Isolated arthroscopic Bankart repair vs. Bankart repair with "remplissage" for anterior shoulder instability with engaging Hill-Sachs lesion: A meta-analysis

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A B S T R A C T

Introduction: Arthroscopic "remplissage" of a Hill-Sachs lesion (HSL) associated with a Bankart repair (BR) has been recently introduced as a surgical option to treat chronic anterior shoulder instability. The purpose of this study was to analyze the current literature comparing results of isolated BR versus BR + remplissage in the treatment of anterior shoulder instability with engaging HSL.
Hypothesis: BR + remplissage are superior to isolated BR in the management of anterior shoulder instability with engaging HSL.
Material and methods: Four electronic databases were searched for original, English-language studies comparing BR vs. BR + remplissage procedures. During the inclusion process we used international Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) guidelines and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. Our data were extracted from the text, tables and figures of the selected studies.
Results: Three comparative studies were identified, which included 146 patients; 74 of them underwent isolated BR, and 72 BR + remplissage procedure. The isolated BR results in significantly higher risk of recurrence and redislocation. There was no significant difference in the rates of reoperation and time to return to sport between the two procedures. Rowe and UCLA scores were lower in the isolated BR group compared with the BR + remplissage group.
Discussion: This meta-analysis demonstrates the superiority of BR + remplissage procedure vs. isolated BR in the management of anterior shoulder instability with engaging HSL and with up to 25% glenoid bone loss regarding redislocation rate, recurrent instability and functional scores. A comparison between postoperative range of motion and particularly external rotation was not able to be formally assessed in this study.
Level of evidence: III.

1. Introduction

The surgical strategy in the management of anterior shoulder instability include prior identification and evaluation of three anatomical lesions: [1] antero-inferior capsulo-ligamentous distension and labral detachment, [2] anterior glenoid bone loss, [3] and humeral bone defect the so-called "Hill-Sachs lesion" (HSL).

Isolated arthroscopic Bankart repair (BR) has been reported to fail in 22% of cases [1]. Risk factors identified for recurrence include substantial glenoid bone loss, hyperlaxity, type of sport and level of practice, and engaging nature of HSL [1–8]. An engaging HSL was described by Burkhart et al. [5,9], as a defect that engaged during arthroscopic examination in abduction and external rotation of the shoulder.

Several surgical procedures have been described to treat the engaging Hill-Sachs bone defect: bone graft [10–12], retrograde desimpaction [13], arthroplasty [10], partial humeral head resurfacing [14], humeral rotation osteotomy [15] and posterior soft

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tissue filling of the HSL commonly called Hill-Sachs remplissage (HSR) [10,16].

Since the last ten years, the emphasis has been placed on the arthroscopic treatment of anterior shoulder instability and arthroscopic surgical procedures for HSR have been described [9,16–18]. Preliminary results suggested that redislocation rate after isolated BR in case of engaging HSL may reduce with the association of a HSR [4,19–24]. However clinical results and biomechanical studies showed that arthroscopic HSR might compromise glenohumeral range of motion [25]. To date, the level of evidence of the superiority of HSR associated with BR versus isolated BR in the treatment of anterior shoulder instability with engaging HSL remains low, and to our knowledge, previous meta-analysis evaluated only each procedure individually [19,26,27].

The purpose of the present study was to do a meta-analysis of the current literature comparing results of BR + remplissage versus isolated BR in the treatment of anterior shoulder instability with engaging HSL.

2. Material and methods

2.1. Literature search strategy

This meta-analysis was conducted according to international Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) guidelines. PubMed, Ovid, MEDLINE, and Cochrane Database of Systematic Reviews were consulted from 2000. The keywords used for the identification of studies were “Bankart” and “remplissage”. The identified articles were screened and reviewed according to the inclusion criteria to select eligible articles.

2.2. Inclusion criteria

The inclusion criteria for this meta-analysis were: [1] studies comparing results of isolated arthroscopic BR versus arthroscopic BR with HSR for the management of anterior shoulder instability, [2] minimum follow-up of two years [3] the reported results including recurrent instability, reoperation, return to sport, and at least one postoperative shoulder functional score (Rowe, UCLA, Walch-Duplay, Western Ontario Instability Index [WOSI]), [4] the description of the method for the assessment of engaging nature of the HSL [5] similar features of the HSL in both groups (volume of bone defect or engaging nature). Biomechanical studies and technical notes without clinical outcomes were excluded.

2.3. Quality assessment

All eligible studies were independently analyzed by two different rewievers regarding inclusion criteria. The quality of the articles was evaluated with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.

2.4. Data extraction

The data were extracted from text, tables and figures of each study including study characteristics, patients’ demographics, details of the surgical procedure and clinical outcomes. The study characteristics of interest included type of study, level of evidence, number of patients with lost to follow-up and mean duration of follow-up. The patients’ demographics data extracted were age at the surgery and gender. The details of the procedures included methods used to quantify the volume of the HSL and to assess its engaging nature, number and location of anchors used for capsulotenodesis. Primary outcomes measure is recurrent instability. The recurrent instability included the occurrence of any instability symptoms postoperatively (dislocation, subluxation, apprehension). Secondary outcomes measures are reoperation, time to return to sport at the same level, pre- and post- operative range of motion and functional score values. The reoperation was defined as any surgical procedures performed for anterior instability management following the initial surgery.

2.5. Statistical analysis

The results of the selected studies were tabulated with number of events (redislocation, recurrent instability, reoperation and return to sport) or mean and standard deviations (UCLA and Rowe scores) and total number of subjects in BR and BR + remplissage groups. To assess heterogeneity across the studies, we used Forest plots as well as Cochran’s heterogeneity statistic and Higgins I^2 coefficients [28]. A p-value of < 0.1 or $I^2 > 50\%$ was considered suggestive of statistical heterogeneity, prompting random effects modeling. We calculated the risk ratio of redislocation, recurrent instability, reoperation and return to sport according to the inverse variance approach with their 95% confidence intervals and overall p-values, for BR versus BR + remplissage. We also estimated the mean differences in UCLA and Rowe scores between BR and BR + remplissage. Finally, we produced Funnel plots to assess small-study effects [29]. Funnel plots did not show evidence of small-study bias. We used the Review Manager 5.2 analysis software (The Cochrane Collaboration, Copenhagen, Denmark) for all analyses. All reported p-values were two-sided and the significant threshold was < 0.05.

3. Results

3.1. Literature research

The literature research produced 42 studies. After the duplicates were removed, there were a total of 38 articles. The title screen revealed that 8 studies were pertinent. The abstracts were then analyzed and biomechanical studies and technical notes with no clinical outcomes were removed. Four of 8 articles were eligible for the analysis, and their full manuscripts were read to ensure they met all the inclusion criteria. One of them was excluded [23] as the groups were not comparable concerning HSL volume and engaging nature. In this study, the choice between isolated BR or BR + remplissage was made according to ISIS score [2]. A flow chart detailing the inclusion process is Fig. 1.

3.2. Study characteristics

Three clinical studies were included in this meta-analysis [20–22]. All studies were Level III retrospective comparative studies. The follow-up seemed to be homogeneous between studies, and in each study, there was no statistical difference between BR and BR + remplissage group regarding mean follow-up. No patients were lost to follow-up. In Garcia et al. study, the follow-up seemed to be longer in the BR group than in the BR + remplissage group [22], but there was no significant difference ($p = 0.12$). The main characteristics of these studies are summarized in Table 1.

3.3. Demographics

A total of 146 patients were enrolled in this study, 74 in isolated BR group and 72 in BR + remplissage group. In each study, there was no statistical difference between BR and BR + remplissage group regarding mean age at surgery, and 82.8% (121/146) of the patients were males.

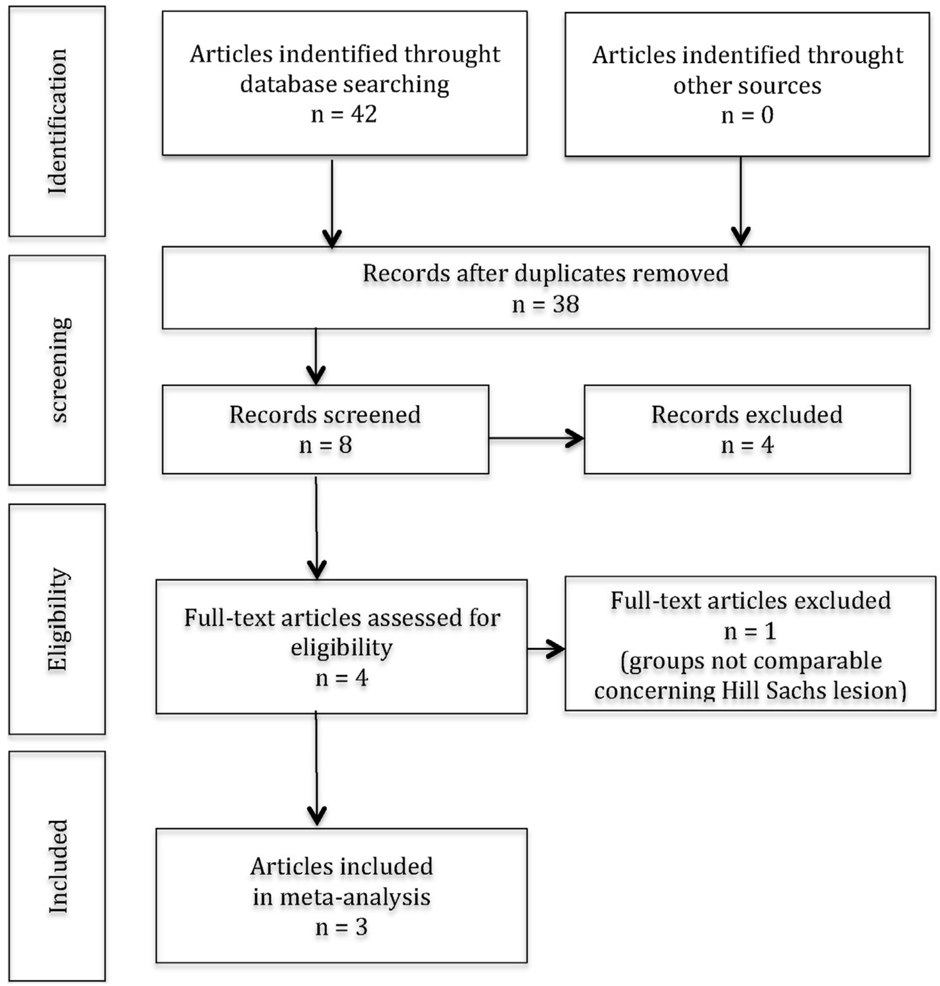

Fig. 1. The inclusion process of the articles.

Table 1
Summary of the design of the included studies.

	n		Age, (year)			FU, (month)		
	BR	BR + remplissage	BR	BR + remplissage	p	BR	BR + remplissage	p
Franceschi(2012)	25	25	27.4 ± 5.2 (22–33)	26.3 ± 8.1 (17–37)	> 0.05	24.5 ± 1.5	24.8 ± 1.1	> 0.05
Cho (2015)	35	37	26.1 ± 7.0 (14–46)	24.8 ± 9.0 (14–52)	> 0.05	22.9 ± 13.5 (12–48)	24.7 ± 9.5 (19–31)	> 0.05
Garcia (2015)	14	10	26.0 (17.8–41.1)	24.4 (16.4–38.3)	0.12	40.7 (26.3–51.1)	31.6 (24.1–39.9)	0.39

Data shown Mean ± Standard Deviation (range). *n*: number of patients; FU: follow-up; BR: Bankart repair.

3.4. Surgical techniques

In the study by Cho et al. the same surgeon performed all procedures. In the study by Franceschiet al. two surgeons performed BR and BR + remplissage. In the study by Garcia et al. first surgeon performed all BR and second performed all BR + remplissage.

In two studies [21,22]. the “remplissage” procedure included a posterior capsulodesis and an infrasupinatus tenodesis, as described by Park et al. [18]. In the third study, Cho et al. [20] performed an isolated posterior capsulodesis without infrasupinatus tenodesis. Mean number of anchors used for each procedures in included articles are described in Table 2. In each article, groups were comparable concerning mean number of anchors used for bankart repair.

All studies applied the same rehabilitation protocol: shoulder immobilization in a sling during 6 weeks with pendulum exercises, then active-assisted and active mobilization from 6 weeks to 3 months, and capsular stretching after 3 months. “At risk” activities were allowed after 6 months.

Table 2
Number of anchors used for each procedure in included studies and statistical analysis about number of anchors used for bankart repair in each procedure.

	BR group	BR + remplissage group		
		BR	Remplissage	*p*
Franceschi(2012)	2.6 (2–4)	3.0 (2–4)	1.7 (1.2)	> 0.05
Cho (2015)	3.8 ± 0.8	3.7 ± 0.6	2.4 ± 0.8	> 0.05
Garcia (2015)	3.2	4	1.5	> 0.05

Data shown Mean ± Standard Deviation (range). BR: Bankart repair.

3.5. Hill-Sachs defect evaluation

All studies used preoperative imaging to evaluate the HSL. Cho et al. [20] used the axial image of CT-scan where HSL is the largest

Table 3
Evaluation method and anatomic characteristics of Hill-Sachs lesion in included studies and results.

	HS defect evaluation	BR	BR + remplissage	*p*
Franceschi(2012)	Plan X-ray in IR, index D/R, (%)	30.1 (15–68)	30.6 (11.6–73.3)	> 0.05
Cho (2015)	CT-scan, axial view, (mm)	6.0 ± 1.5 (3.9–9.7)	6.8 ± 1.7 (4–11)	> 0.05
Garcia (2015)	MRI, volume measurement, (mm^3)	310.22 ± 240.5	283.79 ± 192.6	> 0.05

Data shown Mean ± Standard Deviation (range). HS: Hill-Sachs; BR: Bankart repair; IR: internal rotation; CT: computed tomography; MRI: magnetic resonance imaging.

Table 4
Evaluation method of glenoid bone loss in included studies and results.

	Glenoid bone loss evaluation	BR	BR + remplissage	*p*
Franceschi(2012)	CT-scan Sugaya index, (%)	16.1 (10.3–24.2)	14.9 (11.5–23.6)	> 0.05
Cho (2015)	CT-scan Sugaya index, (%)	9.9 ± 6.9 (0–21.8)	8.5 ± 5.8 (0–20.3)	> 0.05
Garcia (2015)	MRI Sugaya index (%)	< 1	5.3	> 0.05

Data shown Mean ± Standard Deviation (range). BR: Bankart repair; CT: computed tomography; MRI: magnetic resonance imaging.

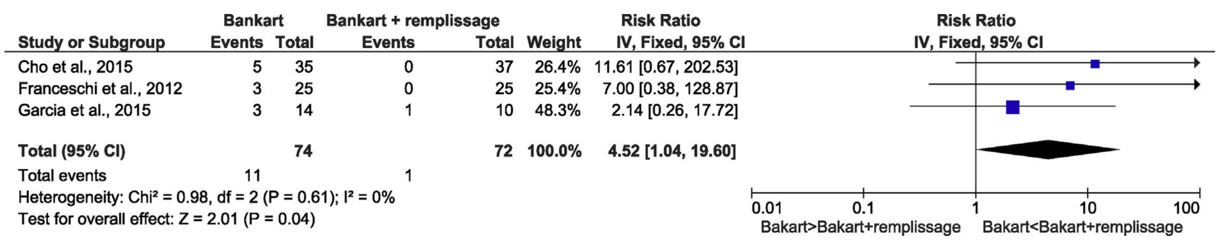

Fig. 2. Meta-analysis of redislocation after isolated BR vs. Bankart + remplissage.

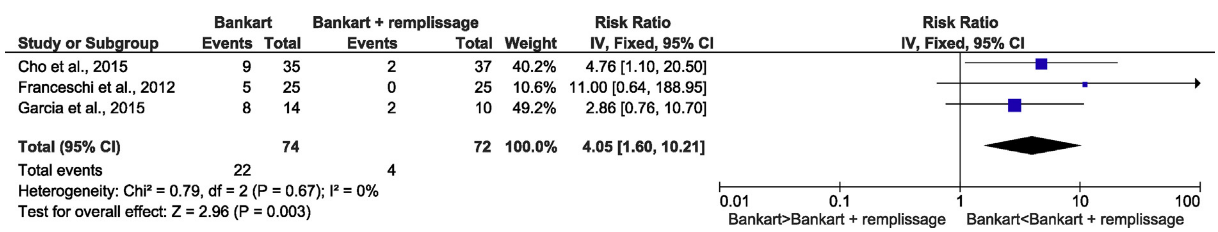

Fig. 3. Meta-analysis of recurrent instability after isolated BR vs. Bankart + remplissage.

to assess its depth. Garcia et al. [22] used 3D-MRI for HSL volume evaluation as described by Park et al. [30]. Franceschi et al. method for HSL evaluation consisted of an index measurement: HSL depth/humeral head radius of curvature on plain radiographs in internal rotation, as described by Charousset et al. [31]. In each article, both groups were comparable concerning the anatomic characteristics of the HSL (Table 3).

All studies performed an intra-operative arthroscopic evaluation of HSL engagement according to the dynamic evaluation proposed by Burkhart et al. [5,9].

3.6. *Methods of glenoid bone loss evaluation*

All studies used 3D measurements to assess anterior glenoid bone loss. Garcia et al. [22] used the circle method as published by Sugaya et al. [32], adapted by Huijsmans et al. [33] for 3D-MRI views, and patients with > 20% glenoid bone loss were excluded. In the two other studies, the glenoid measurements on sagittal views of CT-scan were used as published by Sugaya et al. [32], and patients with > 25% of inferior glenoid diameter bone loss were excluded. In each study, the mean glenoid bone loss was similar in both groups (Table 4).

3.7. *Recurrent instability*

Recurrent dislocation occurred in 14.8% (11/74) of isolated BR and in 1.4% (1/72) of BR + remplissage procedure. This difference was significantly different (RR = 4.52, IC 95% [1.04–19.6], $p = 0.04$) (Fig. 2), with approximately 4.5-fold higher risk of redislocation after isolated BR. No significant heterogeneity was detected in this analysis.

Recurrent instability (including dislocation, subluxation, and apprehension) occurred in 29.7% (22/74) after an isolated BR procedure and in 5.6% (4/72) after a BR + remplissage procedure. This difference was significantly different (RR = 4.05, IC 95% [1.60–10.21], $p = 0.003$) (Fig. 3), with approximately 4-fold higher risk of recurrent instability after isolated BR. No significant heterogeneity was detected.

3.8. *Patient-reported outcomes*

3.8.1. *Functional scores*

Only two studies used similar postoperative scores as the assessment of patient-reported outcomes. The third study recorded WOSI and DASH and could not be included in this analysis. Rowe and UCLA scores were reported for 83% (122/146) of the total cohort: 60 patients in isolated BR group and 62 in BR + remplissage group. The mean difference in UCLA score was 1.42 in favor of BR + remplissage with significant statistical difference (IC 95% [2.68–0.16], $p = 0.03$) (Fig. 4). The mean difference in Rowe score was 9.33 favoring BR + remplissage with significant statistical difference (IC 95% [14.2–4.54], $p = 0.0001$) (Fig. 5). No significant heterogeneity was detected.

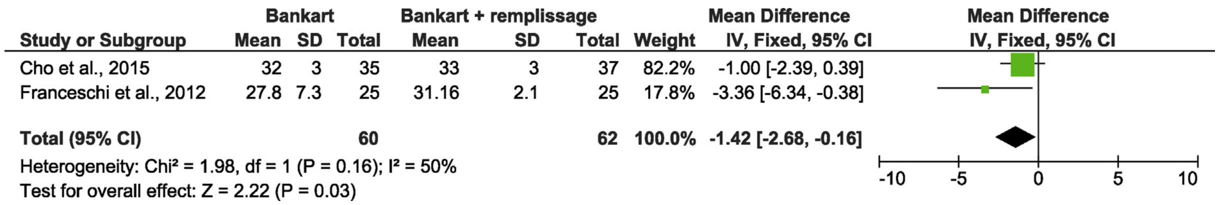

Fig. 4. Meta-analysis of UCLA score after isolated BR vs. Bankart + remplissage. SD: standard deviation.

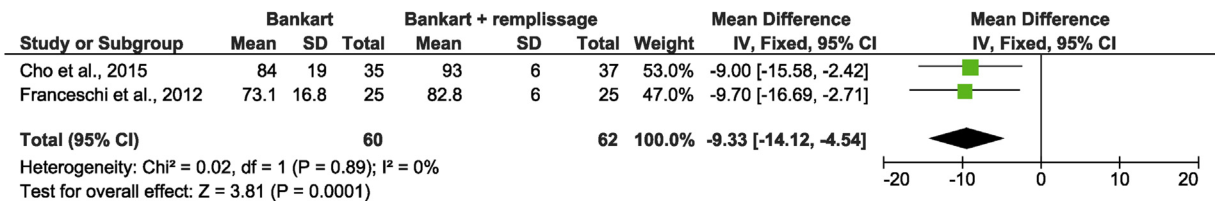

Fig. 5. Meta-analysis of Rowe score after isolated BR vs. Bankart + remplissage. SD: standard deviation.

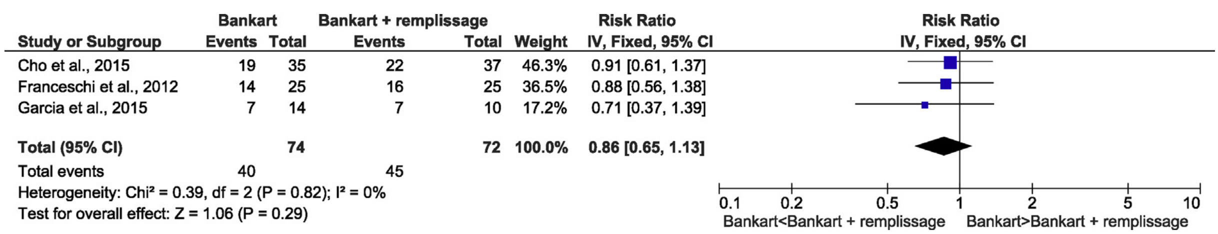

Fig. 6. Meta-analysis of return to sport at the same level after isolated BR vs. Bankart + remplissage.

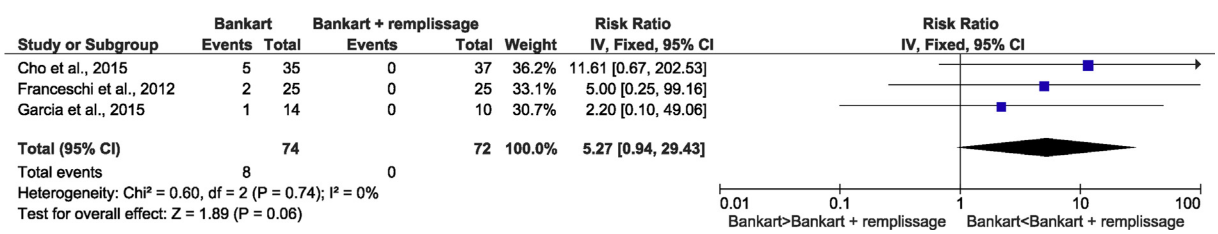

Fig. 7. Meta-analysis of reoperations due to recurrent instability after isolated BR vs. Bankart + remplissage.

3.8.2. Return to sport at the same level

All studies reported at the last follow-up if the patients were returned to sport at the same level as before surgery. After isolated BR, 54,0% (40/74) of patients returned to sport at the same level, and 62.5% (45/72) after BR + remplissage surgery. There was no statistical difference between the two groups concerning this criteria (RR = 0.86, IC 95% [0.65–1.13], p = 0.29) (Fig. 6). No significant heterogeneity was detected.

3.9. Reoperation

Revision surgery due to recurrent instability occurred in 10.8% (8/74) of isolated BR procedure. There was no revision surgery in BR + remplissage group. However, despite a statistical tendency to more revision surgery in BR group, this difference was not significantly different (RR = 5.27, IC 95% [0.94–29.43], p = 0.06) (Fig. 7). No significant heterogeneity was detected.

4. Discussion

Arthroscopic capsulotenodesis of an HSL associated with BR, was introduced as a surgical option to treat chronic anterior shoulder instability in 2008. It resulted from the analysis of the cause of failures after an isolated BR [16], which was reaching more than 20% at long term follow-up [1,2,8]. Even if it is a part of the “à la carte” treatment strategy, arthroscopic capsulotenodesis is not usually recommended in case of substantial anterior glenoid bone loss, when glenoid bone augmentation procedures are required [2,34]. Several meta-analyses studied the outcomes after this procedure [19,26]. However, to our knowledge, none evaluated the superiority of BR + remplissage vs. isolated BR in case of engaging HSL without major glenoid bone loss (up to 25%).

The principal findings of this study highlighted the superiority of BR + remplissage with a RR of redislocation and recurrent instability increased by 4 and 4.5 respectively, in the isolated BR group. Moreover there is a statistical tendency to more reoperations for recurrent instability in the isolated BR group. The difference between the two groups was not significant because of a lack of statistical power (p = 0.06). The functional scores seemed to be superior in BR + remplissage group compared to BR group. Mean Rowe score was lower of 9.33 pt. in isolated BR group, but the difference seemed to be not clinically pertinent for UCLA score (−1.42 pt. disfavoring BR group), and these analyses were used with only two studies, reducing the statistical value of these results. Furthermore, the rate of the patients who returned to sport at the same level at last follow-up was comparable between the two groups.

In this meta-analysis, only three Level III evidence studies were included. With a total of 146 patients included, and without any lost at follow-up, this meta-analysis is based on a small cohort but it was sufficient to increase the clinical evidence on this topic. The mean age, the size of glenoid bone loss and the size of HSL were comparable between the two groups. The fact that the mean follow-up seemed to be longer in BR group in study of Garcia at al. [22], may introduce a bias, but this potential bias is minimized by the low number of patients in this study. Moreover, there is a lack of data in the included studies to assert if both groups were comparable regarding risk factors of isolated BR failures which are potential confounding factors: hyperlaxity, type and level of sport [1,2,8].

Moreover, because some authors pointed out the fact that HSL remplissage could affect shoulder range of motion, especially external rotation [25], it would have been interesting to compare postoperative range of motion between these two surgical techniques. Unfortunately, the clinical methods and the time-to-surgery for collecting these data were too different between the included studies to allow a pertinent statistical analysis. This is particularly unfortunate because it was recently reported that postoperative limitation of external rotation would affect return to throwing sport [35].

The use of different methods for HSL assessment is also a major limitation. Even if each author performed an arthroscopic assessment of the engaging status of the HSL, the preoperative evaluation used different volumetric or depth static measures as axial views of CT-scan, 3D-MRI or plain radiographs. The theory of the glenoid track described by Itoi et al. [36,37] would be more accurate and reproducible. Recently, in a retrospective patient about 100 patients, Locher et al. [6] reported that an off-track HSL was a significant risk factor for recurrence of instability after isolated BR. In a recent cadaveric study, Hartzler et al. [38] highlighted that remplissage of an off-track lesion is necessary to achieve stability of the glenohumeral joint whereas shoulders with on-track HSL achieved stability with isolated BR. Therefore, this method should be used in future clinical comparative studies to include homogenous cohort of patients.

This meta-analysis suggests that in case of anterior shoulder instability with engaging HSL and with up to 20–25% glenoid bone loss, arthroscopic BR + remplissage reduces recurrent instability by 4-fold comparing with an isolated BR with better functional outcomes. However, no significant difference in term of reoperation and return to sport at the same level was highlighted. A comparison between postoperative range of motion and particularly external rotation was not able to be formally assessed in this study.

Disclosure of interest

The authors declare that they have no competing interest.

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Contribution

Dimitri Camus: main author.
Peter Domos: english translation.
Emilie Berard: statistical analysis.
Julien Toulemonde: helping with data collection.
Pierre Mansat: item inclusion and manuscript review.
Nicolas Bonnevialle: project initiation, item inclusion and final manuscript review.

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