J Shoulder Elbow Surg (2011) 20, S2-S8

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

SHOULDER

Superior labral tears: repair versus biceps tenodesis

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Tears of the superior labrum were first described by Andrews et al[3] in 1985 as injuries caused by traction due to throwing. In 1990 Snyder and Karzel[51] published their comprehensive description of the labral/biceps attachment pathology, coining the name ''SLAP (superior labrum anterior-to-posterior)'' lesion. Since that time, understanding the nuances associated with etiology, diagnosis, and treatment of SLAP lesions has proven to be a difficult task. Several published studies have attempted to describe outcomes associated with surgical intervention, but there have been no level I or II publications related to the treatment of SLAP tears to date. Almost all evidence to date consists of level IV studies, making it impossible to draw definitive conclusions from any of the published results. Level III, IV, and V evidence can certainly be of value to the practicing orthopedist, but controversies arise when the published data are not definitive or describe variable, differing, or unpredictable results. Such has been the case with the investigation into the treatment of SLAP tears. The earliest reports described treatment of SLAP lesions with arthroscopic debridement only.[2,3,9] Later, the focus turned to labral repair and repair of the biceps anchor,[5,7,20,30,47,49] and now more recently, the role of biceps tenodesis is being more closely investigated.[4]

This article will discuss SLAP tear surgical treatment, focusing on the current controversy of repair vs biceps tenodesis. The pertinent anatomy, biomechanics, classification, diagnostic imaging, and the literature will also be reviewed, because properly diagnosing symptomatic SLAP tears is difficult, and understanding these elements is a pivotal first step in making an educated decision on surgical management.

Superior labral anatomic presentation and variability

The superior labrum is a typically triangular structure composed of fibrous and fibrocartilaginous tissue. The long head of the biceps tendon originates from both the glenoid bone at the supraglenoid tubercle (approximately 60% of its fibers) and the superior labrum proper (approximately 40% of its fibers).[53] The vascular supply of the superior labrum comes from branches of the suprascapular artery, the circumflex scapular branch of the subscapular artery, and the posterior humeral circumflex artery.[8] This vascular supply reaches the labral tissue through the shoulder joint capsule, not the bone.

Although the superior labral and biceps attachment anatomy has been researched and described extremely well, there is significant variability in the appearance of the superior labrum. The labrum can occasionally attach directly to the glenoid rim, but there is usually a sublabral recess between the labrum and glenoid such that the labrum actually attaches to bone somewhat more medially. Also common are ''meniscoid'' variants, where the labrum overlaps the glenoid articular cartilage superiorly, giving the confusing appearance of a pathologic detachment compared with more common anatomy. The biceps can originate centrally or more posteriorly.[52] Its relative attachment to the supraglenoid tubercle and labrum can be variable as well. The biceps can occasionally appear as a bifid structure or sometimes originate directly from the superior or inferior capsule below the supraspinatus.

Investigational Review Board approval was not necessary for this review article.

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1058-2746/$ - see front matter
doi:10.1016/j.jse.2010.11.013

The anatomy anterior to the biceps is also variable. Most commonly, the labrum is thin but attached circumferentially to the bone in the anterior superior quadrant. However, there can be a ''sublabral foramen'' in 3% to 12% of shoulders, where the labrum detaches from the glenoid in front of the biceps only to be reattached again anteriorly near the midglenoid notch near the attachment of the middle and inferior glenohumeral ligaments.[45] DePalma's work[10] described the middle glenohumeral ligament as the most variable in size, shape, and presence of the glenohumeral ligaments, potentially absent in 12% of shoulders but appearing cord-like adjacent to a sublabral foramen in approximately 9% of shoulders. Another potentially significant normal variant is the Buford complex, which is present in approximately 1.5% of shoulders. It consists of a complete absence of an anterosuperior labrum in the anterior superior glenoid quadrant, coupled with a cord-like middle glenohumeral ligament that attaches directly to the base of the biceps tendon. With all this variability relative to the anatomic appearance of the superior labrum, differentiating ''normal'' from ''pathologic'' is a difficult process that contributes to the controversy of how to surgically manage symptomatic SLAP lesions.

Misdiagnosis of shoulder pathology leading to inappropriate surgical intervention involving labral fixation or biceps tenodesis may cause significant morbidity resulting in pain, stiffness, biceps weakness, cramping, or failure of tenodesis fixation. In addition, an incorrect interpretation of anatomy may distract the surgeon from recognizing and treating the real cause of a patient's shoulder symptoms.

Biomechanics and function

The function of the superior labral complex is not fully understood. Biomechanical studies have shown that a competent biceps labral complex provides both translational and rotational stability to the glenohumeral joint. Proper repair of a true SLAP tear can restore normal biomechanics.[42]

Contraction of the short head of the biceps results in proximal humeral migration. However, this is counterbalanced by humeral head depression with contraction of the long head of the biceps. Release of the long head of the biceps results in an increase in proximal humeral migration by 15.5% with elbow flexion and supination.[31]

In the ''vulnerable'' abducted externally rotated position, the shoulder is partially stabilized with biceps contraction. Anterior displacement is reduced with increased biceps tension, even with the presence of a Bankart lesion.[21] Electromyographic studies have also reported peak biceps activity in the late cocking phase of throwing for pitchers and described higher biceps activity in pitchers with known chronic anterior instability.[15,18] Creation of a SLAP lesion in a cadaveric model decreases torsional rigidity in the overhead position and increases inferior glenohumeral ligament strain.[48]

Superoinferior and anteroposterior translation in the lower and middle ranges of abduction increases with a SLAP lesion because the superior and middle glenohumeral ligaments originate from the superior labrum.[41] Loss of an intact labral complex additionally reduces concavity compression with loss of biceps contraction.[41] In a cadaveric model, SLAP tears increased translation but also external rotation. Arthroscopic repair of isolated SLAP lesions was able to return range of motion to normal levels without the need for additional capsular placation.[42]

In summary, an intact biceps anchor that allows a secure biceps contraction likely contributes to stabilization of the shoulder and to normal shoulder function. In high-level overhead athletes such as baseball pitchers, the true risk of detaching or tenodesing the long head of the biceps is still unknown, but it can be expected to affect the shoulder biomechanics in subtle ways that may eventually become clinically significant.

Diagnostic difficulties

Understanding the normal anatomy and function of the superior labrum is a critical first step, and then properly recognizing a true pathologic condition is the next step for a treating orthopedist. Unfortunately, no single test can consistently and reliably diagnose a symptomatic SLAP lesion. The patient's history can be variable but often involves an injury that includes traction, compression of the shoulder, or repetitive overhead athletic use.[50,51] The history of an insidious onset without these conditions should be questioned.

Pain is the most common presentation, often associated with mechanical components. It can be located posterior, posterosuperior, anterosuperior, or referred to the bicipital groove.[50] There is no reliable diagnostic physical examination maneuver,[25,26,30,40] although many have been described, and therefore, the physical examination is considered insufficient for diagnosis.[34,43] Many provocative tests have been reported, with varying degrees of accuracy.[19,26,32,34,37,38,40] Commonly used tests to diagnose SLAP lesions include the O'Brien test, compression-rotation test, Speed test, Mayo shear test, Kibler anterior slide test, crank test, and the Kim biceps load test.[26-28,32,34,35,44,50,51] We consider mechanical pain and one or more positive results on provocative tests to be consistent with a SLAP lesion and have termed it a ''suspicious'' physical examination.

Although images from high-quality magnetic resonance imaging (MRI) machines and very experienced evaluators may not need arthrograms to achieve similar sensitivity, MRI arthrogram is still the most reliable imaging test of choice.[22-24] The normal anatomic variations can make MRI findings confusing, but perilabral cysts and coronal images with contrast extension under the superior labrum and

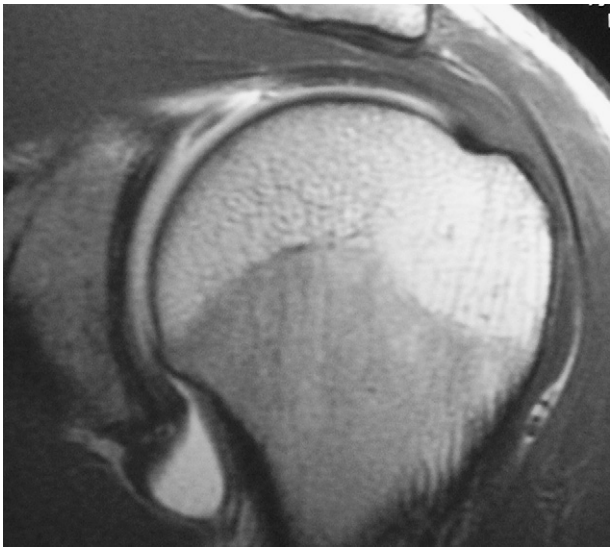

Figure 1 In this T1-weighted coronal oblique image of a superior labrum, anterior-to-posterior (SLAP) lesion, contrast dye can be seen extending laterally into the labrum.

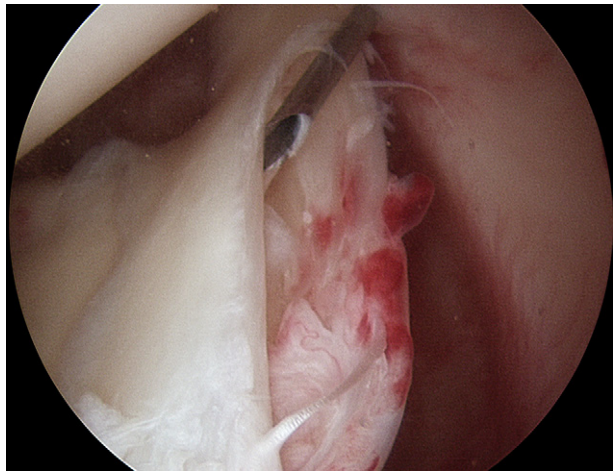

Figure 2 The injury in this type IV superior labrum, anterior-to-posterior (SLAP) lesion can be seen extending up into the biceps tendon, involving slightly less than 50% of the biceps tendon anchor.

extending laterally *into* the substance of the labrum are most commonly associated with true SLAP lesions (Fig. 1).[2,22-24,46]

Arthroscopy is considered the gold standard for diagnosing SLAP tears. However, arthroscopy can be misleading without knowledge of normal anatomic variants, physical examination, patient history, and MRI findings. Significant interobserver and intraobserver reliability issues have been recognized with the use of arthroscopy alone.[16] Obvious traumatic labral and biceps tearing notwithstanding, the subtle differences between a meniscoid superior labrum and one that has been traumatically detached can be very difficult to determine. Peel-back in the abducted externally rotated position,[6,36] reactive appearing synovitis under the labrum, an excessive sublabral recess beyond the edge of the glenoid cartilage, and hypermobility of the superior labrum (>5 mm) with biceps manipulation may all suggest pathology.[39]

Therefore, a combination of knowledge of anatomy (anatomic variants), patient history (traumatic event, overhead athlete), physical examination (''suspicious'' provocative test results), MRI findings (contrast into labral tissue), and arthroscopy (detached unstable labrum and biceps anchor) with no other obvious explanation for the symptoms will give the best chance to correctly diagnose a SLAP lesion. Once a surgeon is confident in the diagnosis, he or she can proceed to treat it.

Arthroscopic classification

In 1990 Snyder et al[51] classified SLAP tears into 4 types. Although other classifications have been suggested to extend this system,[33,36] the Snyder classification is sufficient for the purposes of this review:

- Type I lesions involve degenerative fraying of the labrum, but the biceps anchor is firmly attached to the glenoid. This lesion is part of the aging degenerative process and is more common in patients who are middle-aged and older. It is unlikely to be a significant source of clinical symptoms.
- Type II lesions represent a significant detachment of the biceps/labral anchor from the glenoid bone. This type of SLAP lesion is the most common, occurring in 55%, as noted by Snyder et al.[50]
- Type III lesions are bucket-handle tears of the superior labrum and occur in 9% of patients.[50] The biceps tendon is normal and is firmly attached to the rest of the labrum and supraglenoid tubercle.
- Type IV lesions are bucket-handle tears of the superior labrum with extension of the tear into the biceps tendon.[50] These lesions occurred in 10% of patients (Fig. 2).

Understanding this classification will help a surgeon determine treatment. For the purposes of this article, the type II lesion has been the most difficult to treat and has created the most controversy.

Treatment controversies

Most surgeons will agree that patients with SLAP lesions and obvious biceps pathology on physical examination, MRI, or at arthroscopy should be managed with biceps tenodesis (or tenotomy). Similarly, degenerative labral fraying may develop in older patients as a normal part of the aging process. Although a specific age cutoff cannot be

determined at this point, SLAP repair in patients with generalized degenerative labral tearing or degenerative arthritis is not recommended. The main controversy involves the management of type II SLAP lesions in patients without obvious biceps pathology or degenerative labral tearing.

History of repairs

In the days before the development of suture anchors, type II SLAP lesions were treated with simple debridement and abrasion of the glenoid bone in an attempt to promote bony healing. On second-look arthroscopy in the Snyder et al study,[50] 40% had not healed. In addition, longer-term outcomes from debridement were noted to deteriorate over time.[2,9] Subsequently, an array of different fixation techniques were to date, including staples, transosseous sutures, bioabsorbable tacks, cannulated screw fixation, and suture anchors.[5,7,12,14,41,42,44,50,54] Because of concerns related to loose body formation and synovitis from bioabsorbable tacks and staples,[6,41] current surgical techniques are performed using suture anchors. All of the surgical reviews published since 2007 have used suture anchor technique.[1,4,5,11,14,20,55]

The clinical data published on SLAP repairs to date in 2010 have been level III, IV, or V evidence, using a variety of techniques and different outcomes measures. Unfortunately, there is no validated outcome measure for the treatment of SLAP lesions, and therefore, all published studies must use nonvalidated tools. The published studies generally report overall good results after SLAP repair, with varying degrees of success. ''Excellent'' results have been reported in 15% to 30% of patients,[10,14,20] and ''good or excellent'' combination results have been reported in 40% to 94% of patients. All recent studies report significant improvement in outcomes after surgical repair.[1,4,5,11,14,20,29,55]

Because type II SLAP lesions generally affect younger, more active patients, results other than ''excellent'' can be disappointing to patients and physicians alike. There is no validated outcome measure specific to SLAP lesions, so the ability of nonvalidated tools to properly reflect success or failure of surgery must be questioned.

SLAP tears are common in overhead throwing patients, and several studies have reported inferior outcomes in this group.[5,20,30,55] A recent systematic literature review of type II SLAP repair outcomes by Gorantla et al[17] reported that only about 64% of overhead athletes were able to return to their preinjury level of play and that the rate of baseball players returning was lower than that for other overhead athletes.

A recent level III prospective study by Boileau et al[4] compared the outcomes of type II SLAP repair with suture anchors vs arthroscopic biceps tenodesis. The patients were not randomized, the SLAP repair patients were an average age of 15 years younger than the tenodesis patients (37 vs 52 years), and there were only 25 patients overall (10 repairs, 15 tenodeses). However, the authors reported significantly better results in the patients with biceps tenodesis, noting that 80% the patients in the tenodesis group were subjectively satisfied compared with 40% in the repair group. In the tenodesis group, 87% of athletes returned to their previous level of sports participation compared with 20% in the SLAP group. The significant difference in ages between the groups must be noted, and the number of baseball players in this French study was not stated; however, 3 patients who underwent revision tenodesis for a failed repair all subsequently returned to overhead sports. The authors concluded that arthroscopic tenodesis is a reliable alternative to SLAP repair and can also be useful in revision surgery if the initial repair fails.

In a randomized controlled study evaluating patients with SLAP lesions undergoing concomitant rotator cuff repairs, Franceschi et al[13] reported that patients aged older than 50 years who had biceps tenotomy had superior clinical outcomes than those with SLAP repair. Of course, this is a different subset of patients than those who are younger with isolated SLAP tears, but one might assume that some of the same factors related to treating SLAP pathology were involved in the outcomes of this level I study.

Discussion and recommendations

The reason for unsatisfactory outcomes after some SLAP repairs is not well understood and remains the subject of debate. As discussed, properly diagnosing SLAP tears is difficult, and the injury is likely often overdiagnosed and unnecessarily ''fixed.'' The ideal surgical technique, using suture anchors or otherwise, is not well understood, nor is the ideal postoperative rehabilitation program or the biologic healing potential of these repairs. The action of the biceps tendon on the repair is another uncertainty. Stabilizing a symptomatic detached biceps is believed to be of primary importance, but overconstraining or shortening the tendon is likely detrimental.

It is unclear whether the preoperative pain is generated from the labrum, the biceps, the anterior ligaments, or from all of these structures. In overhead athletes, the chronic attritional loads placed on the superior labrum in the late cocking stage of throwing may be too high for even a repaired labrum to withstand, but the pain associated is likely multifactorial and related to a number of other issues such as pitch counts, throwing mechanics, internal rotation deficits and rotator cuff ''internal impingement.''

From our 25-plus years of experience, we have developed a genuine respect for the SLAP tear. Pending more definitive research, each physician is obliged to make a treatment decision based on his or her best judgment to treat each individual patient. Our recommendations are based on a combination of experience and research to date and must be viewed as recommendations only. Each case of a suspected SLAP lesion must be evaluated on its own

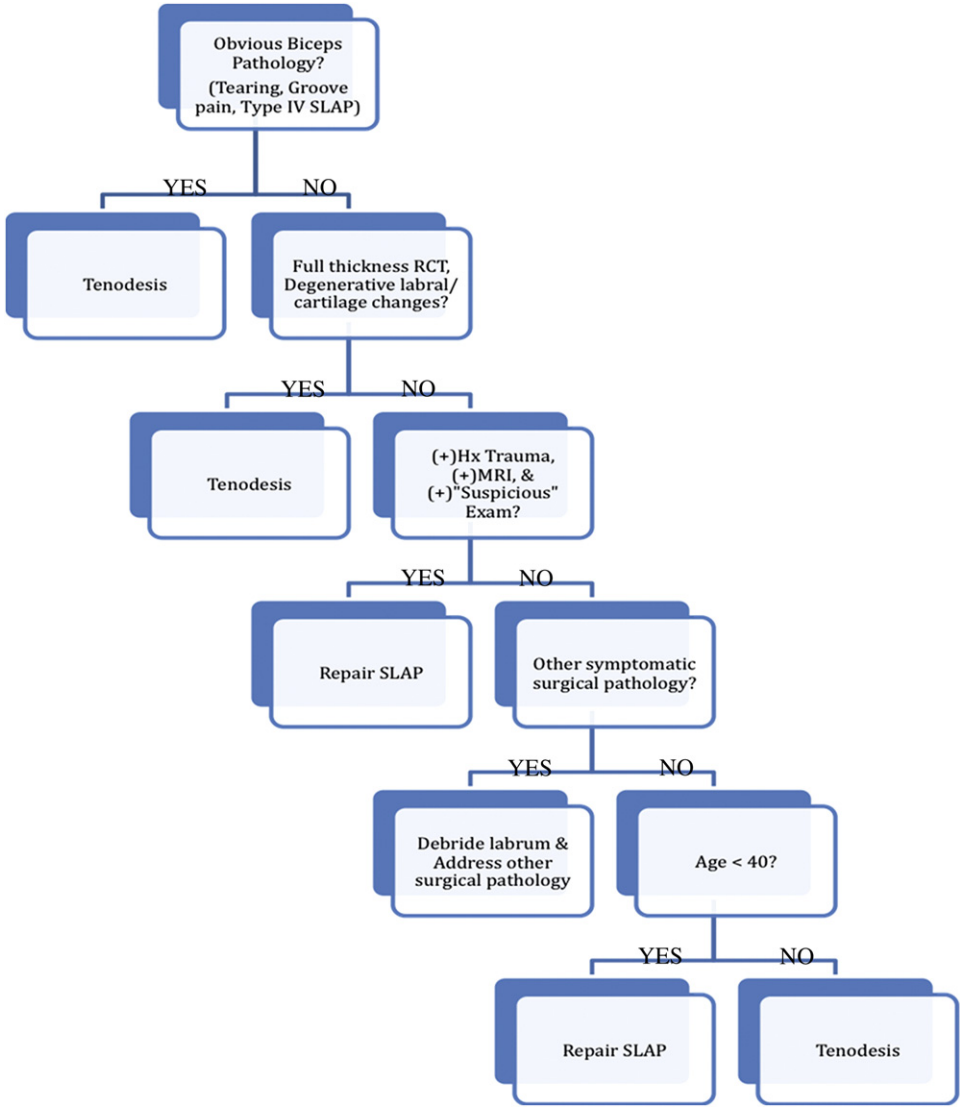

Figure 3 Current Southern California Orthopedic Institute treatment algorithm for superior labrum, anterior-to-posterior (SLAP) tears.

merits, and the surgeon must be prepared to perform both a safe and reliable tenodesis or SLAP repair when required. Figure 3 outlines our current decision-making algorithm.

In the presence of significant biceps pathology such as degenerative tearing, a type IV SLAP tear with greater than 50% of the biceps damaged, or significant biceps groove symptoms, patients with SLAP lesions will be treated with a biceps tenodesis. Similarly, if a patient with a SLAP lesion has significant concomitant pathology such as a full-thickness rotator cuff tear, degenerative osteoarthritis, or significant degenerative labral changes, these patients will be treated with tenodesis or tenotomy as well.

As stated, the best candidates for type II SLAP repair are younger patients with all of the following: a history of acute trauma, a ''suspicious'' physical examination with one or more positive SLAP signs, an MRI arthrogram positive for a SLAP lesion and/or perilabral cyst formation, and detachment of the superior labrum without biceps pathology seen on arthroscopy. When these criteria are met, we prefer to repair superior labral tears with 1 double-loaded anchor placed at the 12 o'clock position exactly in the biceps tubercle under the center of the biceps detachment. Using a shuttling technique, we pass both sutures directly *across* the biceps anchor with a single shuttling stitch, taking care not to pass the sutures through the lateral biceps away from its origin, which would cause shortening of the tendon. One suture is tied on each side of the tendon, creating a balanced but nonstrangulating repair (Fig. 4). A second anchor may be placed posteriorly if necessary, but we strictly avoid anchors anterior to the biceps unless the labral tear has resulted in detachment of the middle glenohumeral ligament.

If all the criteria for SLAP repair are not met, and a patient has significant concomitant surgical pathology, such as symptomatic acromioclavicular arthrosis, recurrent instability, or loose bodies, we prefer to focus on the major surgical pathology

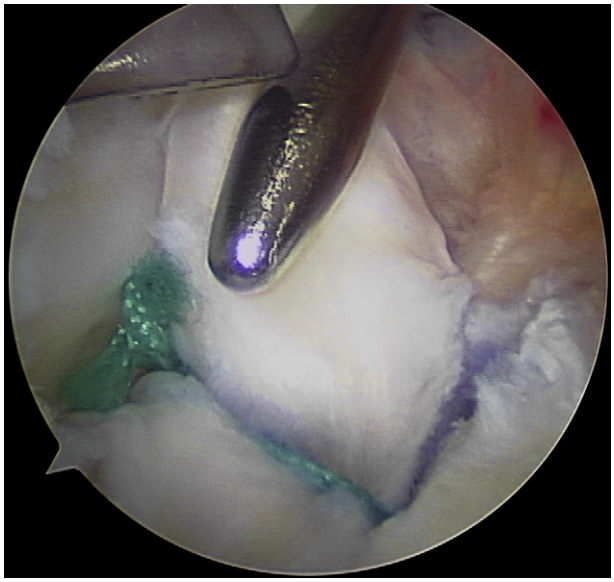

Figure 4 Arthroscopic view shows a completed single-anchor, double-suture repair of a type II superior labrum anterior-to-posterior (SLAP) lesion. The sutures are placed in a balanced, nonstrangulating manner, restoring an anatomical appearance.

and debride labral tearing down to a stable base. In situations where a patient has a significant instability lesion or cuff tear in addition to a SLAP lesion, the surgeon must decide if superior labral repair is appropriate.

Age is a relative indication for tenodesis only. Surgical decision making for patients in their 30s and 40s continues to be a difficult process. A study by Alpert et al[1] showed no difference in outcomes after SLAP repair in patients aged older or younger than 40 years. However, age becomes the most significant factor for patients who get to this point in the algorithm with suggestive symptoms but who do not meet all SLAP criteria (history of trauma, positive MRI, positive exam findings, normal biceps tendon) nor have other obvious surgical pathology (ie, rotator cuff tears). We believe that age does affect the outcomes of SLAP repair to some degree. These patients aged younger than 40 years are usually repaired, whereas patients physiologically older than 40 are usually tenodesed.

SLAP lesions in overhead throwing athletes are usually repaired in appropriate patients. We believe that restoring the patient's normal anatomy is preferable to tenodesis in most cases. The patients are carefully counseled and told they have no guarantee of full recovery and that a biceps tenodesis may be a necessary revision procedure if the primary repair fails to heal acceptably.

In the future, we are challenged to improve our understanding of anatomy. Although we understand that the meniscoid superior labrum and Buford complexes are normal variants, we have personally noticed a high correlation of these variants with SLAP tear imaging and symptoms, raising the question of whether these variants potentially predispose a shoulder to superior labral injury.

There may also be a role for superior labral repair combined with tenodesis because an unstable labrum can theoretically continue to cause pain, even after biceps detachment. High-level research involving prospective, randomized data will be necessary to elucidate on this interesting and complex issue.

Disclaimer

Dr Snyder is a consultant for Conmed/Linvatec and receives royalties from sales of several of the products included in this article. No source of support was received in the form of grants, equipment, or other items. The other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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