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Glenoid Labrum

Background

The shoulder complex consists of various different joint articulations that work together to provide appropriate upper extremity range of motion (ROM). One of the most important articulations in the upper extremity is the glenohumeral joint (GHJ). The GHJ provides not only the largest ROM in upper extremity but also the entire human body.[1] This is primarily due to the large size difference between the small glenoid and the large humeral head.[1] The articular surface area of the proximal humerus is approximately 2.5 times greater than that of the glenoid fossa, and only about 22% of this area is in contact with the fossa.[2,5,6] This may also explain why the GHJ is also known to be the most unstable articulation in the body.

Because of its lack of boney congruency and stability, the GHJ requires the assistance of many other soft tissues for providing support. The glenoid labrum (GL) serves as one of these supportive structures. One of the primary functions of the GL is to act as a passive stabilizer to the glenohumeral articulation by adding depth to the glenoid fossa thereby increasing congruency.[1,2,9,10] The GL increases the glenoid surface area by as much as 50%,[2,7] and experimental removal of the labrum decreased GHJ stability up to 20%.[8] The GL also functions as a site of attachment for the glenohumeral ligaments, joint capsule, and long head of the biceps tendon, all of which are also important GHJ stabilizers.[1] However, these soft tissues attaching to the GL are just a handful of the numerous other stabilizers that support the GHJ. The primary role of the labrum is to stabilize the GHJ passively by increasing joint congruency, which could be considered a relatively small role when bearing in mind the various other strong structures that are active and passive stabilizers of this joint. While it is feasible to assume that the labrum provides some resistance to translation of the humeral head, this would be the primary job of the other muscular and ligamentous structures surrounding the joint.

<u>Composition and Function</u>

To understand fully the function and potential causes of pathology of the GL, one must appreciate the general composition and properties of the tissue. The labrum's size is typically around 4 mm wide and 3 mm thick in the average human.[1] The GL is a circumferential structure consisting mostly of fibrocartilage and dense fibrous connective tissue that overlaps onto the bony glenoid rim.[1,2,9,11] Bain et al.[10] found that the collagen fibers in the labrum are circumferential centrally but become radial and perpendicular peripherally where they merge with the articular cartilage, capsule, and biceps tendon. Nishida et al.[12] further explained the orientation of collagen fibers of the GL with the use of light and electron microscopy. They noticed a varied orientation of the fibers and described them in three layers: a thin mesh-like superficial layer, a stratified middle layer, and a circumferential deep layer, and all of these bundles were reinforced via radial fibers. These findings may indicate that the labrum has a transition zone near the interface of attaching structures in attempts to decrease stress concentration.

Overall, the labrum and bone interface is similar to a tendon insertion. This labrum-bone transitional interface is most pronounced in the inferior labrum between the 2 o'clock to 10 o'clock positions.[2] The interface is described as having a narrow transitional zone through uncalcified labral fibrocartilage, calcified labral fibrocartilage, and then Sharpey's fibers project to the bone (Fig. 1).[10] More specifically, the inferior labrum along the 5-10 o'clock position has a rigid bony attachment[10] and consists of inelastic tissue,[9] which prevents mobility of the labrum.[10] The inferior labrum is considered a fixed organ of compression,[10] meaning it functions somewhat as a stabilizing "bumper" restricting translation of the humeral head.[9] This labral tissue is essentially like a rounded extension of the articular cartilage.[9] The superior labrum has a loose, mobile interface with little to no bony foundation, is meniscal in nature, and is considered a mobile organ of tension.[9,10] Cooper et al.[9] described the attachment of the superior labrum as consisting of thin connective tissue that was easily stretched. The superior labrum functions more as a mobile extension of the glenoid surface than as a stabilizing bumper that is seen in the inferior labrum.[9] The loose superior labrum is anchored near the 10 o'clock and 2 o'clock positions,[2,9] which may be something to consider when analyzing the pathomechanics of labral tears and stress concentrations.

The superior GL is sometimes misunderstood as *the* site of attachment for the long head of the biceps (LHB). However, only a portion of the LHB interacts with the superior labrum before it inserts onto its primary attachment site at the superior glenoid tubercle. The superior labrum contributes to about one-third of the fibers for the origin of the LHB tendon.[10] While the superior GL does not serve as the primary attachment for the LHB, the LHB serves as the primary attachment site for the superior GL, with the GL inserting onto the biceps tendon distal to the insertion of the tendon onto the superior glenoid tubercle (Fig. 2).[9]

<u>Healing Capabilities</u>

Before delving into the details concerning pathology and repair of the GL it is important to consider the vascular anatomy and healing properties, or lack thereof. The arteries that supply the GL originate from the suprascapular artery, the circumflex scapular branch of the subscapular artery, and the posterior circumflex humeral artery.[9] These branches reach the labral tissue through the shoulder joint capsule, not through the bone.[18] In an anatomical study performed by Cooper et al.[9] it was found that these vessels supplied the GL predominantly in its periphery near the attachment of the labrum to the joint capsule. The vessels penetrated the labrum radially then oriented themselves circumferentially throughout the peripheral portions (Fig. 3). Importantly, they found that the superior and anterosuperior portions of the GL were relatively less vascular than the other portions of the labrum. Considering the vascular supply to the periphery of the GL, one could assume that lesions in these small areas have the potential to produce an inflammatory and repair response after injury.[9,13] Nevertheless, all other aspects of the GL lack adequate blood supply to induce a sufficient healing response if torn.

Pathology involving the labrum is somewhat of a common problem and cause of pain that I have seen during my limited clinical experience. The focus of this paper will analyze the two most common types of labral lesions: SLAP lesions (superior labrum anterior and posterior) and Bankart lesions.

<u>SLAP Lesions</u>

Superior labral lesions were first observed by Andrews et al.[14] in a study of high-level throwing athletes in which they noted anteriosuperior labral tissue that was detached, frayed, and occasionally accompanied by partial tearing of the biceps tendon. They predicted that the main reason for this injury is secondary to the tension of the biceps tendon during the deceleration phase of throwing. Snyder et al.[15] identified a similar injury involving the superior labrum, beginning posterior to the biceps tendon and extending anterior to the biceps tendon, currently known as a SLAP lesion. A lesion in this area is functionally important because the superior GL serves as a partial anchor for the LHB on the glenoid, thus can lead to decreased stability.[16] In addition to Andrews et al.[14] observation of superior labral pathology in high-level throwing athletes, various other mechanisms of injury have been reported to cause SLAP lesions including compression injuries, such as falling on an abducted or outstretched arm, and traction injuries in which the arm is pulled inferiorly.[17]

Snyder et al.[15] further categorized SLAP lesions into four distinct types:

- Type I lesions demonstrate fraying and degeneration of the superior labrum with a normal biceps tendon anchor (Fig. 4)
- Type II lesions demonstrate a detachment of the labrum and biceps anchor from the superior glenoid, and could have fraying of the superior labrum (Fig. 5)
- Type III show that the superior labrum has a vertical tear, similar to that of a bucket-handle tear in the meniscus of the knee (Fig. 6)
- Type IV lesions are similar to that of a Type III lesion in that there is a vertical tear of the superior labrum but the tear also extends into the biceps tendon (Fig. 7).

SLAP lesions can result in combinations of two or more of the above mentioned types, type II and type IV being the most common.[16]

Presentation of a SLAP lesion can vary for each patient. Pain is the most common complaint and can be located posterior, posterosuperior, anterosuperior, or referred to the bicipital groove.[18] Burns et al.[18] reports that the reliability of diagnostic physical examination tests are questionable, yet there are many to choose from, including but not limited to the O'Brien test, compression-rotation test, Speed's test, Mayo shear test, Kibler anterior slide test, crank test, and the biceps load II test. They[18] consider mechanical pain along with one or more positive provocation tests to be consistent with SLAP lesion. In a recent systematic review, Karlsson[19] found that there are no highly valid special tests that can conclusively diagnose a SLAP tear, and that the examiner should become more suspicious when the patient presents with multiple positive tests and a history/MOI to back it up. Currently, the most reliable diagnostic tools for evaluating a patient who is suspected to have a labral pathology is an MRI or MR arthrography. These tests are considered the gold standard for diagnosing this pathology.[1,18]

SLAP tears are fairly common in young overhead throwing athletes, but literature indicates that there are inferior outcomes in this group.[18,20] The most common and recommended treatment for patients who have a SLAP lesion with biceps pathology is biceps tenodesis or tenotomy; however, a repair is sometimes indicated in appropriate patients when there is no biceps involvement.[18] A systematic review by Gorantla et al.[21] found that only 64% of overhead athletes returned to their preinjury level of play after repair of a type II SLAP lesion. As previously mentioned, when surgically repairing the GL it is important to consider the vasculature of the structure. It is, therefore, recommended that the guidance of suture anchors in GL repair generally be as peripheral as possible.[11] When reviewing the lack of positive outcomes of this procedure one may question the true healing nature of this peripherally vascular tissue of the superior labrum. As noted in Fig. 3, the anterosuperior portion of the labrum demonstrates less blood supply than any other peripheral portion of the labrum and it may be possible that for many people this tissue simply won't repair and heal due to an inadequate blood supply.

This likely contributes to why biceps tenodesis or tenotomy are the most recommended treatments. Overall, the ideal surgical technique, postoperative rehabilitation program, and the biologic healing potential of these repairs is not very well understood.[18]

Bankart Lesions

A Bankart lesion is a tear of the labroligamentous complex occurring most commonly with a traumatic anterior dislocation in which the labrum is detached anywhere from the 3 o'clock to the 7 o'clock position (anteroinferior).[23] When the humeral head anteriorly displaces out of the glenoid, the labrum is likely injured secondary to a rapid and forceful stretch of the anterior band of the inferior glenohumeral ligament, which is intimately attached to the labrum.[1,9,11] Bankart lesions are often distinguished into two types: a bony Bankart lesion or a soft tissue Bankart lesion.[27] Both of these lesions lead to decreased labral height and laxity of the anterior band of the inferior glenohumeral ligament.[23]

Considering the size discrepancy between the glenoid and humeral head, the joint is naturally susceptible to dislocation and subluxation.[1] Interestingly, detachment of the inferior glenohumeral ligament-labrum complex from the glenoid is found in 94% to 97% of shoulders after initial dislocation.[4] The mechanism of injury leading to an anteriorly dislocated GHJ is usually indirect in nature, such as sudden loading of the arm in varying degrees of abduction, external rotation, and extension.[25] Anterior dislocations can also occur when an individual falls on an outstretched hand posteriorly.[25] These dislocations are less likely to be direct in nature, in which there is a direct impact to the posterior shoulder.[25] An example of how this type of mechanism could occur is if a football player is blocking an opponent with their arm abducted and externally rotated as another player suddenly runs into the back of them.

Patients who anteriorly dislocate their GHJ will feel an immediate sense of discomfort that will remain until it is relocated. The patient who has sustained a Bankart lesion may complain of shoulder pain that they are unable to localize and pain that worsens when the arm is held behind the back in internal rotation.[28] Furthermore, they may report weakness and instability of the shoulder.[28]

Repair of the capsulolabral complex of the glenoid remains the gold-standard treatment of traumatic anterior shoulder instability associated with Bankart lesions.[24] A repair of the labrum restores labral height and tension to the anterior band of the inferior glenohumeral ligament and stability to the GHJ, which decreases re-dislocation.[23] There is a lack in conclusive evidence determining if an open or arthroscopic technique is more effective in the surgical treatment of this pathology.[24] However, evidence supports conservative management for this type of lesion with a period of immobilization.[3,4] Much debate exists as to whether the patient should be immobilized in internal or external rotation during this conservative approach. One author reports that with glenolabral tears there is no glenolabral surface contact at internal rotation, minimal contact at neutral position, and maximum contact at 45 degrees of external rotation.[3] Therefore, the theory is that immobilization in external rotation for a period of time will allow these structures to heal and decrease the incidence of recurrence. One randomized controlled trial found that immobilization in 10 degrees of external rotation for three weeks reduced the relative risk of reoccurring shoulder dislocations by 38.2% compared to the internal rotation group.[4] Furthermore, Taskoparan et al[3] found that it is even more important to immobilize in external rotation in younger patients (21-30 years old). A systematic review performed by Paterson et al[26] found that there is a clinical benefit to treatment in external rotation over conventional sling immobilization, although the advantage was not significant.

If the Bankart lesion heals, recurrence is less likely, emphasizing the importance of proper rehabilitation.[4] Sugaya[22(p.427)] explains a common postoperative rehabilitation protocol for Bankart repairs. The shoulder is immobilized for approximately 3 weeks after surgery. The following 3 weeks consist of passive and active-assisted forward flexion and external rotation staying within a non-painful range. After 6 weeks the patient should start strengthening exercises of the rotator cuff and scapular stabilizers. If rehabilitation goes as planned for the patient they are allowed to practice in non-contact sports and can return to full return to throwing or contact sports after 6 months. It should be mentioned that this is only one protocol by one author to outline a general rehabilitation program that may be provided for this population; all protocols are dependent on the physician providing the surgery.

Conclusion

The glenoid labrum is a fascinating tissue when considering its composition, structure, and function. The GL has many features that are analogous with the meniscus of the knee, such as its shape and design. The glenoid labrum's primary job is to serve as a supportive structure to the glenohumeral joint by increasing the depth of the glenoid fossa, whereas the meniscus of the knee primarily serves as a pressure attenuator. The stabilizing feature of these two tissues, however, is somewhat similar in that they act as "bumpers" for the articulating joint to restrict translation. Acting as this "bumper" can lead to pathology when forces are too high for other surrounding supportive structures to compensate, such as what can occur with Bankart lesions. Furthermore, the lack of blood supply and healing capabilities of the labrum demonstrates the need for intervention when one has sustained a labral injury.

Intervention methods for treatment vary depending on location and severity of the lesion, varying from conservative immobilization to open or arthroscopic surgery. Physical therapy is generally always indicated when one has sustained a labral tear. While the structure or strength of the labrum cannot be changed with physical therapy, it is important to focus on the surrounding structures that help stabilize the GHJ. A gradual return to activity is indicated for these patients and it is important for the therapist to safely optimize function during this gradual period.

Appendix:

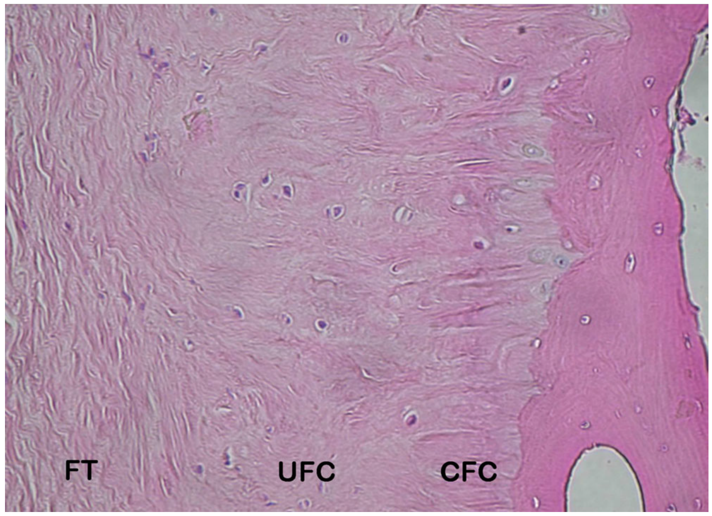

Figure 1 (provided by Bain et al.[10]): Microscopic view of the bone-labrum interface at 6 o'clock occurring through uncalcified and calcified fibrocartilage. FT = labral fibrous tissue; UFC = uncalcified labral fibrocartilage; CFC = calcified labral fibrocartilage.[10]

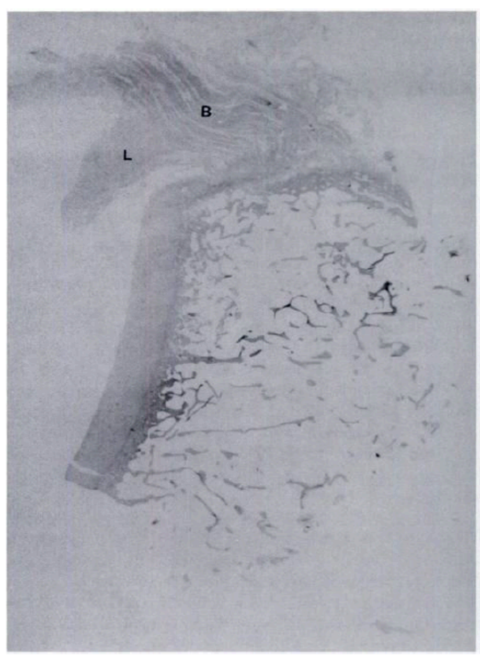

Figure 2 (provided by Cooper et al.[9]): Cross-sectional anatomy of the GL at the 12 o'clock position demonstrating the primary attachment of the superior labrum (L) to the biceps tendon (B) before the tendon inserts onto the superior glenoid tubercle.[9]

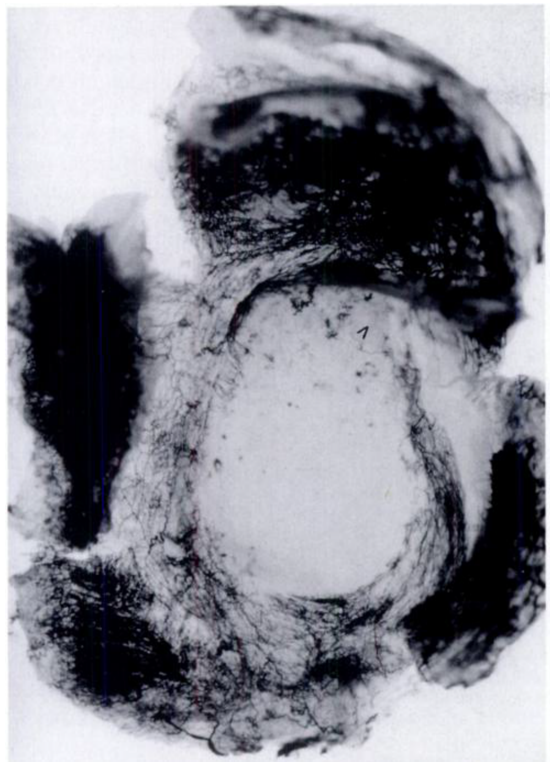

Figure 3 (provided by Cooper et al.[9]): This picture of a disarticulated humeral head demonstrates both the radially and circumferentially oriented vessels of the GL (depicted by India ink). A tiny arrow points at the relative decreased blood supply to the anterosuperior part of the labrum.[9]

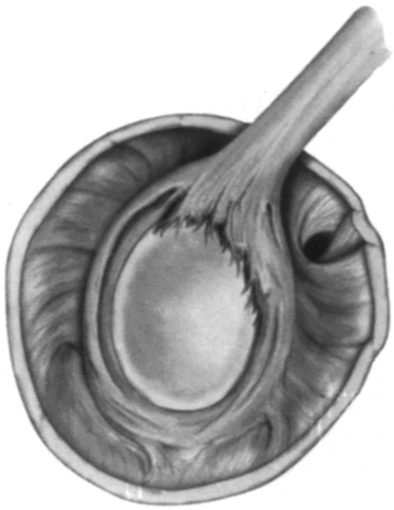

Figure 4: Type I SLAP lesion; frayed and degenerated superior labrum.[16]

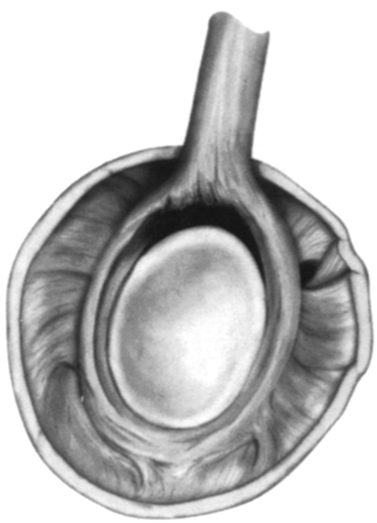

Figure 5: Type II SLAP lesion; detachment of superior labrum and biceps tendon from glenoid rim.[16]

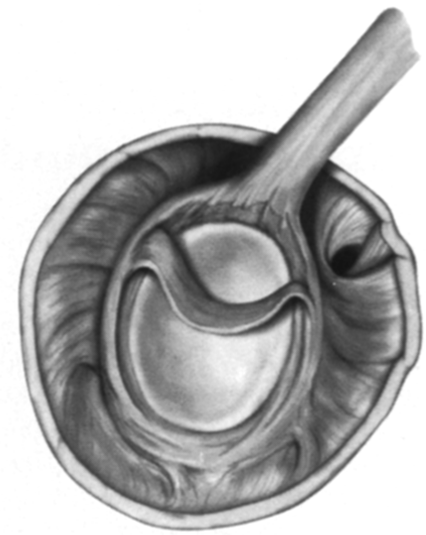

Figure 6: Type III SLAP lesion; vertical tear in the superior labrum demonstrating a bucket-handle appearance.[16]

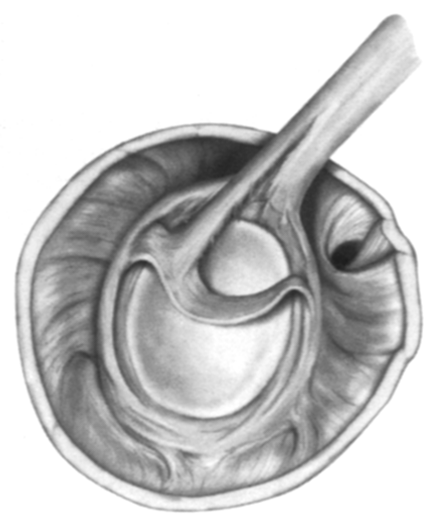

Figure 7: Type IV SLAP lesion; verticle tear in superior labrum that protrudes into the biceps tendon.[16]

* Figures 4-7 provided by Snyder et al. (1995)[16] (1995).

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