

5 Points on Biceps Tenodesis and Superior Labrum Anterior to Posterior (SLAP) Tears

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Injuries of the superior labrum–biceps complex (SLBC) have been recognized as a cause of shoulder pain since they were first described by Andrews and colleagues¹ in 1985. Superior labrum anterior to posterior (SLAP) tears are relatively uncommon injuries of the shoulder, and their true incidence is difficult to establish. However, recently there has been a significant increase in the reported incidence and operative treatment of SLAP tears.² SLAP tears can occur in isolation, but they are commonly seen in association with other shoulder lesions, including rotator cuff tear, Bankart lesion, glenohumeral arthritis, acromioclavicular joint pathology, and subacromial impingement.

Although SLAP tears are well described and classified,³⁻⁶ our understanding of symptomatic SLAP tears and of their contribution to glenohumeral instability is limited. Diagnosing a SLAP tear on the basis of history and physical examination is a clinical challenge. Pain is the most common

presentation of SLAP tears, though localization and characterization of pain are variable and nonspecific.⁷ The mechanism of injury is helpful in acute presentation (traction injury; fall on outstretched, abducted arm), but an overhead athlete may present with no distinct mechanism other than chronic, repetitive use of the shoulder.⁸⁻¹¹ Numerous provocative physical examination tests have been used to assist in the diagnosis of SLAP tear, yet there is no consensus regarding the ideal physical examination test, with high sensitivity, specificity, and accuracy.¹²⁻¹⁴ Magnetic resonance arthrography, the gold standard imaging modality, is highly sensitive and specific (>95%) for diagnosing SLAP tears.

SLAP tear management is based on lesion type and severity, age, functional demands, and presence of coexisting intra-articular lesions. Management options include non-operative treatment, débridement or repair of SLBC, biceps tenotomy, and biceps tenodesis.¹⁵⁻¹⁹

In this 5-point review, we present an evidence-based analysis of the role of the SLBC in glenohumeral stability and the role of biceps tenodesis in the management of SLAP tears.



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1 Role of SLBC in stability of glenohumeral joint

The anatomy of the SLBC has been well described,^{20,21} and there is consensus that SLBC pathology can be a source of shoulder pain. The superior labrum is relatively more mobile than the rest of the glenoid labrum, and it provides attachment to the long head of the biceps tendon (LHBT) and the superior glenohumeral and middle glenohumeral ligaments.

The functional role of the SLBC in glenohumeral stability and its contribution to the pathogenesis of shoulder instability are not clearly defined. Our understanding of SLBC function is largely derived from simulated cadaveric experiments of SLAP tears. Controlled laboratory studies with simulated type II SLAP tears in cadavers have shown significantly increased glenohumeral translation in the anterior-posterior and superior-inferior directions, suggesting a role of the superior labrum in maintaining glenohumeral stability.²²⁻²⁶ Interestingly, there is conflicting evidence regarding restoration of normal glenohumeral translation in cadaveric shoulders after repair of simulated SLAP lesions in the presence or absence of simulated anterior capsular laxity.^{22,25-27} However, it is important to understand the limitations of cadaveric experiments in order to

appreciate and truly comprehend the results of these experiments. There are inconsistencies in the size of simulated type II SLAP lesions in different studies, which can affect the degree of glenohumeral translation and the results of repair.^{23-25,28} The amount of glenohumeral translation noticed after simulated SLAP tears in cadavers, though statistically significant, is small in amplitude, and its relevance may not translate to a clinically significant level. The impact of dynamic components of stability (eg, rotator cuff muscles), capsular stretch, and other *in vivo* variables that affect glenohumeral stability are unaccounted for during cadaveric experiments.

LHBT is a recognized cause of shoulder pain, but its contribution to shoulder stability is a point of continued debate. According to one school of thought, LHBT is a vestigial structure that can be sacrificed without any loss of stability. Another school of thought holds that LHBT is an important active stabilizer of the glenohumeral joint. Cadaveric studies have demonstrated that loading the LHBT decreases glenohumeral translation and rotational range of motion, especially in lower and mid ranges of abduction.^{23,29,30} Furthermore, LHBT contributes to anterior glenohumeral stability by resisting torsional forces in the abducted and externally rotated shoulder and reducing stress on the inferior glenohumeral ligaments.³¹⁻³³ Strauss and colleagues²² recently found that simulated anterior and posterior type II SLAP lesions in cadaveric shoulders increased glenohumeral translation in all planes, and biceps tenodesis did not further worsen this abnormal glenohumeral translation. Furthermore, repair of posterior SLAP lesions along with biceps tenodesis restored abnormal glenohumeral translation with no significant difference from the baseline in any plane of motion. Again, the limitations of cadaveric studies should be considered when interpreting these results and applying them clinically.

2 Biceps tenodesis as primary treatment for SLAP tears

A growing body of evidence suggests that primary tenodesis of LHBT may be an effective alternative treatment to SLAP repairs in select patients.³⁴⁻³⁶ However, the evidence is weak, and high-quality studies comparing SLAP repair and primary biceps tenodesis are required in order to make a strong recommendation for one technique over another. Gupta and colleagues³⁵ retrospectively analyzed 28 cases of concomitant SLAP tear and biceps tendonitis treated with primary open subpectoral biceps tenodesis. There was significant improvement in patients' functional outcome scores postoperatively [SANE (Single Assessment Numeric Evaluation), ASES (American Shoulder and Elbow Surgeons shoulder index), SST (Simple Shoulder Test), VAS (visual analog scale), and SF-12 (Short Form-12)]. In addition, 80% of patients were satisfied with their outcome. Mean age was 43.7 years. Forty-two percent of patients had a worker's compensation claim. Interestingly, 15 patients in this cohort had a type I SLAP tear. Boileau and colleagues³⁴ prospectively followed 25 cases of type II SLAP tear treated with either SLAP repair (10 patients; mean age, 37 years) or

primary arthroscopic biceps tenodesis (15 patients; mean age, 52 years). Compared with the SLAP repair group, the biceps tenodesis group had significantly higher rates of satisfaction and return to previous level of sports participation. However, group assignments were nonrandomized, and the decision to treat a patient with SLAP repair versus biceps tenodesis was made by the senior surgeon purely on the basis of age (SLAP repair for patients under 30 years). Ek and colleagues³⁶ retrospectively compared the cases of 10 patients who underwent SLAP repair (mean age, 32 years) and 15 who underwent biceps tenodesis (mean age, 47 years) for type II SLAP tear. There was no significant difference between the groups with respect to outcome scores, return to play or preinjury activity level, or complications.

There continues to be significant debate as to which patient will benefit from primary SLAP repair versus biceps tenodesis. Multiple factors are involved: age, presence of associated shoulder pathology, occupation, preinjury activity level, and worker's compensation status. Age has convincingly been shown to affect the outcomes of treatment of type II SLAP tears.^{34,35,37-40} There is consensus that patients over age 40 years will benefit from primary biceps tenodesis for SLAP tears. However, the evidence for this recommendation is weak.

3 Biceps tenodesis and failed SLAP repair

The definition of a failed SLAP repair is not well documented in the literature, but dissatisfaction after SLAP repair can result from continued shoulder pain, poor shoulder function, or inability to return to preinjury functional level.^{15,41} The etiologic determination and treatment of a failed SLAP repair are challenging, and outcomes of revision SLAP repair are not very promising.^{42,43} Biceps tenodesis has been proposed as an alternative treatment to revision SLAP repair for failed SLAP repair. McCormick and colleagues⁴¹ prospectively evaluated 42 patients (mean age, 39.2 years; minimum follow-up, 2 years) with failed type II SLAP repairs that were treated with open subpectoral biceps tenodesis. There was significant improvement in ASES, SANE, and Western Ontario Shoulder Instability Index (WOSI) outcome scores and in postoperative shoulder range of motion at a mean follow-up of 3.6 years. One patient had transient musculocutaneous neurapraxia after surgery. In a retrospective cohort study, Gupta and colleagues⁴⁴ found significant improvement in ASES, SANE, SST, SF-12, and VAS outcome scores in 11 patients who underwent open subpectoral biceps tenodesis for failed arthroscopic SLAP repair (mean age at surgery, 40 years; mean follow-up, 26 months). Three of the 11 patients had worker's compensation claims, and there were no complications and no revision surgeries required after biceps tenodesis. Werner and colleagues¹⁶ retrospectively evaluated 17 patients who underwent biceps tenodesis for failed SLAP repair (mean age, 39 years; minimum follow-up, 2 years). Twenty-nine percent of patients had worker's compensation claims. Compared with the contralateral shoulder, the treated shoulder had better postoperative ASES, SANE, SST,

and Veteran RAND 36-item health survey outcome scores; range of motion was near normal.

There are no high-quality studies comparing revision SLAP repair and biceps tenodesis in the management of failed SLAP repair.^{16,41-44} Case series studies have found improved outcomes and pain relief after biceps tenodesis for failed SLAP repair, but the quality of evidence has been poor (level IV evidence).^{16,41-44} The senior author recommends treating failed SLAP repairs with biceps tenodesis.

4 Biceps tenodesis as treatment option for SLAP tear in overhead throwing athletes

Biceps tenodesis is a potential alternative treatment to SLAP repair in overhead throwing athletes. Although outcome scores and satisfaction rates after SLAP repair are high in overhead athletes, the rates of return to sport are relatively low, especially in baseball players.^{38,45-47} In a level III cohort study, Boileau and colleagues³⁴ found that 13 (87%) of 15 patients with type II SLAP tears, including 8 overhead athletes, had returned to their previous level of activity by a mean of 30 months after biceps tenodesis. In contrast, only 2 of 10 patients returned to their previous level of activity after SLAP repair. Interestingly, 3 patients who underwent biceps tenodesis for failed SLAP repair returned to overhead sports. Schöffl and colleagues⁴⁸ reported on the outcomes of biceps tenodesis for SLAP lesions in 6 high-level rock climbers. By a mean follow-up of 6 months, all 6 patients had returned to their previous level of climbing. Their satisfaction rate was 96.8%. Gupta and colleagues³⁵ reported on a cohort of 28 patients who underwent biceps tenodesis for SLAP tears and concomitant biceps tendonitis. Of the 8 athletes in the group, 5 were able to return to their previous level of play, and 1 was able to return to a lower level of sporting activity. There was significant improvement from preoperative to postoperative scores on ASES, SST, SANE, VAS, SF-12 overall, and SF-12 components.

Chalmers and colleagues⁴⁹ recently described motion analyses with simultaneous surface electromyographic measurements in 18 baseball pitchers. Of these 18 players, 7 were uninjured (controls), 6 were pitching after SLAP repair, and 5 were pitching after subpectoral biceps tenodesis. There were no significant differences between controls and postoperative patients with respect to pitching kinematics. Interestingly, compared with the controls and the patients who underwent open biceps tenodesis, the patients who underwent SLAP repair had altered patterns of thoracic rotation during pitching. However, the clinical significance of this finding and the impact of this finding on pitching efficacy are not currently known.

Biceps tenodesis as a primary procedure for type II SLAP lesion in an overhead athlete is a concept in evolution. Increasing evidence suggests a role for primary biceps tenodesis in an overhead athlete with type II SLAP lesion and concomitant biceps pathology. However, this evidence is of poor quality, and the strength of the recommendation is weak. Still to be determined is whether return to preinjury

performance level is better with primary biceps tenodesis or with SLAP repair in overhead athletes with type II SLAP lesion. As per the senior author's treatment algorithm, we prefer SLAP repair for overhead athletes with type II SLAP tears and reserve biceps tenodesis for cases involving significant biceps pathology and/or clinical symptoms involving the bicipital groove consistent with extra-articular biceps pain.

5 Biceps tenodesis for type II SLAP tear in contact athletes and occupations demanding heavy labor (blue-collar jobs)

SLAP tears are less common in contact athletes, and there is general agreement that SLAP repair outcomes are better in contact athletes than in overhead athletes. In a retrospective review of 18 rugby players with SLAP tears, Funk and Snow⁵⁰ reported excellent results and quicker return to sport after SLAP repair. Patients with isolated SLAP tears had the earliest return to play. Enad and colleagues⁵¹ reported SLAP repair outcomes in an active military population. SLAP tears are more common in the military versus the general population because of the unique physical demands placed on military personnel. The authors retrospectively reviewed 27 cases of type II SLAP tears treated with SLAP repair and suture anchors. Outcomes were measured at a mean of 30.5 months after surgery. Twenty-four (89%) of the 27 patients had good to excellent results, and 94% had returned to active duty by a mean of 4.4 months after SLAP repair.

Given the poor-quality evidence in the literature, we believe that biceps tenodesis should be reserved for revision surgery in contact athletes. There is insufficient evidence to recommend biceps tenodesis as primary treatment for type II SLAP tears in contact athletes. SLAP repair should be performed for primary SLAP lesions in contact athletes and for patients in physically demanding professions (eg, military, laborer, weightlifter).

Conclusion

SLAP tears can result in persistent shoulder pain and dysfunction. SLAP tear management depends on lesion type and severity, age, and functional demands. SLAP repair is the treatment of choice for type II SLAP lesions in young, active patients. Biceps tenodesis is a preferred alternative to SLAP repair in failed SLAP repair and in type II SLAP patients who are older than 40 years and who are less active and have a worker's compensation claim. These recommendations are based on poor-quality evidence. There is an unmet need for randomized clinical studies comparing SLAP repair with biceps tenodesis for type II SLAP tears in different patient populations so as to optimize the current decision-making algorithm for SLAP tears.

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