SLAP LESIONS : AN OVERVIEW

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Following recent advances in arthroscopic treatment of the shoulder joint increasing attention has been paid, in clinical practice, to the glenoid labrum. This significance in the superior labrum is greater because understanding the normal anatomy and its variants are primary while undertaking arthroscopic examination diagnosing lesions over this region of the capsulolabral complex. [1,2] One such lesion comprises tearing of the superior labrum near the insertion of the long head of the biceps tendon. Andrews et al described lesions of the glenoid labrum in throwing athletes most of which occurred over the anterior superior labrum.[3] Later Snyder et al. proposed the term SLAP (superior labrum - anterior to posterior) for lesions involving the superior aspect of the glenoid labrum, in which the injury begins posteriorly and extends anteriorly, stopping at or above the mid-glenoid notch.[4] This lesion has, in the past and in recent times, created difficulty in making a diagnosis even with new advances in imaging techniques.[4,5] Thus, this article reviews the various aspects of the lesion concerning the anatomy, biomechanics, classification, clinical diagnosis and treatment.

ANATOMY:

The glenoid labrum is a rim of fibrocartilaginous tissue attached around the margin of the glenoid fossa. Once described as the "meniscus of the shoulder," the labrum serves to enlarge and deepen the articular cavity of the glenoid.[6] The labrum plays an important role by extending the "constraining wall height," adding to the socket, and increasing the load-bearing region.[7] The anatomy of the superior labrum is quite different from that of the inferior labrum as the long head of the biceps is structurally blended with it. The long head of the biceps inserts into the supraglenoid tubercle of the scapula, which is approximatley five millimeters medical to the superior edge of the glenoid rim. [1] Cooper et al. reported that the superior labrum corresponded to a meniscal pattern, with a loose attachment to the supraglenoid tubercle and roughly triangular in cross section, with the free edge pointing towards the glenohumeral articulation. The fibers of the biceps consistently intermingled with the collagen fibers of the labrum. At the twelve o'clock position the hyaline articular cartilage ex-

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tends for a short distance over the edge of the rim and this creates a small recess beneath the biceps tendon and the superior part of the labrum. The arteries to the glenoid labrum originate from the suprascapular artery, the circumflex scapular branch of the subscapular artery, and the posterior circumflex humeral artery. In general, periosteal and capsular vessels supply the peripheral aspect of the glenoid labrum throughout its circumference, but the superior and anterior superior portios of the labrum were less vascular that the posterod and inferior portions.[1] Various anatomical studies have illustrated that the biceps insertion blends with the posterior superior labrum in majority of the cases.[2,8,9] There are three different types of attachment of the biceps labral complex (BLC) to the glenoid:[10]

Type 1: The BLC is firmly adherent to the superior pole of the glenoid and there is no sublabral foramen in the anterosuperior quadrant.

Type 2: The BLC is attached several millimeters medial to the sagittal plane of the glenoid and the superior pole of the glenoid continues its hyaline cartilage surface medially under the labrum. This configuration has a small sulcus at the superior pole of the glenoid that may be continuos with a sublabral foramen and communicate with the subscapularis bursa.

Type 3: The labrum is meniscoid the shape and has a large sulcus that projects under the labrum and over the cartilaginous pole of the glenoid.

BIOMECHANICAL ASPECTS:

There is more freedom of movement at the shoulder joint that any other joint in the body. The labrum, along with other fibrous structure, helps give stability to the shoulder joint.[11] With the addition of the labrum, the diameter of the glenoid surface is increased to 75% of the humeral head vertically and to 57% in the transverse direction.[7]

In the study by Itoi et al. with increasing loads to the long head of the biceps the amount of humeral head translation decreased in response to a 1.5 kg anterior force as compared with when no load was applied tot he long head of the biceps. The effect of biceps-tendon loading on anterior humeral head displacement was even more remarkable after creating a Bankart lesion.[12] Rodosky et al. demonstrated that the BLC and long head of the biceps contributed to anterior stability of the glenohumeral joint by increasing the shoulder resistance to torsional forces in the vulnerable abducted and externally rotated position. The biceps muscle also helps to diminish the stress placed on the inferior glenohumeral ligament. Detachment of the superior glenoid labrum is detrimental to anterior shoulder stability as ti decreases the shoulder torsional resistance and places a greater magnitude of strain on the inferior glenohumeral ligament which could theoretically lead to damage to the inferior glenohumeral ligament and subsequent anterior instability.[13] Pagnani et al. reported that an isolated lesion of the anterosuperior portion of the labrum, which did not involve the supraglenoid insertion of the biceps brachii, has no significant effect on anteroposterior and superoinferior glenohumeral translations. They also reported that application of load to the long head of the biceps resulted in significant decrease in humeral head translation and the influence was more pronounced at middle and lower elevation angles.[14] Grauer et al. stated that the strain in the anterior and posterior superior labrum increased in external rotation and abduction of the arm.[15] Kuhn et al., in their recent study, has shown that the force required to create a type II SLAP lesion is significantly lower in the maximal cocking position than that of the deceleration phases simulating the pitching motion.[16]

ETIOLOGY AND CLASSIFICATION:

Snyder et al. identified arthroscopically, that the injury of the superior labrum began posteriorly and extended anteriorly, stopping before or at the mid-glenoid notch and including the anchor of the biceps tendon to the labrum. They thus proposed the term SLAP (Superior Labrum - Anterior and Posterior).[4] At present, there is no biomechanical proof to support the etiology of SLAP lesions, though several different potential mechanisms of injury are proposed. These mechanisms can grossly be divided into two groups. In their review, Snyder et al. found two distinct mechanisms of injury: 1) a compression force applied to the shoulder and occurred as the result of a fall onto and outstretched arm, with the shoulder positioned in abduction and slight forward flexion; and 2) a traction on the arm, either as a result of a sudden pull on the arm or as a result of repetitive throwing or of an overhead sports motion.[4] Burkhart et al. have recently stated that a torsional force that "peels back" the biceps and posterior labrum as the shoulder goes into extreme abduction and external rotation during the cocking phase of throwing is observed. In this position, the biceps tendon force vector shifts from an anterior-horizontal direction (resting position) to a more vertical and posterior direction (abducted-externally rotated position). This causes a torsional force at the base of the biceps that is transmitted to the posterior labrum. Such a torsional force tends to "peel back' the labrum, and can potentially cause tendon-fiber failure from bone as an acute traumatic avulsion. If such a lesion becomes initiated in a thrower, the torsional peel-back is repeated every time the arm is brought into the cocking position, causing progressive failure over time, with enlargement of the lesion.[17] Pradhan et al. showed that the strain in the superior labrum increased with the load to the biceps and with the rotation of the arm. The strain was significantly higher in the posterior portion in maximum external rotation.[18]

Snyder et al. identified four types of SLAP lesions but later Maffet et al. have added some to the classification.19 Recently Morgan et al. have observed three different Type II lesions based on the involvement of the affected labrum.[20]

Type I (Fig. 1)

The superior labrum has marked fraying with a degenerative appearance, but the peripheral labral edge remains firmly attached to the glenoid, and the attachment of the biceps tendon to the labrum is intact.

Fig. 1

Type II (Fig. 2)

The labrum may have a degenerative appearance similar to type I lesions. However, in type II lesions, the superior labrum is also detached from its insertion of the superior glenoid, and along with the biceps tendon arches away from the underlying glenoid neck, which makes the BLC unstable.

Three subtypes of Type II [20]

i) An anterosuperior lesion; ii) A posterosuperior lesion; iii) A combined anterior and posterior lesion (Combined).

Fig. 2

Type III (Fig. 3)

The superior labrum has a bucket handle tear analogous to that seen in the knee meniscus. The biceps tendon in intact, as is the labral rim attachment of the peripheral portion of the labrum.

Fig. 3

Type IV (Fig. 4)

A bucket handle tear of the superior labrum is seen, which extends up as a split tear of variable degrees into the biceps tendon. The torn biceps tendon is displaced with the labral flap into the joint.

Fig. 4

Type V

This lesion includes superior extension of an anteroinferior Bankart lesion to include the superior labrum and separation of the biceps tendon.

Type VI

An unstable anteroposterior labral flap tear and a biceps tendon separation superiorly.

Type VII

SLAP lesion with anterior extension of a Type II SLAP lesion extends anteriorly beneath the mid dle glenohumeral ligament. Among all these types of lesions Type II (55%) seems to be the most common followed by type I (21%), type IV (10%), type III (9%) and 5% were complex type (Type V - VII).[4]

CLINICAL PRESENTATION AND DIAGNOSIS:

The patients with SLAP lesions usually present with pain in the involved shoulder more with overhead activities.[3,4] The pain can be in the anterior aspect, posterior or be poorly localized. The pain can be sudden with a definite history of injury or can be insidious in onset. Some of the patients have pain during activities of normal daily living and/ or after participating in sports. Many patients complain of mechanical symptoms such as locking, catching, popping or snapping in their shoulder, especially after overhead activities, and experience early fatigue. Others may present with features of an unstable shoulder. An overhead/throwing athlete may present with a "dead arm" complex with pain and decreased level of performance. Overall the symptoms of any labral disorder are nonspecific, so a high index of suspicion is necessary. With a detailed history, followed by appropriate investigative methods, a preoperative diagnosis of superior labral disorder can be reached. The physical examination is proceeded first with three basic steps: look, feel, and move. An initial impression of the patient is followed by inspection and palpation of the shoulder girdle and followed by active and passive ranges of motion are recorded, along with strength testing an neurologic examination. Then the more specific tests for the detection of superior labral lesion are carried out.

The Biceps Tension test that is generally performed with the patient flexing the shoulder against resistance while the elbow is extended an the forearm supinated.[21] Snyder et al. found this to be one of the most useful diagnostic test.[22] Field and Savoie have described a modified biceps stress test to check competency of the origin of the biceps tendon and the test is performed in 90^0 of abductin.[23]

The Active Compression test is performed with the physician standing behind the patient and asking to flex the affected arm 90^0 with the elbow in full extension and adduction of the arm 10^0 to 15^0 medial tot he sagittal plane of the body. The arm is internally rotated so that the thumb is pointed downwards with the examiner applying a uniform downward force to the arm. With the arm in the same position, the palm is then fully supinated and the maneuver is repeated. The test is considered positive if the pain is elicited with the first maneuver and was reduced or eliminated with the second.[24]

The Anterior Slide test put forward by Kibler can be done with the patient sitting or standing, with their hands on the hips with thumbs pointing posteriorly. One of the examiner's hand is placed across the top of the shoulder from the posterior direction, with the last segment of the index finger extending over the anterior aspect of the acromion at the glenohumeral joint. The examiner's other hand is placed behind the elbow and a forward and slightly superiorly directed force is applied to the elbow and upper arm. The patient is asked to push back against this force. Pain localized to the front of the shoulder under the examiner's hand, and/or a pop or click in the same area is considered to be a positive test. The test is also positive if the athlete reports a subjective feeling that this testing maneuver reproduces the symptoms that occur during overhead activity.[25]

The Compression-rotation test is performed with the patient supine, the shoulder abducted 90^0 and the elbow flexed at 90^0. A compression force is applied to the humerus along the axis, which is then rotated, in an attempt to trap the torn labrum. Labral tears may be felt to catch and snap during the test.[4]

The "Crank" test is performed with the patient in the upright position with the arm elevated to 160^0 in the scapular plane. Joint load is applied along the axis of the humerus with one had while the other performs humeral rotation. A positive test is determined either by pain during the maneuver with or without a click or reproduction of the symptoms usually pain or catching felt by the patient during athletic or work activities. This test should be repeated in the supine position, where the patient is usually more relaxed.[26]

The new pain provocation test designed by Mimori et al. is carried out in the sitting position. During testing, the abduction angle of the upper arm is maintained at 900 to 1000 and the shoulder is rotated externally by the examiner, then the forearm is rotated to maximum pronation and maximum supination. The pain is positive for superior labral tears when pain is provoked only when the forearm is in pronation or when pain is more severe in this position than in supination.[27]

The cross chest adduction of the shoulder with the elbow extended and forearm pronated (thumb down) is caused by entrapment of the biceps tendon and is a clinical sign of an unstable Type II SLAP lesion. Repeating the test under less traction on the long head of the biceps, with the forearm supinated (thumb up), should cause pain diminution with a SLAP lesion, distinguishing it from AC joint arthritis. In the latter condition the pain quality is unaffected by forearm rotation.[5] The above mentioned tests are not specific for SLAP lesions but help in differentiating between the pain arising from surrounding areas of the shoulder. Each test has to be recognized and judged carefully.

Plain radiographs are of limited value in detection of SLAP lesions. Among the other investigative procedures include magnetic resonance imaging (MRI) and magnetic imaging arthrography (MRA) and CT arthrography. Most believe that MRI and more recently MRA are the modality of choice for detecting SLAP lesions and other labral lesion.[28] Superior soft tissue contrast and resolution and multiplanar capability allow a global evaluation of all intra-articular and extra-articular soft tissue and osseous structures of the shoulder that is unsurpassed by any other modality. Magnetic resonance arthrography, which consists of MRI after intra-articular injection of saline of dilute gadolinium solution, surpasses the CT arthrography standard for visualization of capsulolabral anatomy and pathology. Typical parameters for shoulder MRI when using a 1.5-T scanner are repetition time/echo time of 2,000/ 20,80 m/sec, using one-signal excitation with 8-12 cam field of view. Three millimeter slice thickness with 1-mm gap is used with 192 X 256 matrix in oblique coronal, oblique sagittal, and axial planes, and the images are filmed with 1.3 to 1.5 magnification.[29] Fast spin echo and multiplanar gradient echo with a dual phased array surface coid and 512 X 256 or 384 pixel imaging matrix is reported to increase the signal-to-noise ratio by virtue of several receiver coils working in concert to receive signal and promote field homogeneity.[30,31] The fast spin echo imaging technique decreases imaging time and is invaluable in the postoperative setting because of the reduction in metallic artifact. With arthroscopy as the standard, this technique revealed a sensitivity of 98%, a specificity of 89.5%, and an accuracy of 95.7%. Still others maintain that magnetic resonance arthrography using a 1% gadolinium-DTPA saline solution may be the first choice in evaluation of the painful shoulder of young athletes due added sensitivity and specificity in the detection of capsulolabral pathology including SLAP lesion, as well as any associated secondary impingement. Findings that may indicate a superior labral lesion include irregularity of the contour, high signal intensity in the biceps-labrum anchor, lobular high signal intensity between the superior glenoid labrum and the superior portion of the glenoid fossa, deformity, either inferior or anterior and medial displacement of the labrum, or the presence of a glenoid cyst.[28] Many patients with cysts who were found to have an associated labral tear also had concurrent shoulder instability. Hence, a high index of suspicion should be warranted for an underlying labral lesion and potential shoulder instability when a glenohumeral cyst is noted on MRI.[32]

Even with recent advances in imaging studies diagnostic arthroscopy remains the only way to diagnose SLAP lesions of the shoulder. While performing arthroscopy, it is important to recognize variants in normal anatomy to appropriately diagnose SLAP lesions. This includes appreciation of the frequently normal sublabral hole at about 2-o'clock position and the commonly seen meniscoid appearance of the superior labrum. The so called "Buford complex" with cord like middle glenohumeral ligament that attaches to the base of the biceps and the absence of labral tissue on the anterior superior glenoid should also be appreciated.[33] Findings consistent with SLAP lesions of the shoulder include signs of hemorrhage or granulation tissue beneath the biceps tendon and superior labrum, presence of a space between the articular cartilage margin of the glenoid and the attachment of the labrum and biceps anchor, and arching of the superior labrum mechanism more that 3 to 4 mm away from the glenoid when traction is applied to the biceps tendon.

TREATMENT:

Labral tears may occur in association with glenohumeral instability, and shoulder stability should always be carefully assessed by examination under anesthesia before stepping with diagnostic shoulder arthroscopy. Treatment of SLAP lesions depends on the type of the lesion that is present. In general, in overhead athlete, glenohumeral instability should be considered present until proven otherwise when labral tears are observed at the time of arthroscopy.[22,34] Type I lesion is debrided back to a stable rim, and care is take not to detach the actual anchoring tissue from the superior glenoid itself. Management of type III lesion is based on the size and tissue quality of the unstable "bucket-handle" fragment. If the fragment is thin, degenerative, or devoid of vascularity, it is debrided back to stable tissue. On the contrary, large, robust, vascular fragments can be abraded and repaired with sutures similar to "all-inside" repair techniques. Type II lesion in which the superior labrum is detached from the underlying superior glenoid, results in instability of the biceps anchor, which must be reattached to the anatomic anchor point in a way that allows healing to occur. Details of the repair are beyond the scope of this article but mostly trans-glenoid fixation using bioabsorable tacks or direct fixation to the glenoid using suture anchors. The cannulated bioabsorable tact has the advantage of easy placement, stout tissue fixation, and absorb ability to reduce potential hardware migration and irritation. Type IV lesion is treated according to the size of the biceps tendon that has been detached. Small unstable labral/biceps fragments are debrided but larger (> 50% thickness) fragments are repaired with fixation techniques. When instability is present, it should be addressed at the time of treatment.

Postoperatively, patients are immobilized in a sling for the three weeks. during which time they are allowed mild elbow, wrist and hand exercises. After removal of the sling after the first week, patients are instructed to abstain from external rotation beyond neutral rotation and extension of the arm for another 4 week. In the next 4 to 5 weeks, biceps strengthening is steadily increased but stressful biceps activity is not allowed till about three months.

SUMMARY:

SLAP lesion is a labral pathology that has been increasingly recognized with the extension of shoulder arthroscopy. A high index of suspicion is necessary in patients presenting with mechanical symptoms of catching or shoulder pain that does not relate to the usual shoulder pathology. The most common mechanisms of injury are traction and compression, although the injury may be insidious. Physical examination still has major role in reaching a diagnosis of the lesion, which also must include an assessment of glenohumeral instability, though MRI and recently MRA have been reported to be highly sensitive. Treatment depends on the type of SLAP lesion. Type I and III lesions can often be treated with simple debridement. Type II lesion should be managed with stabilization of the detached biceps-labral complex. Suture repair of type IV lesion is also suitable if there is extensive involvement of the biceps-labral complex. In arthroscopically detected lesions, instability should be recognized and treated accordingly.

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