



Research Article

Total Shoulder Arthroplasty Postsurgical Complications and Inpatient Versus Outpatient Status

Fabio R Garrote¹, William Srouji¹, Eric Benk¹, Ligia Perez¹, Garrett R Jackson², Aghdas Movassaghi³, Juan Lozano¹, Vani Sabesan^{1,2,3*}

¹Florida International University, Herbert Wertheim College of Medicine, Department of Medical and Population Health Sciences, Miami, FL, USA

²HCA Florida Atlantis, Department of Orthopedic Surgery, Palm Beach Gardens, FL, USA

³Michigan State University, College of Human Medicine, East Lansing, MI, USA

*Correspondence author: Vani Sabesan, Florida International University, Herbert Wertheim College of Medicine, Department of Medical and Population Health Sciences, Miami, FL, USA and HCA Florida Atlantis, Department of Orthopedic Surgery, Palm Beach Gardens, FL, USA and Michigan State University, College of Human Medicine, East Lansing, MI, USA; Email: sabes001@gmail.com

Abstract

Background: Healthcare systems have pursued safe and cost-effective alternatives to procedures that traditionally require inpatient stays. Total hip and knee arthroplasties have successfully transitioned from Inpatient (IP) to Outpatient (OP) settings. Shoulder Arthroplasty (SA) most recently has transitioned to the outpatient setting as well. To enhance our understanding of the impact of these changes, our study aimed to evaluate postoperative complications for inpatient versus outpatient status in patients undergoing SA to determine if the transition is feasible, safe and efficacious.

Methods and Findings: This is a retrospective cohort investigation using the National Surgical Quality Improvement Program (NSQIP) database which was queried for all adults who underwent SA from 2011 to 2016. The primary independent variable was the type of patient status (IP, OP). The dependent variable was postoperative complications within 30 days of surgery. Multivariate logistic regression and propensity score matching were used to determine the association between patient status and postoperative complications while controlling for confounding variables. Of the 13,299 TSA sampled, 94.1% were IP. The IP cohort was significantly older, had a significantly higher proportion of female patients and had significantly higher rates of hypertension. After matching (IP=1,465 patients; OP=81 patients), the frequency of complications was significantly higher in the IP group compared to the OP group (50.8% vs. 34.6%, respectively; $p = 0.004$). The unadjusted odds ratio of postoperative complications in the entire cohort was significantly higher in the IP than in the OP (OR 1.70, 95% CI 1.16-2.49). The adjusted odds ratio was still statistically significantly higher for the inpatient cohort (aOR 1.53, 95% CI 1.41-2.26). After propensity score matching analysis, the odds ratio was similar (aOR = 1.84, 95% CI 1.14-2.98).

Conclusion: Our study provides evidence supporting the safety and efficacy of outpatient TSA compared to the traditional inpatient approach. Our results demonstrated a significant difference in post-op complication rates among the inpatient cohort than the outpatient cohort, with outpatient TSA demonstrating favorable outcomes. These findings demonstrate the importance of appropriately selecting patients for outpatient TSA.

Keywords: Shoulder Arthroplasty; Postoperative Complications; Inpatient; Outpatient

Introduction

In response to escalating healthcare costs, there has been a notable shift towards outpatient settings for surgical procedures, including Total Joint Arthroplasty (TJA), aiming to optimize cost-effective treatment options [1]. Shoulder Arthroplasty (SA) has become a focus in this context, offering relief for debilitating conditions such as end-stage glenohumeral osteoarthritis, rotator cuff arthropathy and proximal humerus fractures [2]. While traditionally performed as an inpatient procedure, new coding and

Citation: Garrote FR, et al. Total Shoulder Arthroplasty Postsurgical Complications and Inpatient Versus Outpatient Status. J Ortho Sci Res. 2024;5(3):1-7.

<https://doi.org/10.46889/JOSR.2024.5310>

Received Date: 09-11-2024

Accepted Date: 25-11-2024

Published Date: 02-12-2024



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advancements in surgical techniques and anesthesia have facilitated the transition to outpatient surgery, driven by the proven safety and financial advantages observed in outpatient total hip and knee arthroplasty [3].

Despite the increasing popularity of outpatient SA, safety and efficacy concerns persist. Numerous studies have explored the safety of outpatient SA with some indicating comparable or even lower complication and infection rates compared to inpatient procedures [4,5,17]. Furthermore, specific patient populations, such as elderly patients, have been the focus of several studies that consistently showed outpatient SAs to be safe and feasible [9,10]. Additionally, outpatient SA has been associated with lower total costs and shorter hospital stays than inpatient SA, supporting its position as a cost-effective alternative [12]. However, despite these promising findings, several other systematic reviews have reported mixed results regarding the safety and cost-effectiveness of outpatient SA warranting further investigation [6-8]. The purpose of this study was to compare inpatient versus outpatient postoperative complications in adults who underwent SA to determine if the transition from inpatient to outpatient is feasible and safe in a large cohort comparison.

Methodology

Study Design

This is a retrospective cohort study using the National Surgical Quality Improvement Program (ACS NSQIP®) to collect all SA patients from 2011 to 2016. Inclusion criteria comprised of patients ≥ 18 years of age who underwent primary SA (reverse shoulder arthroplasty or anatomic total shoulder arthroplasty). Exclusion criteria included patients who ≤ 18 years of age, underwent hemiarthroplasty or revisions SA. The primary independent variable was the setting of the SA, categorized as inpatient or outpatient setting. The classification was based on the variable INOUT (In/Outpatient Status) from the 2016 NSQIP User Guide. The dependent variable was the occurrence of postoperative complications, including open wounds, pneumonia, unplanned intubation, pulmonary embolism, urinary tract infection, stroke/CVA, cardiac arrest, myocardial infarction, bleeding transfusions, DVT/thrombophlebitis, sepsis and readmission.

Statistical Analysis

Multivariate logistic regression and propensity score matching were used to determine the association between patient status and postoperative complications while controlling for confounding variables, such as age, Body Mass Index (BMI), sex, history of heart failure, diabetes, hypertension and smoking. Propensity scores were calculated using multivariate logistic regression analysis to predict the probability of being assigned to either the inpatient or outpatient group based on potential confounders. Following the calculation of propensity scores, patients were matched based on potential confounders using a caliper width of 0.2, creating comparable groups for analysis. Bivariate analyses were performed to assess the association between baseline characteristics, potential confounders and the exposure and outcome variables. Subgroup analyses were performed as needed to explore potential effect modification.

Results

A total of 13,299 patients underwent SA were included in the final analysis. Most of the patients (12,519; 94.1%) underwent SA in the inpatient setting. Table 1 demonstrates the distribution of the baseline characteristics according to operative patient status (inpatient vs outpatient). The inpatient cohort was significantly older ($p < 0.001$), had a significantly higher proportion of female patients (56.5% vs 50%; $p < 0.001$) and had significantly higher rates of hypertension (67.3% vs 59.1%; $p < 0.001$). No statistically significant differences between the inpatient and outpatient groups were observed for BMI, history of chronic heart failure, diabetes mellitus and smoking.

Table 2 displays the frequency of complications according to patient status and other baseline characteristics in the entire cohort and the matched cohorts. In the entire cohort, the inpatient group had a higher percentage of individuals with complications compared to the outpatient group (6.3% vs. 3.6%, $p=0.003$). The percentage of complications was also different for all other baseline characteristics except smoking. The findings were similar for patients in the matched cohorts. The frequency of complications was significantly higher in the inpatient group compared to outpatient (50.8% vs. 34.6%, respectively; $p=0.004$). Again, there were significant differences in the frequency of complications for all other baseline features except for BMI and smoking.

Unadjusted odds ratios revealed a significantly higher risk of postoperative complications in the inpatient group compared to the outpatient group (OR 1.70, 95% CI 1.16 - 2.49). After adjusting for other baseline characteristics, the odds of experiencing postoperative complications decreased but were still statistically significantly higher for the inpatient cohort (aOR 1.53, 95% CI 1.41 - 2.26). The odds ratio was similar after propensity score matching analysis (aOR = 1.84, 95% CI 1.14 - 2.98). Table 3 shows that all covariates, except for hypertension, are significantly associated with an increased risk of complications in the adjusted analysis with the whole cohort. The matched cohorts showed similar findings, except for BMI, which showed no association with complications in the matched sample.

Patient Characteristics	Inpatient	Outpatient	p-value
	N (%)	N (%)	
Age (years)			<0.001
18-64	3597 (28.9)	289 (37.2)	
65-74	4992 (40.2)	293 (37.8)	
75-84	3346 (26.9)	169 (21.8)	
≥85	498 (4.0)	25 (3.2)	
BMI			0.546
Normal	2064 (16.5)	136 (17.5)	
Overweight	4047 (32.4)	259 (33.4)	
Obese	6362 (51.0)	380 (49.0)	
Sex			<0.001
Female	7071 (56.5)	390 (50)	
Male	5448 (43.5)	390 (50)	
Hx. Congestive Heart Failure			0.304
No	12,453 (99.5)	778 (99.7)	
Yes	66 (0.5)	2 (0.3)	
Diabetes Mellitus			0.230
No	10,335 (82.6)	657 (84.2)	
Yes	2184 (17.4)	123 (15.8)	
Hypertension			<0.001
No	4098 (32.7)	319 (40.9)	
Yes	8421 (67.3)	461 (59.1)	
Smoke			0.928
No	11,190 (89.4)	698 (89.5)	
Yes	1329 (10.6)	82 (10.5)	

Table 1: Characteristics of patients undergoing shoulder arthroplasty by inpatient vs outpatient status (ACS NSQIP, 2011-2016).

Patient Characteristics	Full			Matched		
	Complication (n=800)	No Complication (n=12,499)	p-value	Complication (n=773)	No Complication (n=773)	p-value
Admission Status			0.003			0.004
Inpatient	772 (6.2)	11747 (93.8)		745 (50.8)	720 (49.2)	
Outpatient	28 (3.6)	752 (96.4)		28 (34.6)	53 (65.4)	
Age (years)			<0.001			<0.001
18-64	143 (3.7)	3743 (96.3)		142 (37.7)	234 (62.3)	
65-74	265 (5.0)	5020 (95)		262 (48.1)	282 (51.9)	
75-84	299 (8.5)	3216 (91.5)		299 (56.6)	229 (43.4)	

≥85	71 (13.6)	452 (86.4)		70 (71.4)	28 (28.6)	
BMI			<0.001			0.052
Normal	186 (8.5)	214 (91.5)		173 (56.1)	135 (43.9)	
Overweight	246 (5.7)	4060 (94.3)		250 (51.1)	239 (48.9)	
Obese	362 (5.4)	6380 (94.6)		388 (51.8)	361 (48.2)	
Sex			<0.001			<0.001
Female	543 (7.3)	6918 (92.7)		521 (55.2)	422 (44.8)	
Male	257 (4.4)	5581 (95.6)		252 (41.7)	351 (58.3)	
Hx. Congestive Heart Failure			<0.001			0.012
No	787 (5.9)	12,444 (94.1)		762 (49.7)	771 (50.3)	
Yes	13 (19.1)	55 (80.9)		11 (84.6)	2 (15.4)	
Diabetes Mellitus			<0.001			0.007
No	621 (5.6)	10,371 (94.4)		598 (48.3)	640 (51.7)	
Yes	179 (7.8)	2128 (92.2)		175 (56.8)	133 (43.2)	
Hypertension			0.004			0.028
No	229 (5.2)	4188 (94.8)		218 (45.7)	258 (54.3)	
Yes	571 (6.4)	8311 (93.6)		555 (51.8)	515 (48.2)	
Smoke			0.399			0.287
No	708 (6.0)	11,180 (94.0)		683 (49.5)	696 (50.5)	
Yes	92 (6.5)	1319 (93.5)		90 (53.8)	77 (46.2)	

Table 2: Characteristics of patients undergoing shoulder arthroplasty by post-operative complication, full and matched samples (ACS NSQIP, 2011-2016).

Characteristic	Unadjusted		Adjusted		Match adjusted	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Patient Status						
Outpatient	Reference		Reference		Reference	
Inpatient	1.70 (1.16-2.49)	0.007	1.53 (1.41-2.26)	0.031	1.84 (1.14-2.98)	0.013
Age (years)						
18-64	Reference		Reference		Reference	
65-74	1.38 (1.12 -1.70)	0.002	1.35 (1.09-1.67)	0.006	1.50 (1.13-1.98)	0.005
75-84	2.43 (1.98-2.99)	<0.001	2.37 (1.90-2.95)	<0.001	2.09 (1.56-2.80)	<0.001
≥85	4.11 (3.04-5.56)	<0.001	3.81 (2.77-5.25)	<0.001	4.15 (2.50-6.89)	<0.001
BMI						
Normal	Reference		Reference		Reference	
Overweight	0.66 (0.54-0.80)	<0.001	0.75 (0.61-0.92)	0.006	0.79 (0.59-1.07)	0.129
Obese	0.61 (0.51-0.74)	<0.001	0.74 (0.61-0.91)	0.003	0.80 (0.60-1.07)	0.126
Sex						
Male	Reference		Reference		Reference	
Female	1.71 (1.46-1.99)	<0.001	1.51 (1.29-1.76)	<0.001	1.61 (1.30-1.99)	<0.001
Heart Failure						
Yes	Reference		Reference		Reference	
No	0.27 (0.15-0.49)	<0.001	0.37 (0.19-0.73)	0.004	0.20 (0.04-0.96)	0.044
Diabetes						
Yes	Reference		Reference		Reference	
No	0.71 (0.60-0.85)	<0.001	0.69 (0.57-0.82)	<0.001	0.69 (0.53-0.91)	0.008
Hypertension						
Yes	Reference		Reference		Reference	

No	0.80 (0.68-0.93)	0.005	0.92 (0.77-1.09)	0.323	0.92 (0.72-1.16)	0.470
Smoking						
Yes	Reference		Reference		Reference	
No	0.91 (0.73-1.14)	0.399	0.67 (0.53-0.85)	0.001	0.64 (0.45-0.90)	0.01

Table 3: Unadjusted and adjusted association between post-operative complications and inpatient vs outpatient status in patients undergoing shoulder arthroplasty, full and matched samples (ACS NSQIP, 2011-2016).

Discussion

Shoulder arthroplasty is an effective treatment option for managing glenohumeral arthritis, rotator cuff arthroplasty and tears, proximal humeral fractures, upper extremity trauma and failed shoulder prostheses [16]. Although this surgery has been traditionally performed inpatient, the growing demand for a more cost-effective approach has resulted in the transition of many surgical interventions to outpatient settings [1,2]. Using the NSQIP database from 2011 to 2016, we identified 13,299 patients who had undergone TSA, with 780 of them as surgeries performed in the outpatient setting. Although the volume of cases has since considerably increased, our study provides an early baseline to assess the feasibility and safety of this transition.

Our findings highlight the safety of outpatient shoulder arthroplasty, particularly for patients over 65 or those with specific comorbidities, such as diabetes and heart failure. Recent work by Trudeau, et al., examined similar outcomes using NSQIP data from 2015-2019, reporting comparable safety in outpatient shoulder arthroplasty, particularly in lower-risk cohorts [8]. By comparing our findings to this more recent data, we can observe trends in patient selection and complication rates over time. For instance, while our study noted a higher incidence of complications among the inpatient cohort, especially among elderly and high-risk patients, Trudeau, et al., reported that outpatient outcomes as comparable to those in inpatient settings after adjusting for patient risk [8].

A key strength of our study is in our data analysis where propensity scores were used to match patients with a similar distribution of confounders, ensuring unbiased estimates of treatment effect [13]. Following matching based on potential confounders (e.g., age, BMI, sex, comorbidities), 1,546 patients were matched - 773 patients with complications and 773 with no complications. We found that postoperative complications in the inpatient group were significantly higher using this well validated statistical method. Furthermore, the study results demonstrated a higher incidence of post-operative complications in those 65 years of age or older than in younger patients. Consistent with our findings, other studies have reported increased age as an independent risk factor for post-operative complications following shoulder arthroplasty, with a complication rate as high as 15.3% and 5.5% unplanned readmission among elderly patients [19]. Other baseline characteristics associated with an increased likelihood of experiencing postsurgical complications in the inpatient setting were female gender and past medical history of either congestive heart failure or diabetes [17,20]. Finally, the preliminary analysis did not show significant complications associated with smoking history; however, following the adjustment for baseline characteristics and propensity score matching, smoking showed a statistically significant association with postoperative complications following TSA. These results highlight specific risk characteristics that have been and continue to be factors in increased complications and concerns for outpatient setting shoulder arthroplasty to be successful.

A limited number of similar studies analyzing complication rates in the inpatient vs. outpatient settings showed no statistically significant difference in postoperative complication rates between the inpatient and outpatient cohorts [2,8,17]. Contrary to these findings, our study found complication rates in the outpatient population to be significantly lower compared to inpatient even in matched cohorts suggesting there may be some factors in optimization or procedurally itself that provide some advantages in the outpatient setting.

In this study, we utilized data from the NSQIP database from 2011 to 2016 and employed logistic regression and propensity score matching to conduct our data analysis. While previous studies have utilized similar methodologies using the NSQIP database, there have been variations in approach. For instance, one study adjusted for additional variables related to procedural characteristics but did not incorporate propensity score matching into their analysis [2]. Another study, which found a lack of significance between cohorts, may have been influenced by differences in patient population collection methods and the consideration of comorbidities [17]. Furthermore, prior research has consistently reported higher readmission rates and postoperative complications for inpatient surgeries, findings that align with our study [14]. A recent meta-analysis found lower

complication rates in outpatient shoulder arthroplasty, but no difference in hospital readmission rates, revisions or infections [5]. However, it is crucial to acknowledge potential limitations related to database selection, particularly concerning the predominance of older individuals (aged 65 years and older) in the patient demographic, which could impact the external validity of previous studies [14].

Limitations

Conducting a study based on a secondary database analysis presents inherent limitations. Although the impact of confounding variables was minimized with propensity score matching analysis, specific potential residual confounders could not be accounted for in our study. For instance, variations in surgeon characteristics, including training, experience and volume of procedures performed per year could potentially influence postoperative outcomes. Moreover, the NSQIP database's constraints on follow-up duration and complication observation period pose limitations to the completeness of the data. Specifically, the NSQIP limits the complication observation period to the first 30 days after surgery. Furthermore, the substantial difference in sample sizes between inpatient and outpatient cohorts may have implications for the reliability and precision of our study findings which however were addressed with the quality of the analyses and propensity matching in the methods. Additionally, our study specifically focused on five-year data available through NSQIP. While the time frame was chosen because of access limitations and the data reflects an earlier time, the findings remain relevant and continue to be shown in smaller more recent studies. We believe the strength of the national numbers and the matched cohort analyses allow us to better understand the setting variance or impact on results in isolation and understand the true risk factors between patient groups that may lead to higher complications [18].

Conclusion

Our study provides evidence supporting the safety and efficacy of outpatient SA compared to the traditional inpatient approach. Our results demonstrated an increased risk of in post-operative complication rate among patients undergoing SA in the inpatient setting, especially with increased risk for patients over 65 years old, females, patients with congestive heart failure and diabetes and for smoking. These findings demonstrate the importance of appropriately selecting patients for outpatient SA and for us to continually review results and criteria of these optimal patients for this setting.

Conflict of Interest

The authors report no relevant financial conflicts of interest for this manuscript.

Funding

This research did not receive any specific grants from funding agencies in the public, commercial or not-for-profit sectors.

Authors' Contributions

All authors contributed equally in this paper.

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