Original Research

Inpatient versus outpatient shoulder arthroplasty outcomes: A propensity score matched risk-adjusted analysis demonstrates the safety of outpatient shoulder arthroplasty

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ABSTRACT

Objectives: Beginning January 1, 2021 total shoulder arthroplasty (TSA) was removed from the Medicare (U.S national healthcare for patients ≥ 65 years of age) inpatient-only list. Furthermore, there is limited data comparing outpatient and inpatient TSA among recent contemporary large population databases. This study aimed to analyze shoulder arthroplasty outcomes between inpatient and outpatient procedures at the national level.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was utilized (2015–2019). Cases with a current procedural terminology of 23472 indicative of primary TSA and reverse total shoulder arthroplasty were included ($N = 22,452$). Outcomes were then analyzed in two approaches: unmatched analysis and propensity score matched risk-adjusted analysis.

Results: Overall, 9.7% ($N = 2,185$) of cases were performed outpatient and 90.3% ($N = 20,357$) of cases were performed inpatient. The rate of outpatient procedures has been steadily increasing (2015: 8.3%, 2016: 14.7%, 2017: 15.8%, 2018: 26.5%, 2019: 34.6%; $P < 0.001$). Outpatients were more likely to be male (50.7% vs. 43.7%) and younger (age < 65 ; 37.0% vs. 27.9%) and less likely to be ASA class 3 or 4 (49.5% vs. 58.3%). Outpatients had fewer comorbidities including obesity (46.1% vs. 51.9%), hypertension (60.5% vs. 67.4%), diabetes (15.1% vs. 18.2%), chronic obstructive pulmonary disease (4.8% vs. 7.0%), bleeding disorders (1.3% vs. 2.5%), or chronic steroid use (3.5% vs. 5.0%; all $P < 0.001$). In a non-risk matched analysis of outcomes, outpatient procedures displayed lower rates of any adverse event (3.5% vs. 5.3%; $P < 0.001$), minor adverse events (1.5% vs. 3.0%; $P = 0.001$), and readmission (2.2% vs. 2.8%; $P = 0.025$). Following a propensity score matched analysis, two risk matched cohorts of outpatient ($N = 2,172$) and inpatient ($N = 2,172$) procedures were identified. Subsequent analysis of outcomes revealed no significant differences in outcome metrics between risk-matched outpatient and inpatient procedures.

Conclusions: From 2015 to 2019, there has been a four-fold increase in the proportion of outpatient shoulder arthroplasty cases in the ACS-NSQIP database. This study shows that outpatient shoulder arthroplasty may be safely performed in a select cohort of patients without increased risk of adverse events. After adjusting for comorbidities, there were no differences in clinical outcomes or rates of adverse outcomes between inpatient and outpatient shoulder arthroplasty.

Level of evidence: Retrospective Observational Study, Level IV.

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What are the new findings?

- Shoulder arthroplasty can be safely performed in the outpatient setting with equivalent outcomes.
- In the past 5 years, the proportion of outpatient shoulder arthroplasty cases in the NSQIP database has increased four-fold (8.3%–34.6%).
- Currently, patients being selected for outpatient shoulder arthroplasty have significantly less comorbidities.

Introduction

Over the past decade, outpatient total shoulder arthroplasty has become increasingly popular, with four-fold increases over just the past five years [1]. More importantly, on January 1, 2021 total shoulder arthroplasty was removed from the Medicare (U.S national healthcare for patients ≥ 65 years of age) inpatient-only list, which may be the start of increased same-day discharge for private insurance as well [2]. In 2008, Gallay et al. investigated the feasibility of outpatient shoulder arthroplasty in a pilot study and, demonstrated improved pain and patient satisfaction scores with decreased readmissions [3]. This paradigm shift in shoulder arthroplasty has been accelerated due to advances in multimodal anesthesia techniques, effective venous thromboembolism prophylaxis, and appropriate blood and wound care management [4]. The safety and efficacy of outpatient shoulder arthroplasty has been demonstrated in many single-institutional experiences [5–14], large national database investigations [15–18], and systematic reviews with meta-analyses [19–22]. Furthermore, many studies have reported the potential financial advantages of performing outpatient shoulder arthroplasty, predicting annual savings of approximately \$100 million for the healthcare system [4,23–25]. Other investigations have defined objective selection criteria for determining which patients are the best candidates for outpatient shoulder arthroplasty [26–28].

However, few studies have utilized the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database to analyze outpatient shoulder arthroplasty outcomes [15]. Steinhilber et al. used the NSQIP database in an attempt to identify patients not suitable for same day discharge, but did not provide any outcomes comparisons between outpatient and inpatient [17]. To date, the only existing NSQIP investigation comparing outpatient and inpatient complications included patients from 2005 to 2014 and was limited to 173 outpatient procedures [16]. Moreover, recent survey data demonstrates that less than 25% of surgeons perform outpatient shoulder arthroplasty [4]. There is a paucity of data that exists analyzing rates of contemporary outpatient shoulder arthroplasty. Therefore, this study aimed to (1) analyze shoulder arthroplasty outcomes between inpatient and outpatient procedures, and (2) define current rates in outpatient shoulder arthroplasty procedures at the national level.

Methods

Total shoulder arthroplasty and reverse shoulder arthroplasty procedures were queried using the Current Procedural Code (CPT) 23472 to identify cases within the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). The ACS-NSQIP database utilized consisted of five years of data (2015–2019) from over 700 academic and community hospitals. Preoperative, intraoperative, and post-operative factors were included in the database. Patient characteristic data included age, gender, race, American Society of Anesthesiologist (ASA) classifications, smoking, obesity, hypertension, diabetes mellitus, congestive obstructive pulmonary disease (COPD), congestive heart failure (CHF), weight loss greater than 10% within 6 months prior to surgery, bleeding disorders, steroid use, and operative time. Clinical outcome data included superficial incisional surgical site infections, deep

incisional surgical site infections, organ/space surgical site infections, wound disruption, pneumonia, unplanned intubation, pulmonary embolism, ventilator use, progressive renal insufficiency, acute renal failure, urinary tract infection, stroke, cardiac arrest, myocardial infarction, transfusions, deep vein thrombosis, sepsis, septic shock, and *Clostridium difficile* infections (all within 30 days post-operation). Composite outcome metrics were then categorized into severe, minor and any adverse event based on previous research [16]. Severe adverse events included 30-day mortality, cardiac arrest, deep vein thrombosis, myocardial infarction, post-operative intubation, ventilator use, acute renal failure, pulmonary embolism, surgical site infections (superficial, deep, and organ/space), reoperation, stroke, and sepsis. Minor adverse events included progressive renal insufficiency, wound disruption, pneumonia, urinary tract infection, and blood transfusion. Any adverse event consisted of both severe and minor adverse events. This study analyzed outcomes using two approaches: (1) unmatched analysis and (2) propensity score matched risk-adjusted analysis.

Statistical analysis

Descriptive statistics encompassing categorical variables were presented as frequencies and percentages. The association between categorical variables was tested using Pearson's χ^2 test or Fisher exact test, as appropriate. Continuous variables were expressed as mean with standard deviation when parametric and medians and interquartile ranges (IQR) when non-parametric, and comparisons among groups were conducted through ANOVA test or Kruskal–Wallis test, as appropriate. All tests were 2-sided and type I error of 0.05 was used for analysis. Analyses were performed with SPSS 27.0 (IBM Corporation, Armonk, NY).

Propensity score matching (PSM) is a technique accounting for treatment selection bias when estimating treatment effects using non-randomized retrospective data. This study utilized a multivariable logistic regression model to calculate propensity scores accounting for patient characteristics that were significantly different between inpatient and outpatient shoulder arthroplasty procedures (sex, age, ASA, obesity, hypertension, COPD, bleeding disorders, and chronic steroid use) [29]. In this framework, a propensity score was calculated for the patient's probability of receiving a total shoulder arthroplasty inpatient or outpatient. After propensity score calculation, outpatient cases were paired with controls (inpatient) 1:1 using an exact matching algorithm without replacement. Exact matching (caliper = 0.0) results in an unbiased balance of covariates, although reducing the number of matched subjects. After 1:1 matching, outcomes were re-analyzed.

Results

Baseline patient characteristics

Overall, 9.7% (N = 2,185) of cases were performed outpatient and 90.3% (N = 20,357) of cases were performed inpatient. Patients who had outpatient procedures were more likely to be male (50.7% vs. 43.7%; $P < 0.001$) and younger (age < 65 ; 37.0% vs. 27.9%). Outpatients were also less likely to be ASA class 3 or 4 (49.5% vs. 58.3%; $P < 0.001$) and had fewer comorbidities including obesity (46.1% vs. 51.9%; $P < 0.001$), hypertension (60.5% vs. 67.4%; $P < 0.001$), diabetes (15.1% vs. 18.2%; $P < 0.001$), chronic obstructive pulmonary disease (4.8% vs. 7.0%; $P < 0.001$), bleeding disorders (1.3% vs. 2.5%; $P < 0.001$), or chronic steroid use (3.5% vs. 5.0%; $P < 0.001$). Further details between the two cohorts can be observed in Table 1.

Outcomes

In a non-risk matched analysis of outcomes, outpatient procedures displayed lower rates of any adverse event (3.5% vs. 5.3%; $P < 0.001$), minor adverse events (1.5% vs. 3.0%; $P = 0.001$), and readmission (2.2% vs. 2.8%; $P = 0.025$; Table 2).

Table 1

Comparison of patient characteristics between inpatient and outpatient shoulder arthroplasty procedures (N = 22,452).

Variables	Inpatient N = 20,357		Outpatient N = 2185		P
	N	%	N	%	
Gender					
Female	11453	56.3%	1078	49.3%	< 0.001
Male	8904	43.7%	1107	50.7%	
Race					
Black/African American	965	4.7%	112	5.1%	0.643
White	17057	83.8%	1831	83.8%	
Other	2335	11.5%	242	11.1%	
ASA					
1 & 2	8479	41.7%	1104	50.5%	< 0.001
3 & 4	11878	58.3%	1081	49.5%	
Age ≥ 65 years	14593	72.1%	1372	63.0%	< 0.001
Obesity	10575	51.9%	1008	46.1%	< 0.001
Hypertension	13725	67.4%	1321	60.5%	< 0.001
Diabetes mellitus	3699	18.2%	330	15.1%	< 0.001
COPD	1416	7.0%	105	4.8%	< 0.001
Congestive heart failure	147	0.7%	8	0.4%	0.056
Weight loss (> 10%)	37	0.2%	5	0.2%	0.628
Bleeding disorders	512	2.5%	29	1.3%	0.001
Steroid use	1022	5.0%	76	3.5%	0.001

ASA, American Society of Anesthesiologists.

Bold indicates significance.

Following a propensity score matched analysis, two risk-matched cohorts of inpatient (N = 2,172) and outpatient (N = 2,172) procedures were identified (Table 3). All previous differences in patient characteristics (gender, ASA class, age, obesity, hypertension, diabetes, COPD, bleeding disorders, and steroid use) were successfully balanced (all P = 1.000). In this risk-matched comparison there were no significant differences in any adverse event (3.5% vs. 4.1%; P = 0.339), minor adverse event (1.5% vs. 2.0%; P = 0.200), severe adverse event (2.3% vs. 2.5%; P = 0.551), readmission (2.1% vs. 2.6%; P = 0.229), or reoperation (1.0% vs. 1.7%; P = 0.066). While not statistically significant, the outpatient cohort had lower rates of adverse outcomes compared to the inpatient group (any adverse event = 3.5% vs. 4.1%; Table 4).

Current trends in shoulder arthroplasty

Overall, when focusing on inpatient procedures, length of stay has decreased over recent years; 2015: 1.9 ± 3.6 days, 2016: 1.8 ± 3.6 days, 2017: 1.7 ± 3.1 days, 2018: 1.4 ± 4.2 days, 2019: 1.3 ± 3.2 days (P < 0.001). Median and IQR for length of stay by year demonstrated similar findings; 2015: 2.0 (IQR: 1.0–2.0), 2016: 1.0 (IQR: 1.0–2.0), 2017: 1.0 (IQR: 1.0–2.0), 2018: 1.0 (IQR: 1.0–2.0), and 2019: 1.0 (IQR: 1.0–2.0). Similarly, the rate of outpatient procedures has been steadily increasing (2015: 8.3%, 2016: 14.7%, 2017: 15.8%, 2018: 26.5%, 2019: 34.6%; P < 0.001).

Table 2

Unmatched comparison of outcomes between inpatient and outpatient shoulder arthroplasty (N = 22,542).

Outcomes	Inpatient N = 20,357		Outpatient N = 2185		P
	N	%	N	%	
Any adverse event	1085	5.3%	77	3.5%	< 0.001
Minor adverse event	613	3.0%	33	1.5%	
Severe adverse event	575	2.7%	49	2.2%	
Readmission	600	2.8%	46	2.2%	0.025
Reoperation	293	1.4%	22	1.0%	0.102

Bold indicates significance.

Table 3

Comparison of patient characteristics between inpatient and outpatient shoulder arthroplasty procedures following propensity score matched analysis (N = 4344).

Variables	Inpatient N = 2172		Outpatient N = 2172		P
	N	%	N	%	
Gender					1.000
Female	1069	49.2%	1069	49.2%	
Male	1103	50.8%	1103	50.8%	
Race					0.136
Black/African American	89	4.1%	110	5.1%	
White	1811	83.4%	1820	83.8%	
Other	272	12.5%	242	11.1%	
ASA					1.000
1 & 2	1103	50.8%	1103	50.8%	
3 & 4	1069	49.2%	1069	49.2%	
Age ≥ 65 years	1369	63.0%	1369	63.0%	1.000
Obesity	1002	46.1%	1002	46.1%	1.000
Hypertension	1312	60.4%	1312	60.4%	1.000
Diabetes mellitus	323	14.9%	323	14.9%	1.000
COPD	101	4.7%	101	4.7%	1.000
Congestive heart failure	14	0.6%	7	0.3%	0.126
Weight loss (> 10%)	0	0.0%	5	0.2%	0.025
Bleeding disorders	26	1.2%	26	1.2%	1.000
Steroid use	73	3.4%	73	3.4%	1.000

ASA, American Society of Anesthesiologists.

Bold indicates significance.

Discussion

The most important finding of this study is that large, national multi-year data indicate that shoulder arthroplasty can be performed as safely in the outpatient setting as it can in the inpatient setting. When controlling for differences in patient comorbidities using propensity score-matched analysis, there were no significant differences in any-, minor-, or severe adverse events, readmission, and reoperation between inpatients and outpatients.

When comparing inpatient versus outpatient procedures, outpatient cases were more likely to be male and younger (age < 65 years) and less likely to be ASA class 3 or 4, rather than 1 or 2. Outpatients were also less likely to have various comorbidities including obesity, hypertension, diabetes mellitus, COPD, CHF, bleeding disorders, and chronic steroid use. These findings indicate that when insurance is not the driving factor dictating the decision to perform shoulder arthroplasty as outpatient or inpatient, shoulder surgeons are likely reserving outpatient procedures for more robust patients absent of significant comorbidities associated with increased morbidity and mortality [30–32]. These findings may mitigate concern that patient comorbidities drive procedure type. These findings are consistent with prior studies that advocate for the proper selection of patients for outpatient shoulder arthroplasty [26–28]. As advances in perioperative care continue to be established, the number of patients chosen for outpatient surgery will likely continue to rise and include patients of greater comorbidities. Further research is needed to identify what factors most greatly increase the risk of patient complications in the outpatient setting.

While outpatient procedures displayed decreased rates of adverse

Table 4

Risk-matched comparison of outcomes between inpatient and outpatient shoulder arthroplasty (N = 4374).

Outcomes	Inpatient N = 2172		Outpatient N = 2172		P
	N	%	N	%	
Any adverse event	88	4.1%	76	3.5%	0.339
Minor adverse Event	43	2.0%	32	1.5%	
Severe adverse event	55	2.5%	49	2.3%	
Readmission	57	2.6%	45	2.1%	0.229
Reoperation	37	1.7%	22	1.0%	0.066

events in the non-risk-matched analysis, it was evident that this may be an artifact of patient selection. Following the propensity score matched analysis, there was no difference in the number of any-, minor-, or severe adverse events, as well as readmissions and reoperations between inpatient and outpatient procedures. This analysis substantiates the equivalent outcomes previously displayed by single-institution analyses demonstrating the safety and efficacy of outpatient shoulder arthroplasty [5–14].

Despite demonstrating similar outcomes in movement and function, a recent study revealed that outpatient arthroplasty might be associated with an increased post-operative fall rate, as their single-institution experience demonstrated a significant difference (10.6% vs. 1.0%). In addition to other adverse outcomes, patient fall rates may be diminished and eventually eliminated through careful monitoring and implementation of web-based home therapy programs. These programs have shown promise as supplements to the standard post-operative care seen with inpatient shoulder arthroplasty [33].

From 2015 to 2019, the cohort demonstrated a four-fold increase in outpatient shoulder arthroplasty. Outpatient procedures accounted for 34.6% of shoulder arthroplasties from the ACS-NSQIP database in 2019. This is a substantial increase since the only previous NSQIP study comparing outpatient and inpatient outcomes, which encompassed patients from 2005 to 2014, with only 2.4% of patients undergoing outpatient procedures [16]. Considering the equivalent outcomes of risk-match patients receiving inpatient and outpatient shoulder arthroplasty, it is expected the proportion of patients receiving outpatient procedures will continue to increase. Additionally, a recent survey study of outpatient shoulder arthroplasty patients revealed all patients were satisfied with their functional outcome and 84% were satisfied with their outpatient management specifically [34].

From a financial standpoint, these findings are important as health care policy makers have placed increased attention on the cost of health care, making outpatient arthroplasty a cost-effective alternative to routine hospital admission [4]. When compared to inpatient management for shoulder arthroplasty, performing the procedure in the ambulatory setting was associated with an average cost saving of \$5,600 (range: \$747–\$15,507) [23]. A recent study used this average cost difference and a predicted 36% outpatient procedure volume over the next ten years to calculate potential savings, which equated to \$4.1 million to \$349 million per year, and a ten year saving of \$51 million to \$5.4 billion [23]. It is likely that cost savings will continue to be a major driver in the continued increased proportion of shoulder arthroplasty cases performed as outpatient procedures.

There are several limitations to this study. First and foremost, the NSQIP database is not fully representative of the surgical environment of the United States, as the database is predominated by hospitals, with limited inclusion of outpatient surgery centers. Using these data may underestimate the occurrence of outpatient shoulder arthroplasty, across the United States. Moreover, NSQIP does not identify planned outpatient shoulder arthroplasty cases that ultimately were not discharged and required admission to the hospital. This study also lacks important range of motion and functional outcome scores (e.g. American Shoulder and Elbow Surgeons, single assessment numeric evaluation, and visual analog score) and any outcomes beyond 30-days.

Conclusion

From 2015 to 2019, there has been a four-fold increase in the proportion of outpatient shoulder arthroplasty cases in the ACS-NSQIP database. This study shows that outpatient shoulder arthroplasty may be safely performed in a select cohort of patients without increased risk of adverse events. After adjusting for comorbidities, there were no differences in clinical outcomes or rates of adverse outcomes between inpatient and outpatient shoulder arthroplasty.

Author contributions

All authors contributed to data analysis, drafting or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published and agree to be accountable for all aspects of the work.

Declaration of competing interest

The authors Trudeau MT, Peters JP, LeVasseur MR, Hawthorne BC, Dorsey CG, Wellington LJ, and Shea KP declare no conflicts of interest. Mazzocca AD reports research grants from Arthrex, Inc. and is a consultant for Arthrex, Inc.

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