J Shoulder Elbow Surg (2022) ■, 1–8

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Clinical outcomes and recurrence rate of 4 procedures for recurrent anterior shoulder instability: ASA, remplissage, open, and arthroscopic Latarjet: a multicenter study

Marco Maiotti, MD[a,b,*], Andrea De Vita, MD[c], Massimo De Benedetto, MD[d], Simone Cerciello, MD[e], Carlo Massoni, MD[f], Angelo Di Giunta, MD[g], Francesco Raffelini, MD[h], Riccardo Lo Cascio, MD[i], Piergiorgio Pirani, MD[j], Roberto Castricini, MD[d]

[a]*Villa Stuart Hospital, Rome, Italy*
[b]*Mediterranea Hospital, Naples, Italy*
[c]*Concordia Hospital, Rome, Italy*
[d]*Casa di Cura Villa Verde, Fermo, Italy*
[e]*Università Cattolica del sacro cuore, Rome, Italy*
[f]*Mediterranea Hospital, Naples, Italy*
[g]*Policlinico "G.B. Morgagni", Catania, Italy*
[h]*Istituto Fiorentino di Cura e Assistenza, Florence, Italy*
[i]*Karol Cosentino Hospital, Palermo, Italy*
[j]*Infermi Hospital, Faenza, Italy*

Background: The aim of the present study was to compare the clinical outcomes of 4 surgical techniques in patients with recurrent anterior shoulder dislocation, glenoid bone loss (GBL) <15% and Instability Severity Index (ISI) score >3.

Methods: A retrospective multicenter study was conducted on 226 patients who underwent 1 of 4 different techniques (Bankart plus arthroscopic subscapularis augmentation (ASA), Bankart plus remplissage, Latarjet, Arthro-Latarjet). The inclusion criteria were: recurrent dislocation, GBL <15%, and ISI score >3. The exclusion criteria were: GBL >15%, voluntary instability, multidirectional instability, preexisting osteoarthritis, throwing athletes' first dislocation, and ISI score<3. Follow-up ranged from 24 months to 6 years. Hyperlaxity was clinically evaluated according to Neer and Coudane–Walch tests. Clinical outcomes were assessed using the Rowe score and the Western Ontario Shoulder Instability Index (WOSI) for each technique. Before surgery, all patients underwent magnetic resonance imaging and computed tomography scanning. The Pico area method was used to assess the percentage of GBL. The operations were performed by 10 experienced surgeons; the functional outcomes were evaluated by 2 independent observers.

Results: A total of 226 patients who met the inclusion criteria were included in the present series. A total of 89.2% of patients in the ASA group reported an excellent Rowe score at the final follow-up, and their scores on the WOSI scale, improved from 838 to 235 points. A total of 79.9% of patients in remplissage (R) group reported an excellent Rowe score at the final follow-up, and their scores on the WOSI scale improved from 1146 to 465 points. A total of 98.5% of patients in the Latarjet (L) group reported an excellent Rowe

Institutional review board approval was received from Comitato Etico Campania Centro (Prot. N° 229/CE 1-2020 Oss).

*Reprint requests: Marco Maiotti, MD, Villa Stuart Hospital, Rome, Italy; Mediterranea Hospital, Naples, Italy.
E-mail address: marcomaiotti.ortopedia@gmail.com (M. Maiotti).

https://doi.org/10.1016/j.jse.2022.10.030

score at the final follow-up, and their scores on the WOSI scale improved from 1456 to 319 points. A total of 81.6% of patients in the Arthro-Latarjet (AL) group reported an excellent Rowe score at the final follow-up, and their scores on the WOSI scale improved from 1250 to 221 points. The recurrence rates were as follows: ASA group (7%), remplissage group (6.1%), L group (1.5%), Arthro-Latarjet group (0%). Patients in the open L group had 15.5% (10/66) more complications.

Conclusion: The use of ASA and remplissage to augment the Bankart repair have been demonstrated to be effective for restoring joint stability, yielding good clinical outcomes similar to the L procedure in patients affected by recurrent anterior dislocation with GBL <15% and an ISI score score >3. Soft tissues augmentations of the Bankart repair have been demonstrated to be effective for addressing anterior soft tissue deficiency dysfunction and critical Hill–Sachs lesions.

Level of evidence: Level III; Retrospective Comparative Study

Keywords: Traumatic shoulder instability; arthroscopic subscapularis augmentation; glenoid defect; Latarjet; remplissage; Hill–Sachs lesion

The treatment of chronic anterior shoulder instability still remains a challenging topic for orthopedic surgeons since the cause of instability is multifactorial.

Soft tissue damage and dysfunctions, such as the elongation of the coracohumeral ligament and laxity of the upper third of the subscapularis, play an important role in compromising shoulder stability, especially in younger patients who engage in contact sports.

Furthermore, the presence of glenoid and humeral bone loss has been well demonstrated to be an important risk factor for recurrence in patients with chronic shoulder instability.[37]

In recent decades of the twentieth century arthroscopic anatomical capsule-labral repair has been ~~a~~ considered the best surgical option in individuals with chronic anterior instability, although it has also been shown to be associated with, a 20%-60% increase in the risk of recurrence in the presence of risk factors.[4,27,42,48] Therefore, for individuals with an (Instability Severity Index [ISI] score >3) the Latarjet (L) procedure is currently recommended.[9,28]

More recently, the concept of glenoid or humeral bone defects has evolved into a more dynamic scenario with ''on-track'' or ''off-track'' Hill–Sachs lesions.[11] In patients with ''off-track'' humeral bone defect, the risk of recurrence is even higher, therefore, a simple capsule-labral repair is not indicated. Wolf et al. have described the remplissage procedure which aims to fill the Hill–Sachs defect with a tenodesis of the infraspinatus converting the intra-articular lesion into extra-articular and recentering the humeral head, by pulling it back.[35] Such tenodesis reduces the risk of recurrence.[5,26,29,49]

In contrast, the remplissage procedure might be less effective ~~in~~ for restoring shoulder stability among patients with concomitant anterior capsular deficiency. More recently, arthroscopic subscapularis augmentation (ASA) combined with Bankart repair[32] (Maiotti technique) consisting of a tenodesis of the upper third of the subscapularis, has been proposed to treat patients with poor anterior glenohumeral ligaments. The ASA technique has a triple effect: it restores coracohumeral tension addresses the stretched part of the subscapularis tendon and augments capsule-labral insufficiency without causing external rotation restriction.[30,31,33,39]

The open or arthroscopic Latarjet[3,6,50] procedure has emerged in the past decade as one of the most successful options to address chronic instability in patients with a high risk of recurrence[1,25] as these procedures are associated with the lowest recurrence rate in the literature: 2.9% for the arthroscopic technique and 5.7% for the open technique. However, this is a nonanatomical procedure with nonnegligible intra- and postoperative complications. The overall complication rates are 23.7% for the arthroscopic technique and 15.3% for the open technique.[8]

The aim of the present multicenter study was to compare outcomes, recurrence and complications of 4 surgical techniques in patients with recurrent anterior dislocation, glenoid bone loss (GBL) <15% and an ISI score>3.

We hypothesized that outcomes of all patients would be similar regardless of surgical technique; soft tissue augmentation of the Bankart repair could be effective in restoring shoulder stability in patients with capsule-ligamentous deficiency and critical Hill–Sachs lesions.

Methods

This was a retrospective case-control study of 226 patients to compare the clinical outcomes of 4 surgical techniques (Bankart plus, ASA, Bankart plus remplissage, Arthro-Latarjet, and open Latarjet) for the treatment of anterior shoulder instability in a homogeneous cohort of patients. The study was conducted between December 2020 and March 2022 in patients with a minimum follow-up (FU) of 24 months and a maximum FU of 6 years. Ethical committee approval of the local institution was obtained for our study.

The surgical procedures were performed by 10 different experienced surgeons: ASA (M.M., M.D., C.M.), remplissage (A.D., F.R., S.C.), Arthro-Latarjet (R.C., P.P.), open Latarjet (A.D., F.R., R.L.). Ethical committee approval of the local institution was obtained from our study.

All the ASA and remplissage procedures were performed in a lateral decubitus position. According to the original technique that

Table I Baseline demographical and clinical characteristics (numbers and percentages or means and 95% CIs) of participants in the study according to the type of surgery

	Arthro-Latarjet	Latarjet	ASA	Remplissage	*P* value
Number	38	66	57	65	
Sex (M/F)	35/3	55/11	51/6	56/9	.755*
	92.1	83.3	89.5	86.2	
Age	27.3 (24.8-29.8)	32.7 (30.2-35.2)	29.8 (27.5-32.1)	26.7 (24.7-28.7)	<.001†
Follow-up (months)	57.5 (53.1-61.9)	45.5 (39.7-51.3)	44.2 (40.0-48.4)	25.0 (19.5-30.6)	<.001†
Shoulder operated (R/L)	22/16	39/27	33/24	40/25	1.000*
	57.9	59.1	57.9	61.5	
Dominant arm (R/L)	34/4	62/4	47/9	56/9	.444*
	89.5	93.9	82.4	87.7	
Number of luxation	8.6	9.7	6.5	5.7	<.001†
	(5.2-12.0)	(7.6-11.8)	(5.3-7.6)	(4.7-6.7)	
Age at first luxation	24.3 (21.2-27.3)	25.2 (22.8-27.5)	24.2 (22.1-26.3)	22.4 (20.6-24.3)	.147†
Months from first luxation to surgery	32.5 (27.4-37.6)	77.7 (58.7-96.7)	44.1 (24.5-63.6)	50.0 (33.2-66.8)	.003†
Competitive sport (Y/N)	32/6	45/21	49/8	34/31	<.001*
	84.2	68.2	86.0	52.3	
Contact sport (Y/N)	14/24	10/56	39/18	13/52	<.001*
	36.8	15.2	68.4	20.0	
Shoulder hyperlaxity(Y/N)	8/30	15/51	19/38	18/47	.655*
	21.1	22.7	33.3	27.7	
ER1 contralateral	76.7 (73.4-79.2)	53.6 (51.0-56.1)	72.6 (69.0-76.2)	77.8 (74.6-81.1)	<.001†
ER2 contralateral	84.6 (83.0-86.1)	95.6 (92.1-99.2)	91.9 (90.2-93.6)	82.5 (80.0-85.0)	<.001†
Glenoid loss contour (Y/N)	38/0	12/54	18/39	12/53	<.001*
	100.0	18.2	31.6	18.5	
Hill–Sachs (Y/N)	38/0	61/5	51/6	64/1	.068*
	100.0	92.4	89.5	98.5	
Previous surgery	11.	5.	2	3.	>.001

CI, confidence interval; *ASA*, arthroscopic subscapularis augmentation; *ER*, external rotation.

* Chi square.

† Analysis of variance.

has been described in the literature, the ASA consists ~~a~~of tenodesis of the upper third of the subscapularis on the glenoid neck.

A tendon fixation bone hole should be made over the top of the glenoid corner, slightly posterior to the anterior margin of the glenoid surface, to ensure a good bone stock for the anchor fixation. The superior portion of the subscapularis tendon had to be perforated at least 5 mm from its upper border, with a penetrator device slightly flush with the articular surface and the tenodesis was performed with a 2.9 Pushlock loaded with multistrand tape (LabralTape; Arthrex, Naples, FL, USA) The tendon should be fixed at the 2-o'clock position on the right shoulder and the 10-o'clock position on the left shoulder, maintaining the arm in neutral rotation. In the remplissage procedure the infraspinatus tenodesis was performed using a single triple-suture anchor in a parachute configuration. All the Arthrolatarjet (ArthroLTG) procedures were performed in the beach-chair position. The 7-portal technique was performed as described by Lafosse and a dedicated instrumentation (Depuy Mitek Boston, MA, USA) was used.

A subscapularis split was performed and 2 3.5 mm cannulated bicortical screws were used for graft fixation. In the Open Latarjet a subscapularis split 2/3 superior 1/3 inferior was performed and 2 cannulated screws were used for coracoid fixation in all patients.

Two independent observers conducted preoperative and postoperative ratings of functional outcomes using consistent methods. After surgery, the arm was immobilized in a brace in the adducted position for 4 weeks for all patients. The rehabilitation program was started at the end of the fourth week, including passive and active shoulder exercises, to increase joint mobility and restore complete range of motion (ROM) After 8-9 weeks, recovery of strength and proprioceptive abilities were achieved. Return to sports was allowed after 5 months. The inclusion criteria were: recurrent anterior instability; GBL <15%; and an ISI score >3. The exclusion criteria were: GBL >15%, voluntary instability, multidirectional instability, pre-existing osteoarthritis, throwing athletes and first incident of dislocation, and an ISI score <3.

Hyperlaxity was evaluated according to Neer and Coudane–Walch tests.[36] Preoperatively, all patients underwent magnetic resonance imaging to assess Hill–Sachs lesions and underwent computed tomography scan examinations by using the Pico Area method to assess GBL measurement was used.[2] Age, sex, number of pre- and postoperative dislocations, type of trauma at first dislocation, type of sports, and postoperative external rotation (ER1-ER2) were assessed and compared with contralateral side. The time between the first dislocation and surgery was

Table II Mean Rowe scores (95% CI) and level (n. and %) according to the type of surgery

Surgery/Rowe	Arthro-Latarjet	Latarjet	ASA	Remplissage
Follow-up Level:	93.6 (89.7-97.4)	98.5 (97.4-99.6)	91.7 (87.9-95.5)	93.1 (90.9-95.3)
Excellent	31 (81.6)	65 (98.5)	50 (89.2)	50 (76.9)
Good	6 (15.8)	0	2 (3.6)	14 (21.5)
Fair	1 (2.6)	1 (1.5)	2 (3.6)	1 (1.5)
Poor	0	0	2 (3.6)	0

CI, confidence interval; *ASA*, arthroscopic subscapularis augmentation.
Score Systems for Shoulder Stability (Rowe) Rowe levels: Excellent (90-100). Good (75-89). Fair (40–74). Poor (0-39).

Table III Mean (95% CI) Western Ontario Shoulder Instability Index scores and difference between baseline and follow-up according to the type of surgery

Surgery/WOSI	Arthro-Latarjet	Latarjet	ASA	Remplissage
Baseline	1250 (1181-1318)	1456 (1363-1549)	838 (777-900)	1146 (1016-1275)
Follow-up	221 (175-267)	319 (257-381)	235 (171-299)	465 (391-540)
Difference	1028 (997-1060)	1137 (1038-1236)	603 (536-670)	680 (601-760)

CI, confidence interval; *ASA*, arthroscopic subscapularis augmentation; *WOSI*, Western Ontario Shoulder Instability Index.

also assessed (Table I). Preoperative and postoperative patient evaluations were conducted using the Rowe score and the Western Ontario Shoulder Instability Index (WOSI) for each technique. Demographics and outcomes data were collected and evaluated by 2 independent observers.

Statistical analysis

Statistical Package for the Social Sciences 22.0 (SPSS; IBM, Armonk, NY, USA) was used for statistical analysis and was conducted by an expert. To assess differences between categorical demographical data and preoperative characteristics. Regarding the 4 types of surgery, the chi-square test was used. To assess differences between continuous data (described as the mean $\pm$ standard deviation, the analysis of variance (ANOVA) test was used. ANOVA gives a single statistic and one P value indicating that we should support or reject the null hypothesis and stating that groups were different from each other, however ANOVA does not reveal which groups were different.

The significance level was set at a P value of $< .05$. The 95% confidence intervals were calculated using the Poisson distribution for rates of $<5\%$ and the binomial distribution for rates $\geq 5\%$.

Results

A total of 226 patients who met the inclusion criteria were included in the present series: 57 in the Bankart plus ASA group (25%); 65 in the Bankart plus remplissage (R) group (28%). 66 in the Latarjet (L) group (29%); and 38 in the Arthro-Latarjet (AL) group (17%). There were 197 males and 29 females.

Patients in the AL group had the longest FU duration, of 57.5 months; the FU duration was 45.5 months in the L group; 44.2 months in the ASA group; 25 months in the R group. The difference in mean age at the time of first dislocation was not significant (22-25 years) (Table I). The number of dislocations was higher in the L group (9.7, range 7-11) and AL group (8.6, range 5-12) than in other groups.

Patients in the ASA group were more involved in competitive (86%, 49/57) and contact sports (68%, 39/57) than those in the other groups. Hill–Sachs lesions were present in almost all cases.

At the final FU, patients in the ASA group had excellent Rowe scores (89.2%), and their scores on the WOSI scale improved from 838 to 235 points. Patients in the R-group also had excellent Rowe scores (76.9%), and their scores on the WOSI scale improved from 1146 to 465 points. Patients in the L group had excellent Rowe scores (98.5%), and their scores on the WOSI scale improved from 1456 to 319 points. Patients in the AL-group had excellent Rowe scores (81.6%), and their scores on the WOSI scale improved from 1250 to 221 points (Tables II and III).

The mean loss of external rotation measured with the arm at the side of the trunk (ER1) and with the arm at 90° of abduction (ER2) was higher in the remplissage group 31,% (ER1) and 27.6% (ER2) differences compared with the contralateral side (Table IV).

The mean preoperative ISI score was higher in the ASA group, 61% of patients scored more than 6 points (Table V).

Failure of previous surgery was reported among 29% (11/38) of patients in the AL group, which was a higher proportion than that in the other groups. Patients in the open Latarjet group had 15.5% (10/66) more

Table IV External rotations of the operated and contralateral arms and their % difference at follow-up according to the type of surgery

Surgery/ER	Arthro-Latarjet	Latarjet	ASA	Remplissage
ER1:				
Operated	78.3 (75.6-81.0)	52.7 (49.7-55.8)	66.8 (63.8-69.8)	63.3 (58.6-68.0)
Contralateral	81.5 (79.2-83.8)	57.4 (53.4-61.4)	75.2 (71.9-78.4)	83.4 (81.5-85.4)
% Difference	4.1	8.9	12.6	31.7
ER2:				
Operated	87.2 (85.7-88.7)	92.2 (89.4-95.0)	84.5 (82.8-86.3)	69.2 (63.8-74.7)
Contralateral	89.5 (88.4-90.6)	96.9 (94.2-99.6)	91.8 (90.3-93.4)	88.3 (86.7-89.9)
% Difference	2.6	5.1	8.6	27.6

ER, external rotation; *ASA*, arthroscopic subscapularis augmentation.

Table V Mean, 95% CI, and numbers and percentages for Instability Severity Index score subgroups according to the type of surgery

Surgery/ISI score	Arthro-Latarjet	Latarjet	ASA	Remplissage
Mean (95% CI) ISI score subgroup:	6.32 (5.95-6.70)	5.68 (5.31-6.05)	7.00 (6.55-7.45)	6.37 (5.91-6.82)
4-6 points. n (%)	23 (60.5)	47 (72.7)	22 (38.6)	28 (46.0)
>6 points. n (%)	15 (39.5)	18 (27.3)	35 (61.4)	25 (38.1)

ASA, arthroscopic subscapularis augmentation; *ISI*, Instability Severity Index.

complications. The rate of recurrence was 0% in the Arthro-Latarjet group 1.5% in the Latarjet group, 7% in the ASA group, and 6.1% in the remplissage group (Table VI).

Revision surgeries were as follows: 1 ASA procedure after Latarjet failure; 2 ASA + Graft and 2 Latarjet procedures after the 4 ASA failures; 1 Latarjet procedure after the 4 remplissage failures, 2 patients underwent physical therapy and one was lost at FU.

Discussion

The most important finding of this study is that all the 4 surgical techniques were effective in reducing symptoms and improving shoulder functional status. Furthermore, Bankart-plus ASA and Bankart plus remplissage procedures drastically reduce the failure rate of simple Bankart repair in patients with GBL less than 15% yielding similar outcomes to the Latarjet procedure in the medium-term FU.[5,22,39]

The cause of instability is multifactorial, anterior soft tissue damage and dysfunction and critical Hill–Sach lesions play an important role in compromising shoulder stability especially in patients practicing contact sports.

Several studies[45,46] have demonstrated that elongation of the coracohumeral ligament, anterior capsular stretching, poor quality capsular tissue and not only the Bankart lesions may be as responsible for the glenohumeral dislocation. Furthermore, after multiple dislocations, the upper part of the subscapularis tendon is lax.[10,18,23,40,41,44] The ASA technique, augmenting the Bankart lesion from the front, restores anterior soft tissue disfunction and recenters the humeral head, pushing it posteriorly.[32,33,37]

Another common condition in patients with chronic shoulder instability that has been shown to be an important risk factor for recurrence is the bone loss, often bipolar.

Hill–Sachs lesions, depending on size, orientation and site, can engage the GBL defect, the so-called off-track lesion.[12,16,20] However if a lesion is on- or off-track, it is inaccurate to calculate with the current glenoid track paradigm.[17,21,34,38] Remplissage addresses this pathology from the back and converts the Hill–Sachs lesion from intra-articular to extra-articular, recenters the humeral head, pulling it back, tightening the posteroinferior capsule.[15,19]

Hence, remplissage might cause a minimal limitation of the external rotation,[43] however, this possibility is not functionally relevant. Latarjet acts with a triple effect: the bone block effect, the capsular effect, and the most important anterior hammock effect which is due to the action of the conjoined tendon and inferior band of the subscapularis muscle.

The purpose of this paper was to compare the clinical outcomes of 4 different techniques commonly used in surgical treatment of chronic shoulder instability.

A total of 226 cases were examined: 57 ASA and 65 remplissage, 66 Latarjet 38 AL. Both pre- and postoperative patient evaluations were conducted using the

Table VI Complications and re-dislocation rate

	Arthro- Latarjet	Latarjet	ASA	Remplissage	*P* value
Number	38	66	57	65	
Complications	1	10	2	2	.015
Re-dislocation	0	1	4	4	.294
Complication rate	2.63%	15.15%	3.51%	3.08%	
Re-dislocation rate	–	1.52%	7.02%	6.1%	

ASA, arthroscopic subscapularis augmentation.

Rowe score and the WOSI score for each technique employed. Almost all patients reported either good or excellent results. In detail the Rowe scores were excellent for a high proportion of patients in the Arthro-Latarjet (83.3%), Latarjet (98.5%), ASA (89.2%), and remplissage (76.9%) groups. Notably, in subjective evaluation both Latarjet and Arthro-Latarjet patients reported considerable improvement between pre- and postoperative conditions.

In particular, ligamentous laxity in ASA patients (Table II) led to increased patient tolerance of articular instability in 19 preoperative cases. WOSI scores revealed highly positive results for all techniques considered. As shown in Table III, WOSI scores reveal that the largest difference between preoperative and postoperative scores was observed in the Latarjet group (1137 points), indicating improvement in shoulder instability apprehension.

Regarding external rotation, Latarjet patients reveal postoperative ER1 higher limitation when compared to other techniques. This result might be due to the lower percentage of ligamentous laxity in patients in the Latarjet group. A higher limitation in external rotation was seen in the remplissage group (Table IV). Regarding redislocation rate, the Latarjet group had better outcomes, (1.5%). Moreover, the open Latarjet group had a significant higher rate 15.1% of complications (Table VI).[14]

We examined the correlation between the ISI score and the type of surgery performed (Table V). This finding reveals that in patients with ISI score between 4 and 6, all the 4 surgical techniques can be used. We also observed that 47.4% of the patients in ASA group with a score>6 showed good results. Furthermore, this study demonstrates, again, that the ISI score cannot be used to determine the proper surgical tecniques as confirmed by numerous studies.[9,13]

The present comparison of the 4 above mentioned techniques demonstrated good results for all procedures and proved that the addition of soft tissue procedures, such as ASA and remplissage, to the simple Bankart repair can lead to results quite similar to open or arthroscopic Latarjet, but with a lower rate of complications and without altering the anatomy of the coracoacromial arch.

Furthermore, AL is still to be considered a valid technique but necessitates a long learning curve and should be performed only by expert surgeons.[7,24,47]

The elevated failure rate of simple Bankart repair, reported in the literature, confirmed the fact that anterior capsular dysfunction and posterior critical Hill–Sachs lesions were not addressed by antero-inferior capsular repair.

Limitations

There are several limitations in this paper. This was a retrospective study and a longer FU is necessary. On-off track Hill–Sachs lesions were not calculated, which may have affected patient selection. Time and the cost of each individual technique were not considered. The minimal clinically important difference or patient acceptable symptom state were not evaluated.

Conclusion

ASA and remplissage augmenting the Bankart repair have been demonstrated to be effective for restoring joint stability with clinical outcomes similar to the Latarjet procedure in patients affected by recurrent anterior dislocation with GBL <15% and an ISI score >3. Soft tissue augmentations of the Bankart repair have been demonstrated to be effective for addressing anterior soft tissue deficiency and dysfunction and critical Hill–Sachs lesions.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Allain J, Goutallier D, Glorion C. Long-term results of the Latarjet procedure for the treatment of anterior instability of the shoulder. J Bone Joint Surg Am 1998;80:841-52.
2. Baudi P, Righi P, Bolognesi D, Rivetta S, Rossi Urtoler U, Guicciardi N, et al. How to identify and calculate glenoid bone deficit. Chir Organi Mov 2005;90:145-52.
3. Bliven KCH, Parr GP. Outcomes of the Latarjet procedure compared with Bankart repair for recurrent traumatic anterior shoulder instability. J Athl Train 2018;53:181-3. https://doi.org/10.4085/1062-6050-232-16
4. Burkhart SS, De Beer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. Arthroscopy 2000;16:677-94.
5. Camus D, Domos P, Berard E, Toulemonde J, Mansat P, Bonnevialle N. Isolated arthroscopic Bankart repair vs. Bankart repair with "remplissage" for anterior shoulder instability with engaging Hill-Sachs lesion: a meta-analysis. Orthop Traumatol Surg Res 2018; 104:803-9. https://doi.org/10.1016/j.otsr.2018.05.011
6. Castricini R, Castioni D, De Benedetto M, Cimino M, Massarini M, Galasso O, et al. Arthroscopic Latarjet for primary shoulder instability with off-track lesions or revision surgery yields satisfactory clinical results, and reliable return to sports and work at minimum 3-year follow-up. A single surgeon's expeience on 95 cases. Arthroscopy 2002;38:2809-18.e1. https://doi.org/10.1016/j.arthro.2022.04.004
7. Castricini R, De Benedetto M, Orlando N, Rocchi M, Zini R, Pirani P. Arthroscopic Latarjet procedure: analysis of the learning curve. Musculoskelet Surg 2013;97(Suppl 1):93-8. https://doi.org/10.1007/s12306-013-0262-3
8. Cerciello S, Corona K, Morris BJ, Santagada DA, Maccauro G. Early outcomes and perioperative complications of the arthroscopic Latarjet procedure: systematic review and meta-analysis. Am J Sports Med 2019;47:2232-41. https://doi.org/10.1177/0363546518783743
9. Dekker TJ, Peebles LA, Bernhardson AS, Golijanin P, Di Giacomo G, Hackett TR, et al. Limited predictive value of the Instability Severity Index Score: evaluation of 217 consecutive cases of recurrent anterior shoulder instability. Arthoscopy 2021;37:1381-91. https://doi.org/10.1016/j.arthro.2020.12.185
10. DePalma AF, Cooke J, Prabhakar M. Subscapularis in recurrent dislocations of the shoulder. Clin Orthop Relat Res 1967;54:35-49.
11. Di Giacomo G, Golijanin P, Sanchez G, Provencher MT. Radiographic analysis of the Hill-Sachs lesion in anteroinferior shoulder instability after first-time dislocations. Arthroscopy 2016;32:1509-14. https://doi.org/10.1016/j.arthro.2016.01.022
12. Di Giacomo G, Itoi E, Stephen S, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: from "engaging/non-engaging" lesion to "on-track/off-track" lesion. Arthroscopy 2014;30: 90-8. https://doi.org/10.1016/j.arthro.2013.10.004
13. DiGiacomo G, Peebles LA, Pugliese M, Dekker TJ, Golijanin P, Sanchez A, et al. Glenoid track instability Management score: Radiographic Modification of the instability Severity Index score. Arthroscopy 2020;36:56-67. https://doi.org/10.1016/j.arthro.2019.07.020
14. Domos P, Lunini E, Walch G. Contraindications and complications of the Latarjet procedure. Shoulder Elbow 2018;10:15-24. https://doi.org/10.1177/1758573217728716
15. Elkinson I, Giles JW, Faber KJ, Boons HW, Ferreira L, Johnson JA, et al. The effect of the remplissage procedure on shoulder stability and range of motion: an in vitro biomechanical assessment. J Bone Joint Surg Am 2012;94:1003-12. https://doi.org/10.2106/JBJS.J.01956
16. Fox JA, Sanchez A, Zajac TJ, Provencher MT. Understanding the Hill-Sachs lesion and its role in patients with recurrent anterior shoulder instability. Curr Rev Musculoskelet Med 2017;10:469-79. https://doi.org/10.1007/s12178-017-9437-0
17. Funakoshi T, Hartzler RU, Stewien E, Burkhart S. Hill-Sachs lesion classification by the glenoid track paradigm in shoulder instability: poor agreement between 3-dimensional computed tomographic arthroscopic methods. Arthroscopy 2019;35:1743-9. https://doi.org/10.1016/j.arthro.2018.12.005
18. Gamulin A, Pizzolato G, Stern R, Hoffmeyer P. Anterior shoulder instability: histomorphometric study of the subscapularis and deltoid muscles. Clin Orthop Relat Res 2002;398:121-6.
19. Garcia GH, Degen RM, Bui CNH, McGarry MH, Lee TQ, Dines JS. Biomechanical comparison of acute Hill-Sachs reduction with remplissage to treat complex anterior instability. J Shoulder Elbow Surg 2017;26:1088-96. https://doi.org/10.1016/j.jse.2016.11.050
20. Gyftopoulos S, Beltran LS, Yemin A, Strauss E, Meislin R, Laith Jazrawi L, et al. Use of 3D MR reconstructions in the evaluation of glenoid bone loss: a clinical study. Skeletal Radiol 2014;43:213-8. https://doi.org/10.1007/s00256-013-1774-5
21. Hatta T, Yamamoto N, Shinagawa K, Kawakami J, Itoi E. Surgical decision making based on the on-track/off-track concept for anterior shoulder instability: a case-control study. JSES Open Access 2019; 3(1):25-8. https://doi.org/10.1016/j.jses.2018.10.001
22. Jeon YS, Jeong HY, Lee DK, Rhee YG. Borderline glenoid bone defect in anterior shoulder instability: Latarjet procedure versus Bankart repair. Am J Sports Med 2018;46:2170-6. https://doi.org/10.1177/0363546518776978
23. Klapper RC, Jobe FW, Matsura P. The subscapularis muscle and its glenohumeral ligament-like bands: a histomorphological study. Am J Sports Med 1992;20:307-10.
24. Kordasiewicz B, Kicinski M, Matachowski K, Boszczyk A, Chaberek S, Pomianowski S. Arthroscopic Latarjet Stabilization: analysis of the learning curve in the first 90 primary cases: Early clinical results and computed tomography evaluation. Arthroscopy 2019;35:3221-37. https://doi.org/10.1016/j.arthro.2019.07.007
25. Lafosse L, Lejeune E, Bouchard A, Kakuda C, Gobezie R, Kochhar T. The arthroscopic Latarjet procedure for the treatment of anterior shoulder instability. Arthroscopy 2007;23:1242.e1-e5. https://doi.org/10.1016/j.arthro.2007.06.008
26. Lazarides AL KR, Ledbetter L, Riboh JC, Garrigues GE. Arthroscopic remplissage for anterior shoulder instability: a systematic review of clinical and biomechanical studies. Arthroscopy 2019;35:617-28. https://doi.org/10.1016/j.arthro.2018.09.029
27. Lee SH, Hoon K, Lim JW. Risk factors for recurrence of anterior-inferior instability of the shoulder after arthroscopic Bankart repair in patients younger than 30 years. Arthroscopy 2018;34:2530-6. https://doi.org/10.1016/j.arthro.2018.03.032
28. Lonjon G, Hardy P, Schoch B, Werthel JD. Long-term results of arthroscopic Bankart repairs for anterior instability of the shoulder in patients aged thirty years or older. Int Orthop 2021;45:1583-9. https://doi.org/10.1007/s00264-021-05014-4
29. MacDonald P, McRae S, Old J, Jonathan Marsh J, Dubberley J, Stranges G, et al. Arthroscopic Bankart repair with and without arthroscopic infraspinatus remplissage in anterior shoulder instability with a Hill-Sachs defect: a randomized controlled trial. J Shoulder Elbow Surg 2021;30:1288-98. https://doi.org/10.1016/j.jse.2020.11.013
30. Maiotti M, Massoni C. Arthroscopic augmentation with subscapularis tendon in anterior shoulder instability with capsulolabral deficiency. Arthosc Tech 2013;2:e303-10. https://doi.org/10.1016/j.eats.2013.04.005. eCollection 2013.
31. Maiotti M, Russo R, Zanini A, Schröter S, Massoni C, Bianchedi D. Arthroscopic bankart repair and subscapularis augmentation: an alternative technique treating anterior shoulder instability with bone loss. J Shoulder Elbow Surg 2016;25:898-906. https://doi.org/10.1016/j.jse.2015.09.025
32. Maiotti M, Massoni C, Russo R, Schroter S, Zanini A, Bianchedi D. Arthroscopic subscapularis augmentation of bankart repair in chronic anterior shoulder instability with bone loss less than 25% and capsular deficiency: clinical multicenter study. Arthroscopy 2017;33:902-9. https://doi.org/10.1016/j.arthro.2016.09.008
33. Maiotti M, Russo R, Zanini A, Castricini R, Castellarin G, Schröter S, et al. Bankart repair with subscapularis augmentation in athletes with

shoulder hyperlaxity. Arthroscopy 2021;37:2055-62. https://doi.org/10.1016/j.arthro.2021.01.062
34. Parada SA, Jones MC, DeFoor MT, Griswold BG, Roberts AD, Provencher MT. Mathematical modeling of glenoid bone loss demonstrate differences in calculations that May affect surgical decision making. J Orthop 2020;22:402-7. https://doi.org/10.1016/j.jor.2020.09.016. eCollection Nov-Dec 2020.
35. Purchase RJ, Wolf EM, Hobgood ER, Pollock ME, Smalley CC. Hill-Sachs "remplissage": an arthroscopic solution for the engaging Hill-Sachs lesion. Arthroscopy 2008;24:723-6. https://doi.org/10.1016/j.arthro.2008.03.015
36. Roparsa M, Fourniera A, Campilloc B, Bonanb I, Delamarcheb P, Crétual A, Thomazeaua H. Clinical assessment of external rotation for the diagnosis of anterior shoulder hyperlaxity. The French Arthroscopy Society. Orthop Traumatol Surg Res 2010;96S:S84-7.
37. Russo R, Maiotti M, Cozzolino A, Della Rotonda G, Guastafierro A, Massoni C, et al. Arthroscopic iliac crest bone allograft combined with subscapularis upper-third tenodesis shows a low recurrence rate in the treatment of recurrent anterior shoulder instability associated with critical bone loss. Arthroscopy 2021;37:824-33. https://doi.org/10.1016/j.arthro.2020.11.037
38. Schneider A, Hoy GA, Ek ET, Rotstein AH, Tate J, Taylor DMcD, et al. Interobserver and intraobserver variability of glenoid track measurements. J Shoulder Elbow Surg 2017;26:573-9. https://doi.org/10.1016/j.jse.2016.09.058
39. Ren S, Zhang X, Zhou R, You T, Jiang X, Zhang W. Arthroscopic subscapularis augmentation combined with capsulolabral reconstruction is safe and reliable. Knee Surg Sports Traumatol Arthrosc 2019. https://doi.org/10.1007/s00167-019-05648-3
40. Solomon DJ. Editorial commentary: better stability found with primary latarjet compared with those performed after a failed arthroscopic bankart repair: should we be doing more primary latarjet procedures? Arthroscopy 2021;37:3253-4. https://doi.org/10.1016/j.arthro.2021.07.035
41. Symeonides PP. The subscapularis muscle in the pathogenesis of recurrent anterior dislocation of the shoulder. J Bone Joint Surg Br 1972;54:476-83.
42. Trasolini NA, Dandu N, Azua EN, Garrigues GE, Verma NN, Yanke AB. Inconsistencies in Controlling for Risk Factors for Recurrent Shoulder Instability After Primary Arthroscopic Bankart Repair: A Systematic Review. Am J Sports Med 2021;50:3705-13. https://doi.org/10.1177/03635465211038712
43. Trellopoulos A, Brilakis E, Antonogiannakis E. Alternative and additive arthroscopic soft-tissue procedures for anterior shoulder instability. Obere Extremität 2021;16:8-15.
44. Tuoheti Y, Itoi E, Minagawa H, Wakabayashi I, Kobayashi M, Okada K. Quantitative assessment of thinning of the subscapularis tendon in recurrent anterior dislocation of the shoulder by use of magnetic resonance imaging. J Shoulder Elbow Surg 2005;14:11-5.
45. Turkel SJ, Panio MW, Marshall JL, Girgis FG. Stabilizing mechanisms preventing anterior dislocation of the glenohumeral joint. J Bone Joint Surg Am 1981;63:1208-17.
46. Urayama M, Itoi E, Sashi R, Minagawa H, Sato K. Capsular elongation in shoulders with recurrent anterior dislocation. Quantitative assessment with magnetic resonance arthrography. Am J Sports Med 2003;31:64-7.
47. Valsamis EM, Kany J, Bonnevialle N, Castricini R, Lädermann A, Cunningham G, et al. The arthroscopic Latarjet: a multisurgeon learning curve analysis. J Shoulder Elbow Surg 2020;29:681-8. https://doi.org/10.1016/j.jse2019.10.022
48. Verweij LPE, van Spanning SH, Grillo A, Kerkhoffs GMMJ, Priester-Vink S, van Deurzen DFP, van den Bekerom MPJ. Age, participation in competitive sports, bony lesions, ALPSA lesions, >1 preoperative dislocations, surgical delay and ISIS score >3 are risk factors for recurrence following arthroscopic Bankart repair: a systematic review and meta-analysis of 4584 shoulders. Knee Surg Sports Traumatol Arthrosc 2021;29:4004-14. https://doi.org/10.1007/s00167-021-06704-7
49. Wolf EM, Arianjam A. Hill-Sachs remplissage, an arthroscopic solution for the engaging Hill-Sachs lesion: 2- to 10-year follow-up and incidence of recurrence. J Shoulder Elbow Surg 2014;23:814-20. https://doi.org/10.1016/j.jse.2013.09.009
50. Yang JS, Mazzocca AD, Cote MP, Edgar CM, Arciero RA. Recurrent anterior shoulder instability with combined bone loss: treatment and results with the modified Latarjet procedure. Am J Sports Med 2016;44:922-32. https://doi.org/10.1177/0363546515623929