

SLAP Repairs With Combined Procedures Have Lower Failure Rate Than Isolated Repairs in a Military Population

Surgical Outcomes With Minimum 2-Year Follow-up

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Background: Injuries to the superior glenoid labrum represent a significant cause of shoulder pain among active patients. The physical requirements of military service may contribute to an increased risk of injury. Limited data are available regarding the success of superior labral anterior posterior (SLAP) repairs in an active military population.

Purpose: To quantify the rate of clinical failure and surgical revision after isolated and combined SLAP repair.

Study Design: Cohort study; Level of evidence, 3.

Methods: All consecutive active-duty servicemembers undergoing arthroscopic repair of type II SLAP lesions at a single institution between 2006 and 2012 were identified. Patients with less than 2-year clinical follow-up and nonmilitary status were excluded. Demographic variables, surgical variables, and occupational outcomes were extracted from electronic medical records and confirmed with the US Army Physical Disability Agency database. Failure was defined as subsequent revision surgery or medical discharge with persistent shoulder complaints.

Results: A total of 192 patients with SLAP repair were identified with a mean follow-up of 50.0 months (SD, 17.0 months). Isolated SLAP repair occurred in 31.3% ($n = 60$) versus 68.8% ($n = 132$) with concomitant procedures. At final follow-up, 37.0% ($n = 71$) of patients reported some subjective activity-related shoulder pain. Postoperative return to duty occurred in 79.6% ($n = 153$), and only 20.3% ($n = 39$) were discharged with continuing shoulder disability. The combined rotator cuff repair (96%; $P = .023$) and anteroinferior labral repair group (88%; $P = .056$) had a higher rate of functional return than isolated SLAP repair (70%). Thirty-one (16.1%) patients were classified as surgical failure and required revision. Of these, the majority of patients undergoing biceps tenodesis (76%) returned to active duty, as compared with revision SLAP repair (17%). Lower demand occupation and the presence of combined shoulder injuries ($P = .011$ and $.016$, respectively) were significantly associated with a lower risk of medical discharge and revision surgery, respectively.

Conclusion: Favorable outcomes can be anticipated in the majority of military servicemembers after arthroscopic SLAP repair, particularly with combined shoulder injuries. Revision surgery occurred in 16% of patients after primary SLAP repair.

Clinical Relevance: Isolated repair of unstable SLAP lesions and/or increased upper extremity demands are associated with higher failure rates in this population.

Keywords: SLAP lesion; combined labral injury; labral repair; tenodesis

With increased physical demands and repetitive overhead activities, injuries to the superior glenoid labrum may represent a significant cause of shoulder pain among active patients.^{6,14,35} Andrews et al² first described tears of the anterosuperior labrum in a series of 73 throwing athletes with painful shoulders undergoing shoulder

arthroscopy. Snyder and colleagues²⁹ later coined the term *superior labral anterior posterior* (SLAP) lesion while describing 4 basic subtypes still employed today. Although the true incidence of SLAP lesions is unknown, current estimates from military cohorts indicate that SLAP lesions occur in approximately 2 of every 1000 servicemembers each year. The frequency of SLAP lesions diagnosed during shoulder arthroscopy in the general population has also been variably reported, with rates between 6% and 26%.²⁹

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Superior labral tears are commonly found in throwing athletes because of the high stresses of repetitive overhead throwing and subsequent alterations in normal shoulder kinematics. However, the physical requirements of military service may also contribute to an increased risk of SLAP injuries,¹⁰ specifically isolated traction-type injuries and lesions associated with glenohumeral instability. In addition, this cohort has a unique occupational profile that may lead to overuse superior labral pathology, largely due to the frequent exposure to overhead and other labor-intensive upper extremity activities with heavy loads.

SLAP lesions can occur either in isolation or in association with a broad spectrum of other shoulder injuries.¹⁶ Subacromial impingement syndrome (20%-76%),⁹ rotator cuff pathology (14%-56%),¹⁰ and anterior-inferior labral tear (11%-57%)²² may frequently be seen in association with SLAP tears. While several authors have investigated the effect of concomitant treatment of rotator cuff tears,^{1,11,30,32} the existing literature evaluating clinical outcomes after repair of type II SLAP lesions, particularly combined injuries, are limited by small patient cohorts, short-term clinical follow-up, and variable surgical indications.^{10,17,21} Furthermore, there are limited data describing the clinical outcomes of treating coexisting shoulder pathology in the face of SLAP repair.¹⁰

The purpose of this study was to quantify the rates of surgical failure after arthroscopic repair of isolated and combined SLAP tears at a single military medical center. Furthermore, we sought to identify risk factors associated with poor outcomes after arthroscopic SLAP repair. We hypothesized that patients with isolated SLAP lesions, atraumatic onset, older patient age, and increased occupational demands would have greater risk of suboptimal clinical results.

METHODS

Institutional review board approval was obtained for this study. A retrospective query was performed to identify all consecutive active-duty servicemembers undergoing arthroscopic repair of SLAP lesions at a single institution between January 1, 2006 and January 31, 2012 using the Military Health System (MHS) Management Analysis and Reporting Tool. This database represents a repository for all direct and purchased medical care occurring within the MHS among an at-large population of 9.5 million beneficiaries under the United States Department of Defense. Similarly, this system was cross-referenced with the existing electronic surgical scheduling system at our institution to identify cases of SLAP repair.

Independent review of the electronic health record (Armed Forces Health Longitudinal Technology Application [AHLTA], version 3.6.0; 3M Health Information Systems) was performed to confirm the accuracy of clinical diagnosis and surgical treatment. All patients underwent a comprehensive evaluation of their painful shoulder complaints after failing nonoperative treatment measures, including activity modifications, physical therapy, targeted corticosteroid injections, and/or use of oral, nonsteroidal anti-inflammatory or other medications. Focused physical examination routinely entailed evaluation of the affected and contralateral extremity with assessment of range of motion, tenderness to palpation, and strength as well as special testing to determine the presence of subacromial impingement or bursitis, acromioclavicular arthrosis, glenohumeral instability, biceps tendonitis or instability, or symptomatic rotator cuff tear. Specific testing for a SLAP lesion included the O'Brien active compression test, Speed test, crank test, and/or Yergason test. Standard preoperative imaging involved anteroposterior, axillary, and scapular Y views on plain film radiographs, and advanced imaging involved magnetic resonance imaging (MRI) with or without arthrogram on a 1.5-T or greater magnet. Ultimately, patients with arthroscopic confirmation of a SLAP lesion underwent subsequent biocomposite 3-mm suture anchor repair (SutureTak; Arthrex, or Gryphon; DePuy Mitek), with or without additional arthroscopic treatment of concomitant shoulder pathology, and were included for further analysis. The exclusion criteria were less than 2-year clinical follow-up; nonmilitary status; absence of SLAP repair; treatment of types I, III, and IV SLAP lesions; and primary treatment with biceps tenodesis and/or rotator cuff repair.

On line-by-line analysis of the medical record, demographic variables (age, sex, rank, military occupational specialty [MOS]), laterality, injury characteristics (eg, presence of traumatic event), and surgical history were extracted. Additionally, the 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). While observing guidelines specific to other concomitant procedures, the rehabilitation protocol for SLAP repair instructed for sling immobilization with immediate gentle pendulum and limited active assist range of motion exercises for 6 weeks postoperatively. Subsequently, patients were allowed to proceed with early rotator cuff strengthening and advancement to full range of motion by 12 weeks, light resistance weight lifting and modified pushups by 16 weeks, and return to full activity at 24 weeks after surgery.

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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 (either defined surgical and/or clinical failure), surgical failure, and return to military duty were primary outcomes of interest.

Statistical Analysis

The primary outcome measure in this cohort study was rates of surgical failure. Clinical and demographic characteristics were assessed with measures of central tendency. Statistical analyses were performed using SAS software, version 9.2 (SAS Institute). We assessed statistical significance using chi-square and Fisher exact tests. A *P* value of $<.05$ was deemed significant. Univariate and Poisson multivariate regression analyses were utilized to test our hypotheses with odds ratios (ORs) adjusted for identified risk factors associated with poor outcomes and defined rates of failure. All risk factors were included in the multivariate models simultaneously.

RESULTS

Demographics and Surgical Variables

After the exclusion of 74 patients, a total of 192 patients with type II SLAP repair were isolated with a mean follow-up of 50.0 months (SD, 17.0 months). Male patients predominated (95.8%; $n = 184$), and the mean patient age was 35.0 years (SD, 8.2 years; range, 20-56 years). High-demand combat MOS was identified in 37.5% ($n = 72$) of patients, and enlisted servicemembers accounted for 85.9% ($n = 165$).

Injury history revealed that 58.3% ($n = 112$) reported history of shoulder trauma, and 20.3% ($n = 39$) of patients had a documented history of glenohumeral instability. Isolated SLAP repair was performed in 31.3% ($n = 60$), and concomitant procedures were performed in 68.7% ($n = 132$), including the following: combined anterior-inferior labral repair (ie, type V SLAP; $n = 42$), subacromial decompression with or without distal clavicle excision ($n = 35$), rotator cuff repair ($n = 24$), biceps tenodesis ($n = 13$), pan-labral repair (ie, type IX SLAP; $n = 10$), and posterior labrum repair (ie, type VII; $n = 8$) (Table 1).

Clinical and Surgical Outcomes

Postoperative return to duty occurred in 79.6% ($n = 153$) of patients, and only 20.3% ($n = 39$) were discharged with continuing shoulder disability, indicating clinical failure (Figure 1). Increased occupational demands within a combat arms designation was associated with a higher risk of clinical failure (ie, medical separation; $P = .018$), whereas age, sex ($P = .575$), presence of antecedent trauma ($P = .524$), and

TABLE 1
Patient Demographics and Surgical Variables^a

Follow-up, mo, mean \pm SD	50.0 \pm 17.0
Sex, n (%)	
Male	184 (96)
Female	8 (4)
Military occupational specialty, n (%)	
Combat arms	72 (38)
Combat support	120 (63)
Age, y, mean \pm SD (range)	35.0 \pm 8.2 (20-56)
Rank, n (%)	
Enlisted	165 (86)
Officer	27 (14)
Mechanism of injury, n (%)	
Traumatic	112 (58)
Nontraumatic	41 (21)
Instability	39 (20)
Isolated SLAP, n (%)	60 (31)
Concomitant procedures	132 (69)

^aPercentages were calculated per number of patients in each group. SLAP, superior labral anterior posterior tear.

tobacco use ($P = .433$) were not statistically significant (Table 2). Return to duty rates were highest among patients with combined SLAP/rotator cuff repair (95.8%), followed by the combined SLAP/anterior-inferior labral repair group (88.1%), SLAP repair with subacromial decompression and/or distal clavicle resection (82.9%), combined SLAP and posterior labral repair (75%), isolated SLAP repair (70%), pan-labral repair cohorts (70%), and combined SLAP repair/subpectoral biceps tenodesis (Table 3). When compared with patients with isolated SLAP repair, servicemembers with combined rotator cuff repair ($P = .023$) had significantly higher rates or return to duty, while patients with combined SLAP/anterior-inferior labral repair ($P = .056$) and SLAP repair with subpectoral biceps tenodesis ($P = .079$) approached significance (Table 3).

A total of 31 (16%) patients were classified as surgical failure and required revision SLAP repair ($n = 6$) or subpectoral biceps tenodesis ($n = 25$), including 11 patients with isolated type II SLAP repair (18.3%). Of these patients, revision to subpectoral biceps tenodesis (76%) resulted in significantly greater rate of return to duty than patients with revision SLAP repair (17%; $P = .024$). Furthermore, when compared with primary SLAP repair, revision of failed SLAP repair to a subpectoral biceps tenodesis demonstrated no statistically significant differences in rates of return to duty ($P = .76$). The presence of combined shoulder injuries ($P = .011$) was associated with a lower risk of revision surgery (Table 4). When combining patients with surgical and/or clinical failure, a total of 50 patients (26%) had a combined failure due to revision surgery or shoulder-related military discharge, and no significant risk factors were identified (Table 5).

DISCUSSION

Establishing the diagnosis of a SLAP lesion and the optimal clinical management remains controversial, even after diagnostic shoulder arthroscopy.^{15,16} Given the propensity

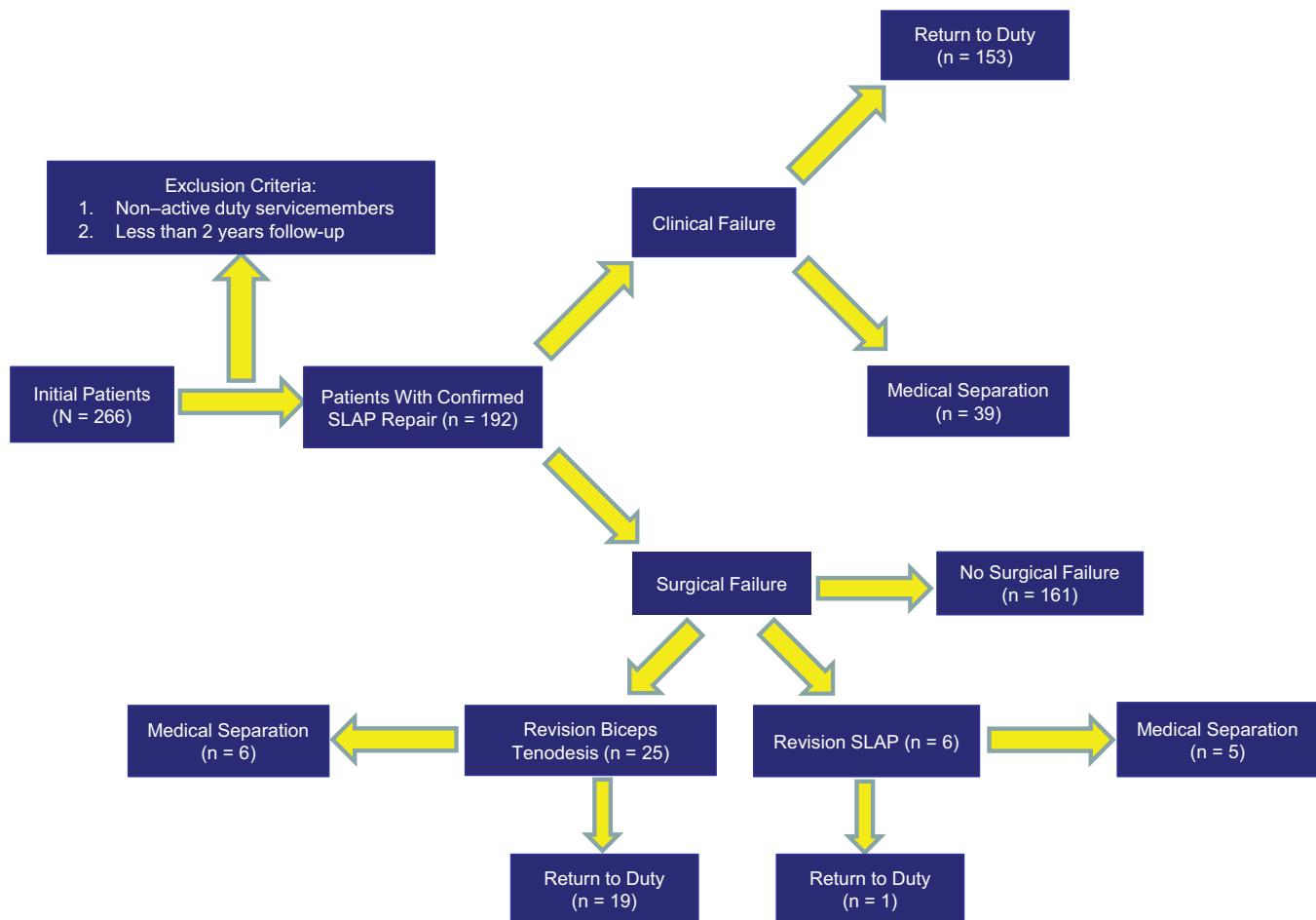


Figure 1. Flow diagram of patient identification, enrollment criteria, and study completion requirements.

TABLE 2
Univariate Analysis of Risk Factors for Clinical Failure After SLAP Repair^a

Variable	Medical Separation (n = 39, 20%)	Return to Duty (n = 153, 80%)	P Value
Age, y, mean (range)	33.1 (20-49)	35.6 (20-56)	
Male:female, n	38:1	146:7	.575
Trauma	21 (54)	91 (59)	.524
Prior instability	5 (13)	34 (22)	.192
Combat arms MOS	21 (54)	51 (33)	.018
Combined injuries	20 (51)	112 (73)	.148
Tobacco use	14 (36)	45 (29)	.433

^aShoulder-related medical discharge from the military denotes clinical failure. Data are presented as n (%) unless otherwise indicated. MOS, military occupational specialty; SLAP, superior labral anterior posterior tear.

for superior labral injuries among an active military population,^{10,28,33} we sought to evaluate the short- to mid-term occupational outcomes and revision rates of all Army servicemembers undergoing isolated or combined SLAP repair at a tertiary referral center. In total, nearly 80% of all patients with SLAP repair were able to return to military function, while 20% had significant shoulder limitations and 16% required surgery for failed SLAP repair. The current investigation also demonstrates the rate of surgical

failure after isolated or combined SLAP repair in a physically active, at-risk military population while identifying demographic and surgical risk factors associated with poor outcomes.

Numerous authors have reported a high prevalence of concomitant pathology with superior labral tears. Consequently, it is difficult to ascertain the true success of arthroscopic SLAP repair when additional procedures are performed concurrently, and few studies have offered

TABLE 3
Return to Duty (RTD) Rates in Isolated and Combined SLAP Repairs^a

	SLAP	Pan-Labrum	Anterior-Inferior Labrum	Posterior Labrum	DCR/ASD	RCR	SLAP/Biceps Tenodesis
SLAP	0.709		0.056	0.903	0.215	0.023	0.780
Pan-labrum		0.348		0.768	0.653	0.122	0.676
Bankart				0.672	0.743	0.544	0.238
Posterior labrum					0.990	0.294	0.831
DCR/ASD						0.270	0.526
RCR							0.079
SLAP/biceps tenodesis							NA
Cases, n	60	10	42	8	35	24	13
RTD, n (%)	42 (70)	7 (70)	37 (88)	6 (75)	29 (83)	23 (96)	9 (69)

^aBoldfaced values indicate statistical significance. ASD, arthroscopic subacromial decompression; DCR, distal clavicle resection; NA, not applicable; RCR, rotator cuff repair; SLAP, superior labral anterior posterior.

TABLE 4
Univariate Analysis of Risk Factors for Surgical Failure after SLAP Repair^a

Variable	Surgical Revision (n = 31, 16%)	Absence of Revision (n = 161, 84%)	P Value
Age, y, mean (range)	32.9 (20-48)	35.5 (20-56)	
Male:female, n	29:2	155:6	.487
Trauma	17 (55)	95 (59)	.667
Prior instability	3 (10)	36 (22)	.108
Combat arms MOS	12 (39)	60 (37)	.879
Combined injuries	15 (48)	117 (73)	.011
Tobacco use	13 (42)	46 (28)	.140

^aSurgical revision for failed SLAP repair denotes surgical failure. Data are presented as n (%) unless otherwise indicated. MOS, military occupational specialty; SLAP, superior labral anterior posterior.

TABLE 5
Univariate Analysis of Risk Factors for Combined Failure after SLAP Repair^a

Variable	Failure (n = 50, 26%)	No Failure (n = 142, 74%)	P Value
Age, y, mean (range)	31.3 (20-41)	35.5 (20-56)	
Male:female, n	11:0	173:8	.476
Trauma	8 (73)	104 (57)	.319
Prior instability	3 (27)	36 (20)	.555
Combat MOS	6 (54)	66 (35)	.229
Combined injuries	8 (73)	124 (68)	.769
Tobacco use	3 (27)	56 (31)	.798

^aShoulder-related medical discharge from the military and/or surgical revision for failed SLAP repair denote combined failure. Data are presented as n (%) unless otherwise indicated. MOS, military occupational specialty; SLAP, superior labral anterior posterior.

comparative evaluations of surgical outcomes after isolated and combined repairs. Hantes and colleagues¹⁷ performed a comparative study between patients with Bankart lesions and those with concomitant Bankart and SLAP lesions. At 2-year follow-up, all patients in both groups returned to work, while 89% (17/19) of patients with isolated Bankart lesions and 76% of patients with combined Bankart and SLAP injuries (10/13) returned to their preinjury sporting activity.¹⁷ Cho et al⁵ also demonstrated equivalent results between young patients with combined SLAP and Bankart repairs and a referent group with isolated Bankart repairs, with all 15 individuals describing good to excellent results. In another study of military servicemembers, Enad et al¹⁰

showed decreased American Shoulder and Elbow Society (ASES) scores and higher values on the visual analog scale among patients with isolated SLAP repair relative to those with other associated diagnoses. In our study, type V SLAP repairs accounted for the most predominant combined injury (21.9%), which is not surprising given the high prevalence of anterior shoulder instability in this population at risk.²⁶ As well, combined surgical repair of SLAP/Bankart lesions resulted in higher rates of return to duty (88%) than isolated SLAP repairs (70%), which approached significance ($P = .056$), and the presence of any combined injury pattern resulted in lower rates of surgical revision ($P = .011$).

The management of rotator cuff disease with adjacent SLAP tears has been controversial,⁸ depending largely on the extent of tendon involvement, patient age, activity level, and operating surgeon. Some authors have also advocated for arthroscopic decompression for selected patients with SLAP lesions and varying degrees of subacromial impingement to avoid symptomatic recurrence, while others have expressed concerns about the risk of subacromial adhesions and secondary stiffness with this intervention.⁷ Our investigation revealed that arthroscopic subacromial interventions for associated rotator cuff tears, impingement, and/or symptomatic acromioclavicular arthrosis occurred in nearly one-third of patients with type II SLAP repair (30.7%). Interestingly, patients with concomitant treatment of a rotator cuff tear had a significantly higher return to duty rate than those servicemembers with isolated SLAP repair ($P = .023$), while arthroscopic subacromial decompression and/or distal clavicle excision failed to yield significantly improved rates of functional return.

Clinically, previous overarching studies have shown successful overall outcomes after type II SLAP repair, indicating that approximately 80% of patients may expect good to excellent results postoperatively.³⁰ Our results indicate that arthroscopic SLAP repair delivered substantial clinical improvements in 79.6% of all servicemembers returning to military duty and 70% of those with isolated type II SLAP repairs, which is comparable to those previously reported in other similar physically active cohorts.^{4,28} Enad and colleagues¹⁰ showed that 29 of 30 Navy servicemembers (97%) were able to return to military duty after type II SLAP repair, and of the 26 patients who participated in competitive recreational sports preoperatively, 76.9% returned to the same activity level or higher. In another military cohort with isolated type II SLAP repair at an average 40.4-month follow-up, Provencher et al²⁸ identified a comparatively higher failure in 36.8% of patients, which was defined as an ASES score less than 70, revision surgery, or inability to return to military duty.

Ostensibly, acute injury to the glenohumeral joint may result in a defined superior labral disruption and predict favorable results with surgical repair. However, other pertinent factors may demonstrate greater influence on clinical and surgical outcomes among military servicemembers. In the current study, we did not correlate a history of trauma with clinical outcomes. Brockmeier and colleagues⁴ evaluated for mechanism of injury as it related to functional outcomes after SLAP repair. In their study, patient-reported satisfaction demonstrated significantly greater improvement among patients with a traumatic etiology, as compared with a group with atraumatic onset. Among the athletic subset, the percentage of return to competition was significantly higher among the traumatic group (92%, 11/12 patients) than the atraumatic group (64%, 14/22 patients; $P < .05$). Conversely, Provencher and colleagues²⁸ failed to demonstrate any significant differences by traumatic or atraumatic tear origin on univariate analysis ($P = .33$).

Despite reasonable surgical results in select patients, most contemporary studies acknowledge the risk of failure after primary SLAP repair. Nonoperative treatment is also largely unsuccessful for treatment of persistent symptoms after prior arthroscopic SLAP repair, with only 29% of patients reporting good to excellent results without further surgery.²⁰ Previously described as a primary treatment of type II SLAP lesions³ or for salvage management of failed SLAP repair,^{23,34} biceps tenodesis has demonstrated utility in carefully select patients with superior labral pathology, particularly those of older chronological age and/or nonthrowing athletes.^{3,28} In our study, 31 patients required revision surgery for failed SLAP repair, including 11 patients (18.3%) with isolated type II SLAP lesions. A total of 25 patients underwent secondary subpectoral biceps tenodesis with a 76% return-to-duty rate. Conversely, revision SLAP repair was associated with significantly lower rates of return to duty (16.7%) among 6 patients, which is consistent with prior reports in the literature indicating poor clinical outcomes with revision repair.²⁷ Comparatively, Provencher and colleagues²⁸ documented a 28% rate of revision surgery in 179 military servicemembers with isolated type II SLAP repair, most commonly to secondary biceps tenodesis. In a subsequent series of 46 military patients with failed SLAP repair, McCormick et al²³ reported an 81% return to duty and sporting activity after subpectoral biceps tenodesis at a mean 3.5-year follow-up.

The relative strengths of this study include its closed health care monitoring, patient activity profile, and the use of consecutive patients undergoing treatment at a single, academic military medical center. However, certain limitations must also be mentioned. First, a servicemember's inability to return to duty postoperatively may not always solely reflect rate-limiting shoulder dysfunction. Issues related to secondary gain, confounding comorbidities, surgical technique, and additional injuries cannot be fully controlled for in the current study. Additionally, validated patient-reported outcome measures were not routinely available for all included patients. Last, while separate analyses were performed for patients with isolated and combined SLAP repairs, these may be underpowered to discern certain relevant risk factors documented in other military studies, such as age.²⁸

CONCLUSION

Favorable outcomes can be expected in the majority of military servicemembers after arthroscopic repair of type II SLAP tears, particularly those with combined shoulder pathology and traumatic injuries. High-demand servicemembers with a combat arms designation had an increased risk of medical separation, whereas combined SLAP lesions had a significantly lower rate of surgical revision at short- to mid-term follow-up. In this study, nearly three-quarters of patients with failed SLAP repair undergoing revision to biceps tenodesis were able to successfully return to active duty. Judicious clinical evaluation and patient selection are paramount for reproducible success in the surgical treatment of type II SLAP tears.

[§]References 1, 8, 11-13, 19, 24, 25, 30, 31.

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