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Evaluation of range of motion and functional outcomes after combined remplissage and bankart repair in recurrent anterior shoulder dislocation with off-track Hill-Sachs lesion and glenoid bone loss (<20%)

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Abstract
Purpose: For anterior shoulder instability with off-track Hill-Sachs lesion (HSL) and subcritical loss of glenoid bone (less than 20%), Bankart repair and Remplissage (BRR) has been recommended. The goal of this work was to assess the functional outcomes following BRR among individuals with anterior shoulder instability and off-track HSL with loss of glenoid bone of less than 20%.
Methods: BRR was used to manage 41 individuals who had anterior shoulder instability with off-track HSL and loss of glenoid bone under 20%. They were monitored for a median of 23 months after surgery. The Western Ontario Shoulder Instability Index (WOSI) and the American Shoulder & Elbow Surgeons score (ASES) were used to evaluate the functional result. The shoulder range of motion including external rotation at the side (ERs), forward flexion (FF), internal rotation in abduction (IRa) and external rotation in abduction (ERa), was recorded.
Results: The postoperative ASES and WOSI scores for each participant significantly improved when compared to their preoperative values, with a mean difference of 46.1%±19.5 and 29.2±13.3 correspondingly. The mean decrease in ERa, ERs, FF, and IRa were (13.09%±8.2), (22.5%±16.18), (2.46%±1.92), and (10.12%±6) respectively. There was no correlation between functional scores and limitation of ER.
Conclusion: In anterior shoulder instability patients with loss of glenoid bone of less than 20% and off-track HSL, combined arthroscopic Bankart repair and remplissage results in satisfactory functional outcomes. Over the duration of the trial, the rate of recurrence was 2.5 percent. There was a statistically significant limitation of range of motion of shoulder mainly in external rotation. However, this was functionally insignificant.
Level of evidence: Therapeutic Level IV, case series study

Keywords: Instability, shoulder, external rotation limitation, ROM, clinical outcomes

Introduction
A Hill-Sachs lesions (HSL) is an osteochondral defect, which lies on posterolateral surface of the head of humerus and is brought on by the humeral head's impaction against the margin of the anterior glenoid during the dislocation of the shoulder. It's reported that the HSL is present up to 47% of initial shoulder dislocation of and over 80% of recurring shoulder dislocations [1-3].

In 2007 Yamamoto *et al.* [4] introduced the glenoid track concept which defines HSL as off-track or on-track based on its location relative to the contact region between the head of the humerus and the glenoid throughout external rotation and abduction (glenoid track). The lesion is "on-track" if the medial margin of the HSL is enclosed by the glenoid tract. Conversely, the lesion is "off-track" if its medial border lies medial to the glenoid tract. This concept does not only consider the size of HSL but takes also into consideration its location and the coexisting glenoid bone loss, since loss of Glenoid bone will cause the glenoid track to be narrower [5, 6].

Multiple research investigations have shown that the existence of an off-track HSL is linked to a higher risk of instability recurrence following non-operative treatment of a first-time shoulder dislocation and standard isolated Bankart repair [7-10]. As a consequence a number of strategies have been proposed to deal with a significant HSL including Remplissage technique.

Wolf *et al*. [11] initially described the Remplissage technique, which involves the tenodesis of the infraspinatus tendon and posterior capsule into the Hill-Sachs lesions to prevent engagement between HSL and the rim of the glenoid. One potential concern over the use of the remplissage is its potential to decrease external rotation (ER), and Its impact on patient function.

The goal of this research was to assess the range of motion and functional outcome among anterior shoulder instability patients with an off-track Hill-Sachs lesion and subcritical (<20%) loss of glenoid bone after BRR.

Methods

Patient selection

41 patients undergoing soft tissue stabilisation of the shoulder for recurrent shoulder instability were prospectively assessed as to their suitability. The inclusion criteria were; Patients requiring an arthroscopic BRR; The presence of an off-track Hill-Sachs lesions. Exclusion criteria were (1) Individuals having on-track Hill-Sachs lesions (2) 20% or more loss of anterior glenoid bone (3) humerus avulsion of the glenohumeral ligament (HAGL) lesions, (4) epileptic individuals, (5) voluntarily dislocation, (6) multidirectional instability, (7) associated full-thickness rotator cuff injury, (8) pre-existing glenohumeral osteoarthritis.

Patient evaluation

Using the patient's medical history, a physical exam, and magnetic resonance imaging (MRI), anterior instability of the shoulder was identified. Patient age, gender, engagement in sports, number of dislocation episodes, hand dominance, preoperative Western Ontario Shoulder Instability Index (WOSI) [12], and American Shoulder and Elbow Surgeons (ASES) score [13], were all recorded.

Post operatively at final follow-up, ASES score [13], WOSI scores [12], recurrence and time to return to sports were recorded. The ROM in both shoulders was measured using a goniometer. The movements recorded were external rotation at the side (ERs), forward flexion (FF), internal rotation at 90° of abduction (IRa), and external rotation at 90° abduction (ERa).

Radiological evaluation

In accordance with the method outlined by Gyftopoulos *et al*. [14] the glenoid tract and Hill-Sachs interval (HSI) were assessed on MRI. The degree of glenoid loss was measured on sagittal MRI utilizing the best-fit circle with a linear evaluation of the bone lacking from the circle, as outlined by Provencher *et al*. [15].

Surgical technique

All patients were operated in the Beach chair position. Initially the surgery was performed through 3 standard portals, a posterior portal, an anterior and an anterolateral superior portals. The anterior labrum was initially mobilised and the glenoid neck was prepared. Prior to completing the bankart repair the HSL was addressed. HSL was visualized from the anterolateral-superior portal, and then, utilizing a needle, an auxiliary deep postero-lateral portal was established to allow access to HSL. The shaver was placed against HSL and used to roughen the bone. A 3.5mm double-loaded suture anchor (TWINFIX, Smith and Nephew, Andover, USA) was introduced via accessory deep posterolateral portal through the posterior rotator capsule and cuff into HSL. Either one anchor or two were used according to the surgeon choice at the time of surgery. A sharp retrograde suture passer was utilized to penetrate the infraspinatus/joint capsule and retrieve the sutures individually through different points in the tendon. The bankart repair was then performed in a standard fashion using three single-loaded 1.7 Anchors (Suturefix Ultra Smith and Nephew). Finally, the Remplissage procedure was completed by tying knots under direct visualization in the subacromial space.

Postoperative rehabilitation protocol

Patients ware place in a sling for six weeks postoperatively. Wrist, Hand and elbow exercises were started immediately, while pendulum and exercises of scapular retraction began at 2 weeks. After six weeks, the sling was removed, and patients started stretching and assisted active range-of-motion exercises. Following 3-months, strengthening exercises were commenced. Return to full activities, including sports started at six-months.

Statistical analysis

Version 20.0 of the IBM SPSS software program (Armonk, NY: IBM Corp.) was used to analyze the data. Data that was categorical was shown as number and percentage. For quantitative parameters with a normally dispersed distribution, the Paired t-test was employed, and for parameters with an abnormal distribution, the Wilcoxon signed ranks test. For the quantitative parameters that were not normally distributed, the Mann Whitney test has been applied for comparing two groups. When comparing quantitative parameters that were not normally distributed, the Spearman coefficient was utilized.

Results

A total of 41 patients completed the minimum duration (1 year) required for the final follow-up. individuals' demographics are presented in table (1). The study population were mainly males (85%) and had a mean age of 23.8 years. On average patients experience 7 dislocations prior to surgery and underwent stabilisation at a median of 3years post first dislocation.

Overall functional results

At a median follow-up of 23 months (17-31), postoperative functional scores significantly improved when compared with preoperative values. The WOSI score improved from 67% (41-73) to 11% (9-14.3) and the ASES score improved from 61.8±13.8 to 91±8.1 (Table2). Of the 41 patients, 40 (97.6%) achieved the minimum clinical important difference (MCID) for ASES score (8.5 difference) [16].

Range of motion

Mean values for ERs and ERa were found to be 52.3°±15.4 and 70.7°±10.9 respectively. A statistically significant decrease in ER was found in the operated shoulders in comparison to the contralateral healthy side in both ERs and Era by a mean of 22.5°±16.18% and 13.09°±8.2% respectively (Table 3). Mean values for FF and IRa were

162.8°±6.4 and 47.8°±12.2 respectively. a statistically significant decrease was found compared to the contralateral healthy side by a mean of 2.46°±1.92 and 10.12°±6% respectively (Table 3).

Recurrence

One patient (2.4%), at three years postoperatively reported an episode of subluxation (subjective feeling of dislocation), there were no recurrent dislocations.

Correlation between limitation of external rotation and functional scores

There was no correlation between functional scores and limitation of ER (Table 4).

Return to sport

Each athlete had the ability to resume their sport. The mean time to return to sport was 9.7±1.6.

Discussion

According to the study's primary results, all of the patients had a clinically meaningful improvement in ASES and WOSI score postoperatively compared to preoperatively. One patient (2.5%) experienced repeated instability as a subluxation episode. There was an overall statistically significant reduction in ROM postoperatively compared to the contralateral normal side, and there was no correlation between functional scores and limitation of ER.

The WOSI score improved from 67% (41-73) to 11% (9-14.3) and the ASES score improved from 61.8±13.8 to 91±8.1 with 40 patients (97.6%) achieved the MCID for ASES score (8.5 difference) [16]. This goes in line with results reported by previous studies in literature, a randomised controlled study by MacDonald *et al*. [17], compared clinical outcomes between arthroscopic BRR in individuals with a HSL and minimal glenoid bone loss. They found that the mean WOSI and ASES score in remplissage group improved from 57 to 15.6 and from 72.5 to 93.3 respectively at 24-months final follow-up. A study by Brilakis *et al*. [18] assessed the long-term outcomes after arthroscopic remplissage in 48 patients at a mean follow-up period of 8.1±1.8 years and reported that the mean ASES score increased by 27.5 units (p<0.01), from 72.5 (range 18–100) preoperatively, to 100 (range 85–100).

Limitation of ER after BRR has previously been reported by a number of studies [19-22]. Possible explanations are shortening of articular arch of motion, a mechanical block by the soft-tissue tenodesis, and decreased excursion of posterior capsule. Anterior labral repair and capsular tensioning are also thought to be a contributing factors to postoperative restriction of ER [22, 23]. It is noticeable that the limitation was greater in ERs than ERa, which has also been reported in previous studies [20, 24, 19]. This finding could potentially be because of increased focus on stretching at variable degrees of abduction rather than at the side during activities of the daily living.

Although patients had variable degrees of limitation of ROM, they all regained a good functional recovery and were satisfied with the outcome with a 100% return to sport in the athletic subpopulation. However, the population in this study didn't include enough high level athletes or throwing athletes, in whom minimal limitation of ERa could have a dramatic effect on their performance and consequent satisfaction levels. One patient (2.5%) experienced a subluxation episode, but there were no dislocations. However, the short period of follow-up in the current study (median of 24 months) did not allow analysis of the long-term recurrence rate of this procedure. A systematic review was done by Liu *et al* [25] to evaluate the outcomes and recurrence rate following arthroscopic BRR among patients with anterior shoulder instability and a subcritical loss of glenoid bone. They reviewed 22 publications with 694 participants and found that the rate of recurrence varied from 0% to 20%. In a multicenter retrospective study performed by Horinek *et al* [26] the recurrence rate was 1.4% in 70 patients, who had a primary arthroscopic Bankart repair with remplissage.

The current study has some limitations. The short follow up period with a median of 24 months prevented analysis of the true recurrence rate of this procedure. No postoperative imaging was performed to evaluate how well the capsulotenodesis healed. Most participants were male (85.4%) and didn't include elite or throwing athletes. Therefore, the results may not reflect the outcomes of females or highly demand or overhead athletes.

Table 1: Distribution of the examined cases based on demographic information (n = 41)

Patient characteristics	No. (%), mean±SD, median (IQR)
Sex	
Male	35 (85.4%)
Female	6 (14.6%)
Age (years)	
Mean ± SD.	23.8±4.6
Dominance	
Non-dominant	21 (51.2%)
Dominant	20 (48.8%)
Duration between 1st dislocation and operation (years)	
Median (IQR)	3 (2 – 5)
Number of dislocations	
Median (IQR)	7 (4 – 10)
Sport	
No sport	16 (39%)
Sport	25 (61%)
Return to sport in months	
Mean ± SD.	9.7±1.6
Time of final follow up	
Median (IQR)	23 (17 – 31)
Number of anchors	
1	20 (48.8%)
2	21 (51.2%)
G. bone loss	
Median (IQR)	0 (0 – 0.16)
G. track	
Mean ± SD.	21.7±2.2
Hill-Sachs interval (HIS)	
Mean ± SD.	24±1.9
Hill-Sachs depth (HSD %)	
Mean ± SD.	27.3±7.6

Number and percentage (%) were used to describe qualitative data. While quantitative data with a normally dispersed distribution was reported as Mean ± Standard deviation (SD), data with an aberrant distribution was represented as median and interquartile range (IQR).

Table 2: Comparison between preoperative and postoperative according to ASES score and WOSI (n = 41)

	Preoperative	Postoperative	Test of sig.	p
ASES score	61.8±13.8	91±8.1	t=14.402*	<0.001*
Improved	29.2±13.3			
WOSI (%)	67(41 – 73)	11(9 – 14.3)	Z=5.580*	<0.001*
Improved	46.1±19.5			

p: p value for contrasting preoperative and postoperative conditions
*: Statistically substantial at p ≤ 0.05

umbers and percentages were used to describe qualitative variables, whereas quantitative variables was typically represented as mean ± standard deviation and abnormally distributed information was represented as median (IQR). t: Paired t-test Z: Wilcoxon signed ranks test

Table 3: Comparison between operated shoulder and normal side according to different parameters (n= 41)

	Operated shoulder	Normal side	t	p
FF	162.8±6.4	166.9±5.4	8.199*	<0.001*
Difference	4.1±3.2			
% Difference	2.46±1.92			
Ira	47.8±12.2	52.9±11.8	11.690*	<0.001*
Difference	5±2.8			
% Difference	10.12±6			
External rotation at the side (ERS)	52.3±15.4	67.8±14.8	8.767*	<0.001*
Limitation	15.4±11.3			
% Limitation	22.5±16.18			
External rotation at the side at abduction(ERa)	70.7±10.9	81.2±9.1	9.601*	<0.001*
Limitation	10.5±7			
% Limitation	13.09±8.2			

p: p value for contrasting preoperative and postoperative conditions
*: Statistically substantial at $p \leq 0.05$

Numbers and percentages were used to describe qualitative variables, whereas quantitative variables was typically represented as mean ± standard deviation and abnormally distributed information was represented as median (IQR) t: Paired t-test

Table 4: Correlation between ERS, ERa and functional scores

	ERS (% of limitation)		ERa(% of limitation)	
	r s Spearman coefficient	p	r s Spearman coefficient	p
WOSI (Post-operative)	0.096	0.551	-0.075	0.641
ASES scores (Post-operative)	-0.079	0.625	0.243	0.125

Conclusion

In anterior shoulder instability patients with < 20% glenoid bone loss and off-track HSL, combined arthroscopic Bankart repair and remplissage results in satisfactory functional outcomes. Over the duration of the trial, the rate of recurrence was 2.5 percent. There was a statistically significant limitation of range of motion of shoulder mainly in external rotation. However, this was functionally insignificant.

Conflict of Interest: Not available

Financial Support: Not available

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