human Services estimated that patients experienced 1.3 million fewer HACs during the period 2010-2013, corresponding to a 17% decline over the 3 years.[43] This translates to an estimated 50,000 fewer mortalities, and $12 billion saved in healthcare costs, over the same period.[43] Preventing HACs helps reduce readmission rates while improving patient outcomes and decreasing healthcare costs.

This study had several limitations. We could not differentiate between ATSA and RTSA readmission rates because, for the study period, these procedures are collectively organized under a common *CPT* code in the NSQIP database. Readmission and complication rates are higher for RTSAs than for ATSAs.[3,14] In addition, our data were limited to hospitals that were participating in NSQIP, which could lead to selection bias. We studied rates of only those readmissions and complications that occurred within 30 days, but many complications develop after 30 days, and these increase the readmission rate. Last, reasons for readmission were not recorded for 2011, so this information was available only for the final 2 years of the study. Despite these limitations, NSQIP still allows for a powerful study, as it includes multiple institutions and a very large cohort.

Conclusion

With medical costs increasing, focus has shifted to quality care and good outcomes with the goal of reducing readmissions and complications after various procedures. SA has recently become more popular because of its multiple indications, and this trend will continue. In the present study, the rate of readmission within 30 days after ATSA or RTSA was 2.7%. Revision surgery, 3 or more comorbidities, and extended LOS were independent risk factors that more than doubled the risk of readmission. Understanding the risk factors for short-term readmission will allow for better patient care and decreased costs, and will benefit the healthcare system as a whole.

Dr. Xu is an Orthopedic Surgery Resident, Department of Orthopedic Surgery, University of Kansas School of Medicine, Kansas City, Kansas. Dr. Baker is an Orthopedic Surgery Resident, Department of Orthopaedic Surgery, Saint Louis University School of Medicine, St. Louis, Missouri. Dr. Woods is an Orthopedic Surgery Resident, Dr. Brabston is an Assistant Professor, and Dr. Ponce is an Associate Professor, Division of Orthopaedic Surgery, University of Alabama at Birmingham School of Medicine, Birmingham, Alabama.

Address correspondence to: Brent A. Ponce, MD, Division of Orthopaedic Surgery, University of Alabama at Birmingham School of Medicine, 1313 13th St S, Suite 203, Birmingham, AL 35205 (tel, 205-930-8552; fax, 205-930-8568; email, bponce@uabmc.edu).

Am J Orthop. 2016;45(6):E386-E392.

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