Superior Labrum Anterior to Posterior 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 and posterior (SLAP) tears and are a cause of both shoulder instability and pain. SLAP tears are frequently seen in those undertaking repetitive frequent overarm activity such as throwing athletes and swimmers. This article reviews the mechanisms and types of SLAP tears and their imaging appearances. It also discusses associated injuries and pitfalls in diagnosing these injuries.

Keywords

► shoulder
► MRI
► MR arthrography
► SLAP tear
► internal impingement

The glenoid labrum is an important fibrocartilaginous structure that 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 and 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 that is centered 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 because symptoms are often nonspecific; patients describe the sensation of popping, clicking, or catching alongside symptoms of generalized weakness and stiffness in the affected shoulder. Patients are typically young and 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 etiology of SLAP lesions, or at least a 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, hyperexternal rotation in the abducted position produces posterosuperior twisting forces on the biceps-labral complex that “peel” the biceps tendon from the superior glenoid leading to a SLAP lesion.6 It is suggested that 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 recognized when reviewing the imaging of patients with SLAP lesions. Although the evidence would suggest an important role for the peel-back mechanism in the etiology 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 (MRA) has been shown to have both high sensitivity and specificity for diagnosing SLAP lesions with superior results when compared with standard MR imaging. Studies have shown the sensitivity of MRA to be between 82% and 100% with a specificity between 71% and 98%. 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 that would otherwise go undetected in a nondistended joint. Disadvantages of this technique over conventional MRI include its inherent invasive nature, which in turn carries a small risk of infection, bleeding, and postprocedural discomfort. 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 anatomical variants.

Indirect arthrography also shows good accuracy for the diagnosis of SLAP lesions using arthroscopy as the gold standard. Indirect arthrography include lack of controlled joint distension and enhancement of all intra-articular vascularized structures, potentially leading to the overestimation of pathology.

There is also evidence to suggest that computed tomography (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 MRA. Limitations of this technique include poor assessment of associated partial-thickness rotator cuff tears, reduced sensitivity to the detection of paralabral cysts, inability to assess bone marrow, and the necessity for radiation exposure.

Ultrasound imaging cannot be used reliably 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. Associated rotator cuff tears are also well demonstrated using this modality.

**Classification**

Originally SLAP lesions were described by Snyder et al and classified into four types (I–IV); this remains the most widely recognized classification system. 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. 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 subtype of SLAP tears and have been shown to account for ~40 to 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 (Fig. 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 that 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 supraspinatus known as the superior labrum anterior cuff (SLAC) 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 (Fig. 4). Type IV lesions also have a bucket-handle configuration, but in this case the tear extends into the biceps tendon (Fig. 5). These types of lesion have similar frequencies of ~3 to 15\(^\%\) and are thought to often relate to a fall on an outstretched hand.

It is recognized that SLAP tears may extend further around the labrum or into other structures, which has led some authors to propose a more comprehensive classification scheme to include the so-called extended SLAP tears.\(^22,23\) The description of these tears is summarized in Table 1. Types I to IV are unchanged compared with the original classification system as previously described. 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 that involve the surrounding structures and may be considered as extended SLAP tears. Other anatomical structures involved include the anteroinferior labrum (type V), middle glenohumeral ligament (VII) (Fig. 6), and posteroinferior labrum (VIII) (Fig. 7).

This revised classification system is often considered complex and unwieldy; a further problem is some ambiguity between the classification commonly described in the radiologic literature (used 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 radiologic 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 are 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 because the involvement of other structures will influence the operative management.\(^24\)

**Paralabral Cyst**

A diagnostic clue to a SLAP lesion can be the presence of a paralabral cyst. These may not fill with gadolinium on MRA 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 (Fig. 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.

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**Fig. 3** (a) SLAP type II. There is detachment of the superior labrum and the biceps insertion from the supraglenoid tubercle (arrows). (b) SLAP type II. Contrast is seen tracking into a tear (arrow) within the superior labrum in this T1-weighted fat-saturated coronal MR arthrogram image in a patient with a type II SLAP lesion.
Fig. 4  (a) 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. (b) SLAP type III. T1-weighted fat-saturated 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).

Fig. 5  (a) 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 intact. (b) SLAP type IV. Coronal T1-weighted fat-saturated MR arthrogram image that demonstrates a SLAP lesion with a bucket-handle tear of the superior labrum and extension of contrast into the biceps tendon (arrow). (c) SLAP type IV. Sagittal T1 fat-saturated MR arthrogram image in the same patient with contrast seen tracking into the substance of the long head of the biceps tendon (arrows).

Table 1 Classification of SLAP lesions

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>I</td>
<td>Fraying of the superior labrum. Seen as part of the normal aging process and may be an incidental finding</td>
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<tr>
<td>II</td>
<td>Tear of the biceps/labral complex. Subdivided into:</td>
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<td></td>
<td>A. Tear extending into the anterosuperior labrum</td>
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<tr>
<td></td>
<td>B. Tear extending into the posterosuperior labrum</td>
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<tr>
<td></td>
<td>C. Tear extending into both the anterior and posterior superior labrum</td>
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<tr>
<td>III</td>
<td>Bucket-handle tear</td>
</tr>
<tr>
<td>IV</td>
<td>Bucket-handle tear that extends into biceps tendon</td>
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<td>V</td>
<td>SLAP tear extending anteroinferiorly into a Bankart lesion</td>
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<tr>
<td>VI</td>
<td>Flap tear, probably due to a bucket-handle tear where the handle has torn</td>
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<tr>
<td>VII</td>
<td>SLAP tear extending into the middle glenohumeral ligament</td>
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<tr>
<td>VIII</td>
<td>SLAP tear extending posterosuperiorly into a reverse Bankart lesion</td>
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<tr>
<td>IX</td>
<td>Tearing of the labrum throughout its circumference</td>
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<tr>
<td>X</td>
<td>SLAP tear associated with a rotator interval tear through superior glenohumeral ligament</td>
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</table>
**Fig. 6** (a) SLAP type VII. T1-weighted fat-saturated 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. (b) SLAP type VII. Axial proton-density image in the same patient that 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.

**Fig. 7** (a) SLAP lesion with reverse Bankart lesion. Coronal proton-density (PD) fat-saturated (FS) image. There is a superior labral SLAP tear with a bucket-handle fragment (arrow). (b) Axial PD FS image in the same patient. There is bone edema within the anteromedial aspect of the humeral head in keeping with recent posterior dislocation (asterisk). 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.

**Fig. 8** (a) Paralabral cyst. T2-weighted fat-saturated (FS) MR arthrogram coronal image demonstrating a type II SLAP lesion (arrow) in this patient with persistent 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). (b) Paralabral cyst. T1-weighted FS coronal MR arthrogram image from the same patient showing the SLAP tear (arrow). Note the cyst shown in (a) 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.
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 chondrolabral junction. At this site the fibers 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 MRA 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 > 2 mm 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 on the glenoid rim. It has been documented that the recess should not extend posterior to the biceps anchor; however, more recently this was disputed. Several further studies reported different features used to distinguish between the recess and a SLAP type II tear, but these often describe conflicting signs. However, most 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 (Fig. 9).

Sublabral Foramen

A sublabral foramen is seen in ~11% of the population, and in contrast to a sublabral recess, it 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 oriented medially toward the glenoid in contrast to a tear, which often has more irregular margins and is oriented in a more lateral direction. It is possible that both a sublabral foramen and sublabral recess may coexist, 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. 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 (Fig. 10).

Buford Complex

A Buford complex is seen in 1.5% of the population 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 posttraumatic 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 (Fig. 11).
**Postsurgical Appearances**

The primary aim of arthroscopy in the treatment of SLAP lesions is to reattach the biceps tendon to the superior labrum. The postoperative 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 retear (► Fig. 12).

**Conclusion**

SLAP lesions are an important cause of shoulder pain, particularly in athletes who perform repetitive overhead movement. These lesions may be difficult clinically to diagnose accurately, 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 MRA, but in some circumstances there may also be a role for CT arthrography or indirect MRA.

Knowledge of normal anatomical variants within the superior labrum is important to avoid misinterpreting these lesions as pathologic labral tears. In terms of classification of superior labral tears, the most critical 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.

**References**


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**Fig. 11** (a) Buford complex. Axial T1-weighted image from MR arthrogram showing the thickened cordlike middle glenohumeral ligament (black arrow) and absence of the anterosuperior labrum. Note normal posterior labrum (white arrow). (b) Buford complex. Sagittal T1-weighted image in the same patient showing the enlarged middle glenohumeral ligament (arrow).

**Fig. 12** SLAP repair. Coronal T1 fat-saturated image from MR arthrogram in a patient who had undergone repair of a previous SLAP tear. There is a suture anchor within the superior glenoid (black arrow) that 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 retear.