Readmission, reoperation, and nonhome discharge rates in patients receiving surgical treatment for proximal humerus fractures

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Background: Proximal humerus fractures (PHFs) are generally surgically treated with open reduction internal fixation (ORIF), hemiarthroplasty (HA), or total shoulder arthroplasty (TSA). Diverse fracture patterns and a high prevalence in the elderly population make it difficult to establish objective guidelines for the decision to undergo surgical treatment. The purpose of this study was to investigate risk factors associated with readmission, reoperation, and nonhome discharge following ORIF, HA, and TSA for PHFs.
Methods: Data on all patients who underwent ORIF, TSA, or HA for treatment of closed PHF between 2015 and 2017 were obtained by querying the American College of Surgeons National Surgical Quality Improvement database. Rates of postoperative readmission, nonhome discharge, and reoperation within 30 days were collected. Multivariate logistic regression was employed to identify predictors of readmission, nonhome discharge, and reoperation.
Results: A total of 2825 patients were included in this study: 1829 underwent ORIF, 707 underwent TSA, and 289 underwent HA. The significant predictors for readmission were having an American Society of Anesthesiologists class ≥ 3 (odds ratio [OR] 1.95, $P = .003$) and being of dependent functional status (OR 3.15, $P < .001$). The significant predictors for reoperation were male sex (OR 2.41, $P < .001$) and dependent functional status (OR 2.92, $P = .006$). The significant predictors for nonhome discharge were age 66-80 years (OR 7.00, $P < .001$), age ≥ 81 years (OR 16.31, $P < .001$), American Society of Anesthesiologists ≥ 3 (OR 2.34, $P < .001$), dependent functional status (OR 2.48, $P < .001$), and inpatient status (OR 3.32, $P < .001$). TSA showed slightly higher rates of nonhome discharge than HA and ORIF.
Conclusion: Significant risk factors for readmission, reoperation, and nonhome discharge within 30 days following surgical treatment for PHF were identified. Additionally, TSA was significantly associated with nonhome discharge compared with HA and ORIF.

Proximal humerus fractures (PHFs) are one of the most common osteoporotic fractures, accounting for roughly 6% of all fractures.[22] The majority of PHFs are seen in elderly patients after low-energy trauma, such as ground-level falls.[28] These fractures are also seen in the younger population after high-energy trauma. The majority of PHFs are treated nonoperatively with sling immobilization.[28] Surgical treatment is often indicated in more complex and displaced fracture patterns. Options for surgical treatment include closed reduction percutaneous pinning, open reduction internal fixation (ORIF), intramedullary nailing, hemiarthroplasty (HA), and total shoulder arthroplasty (TSA, anatomic or reverse).[2,3,5] Selecting an optimal treatment strategy is complex and requires orthopedic surgeons to consider fracture patterns as well as numerous patient-specific factors. These patient-specific factors include age, bone quality, concurrent injuries, and overall health status.[28] The complexity of fracture patterns and diversity in patient characteristics present challenges to establishing objective guidelines for the decision to undergo surgical treatment.[13,28] Ideal management of these fractures would ensure maximal functional outcomes while minimizing complications and costs.

Readmission following surgical treatment of PHF increases patient morbidity and overall health-care expenditures. A majority of readmissions following surgical management of PHF are due to

complications such as septicemia, deep venous thrombosis, and secondary hip fracture.[31] Unplanned readmission can also drastically increase health-care costs. One study found that readmission following surgical treatment of PHF increased in-hospital costs by $54,345.[27] In order to prevent patient morbidity associated with readmission, specific policies such as the Hospital Readmission Reduction Program (HRRP) have been employed to reduce the number of preventable hospital readmissions and reoperations.[14]

Reoperation following surgical treatment of PHF is often secondary to surgical complications such as mechanical problems or dislocation.[7] Reoperation rates have previously been utilized as a metric for monitoring hospital quality.[1,15] Several studies have found that revision shoulder arthroplasty is associated with decreased functional outcomes and higher complication rates than primary shoulder arthroplasty.[8,17,23] Therefore, identifying risk factors for reoperation following surgical treatment of PHF is instrumental to reducing patient morbidity and improving the delivery of care for these patients.

Nonhome discharge following surgical treatment of PHF is attributed to poorer functional independence. This increases health-care expenses. A study by Malik et al. found that 21.6% of patients who underwent surgical treatment of PHF from 2012 to 2016 had nonhome discharges.[16] Patients of partially dependent functional health status who are discharged to nursing homes or continuing-care facilities are at further risk for adverse health events, including thromboembolic and renal complications.[12,16,31]

The primary objective of this study was to identify risk factors associated with 30-day readmission, 30-day reoperation, and nonhome discharge in patients undergoing surgical treatment of PHF with ORIF, HA, or TSA. A secondary objective of this study was to identify the association between procedure choice and individual rates of these adverse events.

Materials and methods

The American College of Surgeons National Surgical Quality Improvement (NSQIP) database was queried for all patients who underwent ORIF, HA, or TSA as surgical treatment for closed PHFs between 2015 and 2017. The NSQIP database is fully deidentified, rendering this study exempt from approval by our university's institutional review board. The NSQIP database collects data from over 600 academic and community hospitals within the United States. The data are collected by trained surgical clinical reviewers. The data are also periodically audited to maintain high fidelity.[24]

Inclusion criteria were postoperative diagnosis of PHF and surgical treatment with ORIF, HA, or TSA. Postoperative diagnoses of PHFs were defined by International Classification of Diseases, Ninth Revision (ICD-9: 812.0, 812.00, 812.01, 812.02, 812.03, 812.09) or International Classification of Diseases, Tenth Revision (ICD-10) codes (Supplementary Appendix S1). Current Procedural Terminology (CPT) codes selected for each procedure were as follows: ORIF (23615, 23616, 23630, 23670, 23680), HA (23470), and TSA (23472). Cases were excluded if any of the following variables had missing information: age, height, weight, American Society of Anesthesiologists (ASA) classification, functional health, or discharge destination.

Variables collected in this study included procedure type, procedure characteristics, patient demographics, comorbidities, reoperation rates, readmission rates, and discharge destination. Patient demographics and comorbidities including age, sex, height, weight, ASA physical classification class, smoking status, diabetes, chronic obstructive pulmonary disorder, congestive heart failure (CHF), hypertension, preoperative use of corticosteroids (steroids), and functional health status were collected. The NSQIP database codes patients' functional health status into "independent," "partially

Table I
Number of patients readmitted within 30 d based on patient demographics.

Characteristic	Readmission within 30 d		P value
	No (n = 2703)	Yes (n = 122)	
Sex			.072
Female	2017 (74.6)	82 (67.2)	
Male	686 (25.4)	40 (32.8)	
Mean age (yr)	64.83 ± 13.52	69.98 ± 12.96	**<.001**
Age ≤ 50	360 (13.3)	10 (8.2)	.130
Age 51-65	922 (34.1)	36 (29.5)	.329
Age 66-80	1130 (41.8)	44 (36.1)	.223
Age ≥ 81	291 (10.8)	32 (26.2)	**<.001**
Mean BMI (kg/m²)	29.69 ± 7.48	29.65 ± 7.32	.964
BMI <18.5	68 (2.5)	4 (3.3)	.551
BMI 18.5-24.9	700 (25.9)	28 (23.0)	.526
BMI 25.0-25.9	818 (30.3)	38 (31.1)	.841
BMI 30-34.9	583 (21.6)	33 (27.0)	.178
BMI 35-39.9	276 (10.2)	10 (8.2)	.542
BMI ≥40	258 (9.5)	9 (7.4)	.527
ASA class			**<.001**
1 or 2	1279 (47.3)	31 (25.4)	
≥ 3	1424 (52.7)	91 (74.6)	
Smoking			.284
Nonsmoker	2208 (81.7)	95 (77.9)	
Smoker	495 (18.3)	27 (22.1)	
Diabetes			.564
Nondiabetic	2163 (80.0)	95 (77.9)	
Diabetic	540 (20.0)	27 (22.1)	
COPD			.367
No	2514 (93.0)	111 (91.0)	
Yes	189 (7.0)	11 (9.0)	
CHF			**.030**
No	2679 (99.1)	118 (96.7)	
Yes	24 (0.9)	4 (3.3)	
Hypertension			.078
No	1217 (45.0)	45 (36.9)	
Yes	1486 (55.0)	77 (63.1)	
Steroids			1.000
No	2615 (96.7)	118 (96.7)	
Yes	88 (3.3)	4 (3.3)	
Functional status			**<.001**
Independent	2603 (96.3)	103 (84.4)	
Dependent	100 (3.7)	19 (15.6)	
Inpatient vs. outpatient			**<.001**
Outpatient	1094 (40.5)	28 (23.0)	
Inpatient	1609 (59.5)	94 (77.0)	
Procedure type			
ORIF	1764 (65.3)	65 (53.3)	**.009**
RTSA	662 (24.5)	45 (36.9)	**.002**
HA	277 (10.2)	12 (9.8)	1.000
Mean operative time (min)	115.91 ± 52.34	116.03 ± 49.37	.978
Mean length of hospital stay (d)	2.23 ± 3.21	3.30 ± 3.95	**<.001**
Discharge destination			**<.001**
Home	2251 (83.3)	83 (68.0)	
Nonhome	452 (16.7)	39 (32.0)	

BMI, body mass index; *ASA*, American Society of Anesthesiologists; *COPD*, chronic obstructive pulmonary disorder; *CHF*, congestive heart failure; *ORIF*, open reduction internal fixation; *RTSA*, reverse total shoulder arthroplasty; *HA*, hemiarthroplasty. Bold P-values indicate patient demographics with statistical significance.

dependent," or "totally dependent." In this analysis, functional health status was recoded into "independent" and "dependent." "Dependent" functional health status included patients who were initially coded as "partially dependent" or "totally dependent." Data on procedure type (ORIF, HA, TSA) and characteristics including mean operative time and inpatient or outpatient designation were also collected. Postoperative outcomes, including reoperation and readmission, were reported within 30 days of procedure. In this study, discharge destination was recoded into either "home" or "non-home." Patients who were discharged "home" or "facility which was home" were considered to be discharged home. Patients who were discharged "rehab," "separate acute care," "skilled care,"
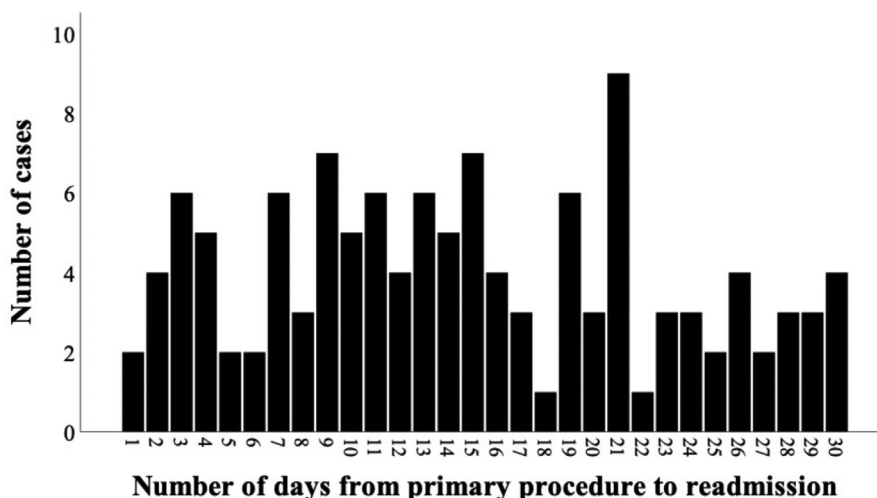
Figure 1 Number of readmissions based on number of days after primary procedure.

not home," and "unskilled facility not home" were considered to have a nonhome discharge.

All statistical analyses were conducted using SPSS Software version 26.0 (IBM Corp., Armonk, NY, USA). Patient demographics, comorbidities, and procedural characteristics were compared between cohorts using bivariate analysis. Multivariate logistic regression, adjusted for all significantly associated patient comorbidities, patient demographics, and procedural characteristics, was used to identify predictors of reoperation, readmission, and nonhome discharge. Odds ratios (ORs) were reported with accompanying 95% confidence intervals. The level of significance was set to $P < .05$.

Results

Following application of International Classification of Diseases, Ninth Revision (ICD-9), International Classification of Diseases, Tenth Revision (ICD-10), and Current Procedural Terminology (CPT) codes, there were 3000 cases of PHFs treated surgically in NSQIP from 2015 to 2017. Cases were excluded as follows: 61 for missing age, 82 for missing height and/or weight, 1 for missing ASA classification, 25 for missing functional health status prior to surgery, 1 for missing length of total hospital stay, and 5 for unknown discharge destination. A total of 2825 patients undergoing surgical treatment for PHF were included in the final cohort. The majority of the patients were between 51 and 80 years of age (N = 2132; 75.4%), with a mean age of 65.05 years. Most patients were female (N = 2099; 74.3%). The most common procedure performed was ORIF (N = 1829; 64.7%), followed by TSA (N = 707; 25.0%), and then HA (N = 289; 10.2%). Overall, there was a 30-day readmission rate of 4.2%, 30-day reoperation rate of 2.6%, and a nonhome discharge rate of 17.4%.

Readmission within 30 days

Of the 2825 patients included in our study, 122 (4.2%) were readmitted within 30 days of the principal procedure (Table I, Fig. 1). Of those readmitted, 65 (53.3%) underwent ORIF, 45 (36.9%) underwent TSA, and 12 (9.8%) underwent HA. In comparison to patients who were not readmitted, readmitted patients were older (69.98 years vs. 64.83 years, $P < .001$) and had a longer mean length of hospital stay (3.30 days vs. 2.23 days, $P < .001$). The readmitted cohort also had higher rates of ASA class ≥3 (74.6% vs. 52.7%,

$P < .001$), CHF (3.3% vs. 0.9%, $P = .030$), functional dependence (15.6% vs. 3.7%, $P < .001$), inpatient procedure designation (77.0% vs. 59.5%, $P < .001$), and nonhome discharge (32.0% vs. 16.7%, $P < .001$). In comparison to patients who were not readmitted, more readmitted patients had undergone TSA (24.5% vs. 36.9%, $P = .002$). In contrast, fewer readmitted patients had undergone ORIF (53.3% vs. 65.3%, $P = .009$).

After adjusting for all significantly associated variables, multivariate logistic regression identified ASA class ≥3 (OR 1.95, 1.25-3.05; $P = .003$) and functional dependence (OR 3.15, 1.79-5.52; $P < .001$) as independent predictors of readmission (Table II). Procedure type (ORIF, TSA, and HA) was not a significant predictor of readmission. The mean number of days from primary procedure to readmission was 14.66 ± 8.13 days.

Reoperation within 30 days

Of the 2825 patients included in our study, 73 (2.6%) underwent reoperation within 30 days of the principal procedure (Table III, Fig. 2). Of those who underwent reoperation, 47 (64.4%) underwent ORIF, 20 (27.4%) underwent TSA, and 6 (8.2%) underwent HA. Patients who underwent reoperation were more likely to be male (42.5% vs. 25.3%, $P = .002$), functionally dependent (12.3% vs. 4.0%), and discharged to a facility other than home (28.8% vs. 17.1%, $P = .018$). Patients who ultimately underwent reoperation had higher rates of inpatient procedure designation (74.0% vs. 59.9%, $P = .015$) and had a greater mean length of hospital stay (3.67 days vs. 2.24 days, $P < .001$).

After adjusting for all significantly associated variables, multivariate logistic regression identified male sex (OR 2.41, 1.49-3.90; $P < .001$) and functional dependence (OR 2.92, 1.37-6.22; $P = .006$) as independent predictors of reoperation within 30 days (Table IV). Procedure type (ORIF, TSA, and HA) was not a significant predictor of reoperation. The mean number of days from the primary procedure to reoperation was 15.48 ± 6.95 days.

Nonhome discharge

Of the 2825 patients included in our study, 491 (17.4%) were discharged to a facility other than home (Table V). Of those who had a nonhome discharge, 196 (39.9%) underwent ORIF, 225 (45.8%) underwent TSA, and 70 (14.3%) underwent HA. In comparison to patients who were discharged home, patients with a nonhome

Table II

Odds ratios for statistically significant predictors of readmission.

Predictors of readmission	Odds ratio	95% CI	*P* value
ASA ≥3	1.95	1.25-3.05	**.003**
Dependent functional status	3.15	1.79-5.52	**<.001**

CI, confidence interval; *ASA*, American Society of Anesthesiologists.
Bold *P*-values indicate statistical significance.

discharge had a greater mean age (62.92 years vs. 75.22 years, $P < .001$) and a greater mean operative time (114.85 minutes vs. 120.91 minutes, $P = .020$). Non−home-discharge patients were more likely to be female (82.1% vs. 72.7%, $P < .001$) and underweight (BMI <18.5 kg/m^2) (4.3% vs. 2.2%, $P = .011$). These patients also had higher rates of comorbidities including ASA class ≥3 (81.5% vs. 47.8%, $P < .001$), diabetes (28.9% vs. 18.2%, $P < .001$), chronic obstructive pulmonary disorder (11.4% vs. 6.2%, $P < .001$), CHF (2.4% vs. 0.7%, $P < .001$), and hypertension (72.5% vs. 51.7%, $P < .001$). Non−home-discharge patients also had higher rates of functional dependence (11.8% vs. 2.6%, $P < .001$) and inpatient procedure designation (92.1% vs. 53.6%, $P < .001$). Non−home-discharge patients also had a longer mean length of hospital stay (5.01 days vs. 1.70 days, $P < .001$). In comparison to patients who were discharged home, more non−home-discharge patients underwent TSA (20.7% vs. 45.8%, $P < .001$) and HA (9.4% vs. 14.3%, $P = .002$). In contrast, fewer non−home-discharge patients underwent ORIF (70.0% vs. 39.9%, $P < .001$).

After adjusting for all significantly associated variables, multivariate logistic regression identified age ≥66 years (OR 7.00, 3.06-15.98; $P < .001$), age ≥ 81 years (OR 16.31, 6.92-38.45; $P < .001$), ASA class ≥3 (OR 2.34, 1.74-3.15; $P < .001$), functional dependence (OR 2.48, 1.59-3.89; $P < .001$), and inpatient procedure designation (OR 3.32, 2.21-4.98; $P < .001$) as independent predictors of nonhome discharge (Table VI). In comparison to ORIF, TSA (OR 1.41, 1.07-1.86; $P = .014$) was significantly associated with increased rates of nonhome discharge.

Discussion

In this study, we reported on the rates of readmission, reoperation, and nonhome discharge within 30 days in 2825 patients who underwent HA, TSA, or ORIF for 3- and 4-part PHFs. We found a 4.2% rate of readmission, 2.6% rate of reoperation, and 17.4% rate of nonhome discharge. Significant risk factors for readmission were ASA class ≥ 3 and dependent functional status. Significant risk factors for reoperation were male sex and dependent functional status. Significant risk factors for nonhome discharge were age > 66 years, ASA ≥ 3, dependent functional status, and inpatient status. In terms of procedure type, TSA was significantly associated with increased rates of nonhome discharge compared with ORIF.

PHFs are common osteoporotic fractures that are often seen in elderly patients following ground-level falls. While most PHFs can be treated nonoperatively, more severe 3- and 4-part fractures may require surgical treatment.[2] There is debate in current literature on the effectiveness of operative vs. nonoperative PHF treatment.[4,9,11,21] Several studies have reported no significant differences in functional or clinical outcomes between these two treatments.[19,26] Technologic advances and a growing elderly population have made surgical treatment for PHF increasingly more commonplace.[7,20,31] In fact, while the rate of PHFs has remained consistent over time, the rate of surgical correction has increased, along with the rate of reverse total shoulder arthroplasty (RTSA) for treatment.[4,20] However, the decision to undergo surgical treatment for PHF remains complex and involves the assessment of many

Table III

Number of patients requiring reoperation within 30 d based on patient demographics.

Characteristic	Reoperation within 30 d		*P* value
	No (n = 2752)	Yes (n = 73)	
Sex			**.002**
Female	2057 (74.7)	42 (57.5)	
Male	695 (25.3)	31 (42.5)	
Mean age (yr)	65.02 ± 13.55	66.33 ± 12.75	.415
Age ≤50	363 (13.2)	7 (9.6)	.461
Age 51-65	926 (33.6)	32 (43.8)	.079
Age 66-80	1151 (41.8)	23 (31.5)	.092
Age ≥81	312 (11.3)	11 (15.1)	.348
Mean BMI (kg/m^2)	29.70 ± 7.48	29.50 ± 7.24	.823
BMI < 18.5	70 (2.5)	2 (2.7)	.710
BMI 18.5-24.9	707 (25.7)	21 (28.8)	.588
BMI 25.0-25.9	835 (30.3)	21 (28.8)	.897
BMI 30-34.9	600 (21.8)	16 (21.9)	1.000
BMI 35-39.9	280 (10.2)	6 (8.2)	.697
BMI ≥40	260 (9.4)	7 (9.6)	1.000
ASA class			.406
1 or 2	1280 (46.5)	30 (41.1)	
≥3	1472 (53.5)	43 (58.9)	
Smoking			.170
Nonsmoker	2248 (81.7)	55 (75.3)	
Smoker	504 (18.3)	18 (24.7)	
Diabetes			.553
Nondiabetic	2197 (79.8)	61 (83.6)	
Diabetic	555 (20.2)	12 (16.4)	
COPD			.643
No	2558 (93.0)	67 (91.8)	
Yes	194 (1.0)	6 (8.2)	
CHF			.521
No	2725 (99.0)	72 (98.6)	
Yes	27 (1.0)	1 (1.4)	
Hypertension			.722
No	1231 (44.7)	31 (42.5)	
Yes	1521 (55.3)	42 (57.5)	
Steroids			1.000
No	2662 (96.7)	71 (97.3)	
Yes	90 (3.3)	2 (2.7)	
Functional status	2642 (96.0)	64 (87.7)	**.003**
Independent	110 (4.0)	9 (12.3)	
Dependent			
Inpatient vs. outpatient			**.015**
Outpatient	1103 (40.1)	19 (26.0)	
Inpatient	1649 (59.9)	54 (74.0)	
Procedure type			
ORIF	1782 (64.8)	47 (64.4)	1.000
TSA	687 (25.0)	20 (27.4)	.681
HA	283 (10.3)	6 (8.2)	.697
Mean operative time (min)	115.80 ± 52.25	120.36 ± 50.75	.462
Mean length of hospital stay (d)	2.24 ± 3.19	3.67 ± 4.87	**<.001**
Discharge destination			**.018**
Home	2282 (82.9)	52 (71.2)	
Nonhome	470 (17.1)	21 (28.8)	

BMI, body mass index; *ASA*, American Society of Anesthesiologists; *COPD*, chronic obstructive pulmonary disorder; *CHF*, congestive heart failure; *ORIF*, open reduction internal fixation; *TSA*, total shoulder arthroplasty; *HA*, hemiarthroplasty.
Bold *P*-values indicate patient demographics with statistical significance.

factors, including the patient's bone quality, social independence, and surgical risk factors.[22] Surgery is needed in most cases of fracture/dislocations, open fractures, and those with associated neurovascular deficit to prevent extreme loss of function. Nonoperative treatment of these fractures sometimes results in a poor outcome that requires subsequent surgery. Performing an acute operation in these cases can be easier than operating on a nonunion or malunion.[11]

Surgical treatment of PHF in the elderly aims to optimize functional outcomes while reducing complications, reoperations, and costs. The HRRP was enacted as part of the Affordable Care Act in 2010, aiming to decrease the amount of preventable hospital
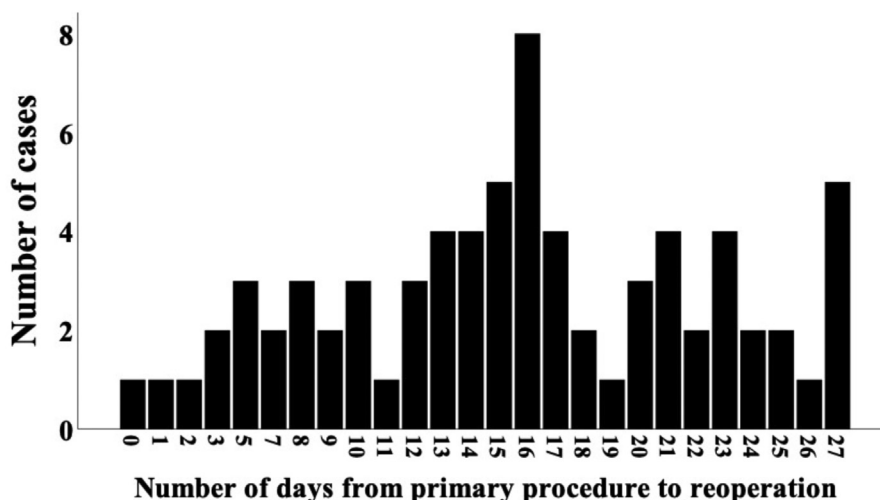
Figure 2 Number of reoperations based on number of days after primary procedure.

Table IV
Odds ratios for statistically significant predictors of reoperation.

Predictors of reoperation	Odds ratio	95% CI	P value
Male sex	2.41	1.49-3.90	**<.001**
Dependent functional status	2.92	1.37-6.22	**.006**

CI, confidence interval.
Bold P-values indicate statistical significance.

readmissions, therefore reducing health-care costs.[14] The focus of this program was to enact payment penalties to hospitals with higher readmission rates in treatment of pneumonia, myocardial infarction, and heart failure. This measure has helped to decrease surgical readmissions as well.[14] The goal of our study was to determine readmission, reoperation, and nonhome discharge rates secondary to surgery for the treatment of PHFs and to identify major contributors to these outcomes. By looking at predictors for these outcomes, we can better consider cost when surgically treating PHFs. There are currently studies that look at readmission, reoperation, or nonhome discharge for all 3 procedures separately, making our study unique in that we analyze and compare all 3 outcomes for each surgical group.

Readmission within 30 days

The HRRP, established in March 2010 under the Affordable Care Act, provides financial incentive to hospitals by placing financial penalties on those that have higher-than-expected rates of readmission.[14] Although the procedure-specific unplanned 30-day readmission measures of the HRRP are limited to elective total hip and knee arthroplasties, the concept still stands that unplanned readmissions are important factors in evaluating hospital performance. Furthermore, Thorsness et al. reported that readmissions following ORIF and HA had a 5.68-fold increase in in-hospital cost.[27]

In our study of 2825 patients, we saw a 30-day readmission rate of 4.2%. Previous studies suggest that readmission is a relatively frequent complication following surgical treatment of PHF. A study by Zhang et al. utilized a large database from 7 states to compare readmission rates and found an overall 30-day readmission rate of 8% for 27,017 patients.[31]

Furthermore, Zhang et al identified female sex, African American ethnicity, discharge to a nursing facility, and Medicaid

insurance as risk factors for readmission following surgical treatment of PHF.[31] This study also found that medical complications accounted for 75% of readmissions, highlighting the impact of medical comorbidities on readmission rates.[31] Singh et al reported that male sex and increased ASA class were risk factors for 30-day and 90-day readmission rates following HA.[25] Our study identified ASA class ≥ 3 and dependent functional status to increase the risk of readmission within 30 days. These findings support the association between patient comorbidity and readmission rates following surgical treatment of PHF. Our results may help better understand the risk factors for readmission when weighing the risks and benefits of undergoing surgical treatment. For patients who are of dependent functional status or with ASA ≥ 3, they must be aware that their condition carries a higher risk for readmission, which could decrease their postoperative quality of life.

Our study identified dependent functional status and ASA class ≥ 3 to be significant predictors for readmission within 30 days. Previous studies have been inconclusive on specific risk factors for readmission and determined that patient comorbidities were important considerations prior to and after surgery. Our findings are consistent with the idea that patient comorbidities can increase the likelihood of readmission.

Reoperation within 30 days

Although the financial incentive of the HRRP only applies to rates of reoperation following hip and knee arthroplasties, healthcare organizations often use reoperation rates as indicators for hospital quality.[1,14,15] A closer look at the significant predictors for reoperation can help hospitals to reduce their rates of reoperation and the associated increase in cost.

In our study of 2825 patients, we saw a reoperation rate of 2.6% within 30 days. A study by Dabija et al looked at 134,111 patients who were treated for PHF either surgically or nonsurgically.[7] This study had a 4-year minimum follow-up and found that 6.6% of patients who underwent ORIF required a revision procedure and 7.2% of patients who underwent arthroplasty required revision.[7]

Several studies reported RTSA as an effective treatment option for failed HA and failed ORIF.[8,17,23] Sebastia-Forcada et al reported that secondary RTSA led to significant functional outcomes and pain relief.[23] However, secondary RTSA still had lower functional scores than primary RTSA, as well as higher complication rates.[23] Nowak et al reported that the number of reoperations following

Table V
Discharge destinations of patients based on patient demographics.

Characteristic	Discharge destination		P value
	Home (n = 2334)	Nonhome (n = 491)	
Sex			<.001
Female	1696 (72.7)	403 (82.1)	
Male	638 (27.3)	88 (17.9)	
Mean age (yr)	62.92 ± 13.31	75.22 ± 9.29	<.001
Age ≤50	362 (15.5)	8 (1.6)	<.001
Age 51-65	902 (38.6)	56 (11.4)	<.001
Age 66-80	905 (38.8)	269 (54.8)	<.001
Age ≥81	165 (7.1)	158 (32.2)	<.001
Mean BMI (kg/m^2)	29.67 ± 7.32	29.76 ± 8.12	.809
BMI <18.5	51 (2.2)	21 (4.3)	.011
BMI 18.5-24.9	598 (25.6)	130 (26.5)	.691
BMI 25.0-25.9	721 (30.9)	135 (27.5)	.145
BMI 30-34.9	515 (22.1)	101 (20.6)	.508
BMI 35-39.9	236 (10.1)	50 (10.2)	.935
BMI ≥40	213 (9.1)	54 (11/0)	.203
ASA class			<.001
1 or 2	1219 (52.2)	91 (18.5)	
≥3	1115 (47.8)	400 (81.5)	
Smoking			<.001
Nonsmoker	1872 (80.2)	431 (87.8)	
Smoker	462 (19.8)	60 (12.2)	
Diabetes			<.001
Nondiabetic	1909 (81.8)	349 (71.1)	
Diabetic	425 (18.2)	142 (28.9)	
COPD			<.001
No	2190 (93.8)	435 (88.6)	
Yes	144 (6.2)	56 (11.4)	
CHF			<.001
No	2318 (99.3)	479 (97.6)	
Yes	16 (0.7)	12 (2.4)	
Hypertension			<.001
No	1127 (48.3)	135 (27.5)	
Yes	1207 (51.7)	356 (72.5)	
Steroids			1.000
No	2258 (96.7)	475 (96.7)	
Yes	76 (3.3)	16 (3.3)	
Functional status			<.001
Independent	2273 (97.4)	433 (88.2)	
Dependent	61 (2.6)	58 (11.8)	
Inpatient vs. outpatient			<.001
Outpatient	1083 (46.4)	39 (7.9)	
Inpatient	1251 (53.6)	452 (92.1)	
Procedure type			
ORIF	1633 (70.0)	196 (39.9)	<.001
TSA	482 (20.7)	225 (45.8)	<.001
HA	219 (9.4)	70 (14.3)	.002
Mean operative time (min)	114.86 ± 50.08	120.91 ± 61.11	.020
Mean length of hospital stay (d)	1.70 ± 2.61	5.01 ± 4.40	<.001

BMI, body mass index; *ASA*, American Society of Anesthesiologists; *COPD*, chronic obstructive pulmonary disorder; *CHF*, congestive heart failure; *ORIF*, open reduction internal fixation; *TSA*, total shoulder arthroplasty; *HA*, hemiarthroplasty.
Bold P-values indicate patient demographics with statistical significance.

secondary RTSA for failed ORIF was significantly higher than that after primary RTSA.[17] The study concluded that primary arthroplasty is a better treatment choice in cases where the patient's prognostic factors suggest a high reoperation rate for ORIF.[17] These studies all showed that revision procedures yielded less optimal outcomes than a successful primary procedure.

Our study identified dependent functional status and male sex as significant predictors for reoperation within 30 days. Some previous studies concluded higher readmission rates in females, while other studies concluded higher readmission rates in males.[25,31] However, these studies looked at readmission rates in general and not specifically at reoperation rates. The variation in study results may be due to differences in timing or location of the data used for the study. Our study did not find male or female sex to be a significant predictor for readmission; male sex was only significant specifically for reoperation. For patients who are of dependent functional status or male sex, the decision for choice of procedure may be crucial in obtaining the optimal outcome.

Nonhome discharge

Nonhome discharge is a suboptimal outcome for patients due to their independence being compromised. Nursing homes or continuing-care facilities also have their own costs that contribute to the total cost incurred on the patient.[18] Patients discharged to a nonhome destination have been found to have a higher likelihood of readmission.[31]

In our study of 2825 patients, we saw a nonhome discharge rate of 17.4% within 30 days. A study by Malik et al looked at a total of 2674 patients and found a nonhome discharge rate of 21.5%.[16]

Malik et al reported several significant risk factors associated with nonhome discharge following surgical management of PHF: age >65 years, partially dependent functional health status prior to surgery, inpatient surgery, ASA grade >2, transfer from nursing home/chronic care facility, undergoing a TSA vs. ORIF, length of stay > 2 days, and the occurrence of any predischarge complication.[16] While Malik et al associated shoulder arthroplasty with higher rates of nonhome discharge, Rajaee et al reported that RTSA patients were more likely to be discharged home than HA patients.[16,20] The study by Rajaee et al only included patients aged 65 years or older, which may account for the difference in rates of nonhome discharge.[20]

Our study identified dependent functional status, ASA ≥ 3, inpatient status, and age ≥66 years to be significant predictors for nonhome discharge. Patients treated with TSA also had higher rates of nonhome discharge than those treated with HA or ORIF. These findings are consistent with the study by Malik et al that identified age >65 years, dependent functional status, inpatient status, and ASA >2 to be significant predictors for nonhome discharge.[16] The same study also found higher rates of nonhome discharge for patients who underwent RTSA instead of ORIF.[16] Nonhome discharge is not an ideal outcome for patients because they do not have the same independence as they would at home. Patients with significant risk factors for nonhome discharge should be made aware of the associated risk when deciding to undergo surgical treatment for PHF.

Procedure choice

The choice among RTSA, ORIF, and HA often takes into consideration the high short-term complication and reoperation rates associated with ORIF and the superior short-term quality of life but lifelong complication risk associated with RTSA.[2] ORIF is often used in patients aged 18-40 years because the lifespan of arthroplasty would likely necessitate revision in this age group. ORIF complications include screw cutout, malunion, avascular necrosis, and varus collapse.[3] RTSA is more often utilized in lower demand, elderly individuals (>65 years old) with nonreconstructable tuberosities and poor bone stock. RTSA complications include scapular notching, dislocation, glenoid loosening, deep infection, acromial or scapular spine fractures, and axillary neuropraxia.[10] HA is a viable treatment option in patients aged 40-65 years with complex fracture-dislocations or head-splitting components that are otherwise likely to fail fixation. However, with HA, lesser and greater tuberosity nonunion may lead to diminished liftoff strength as well as active shoulder elevation and external rotation,

Table VI
Odds ratios for statistically significant predictors of nonhome discharge.

Predictors of nonhome discharge	Odds ratio	95% CI	*P* value
Age ≤50	Reference	—	—
Age 51-65	1.67	0.72-3.90	.232
Age 66-80	7.00	3.06-15.98	**<.001**
Age ≥81	16.31	6.92-38.45	**<.001**
ASA ≥3	2.34	1.74-3.15	**<.001**
Dependent functional status	2.48	1.59-3.89	**<.001**
Inpatient	3.320	2.21-4.98	**<.001**
ORIF	Reference	—	—
TSA	1.41	1.07-1.86	**.014**
Hemiarthroplasty	1.21	0.829-1.77	.322

CI, confidence interval; *ASA*, American Society of Anesthesiologists; *ORIF*, open reduction internal fixation; *TSA*, total shoulder arthroplasty.
Bold *P*-values indicate statistical significance.

respectively.[29] Previous studies suggest that RTSA may offer superior functional outcomes to HA.[2]

In terms of choice of procedure (ORIF, HA, or TSA), several studies have reported that ORIF had the lowest probability of needing follow-up surgery and overall complications.[6,7] Other studies have reported that ORIF had higher rates of readmission and reoperation than RTSA.[30,31] These different conclusions may be explained by the variations of location and timing of data used for the studies, since RTSA has recently become more common for treatment of PHF.[20] Most of these studies concluded that patient comorbidities are important considerations both before and after operation.

Our study did not find the choice of procedure to be a significant predictor for readmission or reoperation. However, TSA was found to be significantly associated with increased rates of nonhome discharge compared with ORIF. As mentioned above, TSA is the procedure of choice in elderly individuals. The increased prevalence of chronic comorbidities in an older cohort may contribute to higher rates of nonhome discharge. Further studies that investigate significant differences between procedure types with matched aged groups would likely provide a better understanding. The retrospective nature of this study also carries an inherent bias in procedure selection. Ideally, a double-blind randomized study would provide the best comparison across procedure types, although not in practicality.

Our study was limited by the information available on the NSQIP database. We could not account for perioperative variables such as experience of the surgeon, mechanism of injury, fracture pattern, institution where the procedure was performed, and postoperative rehabilitation. These factors could have contributed to the rates of readmission, reoperation, and nonhome discharge. Another limitation of our study was that readmission and reoperation were only considered within a 30-day period. This is particularly important when considering reoperation, as reoperation rates are typically low within 30 days postoperatively. This foregoes later revisions due to failure of hardware which could have been avoided by placement of a prosthesis. A follow-up period over 1 year would likely yield better insight into risk factors for reoperation. The NSQIP database also does not include orthopedic-specific scores to properly assess the outcomes of these procedures.

This is the first study to investigate and compare rates of readmission, reoperation, and nonhome discharge following TSA, HA, and ORIF treatment for PHF. Previous studies have investigated risk factors for these rates individually.

Conclusion

The clinically significant risk factors for 30-day readmission following surgical treatment for PHF are ASA class ≥ 3 and dependent functional status. The clinically significant risk factors for 30-day reoperation following surgical treatment for PHF are male sex and dependent functional status. The clinically significant risk factors for nonhome discharge following surgical treatment for PHF are age > 66 years, ASA ≥ 3, dependent functional status, and inpatient status. TSA was significantly associated with increased rates of nonhome discharge compared with HA and ORIF. Evaluation of these factors in patients undergoing surgical treatment for PHF can help with perioperative risk management and minimizing the cost of care associated with readmission, reoperation, and nonhome discharge.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jseint.2022.02.008

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