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SLAP lesions and the Superior Labrum

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Abstract

The fibrocartilaginous glenoid labrum contributes to shoulder stability and provides attachment for the long head of biceps tendon and the glenohumeral ligaments. The superior site of attachment of the long head of biceps (biceps anchor) represents a site of injury to the superior labrum where tearing may extend into the biceps tendon as well as anterior and/or posterior to the biceps anchor. Such tears are known as Superior Labrum Anterior to Posterior (SLAP) tears and are a cause of both shoulder instability and pain. SLAP tears are frequently seen in those undertaking repetitive frequent over arm activity such as throwing athletes and swimmers. This article will review the mechanisms and types of SLAP tears and the imaging appearances. It will also discuss associated injuries and pitfalls in diagnosing these injuries.

Keywords

Shoulder, MRI, MR arthrography, SLAP tear, Internal Impingement

Introduction

The glenoid labrum is an important fibrocartilaginous structure which serves to deepen the glenoid contributing to the stability of the glenohumeral joint. Functionally the superior labrum is important as the site of attachment of the long head of biceps tendon onto the superior glenoid rim. Superior labrum anterior posterior (SLAP) tears are a common cause of instability and shoulder pain. The reported incidence of SLAP lesions varies within the published literature; the original studies describing this type of injury to the superior labrum report a prevalence of between 3.9% and 11.8% [1, 2]. This figure increases dramatically when considering overhead throwing athletes and has been shown to be as high as 26% in patients undergoing shoulder arthroscopy [3].

A SLAP lesion is an acquired, usually traumatic, lesion of the superior labrum which is centred around the biceps anchor but can extend to include the anterior or posterior labrum and other surrounding structures. The most common mechanisms of injury include repetitive microtrauma secondary to overhead throwing type movement, or a fall onto the outstretched hand. SLAP tears can be difficult to diagnose clinically as symptoms are often non-specific; patients describe the sensation of popping, clicking or catching alongside symptoms of generalised weakness and stiffness in the affected shoulder. Patients are typically young and are often prone to repetitive overhead movements such as swimmers and throwing athletes. There is a strong association with concurrent shoulder injuries including partial thickness rotator cuff tears, Bankart lesions and glenohumeral chondromalacia [4].

The peel back mechanism has been shown to be important in the aetiology of SLAP lesions, or at least a specific subset of these injuries, typically giving rise to a posterosuperior tear [5]. The peel back mechanism was proposed by Burkhart and Morgan who suggested that when the arm is put into a "cocked" position for throwing, hyper-external rotation in the abducted position produces posterosuperior twisting forces on the biceps-labral complex which "peel" the biceps tendon from the superior glenoid leading to a SLAP lesion [5, 6]. It is suggested the same process eventually leads to partial thickness undersurface tearing of the posterior aspect of the supraspinatus tendon [7]. The association with partial thickness rotator cuff tears needs to be recognised when reviewing the imaging of patients with SLAP lesions. While the evidence would suggest an important role for the peel back mechanism in the aetiology of SLAP lesions, it is possible that the mechanism of injury varies in the different types of SLAP tear that have been described.

Clinical tests have proven to be equivocal for SLAP injuries in a large proportion of cases with no single test proving reliable and therefore imaging is important in the work-up of these lesions.

Imaging techniques

MR arthrography has been shown to have both high sensitivity and specificity for diagnosing SLAP lesions with superior results when compared with standard MR imaging [8]. Studies have shown the sensitivity of MR arthrography to be between 82 and 100% with a specificity of between 71 and 98% [9-12]. This technique is therefore the most commonly used form of imaging investigation for interrogation of the superior labrum.

The superior diagnostic capability of direct MRI arthrography is related to the distension of the joint as compared with conventional MRI, thereby allowing passage of contrast into small tears which would otherwise go undetected in a non distended joint. Disadvantages of this technique over conventional MRI include its inherent invasive nature which in turn carries a small risk of infection, bleeding and post procedural discomfort [13]. However, these complications occur infrequently and most patients tolerate this procedure well. Intra articular contrast has been shown to be especially useful in the differentiation of SLAP lesions from anatomic variants [14, 15].

Indirect arthrography also shows good accuracy for the diagnosis of SLAP lesions using arthroscopy as the gold standard [16]. There is evidence to suggest that this technique is more sensitive but less specific than conventional MR in detection of labral tears [12], and that incorporating a post injection exercise regime can further improve results. When compared with direct arthrography, an indirect technique obviates the need for an invasive procedure to the shoulder, thereby reducing risk of infection and post procedural pain and also removes the need for ionising radiation exposure to the patient. The disadvantages of indirect arthrography include lack of controlled joint distension and enhancement of all intra articular vascularised structures, potentially leading to the over estimation of pathology [13, 17].

There is also evidence to suggest that CT arthrography may also be used to distinguish between normal variants and SLAP lesions but with significantly decreased capability of staging of SLAP lesions compared with MR arthrography [18]. Limitations of this technique include poor assessment of associated partial thickness rotator cuff tears, reduced sensitivity to the detection of para labral cysts, inability to assess bone marrow and the necessity for radiation exposure.

Ultrasound imaging cannot be reliably used to evaluate the superior labrum, but the posterior labrum is well seen using a transverse approach and SLAP tears extending into this portion of the labrum may be demonstrated on ultrasound (Figure 1). Associated rotator cuff tears will also be well demonstrated using this modality.

Classification

Originally SLAP lesions were described by Snyder and classified into four types (I to IV); this remains the most widely recognised classification system [2]. The Snyder classification considers only the extent and morphology of the tear at the superior labrum and biceps anchor.

Type I lesions involve fraying of the undersurface of the biceps anchor but without a frank tear of the superior portion of the glenoid labrum (Figure 2). This finding is commonly seen in asymptomatic patients where it is likely to be age related. This type of tear may be particularly important in young athletic patients who perform repetitive overhead movements.

Type II tears are the most common sub type of SLAP tears and have been shown to account for approximately 40-50% of lesions [2, 19]. They involve tearing of the labrum with detachment of both the biceps anchor and the superior labrum from the underlying glenoid (Figure 3). The Type II tears are subdivided into three further groups according to the location of the tear [20]. A type IIA SLAP lesion involves tearing of the anterosuperior labrum, in contrast the IIB tear affects the posterosuperior labrum. The type IIC tear extends both anterior and posterior to the biceps anchor. The location of the subtype of type II tear relates to the mechanism of injury. The posterosuperior (IIB) tear is seen as a result of the peel-back mechanism and is seen in throwing athletes. It is suggested this pattern is associated with undersurface tearing of the posterosuperior rotator cuff [6]. The anterosuperior (IIA) tear is commonly associated with articular surface partial thickness tears involving the anterior supraspinatous known as the SLAC (Superior labrum anterior cuff) lesion, this may also relate to microinstability and/or internal impingement [21].

A type III SLAP tear has a bucket handle configuration involving the superior labrum with the central portion of the tear being displaced into the joint, however the biceps tendon is not involved (Figure 4). Type IV lesions also have a bucket handle configuration, but in this case the tear extends into the biceps tendon (Figure 5). These types of lesion have similar frequencies of around 3-15% [2] [4] and are thought to often relate to a fall on an outstretched hand.

It is recognised that SLAP tears may extend further around the labrum or into other structures and this has led to some parties proposing a more comprehensive classification scheme to include the so called "extended" SLAP tears [22, 23]. The description of these tears has been summarised in Table 1. Types I-IV are unchanged compared with the original classification system as described above. These tears along with type VI represent varying degrees of detachment and displacement of the superior labrum, either with or without extension into the biceps, which are likely to be symptomatic and to require surgery. The remaining types describe tears which involve the surrounding structures and may be considered as extended SLAP tears. Other anatomic structures involved include the anteroinferior labrum (type V), middle glenohumeral ligament (VII) (Figure 6) and posteroinferior labrum (VIII) (Figure 7).

This revised classification system is often considered complex and unwieldy; a further problem is that there is some ambiguity between the classification commonly described in the radiological literature (employed here) and that in the surgical literature. For instance the surgical literature describes a type X lesion as a tear associated with a reverse Bankart lesion [24] whereas the radiological literature would consider that as a tear with rotator interval extension [25]. In practice the relevant findings can be described without the need for determining the type of tear, the most important factors being to describe the extent of the tear, the involvement of the biceps tendon and extension into any surrounding structures and any flipped or displaced fragments. Nevertheless the accuracy of this description is important as the involvement of other structures will influence the operative management [24].

Paralabral cyst

A diagnostic clue to there being a SLAP lesion can be the presence of a paralabral cyst. These may not fill with gadolinium on MR arthrography but are well shown on T2 weighted imaging and may occasionally be picked up on ultrasound. They usually communicate with the labral tear and often extend into the spinoglenoid notch (Figure 8) where they may cause compression of the supraspinatus nerve and associated infraspinatus muscle atrophy. If the cyst extends very anteriorly there may also be atrophy of the supraspinatus muscle belly.

Normal variants versus SLAP lesions

The superior labrum, particularly between the 1 o'clock and 11 o'clock positions, is the most common site for variants of the chondro labral junction. At this site the fibres of the long head of biceps tendon blend with the superior labrum to form the bicipital-labral complex. The anatomical relationship between the biceps tendon insertion and the superior labrum is highly variable. In a type I attachment the labral bicipital complex attaches firmly to the superior glenoid rim so that on MR arthrography no contrast will pass between these two structures. In a type II attachment there is a small recess between the glenoid and the glenoid rim and the biceps. A type III attachment involves a deep sulcus between the glenoid and the adjacent biceps.

Sublabral Recess

The sublabral recess has smooth margins and should not measure more than 2mm in maximum depth at any point. This normal variant is usually seen within the superior labrum between the 1 o'clock and 11 o'clock positions at the site of attachment of the long head of biceps tendon onto the glenoid rim. It has been documented that the recess should not extend posterior to the biceps anchor, however, more recently this has been disputed [26]. Several further studies have reported different features used to distinguish between the recess and a SLAP type II tear but these often describe conflicting signs [25, 27, 28]. However the majority of authors agree that smooth superomedial extension as opposed to laterally curved high signal intensity into the labral substance is a reliable way of distinguishing between these two entities (Figure 9).

Sublabral Foramen

A sublabral foramen is seen in approximately 11% of the population [29], and in contrast to a sublabral recess, is situated between the 12 o'clock and the 2 o'clock positions and anterior to the attachment of the biceps tendon. The foramen has smooth edges and is orientated medially towards the glenoid in contrast to a tear which often has more irregular margins and is orientated in a more lateral direction. It is possible that both a sublabral foramen and sublabral recess may co-exist, and either one may potentially be incorrectly diagnosed as a labral tear.

Pseudo SLAP tear

In addition to the labral origin, the biceps tendon also has an attachment more medially onto the superior glenoid tubercle. A small synovial lined sulcus may exist between the biceps tendon and the superior labrum [30]. This has a variable depth but usually fills with contrast on arthrography and is best appreciated on oblique coronal imaging. A deep sulcus may mimic a SLAP lesion and has been termed the pseudo SLAP tear [31, 32] (Figure 10).

Buford Complex

A Buford complex is seen in 1.5% of the population [29] and is the term used to describe an anatomical variant in which there is thickening of the middle glenohumeral ligament in association with absence of the superior labrum. It is important not to misinterpret this finding as tearing or detachment of the superior labrum; at arthroscopy a Buford complex may be misinterpreted as a post-traumatic labral detachment and attached surgically to the superior labrum – a potential cause of failed surgery. This normal variant is best appreciated on axial fat-saturated T1-weighted arthrographic images (Figure 11).

Post surgical appearances:

The primary aim of arthroscopy in the treatment of SLAP lesions is to reattach the biceps tendon to the superior labrum. The post-operative labrum may appear truncated or diminutive but should be evaluated on imaging in a similar way to the native labrum. Extension of contrast into or deep to the labrum should be interpreted as a re-tear (Figure 12).

Conclusion

SLAP lesions are an important cause of shoulder pain, particularly in athletes who perform repetitive overhead movement. These lesions may be difficult to accurately diagnose clinically and therefore imaging plays an important role in the evaluation of the superior labrum in a patient with shoulder pain. The imaging modality of choice in most institutions is MR arthrography; but in some circumstances there may also be a role for CT arthrography or indirect MR arthrography.

Knowledge of normal anatomic variants within the superior labrum is important to avoid misinterpreting these lesions as pathological labral tears. In terms of classification of superior labral tears, the most important features to describe are the location of the tear, the morphology of the tear and any extension into surrounding structures. In addition it is important to describe any free or displaced fragments and also to describe any associated injuries such as rotator cuff pathology, chondral damage or acromioclavicular joint degeneration.

Table 1: CLASSIFICATION OF SLAP LESIONS [1, 2, 20, 25]

TYPE	Description
I	Fraying of the superior labrum. Seen as part of the normal aging process and may be an incidental finding
II	Tear of the biceps/labral complex. Subdivided into: A) Tear extending into the anterosuperior labrum B) Tear extending into the posterosuperior labrum C) Tear extending into both the anterior and posterior superior labrum
III	Bucket handle tear
IV	Bucket handle tear which extends into biceps tendon

V	SLAP tear extending anteroinferiorly into a Bankart lesion
VI	Flap tear, probably due to a bucket handle tear where the handle has torn
VII	SLAP tear extending into the middle glenohumeral ligament
VIII	SLAP tear extending posteroinferiorly into a reverse Bankart lesion
IX	Tearing of the labrum throughout its circumferance
X	SLAP tear associated with a rotator interval tear through SGHL

Figure Legends:

Figure 1 US SLAP tear: Transverse US image of the posterior aspect of the glenohumeral joint shows a tear separating the posterosuperior labrum (arrow) from the glenoid. There is no evidence of associated joint effusion within the glenohumeral joint. G=glenoid, H=humeral head.

Figure 2 SLAP type I: The lesion comprises fraying and degeneration of the superior labrum (*). There is no significant tear into the labrum or biceps tendon.

Figure 3a SLAP type II: there is detachment of the superior labrum and the biceps insertion from the supraglenoid tubercle (arrows).

Figure 3b SLAP type II: Contrast is seen tracking into a tear (arrow) within the superior labrum in this T1 FS coronal MR arthrogram image in a patient with a type II SLAP lesion.

Figure 4a SLAP type III: a type III lesion is a tear of the superior labrum with a bucket handle configuration with the biceps anchor remaining intact.

Figure 4b SLAP type III: T1 FS coronal MR arthrogram image demonstrating a SLAP type III bucket handle tear of the superior labrum but with a normal biceps tendon. The bucket handle fragment is seen as a separate flap of tissue (arrow).

Figure 5a: SLAP Type IV: A type IV lesion describes a tear of the superior labrum with a bucket handle configuration with extension into the biceps tendon. A portion of the biceps anchor remains in tact.

Figure 5b SLAP Type IV: Coronal T1 FS MR arthrogram image which demonstrates a SLAP lesion with a bucket handle tear of the superior labrum and extension of contrast into the biceps tendon (arrow).

Figure 5c SLAP Type IV: Sagittal T1 FS MR arthrogram image in the same patient with contrast seen tracking into the substance of the long head of the biceps tendon (arrows).

Figure 6a SLAP Type VII: T1 FS MR arthrogram coronal image demonstrated a tear of the superior labrum (arrow). The full extent of the tear cannot be appreciated on this single coronal image.

Figure 6b SLAP Type VII: axial PD image in the same patient which shows extension of the tear into the middle glenohumeral ligament (arrow). The ligament is seen to be torn and irregular. Note also the continuation of the tear into the posterosuperior labrum. Involvement of the middle glenohumeral ligament is in keeping with a type VII SLAP tear.

Figure 7a: SLAP lesion with reverse Bankart lesion. Coronal PD FS image. There is a superior labral SLAP tear with a bucket handle fragment (arrow).

Figure 7b: Axial PD FS image in the same patient. There is bone oedema within the anteromedial aspect of the humeral head in keeping with recent posterior dislocation (*). In addition there is a reverse Bankart lesion shown (arrowhead) – this is one of the recognized associated features of a SLAP tear. The radiology literature describes this combination of findings as a Type VIII SLAP lesion.

Figure 8 a Paralabral cyst: T2 FS MR Arthrogram coronal image demonstrating a Type II SLAP lesion (arrow) in this patient with persisting pain and clicking of the shoulder. There is also a paralabral cyst lying adjacent to the superior aspect of the glenoid within the spinoglenoid notch (arrowhead).

Figure 8 b Paralabral cyst: T1 FS coronal MR arthrogram image from the same patient showing the SLAP tear (arrow). Note the cyst shown in 8a fails to fill with contrast and is much less easily visualized. This case illustrates the importance of including a T2 weighted sequence to demonstrate pathology in the surrounding tissues.

Figure 9 Sub Labral Recess: Coronal T1W image from MR arthrogram demonstrating a sublabral recess (arrow). A sublabral recess should have smooth margins and is located between the 1 and 11 o'clock positions. The recess should extend in a supero medial direction.

Figure 10 Pseudoslap Tear: Coronal T1 MR arthrogram image shows a small contrast filled sulcus between the long head of biceps tendon and the superior labrum. This is a normal appearance and should not be misinterpreted as a SLAP tear.

Figure 11 a Buford complex: Axial T1 image from MR arthrogram showing the thickened 'cord like' middle glenohumeral ligament (black arrow) and absence of the anterosuperior labrum. Note normal posterior labrum (white arrow).

Figure 11 b Buford complex: Sagittal T1 image in the same patient showing the enlarged middle glenohumeral ligament (arrow).

Figure 12 SLAP repair: Coronal T1 FS image from MR arthrogram in a patient who has undergone repair of a previous SLAP tear. There is a suture anchor within the superior glenoid (black arrow) which is causing adjacent artifact (small white arrows). This should not be misinterpreted as contrast in a recess or tear. There is also contrast seen within the substance of the superior labrum (large white arrow) in keeping with a re-tear.

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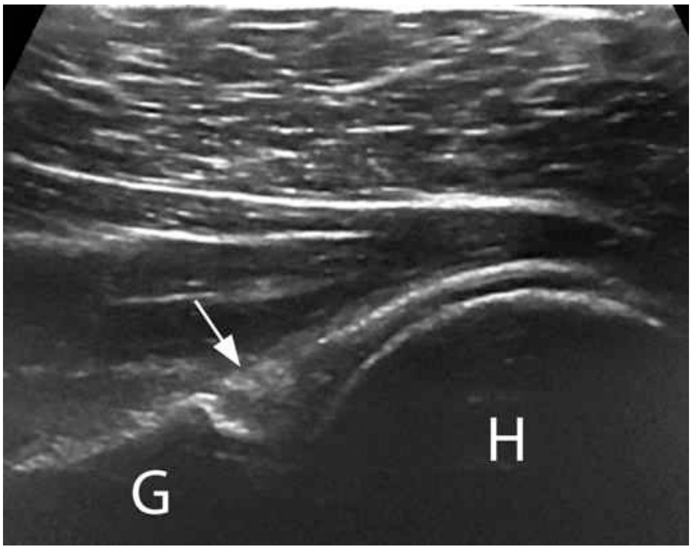
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