Clinical Relevance of Persistent Off-Track Hill-Sachs Lesion After Arthroscopic Latarjet Procedure

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Background: The Latarjet procedure is often used to address off-track Hill-Sachs lesions (OFF-HS) in shoulders with anterior instability. There are concerns as to whether the Latarjet procedure is able to convert all OFF-HS into on-track Hill-Sachs lesions (ON-HS) and whether this limitation could explain the cases of recurrent postoperative instability.

Hypothesis: Latarjet surgery converts many preoperative OFF-HS lesions, but not all of them, and there is a difference in the failure rate between shoulders with converted lesions and those with persistent OFF-HS lesions.

Study Design: Case series; Level of evidence, 4.

Methods: Patients with anterior shoulder instability and an OFF-HS lesion treated with an arthroscopic classic Latarjet procedure between January 2010 and September 2017 were retrospectively evaluated. Patients with moderate or severe shoulder arthrosis, rotator cuff tears, or age older than 50 years were excluded. Glenoid track (GT), HS, HS interval (HSI), and the difference between HSI and GT (ΔHSI-GT) were measured preoperatively. A postoperative computed tomography scan and a clinical evaluation, including the Rowe and Western Ontario Shoulder Instability scores, were performed at a minimum 1- and 2-year follow-up, respectively. Postoperatively, 2 groups of patients were obtained: (1) patients with postoperative persistent OFF-HS; (2) patients with postoperative ON-HS. Clinical and imaging data were compared between the 2 groups.

Results: A total of 51 patients (n = 51 shoulders), with a mean age of 29.8 ± 8.4 years (range, 15-50 years), met the inclusion criteria. Six shoulders (11.8%) still showed OFF-HS lesions despite Latarjet surgery. There were no postoperative dislocations, but 3 patients reported subluxations. The subluxation rate was significantly higher in the postoperative persistent OFF-HS group (2 [33%] vs 1 [2.2%]; P = .033). There was a wider preoperative HSI (29.8 ± 2.4 mm vs 22.9 ± 3.5 mm; $P < .001$) and a larger preoperative ΔHSI-GT (12.2 ± 3.8 mm vs 4.82 ± 3.2 mm; $P < .001$) in the persistent OFF-HS group. A receiver operating characteristic curve was performed based on preoperative ΔHSI-GT values. A preoperative ΔHSI-GT value ≥7.45 mm predicted a persistent OFF-HS after Latarjet surgery (sensitivity, 100%; specificity, 87%; positive predictive value, 50%; and negative predictive value, 100%).

Conclusion: Latarjet surgery converted many preoperative OFF-HS lesions into ON-HS lesions, but not all of them. Six patients (11.8%) retained an OFF-HS and had a statistically significantly higher failure rate after Latarjet surgery compared with those with postoperative ON-HS lesions. Because there were few postoperative OFF-HS lesions and few recurrences, findings are statistically fragile and should be confirmed with larger series.

Keywords: shoulder instability; glenoid track; arthroscopic Latarjet; off-track Hill-Sachs lesion

Bone defects are common in shoulders with recurrent anterior instability, and they are strongly associated with recurrences after an isolated Bankart repair.[3] Posterolateral humeral head defects, known as Hill-Sachs (HS) lesions, and anterior glenoid defects are reported in up to 93% and 86% of shoulders with anterior instability, respectively.[7,28] Historically, isolated glenoid defects involving more than 20% to 25% of the glenoid diameter have been considered large enough to be reconstructed with techniques different from a conventional Bankart repair.[2,3] However, this value has decreased recently to 13.5%.[3,4,24] On the humeral side, there is no consensus on the critical value for an isolated HS lesion. Nowadays, it is clear that bone defects in unstable shoulders should not be regarded as humeral- or glenoid-sided independent problems, but as the 2 sides of a bipolar lesion that interact in the instability process as described by the "glenoid track (GT)" concept. This concept was introduced by Yamamoto et al[27] in 2007 in a cadaveric biomechanical study. They showed how to predict an engaging HS lesion by considering bipolar bone loss and named it off-track HS (OFF-HS). Later, the

The American Journal of Sports Medicine
2021;49(8):2006–2012
DOI: 10.1177/03635465211019979

GT concept was clinically validated by other studies reporting a good correlation between an OFF-HS lesion and a higher postoperative instability risk.[11,12,23,25]

Among other indications, Latarjet surgery is a glenoid bone graft technique suitable for anterior glenoid defects that has been recently proposed to indirectly manage OFF-HS defects.[18] As the procedure transfers the coracoid process to the anterior glenoid, this might effectively convert an OFF-HS into an on-track (ON-HS) or nonengaging HS defect by increasing the glenoid surface. However, there are concerns regarding the capability of the Latarjet procedure to turn all OFF-HS lesions into ON-HS, as the coracoid graft might not be big enough to accomplish this mission in certain shoulders with severe bone defects.[16] Moreover, it remains unclear whether the remaining OFF-HS is clinically relevant in terms of postoperative recurrent instability.[15]

The main purpose of this study is (1) to evaluate whether arthroscopic Latarjet surgery converts all OFF-HS lesions into ON-HS and (2) to compare the recurrence rate and clinical outcomes between these 2 postoperative groups in the event that arthroscopic Latarjet surgery is not able to convert all of them.

Our hypothesis was that Latarjet surgery would be able to convert many but not all OFF-HS into ON-HS defects and that there would be differences in clinical outcomes between these groups.

METHODS

Study Population

Patients with anterior shoulder instability and a preoperative OFF-HS treated with the arthroscopic classic Latarjet technique procedure between January 2010 and September 2017 and operated on by the senior surgeon (E.C.) were retrospectively evaluated. The diagnosis of anterior instability was made based on a combination of signs and symptoms, according to the criteria defined by Gartsman et al[6]: (1) the patient's description of shoulder dislocation or a sensation of looseness and slipping; (2) pain or apprehension, or both, on anterior instability tests; (3) imaging evidence of anterior glenohumeral instability; and (4) findings during the examination under anesthesia or arthroscopic operation that documented anterior glenohumeral instability.

A standard all-arthroscopic Latarjet procedure as described by Lafosse et al[10] was performed in all cases. Coracoid grafts were fixed with two 4.5–mm partial threaded cancellous bone screws (DePuy Synthes Mitek).

Patients were included in the analysis if they had a preoperative OFF-HS identified on either computed tomography (CT) scan or magnetic resonance imaging (MRI) scan, a postoperative CT scan at a minimum 12-month follow-up, and a clinical evaluation at a minimum 24-month follow-up. Exclusion criteria were patients with posterior or multidirectional instability, moderate or severe shoulder arthrosis according to Samilson and Prieto,[22] full-thickness rotator cuff tears, age older than 50 years at the time of surgery, graft malpositioned according to Barth et al[1] or nonunion at the final CT, and patients whose mental condition did not allow clinical assessment.

Data Collection

Demographic and clinical data prospectively collected and saved in a patient database were retrospectively reviewed for this investigation. These data included dominant arm, age at the time of first dislocation, athletic activity, ligamentous laxity, epilepsy, and presence of a previous instability surgery on the index shoulder. Patients were classified as having ligamentous laxity if 2 of the following 3 findings were demonstrated on examination: (1) hyperextension of the elbow beyond neutral, (2) hyperextension of the index metacarpophalangeal joint beyond 90°, and (3) hyperabduction of the thumb to the forearm.[14] Regarding the activity level, patients were grouped into 1 of the following 5 categories[3]: Type 0, sedentary life without sporting activity; type 1, nonimpact sports (swimming the breaststroke, rowing, bowling, and running); type 2, impact sports that did not require overhead use of the arm (cycling, motorcycling, and water skiing); type 3, sports that required overhead use of the arm without forced abduction and external rotation (swimming the crawl, weightlifting, golf, and sailing); and type 4, sports that included overhead hitting movements or collision sports with high risk of fall (basketball, handball, volleyball, tennis, soccer, downhill skiing, rugby, judo, and karate). Additionally, the Rowe score[20] and the Spanish validated version of the Western Ontario Shoulder Instability (WOSI)[29] scores were collected pre- and postoperatively. The Single Assessment Numeric Evaluation (SANE) score was collected postoperatively. A failed Latarjet was defined as any event of shoulder dislocation or subjective subluxation at the final follow-up. Institutional review board approval was obtained under act 10/11 before the initiation of this study, and written informed consent was obtained from all patients.

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Submitted July 8, 2020; accepted January 28, 2021.

One or more of the authors has declared the following potential conflict of interest or source of funding: E.C. has received consulting fees from DePuy Synthes, Smith & Nephew, and Stryker. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

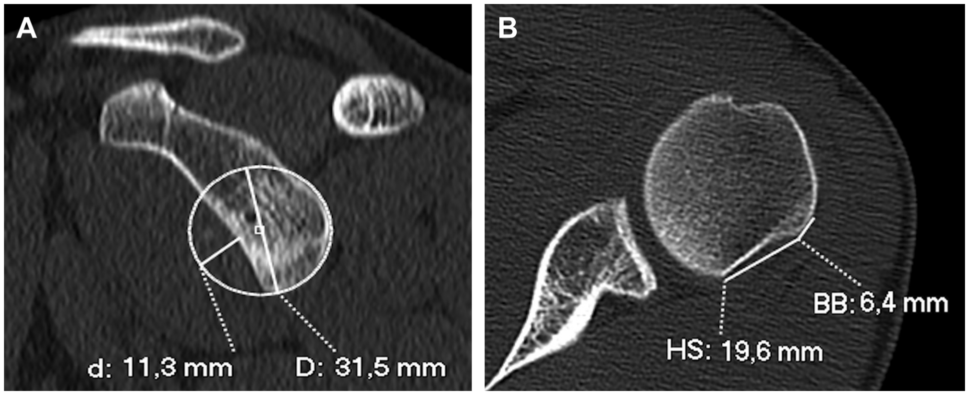

Figure 1. (A) Glenoid measurements. Glenoid track (GT) = 0.83 × D - d, where D is diameter and d is length of defect. In this image, GT = 0.83 × 31.5 mm - 11.3 mm = 14.8 mm. (B) Humeral measurements. Hill-Sachs interval (HSI) = HS + BB, where HS is the Hill-Sachs lesion length and BB is the bony bridge length. In this image, HSI = 19.6 + 6.4 mm = 26 mm. This is an OFF-HS, as HSI is >GT and the difference between HSI and GT (ΔHSI-GT) value is 11.2 mm.

Imaging Study

All patients had anteroposterior and scapular Y radiographic views of the shoulder. Preoperative CT scans or MRIs were evaluated. Glenoid measurements were performed on a 2-dimentional (2D) sagittal plane image at the articular level as described by Gyftopoulos et al.[8] To measure the glenoid bone defect, sagittal images lateral to the level of the coracoid base were selected and then reoriented into the plane of the glenoid, as defined by the superior pole, inferior pole, and most posterior osseous point of the glenoid. Measurements included the native glenoid diameter and the anterior glenoid defect. The best-fit circle technique superimposed on the glenoid was used to obtain the native glenoid diameter, and the anterior glenoid defect was obtained by drawing a line perpendicular to the glenoid rim from the anterior margin of the circle to the anterior margin of the glenoid (Figure 1A).[26] Finally, the GT was calculated (GT = 0.83 × D – d), where D is the native glenoid diameter and d represents the anterior glenoid defect, according to Di Giacomo et al.[5] Humeral measurements were performed on a 2D axial plane image at the level of the widest medial extent of the HS lesion.[8] Measurements to obtain the HS interval (HSI) included the bony bridge (bb) and the HS. HSI was calculated as the distance between the medial edge of the HS to the insertion of the articular fibers of the rotator cuff (HSI = bb + HS)[5] (Figure 1B).

Evaluation of postoperative CT scans followed the same protocol as described in preoperative images. Osteolysis was examined in sagittal CT scan images by measuring the distance between each screw and the superior and inferior borders of the graft. A reduction of 1 mm in this distance was considered osteolysis. Concerning the postoperative status of the HS lesion, HSI was considered an OFF-HS if the width was greater than the calculated GT (OFF-HS = HSI > GT), whereas it was classified as an ON-HS if the width was shorter than the GT (ON-HS = HSI < GT).

Measurements on the CT scan (Siemens Somatom Definition Flash 128 slice CT Dual Energy; Siemens Healthcare) or the MRI scan (Siemens Magnetom Verio 3T, A Tim + Dom System; Siemens Healthcare) were performed by a shoulder and elbow fellow (C.C.) previously trained by a senior musculoskeletal radiologist using Digital Imaging and Communications in Medicine software and Syngo via imaging software (Siemens Healthcare).

Outcome Assessment

Patients were allocated to 2 groups after postoperative measurement: a group with postoperative ON-HS shoulders and a group with postoperative persistent OFF-HS shoulders. Postoperative recurrences, clinical data, clinical scores, and preoperative imaging measurements were compared between these groups. An imaging study was also performed separately in both groups for comparison. To obtain a threshold value that would predict a persistent OFF-HS defect after Latarjet surgery, a receiver operating characteristic (ROC) curve was performed based on preoperative measures of the difference between HSI and GT (ΔHSI-GT). This measurement was chosen because, unlike the others, it is the only one that involves humeral and glenoid lesions at the same time (bipolar concept). This measurement expresses how much wider the HS is than the GT in a preoperative shoulder imaging.

Statistical Analysis

Categorical variables were expressed as frequencies and percentages, and quantitative variables as mean ± SD. Categorical variables were compared between postoperative groups using chi-square or Fisher exact tests and quantitative variables were compared using the *t* test (parametric data) or the Wilcoxon test (nonparametric data). An ROC curve was performed based on ΔHSI-GT values and the Youden index was used to find the cutoff point (predictor value) for a persistent OFF-HS. All statistical analyses were performed with R Statistical software

TABLE 1
Patient Characteristics[a]

	Preoperative Total	Postoperative ON-HS	Postoperative OFF-HS	Postoperative P Value[b]
No. of shoulders	51	45	6	
Age	29.8 ± 8.4 (15-50)	29.7 ± 8.5	30.2 ± 8.9	.902
Male (%)	48 (94.1)	42 (93.3)	6 (100)	.999
Dominant arm affected (%)	28 (54.9)	24 (53.3)	4 (66.7)	.678
Age at time of first dislocation		21.8 ± 7	22.7 ± 4.8	.765
Contact sports (%)	34 (66.7)	29 (64.4)	5 (83.3)	.650
Ligamentous hyperlaxity (%)	32 (62.7)	26 (59.1)	6 (100)	.075
Epilepsy (%)	7 (13.7)	5 (11.1)	2 (33.3)	.186
Previous surgery (%)	23 (45.1)	20 (44.4)	3 (50.0)	.999
Postoperative instability (%)		1 (2.2)	2 (33.3)	.033

[a]Data are presented as mean ± SD (range), unless otherwise stated. OFF-HS, off-track Hill-Sachs; ON-HS, on-track Hill-Sachs.
[b]Comparing postoperative values between groups.

Version 3.6.1. (R Foundation for Statistical Computing). Statistical significance was set at $P < .05$.

RESULTS

A total of 68 patients were initially evaluated. Seventeen patients were excluded because of incomplete postoperative imaging study or insufficient follow-up, leaving 51 patients (n = 51 shoulders), with a mean age of 29.8 ± 8.4 years (range, 15-50 years) at time of surgery, who met the inclusion criteria for this study. There were 48 men (94.1%). There were no intraoperative complications. The dominant arm was involved in 28 (54.9%) patients. A total of 34 (66.7%) patients had participated in contact sports. Ligamentous hyperlaxity and epilepsy were reported in 32 (62.7%) and 7 (13.7%) patients, respectively. Also, 23 patients (45.1%) underwent a previous instability surgery on the index shoulder (Table 1). All previous surgeries were arthroscopic Bankart repair.

Preoperative CT, MRI, or CT plus MRI scans were obtained in 20, 22, and 9 patients, respectively. Postoperative CT scans were obtained at a mean of 35.8 ± 22.4 months (range, 12-101 months). There were no cases of bone graft malposition, osteolysis, or nonunion precluding image analysis. The mean preoperative native glenoid diameter was 28.2 ± 2.2 mm (range, 23.9-32.8 mm), and the mean dimensions of the HSI width and depth were 23.7 ± 4.1 mm (range, 13.4-33.2 mm) and 6.2 ± 2.5 mm (range, 1.5-13.5 mm), respectively. The glenoid diameter increased significantly to 33.3 ± 3.3 mm (range, 24.7-42.9 mm) ($P < .001$) after arthroscopic Latarjet, and this change resulted in a GT increase from 18 ± 2.7 mm preoperatively to 27.7 ± 2.7 mm postoperatively ($P < .001$), with a mean difference of 9.7 mm (CI, 95%; 8.8 -10.5 mm). Six patients (11.8%) still had an OFF-HS defect despite correct coracoid transfer after the arthroscopic Latarjet technique, and therefore 2 groups of patients, postoperative ON-HS and postoperative persistent OFF-HS, were obtained. These 2 groups were homogeneous in terms of age, sex, dominant affected arm, age at the time of first dislocation, ligamentous hyperlaxity, athletic activity, and presence of a previous surgery (Table 1).

Table 2 shows data on clinical outcomes of the patients studied. The Rowe and WOSI clinical scores changed significantly in the overall series of patients evaluated at a mean of 36.4 ± 11.5 months (range, 24-67 months) after an arthroscopic Latarjet, and the overall mean postoperative SANE as scored by patients was 83.6 ± 15.8 (range, 30 to 100). Three patients experienced at least 1 episode of self-reduced subluxation through the follow-up, with a higher recurrence rate in the postoperative OFF-HS group (2 [33%] vs 1 [2.2%]; $P = .033$). None of them required revision procedures for shoulder stabilization. There were no dislocations in either group. We did not find significant differences on postoperative Rowe, WOSI, or Subjective Shoulder Value scores between patients with postoperative ON-HS or OFF-HS (Table 3).

When the imaging study was performed separately in both groups, there were no significant differences in native glenoid diameter, preoperative glenoid defect, or HSI depth. However, the postoperative OFF-HS group showed statistically significant greater HSI width (29.8 ± 2.4 mm vs 22.9 ± 3.5 mm; $P < .001$) and a higher ΔHSI-GT value (12.2 ± 3.8 mm vs 4.82 ± 3.2 mm; $P < .001$) (Table 4). An ROC curve was performed based on ΔHSI-GT. The Youden Index was used and the threshold value obtained was 7.45 mm (sensitivity, 100%; specificity, 87%; positive predictive value, 50%; and negative predictive value, 100%). This means that if the HSI is wider than the GT in a value between 0 and 7.45 mm, all preoperative OFF-HS defects will be converted into an ON-HS with the Latarjet procedure. However, if the HSI is wider than the GT in a value >7.45 mm, half of these HS lesions will remain OFF-HS in spite of the coracoid transfer (Figure 2).

DISCUSSION

Our study confirms that Latarjet surgery is able to convert the majority of, but not all, preoperative OFF-HS defects into ON-HS. In fact, 11.8% of shoulders had persistent

TABLE 2
Clinical Score Improvements Based on Postoperative Groups[a]

Score	Group	Pre	Post	*P* Value
Rowe	Overall	45.3 ± 15.8	90.4 ± 14.8	<.001
	Post OFF-HS	40.8 ± 12.8	85.0 ± 19.8	.034
	Post ON-HS	46.4 ± 16.9	91.1 ± 12.9	<.001
WOSI	Overall	1113 ± 398	432 ± 342	<.001
	Post OFF-HS	1330 ± 384	567 ± 366	.015
	Post ON-HS	1094 ± 386	413 ± 360	<.001

[a]Data are presented as mean ± SD. OFF-HS, off-track Hill-Sachs; ON-HS, on-track Hill-Sachs; Pre, preoperative; Post, postoperative; WOSI, Western Ontario Shoulder Instability Index.

TABLE 3
Comparison of Postoperative Clinical Scores Based on Postoperative Groups[a]

Score	Post OFF-HS	Post ON-HS	*P* Value
Rowe	85 ± 19.8	91.1 ± 12.9	.716
WOSI	567 ± 366	413 ± 361	.428
SANE	75 ± 18.7	85 ± 15	.141

[a]Data are presented as mean ± SD. OFF-HS, off-track Hill-Sachs; ON-HS, on-track Hill-Sachs; Post, postoperative; SANE, Single Assessment Numeric Evaluation score; WOSI, Western Ontario Shoulder Instability Index.

TABLE 4
Preoperative Imaging Measurements[a] (Postoperative Groups)[b]

	Post OFF-HS	Post ON-HS	*P* Value
Glenoid native diameter	27.4 ± 1.5	28.3 ± 2.2	.378
Glenoid defect as percentage of native glenoid	18.7 ± 15.1	18.8 ± 10.1	.692
HSI	29.8 ± 2.4	22.9 ± 3.5	<.001
HS depth	7.8 ± 2.8	6.0 ± 2.5	.118
GT	17.6 ± 3.8	18.0 ± 2.6	.676
HSI-GT (ΔHSI-GT)[b]	12.2 ± 3.8	4.8 ± 3.2	<.001

[a]Data are presented as mean ± SD, in mm. GT, glenoid track; HS, Hill-Sachs; HSI, Hill-Sachs interval; OFF-HS, off-track Hill-Sachs; ON-HS; on-track Hill-Sachs; Post, postoperative.
[b]Difference between Hill-Sachs interval and glenoid track.

OFF-HS at a minimum follow-up of 12 months, despite the Latarjet procedure and follow-up CT scans showing the coracoid grafts in good position. Moreover, the persistent postoperative OFF-HS group showed a higher failure rate at a minimum clinical follow-up of 24 months. It is important to note that all recurrences were clear subjective subluxations as reported by the patient and no objective dislocation events. These results confirmed our hypotheses. Latarjet surgery is able to convert many, but not all, preoperative OFF-HS, and there is a difference in the recurrence rate between the persistent OFF-HS group versus the converted ON-HS group.

Our findings differ from the results of Plath et al,[18] who described arthroscopic Latarjet as an isolated procedure and were able to convert all preoperative OFF-HS lesions to ON-HS lesions in a study of 23 shoulders with pre- and postoperative CT scans and a mean final follow-up of 23 months. Plath et al[18] also evaluated the role of a potential postoperative remodeling process of the coracoid graft on the final GT and concluded that remodeling occurred in the first 6 postoperative months. In our study, no osteolysis or remodeling was observed on follow-up CT scan at a minimum 12-months follow-up, supporting the validity of our conclusions.

Theoretically, the association of a large HS lesion with a significant glenoid defect increases the chances that the coracoid graft will fail to convert the OFF-HS into an ON-HS. Specifically, if the difference between the HSI size and the GT size (ΔHSI-GT) is greater than the graft size, the coracoid graft will not be enough to convert the OFF-HS into an ON-HS, and our study confirms this hypothesis.

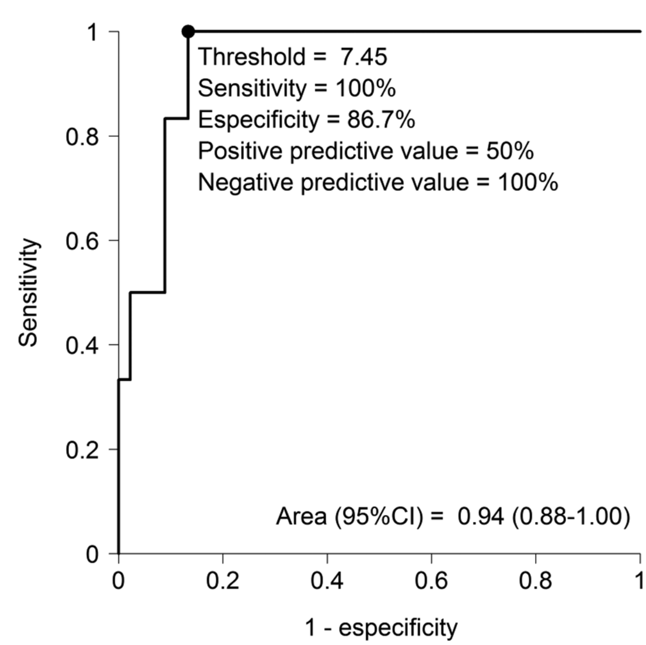

Figure 2. The receiver operating characteristic curve based on preoperative ΔHSI-GT values. ΔHSI-GT, difference between Hill-Sachs interval and glenoid track.

Supporting this idea, Mook et al[15] performed a clinical study looking at persistent OFF-HS lesions after an open Latarjet and the recurrence rate after a minimum 2-year follow-up. They found that 8 out of 33 shoulders (24.2%) remained OFF-HS after Latarjet surgery. It is important to notice that all postoperative values were an estimation based on preoperative images, in which the coracoid graft size was added to the preoperative glenoid diameter, with the consequent potential bias. Because of this lack of postoperative images, the preparation of the glenoid and the graft, the final position of the graft, and the remodeling process over the graft were not considered. Our study is among the first to confirm, by using postoperative images, the existence of a persistent OFF-HS group of patients despite Latarjet surgery.

The necessity of restoring the GT in all patients with OFF-HS to achieve postoperative stability has been questioned in the literature based on the idea that the dynamic effect of both the conjoined tendon and the subscapularis muscle in the position of abduction and external rotation would contribute to stabilize shoulders with persistent postoperative OFF-HS lesions. The dynamic stabilization effect of the conjoined tendon and subscapularis muscle are difficult to assess quantitatively. Patel et al,[17] in a cadaveric study, described how the Latarjet procedure was not enough to restore stability in shoulders with a glenoid defect of 20% and HS lesions >31%, but the GT was not evaluated. Mook et al[15] described a relative risk of recurrence 4 times higher in the group with persistent OFF-HS compared with a group with postoperative ON-HS after Latarjet surgery. Our study confirms this idea and reports a higher recurrence rate in the persistent OFF-HS group after an arthroscopic Latarjet procedure (33% vs 2%).

In view of our results and their clinical relevance, we tried to identify those patients likely to have a persistant OFF-HS lesion after the Latarjet procedure. We observed a significant difference in preoperative HSI and ΔHSI-GT between these groups. We performed an ROC curve analysis based on this measure and obtained 7.45 mm as our threshold value. This means that if the ΔHSI-GT is >7.45 mm, the shoulder will have a persistent OFF-HS lesion postoperatively, whereas if the ΔHSI-GT is ≤7.45 mm, the shoulder will convert to an ON-HS lesion. Even though this threshold value is excellent to identify which patients do not need a procedure in addition to the isolated Latarjet procedure, it is still not accurate enough to identify which patients do need an additional procedure on the humeral side, as the ΔHSI-GT >7.45 mm had a positive predictive value of 50% for persistent OFF-HS.

There are different ways to manage humeral side defects. Procedures such as remplissage, allografts, arthroplasty, or even partial resurfacing have been described to address this problem. As the Latarjet procedure is not able to convert all OFF-HS into ON-HS, another procedure should be added to the coracoid transfer in this small subpopulation of patients with persistent postoperative OFF-HS. Recently described open and arthroscopic techniques to add a remplissage to the Latarjet procedure could be valid alternatives in this situation.[9,19,21]

There are several limitations of this study that should be considered. First, it is a retrospective study of prospectively recorded data, and only patients with a preoperative OFF-HS and a complete set of preoperative images and minimum 12-month follow-up CT scan were collected; thus, 17 patients were excluded, raising the possibility of a selection bias. Second, not all patients had both MRI and CT scans preoperatively, and both methods were used preoperatively to evaluate glenoid defects. However, several studies have validated the use of these 2 methods to measure both glenoid and humeral head bone defects.[8,13] Third, we used 2D instead of 3D images. This limitation was mitigated following a strict protocol of imaging analysis consisting of reorientation of glenoid orientation to obtain a true en face view and measuring at the same parasagittal imaging lateral to the coracoid base in a reproducible manner. We hope this method facilitated the evaluation of bone defects as 3D images were not always available. Fourth, all measurements were done by 1 observer (C.C.). Finally, because there were few postoperative OFF-HS and few recurrences, our findings are statistically fragile and should be confirmed with larger series.

Nevertheless, this study has important strengths. First, it includes the largest case series evaluating the capability of the arthroscopic Latarjet to convert an OFF-HS to an ON-HS lesion. Second, to our knowledge, the present study is the first to evaluate clinical results of patients with persistent OFF-HS shown on postoperative images after an arthroscopic Latarjet procedure. Third, all procedures were performed by the same experienced arthroscopic surgeon.

In the future, research should focus on evaluating whether adding another procedure, particularly remplissage, can successfully convert a persistent OFF-HS into an ON-HS and improve clinical outcomes for the patient.

CONCLUSION

Arthroscopic Latarjet surgery is not able to convert all preoperative OFF-HS lesions into ON-HS ones. In our study, 11.8% of the shoulders still showed OFF-HS with coracoid grafts in good position on imaging at a minimum follow-up of 12 months. The group with persistent postoperative OFF-HS had a statistically significantly higher failure rate at a minimum follow-up of 24 months, but no clinical outcome measures were statistically significantly different between this group and those with postoperative ON-HS. The isolated Latarjet procedure is a valid option for shoulders with OFF-HS and a preoperative ΔHSI-GT <7.45 mm. However, adding another procedure on the humeral side should be considered for shoulders with higher values.

ACKNOWLEDGMENT

The authors acknowledge Javier Fernandez-Jara, MD, Department of Radiology, IIS-Fundacion Jimenez Diaz, and Ignacio Mahillo, Department of Statistics, IIS-Fundación Jiménez Diaz, for their support in the preparation of this manuscript.

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