Functional outcome and the structural integrity of arthroscopic Bankart repair: a prospective trial

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Abstract

Background: Recurrent anterior shoulder dislocations are common in young patients with Bankart lesions. Arthroscopic repair is an established treatment; however, recurrent instability occurs in up to 35% of patients. It is unclear whether recurrence is the result of a failure of the surgical repair to heal or a repeat injury. The aim of the present pilot study was to assess radiographic healing of Bankart lesions 6 months post surgical repair and identify any correlations between radiographic findings and subsequent recurrent dislocations.

Methods: Eighteen patients underwent arthroscopic Bankart repair for recurrent instability. Magnetic resonance (MR) arthrograms were obtained both pre-operatively and 6 months postoperatively. Standard T1 and T2 views were obtained along with an abduction and external rotation (ABER) view. Patients were followed for a minimum of 4 years for the risk of recurrence, and functional outcomes were obtained, including the American Shoulder and Elbow Surgeons Subjective Shoulder Scale, Ontario Shoulder Instability Index, Oxford Shoulder Instability Score and 12-Item Short Form Health Survey. Scores were correlated with pre-operative and postoperative MR findings.

Results: Six of 18 patients developed recurrent instability. We could not identify correlations between reconstructed labrum (labral bumper) position, failure at suture sites and ABER findings with recurrent instability or functional outcome. Paradoxically, there was a nonstatistically significant trend for patients with no clefts between the labrum and the glenoid at any points along the repair to have worse outcomes than patients with partial or complete clefts.

Conclusions: In our pilot study, MR arthrogram was used to evaluate the labrum in detail 6 months postoperatively. Despite its proven ability to detect labral lesions, we were unable to demonstrate any features on postoperative MR arthrogram that predicted either functional outcome or recurrent instability. At 6 months post operation, functional recovery and the risk of recurrence may not depend on the anatomical appearance of the labrum alone.

Keywords

Arthroscopic, Bankart, functional outcome, labrum, MR arthrogram, MRI, postoperative

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Introduction

An anterior shoulder dislocation is a common injury in young and active patients. In New Zealand, the incidence of this injury is as high as 750 dislocations per 100,000 population at age 20 years.^{1,2} During the first dislocation, the anterior portion of the glenoid labrum and associated capsule/ligaments are often torn, creating the 'Bankart lesion' and leading to recurrent instability in patients without significant bone loss.^{3,4} Surgical repair of the Bankart lesion involves reattaching the torn anterior labrum and anterior band of the inferior glenohumeral ligament (AIGHL) (i.e. the capsulolabral complex) to the glenoid rim.

However, recurrent instability can occur in up to one-third of patients following surgery.⁵ It is unclear whether this is a result of failure of the original repair to heal or a repeat injury.

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The magnetic resonance (MR) arthrogram has been validated as the standard tool for assessing capsulolabral morphology. It has also been used to determine the quality of healing after surgical Bankart repair.^{3,6,7} However there is a lack of data in the literature assessing the relationship between capsulolabral morphology following Bankart repair and clinical outcomes. The purpose of the present pilot study was to establish the relationship between features commonly associated with repair quality on postoperative MR arthrograms with clinical outcomes following arthroscopic Bankart repairs.

Materials and methods

Twenty-five patients with recurrent anterior shoulder instability undergoing arthroscopic Bankart repair have their consent and enrolled in the present study. All patients presenting to a single surgeon between January 2008 and December 2009 and meeting the inclusion criteria were invited to participate. Inclusion criteria were skeletally mature patients less than 36 years of age with recurrent anterior instability and a Bankart lesion confirmed by magnetic resonance imaging (MRI). Patients with previous surgery of the affected shoulder, bilateral instability, multidirectional instability, connective tissue disorders and >20% bone loss were excluded.

All patients underwent a pre-operative MR arthrogram and completed the American Shoulder and Elbow Surgeons Subjective Shoulder Scale, the Western Ontario Shoulder Instability Index, Oxford Instability Score and the 12-Item Short Form Health Survey questionnaires. These questionnaires were repeated 6 months postoperatively.

Arthroscopic Bankart repair was performed by the senior author (PP) using a standardized protocol. All patients received an interscalene nerve block, general anaesthesia and intravenous antibiotic prophylaxis. Repairs were carried out in the beach chair position using a standard posterior viewing port and two anterior working ports through the rotator interval. A diagnostic arthroscopy of the shoulder was carried out to assess rotator cuff and other ligamentous damage, the presence of significant glenoid bone loss and, finally, the size and engagement of any Hill-Sachs lesion. The extent of the labral tear was also assessed. The torn labrum was then extensively mobilized until it reached the rim of the glenoid. The anterior glenoid bone and rim of the glenoid were prepared to a bleeding surface using the combination of a rasper and a 4.5-mm arthroscopic shaver. A 60° Spectron (Arthrex Inc., Naples, FL, USA) was used to grasp the capsule and labrum inferior to the inferior extent of the labral tear. A relay suture was passed first. This was

initially used as a traction suture to check that the first suture pass was sufficiently inferior and to establish the placement of the first and most inferior anchor. This technique created an inferior to superior capsular shift and tensioning of the AIGHL. Hand-tied simple sutures were used. The first and most inferior anchor was a double simple suture tie; the anchors above this were single simple suture ties. This was repeated sequentially from inferior to superior. A minimum of three anchors was used. Bio-FASTak suture anchors (Arthrex Inc., Naples, FL, USA) were used for all patients. In all cases, sliding locking knots were used with #2 FiberWire (Arthrex Inc.) for repair.

Postoperatively, all patients were managed in a sling for 6 weeks with pendulum exercises. Range of motion exercises commenced at 6 weeks and strengthening exercises were permitted after 12 weeks. Postoperative MR arthrograms were obtained at 6 months, as well as functional questionnaires. Telephone follow-up was conducted to a minimum of 4 years to identify patients who required further surgical intervention for stabilization.

The present study received ethical approval from the Northern A Ethics Committee. Arthrex Inc. funded all postoperative MR arthrograms.

Radiological assessment

MR arthrograms were conducted pre-operatively and 6 months postoperatively. All were contrast enhanced using 12 mL to 15 mL of dilute gadolinium mixed with normal saline and 1% xylocaine with adrenaline (300 strength non-ionic contrast) injected 15 minutes prior to the scan. A 1.5-T General Electric (Signa; GE Medical Systems, Milwaukee, WI, USA) scanner with a dedicated shoulder coil was used for all scans.

During the scan, the arm was placed in neutral position. Sequences performed were: T1 weighted (fast) spin echo with fat suppression in axial, oblique coronal, and oblique sagittal planes; T2 weighted (fast) spin echo with fat suppression in oblique coronal and oblique sagittal planes; and T1 weighted (fast) spin echo without fat suppression in oblique coronal and oblique sagittal planes. An axial T1 nonfat-saturated image in abduction and external rotation (ABER) was performed in patients who could tolerate this position without apprehension.⁸

Pre-operative scan

All pre-operative MR arthrograms were re-visited for study purposes. Labral tear diagnostic criteria included identification of gadolinium based contrast material extending into a linear or complex tear cleft within the labrum; absence, truncation or

fragmentation of the labrum;⁷ or displacement of the labrum from its expected anatomic location. Lesions were classified by type, location and size as a percentage of total labrum. Other pertinent findings recorded include the presence of Hill–Sachs lesions, concurrent rotator cuff tears, chondrolabral junction damage and glenoid bone loss.

Postoperative scan

Postoperative MR arthrogram images were assessed using the method of Sugimoto et al. for evaluation of labral structural integrity following arthroscopic repair.⁸ The quality of the structural re-establishment of the labral bumper was classified by position of the reconstructed labrum on slices transverse to the glenoid. Type A represented a labral reconstruction with the apex of the ‘bumper’ posterior to a line drawn perpendicular to the glenoid face at its anterior margin; a Type B bumper has the reconstructed apex anterior to this line but lateral to a second line parallel to the glenoid face; and, in Type C, the bumper apex lies medial to the glenoid face (Figure 1).

Functional re-establishment of the capsulolabral complex was assessed by oblique transverse images obtained with the shoulder in the ABER position to allow evaluation of the integrity of the AIGHL. This was categorized as good, fair or poor based on the system of Sugimoto et al.⁸ Where the AIGHL directly abuts the humeral head and the transition from AIGHL is seamless, the AIGHL repair was rated as ‘good’. Where a small pool of contrast material was visible between the humeral head and the AIGHL but the transition to the labrum remained seamless, the repair was rated ‘fair’. Where a ‘divot’ was seen at

the junction of the AIGHL to the glenoid rim, the repair was rated ‘poor’. Postoperative ABER images were only available in twelve patients as a result of positioning difficulties or patient apprehension in the ABER position.

The presence of low MR intensity structures (assumed to be reattached capsulolabral complex) abutting the glenoid rim at each anchor point was considered indicative of intact healing. In addition, intravasation of intra-articular contrast material through a suture point was taken to signify a failed suture. These MRI findings were previously shown on a 1.0-T MR scanner to have 100% sensitivity and 82% specificity for detecting intact sutures.⁹ Focally absent labrum at suture points were taken to signify tissue failure.

Intravasation of contrast along the labral edge between the suture points were also recorded, this cleft was identified to be either partial or complete.

Statistical analysis

When more than two groups were compared, all continuous variables were analyzed using the Kruskal – Wallace test for significance. Mann–Whitney *U*-tests were used when two groups were directly compared. $p < 0.05$ was considered statistically significant.

Results

Eighteen of the 25 patients attended postoperative MR arthrograms and completed the functional outcome questionnaires. Demographic data are summarized in Table 1. There were 15 males and three females, with an average age of 25 years. In eight patients, the dominant side was involved in the injury. Sixteen of the 18 injuries had traumatic causes, whereas two were nontraumatic. Nine patients were involved in physical occupations

Figure 1. Labrum position. Three quadrants are defined by two lines, with the first line being a continuation of a line drawn along the cortex of the anterior glenoid, and the second line a continuation of a line drawn along the subchondral bone of the face of the glenoid.

Table 1. Demographics.

Sex	15 male	3 female
Hand dominance	17 right	1 left
Injury side	9 right	9 left
Injury of dominant shoulder	8 dominant	10 nondominant
Mechanism of injury	16 traumatic	2 nontraumatic
Physical occupation	9 Physical	9 Sedentary
Involvement in sports	8 contact	10 noncontact
Average age	25 years	25 years

prior to the injury and eight were able to return to the same occupation. Sixteen patients were actively engaged in sports before injury, of whom eight were involved in contact sports.

At a minimum follow-up of 4 years (48 months to 60 months), six of 18 patients (33%) experienced recurrent dislocations. All dislocations occurred after the 6-month postoperative scan. The average age of these patients with recurrence was 24 years and not significantly different those without recurrence. Their six month functional scores and were also not dissimilar to those without recurrence (Table 2). There were also no differences identified on postoperative MR arthrogram in terms of suture failure, cleft formation or capsulolabral morphology. However, the inability to tolerate the ABER position was more common in the group that went on to dislocate. In one of these patients, the recurrent instability was associated with repeat injury. Four patients underwent revision stabilization with a Laterjet procedure, whereas two others were treated conservatively. The Laterjet procedures were performed between 17 months and 30 months after the initial repair.

We also attempted to correlate findings on postoperative MRI arthrogram with functional scores (Table 3). Failed sutures were clearly identified in

five of the eighteen patients as demonstrated by the presence of complete clefts between the labrum and the glenoid at suture sites. Three patients had partial clefts between the repaired labrum and glenoid, whereas three other patients were noted to have a globally attenuated labrum indicative of tissue degeneration (Figure 2). Paradoxically, there was a trend for patients with no significant clefts anywhere along the repair to perform worse than patients with partial or complete clefts (Table 3) when the opposite was expected (Figures 3–5). The presence of suture failure was also not indicative of poorer function, nor the risk of recurrence.

The post-repair position of the labrum was assessed in all 18 patients. One patient had a completely detached labrum, whereas another was noted to have partial detachment superiorly. Both of these patients went on to dislocate despite good functional outcomes at 6 months. In five patients, the position of the labrum was rated as Type C inferiorly. The other 12 patients had mainly Type B reattachments. Once again, the position recorded did not correlate with functional outcomes or recurrent dislocations (Table 3).

ABER views were completed in 12 out of the 18 patients as a result of the inability of six patients to

Table 2. Dislocation data.

	No dislocations (<i>n</i> = 12)	Dislocations (<i>n</i> = 6)	<i>p</i>
Suture/tissue failure or attenuation	6 (50%)	2 (33%)	0.64
Cleft formation at all sites	8 (67%)	5 (83%)	0.61
Good/fair on ABER	8 out of 10 (80%)	2 out of 2 (100%)	1
Labral bumper position as A or B	9 (75%)	3 (50%)	0.80
Bumper position satisfactory (A/B)	9 (75%)	3 (50%)	0.29
Bone loss around anchor present	0 (0%)	1 (17%)	1
Peri-anchor oedema present	7 (58%)	1 (17%)	0.15
Partial replacement of anchor by bone	8 (67%)	2 (33%)	0.32
Six month postoperative ASES	23.6	26.3	0.37
Six month postoperative WOSI	66.8	80.1	0.20
Six month postoperative Oxford	45	52.3	0.18
Six month postoperative SF-12 Physical	47.6	51.1	0.30
Six month postoperative SF-12 Mental	54.5	53.2	0.87

ABER, abduction and external rotation; ASES, American Shoulder and Elbow Surgeons Subjective Shoulder Scale; SF-12, 12-Item Short Form Health Survey; WOSI, Western Ontario Shoulder Instability Index.

Table 3. Cleft between repaired labrum and glenoid at suture sites versus functional scores.

	ASES	WOSI	Oxford	SF-12 Physical	SF-12 Mental
Complete (<i>n</i> = 5)	26.9	319.1	84.8	51.2	53
Partial/attenuation (<i>n</i> = 6)	24.2	504.6	75.9	48.3	48.9
No significant clefts (<i>n</i> = 7)	23.2	834.3	60.3	44.5	46.0
<i>p</i> -value	0.56	0.11	0.57	0.39	0.29
ABER					
Good (4)	21.5	914.7	42.8	48.1	61.9
Fair (6)	27.8	302.1	52.8	51.5	54.5
Poor (2)	27.0	869.3	40.8	41.6	52.1
<i>p</i> -value	0.23	0.052	0.18	0.31	0.18
Bumper position					
Type A/B	25.6	542.3	48.9	50.2	55.6
Type C/detachment	22.3	714.1	44.5	45.3	47.3
<i>p</i> -value	0.27	0.46	0.44	0.26	0.11

ABER, abduction and external rotation; ASES, American Shoulder and Elbow Surgeons Subjective Shoulder Scale; SF-12, 12-Item Short Form Health Survey; WOSI, Western Ontario Shoulder Instability Index.

Figure 2. T1 views showing a globally attenuated repair. The patient experienced poor functions, postoperatively with no further dislocations. His repair was a Type A superiorly and a Type C inferiorly. He also could not tolerate the abduction and external rotation position at 6 months.

tolerate the shoulder coil position used in ABER. Out of the 12 patients, two patients were rated as ‘poor’, whereas 10 were rated as ‘fair’ or ‘good’ in accordance with the criteria established by Sugimoto et al.⁸ Neither patient with poor ratings experienced further dislocations and both had an improvement in functional scores postoperatively.

Discussion

Recurrent anterior shoulder dislocation is a common problem following arthroscopic repair of Bankart lesions, with reported recurrence rates of between 3% and 35%.¹¹ The reported risk factors for recurrent anterior stability include glenoid bone loss, large

Figure 3. T1 axial and T2 coronal FS showing a well repaired labrum (see white arrow). Type A/B position. Abduction and external rotation not shown – Good. A 1.5-cm full thickness supraspinatus tear was also repaired. This patient had particularly poor functional outcomes at the time of the scan but did not go on to require further surgery for recurrent instability.

Figure 4. T1 axial fat saturated image and abduction and external rotation (ABER) views showing a partial cleft between the repaired labrum and glenoid (see white arrow); the quality of ABER was rated as ‘fair’. The position of the labrum repair was a Type B. This patient had excellent outcomes following the procedure and did not experience recurrent instability.

Hill–Sachs lesions and the use of less than three anchors.^{5,10–18} Such risk factors were identified on pre-operative, and not postoperative, MR arthrograms, and it is unclear whether postoperative structural integrity of the anteroinferior labrum as demonstrated on MR arthrogram post repair can predict clinical outcomes.

We were unable to identify any specific features on 6-month postoperative MR arthrograms that predicted subsequent recurrent instability. In our series of 18 patients, six (33%) experienced a recurrent dislocation, which is comparable to other reports on arthroscopic Bankart repair in a young, active population.¹⁹ In these six patients, two were found to have detachment of the labrum on their postoperative scan, yet both achieved excellent functional outcomes at the time of the MR

arthrogram. No other 6-month MR findings were effective at distinguishing these patients from the 12 others who did not go on to experience recurrent instability.

The present study is the first to use MRI to attempt to define prospectively which anatomical aspects of Bankart repair can predict the onset of recurrent instability. Yoo et al. retrospectively compared the MRI findings of 21 patients with recurrent instability following arthroscopic repair with those of 21 patients who had no recurrence, and found reduced height and slope of the capsulolabral buttress in patients with recurrent instability.²⁰ Similarly Probyn et al. found that 26 of 37 patients with recurrent instability following Bankart repair had evidence of labral detachment on MR scan.¹² However, because the scans in both

Figure 5. T1 axial FS and T2 coronal FS showing a complete cleft between the labrum and glenoid (see white arrow). On magnetic resonance imaging, there is evidence of suture failure at all anchor points and the labrum is completely detached. Despite this, the patient performed well above average in his functional outcomes at 6 months; however, he required a Latarjet procedure 17 months postoperatively as a result of recurrent instability secondary to re-injury.

these studies were performed following the onset of recurrent instability, it is unclear whether these findings represent a repeat injury or inadequacy of the original repair. In the only previous prospective clinical study attempting to correlate quality of repair with outcome, Park et al. examined 40 patients with stepwise CT scans at 3 months and 12 months post repair to produce an estimation of labral height. There was a statistically significant association with predicted labral height and Rowe scores at 1 year; however, as a result of the relatively short follow-up, an association with recurrent instability could not be identified.²¹

Evaluating the labral bumper height/position is very dependent on the position of the patient's arm. Kim et al. found, in immediate postoperative patients, that the positioning of the arm during the scan significantly affected the position of the labral bumper and suggested that labrum height is optimized with the arm in external rotation.²² This may account for the varying reports on the importance of labral height and morphology. Hence, a standardized method for evaluating the bumper position needs to be applied to future studies. Using contrast enhanced MR arthrogram, the present study examined the capsulolabral complex in greater detail, although we did not find an association between labral slope and outcome, suggesting that factors other than labral height and attachment may influence functional results.

The presence of a cleft between the repaired labrum and the glenoid was noted in a number of our patients following repair. Similarly, Sugimoto et al. validated MR arthrogram findings by comparison with 'second look' arthroscopic findings in 33 patients following Bankart repair, and found clefts between the labrum and glenoid in two patients.⁸ They postulated that the

presence of a visible cleft between the labrum and the glenoid implies a lack of healing in that area; however, this did not lead to worse outcomes in our group of patients. This finding suggests that such a cleft may not always indicate structural instability/failure at the suture site.

An MR arthrogram has been reported to provide superior detection of anterior labrum detachment with the patient in the ABER position. The AIGHL can also be effectively assessed because it is under maximum tension in this position. In the present study, ABER views could not be completed in six patients because of apprehension; four of these patients went on to dislocate again. The ABER ratings themselves were not indicative of functional outcomes. A score of 'good' on ABER is associated with poorer Western Ontario Shoulder Instability Index scores at 6 months postoperatively. Previous studies have demonstrated that ABER has equal, if not better, sensitivity and specificity compared to standard MR arthrogram views for detecting anterior inferior labroligamentous lesions.²³ Hence, our findings indicate once more that reestablishment on MR arthrogram at 6 months postoperatively may not correlate with functional outcomes.

MR arthrogram has its limitations; in particular, it is unable to quantify the the shift in AIGHL postoperatively that is associated with stability.²⁴ The present study was also limited by the small sample size and incomplete capture of patients. It was difficult for some patients to consent to a postoperative contrast enhanced MR arthrogram as a result of the discomfort associated with the procedure. Furthermore, all radiographs were reviewed by only one consultant radiologist. In our small series, we were unable to

establish significant associations between postoperative MR arthrogram findings and functional outcomes at 6 months. However, this pilot study does raise questions regarding the significance of suture/tissue failure and cleft formation between the labrum and glenoid and hence provides a basis for further studies.

Conclusions

In our pilot study, MR arthrogram was used to evaluate the labrum in detail 6 months post Bankart repair. Despite its proven ability to detect labral lesions, we were unable to demonstrate any features on postoperative MR arthrogram that predicted either functional outcome or recurrent instability. At 6 months post-operatively, functional recovery may not depend on the anatomical appearance of the labrum alone.

Declaration of conflicting interests

None declared.

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Level of evidence

IV – Case series.

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