Factors Influencing Surgeon's Choice of Procedure for Anterior Shoulder Instability: A Multicenter Prospective Cohort Study

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Purpose: To investigate preoperative factors associated with selection of surgical treatment for anterior shoulder instability. **Methods:** Patient demographics, initial physical examinations, and patient-oriented outcome questionnaires were collected prospectively from 26 shoulder surgeons at 10 sites. Symptom duration, number of dislocations, sport, history of prior stabilization procedure, Hill-Sachs/glenoid bone loss, pain level, and failure of conservative treatment were recorded. Statistical analysis was performed with Fisher's exact test and logistic regression analysis. **Results:** A total of 564 patients who underwent surgical treatment for anterior shoulder instability from November 2012 to June 2017 were enrolled. Of these, 426 shoulders underwent arthroscopic stabilization alone, 38 underwent arthroscopic stabilization with remplissage, 28 underwent open Bankart repair, and 72 underwent a Latarjet procedure. Predictors for undergoing Latarjet ($P < .003$) were symptom duration (75% had symptoms for >1 year), number of dislocations (47% had >5 dislocations), revision surgery (69%), Hill-Sachs lesion size (45% had a lesion between 11% and 20% of the humeral head), and glenoid bone loss (75% of Latarjet patients had 11% to 30% loss). Predictors for undergoing open Bankart repair ($P < .001$) were number of dislocations (32% had >5 dislocations), revision surgeries (54%), and glenoid bone loss (11% of open Bankart patients had 11% to 20% loss). History of prior shoulder surgery was the only significant predictor of open versus arthroscopic Bankart procedure. Prediction models showed athletes involved in high-risk sports were 2.61 times more likely to have a Latarjet ($P < .01$). **Conclusions:** Indications for the Latarjet were: humeral and glenoid bone loss, duration of symptoms, number of dislocations, and revision stabilizations. Athletes involved in high-risk sports were more likely to undergo the Latarjet procedure, even if other predictive factors were not present. The open Bankart procedure was the least common procedure performed, with a history of prior shoulder surgery being the only predictor for use when treating recurrent instability. **Level of Evidence:** Level II, prospective prognostic cohort investigation.

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Surgical management for recurrent anterior shoulder instability remains a topic of controversy, and indications for arthroscopic Bankart repair with or without a remplissage procedure, open Bankart repair, or the open Latarjet procedure are vague. A growing wealth of literature has addressed the indications, outcomes, and return to sports after each procedure.[1-8] The controversy of surgical preference often revolves around risk factors

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for recurrent shoulder instability after an arthroscopic Bankart procedure. Recent studies have reported disappointing results after arthroscopic Bankart repairs[1-3,5,8,9]; therefore, subsequent studies have sought to identify the predictive factors for failure.[10-12] Although earlier studies emphasized bone loss as the primary indication for the Latarjet procedure,[4,9] recent data suggest that patient-specific risk factors such as number of lifetime dislocations, high-risk sport participation, and the glenoid track are more reliable for determining return to sport and recurrent instability rates.[1-3,13]

Given these concerns, Owens et al.[14] reviewed the trend for arthroscopic versus open Bankart stabilization from 2003 through 2008 using the American Board of Orthopaedic Surgery Part II Board Certification database and found an increasing trend toward arthroscopic stabilization. Similarly, Degen et al.[15] studied the same examination from 2004 to 2013 and found that the number of bone-block augmentation procedures has increased 10-fold, predicting an exponential trend among recently trained orthopaedic surgeons. Furthermore, Bonazza et al.[16] investigated 66,564 shoulder stabilization procedures between 2008 and 2012 and found that arthroscopic procedures increased in total number and percentage of all procedures and that bone-block procedures increased in total number each year. All other open procedures, however, decreased in total number during that period. Open Bankart repair appears to be a "lost art" despite excellent long-term outcomes.[17,18] In addition, remplissage is commonly used at the time of arthroscopic stabilization for engaging Hill-Sachs lesions; however, better stability may come at the expense of losing external rotation.[19-23] Clear indications for remplissage at the time of arthroscopic stabilization are lacking. In a survey of 417 members of the American Shoulder and Elbow Society, arthroscopic treatment was the preferred treatment for young contact, young noncontact, and weekend warriors without bone loss, regardless of age or sport.[24] In the same survey, the Latarjet procedure was preferred for glenoid bone loss, and the remplissage was chosen for engaging Hill-Sachs lesions.[24] Few studies, however, have reported what shoulder fellowship-trained surgeons actually do when faced with recurrent anterior instability in the clinical setting.

Given the lack of conclusive, prospectively collected outcome data, it is difficult for surgeons to make evidence-based operative decisions; therefore, we collected data from 26 fellowship-trained shoulder surgeons from 10 different sites throughout the United States to identify current surgical trends and indications for recurrent anterior shoulder instability. Our hypotheses were threefold: (1) the Latarjet procedure is used primarily for cases of bone loss, revision surgeries, high level contact athletes, and those with >5 dislocations before the index procedure; (2) an open Bankart repairs are performed more often for revision surgery with less bone loss; and (3) a remplissage procedure is used for large Hill-Sachs lesions or glenoid bone loss at the time of arthroscopic stabilization. The purpose of this study was to investigate preoperative factors associated with selection of surgical treatment for anterior shoulder instability among shoulder surgeons.

Methods

Study Design and Compliance With Ethical Standards

Our multicenter research collaborative comprises 25 surgeons from 9 academic centers and 1 surgeon from a separate private practice group throughout the United States, totaling 10 different sites. The 25 academic surgeons contributed 492 patients, and the 1 private practice surgeon contributed 72 patients. This study was approved by the Biomedical Institutional Review Board of the Ohio State University and all other institutions listed in this article. The primary goal of the group is to improve care for patients with all types of shoulder problems, including shoulder instability. The current study prospectively enrolled a cohort of patients from November 2012 to June 2017 with anterior shoulder

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instability requiring surgical stabilization. Initial demographic and detailed surgical data were collected. Participants provided written, informed consent using institutional review board–approved consent forms and protocols. Additional data time points will be collected at future visits. Although outcome data were collected concomitantly as part of this study, no outcomes will be reported because it is outside the purpose of this manuscript.

Participants

We enrolled 564 patients at 1 of 10 participating institutions. Six patients were separately enrolled for each shoulder because of bilateral surgery, totaling 12 records. Inclusion criteria were patients $\geq$12 years who elected to enroll and had a history and physical examination consistent with anterior shoulder instability. Exclusion criteria included patients who chose to not enroll, those with concomitant rotator cuff surgery or posterior or multidirectional instability, and any workers' compensation claims. Prior shoulder surgery was not an exclusion in this study because this factor may influence surgical decision-making in the setting of revision stabilization procedures.

Data Collection

Patients who elected to participate in the study provided initial data upon enrollment. These data included demographic characteristics, medical comorbidities, previous surgeries or treatments, and any subjective history of shoulder instability.

Patient Variables

The patient variables that were collected included sex, age, level of education, occupation, duration of symptoms, initial injury that led to the index dislocation, lifetime number of dislocations, sport-associated dislocations, past shoulder surgeries, previous type and duration of conservative treatment, and primary sport, if any.

Surgeon Evaluation Variables

Fellowship-trained shoulder surgeons recorded the operative side as well as the total number of patient-reported dislocations per lifetime and within 1 year before presentation. Surgeons also documented pertinent preoperative physical examination findings, including active and passive range of motion measured in 10° increments, strength graded from 0 to 5, direction(s) of instability, the Beighton score, and any presence of anterior apprehension or other provocative maneuvers. Plain radiographs were obtained for each subject and reviewed at the time of enrollment. Twenty-three patients had radiographs only. Magnetic resonance imaging was obtained for 449 patients, and computed tomography was obtained for 30 patients. Sixty-two patients had both an magnetic resonance imaging and computed tomography preoperatively. Appropriate measurements were subjectively made by the individual treating surgeon, noting the size of any bony defects (Tables 1 and 2). Finally, surgeons recorded their indications for the chosen surgery, which included age, pain, number of dislocations, percentage of bone loss, high-risk sports, failed conservative treatment, and other.

Surgeon Operative Variables

Operative forms were filled out immediately following each surgery. The type of surgery (revision vs. primary), exact surgery performed, and the reason for any reoperation were documented. Hill-Sachs pathology was recorded, specifically the width of the defect and if the lesion engaged. Any capsular pathology and treatment to address it were noted. Articular cartilage pathology on both the humerus and glenoid was recorded as were the size and percent bone loss for any bony Bankart or glenoid bone deficiency. If open treatment was undertaken, the type of bone procedure was noted as well as number of screws and fixation type (Table 1).

Statistical Methods

Baseline characteristics were described by outcome groups using the mean plus standard deviation for continuous variables and percentages for categorical variables. Group differences in continuous measures were evaluated using t tests, and distributions of categorical variables were compared using Fisher's exact tests. The significance level was set at $P < .05$. Variables that were not normally distributed were compared using the Wilcoxon rank-sum test. A multivariate multinominal logistic regression was obtained using backwards selection to create a parsimonious model to predict who would have a Latarjet procedure or an open Bankart repair over arthroscopic Bankart. Each variable was tested individually; thus, no variables were controlled for. These variables were then used to build prediction models to determine who would have a Latarjet procedure versus an open Bankart. Our arthroscopic Bankart group was then analyzed, comparing variables between patients undergoing remplissage versus no remplissage. Analyses were completed using STATA 13 (StataCorp LP, College Station, TX).

Results

Demographics

A total of 564 patients with a history of surgical treatment for anterior shoulder instability were identified. Four hundred and sixty-eight were male and 96 were female. Four hundred and twenty-six underwent

Table 1. Patient Demographics and Shoulder Findings for Each Surgical Group

	Arthroscopic Bankart		Latarjet		Open Bankart		
	n	%	n	%	n	%	*P*
Sex							
Male	375	80.82	67	93.06	26	92.86	.010
Female	89	19.18	5	6.94	2	7.14	
Symptom duration, mo							
<1	36	7.76	5	6.94	2	7.14	.003
1-3	97	20.91	7	9.72	5	17.86	
4-6	70	15.09	4	5.56	4	14.29	
7-12	49	10.56	2	2.78	2	7.14	
>12	212	45.69	54	75.00	15	53.57	
No. of dislocations							
0	88	18.97	2	2.78	3	10.71	<.001
1	117	25.55	7	9.72	5	17.86	
2-5	158	34.05	29	40.28	11	39.29	
>5	101	21.77	34	47.22	9	32.14	
Injured in sport							
No	114	24.84	16	22.22	6	21.43	.900
Yes	345	75.16	56	77.78	22	78.57	
Past shoulder surgery							
No	396	85.34	22	30.56	13	46.43	<.001
Yes	68	14.66	50	69.44	15	53.57	
Anterior apprehension							
No	51	10.99	0	0.00	2	7.14	.002
Yes	413	89.01	72	100.00	26	92.86	
Positive relocation							
No	30	7.26	1	1.45	3	13.64	.055
Yes	383	92.74	68	98.55	19	86.36	
Positive relocation reason							
Pain	29	7.69	0	0.00	2	10.53	.001
Both	267	70.82	38	57.58	11	57.89	
Fear	81	21.49	28	42.42	6	31.58	
Type of surgery							
Primary	434	93.53	24	33.33	13	46.43	<.001
Reoperation	30	6.47	48	66.67	15	53.57	
Surgical indication: no. of dislocations*							
No	139	29.96	6	8.33	6	21.43	<.001
Yes	325	70.04	66	91.67	22	78.57	
Surgical indication: bone loss*							
No	427	92.03	13	18.06	19	67.86	<.001
Yes	37	7.97	59	81.94	9	32.14	
Surgical indication: age*							
No	203	43.75	26	36.11	18	64.29	.040
Yes	261	56.25	46	63.89	10	35.71	
Surgical indication: pain*							
No	271	58.41	58	80.56	20	71.43	.001
Yes	193	41.59	14	19.44	8	28.57	
Surgical indication; high-risk sport*							
No	272	58.62	39	54.17	18	64.29	.651
Yes	192	41.38	33	45.83	10	35.71	
Surgical indication: failed conservative treatment*							
No	140	30.17	21	29.17	14	50.00	.093
Yes	324	69.83	51	70.83	14	50.00	
Surgical indication: other*							
No	454	97.84	68	94.44	28	100.00	.190
Yes	10	2.16	4	5.56	0	0.00	
Hill-Sachs lesion							
No	245	52.80	16	22.22	17	60.71	<.001
0-10%	161	34.70	20	27.78	8	28.57	
11-20%	48	10.34	33	45.83	1	3.57	
21-30%	10	2.16	3	4.17	2	7.14	
>30%	0	0.00	0	0.00	0	0.00	
Glenoid bone loss							

(continued)

Table 1. Continued

	Arthroscopic Bankart		Latarjet		Open Bankart		
	n	%	n	%	n	%	*P*
No	393	84.70	13	18.06	23	82.14	<.001
0-10%	50	10.78	4	5.56	2	7.14	
11-20%	17	3.66	36	50.00	3	10.71	
21-30%	4	0.86	18	25.00	0	0.00	
>30%	0	0.00	1	1.39	0	0.00	
High-risk sport[†]							
No	294	63.36	36	50.00	16	57.14	.085
Yes	170	36.64	36	50.00	12	42.86	

*The 7 surgical indications listed were part of a preoperative survey given to the treating surgeon to identify reasons for proceeding with surgery.

[†]Baseball, diving, extreme sports, football, hockey, rodeo, wrestling.

arthroscopic stabilization alone, 38 underwent arthroscopic stabilization with remplissage, 28 underwent an open Bankart repair, and 72 underwent a Latarjet procedure. When using Fisher's exact test to determine significant differences between the surgical groups, the significant predictors of surgical decision-making were the following.

1. Symptom duration: 75% of Latarjet patients had symptoms for >1 year ($P < .003$).
2. Number of dislocations: 47% of Latarjet patients had greater than 5 dislocations compared with 32% of open Bankart patients and 21.7% of arthroscopic Bankart patients ($P < .001$).
3. Past shoulder surgery: 69% of Latarjet patients were revision surgeries compared with 53.6% of open Bankart patients and 6.46% of arthroscopic Bankart patients ($P < .001$).
4. Hill-Sachs lesion size: 45.8% of Latarjet patients had Hill-Sachs lesions measuring 11% to 20% compared with 10.3% of arthroscopic Bankart patients and 3.57% of open Bankart patients ($P < .001$).
5. Glenoid bone loss: 76% of Latarjet patients had >11% glenoid bone loss compared with 10.7% of open Bankart patients and 4.5% of arthroscopic Bankart patients ($P < .001$).

Demographic factors that were not found to be predictors of surgical decision-making were sex, athletic participation during the primary dislocation, presence of a positive relocation test, high-risk sport participation, failure of conservative treatment, and preoperative range of motion (Table 1).

Predicting Surgical Decision-Making: Latarjet Versus Open Bankart Repair

When comparing the Latarjet and open Bankart patients, logistic regression analysis predicted those with an 11% to 20% Hill-Sachs lesion were 10.53 times more likely to have a Latarjet procedure ($P < .001$). Patients with 11% to 20% and 21% to 30% glenoid bone loss were 64 times and 136 times more likely to have a Latarjet procedure, respectively ($P < .001$) (Table 2). High-risk athletes were 1.73 times more likely to have a Latarjet ($P < .001$). In addition, patients with more than 5 dislocations were 14.81 times more likely to undergo the Latarjet procedure ($P < .001$). Finally, patients who underwent prior shoulder surgery were 13.24 times more likely to have a Latarjet procedure ($P < .001$). Although those who underwent prior shoulder surgery were more likely to undergo a Latarjet, this group of patients was the only significant predictor for patients undergoing open Bankart repair ($P < .001$).

Prediction Models

A prediction model was created to determine significant factors predisposing patients for a Latarjet procedure versus an open Bankart procedure (Table 3). Three variables were controlled for: glenoid bone loss, high-risk athletes, and past shoulder surgery. When controlling for prior surgeries and bone loss, the prediction model showed that athletes involved in high-risk sports were 2.61 times more likely to undergo a Latarjet procedure than nonathletes or low-risk sport participants ($P < .015$). When controlling for glenoid bone loss and high-risk athletes, those with past shoulder surgery were 12.79 times more likely to undergo a Latarjet procedure ($P < .001$). When controlling for prior shoulder surgery and high-risk athletes, patients with 11% to 20% bone loss were 60.98 times more likely to have a Latarjet procedure, and those with 21% to 30% glenoid bone loss were 147.68 times more likely to have a Latarjet procedure ($P < .001$). Finally, when glenoid bone loss, high-risk athletes, and past shoulder surgeries are all present together, one can predict with 95% accuracy that the patient will receive the Latarjet procedure. When controlling for glenoid bone loss and high-risk athletes, patients with prior shoulder surgery were 6.69 times more likely to have an open Bankart repair; thus, if the

Table 2. A Multinomial Logistic Regression Showing Which Factors Can Predict Those Who Would Have a Latarjet Versus an Open Bankart Repair

Procedure	Predictor		RRR	SE	*P*	95% CI	
Latarjet	Hill-Sachs	No	—	—	—	—	—
		0-10%	1.90	0.67	.067	0.96	3.78
		11-20%	**10.53**	**3.61**	**<.001**	**5.37**	**20.62**
		21-30%	**4.59**	**3.25**	**.031**	**1.15**	**18.37**
Open Bankart	Hill-Sachs	No	—	—	—	—	—
		0-10%	0.72	0.32	.449	0.30	1.70
		11-20%	0.30	0.31	.248	0.04	2.31
		21-30%	2.88	2.35	.194	0.58	14.22
Latarjet	Glenoid bone loss	No	—	—	—	—	—
		0-10%	2.42	1.43	.135	0.76	7.70
		11-20%	**64.00**	**26.08**	**<.001**	**28.80**	**142.26**
		21-30%	**136.02**	**84.40**	**<.001**	**40.31**	**458.97**
Open Bankart	Glenoid bone loss	No	—	—	—	—	—
		0-10%	0.68	0.51	.61	0.16	2.99
		11-20%	3.01	2.00	.096	0.82	11.03
		21-30%	NA	NA	NA	NA	NA
Latarjet	High risk	No	—	—	—	—	—
		Yes	**1.73**	**0.44**	**.031**	**1.05**	**2.85**
Open Bankart	High risk	No	—	—	—	—	—
		Yes	1.30	0.51	.509	0.60	2.81
Latarjet	No. of dislocations	0	—	—	—	—	—
		1	2.63	2.14	.234	0.53	12.98
		2-5	**8.08**	**6.00**	**.005**	**1.88**	**34.65**
		>5	**14.81**	**10.99**	**<.001**	**3.46**	**63.43**
Open Bankart	No. of dislocations	0	—	—	—	—	—
		1	1.25	0.93	.761	0.29	5.39
		2-5	2.04	1.36	.283	0.55	7.52
		>5	2.61	1.78	.159	0.68	9.96
Latarjet	Past shoulder surgery	No	—	—	—	—	—
		Yes	**13.24**	**3.81**	**<.001**	**7.53**	**23.25**
Open Bankart	Past shoulder surgery*	No	—	—	—	—	—
		Yes	**6.72**	**2.69**	**<.001**	**3.06**	**14.75**

NOTE. Boldface indicates statistical significance.
CI, confidence interval; NA, not available; RRR, relative risk reduction; SE, standard error.
*Past shoulder surgery was the only significant predictor for open Bankart repair.

patient was undergoing a revision without bone loss or a history of high-risk sport, they were 6.69 times more likely to undergo an open Bankart. Prior shoulder surgery was, again, the only significant predictor for patients undergoing open Bankart repair in this prediction model ($P < .001$).

Predictors for Remplissage During Arthroscopic Stabilization

Finally, the arthroscopic Bankart procedures were analyzed to determine significant factors predisposing patients to remplissage at the time of surgery (Table 4). Surgeons recording a higher number of dislocations and initial bone loss were found in 97.4% and 42.1% of remplissage patients, respectively ($P < .001$). Forty-seven percent of patients with Hill-Sachs lesions measuring 11% to 20% underwent a remplissage, and 18.4% of patients with anterior glenoid bone loss measuring 11% to 20% underwent remplissage ($P < .001$). Of interesting, 30 patients (7%) with 11% to 20% humeral bone loss did not undergo remplissage at the time of arthroscopic stabilization. High-risk sport, symptom duration, number of dislocations, and past shoulder surgery were not found to be predictive factors for remplissage at the time of arthroscopic stabilization.

Discussion

Our data show that sports and shoulder fellowship-trained surgeons consider more than just bone loss when deciding between the Latarjet procedure, open Bankart repair, or arthroscopic stabilization for recurrent instability. The most significant factors predictive of surgical decision-making are symptom duration, total number of dislocations, revision surgery, and the degree of humeral and glenoid-sided bone loss. The factors most predictive of patients undergoing the Latarjet procedure were those involved in a high-risk sport, presence of glenoid bone loss, and those undergoing revision surgery. High-risk athletes, even when controlling for both bone loss and secondary stabilization, were more likely to undergo the Latarjet procedure.

Table 3. Prediction Model Controlling for Glenoid Bone Loss, High-Risk Sports, and Prior Shoulder Surgery to Determine Which Patients Would More Likely Have a Latarjet Versus an Open Bankart Procedure

Procedure	Predictor		RRR	SE	*P*	95% CI	
Latarjet	Glenoid bone loss	No	—	—	—	—	—
		0-10%	2.75	1.73	.109	0.80	9.42
		11-20%	**60.98**	**28.88**	**<.001**	**24.10**	**154.30**
		21-30%	**147.68**	**105.86**	**<.001**	**36.24**	**601.83**
	High risk	No	—	—	—	—	—
		Yes	**2.61**	**1.03**	**.015**	**1.20**	**5.67**
	Past shoulder surgery	No	—	—	—	—	—
		Yes	**12.79**	**5.29**	**<.001**	**5.68**	**28.78**
Open Bankart	Glenoid bone loss	No	—	—	—	—	—
		0-10%	0.69	0.53	0.633	0.15	3.11
		11-20%	2.79	1.91	0.134	0.73	10.67
		21-30%	NA	NA	NA	NA	NA
	High risk	No	—	—	—	—	—
		Yes	1.37	0.56	0.443	0.62	3.03
	Past shoulder surgery	No	—	—	—	—	—
		Yes	**6.69**	**2.70**	**<.001**	**3.04**	**14.74**

NOTE. Boldface indicates statistical significance.
CI, confidence interval; NA, not available; RRR, relative risk reduction; SE, standard error.

Prior shoulder surgery was the only predictive factor contributing to a decision for an open Bankart repair. Remplissage was used in conjunction with an arthroscopic Bankart repair most often for Hill-Sachs lesions or glenoid defects measuring 11% to 20%.

Recently, literature has shown that the recurrence rate of instability after arthroscopic stabilization has been higher than anticipated.[1-3,8,9] This has caused an influx of studies to identify preoperative risk factors predictive of arthroscopic failure, including components that we evaluated such as high-risk sport participation, symptom duration, and number of dislocations. Although glenoid-sided bone loss has been commonly cited as the main factor for recurrence in past studies, more recent investigations have attributed higher failure rates to a combination of patient-related factors, including the patients' functional status, degree of bone loss, glenoid track, and capsular redundancy in those with baseline ligamentous laxity or chronic attenuation from repetitive episodes of instability.[10,25,26]

In an effort to help improve the indications for the arthroscopic Bankart repair, the Instability Severity Index Score (ISIS) was developed.[13] Calvo et al.[27] published 1 of the first scores in 2005 based on 61 failed arthroscopic procedures, identifying predictive factors for recurrence to be age, ligamentous laxity, >15% glenoid bone loss, and patients resuming a contact sport. In 2006, Boileau et al.[9] found that the same factors led to recurrence in 91 failed surgeries. These data led to a more comprehensive score reported in 2007, identifying patients to have a 70% risk of recurrence with scores >6 points. When applying these results to a more comprehensive cohort, Balg and Boileau[28] showed an encouraging 3.2% recurrence rate at 18 months. Phadnis et al.[29] later independently validated the ISIS score in a cohort of 141 patients. Although our multicenter group did not collect or use the ISIS score in this cohort, it would certainly be of interest to apply these criteria to gauge our decision-making versus what the ISIS score recommends.

When evaluating the glenoid track alone, several authors have confirmed the importance of identifying lesions on both sides of the joint, both preoperatively and intraoperatively. Bony augmentation is preferred for "off-track" or engaged shoulders based on the size of the glenoid defect coupled with the size and location of the Hill-Sachs lesion.[10] This mathematical model provides a straightforward decision when this degree of bone loss is present; however, surgical decision-making is clinically more challenging when the bone loss is subtle, relying on other patient or tissue-related factors for stabilization options. Bipolar bone loss did influence decision-making in our cohort, because 50% of the Latarjet population had >11% Hill-Sachs lesions compared with 12% of the arthroscopic cases. Twenty-one percent of the arthroscopic population had >11% glenoid bone loss compared with 76% of the Latarjet patients; however, bipolar bone loss did not influence decision-making for an open Bankart procedure.

Despite these objective measures to identify patients at risk for arthroscopic failure, the literature shows conflicting data as to which procedure is actually performed in different clinical settings. Mohtadi et al.[30] performed a randomized clinical trial comparing open Bankart versus arthroscopic Bankart repair and demonstrated a relatively high recurrence rate (23%) for the arthroscopic Bankart group versus the open Bankart group (11%). The overall recurrence rates after arthroscopic Bankart repair have been reported as high as 41.7%, whereas recurrence rates after the Latarjet

Table 4. Factors Predictive of Remplissage Time of Arthroscopic Bankart Repair

	No Remplissage		Remplissage		
	n	%	n	%	*P*
Sex					
Male	344	80.75	31	81.58	1.000
Female	82	19.25	7	18.42	
Symptom duration, mo					
<1	34	7.98	2	5.26	.192
1-3	93	21.83	4	10.53	
4-6	66	15.49	4	10.53	
7-12	42	9.86	7	18.42	
>12	191	44.84	21	55.26	
No. of dislocations					
0	83	19.48	5	13.16	.273
1	111	26.06	6	15.79	
2-5	142	33.33	16	42.11	
>5	90	21.13	11	28.95	
Injured in sport					
No	101	23.99	13	34.21	.172
Yes	320	76.01	25	65.79	
Past shoulder surgery					
No	366	85.92	30	78.95	.236
Yes	60	14.08	8	21.05	
Anterior apprehension					
No	48	11.27	3	7.89	.786
Yes	378	88.73	35	92.11	
Positive relocation					
No	25	6.65	5	13.51	.172
Yes	351	93.35	32	86.49	
Positive relocation reason					
Pain	28	8.09	1	3.23	.351
Both	241	69.65	26	83.87	
Fear	77	22.25	4	12.90	
Type of surgery					
Primary	403	94.60	31	81.58	.007
Reoperation	23	5.40	7	18.42	
Surgical indication: no. of dislocations					
No	138	32.39	1	2.63	<.001
Yes	288	67.61	37	97.37	
Surgical indication: bone loss					
No	405	95.07	22	57.89	<.001
Yes	21	4.93	16	42.11	
Surgical indication: age					
No	184	43.19	19	50.00	.495
Yes	242	56.81	19	50.00	
Surgical indication: pain					
No	249	58.45	22	57.89	1.000
Yes	177	41.55	16	42.11	
Surgical indication: high-risk sport					
No	245	57.51	27	71.05	.123
Yes	181	42.49	11	28.95	
Surgical indication: failed conservative treatment					
No	132	30.99	8	21.05	.268
Yes	294	69.01	30	78.95	
Surgical indication: other					
No	418	98.12	36	94.74	.194
Yes	8	1.88	2	5.26	
Hill-Sachs lesion					
No	241	56.57	4	10.53	<.001
0-10%	155	36.38	6	15.79	
11-20%	30	7.04	18	47.37	
21-30%	0	0.00	10	26.32	
>30%	0	0.00	0	0.00	
Bankart bone loss					

(continued)

Table 4. Continued

	No Remplissage		Remplissage		
	n	%	n	%	*P*
No	369	86.62	24	63.16	<.001
0-10%	44	10.33	6	15.79	
11-20%	10	2.35	7	18.42	
21-30%	3	0.70	1	2.63	
>30%	0	0.00	0	0.00	
High-risk sport					
No	268	62.91	26	68.42	.599
Yes	158	37.09	12	31.58	

procedure are much lower, up to 14.2%.[15] Proponents of the arthroscopic technique, however, cite the high reported complication rate for the Latarjet and its nonanatomic reconstruction of the glenoid.[13]

The open Bankart procedure has lost popularity within the past decade despite excellent results, possibly attributed to surgeon familiarity.[15] Of the 564 stabilization procedures performed in this cohort, only 28 patients (5%) underwent an open Bankart procedure. Of interest, we did evaluate the age of the treating surgeons and years that each had been in practice, because we hypothesized that younger surgeons would perform less open Bankart surgeries. The age range of the surgeons was between 32.4 and 59.2 years, with an average age of 44.8 years. The amount of time in practice because completion of fellowship ranged from 11 months to 26 years, with an average of 11.3 years. We did not find any significant difference between surgeon age or experience when comparing the open Bankart cohort with the arthroscopic or Latarjet groups. Certainly, our number of open Bankart surgeries could be underpowered to detect a difference. In 1 of the largest cohorts of open Bankart repairs with mid- to long-term follow-up, Neviaser et al.[18] demonstrated an overall dislocation recurrence rate of 0.8% using the technique described by Rowe et al.[31] Other studies have supported the use of open Bankart repair compared with arthroscopic stabilization because of lower recurrence rates (0% to 16.7%).[32,33] Moroder et al.[17] demonstrated a higher recurrence rate at 17.5% in a smaller cohort of 40 patients without critical Hill-Sachs lesions. Despite good outcomes in the literature, our data show that there has been a decline in the performance of open Bankart procedures, which was once the gold standard treatment for shoulder instability. Most would agree that an open Bankart repair has a relevant role in the treatment of recurrent anterior shoulder instability; however, that role in the modern-day shoulder instability treatment algorithm is not clear.

Regarding return to play, some recent studies looking at arthroscopic Bankart repair versus the open Latarjet have shown a faster return and a higher subjective perception of the shoulder with the Bankart repair.[3] Conversely, Zimmermann et al.[8] recently showed that Latarjet patients demonstrated superior results in terms of recurrence and apprehension (11%) compared with arthroscopic Bankart repairs (41.7%). Bessiere et al.[1] showed that the arthroscopic Bankart procedure fails progressively over time. More than one-half of the reported cases of recurrent instability after arthroscopic Bankart repair occurred later than 2 years postoperatively, compared with just 11% after the Latarjet procedure. Proponents of the Latarjet procedure have argued that regardless of bone loss, ligamentous laxity, or the potential complication rate, patients involved in collision sports may be best treated by the Latarjet procedure. Neyton et al.[6] showed that arthritic change was minimal and that shoulders remained stable with minimum 5-year follow-up. The decision to proceed with the Latarjet was primarily based on the high-energy nature of rugby, which can lead to a higher failure rate in a soft tissue—only reconstruction. In a systematic review comparing return to play among arthroscopic Bankart repair, open Bankart, and the Latarjet, Ialenti et al.[34] showed a similar overall return rate of 73% for Latarjet patients (n = 353), 71% for arthroscopic Bankart patients (n = 545), and 66% for open Bankart patients (n = 138), with no statistically significant difference. In our cohort, revision stabilization procedures and the amount of bone loss were the most influential factors that favored the Latarjet procedure. When controlling for the amount of bone loss and number of previous surgeries, our data demonstrated that high-risk athletes are more likely to undergo a Latarjet procedure; however, our data demonstrate surgeon choice only and cannot be used to predict if these patients will have a successful return to activity.

Revision options for patients after failed surgical stabilization with recurrent instability remain another key point of debate. Of the 95 revision stabilization procedures in our cohort, 30 patients had an arthroscopic Bankart repair, 15 had an open Bankart repair, and 50 had a Latarjet procedure as their revision surgery; therefore, although revision arthroscopic Bankart repairs consisted of only 6% of the total arthroscopic cases, 31% of the revision surgeries were performed arthroscopically. A systematic review by

Friedman et al.[35] explored 17 studies that addressed different surgical options for recurrent instability, finding no statistical difference between the arthroscopic Bankart or Latarjet procedures, suggesting that revision success rates are largely dependent on appropriate patient selection. Blackman et al.[36] examined 15 adolescent athletes undergoing revision stabilization after having failed primary arthroscopic (n = 13) or open (n = 2) Bankart repairs. Revision stabilizations were performed arthroscopically (n = 7) or open (n = 8). Five of the 15 athletes (33%) failed these revision stabilizations; however, it is unclear which stabilization method had recurrent failure. Ranalletta et al.[37] analyzed 68 athletes undergoing a modified Latarjet procedure without capsulolabral repair as a revision stabilization procedure after having failed a prior operation with a mean follow-up of 44 months. Glenoid bone loss was measured at an average of 28%, and 83% of their cohort were competitive athletes. Ultimately, the long-term follow-up after revision stabilization in our cohort will hopefully provide an appropriate treatment algorithm when treating recurrent instability.

Indications for remplissage at the time of arthroscopic stabilization are also unclear. Of 464 arthroscopic stabilization procedures in our cohort, only 38 (8%) had a concomitant remplissage. These patients had greater bone loss, especially the Hill-Sachs lesion size. Buza et al.[20] performed a systematic review of remplissage performed in 167 total patients with a mean follow-up of 26.8 months. Only 2 of the 6 studies commented on the preoperative Hill-Sachs lesion size, with an average of 30.6% reported, and 2 studies reported glenoid bone loss at an average of 14.9%. Ko et al.[21] performed a randomized control trial comparing 48 patients with recurrent instability undergoing arthroscopic Bankart repair. Twenty-four patients underwent remplissage, whereas the other 24 patients acted as controls. All patients had preoperative glenoid defects <25%; thus, it is unclear if a certain percentage bone loss would warrant concomitant remplissage. Our data showed that patients undergoing revision surgery or with humeral or glenoid-sided defects >11% were more likely to have a remplissage at the time of arthroscopic stabilization.

Given the paucity of literature that addresses surgical decision-making for recurrent anterior shoulder instability, our current data may provide insight for the treating surgeon when deciding between the arthroscopic Bankart, open Bankart, or Latarjet procedures. Symptom duration and number of dislocations go hand in hand because the longer duration of instability may influence soft-tissue deficiency, capsular redundancy, and overall shoulder laxity. These factors may predispose surgeons to consider the Latarjet, even in the setting of minimal bone loss; however, the literature requires better designed, prospective studies that control for bone loss and revisions. Expert opinion can still provide a sound treatment guideline, which our study aims to fulfill.

Strengths

This study involved surgeons from both academic and private practice settings. In addition, all data were carefully and prospectively collected with detailed surgeon documentation and validated patient outcome questionnaires. Five hundred and sixty-four patients were enrolled, providing a large degree of pathology and patient-specific variables for future outcomes literature.

Limitations

Objective data, including physical examination findings and percent bone loss, were subjectively collected by the numerous treating surgeons at 10 institutions, thus introducing interobserver bias. Furthermore, additional data that may influence surgical decision-making such as on-track versus off-track Hill-Sachs lesions were not recorded. The final decision on which surgical procedure to undergo was also based on surgeon preference and not standardized nor randomized. Doing so, however, would take away from the overall purpose of this article, which was to demonstrate what fellowship-trained surgeons actually do in different clinical situations. We analyzed the treatment choice, not the treatment outcome.

In addition, the regression model in Table 3 may be underpowered based on the small number of open Bankart procedures performed (n = 28) compared with the total number of procedures in our cohort (n = 564). This may explain why the relative risk reduction and standard error are inflated for glenoid bone loss measuring 11% to 20% and 21% to 30%. The regression model in Table 2 would be powered appropriately, however, because each variable is tested individually. The rule of thumb is that one needs 20 to 30 observations per variable. Finally, all surgeons in the multicenter shoulder group were trained and currently practice in the United States, which may pose a cultural and regional bias for surgical preference. Certainly, training exposure and surgeon experience may factor into surgical decision-making; however, we believe these factors stray away from the purpose of this study, which was to highlight which patient-related (not surgeon-related) factors that influenced procedural decision-making.

Conclusions

Indications for the Latarjet were: humeral and glenoid bone loss, duration of symptoms, number of dislocations, and revision stabilizations. Athletes involved in

high-risk sports were more likely to undergo the Latarjet procedure, even if other predictive factors were not present. The open Bankart procedure was the least common procedure performed with a history of prior shoulder surgery being the only predictor for its use when treating recurrent instability.

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