Arthroscopic repair of isolated type II superior labrum anterior posterior lesion

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Title Page

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Running title: Arthroscopic repair of isolated Type II SLAP lesion

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Abstract

The effectiveness of arthroscopic repair of type II superior labrum anterior posterior lesion (SLAP) was unclear as previous studies examined this treatment with patients of combined types of SLAP lesions. To address this research gap, we evaluated the clinical and functional outcomes of arthroscopic repair for 16 patients (*Mean* = 24.2, *S.D.* = 6.5) with clinical evidence of isolated type II SLAP lesion. After having arthroscopic stabilizations with Bioknotless suture anchors (Mitek), the patients were offered post-operative rehabilitation programs (e.g., physiotherapy) for 6 months. The symptoms of SLAP lesion and the functions of the shoulder were assessed preoperatively and 28-month post-operatively by O'Brien test, Speed test, Yergason test, and University of California at Los Angeles rating for pain and function of the shoulder. Wilcoxon Signed Ranks test and McNemar test were employed to analyze the difference between assessment in pre-operation and post-operation phases. The result showed that patients' shoulder functions improved (UCLA Shoulder Score), and symptoms of SLAP lesion reduced (O'Brien test, Speed test, and Yergason test) significantly ($p < 0.05$). Time for returning to play with pre-injury level was in average 9.4 months (range: 4-24), and no complication or recurrence was detected. We concluded that arthroscopic repair is an effective operation of type II SLAP lesion with good clinical and functional outcomes, however, athletes with high demand of overhead throwing activities are likely to take longer duration of rehabilitation attain fully recovery.

Keywords: Shoulder, SLAP, sports medicine, arthroscopy, surgery

Introduction

Historically, "dead arm" has been regarded as a career ending affliction for overhead throwing athletes, as the causes and treatment of this pathology were almost unknown until the recent advent of arthroscopy [3,5]. Advances in imaging techniques and the rapid developments and evolutions of arthroscopic surgery enabled surgeons to understand a lot of previously unknown shoulder pathologies and to treat them accordingly during the past two decades. The story of the "dead arm" was begun to be uncovered 23 years ago, when Andrews et al [2] carried out initial investigation and suggested that injuries in superior labrum-bicep anchors in glenoidhumeral joints was the major cause of the pathology. By then, there has been an increasing number of orthopedic and radiology literatures focusing on the diagnosis and treatment of this shoulder pathology.

Synder et al [24] defined this type of shoulder pathology, named superior labrum anterior posterior (SLAP) lesion, as the superior labrum-biceps tendon complex disruptions which involved of tearing and separation of the superior labrum, or both; in addition, the tearing or separation is developed posteriorly from the biceps tendon insertion and extending anteriorly. Besides, Snyder et al [24] pointed out that this lesion is not uncommon, while 6% of his arthroscopic operations were related to SLAP lesion. Maffet et al [14] also revealed that SLAP lesion presented in 12 % of his shoulder arthroscopy cases.

As we have previously mentioned, one of the interesting phenomena of the prevalence of SLAP lesion is that, the pathology is usually specified to athletes of particular sports, who developed the lesions from a compression force of the injured shoulder with the arm flexed and abducted upon a fall, or upon a traction injury to the arm [14]. Whereas Warner et al [28] described another group of patients of SLAP lesion developed the lesions by repetitive overhead pitching activities. This is probably resulted from eccentric loading of the bicep with a sudden increase in the tensile force of the anchor, during the cocking phase of a throw, and lesion is developed either by repetitive micro trauma or single major trauma.

From all his arthroscopic cases, Synder et al [24] identified four major types of injuries (outstretching injury, traction, direct trauma, external rotation) causing this superior glenoid labrum lesion, and thus categorize SLAP lesions into four types (Type I, II, III, IV) in terms of the mechanism of the injuries and arthroscopic evaluations. In the past decade, while more and more studies investigated the pathologies and treatment, ten types of SLAP lesions have been identified [3,12,16,19,20]. Among the ten types of SLAP lesion, type II lesion is the most common one, which is defined by *"superior labral fraying with stripping of the superior part of the labrum and attached biceps tendon from the underlying glenoid cartilage"* [3,19]. Later on, Morgan et al [16] further identified three distinct sub types of type II SLAP lesions (Type II A, B, and C). In particular, type IIA, IIB, and IIC represent anterosuperior labral lesion, posterosuperior lesion, and superior lesion with both anterior and posterior components respectively.

Reported treatment for SLAP lesion have found to be mixed, which ranged from

debridement of the lesions (for type I and III) [1,6] to surgical repair (for type II and IV lesion) [8,11,22,25]. Moreover, the surgical treatments of these various types of SLAP lesion differ from each other in terms of the fixation methods and operative devices, such as staples, metallic and absorbable suture anchors or tacks. As a result, it is difficult to justify the overall surgical outcomes of SLAP lesion while inconsistencies about the type of injuries and surgical treatment present within a single study. Although there have been dozens of relevant clinical studies about surgical treatment of SLAP lesion over the decades, most previous studies only consisted of SLAP cases with the combinations of SLAP lesions and other related intra-articular pathologies, like Bankart lesion or rotator cuff tear. Thus, the results of these studies may be confounded by subject effects, and the effectiveness of the surgical treatments of type II SLAP lesion was unclear.

To address this research gap, the purpose of this study is to evaluate the clinical and functional outcome of our patients, with isolated Type II SLAP lesion of the shoulder, who underwent arthroscopic stabilization as the surgical treatment of SLAP lesion, from July 2003 to March 2005. Thus, the clinical and functional outcomes of arthroscopic treatment to isolated Type II SLAP lesion can be examined.

Methods

Participants

In order to obtain our target sample, we revealed all patients of the Prince of Wales Hospital who showed clinical evidence of isolated Type II SLAP lesion during the period (July 2003–October 2005). They were also required to fulfill the following inclusion criteria:

1. No history of shoulder dislocation or subluxation.
2. No intra-articular injuries of Type II SLAP lesion
3. No neurological complications affecting mobility and physical sensation
4. No previous surgery over the same shoulder
5. Non work-compensation cases
6. Age less than 40

After employing a prospective cohort study using magnetic resonance imaging (MRI) arthrogram, 23 cases of Type II SLAP lesion satisfied the above criteria, and were advised by their physicians to undergo arthroscopic stability operations. Among the cases, 20 patients agreed to participate after being consented about the study purposes and their rights of participating the study. However, 4 patients were found to have concomitant intra-articular pathologies during arthroscopic examination, so they were then excluded from our study. Finally, our sample consists of 13 male and 3 female participants whose ages ranged from 15 to 38 (*Mean* = 24.2, *S.D.* = 6.5).

Among the 16 participants, fifteen had type II lesion on their right shoulders, and only 1 had the lesion on the left shoulder. Before injury, 13 participants were actively involved in overhead sports (e.g., tennis, handball, badminton) in either elite or recreational levels, two others were believed to get injured by lifting heavy weights, and one was injured by landing with an outstretched hand after a fall. All patients received operation within 1 month after their first visit to the clinic, and were given physiotherapy and analgesics treatment after their operations.

Operative procedures

After receiving general anaesthesia, patients were put into lateral decubitus position under traction of three to four kilograms. Diagnostic arthroscopy was performed via the standard posterior portal. Superior labrum was carefully tested with an arthroscopic probe through an anterior-superior portal. Not uncommonly a Type II SLAP lesion looks normal upon arthroscopic examinations, but became obvious when it is tested with an arthroscopic probe for its stability. Other associated intra-articular structures, including the rest of the labrum, bicep tendon, the anterior, inferior and posterior capsules, undersurface of the rotator cuff, and the articular cartilage, were throughout examined.

After identification of the SLAP lesion, an arthroscopic shaver or a burr was introduced via the antero-superior portal to debride the superior glenoid bone edge till the good bleeding raw area was prepared. Based on particular extent of the SLAP tear, we used different portals to fix the lesion for the patients. For anterior extension of the SLAP tear, we tackled lesions via the anterior-superior portals. For posterior extension of the lesion, we used trans-rotator cuff portals, as suggested by O'Brien et al [10]. These portals were approximately 1-2 cm lateral to the lateral edge of the acromion. Spectrum suture passer device (Linvatec) was used to deliver a PDS-1 suture via either superior labrum or working portals, which depended upon the location of the lesion. The free distal limb of the PDS-1 suture was retrieved through the anterior-superior portal, or an anterior-mid glenoid portal.

Except two cases, all patients' Type II SLAP tears were fixed with bioabsorbable knotless suture anchors (Bioknotless Anchor, Mitek) by the technique described by Thal [17] , at 2, 1, 11 or 10 o'clock region according to the pattern of labral tear. The utility loop suture ends of the Bioknotless anchors were then loaded into the proximal open loop end of the PDS-1, and were pulled from the other portal through the labral tissue using "poor man shuttle" technique. Tension was maintained along both suture ends while passing the anchor in. After the utility loop passed via the superior labrum, one of the strands of the loop was captured under the anchor prongs, and then the anchor was driven into the drill hole under direct vision, until the anchor was completely engaged. Precautions were taken to ensure that the suture loop was not twisted while the anchor was being inserted, and the anchor was not inserted too deeply into the drill hole, as these two situations may lead to the abrasion of the sutures, and thus breakage. The number of anchors used in this study ranged from 2 to 4 (*Mean* = 2.6, *S.D.* = .7), while two to three absorbable anchors are usually enough to provide

a stable repair to most SLAP lesions. The operation time, type of SLAP lesions, number of anchors and hospitalized days are listed in table 1.

Post-operative rehabilitation

Post-operatively, the patients followed a standard rehabilitation protocol of shoulder lesion surgery [9]:

Week 1: - Sling immobilization at all times

Week 2-3: - Codman circumduction
- Passive range of motion (0-90 abduction)
- External rotation adduction
- No external rotation in abduction

Week 4-6: - Discontinue sling
- Progressive passive range of motion (PROM) to full in all planes
- Passive posterior capsular and internal rotation stretching
- Passive and manual scapulothoracic mobility program
- External rotation in abduction

Week 7-16 - Progressive strengthening of the rotator cuff, scapular stabilizers and biceps

Month 4-6: - Internal throwing program on level surface
- Return to full throwing activities

In addition, during the first 4 post operative weeks, the patients were advised to restrain from external rotation in the abduction for reducing the possibilities of re-injury due to peel-back mechanism. Finally, patients were also advised not to resume throwing sports activities until improvement in their shoulders' range of motion, rotator cuff strength, and biceps strength, were observed compared to their preoperative status. All the patients were able to comply with the rehabilitation program and attend follow-up reassessment regularly in our clinic, with an average follow-up of 27.6 ± 2.6 months (range: 24-31).

Assessments and analysis

Participants were asked to undergo O'Brien test [17] for detecting SLAP lesion. O'Brien test [17] is a newly developed compression test to diagnose labral tears and pathological conditions of the acromioclavicular joint, and was clinically found to be highly reliable in detecting SLAP injuries. In the test, patients are asked to sit in an upright position and elevate their shoulder with the arm in full extension. Examiner then adducts the arm for 10°, and rotates internally until the thumb points downwards. The arm in the position is then pushed downwards repeatedly with supination of the arm. A sensation of pain or clicking inside the joint indicates the presence of labral or SLAP tear.

Besides, Speed test [9] and Yergason test [30] were performed for assessing patients' biceps tendon instability or tendonitis. These two tests are not specific for detecting SLAP lesion, as recent studies showed that Speed test and Yergason test are not sensitive clinical

tests for detecting SLAP lesion [10] in particular shoulder region (e.g., posterior SLAP lesion for Speed test). However, we decide to include these two tests to provide additional information as they are classical test for diagnosing shoulder injuries, and it is not clear about their sensitivities in detecting lesion specifically for type II lesion.

Moreover, The University of California at Los Angeles rating for pain and function of the shoulder [7] was adopted to access the patients' shoulder joins functions. The scale consists of five items. The two items corresponding for the range and strength (manual muscle-testing) of active forward flexion are graded by physicians in a 6-point-likert scale (0 indicates worst condition, and 5 indicates best condition). The other three corresponding for the pain and function of shoulders, and satisfaction towards their shoulders are self-reported by patients. Pain and function are measured in 10-point-likert scale with the scores of 1 and 10 representing the worst and best condition respectively. The satisfaction score is accessed in a 6-point-likert scale as pain and function do. Therefore, the scores of the five items composite into a UCLA Shoulder Score [6] with a maximum of 35 marks, while patients receiving 34-35 marks, 29-33 marks, and 29 marks or lower are classified as having excellent, good, and poor shoulder function respectively [6].

These assessments were performed preoperatively (the day before surgery) and postoperatively (27.6 ± 2.6 months after the surgery) by two orthopaedics specialists with more than 15 years of clinical experience. In addition, at the final postoperative assessment, participant were asked to report their pre-injury activity levels, injury mechanisms, duration of symptoms, and the time required to return to pre-injury activity levels. (See table 2)

In this study, the effect of the operative treatment of type II SLAP lesion were examined by comparing the difference of test scores patients obtained in their pre-operative assessment and post-operative assessment, in which participant served as their own control. McNemar test (for categorical variables) was employed to examine the categorical variable of O'Brien test. As the problem of non-normality, which violates the assumptions of t-test, might possibly presented in our small sample, we examined the normality of continuous variables like UCLA shoulder scores and sub-scores by Shapiro-Wilk tests to determine whether Wilcoxon Signed Ranks test (for skewed population) or paired sample t-test (for normally distributed sample) should be used for analyzing the continuous variables. Significant difference of the test scores between pre-operative assessment and post-operative assessment were indicated by significant p values <.05.

Results

Intra-operative findings

The operations took 71 minutes on average (S.D. = 14; range: 52-105). Arthroscopic screening based on the morphology of the Type II SLAP lesions revealed that, there were seven cases of superior-anterior lesion (Type IIA), five cases of superior-posterior lesion (Type IIB), and four cases of combined superior-anterior-posterior lesions (Type IIC), where

the lesions were located around the bicep anchor region, namely the 12 o'clock position. The lesions were repaired with two to four anchors (Mean= 2.6, SD = 0.7), distributed equally from two to ten o'clock area. Intra-operatively, there were two episodes of breakage of anchors during the insertion due to incorrect approaching angle with respect to the drill hole. There were also two episodes of suture abrasion and then breakage noted intra-operatively. One of the cases was because of twisting of the suture loop during anchor insertion, and the other case was related to too deep suture anchorage into the glenoid bone. Both problems were noted intra-operatively and another suture anchor was placed right next to it for repairing the labrum.

Outcome assessment

McNemar test showed that significant difference was observed between the test-retest assessment of O'Brien test, Speed test, and Yergason test (p <.05). Patients with a positive signs of O'Brien test Speed test, and Yergason test significantly reduced in the post-operative phase.

Shapiro-Wilk tests revealed that all UCLA shoulders scores in the pre-operative assessment, and post-operative assessment were significantly skewed (p<.05, despite the post-operative UCLA total score (p=.06). Therefore, Wilcoxon Signed Ranks test was used, and the result showed that significant difference were observed in all dimensions of UCLA Shoulder assessment scores, and thus, the composite score of UCLA (p <.05) between the pre-operative and post operative assessment. Specifically, the shoulders' pain, function, active forward flexion, strength, satisfaction, and overall function (composite scores) of their shoulders significantly increased in the post-operative phase (p <.05). Details are shown in table 2.

In addition, based on the grading system of UCLA assessment, 100% of patients in the pre-operative phase were categorized as having poor shoulder function (Mean=18.1, SD=3.3), while in the post-operative assessment, 31.3%, 43.8%, and 25.0% of patients were categorized as having excellent (Mean=35.0, SD=0), good (31.6, SD=1.9), and poor function (26.3, SD=2.1). See table 2 for details.

Discussion

The purpose of the study was to examine the effects of surgical treatment of isolated type II lesion. The results showed that arthroscopic repair of isolated Type II SLAP lesion achieved excellent to good results in majority of patients (N=14, 87.5%), which was comparable to other series, with a mixed combinations of pathologies associated to SLAP lesion, as reported by different authors [8,11,14,22,24,25,28] (80-100% good outcomes).

Clinical outcomes

Compared to the results of the pre-operative assessments, positive signs from O'Brien test, Speed test, and Yergason test significantly reduced in the post-operative assessment, providing supporting evidence for the effectiveness of the arthroscopic treatment of type II

SLAP lesion. UCLA scores increased sharply from an average of 18.1 (SD = 3.3) to 31.3 (SD = 3.7), which indicated the shoulder function improved significantly after the surgical treatment. According to the categorization of UCLA shoulder assessment [7], the percentage of patients having poor shoulder function reduced from 100% at the pre-operative assessment, to only 25% at the post-operative assessment. While the UCLA total scores of these 25% patient on average increased to 26.3 (SD = 2.1), a value closed to good function category. These evident support the effectiveness of arthroscopic treatment of type II SLAP lesion.

Despite of clinical assessments, the recovery duration patients need for returning their pre-injury activities levels is also an important success indicator towards treatment. In our study, all patients started to regain active and passive range of motions from the fourth weeks after the operations. At six months after the operation, 14 patients (88%) regained active range of motion within 9 months post-operatively. All patients regained their full range of motion upon the final assessment without complications. Filed and Savoie [8] reported that all their patients returned to athletic activities without limitations. However, we argue that the recovery of SLAP lesion after the operation might depend on pre-injury activity levels of the patients. In our study, elite athletes who required frequent overhead activity required longer duration of rehabilitation and time to return to pre-injury activity level. Eleven patients (69%) regained pre-injury activity level within nine months after the operation (average = 7.0 months), and four patients, who previously performed intense and frequent overhead activities (2 tennis, 1 badminton, and 1 cricket) in elite levels returned to their pre-injury levels after an obviously longer period of post-operation rehabilitation (Mean = 11.0 months). The remaining one elite handball athlete could not resume his pre-injury activity level at 24 months after the operation, because of residual pain and weakness of the supraspinatus. In line with our study, Burkhart et al [4] and Kim et al [11] both reported that throwing athletes produced statistically inferior results for SLAP lesion than non-throwing athletes. They usually took longer period of time to recover, and sometimes even failed to show return to their pre-injury performance.

Though there was significant improvement in terms of clinical test scores in the post-operative phase, it is important to note that reported pain persisted in minority of cases (N=3), including night pain. MRI were employed post-operatively for these patients and revealed that their SLAP lesions did not present, which evidenced by the marked difference in supraspinatus tendinosis, and articular side tear of the supraspinatus tendon. We suggested that the pain could be explained by the occult pathology beyond our clinical detection, and thus residual pain and signs of impingement syndrome persisted even though we had tackled the SLAP lesion. Further studies may examine the operative pain phenomenon, in terms of the causes, screening methods, and treatments.

Surgical treatments of SLAP lesion

Over the past two decades, a number of technical innovations have been developed for

the surgical treatment of SLAP lesion (e.g., metal screws, metal staples, suture, and absorbable tack or screw), however, dozens of argument and concerns have been pointed out regarding the use of these metal implants. For examples, it has been suggested that metal implant may possibly injure the articular cartilage upon insertion, and subsequently protrude into the joint, or become loosen [19,31,32]. For this reason, surgeons began to put more attention in using absorbable sutures. Field and Savio [8], who used absorbable sutures, reported good clinical results in the operation of SLAP lesion. Similarly, Snyder el al [23] and Burkhart et al [4] demonstrated encouraging results by using absorbable tacks, but both of them illustrated problems of tack fragment which required removal post-operatively. There have also been concerns over the development of synovitis [4], and possibly bony lysis [23] at the anchor site. In this study, we used Bioknotless suture anchors (Mitek) as described by Thal [27]. It has been reported to provide a secure process, low profile of repair, and improved healing potentials [27], as part of the tissue is pulled into the drill hole rather than on the top of the anchor. Moreover, it avoids the added complexities of arthroscopic knot tying, thus, the processes of surgery become more efficient [27].

Limitation

In this study, O'Brien test was the only test which is specifically for detecting SLAP lesion. Further studies should include more shoulder SLAP lesion test, such as compression-rotation test and crank test, which have been suggested to be as sensitive as O'Brien test in detecting SLAP lesion in general [21,22].

Although type II SLAP lesion is the most common type of SLAP lesion [15,19], recruiting participants with isolated type two SLAP lesion was somehow difficult, as most type II SLAP lesion cases were combined with either type of SLAP injuries or rotator cutoff pathologies [2,6,8,11,12,14,25,28], so the sample size was relatively small, which was one of the major limitation in our study.

Conclusion

Our study showed that arthroscopic stabilization of Type II SLAP lesion is effective treatments evidenced by good clinical and functional outcome in majority of patients. However, it was observed that athletes with high demand of overhead throwing activities were likely to take longer duration of rehabilitation attain fully recovery.

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Table 1 – Demographics of the patients and details of operation and final assessment

Age (years)	24.2 ± 6.5 (range: 15-38)
Gender (male/female)	13 / 3
Injured side (left/right)	1 / 15
Duration of symptoms at admission (weeks)	18.3 ± 6.1 (range: 12-36)
Pre-injury activity level	
Overhead sports at national/varsity level	5
Overhead sports at recreational level	8
Non-overhead sports	2
No sports	1
Injury mechanism	
Sports related with definite history of injury	8
Sports related with repetitive overuse	4
No-sports related	2
Cannot be recalled	2
Treatment sought	
Physiotherapy	16
Analgesics	16
Operation time (minutes)	71 ± 14 (range: 52-105)
Type of SLAP lesions	
IIA	7
IIB	5
IIC	4
Number of anchors	2.6 ± 0.7 (range: 2-4)
Number of days of hospital stay (days)	1.2 ± 0.4 (range: 1-2)
Time for the final outcome assessment (months)	27.6 ± 2.6 (range: 24-31)
Time for return to play with pre-injury level (months)	9.4 ± 5.2 (range: 4-24)

Table 2 – Pre-operative assessment, final outcome and results of statistical tests.

	Pre-operative	Final outcome	Statistical results
Clinical test (+ / -)			
Speed test	10 / 6	4 / 12	$p < 0.05$[1]
Yergason test	9 / 7	2 / 14	$p < 0.05$[1]
O'Brien test	14 / 2	1 / 15	$p < 0.05$[1]
UCLA Shoulder Assessment Score (mean ± SD)			
Pain	4.0 ± 1.6	8.2 ± 1.5	$p < 0.05$[2]
Function	4.8 ± 2.0	8.0 ± 2.3	$p < 0.05$[2]
Active forward flexion	4.8 ± 0.4	5.0 ± 0.0	$p < 0.05$[2]
Strength of forward flexion	4.3 ± 0.4	4.8 ± 0.4	$p < 0.05$[2]
Patient satisfaction	0.0 ± 0.0	5.0 ± 0.0	$p < 0.05$[2]
Total score	18.1 ± 3.3	31.3 ± 3.7	$p < 0.05$[2]
UCLA score graded as Excellent (%)	- (0%)	35.0±1.1 (31.3%)	-
UCLA score graded as Good (%)	- (0%)	31.6±1.9 (43.8%)	-
UCLA score graded as Poor (%)	18.1±3.3 (100%)	26.3±2.1 (25.0%)	-

[1] Results from McNemar test

[2] Results from Wilcoxon Signed Ranks test