



# Primary Double-Pulley SLAP Repair in an Active-Duty Military Population With Type II SLAP Lesions Results in Improved Outcomes and Low Failure Rates at Minimum Six Years of Follow-up

Nata Parnes, M.D., Alexis B. Sandler, M.D., John C. Dunn, M.D., Olivia Duvall, B.S., and John P. Scanaliato, M.D.

**Purpose:** To report mid-term outcomes of active-duty patients younger than the age of 35 years with shoulder type II SLAP lesions following our technique for double-pulley SLAP repair (DPSR). **Methods:** All consecutive patients aged 18 to 35 years from January 2014 through December 2015 who underwent primary DPSR by the senior surgeon with complete outcome scores were identified. The clinical significance measures (patient acceptable symptomatic state [PASS], substantial clinical benefit [SCB], minimal clinically important difference [MCID]) have not yet been fully defined for type II SLAP repair procedures, so the values for biceps tenodesis were used as a stand-in. Patients were excluded if they were lost to follow-up or if they underwent a concomitant rotator cuff repair. Outcome measures were completed by patients within 1 week before surgery and at latest follow-up. **Results:** Overall, 22 of 41 (53.7%) patients met the inclusion criteria for the study, and all were active-duty military at time of surgery. In total, 21 of 22 (95.5%) patients met the PASS, whereas 20 of 22 (90.9%) achieved SCB and 22 of 22 (100.0%) exceeded the MCID for their operative shoulder as determined by the American Shoulder and Elbow Surgeons score. In total, 19 of 22 (86.4%) patients met the PASS, whereas 22 of 22 (100.0%) achieved SCB and exceeded the MCID for their operative shoulder as determined by the Single Assessment Numeric Evaluation. In addition, 21 of 22 (95.5%) met the PASS, whereas 22 of 22 (100%) achieved SCB and exceeded the MCID for their operative shoulder as determined by the pain visual analog scale. Pre- and post-operative range of motion did not vary significantly. In total, 18 of 22 (81.8%) of patients remained on active duty and were able to return to preinjury work and recreation activity levels. In 2 patients (9.09%), the repair did not heal. **Conclusions:** Mid-term outcomes in this population of young, active-duty patients undergoing DPSR for type II SLAP tears demonstrate a statistically and clinically significant improvement in patient-reported outcomes and an overall return to active-duty rate of 81.8%. **Level of Evidence:** Level IV, therapeutic case series.

From Carthage Area Hospital, Carthage, New York (N.P., O.D.); Claxton-Hepburn Medical Center, Ogdensburg, New York (N.P.); and William Beaumont Army Medical Center, El Paso, Texas (A.B.S., J.C.D., J.P.S.), U.S.A.

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Address correspondence to John P. Scanaliato, M.D., Department of Orthopaedic Surgery, William Beaumont Army Medical Center, 18511 Highlander Medics St., Fort Bliss, TX 79918. E-mail: [jscans@gmail.com](mailto:jscans@gmail.com)

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The superior labrum and biceps anchor are important secondary stabilizers of the glenohumeral joint and aid the rotator cuff musculature in keeping the humeral head depressed and centered on the glenoid.<sup>1,2</sup> Tears of this important anatomic complex were originally described by Andrews et al.<sup>1</sup> in 1985, at which time the orthopaedic community was formally introduced to the SLAP lesion. These lesions were originally classified by Snyder et al.<sup>3</sup> and later expanded on by the work of Maffet et al.<sup>4</sup> The type II SLAP tear, characterized by the disruption of the superior labrum and biceps anchor from the glenoid, has been found to be the most common variant of SLAP injury and can have devastating implications for overhead athletes and other high-demand patient populations.<sup>5,6</sup> Owing to the high physical demands and intense physical training requires of active-duty military service, it comes as no

surprise that this population is at an increased risk for shoulder pain and dysfunction secondary to SLAP tears, and face a markedly increased risk of this injury compared with the civilian population.<sup>7-10</sup> Even more concerning is that the annual incidence of these injuries in this patient population appears to be increasing.<sup>11</sup>

Historically, arthroscopic repair of these injuries was identified and promoted as the gold-standard treatment in patients with symptoms refractory to nonoperative management.<sup>12-14</sup> Poor outcomes following repair of type II SLAP lesions in older patients, however, motivated surgeons to investigate alternative treatment solutions for this injury.<sup>15</sup> Further research postulated that in this older patient population, patient satisfaction, subjective outcomes, and return to sporting activity were more favorable following biceps tenodesis when compared with SLAP repair.<sup>16,17</sup> There was fear, however, that tenodesis in a younger patient population could lead to altered glenohumeral biomechanics and kinematics, and surgeons continued to investigate the optimal means by which to repair to the superior labral–biceps anchor complex. Various arthroscopic techniques for the repair of type II SLAP tears have been described, many with good-to-excellent outcomes.<sup>18</sup> There is concern, however, that over-tensioning of the biceps–anchor and superior labrum during SLAP repair may lead to altered biomechanics, which could drive the development of biceps tendon pathology following repair.<sup>19,20</sup> Recent studies have improved our understanding of the anatomic derangements that occur secondary to SLAP tears and have helped to guide surgeons in restoring the native anatomy during repair.<sup>19,21</sup> Specifically, concerns regarding too stiff a fixation construct following traditional repair techniques have led authors to investigate alternative methods through which to perform a SLAP repair. Extrapolating the findings of these authors, in 2015 we published a “double-pulley” technique for anatomic repair of the superior labrum and biceps anchor following a type II SLAP tear.<sup>22,23</sup>

The purpose of this study is to report mid-term outcomes of active-duty patients younger than the age of 35 years with type II SLAP lesions following our technique for double-pulley SLAP repair (DPSR). Our hypothesis is that DPSR would produce statistically and clinically significant improvements in patient-reported outcomes with a high rate of maintenance of active-duty status at mid-term follow-up.

## Methods

### Study Design

This is a retrospective review of prospectively collected data consisting of patient-reported outcomes and range of motion measurements in active-duty service members younger than 35 years of age who

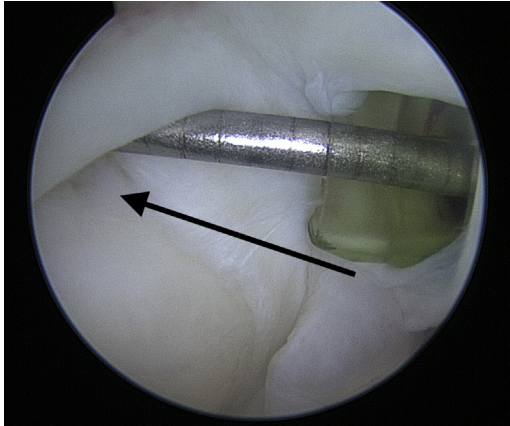
underwent DPSR for type II SLAP lesions between January 2014 and December 2015. Outcome measures collected included the American Shoulder and Elbow Surgeons (ASES) Score and the Single Assessment Numeric Evaluation (SANE).<sup>24,25</sup> Additional outcome measures collected included pain as measured by the pain visual analog scale (VAS); range of motion in forward flexion, external rotation and internal rotation; complications; and active-duty status.

Outcome measures were collected as part of the standard of care during all patient visits. Range of motion in forward flexion and external rotation were measured with a goniometer. Internal rotation was measured by determining the highest spinal level to which the patient could place the dorsum of the hand. Treatment failure was defined as the need for revision surgical treatment. All in-office assessments were performed by a single surgeon (N.P.), who is a shoulder and elbow fellowship-trained surgeon with a large active-duty patient population. The decision to proceed with surgery was made solely by the senior surgeon (N.P) following an in-office assessment.

All the patients reported shoulder pain severe enough to limit shoulder function and all had not responded to at least 3 months of conservative treatment, including anti-inflammatory medications, physical therapy, and home exercise before being considered for surgery. All patients underwent magnetic resonance arthrogram evaluation, which was reviewed along with arthroscopic images and operative reports. Arthroscopic criteria for the diagnosis of a type II SLAP tear included a superior sublabral sulcus greater than 5 mm in depth, a bare superior labral footprint, a displaceable biceps root and/or a positive peel-back sign.<sup>26</sup> All surgical procedures were performed by the senior surgeon at a single hospital. Patients were excluded from the study if they were undergoing a revision procedure, had a full-thickness rotator cuff tear at time of surgery, or if they were younger than the age of 18 years or older than the age of 35 years. Patients were also excluded if they had subjective physical examination or diagnostic arthroscopic findings consistent with biceps tendinopathy, as these patients were treated with arthroscopic assisted biceps tenodesis. The reporting of our findings adheres to the Strengthening of Reporting of Observation Studies in Epidemiology recommendations.<sup>27</sup> This retrospective study was approved by the Carson Carthage Institutional Review Board.

### Surgical Technique

The technique used in this study has been previously described in detail and has not changed since its original publication.<sup>22</sup> The double-pulley configuration provides a horizontal repair with large biceps–bone footprint, which improves healing and hopefully avoids strangulation of the superior labrum.<sup>22,23</sup>



**Fig 1.** Right shoulder, type II SLAP tear with a normal biceps tendon as viewed from the standard posterolateral viewing portal.



**Fig 2.** Right shoulder, glenoid neck debrided to bleeding bone with a 4.5-mm shaver as viewed from the standard posterolateral viewing portal.

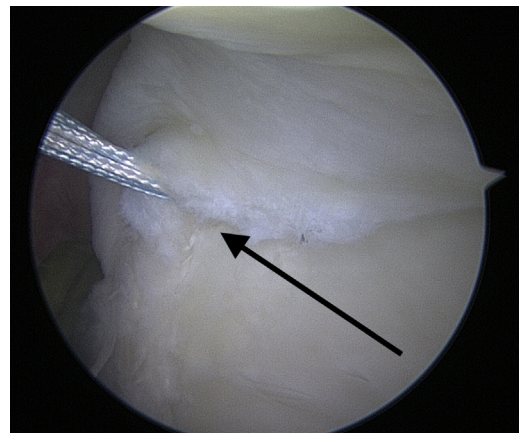
The patient is placed into the beach-chair position. We then perform a diagnostic arthroscopy through a standard posterior portal. An anterior–superior portal is established high and lateral in the rotator interval area. Associated intra-articular pathology is documented and addressed as indicated. Then, a probe is used to check for the existence of a type II SLAP lesion (Fig 1) and a peel-back test is used to confirm the diagnosis.<sup>26,28</sup> Once the lesion is verified, a transrotator cuff portal that is medial to the rotator cuff cable (at the musculotendinous junction), as described by O'Brien et al., is established.<sup>29</sup>

A 4.5-mm shaver is introduced through the anterior–superior portal to debride the superior glenoid neck to bleeding bone, and the edge of the superior labrum as identified (Fig 2). Through the transrotator cuff portal, a SUTUREFIX 1.9-mm double-loaded anchor (Smith & Nephew, Andover MA) is placed at the 10-o'clock position for a right shoulder (Fig 3). One suture limb is passed at a point where the position of the superior posterior labrum does not change with shoulder motion. With the arthroscope placed in the posterior portal, an arthroscopic simple vertical knot-tying technique is used through the transrotator cuff portal. The other 2 arms of the second suture on the anchor are shuttled through the superior–posterior labrum using a 45° lasso loop device (Fig 4). Then, by use of the anterior–superior portal, a SUTUREFIX 1.7-mm single-loaded anchor (Smith & Nephew) is placed on the glenoid rim in line with the anterior edge of the biceps' insertion. A 45° lasso-loop device is used through the anterior–superior portal to shuttle the 2 arms through the superior-anterior labrum in line with the anterior edge of the biceps tendon. Using a suture manipulator, the surgeon retrieves the 4 limbs of the 2 sutures through the transrotator cuff portal, taking care to retrieve the suture limbs from the

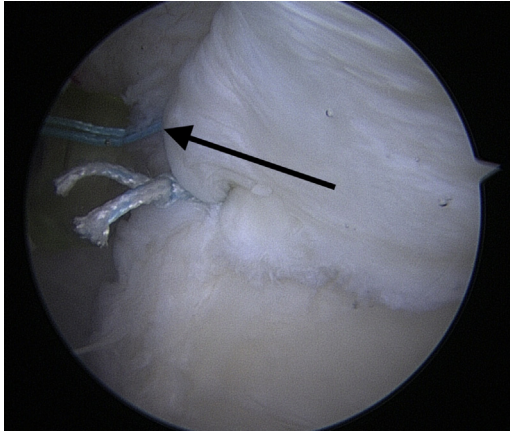
anterior anchor, superior to the biceps tendon (Fig 5). For each anchor, one suture limb is chosen to be coupled in a double-pulley configuration (Fig 6). Once the double pulley is done, fixation of the biceps anchor is completed with tightening non-sliding knots on the remaining suture limbs of each anchor (Fig 7). At the end of the procedure, the adequacy of the repair is confirmed with a probe (Fig 8). The shoulder is taken through a full range of motion to rule out over-tension of the repair which could lead to postoperative stiffness. The detailed step-by-step surgical technique and corresponding video are available in our Technical Note article.<sup>22</sup>

### Postoperative Rehabilitation

The postoperative protocol consists of sling immobilization for 4 weeks. Early pendulum shoulder exercises and distal range-of-motion exercises involving the



**Fig 3.** Right shoulder, first 1.9-mm double-loaded SUTUREFIX (Smith & Nephew, Andover MA) is placed at the 10-o'clock position as viewed from the anterior–superior portal.

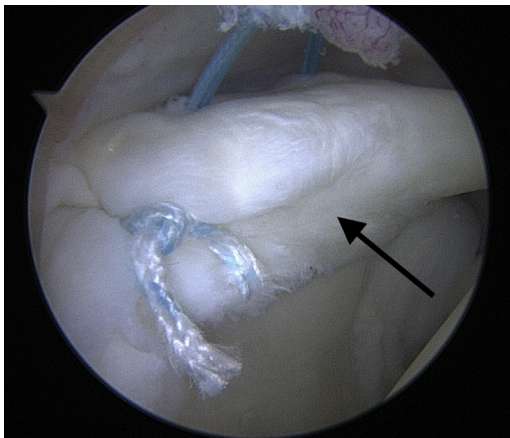


**Fig 4.** Right shoulder, first knot tied and the remaining suture limbs are passed through the labrum as viewed from the anterior-superior portal (arrow indicates suture limbs).

elbow, wrist, and hand are initiated immediately. Passive range of motion of the shoulder is started during the first 2 weeks postoperatively, with a gradual progression of forward flexion from 90° to 150° over a period of 6 weeks. Active range of motion of the shoulder and a progressive strengthening program start at 6 weeks after surgery. Return to unrestricted activities, including vigorous sports, is permitted at 6 months postoperatively.

#### Statistical Analysis

Statistical analyses were conducted by using IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY). Continuous data were described by mean and standard deviation. A paired Student *t*-test was used to compare the differences between the preoperative and



**Fig 5.** Right shoulder, all 4 limbs are retrieved through the transrotator cuff portal as viewed from the standard posterolateral viewing portal. Note that a 1.7-mm double-loaded SUTUREFIX (Smith & Nephew, Andover MA) anchor has been placed in line with the anterior edge of the biceps tendon (arrow).

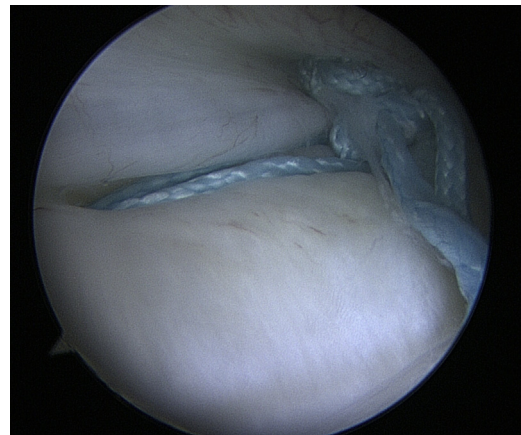


**Fig 6.** Right shoulder (on screen), one limb from each portal is coupled into a double-pulley configuration as viewed from the standard posterolateral viewing portal.

postoperative results. Statistical significance was set at  $P < .05$  in all cases. The clinical significance measures (PASS, SCB, MCID) are not yet fully defined for type II SLAP repair procedures, so the values for biceps tenodesis were used as a stand-in.

#### Results

During the current study, the senior surgeon surgically treated 41 patients with type II SLAP lesions. DPSR was performed in 24 of these 41 procedures. Two patients had previous surgeries on the operative shoulder, 4 patients had concomitant full-thickness rotator cuff tears, and 11 were treated with biceps tenodesis. Two patients were lost to follow-up, leaving a population of 22 patients available for final analysis (Fig 9). Mean follow-up period was 85.27 months (range 72.0-95.0 months). Mean patient age at time of surgery was 27.73 years (range 19-34 years). All 22 participants were male and active-duty military at time of surgery. Fifteen (68.18%) were soldiers in a combat



**Fig 7.** Right shoulder, final knot tying and completion of repair as viewed from the standard posterolateral viewing portal.



**Fig 8.** Right shoulder, adequacy of repair is assessed with an arthroscopic probe as viewed from the standard posterolateral viewing portal.

arms military occupation specialty, suggesting greater physical performance standards for occupational requirements than those in noncombat arms. The operative shoulder was right sided in 12 patients (54.5%) and the dominant shoulder in 12 patients (54.5%). All procedures performed were primary procedures and concomitant procedures performed can be seen in [Table 1](#).

All patients demonstrated a statistically significant increase in the ASES score and SANE and a statistically significant decrease in pain, as measured by the pain VAS, at final follow-up ( $P < .0001$ ) ([Table 2](#)). Range of motion in forward flexion, external rotation, and internal rotation did not change significantly post-operatively ( $P = .8778, .1294, \text{ and } .1918$ , respectively). In total, 21 of 22 (95.5%) patients met the patient acceptable symptomatic state (PASS), whereas 20 of 22 (90.9%) achieved substantial clinical benefit (SCB) and 22 of 22 (100.0%) exceeded the minimal clinically important difference (MCID) for their operative shoulder as determined by the ASES score.<sup>30</sup> In addition 19 of 22 (86.4%) patients met the PASS, whereas 22 of 22 (100.0%) achieved SCB and exceeded the MCID for their operative shoulder as determined by the SANE. Finally, 21 of 22 (95.5%) met the PASS, whereas 22 of 22 (100%) achieved SCB and exceeded the MCID for their operative shoulder as determined by the pain VAS ([Table 3](#)).<sup>31</sup>

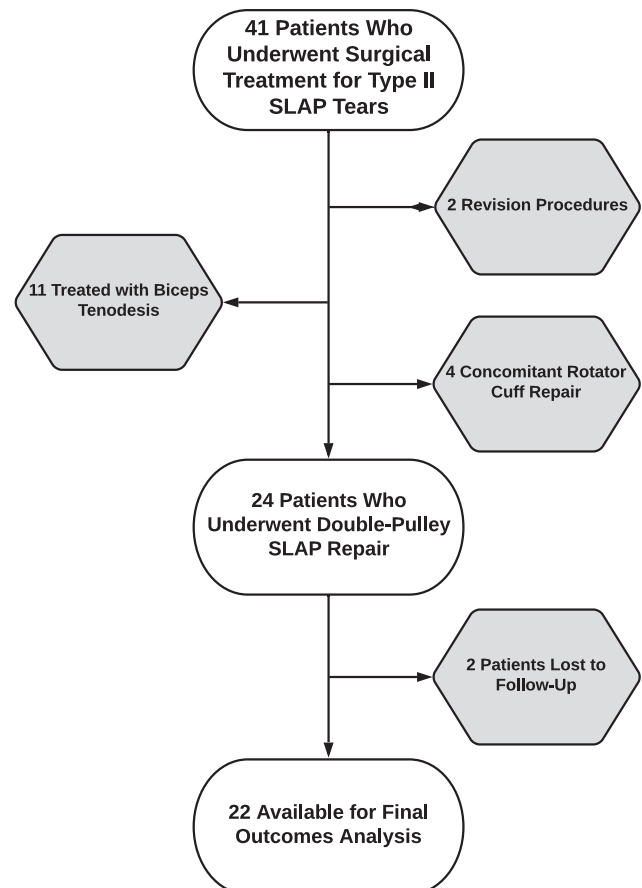
At final follow-up, 18 of the 22 participants (81.82%) remained on active duty. Of these 18, 18 (100%) were able to return to preinjury work and recreational activity levels. There were no instances of infection or nerve injury. Two patients had persistent pain after surgery with evidence on magnetic resonance imaging of a nonhealing SLAP repair. Both patients underwent revision surgery with an arthroscopic assistant subpectoral biceps tenodesis. Both patients had good

results and both were able to return to full military activity. As a result of these 2 patients, the overall complication rate was 9.09%, with a treatment failure rate of 9.09%.

## Discussion

Overall, our findings supported our hypothesis. In this population of 22 active-duty service members under the age of 35 at time of DPSR for a type II SLAP tear only 4 did not return to active duty, and only 2 had evidence of repair failure. Outcomes following DPSR were excellent, with a majority of patients achieving a statistically and clinically significant improvement in outcomes, decrease in pain and no appreciable loss of range of motion.

The optimal treatment of type II SLAP tears remains controversial. While outcomes following repair in younger patients are often promising, the same procedure portends an increased risk of failure and poor outcomes in older patients, and recent literature has supported biceps tenodesis as an attractive alternative to reinsertion in patients older the age of 35 years.<sup>16,17</sup> Subsequently, the rates of SLAP repair performed in patients over the age of 35 has begun to decrease.<sup>32,33</sup> In the absence of high-quality, randomized controlled



**Fig 9.** Flowchart of patient inclusion.

**Table 1.** Study Population Characteristics

Patients (shoulders)	22 (22)
Follow-up, mo (range)	85.27 (72-95)
Age, y (range)	27.73 (19-34)
% Male	100%
% Right shoulder	54.5%
% Dominant shoulder	54.5%
% Combat arms*	68.2%
Concomitant procedures	
Arthroscopic subacromial decompression	22/22 (100%)
Arthroscopic distal clavicle resection	2/22 (9.1%)
Anterior labral repair	6/22 (27.3%)
Posterior labral repair	8/22 (36.4%)
Glenoid microfracture	4/22 (18.2%)
Debridement of partial articular-sided supraspinatus tear	4/22 (18.2%)

\*Non-administrative/non-support infantry, artillery, and/or military police.

trials, it appears that biceps tenodesis is the preferred operative intervention for patients older than the age of 35 years with type II SLAP tears recalcitrant to conservative management. The appropriate surgery for younger and/or greater-demand patients with this pathology, however, is not as clear.<sup>34-37</sup> Recent data cite technical difficulty with respect to the restoration of native anatomy and high revision rates as reasons to perform biceps tenodesis as opposed to SLAP repair in younger patients.<sup>9,34,35</sup>

Injuries to the superior labrum and biceps anchor complex are a common cause of pain among members of the US military.<sup>7,10,11</sup> Previous studies have demonstrated suboptimal outcomes following repair, with authors citing residual pain, stiffness, high rate of failure, and poor rates of return to preinjury levels of performance as reasons to avoid repair.<sup>15,38</sup> Although these findings seem to suggest that biceps tenodesis is favorable in younger patients as well, an important question as to why tenodesis may be favorable still remains unanswered: is it simply that the local anatomy is not amenable to repair, thereby portending poor outcomes? Or is the technique used for said repair the underlying issue<sup>18</sup>?

**Table 2.** Outcome Measures

Outcome Measure	Preoperative, Mean (SD)	Postoperative, Mean (SD)	Difference,* Mean (SD)	95% CI <sup>†</sup>	P Value
ASES	40.05 (14.4)	86.18 (11.8)	46.14 (16.2)	39.37-52.90	<.0001
SANE	38.18 (18.6)	81.82 (15.6)	43.64 (17.7)	36.25-51.02	<.0001
Pain VAS	8.05 (1.6)	1.34 (1.4)	-6.70 (1.6)	-7.39 to -6.02	<.0001
Forward flexion	156.82 (4.8)	156.59 (5.0)	-0.23 (2.9)	-1.43 to 0.98	.8778
External rotation	67.73 (4.3)	66.14 (6.5)	-1.59 (4.7)	-3.57 to 0.38	.1294
Internal rotation	T9.82 (1.8)	T10.09 (1.8)	T0.27 (2.0)	-0.56 to 1.11	.1918

ASES, American Shoulder and Elbow Surgeons; CI, confidence interval; SANE, Single Assessment Numeric Evaluation; SD, standard deviation; VAS, visual analog scale.

\*The difference is the mean postoperative score minus the mean preoperative score; positive values indicate greater postoperative values, on average.

<sup>†</sup>The 95% CI represents the CI for the difference between the mean postoperative score minus the mean preoperative score.

**Table 3.** Percentage of Patients Meeting the MCID, SCB, and PASS Thresholds

	MCID	SCB	PASS
ASES	100%	90.9%	95.45%
SANE	100%	100%	86.35%
Pain VAS	100%	100%	94.45%

NOTE. Values: ASES: MCID 11, SCB 16.8, PASS 59.6; SANE: MCID 3.5, SCB 5.8, PASS 65.5; Pain VAS: MCID -1.29, SCB -2.51, PASS 2.74.

ASES, American Shoulder and Elbow Surgeons; MCID, Minimum clinically important difference; PASS, patient acceptable symptomatic state, SANE, Single Assessment Numeric Evaluation; SCB, substantial clinical benefit; VAS, visual analog scale.

Although the functional role of the long head of the biceps tendon is not completely elucidated, concern prevails among many orthopaedic surgeons that the removal of the intra-articular segment of the biceps tendon may adversely affect the overall function and stability of the shoulder, especially in younger, greater-demand patients.<sup>2,39,40</sup> Secondary to these concerns, there has been much research performed with regards to techniques for SLAP repair based on improved understanding of the pathological changes that occur with a SLAP tear and the normal anatomy and function of the superior labrum and long head of biceps. Burkhart et al.<sup>5</sup> suggested that in type II SLAP lesion repair, the posterior aspect of the fixation construct is the critical factor in resisting peel-back forces during the late cocking phase, a finding later supported by Seneviratne et al.<sup>28</sup> These studies suggest that the rigidity, rather than flexibility, of the labral fixation at this posterior portion of the tear is critical in restoring restraint to labral peel-back. In our DPSR technique, we use a simple vertical suture configuration for the posterior, non-mobile labral fixation, which provides a stronger initial fixation than a horizontal mattress suture.<sup>41</sup> For the anterior aspect of the repair, we use a horizontal mattress suture configuration to attach the medial insertion of the long head of the biceps tendon origin to the glenoid rim, a configuration suggested by Domb et al.<sup>42</sup> and Baldini et al.<sup>43</sup> It has been purported that

this configuration not only avoids strangulation of the biceps at its anchor, but also allows for restoration of the normal labral laxity as it abuts the glenoid rim.<sup>44</sup> The avoidance of strangulation is of paramount concern, as authors have previously demonstrated that overtensioning the biceps tendon and anchor at its insertion on the superior glenoid can have a deleterious effect on biceps biomechanics, and can initiate a pathologic cascade of biceps tendinopathy.<sup>19,20</sup> The lack of secondary biceps tendon pathology at minimum 6 years of follow-up among our cohort supports the assertion that the horizontal configuration anteriorly can help to decrease the risk of future tendinopathy.

Furthermore, the double-pulley technique has been heralded as a means by which surgeons can achieve stable fixation with a broad area of tissue compression against native bone in cases of bony Bankart repair, rotator cuff repair and remplissage.<sup>23,45,46</sup> In the DPSR, we feel that the double-pulley technique allows for stable horizontal fixation of the biceps anchor while still allowing for the native mobility of the superior labral edge. Furthermore, it provides a wide area for compression of the biceps anchor and posterosuperior labral periosteal sleeve against the native bone-bed of the glenoid neck, promoting increased healing by minimizing synovial fluid interference with the bone–tendon interface. In addition, although the use of a transrotator cuff portal has been associated with postoperative rotator cuff injury, we feel that the use of this portal greatly streamlines the procedure.<sup>47</sup> Promisingly, none of our patients had clinical evidence of rotator cuff injury at 6 years postoperatively. These findings align with those of Oh et al.,<sup>48</sup> who in an analysis of 58 patients found the transcuff portal to be a safe and efficacious means through which to perform a SLAP repair. Lastly, with regards to technique, one must exercise caution when placing an anchor anterior to the biceps tendon as previous research has attributed a small but statistically significant loss of external rotation in patients with excessively anterior anchors.<sup>49</sup> Considering that past studies have implicated excessive stiffness and loss of external rotation as a major complication following SLAP repair in high-demand patients, we avoid placing any anchor anterior to the anterior edge of the biceps tendon.<sup>12,15</sup>

At mid-term follow-up, a majority of the patients included in this study demonstrated statistically and clinically significant increases in patient-reported outcome scores and decreased pain; furthermore, there was no appreciable loss of range of motion in forward flexion, external rotation or internal rotation at final follow-up. Only 2 patients required a revision procedure, and a majority were able to remain on active-duty status. This contrasts sharply to previously published outcomes data on active-duty patients following SLAP repair using the classical nonanatomic

technique for type II SLAP tears, which report a failure rate of up to 36.8% and revision rate of up to 27.9%.<sup>15</sup> It also appears that a double-pulley configuration does not constitute a risk factor for the development of postoperative stiffness. While we still believe that patients younger than the age of 35 years with subjective or objective findings of biceps tendon pathology are probably best treated with a biceps tenodesis, the anatomic, double-pulley SLAP repair has become an important part of our armamentarium in managing type II SLAP tears in young, high-demand patients without evidence of biceps tendon pathology.

### Limitations

Our study is not without limitations. There is no control group with which we could compare outcomes. The sample size is small, and the cohort was composed entirely of active-duty male soldiers who have the option of going on restricted duty during rehabilitation, so the generalizability of our findings is limited. All procedures were performed by a single shoulder-elbow fellowship-trained surgeon with extensive experience in treating active-duty military patients. This creates the potential for selection bias and may limit the generalizability of the results. The clinical significance measures (PASS, SCB, MCID) are not yet fully defined for type II SLAP repair procedures, so the values for biceps tenodesis were used as a stand-in. Finally, the results are a retrospective review of prospectively collected data, and therefore, there is a risk for selection bias inherent to a case series.

### Conclusions

Mid-term outcomes in this population of young, active-duty patients undergoing DPSR for type II SLAP tears demonstrate a statistically and clinically significant improvement in patient-reported outcomes and an overall return to active-duty rate of 81.8%.

### References

1. Andrews JR, Carson WG Jr, McLeod WD. Glenoid labrum tears related to the long head of the biceps. *Am J Sports Med* 1985;13:337-341.
2. Kumar VP, Satku K, Balasubramaniam P. The role of the long head of biceps brachii in the stabilization of the head of the humerus. *Clin Orthop Relat Res* 1989;172-175.
3. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ. SLAP lesions of the shoulder. *Arthroscopy* 1990;6:274-279.
4. Maffet MW, Gartsman GM, Moseley B. Superior labrum-biceps tendon complex lesions of the shoulder. *Am J Sports Med* 1995;23:93-98.
5. Burkhart SS, Morgan CD, Kibler WB. The disabled throwing shoulder: Spectrum of pathology. Part II: Evaluation and treatment of SLAP lesions in throwers. *Arthroscopy* 2003;19:531-539.

6. Knesek M, Skendzel JG, Dines JS, Altchek DW, Allen AA, Bedi A. Diagnosis and management of superior labral anterior posterior tears in throwing athletes. *Am J Sports Med* 2013;41:444-460.
7. Rossy W, Sanchez G, Sanchez A, Provencher MT. Superior labral anterior-posterior (SLAP) tears in the military. *Sports Health* 2016;8:503-506.
8. Enad JG, Kurtz CA. Isolated and combined Type II SLAP repairs in a military population. *Knee Surg Sports Traumatol Arthrosc* 2007;15:1382-1389.
9. Parnes N, Dunn JC, Czajkowski H, DeFranco MJ, Green CK, Scanaliato JP. Biceps tenodesis as an attractive alternative to superior labral anterior-posterior (SLAP) repair for type II SLAP lesions in active-duty military patients younger than 35 years. *Am J Sports Med* 2021;49:3945-3951.
10. Kampa RJ, Clasper J. Incidence of SLAP lesions in a military population. *J R Army Med Corps* 2005;151:171-175.
11. Waterman BR, Cameron KL, Hsiao M, Langston JR, Clark NJ, Owens BD. Trends in the diagnosis of SLAP lesions in the US military. *Knee Surg Sports Traumatol Arthrosc* 2015;23:1453-1459.
12. Brockmeier SF, Voos JE, Williams RJ 3rd, et al. Outcomes after arthroscopic repair of type-II SLAP lesions. *J Bone Joint Surg Am* 2009;91:1595-1603.
13. Gorantla K, Gill C, Wright RW. The outcome of type II SLAP repair: A systematic review. *Arthroscopy* 2010;26:537-545.
14. Ide J, Maeda S, Takagi K. Sports activity after arthroscopic superior labral repair using suture anchors in overhead-throwing athletes. *Am J Sports Med* 2005;33:507-514.
15. Provencher MT, McCormick F, Dewing C, McIntire S, Solomon D. A prospective analysis of 179 type 2 superior labrum anterior and posterior repairs: outcomes and factors associated with success and failure. *Am J Sports Med* 2013;41:880-886.
16. Boileau P, Parratte S, Chuinard C, Roussanne Y, Shia D, Bicknell R. Arthroscopic treatment of isolated type II SLAP lesions: Biceps tenodesis as an alternative to reinsertion. *Am J Sports Med* 2009;37:929-936.
17. Denard PJ, Ladermann A, Parsley BK, Burkhart SS. Arthroscopic biceps tenodesis compared with repair of isolated type II SLAP lesions in patients older than 35 years. *Orthopedics* 2014;37:e292-297.
18. Ek ET, Shi LL, Tompson JD, Freehill MT, Warner JJ. Surgical treatment of isolated type II superior labrum anterior-posterior (SLAP) lesions: Repair versus biceps tenodesis. *J Shoulder Elbow Surg* 2014;23:1059-1065.
19. Arai R, Kobayashi M, Harada H, et al. Anatomical study for SLAP lesion repair. *Knee Surg Sports Traumatol Arthrosc* 2014;22:435-441.
20. Castagna A, De Giorgi S, Garofalo R, Tafuri S, Conti M, Moretti B. A new anatomic technique for type II SLAP lesions repair. *Knee Surg Sports Traumatol Arthrosc* 2016;24:456-463.
21. Bain GI, Galley IJ, Singh C, Carter C, Eng K. Anatomic study of the superior glenoid labrum. *Clin Anat* 2013;26:367-376.
22. Parnes N, Ciani M, Carr B, Carey P. The double-pulley anatomic technique for type II SLAP lesion repair. *Arthrosc Tech* 2015;4:e545-550.
23. Arrigoni P, Brady PC, Burkhart SS. The double-pulley technique for double-row rotator cuff repair. *Arthroscopy* 2007;23:675 e671-674.
24. Kocher MS, Horan MP, Briggs KK, Richardson TR, O'Holleran J, Hawkins RJ. Reliability, validity, and responsiveness of the American Shoulder and Elbow Surgeons subjective shoulder scale in patients with shoulder instability, rotator cuff disease, and glenohumeral arthritis. *J Bone Joint Surg Am* 2005;87:2006-2011.
25. Williams GN, Gangel TJ, Arciero RA, Uhorchak JM, Taylor DC. Comparison of the Single Assessment Numeric Evaluation method and two shoulder rating scales. Outcomes measures after shoulder surgery. *Am J Sports Med* 1999;27:214-221.
26. Burkhart SS, Morgan CD. The peel-back mechanism: Its role in producing and extending posterior type II SLAP lesions and its effect on SLAP repair rehabilitation. *Arthroscopy* 1998;14:637-640.
27. von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. *Int J Surg* 2014;12:1495-1499.
28. Seneviratne A, Montgomery K, Bevilacqua B, Zikria B. Quantifying the extent of a type II SLAP lesion required to cause peel-back of the glenoid labrum—a cadaveric study. *Arthroscopy* 2006;22:1163.e1161-1166.
29. O'Brien SJ, Allen AA, Coleman SH, Drakos MC. The trans-rotator cuff approach to SLAP lesions: Technical aspects for repair and a clinical follow-up of 31 patients at a minimum of 2 years. *Arthroscopy* 2002;18:372-377.
30. Puzzitiello RN, Gowd AK, Liu JN, Agarwalla A, Verma NN, Forsythe B. Establishing minimal clinically important difference, substantial clinical benefit, and patient acceptable symptomatic state after biceps tenodesis. *J Shoulder Elbow Surg* 2019;28:639-647.
31. Lu Y, Beletsky A, Chahla J, et al. How can we define clinically important improvement in pain scores after biceps tenodesis? *J Shoulder Elbow Surg* 2021;30:430-438.
32. Cvetanovich GL, Gowd AK, Frantz TL, Erickson BJ, Romeo AA. Superior labral anterior posterior repair and biceps tenodesis surgery: Trends of the american board of orthopaedic surgery database. *Am J Sports Med* 2020;48:1583-1589.
33. Wang KK, Yalozis M, Hoy GA, Ek ET. Current trends in the evaluation and treatment of SLAP lesions: Analysis of a survey of specialist shoulder surgeons. *JSES Open Access* 2018;2:48-53.
34. Hurley ET, Colasanti CA, Lorentz NA, et al. Open Subpectoral biceps tenodesis may be an alternative to arthroscopic repair for SLAP tears in patients under 30. *Arthroscopy* 2022;38:307-312.
35. Dunne KF, Knesek M, Tjong VK, et al. Arthroscopic treatment of type II superior labral anterior to posterior (SLAP) lesions in a younger population: Minimum 2-year outcomes are similar between SLAP repair and biceps tenodesis. *Knee Surg Sports Traumatol Arthrosc* 2021;29:257-265.
36. Pogorzelski J, Horan MP, Hussain ZB, Vap A, Fritz EM, Millett PJ. Subpectoral biceps tenodesis for treatment of



- isolated type II SLAP lesions in a young and active population. *Arthroscopy* 2018;34:371-376.
37. Chalmers PN, Erickson BJ, Verma NN, D'Angelo J, Romeo AA. Incidence and return to play after biceps tenodesis in professional baseball players. *Arthroscopy* 2018;34:747-751.
  38. Arroyo W, Misenhimer J, Cotter EJ, et al. Effect of anterior anchor on clinical outcomes of type II SLAP repairs in an active population. *Orthopedics* 2019;42:e32-e38.
  39. Strauss EJ, Salata MJ, Sershon RA, et al. Role of the superior labrum after biceps tenodesis in glenohumeral stability. *J Shoulder Elbow Surg* 2014;23:485-491.
  40. Patzer T, Habermeyer P, Hurschler C, et al. The influence of superior labrum anterior to posterior (SLAP) repair on restoring baseline glenohumeral translation and increased biceps loading after simulated SLAP tear and the effectiveness of SLAP repair after long head of biceps tenotomy. *J Shoulder Elbow Surg* 2012;21:1580-1587.
  41. Yoo JC, Ahn JH, Lee SH, et al. A biomechanical comparison of repair techniques in posterior type II superior labral anterior and posterior (SLAP) lesions. *J Shoulder Elbow Surg* 2008;17:144-149.
  42. Domb BG, Ehteshami JR, Shindle MK, et al. Biomechanical comparison of 3 suture anchor configurations for repair of type II SLAP lesions. *Arthroscopy* 2007;23:135-140.
  43. Baldini T, Snyder RL, Peacher G, Bach J, McCarty E. Strength of single- versus double-anchor repair of type II SLAP lesions: A cadaveric study. *Arthroscopy* 2009;25:1257-1260.
  44. Yang HJ, Yoon K, Jin H, Song HS. Clinical outcome of arthroscopic SLAP repair: Conventional vertical knot versus knotless horizontal mattress sutures. *Knee Surg Sports Traumatol Arthrosc* 2016;24:464-469.
  45. Zhang J, Jiang C. A new "double-pulley" dual-row technique for arthroscopic fixation of bony Bankart lesion. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1558-1562.
  46. Koo SS, Burkhart SS, Ochoa E. Arthroscopic double-pulley remplissage technique for engaging Hill-Sachs lesions in anterior shoulder instability repairs. *Arthroscopy* 2009;25:1343-1348.
  47. Stephenson DR, Hurt JH, Mair SD. Rotator cuff injury as a complication of portal placement for superior labrum anterior-posterior repair. *J Shoulder Elbow Surg* 2012;21:1316-1321.
  48. Oh JH, Kim SH, Lee HK, Jo KH, Bae KJ. Trans-rotator cuff portal is safe for arthroscopic superior labral anterior and posterior lesion repair: Clinical and radiological analysis of 58 SLAP lesions. *Am J Sports Med* 2008;36:1913-1921.
  49. McCulloch PC, Andrews WJ, Alexander J, Brekke A, Duwani S, Noble P. The effect on external rotation of an anchor placed anterior to the biceps in type 2 SLAP repairs in a cadaveric throwing model. *Arthroscopy* 2013;29:18-24.