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The impact of age on 30-day complications following shoulder instability surgery

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Hypothesis: The purpose of this study was to evaluate short-term outcomes including medical complications, overnight admission, and 30-day readmission with regard to patient age at the time of shoulder instability surgery.

Methods: Patients undergoing surgery for glenohumeral instability were collected from the National Surgical Quality Improvement Program between the years of 2005 and 2016. These patients were separated into cohorts of younger than 25 years, 25-34 years, and older than 34 years. Medical complications, hospital admission, and 30-day readmission were compared using multivariate analysis.

Results: Of the 5449 patients included, there were 2035 (37.0%) patients younger than 25 years, 1815 (33.0%) between 25 and 34 years, and 1649 (30.0%) 35 and older. Overall, 81.7% of patients underwent an arthroscopic Bankart repair, 12.6% of patients underwent an open Bankart repair, and 5.7% of patients underwent a Latarjet-Bristow procedure. The risk of 30-day readmission increased with age, ranging from 0.24% for <25 years old to 0.92% for 35 years and older ($P = .040$). Operative duration greater than 60 minutes (odds ratio [OR] 1.76; $P = .001$), duration greater than 90 minutes (OR 3.58; $P < .001$), and American Society of Anesthesiologists class III and IV (OR 1.80; $P = .001$) were associated with increased risk of overnight hospital stay. Compared with arthroscopic Bankart repair, the Latarjet-Bristow procedure was associated with increased total complications (OR 3.30; $P = .021$), overnight hospital stay (OR 4.64; $P < .001$), and 30-day readmission (OR 3.39; $P = .013$).

Conclusion: This study demonstrates that even in the relatively young and healthy shoulder instability patient cohort, patients older than 25 years are almost 4 times more likely to experience a complication. Additionally, Latarjet-Bristow procedures are 3-4 times more likely to experience a complication or readmission than other shoulder instability procedures.

Level of evidence: Level III; Retrospective Cohort Design using Large Database; Treatment Study

Keywords: Glenohumeral instability; shoulder arthroscopy; Bankart; Latarjet; complications; Bristow

Glenohumeral instability represents a common musculoskeletal pathology that warrants evaluation from an orthopedic surgeon.[6,13,21] Prospective cohorts have demonstrated that shoulder instability most frequently occurs in young men.[8,12] Multiple surgical options may be offered depending on a variety of patient factors, including age, gender, prior dislocation, activity level, and glenohumeral pathology.[20,21] Frequently performed surgeries include arthroscopic and open Bankart repairs in addition to bony procedures such as the Bristow and Latarjet procedures.[18,23] Currently, the literature reporting outcomes of surgery for glenohumeral instability focuses primarily on nerve injury, recurrent dislocation, graft failure, and shoulder function.[9,16,17]

Institutional review board approval was not required for the retrospective study.

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Similar to other common outpatient surgeries, relatively little is known regarding the incidence of readmission, unintended admission, deep vein thrombosis/pulmonary embolism, and superficial and deep infection.[3,4] To study these complications, the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) is increasingly being used in orthopedic surgery as a whole and within the subset of shoulder surgery.[10,11,19] Although one study has used the NSQIP to contrast the relative risk of treatment options (arthroscopic Bankart, open Bankart, Bristow-Latarjet),[2] no study to date has investigated the risk of age, American Society of Anesthesiologists (ASA) class, or comorbidities with regards to the aforementioned complications.

The purpose of this study was to assess the impact of age on short-term complications, overnight hospital stay, and unplanned hospital readmissions in patients undergoing surgical treatment for shoulder instability. We hypothesized that patients older than 35 years would have increased rates of readmissions and short-term complications.

Materials and methods

This study was a retrospective cohort study conducted using the ACS-NSQIP database from 2005 to 2016. This registry aggregates data from more than 600 sites, which range from community hospitals to tertiary academic medical centers and their associated surgical centers. Surgical clinical reviewers, who are specifically-trained for the role, manually enter data into the database, and these are audited to optimize data accuracy.[5,25] All data points are corroborated by multiple reviewers, and the database accuracy and consistency demonstrated an increase in variable agreement from 97% in 2005 to 98.5% in 2008. This figure is likely even higher for more recent years after further quality improvement projects.

All patients undergoing surgery for glenohumeral instability were identified using Current Procedural Terminology codes 23455 (capsulorrhaphy, anterior, with labral repair), 23462 (capsulorrhaphy, anterior, any type; with coracoid process transfer), and 29806 (arthroscopy, shoulder, surgical; capsulorrhaphy). Patients were excluded if the surgery was emergent, an unclean wound classification was noted, or if baseline demographic characteristics were not complete. These criteria excluded 68 patients. Eligible patients were then split into 3 age-based cohorts: less than 25 years, between 25 and 34, and 35 and older.

Patient demographic characteristics included age, gender, and body mass index. Surgical characteristics included type of anesthesia (general vs regional), operative duration, and ASA class. Medical comorbidities included a history of hypertension, diabetes mellitus, smoking, chronic obstructive pulmonary disease, and preoperative corticosteroid use.

Statistical analyses in this study were performed using SPSS software (version 25; IBM, Armonk, NY, USA). A bivariate analysis using the Pearson χ^2 test was conducted to contrast patient characteristics and 30-day outcomes including all complications, admission, and 30-day readmissions. The outcome variables that were determined to be statistically different by age stratification on bivariate analysis were then carried forward to multivariate analysis. Patient characteristics with $P > .20$ on bivariate analysis were adjusted for in the multivariate models.

Results

From 2005 to 2016, a total of 5449 patients were included from the NSQIP database. In this cohort, there were 2035 (37.0%) patients younger than 25 years, 1815 (33.0%) between 25 and 34 years, and 1649 (30.0%) 35 years and older (Table I). Older patients were more likely to be female ($P < .001$), obese ($P < .001$), have diabetes ($P < .001$), have hypertension ($P < .001$), have a smoking history ($P = .001$), take preoperative corticosteroids ($P = .027$), and to have a higher ASA class ($P < .001$). Surgically, 81.7% of patients underwent an arthroscopic Bankart repair, 12.6% of patients underwent an open Bankart repair, and 5.7% of patients underwent a Latarjet-Bristow procedure.

On bivariate analysis, the risk of any complication was higher in patients 25 years and older compared with those younger than 25 years ($P = .014$). The risk of overnight hospital stay increased with age, ranging from 7.13% for <25 years, to 12.25% for 35 years and older ($P < .001$). The risk of 30-day readmission also increased with age, ranging from 0.24% for <25 years to 0.92% for 35 years and older ($P = .040$) (Table II).

On multivariate analysis, the correlation between age and any complication held for both 25-34 years (odds ratio [OR] 4.63; $P = .017$) and for greater than 35 (OR 3.33; $P = .048$). Diabetes was associated with overnight hospital stays (OR 1.89; $P = .009$) though hypertension (OR 1.29; $P = .129$) and smoking (OR 0.99; $P = .925$) were not. Operative duration greater than 60 minutes (OR 1.76; $P = .001$), duration greater than 90 minutes (OR 3.58; $P < .001$), and ASA class III and IV (OR 1.80; $P = .001$) were associated with increased risk of overnight hospital stay (Table III).

Among glenohumeral instability surgeries using arthroscopic Bankart repair as a reference, Latarjet-Bristow was associated with increased total complications (OR 3.30; $P = .021$), overnight hospital stay (OR 4.64; $P < .001$), and 30-day readmission (OR 3.39; $P = .013$). Open Bankart procedures were associated with overnight hospital stays (OR 3.10; $P < .001$) but was not associated with readmission (OR 1.21; $P = .734$).

Discussion

In this national database study of more than 5000 patients who underwent surgical stabilization for glenohumeral instability, age was associated with increased risk of all complications, overnight admission, and 30-day readmission. Patients older than 25 years were almost 4 times more likely to experience a complication than patients younger than 25 years. On multivariate analysis, diabetes,

Table I Comparison of baseline patient characteristics in patients with shoulder instability

	All patients, % (N = 5499)	Age			*P* value
		<25 yr, % (n = 2035)	25-34 yr, % (n = 1815)	≥35 yr, % (n = 1649)	
Patient characteristics					
Female %	22.7	17.0	19.3	33.5	**<.001***
Body mass index					**<.001***
Nonobese (<30)	75.8	84.8	75.6	64.8	
Obese I (30-34.9)	15.7	10.3	16.5	21.5	
Obese II (35-39.9)	5.3	3.1	4.9	8.5	
Obese III (>40)	3.2	1.8	2.9	5.2	
Comorbidities					
Preoperative corticosteroid use	0.6	0.3	0.6	1.0	**.027***
Diabetes mellitus	2.5	0.4	0.6	7.3	**<.001***
Hypertension	8.5	1.0	3.5	23.3	**<.001***
Smoking history	22.6	20.3	26.7	21.1	**.001***
Operative chracteristics					
Anesthesia type					.576
General	94.1	94.1	93.8	94.6	
Regional	5.9	5.9	6.2	5.4	
Operative duration, min					.199
≤60	27.8	26.8	27.8	28.9	
61-90	34.1	35.8	33.6	32.4	
>90	38.2	37.3	38.7	38.6	
ASA class					**<.001***
I or II	94.4	99.0	97.3	85.5	
III or IV	5.6	1.0	2.7	14.5	
Procedure performed					**<.001***
Arthroscopic Bankart	81.7	81.7	79.8	83.6	
Open Bankart	12.6	13.1	12.5	12.2	
Latarjet-Bristow	5.7	5.3	7.7	4.2	

ASA, American Society of Anesthesiologists.
* Significance defined as $P < .05$; significant values are in bold.

Table II Bivariate comparison of adverse outcomes by age

	Age			Bivariate analysis
	<25 yr, % (n = 2035)	25-34 yr, % (n = 1815)	≥35 yr, % (n = 1649)	*P* value
Any complication	**0.15**	**0.77**	**0.67**	**.014***
Cardiac complications	0.00	0.00	0.08	.324
Renal complications	0.00	0.06	0.06	.554
Respiratory complications	0.00	0.17	0.12	.210
Deep vein thrombosis	0.05	0.06	0.12	.681
Surgical site infection	0.01	0.33	0.12	.310
Urinary tract infection	0.00	0.11	0.18	.180
Wound dehiscence	0.00	0.00	0.06	.311
Nonhome discharge	0.45	0.54	0.34	.700
Overnight hospital stay	**7.13**	**7.38**	**12.25**	**<.001***
Thirty-day readmission	**0.24**	**0.72**	**0.92**	**.040***

* Significance defined as $P < .05$, significant values are in bold.

operative duration, and higher ASA class were all associated with increased risk of overnight admission. Latarjet-Bristow procedures were associated with between 3 and 4 times the risk of any complication, overnight admission, and 30-day readmission. Of note, the 7%-12% admission rate includes overnight observation in addition to formal

Table III Multivariate comparison of adverse outcomes by age

	Any complication			Overnight hospital stay			Readmission code		
	Odds ratio	95% confidence interval	*P* value	Odds ratio	95% confidence interval	*P* value	Odds ratio	95% confidence interval	*P* value
Age, yr									
<25	Reference	—	—	Reference	—	—	Reference	—	—
25-34	**4.63**	**1.32, 16.27**	**.017***	0.91	0.71, 1.18	.488	2.64	0.83, 8.37	.100
≥35	**3.33**	**1.03, 13.03**	**.048***	**1.41**	**1.09, 1.84**	**.010***	3.27	0.98, 10.95	.055
Female gender	1.41	0.60, 3.29	.431	**1.49**	**1.19, 1.88**	**.001***	0.52	0.18, 1.54	.237
Body mass index > 30	1.26	0.54, 2.94	.588	1.16	0.92, 1.45	.218	1.29	0.56, 2.97	.554
Comorbidities									
Preoperative corticosteroid use	—	—	—	—	—	—	—	—	—
Diabetes mellitus	3.99	0.92, 17.30	.064	**1.89**	**1.17, 3.07**	**.009***	—	—	—
Hypertension	1.30	0.40, 4.25	.663	1.29	0.93, 180	.129	1.70	0.58, 4.96	.331
Smoking history	1.72	0.78, 3.79	.178	0.99	0.78, 1.25	.925	1.65	0.74, 3.65	.220
Operative duration, min									
≤60	Reference	—	—	Reference	—	—	Reference	—	—
61-90	1.47	0.43, 5.06	.544	**1.76**	**1.27, 2.45**	**.001***	1.03	0.28, 3.88	.963
>90	2.47	0.79, 7.75	.122	**3.58**	**2.64, 4.85**	**<.001***	2.41	0.78, 7.50	.128
ASA class									
I or II	Reference	—	—	Reference	—	—	Reference	—	—
III or IV	0.86	0.211, 3.49	.830	**1.80**	**1.26, 2.57**	**.001***	2.39	0.79, 7.22	.121
Procedure performed									
Arthroscopic Bankart	Reference	—	—	Reference	—	—	Reference	—	—
Open Bankart	1.21	0.40, 3.66	.732	**3.10**	**2.43, 3.94**	**<.001***	1.21	0.40, 3.69	.734
Latarjet-Bristow	**3.30**	**1.20, 9.12**	**.021***	**4.64**	**3.46, 6.23**	**<.001***	**3.39**	**1.29, 8.90**	**.013***

ASA, American Society of Anesthesiologists.
* Significance defined as $P < .05$; significant values are in bold.

admission and is likely skewed toward the early period of this study, though the investigation did not specifically analyze admissions by year.

Although the average age of most shoulder surgery patients is significantly higher, including those undergoing rotator cuff repair,[24] arthroplasty,[15] and proximal humerus fracture open reduction internal fixation,[14] this study focused on a significantly younger patient cohort. An age-dependent relationship for shoulder instability surgeries has not been previously established, with prior database studies focusing on the relative risk between specific surgical options.[2] Despite this younger patient cohort, the results of this investigation still demonstrated an age-related correlation for complications and readmission.

As the importance and prevalence of risk stratification continues to increase in elective orthopedic surgery, identifying modifiable risk factors is crucial. Prior studies using the NSQIP database have demonstrated increased risk of complications and readmission in arthroplasty using factors such as ASA class and obesity.[22,26] The results of this study demonstrate that characteristics such as diabetes and ASA class are relevant even in the relatively young and healthy shoulder instability patient cohort. Additionally, operative length has been correlated with complication risk in prior literature,[1] and this study signifies that this link may exist in shoulder instability surgery as well. These findings indicate that more stringent risk stratification and screening in shoulder instability patients may aid in identifying high-risk patients and potentially in risk reduction. Further, prospective research is necessary to demonstrate the efficacy of shoulder instability screening and the impact it may have in modifying postoperative complication risk.

This study employed a database far larger than previous shoulder instability cohorts[2,7] and shows a significant trend of age impacting both complication risk and readmission risk in glenohumeral instability. Despite this, this study has several limitations. The NSQIP database does not record complications beyond 30 days from surgery, preventing late-term complication reporting. The data analyzed also is dependent on the accuracy of data entry, though internal auditing has demonstrated validity approaching 99%. Additionally, preoperative attributes germane to shoulder instability such as bone loss proportion, history of prior shoulder stabilization procedure, and history of epilepsy are not recorded in NSQIP. Although more than 5000 patients

were included in this study, the NSQIP does not capture patients from many freestanding ambulatory surgery centers, and the population may not reflect the nation as a whole.[24] Lastly, because of procedural coding, Latarjet and Bristow procedures could not be separately analyzed.

Conclusion

Preoperative risk stratification to minimize patient risk has become crucial in elective orthopedic surgery. This study demonstrates that even in the relatively young and healthy shoulder instability patient cohort, patients older than 25 years are at increased risk of overall complications, overnight admission, and readmission. Further research prospectively risk-stratifying shoulder instability patients may help guide optimal risk reduction in this patient cohort.

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