Effect of Anterior Anchor on Clinical Outcomes of Type II SLAP Repairs in an Active Population

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abstract

This study evaluated the role of anchor position in persistence of pain and/or revision biceps tenodesis after arthroscopic repair of type II superior labrum anterior and posterior (SLAP) lesions and assessed for patient- and injury-specific variables influencing clinical outcomes. Active-duty service members who underwent arthroscopic repair of type II SLAP lesions between March 1, 2007, and January 23, 2012, were identified. Patients with less than 2-year clinical follow-up; type I, III, and IV SLAP lesions; and primary treatment with biceps tenodesis and/or rotator cuff repair at the time of index surgery were excluded. Demographic, preoperative, and operative variables, including anchor positions, were reviewed and evaluated for association with outcomes. Total failure rate (defined as either surgical and/or clinical failure), anchor position, and return to military function were the primary outcomes of interest. Forty-nine patients underwent type II SLAP repairs with a mean follow-up of 52.3 months. Forty-eight (97.9%) were men, and mean age was 35.2 years. Eleven patients (22%) underwent subsequent subpectoral biceps tenodesis. Forty patients (82%) returned to military function, whereas 9 patients (18%) had medical discharge for significant, rate-limiting, shoulder pain. Age was a significant predictor of surgical failure. Patients with anchor position anterior to the biceps attachment had no increased risk of clinical or surgical failure compared with patients with only posterior-based anchors. Anchor placement anterior to the biceps tendon was not associated with inferior outcomes. Younger age was shown to be a poor prognostic factor in patients' ability to return to active duty. Revision with biceps tenodesis showed significant utility in achieving good clinical outcomes and return to duty in more than 90% of patients. Patient-, injury-, and surgery-specific variables need to be identified as prognostic indicators so that clinical outcomes can continue to be improved. [*Orthopedics*. 2019; 42(1):e32-e38.]

Superior labrum anterior and posterior (SLAP) lesions are recognized as a significant cause of shoulder pain in young patients, particularly those engaged in overhead activities.[1-3] Military service members have been identified as having a greater risk of biceps–superior labral complex injury when compared with their civilian counterparts,[4-6] with disproportionately higher incidence rates of up to 38.6% vs 11.1%, respectively.[6] This preponderance of SLAP injuries in the military population may be attribut-

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able to the high physical demands and frequent at-risk activity in the line of duty.[5]

Although multiple repair techniques and fixation methods with varying degrees of successful clinical outcomes have been described for SLAP lesions, overhead athletes and active-duty military personnel have had comparatively worse results, particularly in terms of return to high-demand activity, such as return to sport or return to military function.[7,8] Thus, treating highly active individuals with SLAP lesions remains a challenge. Few have sought to identify patient-, injury-, and surgery-specific variables that influence clinical outcomes following SLAP repair.[4,5,9] Recently, variables of interest, including method of fixation (ie, suture configuration, knotless vs knotted), anchor position, patient age, and mechanism of injury, have been evaluated. In addition, novel techniques for arthroscopic anatomic repair aiming to improve clinical outcomes and sports performance have been recently described.[10-12] However, whereas some have described routine or selective anterior anchor placement with suture passage anterior to the biceps anchor,[13] others have exercised caution with this technique because of concerns about overconstraint of the anterior-superior labrum, incarceration of the proximal biceps attachment, and/or knot prominence, especially in overhead throwing athletes.[14] Repairs of SLAP lesions may fail for a multitude of reasons, leading to significant pain and functional limitation. The approach to management of failed SLAP repairs remains a topic of debate, with many authors reporting high clinical utility of salvage biceps tenodesis.[15,16] In fact, several authors have recently reported a decreasing incidence of SLAP repairs and an increasing incidence of biceps tenodesis for primary management of SLAP pathology.[17,18]

The purpose of this study was to evaluate the role of anchor position and points of fixation in persistence of pain and/or revision biceps tenodesis after arthroscopic repair of type II SLAP lesions and to assess the role of patient- and injury-specific variables in overarching clinical outcomes. The authors hypothesized that fixation anterior to the biceps anchor attachment and more points of fixation would contribute to an increased risk of failed SLAP syndrome and reoperation due to persistent biceps–labral symptoms. Additionally, the authors postulated that older age and absence of traumatic injury would be associated with inferior outcomes.

Materials and Methods

After institutional review board approval was obtained, a retrospective query was performed to identify consecutive active-duty service members undergoing arthroscopic repair of type II SLAP lesions with 3-mm biocomposite suture anchors at a single teaching hospital between March 1, 2007, and January 23, 2012. Patients were identified using the Military Health System Management Analysis and Reporting Tool and electronic Surgical Scheduling System. This database represents a repository for all direct and purchased medical care occurring within the Military Health System among an at-large population of 9.5 million beneficiaries under the US Department of Defense.

Independent review of the electronic medical record (Armed Forces Health Longitudinal Technology Application version 3.6.0; 3M Health Information Systems, Salt Lake City, Utah) was performed to confirm the accuracy of clinical diagnosis and surgical treatment. Exclusion criteria were applied to the following: less than 2-year clinical follow-up; nonmilitary status; absence of SLAP repair; treatment of type I, III, and IV SLAP; and primary treatment with biceps tenodesis and/or rotator cuff repair at the time of index surgery. Demographic variables (age, sex, rank, and military occupational specialty [defined as 1 of the following: subspecialized infantry, armor, artillery, air defense artillery, and aviation occupational specialists]), laterality, injury characteristics (eg, presence of traumatic injury event), and surgical history were extracted during line-by-line analysis of the medical record. Surgical variables (number of suture anchors, anchor position as reflected by clock face annotation and location relative to the biceps anchor), clinical outcomes, and rates of persistent biceps–labral symptomatology (ie, clinical failure) or revision surgery (eg, biceps tenodesis, SLAP repair) were extracted and verified from the electronic medical record. Surgical and clinical failure were not considered mutually exclusive events; thus, patients could have failed index SLAP repair surgically and been medically discharged. In addition, clinical course was analyzed to determine surgical variables (perioperative complications, concomitant/secondary procedures, revision) and occupational outcomes (medical discharge, return to military duty, permanent activity limitations).

For the purposes of this study, surgical failure was defined as secondary surgery related to primary repair of a type II SLAP lesion, including revision SLAP repair and/or biceps tenodesis. Additionally, clinical failure was defined as initiation of a medical discharge for persistent shoulder complaints, with confirmation through the US Army Physical Disability Agency database. Total failure rate (defined as either surgical and/or clinical failure), anchor position, and return to military duty were primary outcomes of interest.

Statistical Analysis

Univariate and Poisson multivariate regression analyses were used to determine the association between the identified variables and defined rates of failure in the current study, and odds ratios (ORs) were determined. Significant independent predictors were determined to be those that maintained $P<.05$ with OR. Calculations were performed using SAS version 9.2 software (SAS Institute, Cary, North Carolina).

Table 1

Demographic and Surgical History Data for the 49 Patients

Variable	Value
Demographic	
Age, mean (range), y	35.2 (21-54)
Sex, male:female, No.	48:1
Tobacco use, No.	21 (43%)
Enlisted service member, No.	43 (88%)
Dominant shoulder injury, No.	29 (59%)
Combat military occupational specialty, No.	24 (49%)
Mechanism of injury	
Trauma, No.	24 (49%)
Surgical variable	
Anterior anchor placement, No.	46 (94%)
Anchors, mean (range), No.	2.4 (1-5)

Surgical Technique

All of the surgeries were performed at a single institution. Isolated SLAP repairs were performed with patients in the beach chair position using a shoulder positioner (Trimano [Arthrex, Naples, Florida] or Spyder [Smith & Nephew, London, United Kingdom]) with slightly modified 3-portal arthroscopy. The posterior viewing portal was placed slightly more proximal and lateral than standard. An anterosuperior portal was placed to allow manipulation on either side of the biceps, and a mid-anterior portal was placed.

Standard diagnostic arthroscopy was undertaken, and stability of the biceps–labral complex was evaluated. Care was taken to identify and discern between normal sublabral sulcus and anterosuperior labral variants, such as a sublabral foramen or Buford complex. Depending on the extent of injury, loose labral tissue was debrided from the rim using a 4-mm shaver, and a tissue elevator was used to develop a clean plane for subsequent repair. Light burring with either a 4-mm barrel burr or shaver was performed, followed by use of a rasp to develop a bleeding bony bed for subsequent repair. Two 7- or 8.25-mm cannulas were used, and 3-mm biocomposite anchors (Biosuture-tak [Arthrex] or Gryphon [DePuy Mitek, Raynham, Massachusetts]) were placed either through existing portal sites or percutaneously through the portal of Wilmington. Retrograde suture passage was then accomplished using tissue-penetrating devices or suture-shuttling techniques (Suturelasso; Arthrex) to achieve isolated simple or alternating simple and mattress configurations. Arthroscopic knot tying was performed using a modified Roeder knot through the anterosuperior portal, and knot stacks were directed medially away from the articular surface to avoid iatrogenic chondral damage or persistent mechanical symptoms. The points and position of anchor fixation were not standardized and varied based on the extent of injury and surgeon preference; however, 1 to 2 anchors placed posterior to the biceps anchor (11- and 12-o'clock positions on a right shoulder; 12- and 1-o'clock positions on a left shoulder) was the most common configuration. However, if the SLAP tear extended anteriorly with involvement of the biceps anchor, additional anterior anchor fixation was considered at the discretion of the operating surgeon, with care taken not to overconstrain the superior glenohumeral ligament or proximal biceps attachment during suture passage and knot tying. Final stability was assessed after labral fixation, and portals were closed in standard fashion.

Rehabilitation Protocol

At the authors' institution, the physical therapy protocol for SLAP consisted of initial sling immobilization for 6 weeks. For the first week, supported pendulum exercises and shoulder shrugs or scapular retraction (without resistance) were encouraged. After 1 week, full pendulum exercises were started. Active assist motion was started in the supine position with a wand and continued until 6 weeks postoperatively. After 6 weeks, sling immobilization was discontinued and full active range of motion was encouraged with resistance exercises. Additional rotator cuff exercises and shoulder strengthening exercises were progressively added to allow a return to full activity at 4 to 6 months.

Results

A total of 49 patients who underwent type II SLAP repairs were isolated. They had a mean follow-up of 52.3 months (range, 27-86 months). Most of the cohort (97.9%, n=48) were men. Mean age was 35.2 years (range, 21-54 years). Twenty-four patients (49%) had high-demand combat military occupational specialties. Demographic information is provided in **Table 1**.

Injury history revealed that 49% (n=24) of the patients reported a history of an inciting traumatic event. Twenty-nine patients (59%) had a SLAP injury in their dominant extremity. At final follow-up, activity-related anterior shoulder pain was identified in 17 (35%) patients, and 4 (8%) patients reported continuous subjective shoulder stiffness without objective losses in range of motion. The average self-reported pain score at final follow-up was 2.6 (SD, 1.8; range, 0-8). Furthermore, surgical failure was reported in 11 patients (22%) with subsequent arthroscopic debridement and salvage open, subpectoral biceps tenodesis (**Table 2**). Of these patients with secondary surgery, 10 (91%) were able to return to a preinjury status and complete function of the operative extremity and 1 (9%) underwent medical evaluation board review.

At final follow-up, 40 patients (82%) had returned to military function, whereas 9 patients (18%) had medical discharge for significant, rate-limiting, shoulder pain postoperatively and were classified as clinical failures. Three patients (7.5%)

Table 2

Clinical and Functional Outcomes of Type II SLAP Repair (N=49)

Outcome	No.
Subjective postoperative stiffness	4 (8%)
Activity-related pain	17 (35%)
Revision biceps tenodesis (surgical failure)	11 (22%)
Medical discharge (clinical failure)	9 (18%)
Return to military function	40 (82%)

Abbreviation: SLAP, superior labrum anterior and posterior.

Table 3

Associations Between Demographic Variables and Surgical Failure, Clinical Failure, and Overall Failure Based on Regression Analyses

Failure and Variable	Odds Ratio	*P*
Clinical failure		
Age	0.96	.427
Trauma	1.67	.480
Total number of anchors	0.86	.709
Dominant vs nondominant shoulder	0.73	.651
Tobacco use	2.63	.177
Surgical failure		
Age	0.89	.039
Trauma	1.32	.712
Total number of anchors	1.41	.405
Dominant vs nondominant shoulder	0.78	.741
Tobacco use	1.24	.786
Overall failure		
Age	0.92	.062
Trauma	1.43	.552
Total number of anchors	1.19	.617
Dominant vs nondominant shoulder	0.59	.374
Tobacco use	1.93	.282

who returned to military function required permanent occupational limitations. Traumatic injury and age were not shown to be significant predictors of clinical or overall failure; however, age was shown to be a significant predictor of surgical failure (OR, 0.89; *P*=.039). Patients with anchor position anterior to the biceps attachment (n=46, 93.9%) had no increased risk of clinical or surgical failure (37.8%) when compared with those with only posterior-based anchors (50%; *P*=.66). Similarly, the total number of suture anchors (mean, 2.4; range, 1-5) was not associated with failure rate (OR, 1.19; *P*=.617) (**Table 3**).

Discussion

The principle findings of this study indicate that (1) anchor placement anterior relative to the biceps tendon had no significant association with inferior outcomes (*P*=.66), (2) younger age was shown to be significantly associated (*P*=.039) with medical discharge of service members due to persistent symptoms following SLAP repair, and (3) a history of traumatic injury, tobacco use, injury of dominant arm, and number of anchors were not shown to be correlated with surgical, clinical, or overall failure. Together, these findings can be used to counsel patients, particularly highly active patients, about variables specific to their case that may potentially affect their outcome. In addition, these findings provide evidence that anterior anchor placement does not lead to inferior outcomes in an active, non-throwing population.

The results of the current study reveal mostly positive clinical outcomes after arthroscopic type II SLAP repair, as 82% of patients were able to return to military function. However, 35% of patients continued to have activity-related pain, and 18% had medical discharge due to their shoulder. Others have reported positive outcomes in highly active populations, including athletes, following SLAP repairs. Friel et al[19] reported significant improvements in numerous patient-reported outcome scores in a predominantly young, active cohort of 48 patients at an average follow-up of 3.4 years. Further, 80% of patients reported good to excellent outcomes on University of California–Los Angeles score, with 89% stating they would have the surgery again.[19] Similarly, in a recent study of 192 active-duty service members who underwent isolated and combined type II SLAP repair with an average follow-up of 50 months, Waterman et al[4] reported that 79.6% of patients returned to duty. These positive outcomes corroborate the findings of the current study that SLAP repair can provide favorable outcomes in a young, active patient population.

Others have investigated variables associated with favorable or inferior clinical outcomes. In a recent prospective study of 179 young, active patients treated arthroscopically with suture anchors and a vertical suture construct with a mean

follow-up of 40.4 months, Provencher et al[5] found that 36.8% of the patients were classified as failed SLAP repairs, defined by an American Shoulder and Elbow Surgeons score below 75, subsequent revision surgery (28%), or an inability to return to military duty. The authors reported that older age (>36 years, *P*<.01) was associated with higher likelihood of failure; however, no significant associations between mechanism of injury (traumatic vs atraumatic), smoking history, or individual preoperative patient-reported outcomes and failure of SLAP repair were identified.[5] Similarly, Frank et al[20] sought to determine prognostic variables associated with failure in a retrospective study of 62 patients at an average follow-up of 3.3 years. They reported that age older than 40 years, alcohol and tobacco use, coexisting diabetes, high demand or overhead lifting at work, and numerous positive physical examination maneuvers (eg, O'Brien's, Speed's, and Yergason's) were associated with postoperative American Shoulder and Elbow Surgeons score less than 50 (clinical failure).[20] Although both of these studies showed an association between older age and failure following SLAP repair, this finding has not been consistently reported throughout the literature nor was it reported in the current study.

In contrast to Frank et al,[20] Alpert et al[21] found no significant difference in clinical outcomes between patients older than 40 years compared with those younger than 40 years at an average follow-up of 28 months. Schrøder et al[22] reinforced these findings in 107 patients at an average follow-up of 5.3 years. The results of the current study indicate that younger, active patients are significantly more likely to meet criteria for surgical failure following isolated SLAP repair (OR, 0.89; *P*=.039). This finding may be due to higher postoperative physical demands and expectations of younger patients. These variables are important factors to consider when discussing treatment approaches and the postoperative recovery period with patients to promote activity modification and an adequate period for healing of the repair.

Recurrent injury may be a cause of failed SLAP repairs in patients who return to high-level activities such as overhead throwing; however, many authors have also identified postoperative stiffness as a common cause of failure following SLAP repairs.[15,23,24] In some circumstances, overtensioning of the biceps during SLAP repair may be the etiology for postoperative stiffness, as the overtensioned biceps may restrict movement of the shoulder and elbow.[13,24] In addition, Byram et al[23] reported humeral head chondral abrasions in 13 (72.2%) of 18 patients with failed SLAP repairs. They speculated that chondral lesions are due in part to increased biceps–humeral head contact pressure from overtensioned biceps during SLAP repairs. These findings raise the concern that overconstraint of the biceps may contribute to failure of SLAP repairs. Positioning of an anchor anterior to the biceps insertion has been described as a possible mechanism of overconstraint. Although the current study did not find inferior clinical outcomes in active patients with anterior anchors, these patients were not overhead throwers, who have been reported to suffer most from overtensioning the biceps.[1,14,24]

The clinical outcomes of various types and locations of fixation methods have been described. Cohen et al[1] studied the clinical outcomes of isolated type II SLAP tears fixed with a bioabsorbable suture anchor in an athletic population, reporting a relatively poor return to previous level of athletic activity (48.3%). In contrast, Neuman et al[25] reported high satisfaction (93.3%) and return to sport (84.1%) rates in 30 overhead athletes treated with 3.0-mm bioabsorbable, simple-stitch suture anchors. Others have evaluated glenohumeral motion and load to failure of arthroscopic knotless suture anchor repair (3.5-mm biocomposite PushLock anchors; Arthrex) vs simple arthroscopic repair (3.0-mm biocomposite SutureTak; Arthrex anchors) in human cadavers, reporting no significant difference.[26] Still others have compared numerous fixation methods in a single human cadaveric study. DiRaimondo et al[27] compared mean load to failure and location of failure for screw-in anchors with either vertical or horizontal sutures and a bioabsorbable anchor group. All groups failed at the labral–implant interface, and no significant differences were noted in load to failure.[27]

Cadaveric studies have examined differences in external rotation between anchors placed posterior to the biceps insertion compared with those placed anteriorly.[14] In 1 study, the removal of an anteriorly placed anchor afforded a small (1.4°) but significant (*P*=.0011) increase in external rotation, whereas omitting the posterior anchors did not.[14] Thus, for active patients, it may be advantageous to avoid the use of anterior anchors (relative to biceps insertion) whenever possible. The results of the current study indicate no significant differences in clinical outcomes based on anchor location or anchor number of 3.0-mm biocomposite suture anchors. Studies need to be conducted to elucidate anchor-specific variables associated with prognosis.

The optimal treatment methodology for failed SLAP repair continues to be a topic of discussion. In a recent review, Werner et al[15] described their treatment algorithm for failed SLAP repairs. Specifically, if patients fail conservative management, the authors recommend revision SLAP repair only for active patients younger than 35 years without concomitant biceps pathology. Biceps tenodesis is recommended for middle-aged patients, females, and those with concomitant biceps pathology—most patients.[15] Multiple studies have evaluated the efficacy of salvage biceps tenodesis following failed SLAP repair. McCormick et al[28] reported a high rate of return to sports and active military duty (81%) in a cohort of 46 pa-

tients who underwent open subpectoral biceps tenodesis for failed SLAP repair. Other investigators have corroborated these findings of favorable outcomes of salvage subpectoral biceps tenodesis.[16,29] The results of the current study reinforce these findings. In a young, active population, salvage subpectoral biceps tenodesis allowed 10 (91%) of 11 patients to return to their previous level of activity. Investigators are beginning to evaluate the utility of subpectoral biceps tenodesis as a primary procedure for SLAP tears and as a concomitant procedure with SLAP repair with promising results.[30,31] Further studies are needed to better delineate the indications for primary or concomitant subpectoral biceps tenodesis in the setting of SLAP tear pathology.

Strengths of this study included enrolling consecutive patients from a single institution, patient activity profile, and the closed health care monitoring. However, there were several limitations. First, this study involved only active-duty military service members; thus, the results may not be generalizable to other populations. All military members included were active duty at the time of injury, meaning they met minimum physical fitness requirements, including push-ups and pull-ups, for combat operations. Second, although 3.0-mm biocomposite suture anchors were used by all surgeons at the study institution, multiple surgeons performed the procedures, having differing years of experience. This potentially confounded outcomes based on differences in both technique and familiarity performing the procedure. The failure rate reported in this cohort was similar to those published in previous cohorts of physically active individuals. Finally, validated patient-reported outcome measures were not available for most of the included patients and thus could not be analyzed.

Conclusion

Anchor placement anterior to the biceps tendon was not associated with inferior outcomes. Younger age was shown to be a poor prognostic factor in patients' ability to return to active duty. Revision with biceps tenodesis showed significant utility in achieving good clinical outcomes and return to duty in more than 90% of patients. Patient-, injury-, and surgery-specific variables need to be identified as prognostic indicators so that clinical outcomes can continue to be improved.

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