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Long-term results of arthroscopic Bankart repair with Hill-Sachs remplissage



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A R T I C L E I N F O

Keywords: Bankart Hill-Sachs remplissage Anterior shoulder instability Arthritis Recurrence Failure Dislocation

Level of evidence: Level IV; Case Series; Treatment Study **Background:** Arthroscopic Bankart repair with Hill-Sachs remplissage (BHSR) is suggested for the treatment of anterior shoulder instability in the presence of an engaging humeral lesion. The objective of this study is to report the long-term clinical and radiological results of this procedure.

Methods: This is a single-center retrospective study including 51 patients who underwent surgery by BHSR for anterior shoulder instability with engaging Hill-Sachs lesion and who were reviewed after a minimum follow-up of 5 years. The mean age was 26 years (16-49; \pm 8.4) and 70% of the patients practiced sports. The average for Instability Severity Index score was 3.3 points (3-7; \pm 1.7). At the last follow-up, active range of motion, Subjective Shoulder Value, Walch-Duplay and Rowe scores, and the incidence of osteoarthritis according to the Samilson classification were assessed.

Results: At a mean follow-up of 87 months (60.0-124; \pm 17), 83% of the patients had resumed their sports activities. The mean Rowe, Walch-Duplay, and Subjective Shoulder Value scores were respectively 88 points (51-100; \pm 12), 82 points (50-100; \pm 16.4), and 89% (50-100; \pm 8). There was a recurrence of dislocation or subluxation for 8 patients (15.6%). In univariate analysis, patients who were unstable at follow-up had a deeper Hill-Sachs lesion (25% vs. 18% of the humeral head radius, *P* = .04) and were younger (19 vs. 27 years, *P* = .04). Radiographically, 17% of the patients showed signs of osteoarthritis (14% grade 1).

Conclusion: Considering that at a follow-up of more than 5 years, the failure rate was more than 15% of the BHSR, this procedure should be recommended with caution in case of deep Hill-Sachs lesions in young patients. The incidence of osteoarthritis after this procedure was acceptable, with few severe forms.

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Arthroscopic Bankart repair with Hill-Sachs remplissage (BHSR) is one of the options available to treat anterior shoulder instability.^{3,7,8,12,21,28} Infraspinatus capsulotenodesis in the Hill-Sachs could decrease the risk of recurrence by a factor of 4 compared to isolated Bankart repair.¹²

For Boileau et al,⁶ the indication is based on an Instability Severity Index (ISI) score of more than 3 points, and a Hill-Sachs lesion without glenoid bone defect. Di Giacomo et al¹⁵ reported that a Hill-Sachs lesion is at risk for engagement when it is "offtrack," and consider this situation an indication for BHSR.

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The literature reports a recurrence rate of 0%-15% at short-term follow-up.^{6,21,28,34} Fewer studies examine long-term outcomes and seem to report equally encouraging results.^{3,10,17,27}

Moreover, postinstability osteoarthritis is a potential long-term complication and to date, the incidence subsequent to this procedure has not been reported.¹¹

The objective of our study is to evaluate the clinical and radiographic outcomes more than 5 years after arthroscopic BHSR. Our hypothesis was that this procedure provides satisfactory long-term clinical results without causing degenerative arthritis.

Materials and methods

This study was approved by the ethics committee (study no. RnIPH 2021-006) and the patients gave their permission to exploit clinical and radiological data.

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This study was approved by the University Hospital of Toulouse, France (study no. RnIPH 2021-006).

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Figure 1 Hill-Sachs remplissage technique with 2 anchors. (A) Assembled from 2010 to 2012: the 2 anchor wires are passed independently through the tendon to form 2 matress knots. (B) Assembled from 2013: one wire from each anchor is tied to that of the other anchor to create a dependent bridge assembly.

This is a retrospective, single-center study of a continuous series of patients managed surgically from January 2010 to December 2016.

Inclusion criteria were: (1) chronic unidirectional anterior shoulder instability, (2) with an engaging Hill-Sachs lesion (3) treated with arthroscopic BHSR, and (4) being reviewed after a minimum follow-up of 5 years.

The following exclusion criteria were (1) the surgical history of the shoulder concerned, (2) >20% loss of glenoid bone substance from the anteroposterior glenoid diameter, and (3) preoperative or intraoperative presence of another associated intra-articular pathology (superior labral anterior posterior tears, rotary cuff injury, glenohumeral arthropathy).

The indication for a BHSR was identified before surgery, that is, ISI score \geq 3 points, and a Hill-Sachs lesion.^{2,7}

Surgical procedure

Surgery was performed by only 1 surgeon specialized in shoulder surgery (N.B.). The patients underwent surgery in a beach chair position, under general anesthesia combined with a locoregional analgesic interscalene block. Three arthroscopic portals were used: posterior-optical and anterosuperior portals allowed repair of the Bankart lesion combined with anteroinferior capsular tightening; a posterolateral portal was used for Hill-Sachs remplissage.

The first step consisted of an arthroscopic intra-articular glenohumeral exploration by posterior-optical approach using a 30° scope. An intraoperative dynamic evaluation of the arm in abduction and external rotation confirmed that this was an engaging Hill-Sachs lesion. In preparation for the Bankart repair, the labrum was mobilized and detached from the neck of the scapula by alternating use of a spatula and a coagulation electrode until the deep subscapular muscle fibers were visible. The anteroinferior capsule was tightened, using a temporary traction wire placed in the 5-o'clock position.⁵ The anterior glenoid rim was then refreshed with the shaver and the first resorbable anchor was placed at the 5-o'clock position (GRYPHON BR; DePuy Mitek, Raynham, MA, USA). A strand of this anchor was passed through the labrum and anteroinferior capsule as distally as possible and left to stand.

The second step was to prepare the filling of the Hill-Sachs lesion and the scope was positioned by the anterosuperior portal. The posterolateral accessory pathway was identified with a needle placed centrally at the Hill-Sachs lesion. To facilitate exposure of the humeral bone loss, the operating assistant then carried out a posteroanterior translation of the humeral head. A 6.5-mm working cannula was placed by the posterolateral portal in the subdeltoid space without crossing the capsule. The Hill-Sachs lesion was then refreshed by the anchor insertion mandrel passed through the joint capsule. Two resorbable impacted anchors (GRYPHON BR; DePuy Mitek) were then juxtaposed in relation to the joint on the upper and lower parts of the medial side of the notch in 2 separate passes (4). From 2010 to 2012, one strand of each anchor was then retrieved through the tendon and capsule using hook forceps introduced posterolaterally, which enabled filling through 2 independent matress suture technique (n = 11; Fig. 1, *A*). As of 2013, one suture from each anchor was linked to the other, creating a dependent bridge assembly between the 2 anchors (n = 40; Fig. 1, *B*). The sutures were left on clamps without being permanently tied.

The Bankart repair was finalized in the third step: the scope was again positioned posteriorly and 2 additional anchors were placed at the 3- and 4-o'clock positions for capsular tightening from south to north and to reinsert the labrum.

Finally, the posterior anchors of the filling were tied to finalize the capsulotenodesis.

Postoperative care

The limb on which surgery was performed was placed in an sling in internal rotation for 6 weeks postoperatively. Self-rehabilitating pendular exercises were recommended in the immediate postoperative period. Active assisted recovery work was started under the supervision of a physiotherapist as of the second week. Work in external rotation beyond the 0° position was only allowed as of the sixth week. Muscle strengthening was started in the third month. Contact or throwing sports were allowed as of the sixth month postoperatively.

Clinical evaluation

Prospectively, patients were followed clinically in consultation at 6 weeks, 3 months, 6 months, 12 months, and then 24 months. Beyond 5 years, a clinical examination was performed by an independent observer (A.B.) in a face-to-face consultation or via teleconsultation.

At each examination, the active range of motion in anterior elevation, external rotation elbow at side, external rotation in 90° of abduction, as well as internal rotation (vertebral level reached by



Figure 2 Flow chart.

Table I

Demographic characteristics.

Parameters	Data (maximum-minimum)
Average age (yr)	26 ± 8.4 (16-49)
Gender	
Female	10 (20%)
Male	41 (80%)
Hyperlax patient	22 (43%)
Operated side dominant	
Right	22 (43%)
Left	1 (25%)
Manual worker	17 (34%)
Regular sports activity	35 (68%)
Contact or throwing sport	26 (51%)
Competitive sports	15 (29%)
Average number of instability	$12 \pm 16.2 (2-50)$
episodes (dislocation or subluxation)	
Time before surgery (mo)	56 ± 56.2 (2-199)
Average ISIS (points)	3.3 ± 1.7 (3-7)
Average notch depth (%)	18 ± 7 (9-42)
Mean glenoid bone defect (%)	12 ± 6 (0-18)

ISI, Instability Severity Index.

the thumb with hand in the back) were measured. Preoperatively, a patient with external rotation elbow at side $>85^\circ$ or a positive Gagey test was considered to be hyperlax.¹⁸

An apprehension test was carried out from the third month postoperatively and then at each follow-up consultation. Objective functional assessment was based on Rowe and Walch-Duplay scores out of 100 points. 30,33 A subjective evaluation was requested at each consultation according to the Subjective Shoulder Value. 22

Radiographic assessment

Standard frontal (internal, neutral, and external rotation) and lateral radiographs were taken preoperatively according to Bernageau et al. 4

The depth of the Hill-Sachs was measured according to the modified Conso method on computed tomography scan as a ratio of the deepest point/the humeral head radius.¹⁴ The glenoid bone loss was assessed by the Sugaya et al³² method.

At the last follow-up, a standard anteroposterior view in neutral rotation quantified the progression of glenohumeral osteoarthritis according to the Samilson and Prieto stages.³¹

Statistical analysis

Statistical analyses were performed using the EasyMedStat software (http://www.easymedstat.com; EasyMedStat, Neuilly Sur Seine, France). Continuous variables were expressed by their mean, extremes, and standard deviation. An D'Agostino-Pearson test was used to examine the distribution of the different variables. Paired quantitative variables were compared by Wilcoxon signed rank tests. Unpaired quantitative variables were compared by the Mann-Whitney test. The chi-squared test or Fisher's exact test was used to

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Table II

Univariate analysis of risk factors for recurrence.

Parameter	Recurrence group $(n = 8)$	Stable group $(n = 43)$	P value
Average age (yr)	19.7 ± 5.4 (16-33)	27.3 ± 8.6 (16-49)	.04
Gender ratio	7M/1F	34M/9F	.58
Average ISI score (points)	3.7 ± 1.2 (3-5)	3.3 ± 1.8 (3-7)	.42
Practice of contact or throwing sports (n)	8	30	.3
Hyperlaxity (%)	3	19	.72
Mean glenoid bone defect (%)	$9 \pm 4 (0-11)$	$12 \pm 7 (0-18)$.12
Average Hill-Sachs depth (%)	25 ± 8 (15-42)	18 ± 6 (9-33)	.03

M, male; F, female; ISI, Instability Severity Index.

Bold indicates *P* value that reached statistical significance.

Table III

Mean preoperative range of motion and at mean follow-up of 86 mo.

Parameters	Preoperative	At follow-up	<i>P</i> value Average delta Δ
AAE (°)	173 ± 13.3 (120-190)	171 ± 12.4 (130-180)	.39 $\Delta = -1.7$
ER1 (°)	66 ± 20.8 (10-100)	59 ± 18.3 (10-110)	.02 $\Delta = -7$
ER2 (°)	91 ± 11.6 (60-110)	85 ± 14.5 (40-120)	.006 $\Lambda = -6.4$
IR (points)	9.3 ± 1.1 (6-10)	9.6 ± 0.9 (6-10)	$\Delta = 0.2$

AAE, active anterior elevation; ER1, external rotation elbow at side; ER2, external rotation in 90° of abduction; IR, internal rotation (24). Values are expressed as mean \pm standard deviation and (maximum-minimum).

Bold indicates *P* value that reached statistical significance.

compare categorical variables. Results were considered significant for P < .05.

Results

Our study population

From January 2010 to April 2016, 61 patients underwent arthroscopic BHSR surgery for recurrent anterior instability. Three patients were excluded because of previous surgery (1 Bankart revision and 2 abutment revision). Seven patients (12%) were considered lost to follow-up because they could not be evaluated for the 5-year postoperative assessment.

A total of 51 patients formed the basis for the statistical analysis of this study.

Six patients (12%) had a clinical review during a face-to-face consultation and 45 patients during teleconsultation (Fig. 2).

The mean age at the time of surgery was 26 years (16-49; \pm 8.4 years); sex ration was 80% of male (Table I).

A procedure was indicated after an average of 12 (3-50; \pm 16.2) episodes of instability (dislocation and/or subluxation). The mean time from the first episode of instability to surgery was 56 months (2-199; \pm 56.2). Hyperlaxity was found in 22 patients (43%). A highrisk sport (contact and/or throwing) was practiced by 26 (51%) of the 35 patients who practiced sports (68%). The average ISI score was 3.3 points (3-7; \pm 1.7). Preoperatively, the mean depth of the Hill-Sachs lesion was 18% (9-42; \pm 7%) of the humeral head.

Recurrence

At a mean follow-up of 87 months (60.0-124; \pm 17), 8 patients (15.6%) had a recurrence of instability in the form of a dislocation or subluxation. In 7 patients (90%), the failure occurred during the first 12 months postoperative, mainly in a major traumatic context (n = 5) (skateboard fall, assault, rugby tackle, motorcycle fall in competition, fall during soccer). In addition, 4 patients (9%) who had no recurrence had persistent apprehension when throwing.

In the univariate analysis, patients with recurrent instability were significantly younger and the notch was significantly deeper (Table II).

On the other hand, no correlation was found between stabilization failure and gender, the context of hyperlaxity, the type of sport, ISI score, or glenoid bone loss.

At the last follow-up, 5 patients for whom the procedure failed underwent repeat surgery with bone block stabilization according to the Latarjet procedure.

Mobilities

The analysis of mobilities at the last follow-up is shown in Table III. There was a significant decrease in external rotation elbow at side and abduction of 7° and 6° , respectively.

Patients with failed stabilization had earlier recovery of active mobility at 1.5 months postoperatively in the areas of anterior elevation, external rotation at side, and internal rotation (Fig. 3).

Functional scores

Among patients without recurrence (n = 43), the mean Rowe and Walch-Duplay scores were 88 points (51-100; ±12) and 82 points (50-100; ±16.4), respectively. The mean Subjective Shoulder Value was 89% (50-100; ±8). At the last follow-up, 29 patients (83%) had resumed their sports activity, including 24 (69%) who maintained the same level.

Radiographic change

For 35 patients (69%), the mean radiological follow-up was 5.6 years (5-11; ± 2.8). Twenty-nine (83%) patients had no osteoarthritic progression, 5 (14%) had grade 1 osteoarthritis, and 1 (3%) had grade 2.

Patients with an osteoarthritic change were significantly older at the time of surgery (25.9 vs. 39.0 years; P = .02).



Figure 3 Comparison of the recovery of active mobility between patients with and without recurrence at follow-up. (A) Recovery of active anterior elevation. (B) Recovery of external rotation elbow at side. (C) Recovery of internal rotation in points (24). AAE, active anterior elevation; ER1, external rotation elbow at side; IR, internal rotation.

Discussion

Our study validated the hypothesis that arthroscopic BHSR in the treatment of anterior shoulder instability provides a satisfactory outcome in a follow-up of more than 5 years with a low rate of osteoarthritic degeneration. Nevertheless, with a stabilization failure rate of more than 15%, this procedure has its limitations in young patients with a deep Hill-Sachs. Rapid postoperative recovery of full range of motion would appear to be a predictive factor for failure at follow-up.

The literature reports a recurrence rate of 0%-15% for short-term postoperative recurrence of instability.^{6,21,28,34} Fewer studies examine long-term outcomes and seem to report equally encouraging results. At a mean follow-up of 8 years, Brilakis et al¹⁰ identified only 5.6% of recurrences among the 54 patients followed. According to the authors, early failures are related to technical or indication errors. After 2 years, the rate seemed to remain stable. Bastard et al³ reported no recurrence in a cohort of 28 patients seen again in more than 10 years, without any apprehension at throwing. Randelli et al²⁹ recently described a 14% recurrence at a mean follow-up of 4.5 years in an unselected population with a mean overall notch volume of 1000 mm³. Park et al²⁷ reported a similar failure rate of 15% at follow-up in 30 months, in a population with an average Hill-Sachs depth of 25% of the humeral head. With one of the largest cohorts of the literature, the failure rate found in our series is close to this, and the risk factors for failure identified were identical, thereby validating this work. This unfavorable lesion factor was considered significant at above 20% by

Bonnevialle et al⁸ in a short-term series. In a cadaveric study, Elkinson et al¹⁶ showed that the depth of the Hill-Sachs was a factor in instability: a 15% of humeral depth could be stabilized by an isolated Bankart repair, whereas beyond 30%, it systematically required filling to restore glenohumeral stability. Park et al²⁷ also reported that this parameter was a risk factor for failure, reaching 9% in their series for a volume of 825 mm³.

The first consequence of the depth and, indirectly, the volume of the Hill-Sachs to be filled could affect the healing of the capsulotenodesis. The rate of healing of the capsulotenodesis in vivo is a critical point noted by Randelli et al,²⁹ especially since in their series, the failures seemed to be associated with Hill-Sachs volumes twice as high as the average (2000 mm³). Park et al²⁶ studied the correlation between clinical examination and the healing of filling assessed by magnetic resonance imaging. According to these authors, healing takes place between the eighth and the ninth month. Franceschi et al¹⁷ found that failures occurred early between the sixth and ninth months. Nourissat et al²⁴ found partial healing at 1 year in 33% of his patients. For Boileau et al,⁶ healing of the filling was an essential prerequisite for successful stabilization. They explain that a capsulotenodesis that did not heal during the first year was a factor of early recurrence.

The second consequence is a potential excess in external rotation limitation. Like Omi et al,²⁵ Elkinson et al¹⁶ demonstrated in their biomechanical study that filling decreased external rotation by approximately 15°. This amplitude limitation was proportional to the extent of the notch and the positioning of the anchors. Many clinical studies have found this limitation of external rotation following BHSR, which ranges from -2° to -10° .^{6,10,20,21,24,27-29,34} This could support the hypothesis that early and complete postoperative amplitude recovery, as seen in our series, could be associated with a failure of filling to heal and therefore potential recurrence at follow-up.

For Cavalier et al,¹³ the presence of glenoid erosion is the main bad prognostic factor associated with the patient being young (<23 years). Beyond a 10% bone loss, the relative risk of recurrence is multiplied by 35. Although being young also appeared to be a predictive parameter for failure in our study (19 vs. 27 years), no glenoid bone loss was noted. However, since the inclusion of patients was based on the ISI score associated with a minor glenoid bone defect, such a parameter could not be discriminating.²

This would suggest that in case of a subcritical glenoid bone defect (>10%) or a deep notch (>20%), the surgical alternative would be stabilization by a Latarjet procedure. Bah et al¹ reported a similar recurrence rate of approximately 10%, and comparable functional scores between the 2 stabilization techniques in their comparative study. However, they found a limitation in external rotation, as well as persistent pain, which was significantly greater in BHSR surgery. Yang et al³⁵ described functional scores as well as a recurrence rate in favor of Latarjet stabilization in high-level contact sport athletes (recurrence: 0% vs. 30%).

In our study, the overall osteoarthritis rate was 17%. Only 1 patient, older than the average in our series (42 vs. 26 years), presented a grade 2 osteoarthritic change, but remained asymptomatic at the 86-month follow-up. Therefore, signs of osteoarthritis noted were minor in the majority of cases and were associated with being older at the time of surgery. This risk factor had already been identified after other operative techniques including abutment stabilization.^{9,11,17} In their review of the literature at over 10 years of follow-up, Hurley et al¹⁹ found an osteoarthritic change in 38% of the patients stabilized with a bone block, but <10% reached Samilson stage 2 or 3. Mizuno et al²³ found 20% osteoarthritic change in patients free of any preoperative osteoarthritis, 20 years after a Latarjet procedure.

Our study has a number of limitations. The first is related to the retrospective nature, with a limited number of subjects. Nevertheless, this is one of the largest series with a minimum follow-up of 5 years. The second limitation is related to the Hill-Sachs lesion analysis. In fact, only the depth was measured, and the width, length, orientation, and the volume were not. Similarly, capsulotenodesis healing was not assessed at follow-up and was not analyzed as a risk factor for potential failure. Finally, because of a small number of patients with failed stabilization, multivariate analysis could not be performed since the statistical independence of authenticated risk factors could not be confirmed.

Conclusion

The failure rate of more than 15% at a follow-up of more than 5 years means that BHSR should be recommended with caution in case of deep Hill-Sachs lesion in young patients. Early postoperative recovery of joint amplitudes is a predictive factor of medium-term failure. The incidence of osteoarthritis after this procedure was acceptable, with few severe forms grade 2 in older patients.

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