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The Superior Labral Anterior to Posterior (SLAP) Lesion: An elusive pathology

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Abstract

Aim

The SLAP (Superior Labral Anterior to Posterior) lesion has become a popular clinical and radiological diagnosis The purpose of this article is to review the international literature of the SLAP lesion and describe our experience with the diagnosis and surgical treatment of this lesion in a New Zealand practice.

Data Sources

We reviewed the available literature on SLAP lesions based on an index medicus Pubmed search and proceedings from relevant international meetings attended by the senior author (KDM). We included original articles, review articles and metaanalyses in our search. We also include data from a 2 year period of the senior subspecialist practice.

Data Extraction

The data from these studies was reviewed in combination with that form the senior authors practice and is included for illustration purposes with associated referencing.

Conclusions

The clinical presentation, imaging diagnosis and arthroscopic diagnosis are variable and imprecise. There is debate about the clinical relevance and treatment of SLAP lesions. There is no universally agreed clinical test to diagnose a SLAP lesion. Surgical treatment results range from very good to unsatisfactory. Patient populations differ from predominantly young baseball throwing athletes in USA and some Asian series, to older non throwing populations in European studies. These groups may differ from a New Zealand patient population. With selective indications, we achieved good results in our patients.

Key Words

Shoulder, Arthroscopy, Superior Labrum, Biceps, Repair

Introduction

In 1985[2] Andrews described the Superior Labral tear in overhead athletes. Snyder[47] coined the acronym SLAP (Superior Labral Anterior Posterior) lesion in 1990. Snyder's original classification is quite long and descriptive but can be summarised as follows:

Type 1 Marked fraying of the superior labrum with a degenerative appearance but no disruption of either the labral attachment or that of the biceps anchor.
Type 2 The biceps anchor and superior labrum are detached or partially detached from the superior glenoid. The biceps labral anchor is unstable.
Type 3 Disruption of the superior labrum with a "bucket handle" tear through the labrum with the peripheral labrum and biceps anchor remaining firmly attached.
Type 4 Bucket handle labral tear which extends into the biceps tendon. The remainder of the tendon and labrum are intact.

Other subtypes have been described[33,36] but the Snyder Classification is most commonly used. There is general agreement that a Type 1 may be asymptomatic and not require treatment, with the surgical treatment option being debridement. Type 3 and 4 lesions can be recognised and treated at surgery. For Type 3 and 4 lesions treatments include excision of the bucket handle tear with or without repair of any residual biceps / labrum detachment, or tenodesis. The Type 2 lesion is more frequently reported, but more difficult to diagnose, with more diversity of opinion on treatment.

This article focuses on the Type 2 SLAP lesion. What is the normal anatomy? How do you get a SLAP lesion? How do you diagnose a SLAP lesion? What are the results of treatments internationally and locally? We attempt to answer these questions.

Anatomy

To understand the SLAP lesion, we must understand the normal anatomy. At the 12 o'clock position on the 'glenoid clock', articular cartilage extends 4 or 5 mm over the superior margin of the glenoid, beneath the biceps and labrum. The superior labrum at the 12 0'clock position has a meniscoid margin which covers the superior extension of articular cartilage.[6] Forty to sixty percent of the biceps insertion is into the supraglenoid tubercle with the remainder inserting into the labrum. Histologically, usually most of the biceps insertion into the labrum is into the postero-superior labrum.[49,50] In the postero-superior 10 o'clock position, the labral attachment to the glenoid is meniscal in shape in 50% and rounded in 50%. By comparison the inferior labrum of the shoulder from the 4 o'clock to the 8 o'clock position is a rounded extension of articular cartilage with hyaline cartilage transitioning to fibrous tissue with a firm attachment.

There is a loose connective tissue attachment of the superior labrum to the glenoid which has elasticity. This construction indicates the natural mobility of the superior labrum and its close relationship with the long head of biceps (LHB). There are variations in the attachment of the mobile antero-superior segment of the labrum to the glenoid, including a sublabral foramen (present in 3.3%), middle cord pattern (present in 8.6%) and the Buford complex (present in 1.5%).[44] It is important to recognise these normal variants as surgical fixation of them may restrict external rotation.

The superior labral and biceps anchor complex function is a topic of debate. The labrum is widely accepted to act to deepen the concavity of the glenoid and widen its diameter improving concavity compression and excursion distance in rotation. In conjunction with the glenohumeral ligaments and bony anatomy it acts as a static constraint to instability. The superior labral complex (SLC) has a role to play in anterior stability and in experimental models SLAP lesions have been shown to increase the load on the inferior glenohumeral ligament (IGHL), reduce ability to resist external rotation and increase anterior and superior translation under load.[35,40,45] The LHB itself has also been shown to affect translation[41] especially in mid abduction and in shoulders that are unstable for other reasons.[19] The LHB is also thought to act as a depressor of the humeral head in the presence of rotator cuff tear.[26]

Pathogenesis

Causes of SLAP tears can largely be divided into traumatic, attritional and degenerative. Traumatic lesions may occur in compression due to falls onto the outstretched limb, more commonly in the forward flexed position[9] or with direct impact onto the shoulder. They can also occur in tension. Examples include using the limb to break a fall from a height, grasping at a heavy object below waist level or being pulled anteriorly as in waterskiing or drag ski lifts. These events cause sudden tension on the LHB tendon in the superior, inferior or anterior directions. The position of the humeral head in the glenoid at the time of impact or traction plays a role in the type of injury sustained.[3]

Attritional injuries may occur in overhead and throwing athletes. Considerable investigation of the pathogenesis of SLAP tears in these patients has been performed. One theory suggests that the primary pathology is a tight posterior capsular complex coupled with a relatively loose anterior capsule frequently seen in this group.[6] This may be associated with increased humeral retroversion and may develop as an adaptive anatomical variation in throwers. The increased external rotation achieved in the late cocking phase of throwing is contributed to by postero-superior humeral migration at this point which allows greater tuberosity clearance. This has been borne out by cadaver studies.[15] Such increased external rotation puts increased tension on the fibres of the LHB anchor resulting in a so called "peel back" lesion as the superior labrum complex displaces medially over the glenoid rim. The posterior vector produced by such motion puts the superior labrum at risk as it is weakest in this direction[46] and SLAP lesions may result.

Degenerative tears of the superior labrum are commonly seen in elderly and middle aged patients and may be the result of age related degeneration of the labral tissue rather than any specific event or attrition. They are not always symptomatic.

In summary, there is no specific history for a SLAP lesion. They may occur in different patient populations spontaneously, gradually or traumatically from a variety of mechanisms.

Diagnosis

The clinical presentation of SLAP lesions is extremely variable. Coexisting pathology may be present and more symptomatic. It is essential that the clinician determines the relative significance of the clinical presentation, imaging and operative findings.[25,30] The patient may present with a history of gradual or sudden onset of symptoms, with a wide range of trauma mechanisms possible.

Symptomatic SLAP lesions cause pain, but the pattern is variable.[25] Pain, which may be sharp or dull, is typically felt deep inside the shoulder and may radiate either anteriorly or posteriorly mimicking anterior or posterior labral lesions or indeed acromioclavicular pathology. Exacerbation of pain can be expected with heavy lifting, overhead motion and pushing. Throwing athletes frequently report pain in the late cocking and early acceleration phase of throwing.

Weakness in these positions may also be a feature and development of labral tear related cysts and suprascapular nerve compression may cause infraspinatus weakness. Lack of trust in the shoulder and a sensation of giving way are also common especially in the overhead position. Patients may report mechanical symptoms of clicking and locking. Essentially the SLAP lesion may present with the symptoms of any other shoulder pathology and given the propensity for concomitant pathology it is difficult to delineate which is truly the cause of the patient's symptoms.

Clinical examination for SLAP tears is rarely decisive. It is important to examine the shoulder for other pathologies e.g. instability, rotator cuff disorders, capsulitis and pain syndromes. Wasting of infraspinatus may indicate suprascapular nerve compromise which may be secondary to compression by a sublabral cyst. These are frequently associated with SLAP tears. Posterior capsular tightness may be present and may be a contributor to the pathogenesis of SLAP tears. It is important to differentiate apprehension from pain and important also to remember that Bankart lesions in combination with SLAP tears are common, especially in those under 40.[30]

While many special tests have been described[27,28] concerns regarding the accuracy of these techniques have been expressed.[24,34,43] Biceps tests, like Speed's test, may aid in suggesting pain in from the long head of biceps. Several tests to isolate the superior labral complex have been described including the Kim's biceps load tests (I and II), Liu's Crank test, Jobe's relocation test, McFarland's compression rotation test, forced shoulder abduction test and O'Brien's active compression test.[16,27,28,32,34,37,39] These tests aim to provoke pain by stressing the superior labrum and long head of biceps. Perhaps the most commonly used is O'Brien's active compression test. O'Brien reported a sensitivity of 100% and a specificity of 98.5% but independent assessors have been unable to reproduce these results for this or other described tests.[24,34,42,43]

Imaging plays a central role in the diagnosis of SLAP lesions. Magnetic resonance imaging (MRI) is the best modality to assess the labrum. Whether MRI arthrography or non contrast MRI is most useful in diagnosing SLAP lesions has yet to be resolved.[18] We prefer MRI arthrography for examination of the labrum. The interpretation of pathology in this region is impeded by the variability of the local anatomy however specific findings suggestive of SLAP lesions include tracking of contrast under the superior labrum, best seen on coronal cuts, and increased signal intensity in labral tissue and the biceps anchor on T2 axial cuts.[22,48] It has been suggested that positioning the arm in the abducted and externally rotated position may improve diagnosis by displacing the lesion.[8,23] Nonetheless even with arthrography one study reported that sensitivity may be as low as 89%, specificity 78% and accuracy 82%.[20]

Arthroscopy is the gold standard for diagnosis but even at arthroscopy it can be difficult to agree on what is and what is not a type 2 SLAP lesion. Gozebie et al[12] surveyed the opinion of fellowship trained expert shoulder and sports surgeons. Members of the American Shoulder and Elbow Society and the American Orthopaedic Society of Sports Medicine were asked to comment on arthroscopic videos. There was high interobserver and intraobserver variability and difficulty distinguishing a Type 2 SLAP lesion from normal. Jia et al, however, reported good reliability in a small study group of experienced shoulder surgeons.[21]

Treatment

Type 1 SLAP lesions may need no treatment or debridement. Little has been written regarding outcomes of treatment of the less common Type 3 and 4 lesions. Few studies exist documenting the natural history of conservatively treated SLAP lesions.[10] In cases with a concomitant rotator cuff tear, cuff repair with debridement of the SLAP 2 tear[1] or with tenotomy of the LHB[11] have better outcomes than repair. These studies involved patients ranging from 45-60 and over 50 years of age respectively. More recently Koh et al have shown_no difference except in the appearance of a popeye sign between patients treated with tenotomy rather than tenodesis when treating biceps pathology identified at rotator cuff surgery.[31]

Reported results of surgical treatment of isolated Type 2 SLAP lesions with arthroscopic repair vary considerably. Some North American literature

reports favourable results. Morgan et al[36] reported 97% good and excellent results in 102 patients. The mean age of their patients was 33 years. Fifty-three were throwing athletes with an average age of 24 and all had dominant arm injuries. The other 49 were non throwers with a single traumatic event and an average age of 40. Twenty-nine patients had dominant arm injuries and 20 had non dominant pathology. Kim et al,[29] reported 94% good and excellent results in 34 patients in their Korean series. The mean age was 26. Eighteen were overhead athletes, 12 were contact athletes and 4 were not involved in organised sport. In a Japanese series of 40 overhead athletes,[17] Ide et al reported 90% good and excellent results in 40 overhead athletes with a mean age of 24. Brockmeier and Altchek[5] studied outcomes at 2 years of isolated SLAP type 2 lesion repairs in 47 patients with a mean age of 36 years. In total 28 of 47 were overhead athletes of varying levels. Overall 25 patients had a specific traumatic event that triggered their pain and 22 had an insidious onset with 20 of these being involved in overhead sports. Eighty-seven percent of patients in this study reported good or excellent results with 71% returning to premorbid level of sports participation. Having an identifiable traumatic event was associated with improved outcome in both subjective assessment and level of competition.

Conversely, poor results of SLAP lesion repair have been reported in Europe. The French Arthroscopy Society presented a multicentre retrospective study comparing repair of Type 2 SLAP tears to tenodesis. The mean age of their patients was 36 years, 52% had a traumatic, 30% had a progressive and 18% had mixed aetiologies. Thirty-three patients had a repair and 20 had tenodesis. In the tenodesis group 90% were satisfied or very satisfied, whereas only 57% of the repair group were satisfied or very satisfied ($p<0.01$).[14] In their non randomised prospective study, Boileau et al also published superior results for biceps tenodesis compared to SLAP repair.[4] There were differences in the ages of each patient group (37 in the SLAP repair group versus 52 in the tenodesis group) and small sample sizes (10 repairs and 15 tenodeses). The authors reported significantly better results in the patients with biceps tenodesis. Eighty percent of patients in the tenodesis group were satisfied compared with 40% in the repair group. Return to sports was also superior in the tenodesis group with 87% of athletes returning to their previous level of competition compared with 20% in the SLAP repair group. Eighty percent of patients in the SLAP repair group and 60% patients in the tenodesis group were overhead athletes. Overall 60% reported a specific traumatic event.

Despite these geographical differences it is generally recognised that overhead throwing athletes, especially baseball players have inferior outcomes after SLAP repair than other patients.[5,13,17,29,30,51] It is also widely accepted that poorer outcomes are seen with SLAP repairs performed in the presence of other pathologies, such as rotator cuff tears. Debridement or tenotomy/tenodesis rather than repair is preferred in combination with treatment of the major pathology.[1,11] Further debate exists about the repair of SLAP tears in older patients[38] but despite this recommendations lean towards repair in appropriate cases under 40 and tenodesis or tenotomy above this age.[7]

A New Zealand Perspective

Patients and Methods

Over a two year period, between 1st November 2007 and 31st October 2009, of new patients attending the senior author (KDM), 457 had an MRI scan of the shoulder. Of these 148 (32.39%) had a report which included a SLAP lesion. During the same period the senior author performed 41 arthroscopic SLAP repairs. In 24 of these cases other significant procedures were performed concomitantly, usually arthroscopic stabilisations for glenohumeral instability, acromioplasties or less commonly rotator cuff surgery. Excluding these 24 patients and 4 other cases requiring treatment of Type 3 SLAP lesions left 17 cases where the repair of the Type 2 SLAP lesion was the isolated therapeutic procedure. In 5 of these 17 cases there was a paralabral cyst. There were 15 males and 2 females. The mean age at surgery was 35 years (range 19-51 years). All were funded by the Accident Compensation Corporation (ACC).

The injury mechanisms are listed in table 1. Most patients had already received physiotherapy and 4 patients had subacromial cortisone injections prior to referral to our practice. The mean time from injury to surgery was 25 months (range 4 months – 8 years). All had an MRI diagnosis of a SLAP lesion. All were repaired with a knotless anchor technique, using 1 postero-superior anchor in 12 cases and 2 anchors (1 antero-superior and 1 postero-superior) in 7 cases. Patients were asked to complete the American Shoulder and Elbow Society Score (ASES) pre operatively and 6 months post operatively. At 6 months patients were asked to report their satisfaction with the options being dissatisfied, not sure, satisfied and very satisfied. Patients were asked at 1 to 3 years follow up (mean 25 months) to once again rate satisfaction and also estimate the "percentage of normal" for their treated shoulder.

Table 1: Mechanism of Injury

Mechanism of Injury	Number
Fall (Soccer, Snowboard, Bike, Stairs)	6
Collision (Rugby, Soccer, Squash)	4
Combat	2
Heavy Lift	2
Road Trafffic Accident	1
Repetitive Overhead	1
Repetitive Throwing	1

Results:

Sixteen patients completed the pre operative ASES score and 11 of these (69%) completed their 6 months ASES scores with an increase from 46 to 82 points. The highest score on this scale is 100 points. (Fig 1) Of those that completed their 6 month assessment,

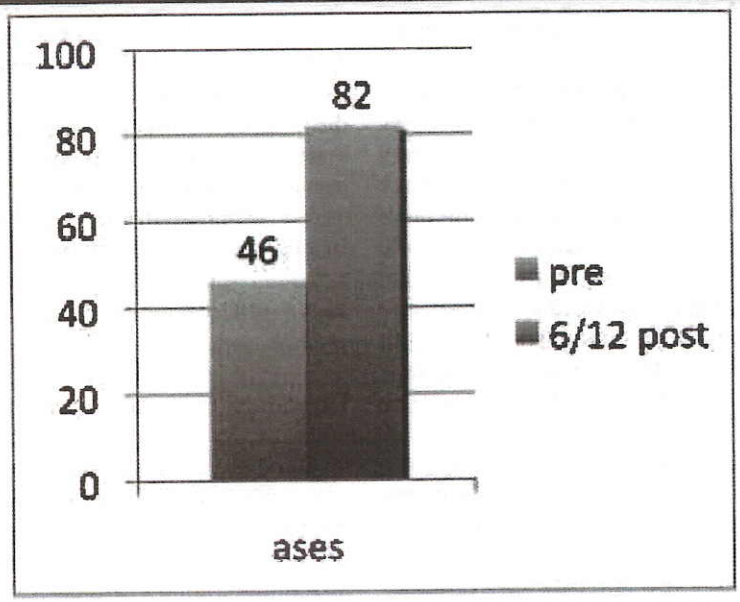

Figure 1: Pre-operative and 6 month Post-operative ASES scores.

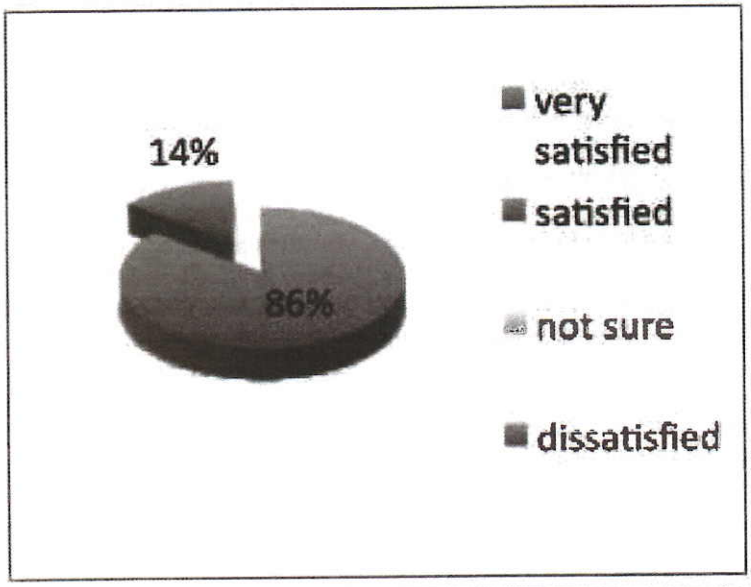

Figure 2: Satisfaction at minimum 1 year follow up.

82% were very satisfied with the remaining 18% satisfied. At a minimum of 1 year follow up, 14 out of 17 (82%) of our patients were contactable. Once again there was a high satisfaction rate. (Fig 2) The mean percentage of normal rating was 94% (85-100%).

One patient, who was not contactable for follow up, was experiencing pain with collisions at rugby. At the index procedure he was noted to have a posterior labral tear that was debrided. He was offered further surgery with a view to posterior labral repair, but has subsequently left New Zealand. One patient had a reoperation. He was happy with his shoulder but more than a year post surgery he reported a painless graunching sensation in his shoulder. He had an arthroscopy at 22 months following the index procedure to exclude suture anchor prominence. At surgery a labral flap was debrided and the graunching has not recurred. One patient had mild median nerve symptoms for several months following surgery. Neurophysiological studies suggested mild compromise of the median nerve in the infraclavicular region and the carpal tunnel. His symptoms resolved adequately without intervention. In 2 patients slow progress was reported in their notes. One with aching at 1 year reported he was 'very satisfied' and rated the shoulder as 90% normal at final follow up. Another with slow progress recorded at 3 months post surgery reported he was 'very satisfied' and rated the shoulder as 95% normal at final follow up.

Illustrative Case:

A 20 year old elite swimmer (Olympic trialist) and surf life saver hit a lane rope swimming backstroke and experienced sudden severe pain in his right shoulder. His pain was ongoing despite rest and physiotherapy. He was unable to swim or throw. He had sharp pain reaching out. The shoulder did not feel unstable to him. On examination he had a good range of movement, with pain on internal rotation in abduction and pain on the apprehension Test. O'Brien's compression test was negative and Speed's biceps test was positive. Prior to referral he had cortisone subacromial injection without improvement and had seen a physiotherapist. His MRI reported a SLAP lesion. Figure 3 demonstrates the appearances of the superior labrum and biceps after debridement. Figure 4 demonstrates the postero-superior repair with a single knotless anchor. Post operatively he wore a sling for 4 weeks then started physiotherapy. At 3 months from surgery he was comfortable for activities of daily living and had regained near full range of movement (Figures 5) and rehabilitation included gym strengthening. His ASES score improved from 47/100 preoperatively to 98/100 at 6 months postoperatively. He was able to swim and returned to work as a surf lifeguard. He reported he was 'very satisfied' with the outcome on his 6 month post operative questionnaire.

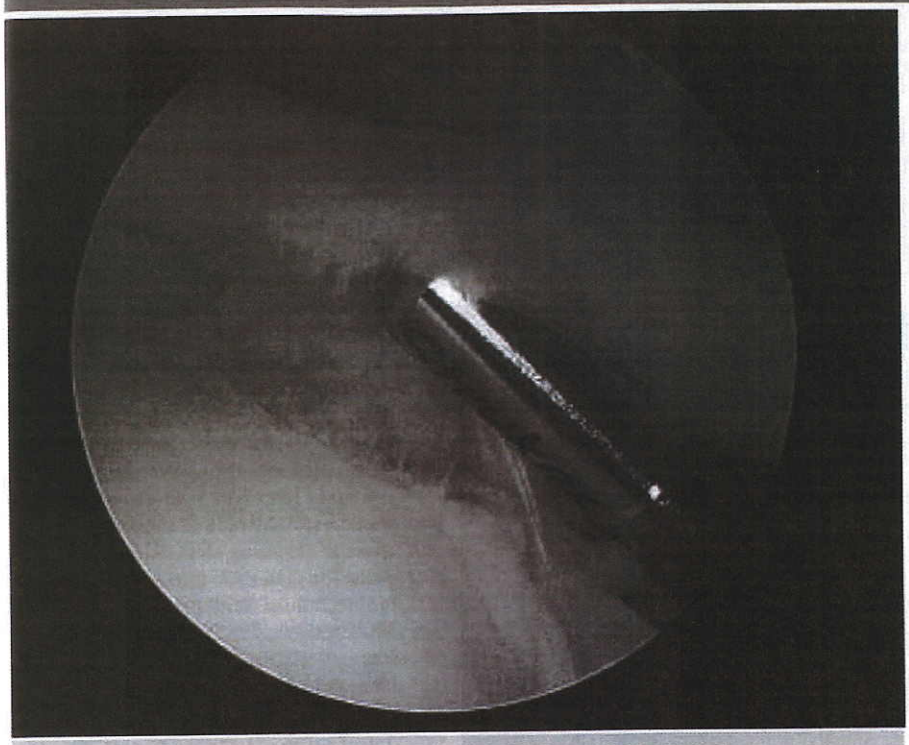

Figure 3: Arthroscopic photograph of the debrided type 2 SLAP lesion demonstratikng abnormal mobility of the superior labral and biceps complex.

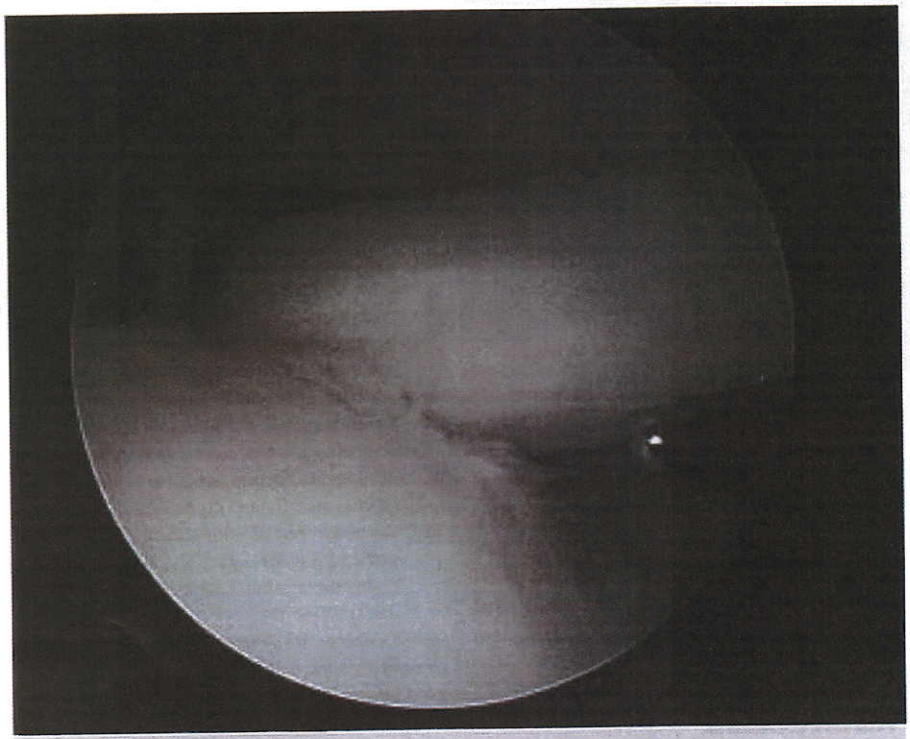

Figure 4: Superior labrum and biceps anchor following SLAP repair.

Discussion

There are a wide range of proposed aetiologies for SLAP lesions, with an equally wide range of symptoms described. No clinical presentation or test will allow the clinician to diagnose a SLAP lesion with certainty. The anatomy of the superior labrum is variable. There is a normal recess beneath the biceps insertion and the postero-superior labrum may have a meniscoid shape. There is some mobility of the normal superior labrum and biceps. It can be difficult to distinguish a Type 2 SLAP lesion from normal anatomy on MRI scans and even at arthroscopy. In our practice over a 2 year period, it was common for a patient's MRI scan to include a report of a SLAP lesion with approximately one third of MRI scans reporting a SLAP lesion, with or without other pathologies. In this time period we performed just 41 SLAP repairs. SLAP repair was an isolated procedure in only 17 of these.

The results of surgical treatment in the literature are variable. We believe that part of this variation may relate to differing patient populations. We have described good results in a New Zealand practice but wish to stress how selective we are in considering whether an MRI diagnosis of a SLAP lesion is clinically relevant.

If a patient has a traumatic event with onset of mechanical symptoms, then labral abnormalities may be relevant. With increasing age, however, degeneration of the labrum may occur and it is difficult to determine what may be normal for age and whether the labrum is a cause of symptoms. We consider most other pathologies e.g. instability, rotator cuff tears, capsulitis or regional pain syndromes to be dominant in causing symptoms. Not all labral tears remain symptomatic and a period of conservative treatment including posterior capsular stretching and scapular stabilising is worth a trial in most cases. Vigilance for suprascapular nerve compression is however important. This can often occur in patients with a paralabral cyst related to SLAP tears and requires more urgent surgical intervention.

Our guidelines for selection for surgical repair of a SLAP lesion are:

- Traumatic onset with mechanical symptoms
- Symptoms ongoing for more than 6 months
- Patient age usually less than mid 40's and physically active
- No capsulitis, regional pain syndrome or other dominant

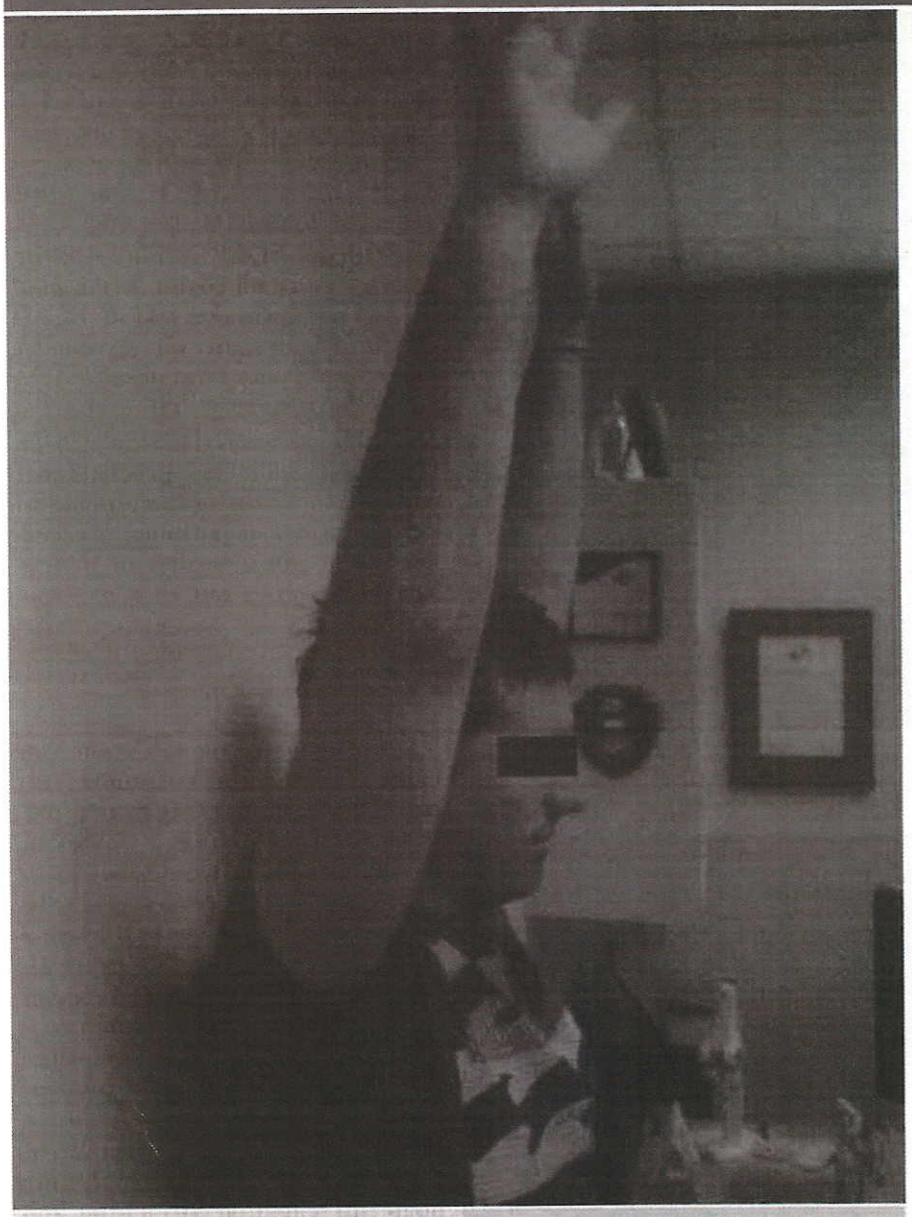

Figure 5: Forward elevation 3 months post SLAP repair right shoulder.

pathology such as a rotator cuff tear.

- An MRI arthrography proven SLAP lesion with the presence of a paralabral cyst an even clearer indication.
- Confirmation of the SLAP lesion at arthroscopy.

We prefer repair with 1 postero-superior anchor taking care not to restrict antero-superior labral mobility to avoid stiffness in external rotation.

Conclusion

Diagnosis of SLAP lesions can be difficult. Careful correlation of clinical presentation and diagnostic tools is essential to avoid poor surgical outcomes. Use of a well devised algorithm fro treatment can be of use in identifying which patients will benefit from which intervention, but definitive indications are yet to be determined.

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