

Return to Sport and Patient-Reported Outcomes After Subpectoral Biceps Tenodesis for SLAP Tear in Collegiate Gymnasts

Marisa N. Ulrich,* BS, Gregory L. Cvetanovich,*† MD, Brett D. Meeks,*# MD, and Grant L. Jones,* MD

Investigation performed at The Ohio State University, Columbus, Ohio, USA

Background: The biceps superior labral complex is a known source of shoulder dysfunction in young, high-level athletes. Superior labral anterior-posterior (SLAP) repairs are often unsatisfactory for treating biceps-labral pathology in this demographic group, with high failure rates and poor return to sport (RTS). Minimal data have been published to demonstrate patient-reported outcomes (PROs) and RTS in gymnasts after treatment of SLAP pathologies.

Hypothesis: Gymnasts undergoing biceps tenodesis for SLAP pathologies would have satisfactory PROs and satisfactory RTS.

Study Design: Case series; Level of evidence, 4.

Methods: Gymnasts aged ≤ 25 years who underwent open subpectoral biceps tenodesis for SLAP tears with or without biceps tendon pathology between August 20, 2014, and August 20, 2019, and who had minimum 2-year follow-up data were included in this study. Tenodesis was performed using a subpectoral technique with bicortical button fixation. The following PROs were included: RTS, postoperative activity level, 10-point visual analog scale for pain (VAS-Pain), American Shoulder and Elbow Surgeons (ASES), and Disabilities of the Arm, Shoulder and Hand (DASH) scores.

Results: Of 16 shoulders in 14 gymnasts undergoing biceps tenodesis for SLAP tear during the study period, a follow-up was obtained for 13 of 16 shoulders (81%) at 4.3 ± 1.5 years. The mean age of patients at the time of surgery was 21.8 ± 2.2 years, with 12 (92%) male patients. Biceps tenodesis was performed as the primary procedure for the diagnosis of SLAP tear in 12 patients (92%) and for failed prior SLAP repair in 1 patient (8%). PROs were excellent at the follow-up, with VAS-Pain scores of 1.8 ± 1.7 , ASES scores of 89.1 ± 9.1 , and DASH scores of 2.4 ± 3.2 . After surgery, 8 (62%) patients returned to their prior level of collegiate gymnastics. Three (60%) of 5 patients did not return to collegiate gymnastics because of the end of eligibility, and 2 (40%) patients did not return to collegiate gymnastics because of knee injuries. Significantly higher DASH scores were noted in the group that did not RTS ($P = .04$). No patients experienced postoperative complications or reoperation.

Conclusion: Biceps tenodesis was an effective primary operation for high-level gymnasts with SLAP tears, with a satisfactory rate of return to the same level of sport and excellent PROs.

Keywords: biceps; gymnast; rotator cuff; SLAP tear; tenodesis; tenotomy

The biceps-superior labral complex is a known source of shoulder dysfunction in young, high-level athletes.^{2,3,19,22,27,31} Gymnastics is a sport commonly associated with superior labral anterior-posterior (SLAP) tears, with pathologies presenting similarly to those of overhead athletes.^{4,9,12,14,32} Historically, operative treatment of SLAP pathologies in

young patients consisted of labral and biceps anchor repair. Outcomes were unsatisfactory, with variable postoperative satisfaction and functional outcomes.[§] The inconsistent nature of SLAP repairs has proven to be a major concern for gymnasts, where up to 50% of these athletes have findings consistent with SLAP lesions.^{4,9,12,14}

Return to sport (RTS) in overhead athletes after SLAP repair ranges from 22% to 64%, according to a recent meta-analysis.¹⁵ These variable outcomes have spurred increasing interest in biceps tenodesis in younger populations.^{7,8} Outcomes have looked promising, with many reports citing a $\geq 80\%$ return to the prior level of play in this patient

[§]References 1, 6, 10, 12, 15–18, 21, 26, 28, 29.

population.¹¹ When comparing biceps tenodesis to SLAP repairs, many studies have demonstrated noninferiority or superiority of biceps tenodesis in young athletes.^{20,26,29}

Despite many studies characterizing the shoulder pathology encountered in gymnasts, these athletes remain a relatively understudied demographic group with regard to SLAP pathology.^{9,12,14,32} Moreover, few studies have evaluated patient-reported outcomes (PROs) and RTS after biceps tenodesis in gymnasts. Thus, the purpose of this study was to evaluate RTS and PROs after biceps tenodesis in collegiate gymnasts aged ≤ 25 years. We hypothesized that gymnasts undergoing biceps tenodesis for SLAP pathologies would have satisfactory RTS and excellent PROs.

METHODS

Patient Selection

After receiving institutional review board approval, we performed a retrospective chart review to identify collegiate gymnasts who underwent biceps tenodesis by the senior author (G.L.J.) between 2014 and 2019. For all patients, SLAP diagnosis was confirmed with preoperative magnetic resonance imaging. Inclusion criteria were collegiate gymnasts aged ≤ 25 years with confirmed SLAP pathologies who had failed nonoperative management or failed prior SLAP repair with a minimum 2-year follow-up. Exclusion criteria were patients with preexisting connective tissue disorders, patients with associated fractures, or patients who sustained shoulder injuries outside of gymnastics.

Demographic data were collected, including age, sex, race, body mass index, and smoking status. Medical history—including previous surgeries and postoperative information—was reviewed for each patient. Conservative treatment included physical therapy and/or corticosteroid joint injections. Duration of therapy and administration of corticosteroid injection was based on the severity of symptoms and discretion of the surgeon and patient.

Surgical Technique

After the confirmation of SLAP pathology during arthroscopy, biceps tenodesis was performed using a miniopen subpectoral technique for each patient. The biceps tendon was tenotomized near the biceps–labral complex junction. After the tenotomy, other intra-articular pathology was evaluated and treated, including debridement of labral tears, chondral lesions, articular-sided partial-thickness rotator

cuff tears, and labral repairs in those patients with paralabral cysts. After the arthroscopic procedure, the biceps tendon was retrieved through an open subpectoral incision. The tendon was then whipstitched near the biceps musculotendinous junction for a length of approximately 2 cm distally. Next, a drill was used to make a bicortical hole in the appropriate location on the humerus to preserve the length-tension relationship of the biceps. The biceps diameter was then measured, and we drilled the corresponding unicortical hole with a reamer. A cortical button (Arthrex) was then placed and flipped on the far cortex and the biceps tendon was shuttled into the humerus by sequentially toggling the suture limbs from the button. The limbs of the suture were then tied on top of the tendon with alternating half-hitches.

Postoperative Rehabilitation

All athletes underwent a standard rehabilitation protocol postoperatively. Immediate passive range of motion for the shoulder and the elbow was initiated. Each athlete wore a sling for 4 weeks. Active biceps and shoulder motion was initiated during the 4-week period. Between 4 and 6 weeks postoperatively, there was a gradual transition out of the sling. At 6 to 12 weeks, the athlete transitioned to a gradual light strengthening program with the shoulder and the elbow. The athlete participated in progressive strengthening activities from 3 to 4 months. There was a gradual progression to gymnastics-specific activities, with ring exercises as the last events to progress 4 to 6 months postoperatively. Patients were released to full competition as tolerated at 6 months.

Outcome Assessment

Functional outcomes were measured using visual analog scale for pain (VAS–Pain) scores ranging from 0 to 10, with higher scores indicating greater pain; American Shoulder and Elbow Surgeons (ASES) scores ranging from 0 to 100, with higher scores indicating better condition; and Disabilities of the Arm, Shoulder and Hand (DASH) scores ranging from 0 to 100, with higher scores indicating greater difficulty with activities. The DASH–Work and DASH–Sport modules were also used. The DASH–Sport score was interpreted as the level of difficulty if patients were to practice gymnastics again. All patients were contacted via telephone to obtain PRO scores. In addition, reoperations and complications were recorded and RTS was assessed, including the level of competition, if applicable. If patients did not

[†]Address correspondence to Gregory L. Cvetanovich, MD, Jameson-Crane Sports Medicine Institute, 2835 Fred Taylor Drive Columbus, OH 43202, USA (gregory.cvetanovich@osumc.edu).

*The Ohio State University Sports Medicine Research Institute, Columbus, Ohio, USA.

#Northeast Georgia Physicians Group, Gainesville, Georgia, USA.

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Ethical approval for this study was obtained from The Ohio State University (ref No. 2019H0121).

TABLE 1
Patient and Surgery Characteristics (N = 13 Patients)^a

Characteristic	Value
Sex, male	12 (92)
Age, y	21.8 ± 2.2
Race, White	13 (100)
Nonsmoker	13 (100)
BMI	22.9 ± 1.9
Follow up, y	4.3 ± 1.5
Right arm affected	7 (54)
Dominant arm affected	6 (46)
Revision procedure	1 (8)
Operative findings: SLAP tear only	2 (15)
Operative findings: SLAP tear with biceps tendinitis/ tenosynovitis	8 (62)

^aData are presented as mean ± SD or n (%). BMI, body mass index; SLAP, superior labral anterior-posterior.

RTS, reasons were assessed to be either related or unrelated to their shoulder surgery.

Statistical Analysis

Demographic data for qualifying patients were assessed using descriptive statistics. Continuous data were evaluated using means and standard deviations, and categorical data were reported as percentages. Differences in continuous data between patients who returned to sport and patients who did not were evaluated using *t* tests, with *P* ≤ .05 indicating statistical significance (Excel, Version 16.71, Microsoft).

RESULTS

A total of 14 collegiate-level gymnasts underwent biceps tenodesis as a treatment for a SLAP tear between August 20, 2014 and August 20, 2019. No patients were excluded based on our criteria. Of the 16 shoulders in 14 gymnasts undergoing biceps tenodesis for a SLAP tear during the study period, a follow-up was obtained for 13 of 16 shoulders (81%) at a mean follow-up of 4.3 ± 1.5 years. Demographic data are shown in Table 1. Biceps tenodesis was performed as the primary procedure for the diagnosis of SLAP tear in 12 patients (92%) and for failed prior SLAP repair in 1 patient (8%). Ten patients demonstrated type 2 SLAP tears, and 3 patients had type 4 SLAP tears. The diagnosis of bicipital tenosynovitis was also recorded after an arthroscopic examination if present.

Intraoperatively, 2 patients demonstrated paralabral cysts that were decompressed, and the SLAP tear underwent repair along with the biceps tenodesis. Aside from concomitant SLAP repair performed in 2 patients, distal clavicle excision was performed in 1 patient. Five patients demonstrated intraoperative findings of partial-thickness supraspinatus tears, and 3 of these patients underwent rotator cuff repair. There were no other additional

TABLE 2
Comparison of PROs by RTS Status^a

	Returned to Sport (n = 8)	Did Not Return (n = 5)	<i>P</i>
ASES	90 ± 10.5	87.7 ± 7.3	.67
VAS–Pain	1.9 ± 2.1	1.8 ± 0.8	.94
DASH	1 ± 1.2	4.7 ± 4.4	.04
DASH–Work	0 ± 0	0 ± 0	>.99
DASH–Sport	17.9 ± 15.8	31.3 ± 19.8	.2

^aData are presented as mean ± SD. The bold *P* value indicates a statistically significant difference between the 2 groups (*P* ≤ .05). ASES, American Shoulder and Elbow Surgeons; DASH, Disabilities of the Arm, Shoulder and Hand; PRO, patient-reported outcome; RTS, return to sport; VAS, visual analog scale.

concomitant procedures. There was no evidence of subscapularis/infraspinatus tears intraoperatively.

Return to Sport

After surgery, 8 (62%) patients returned to their prior level of collegiate gymnastics. Five (38%) patients did not return to gymnastics because of reasons unrelated to their shoulder, and 13 patients (100%) were able to perform recreational sports without limitations. The reasons why patients did not return to collegiate gymnastics were end of eligibility for 3 (60%) patients and knee injuries for 2 (40%) patients. No patients experienced postoperative complications or reoperation.

Patient-Reported Outcomes

Overall, the mean PRO scores at the follow-up were 89.1 ± 9.1 for the ASES, 1.8 ± 1.7 for the VAS–Pain, 2.4 ± 3.2 for the DASH, 0 ± 0 for the DASH–Work, and 23.1 ± 17.9 for the DASH–Sport. Only the DASH score was significantly different between groups, with higher scores noted in the patients who did not RTS (*P* = .04). PROs are summarized in Table 2.

DISCUSSION

Our study evaluated RTS and PROs in gymnasts after biceps tenodesis for SLAP pathologies. In our cohort, 62% of patients returned to gymnastics. Of those who did not, all cited reasons other than their shoulder for their inability to continue the sport. DASH scores were the only PRO measure with a significant difference between those who did and did not RTS, with higher scores observed in those who did not RTS.

In 2019, Abdul-Rassoul et al¹ reported a high RTS rate in athletes, with a mean age of 24 years, after tenodesis for SLAP tears. Moreover, another recent study concluded that biceps tenodesis is an acceptable alternative to SLAP repair in young athletes <25 years, with two-thirds of patients able to RTS after surgery.¹⁷ This is similar to our study, which found that 62% of gymnasts were able to RTS after

biceps tenodesis after a SLAP tear. Based on these data, biceps tenodesis yields satisfactory outcomes for the treatment of SLAP tears in athletes ≤ 25 years.

Data focused on gymnasts are sparse in the literature, with most studies differentiating between overhead versus nonoverhead athletes. Many studies assess athletes of various sports together without clearly defining how gymnasts are grouped in the study population. In a recent review,¹¹ overhead athletes (including 2 gymnasts) who received biceps tenodesis for SLAP pathologies demonstrated an overall RTS rate of 70%, with ASES scores ranging from 81.7 to 97 and VAS scores ranging from 0.8 to 1.5. Another study²³ of overhead athletes found similar results, with an overall RTS rate of 82%, rate of return to the same or higher level of play of 59%, and the mean ASES and VAS scores of 92 and 0.8, respectively. These are similar to the outcomes found in our study, which found an RTS rate of 62%, ASES score of 89.1, and VAS-Pain score of 1.8.

Interestingly, the DASH scores were significantly higher for patients who did not RTS. There is a paucity of research evaluating DASH scores for gymnasts, preventing further assessment of this phenomenon. However, it is possible that athletes who did RTS received more consistent guidance on strength and recovery because of team trainers/resources, leading to greater ease with daily activities. Perhaps higher DASH scores were the reason the athlete did not RTS; however, no other outcome scores were significantly different in this study. In addition, all athletes reported reasons other than their shoulder for not returning to sport. Alternatively, there is a possibility that patients who no longer participated in gymnastics selected “unable to do” certain activities, mistaking a lack of participation for an inability to participate. Our small sample size also increases the likelihood of a type I error. While gymnasts are often grouped with overhead athletes, independent evaluation should be considered because of the unique needs of the gymnast’s shoulder compared with other overhead athletes.³² Further evaluation of PROs in gymnasts could provide essential insights that would improve treatments and recovery after SLAP tears.

To our knowledge, the Gendre and Boileau¹³ study is the only study focusing exclusively on gymnasts after biceps tenodesis. In this case series, 100% of gymnasts returned to sport after biceps tenodesis. PROs were not recorded. Our study evaluated not only RTS rates but reasons why patients did not RTS. While only 62% of patients returned to sport after surgery, the remaining 38% cited reasons other than their shoulder for not returning to sport. This highlights differential reasoning that could prove valuable for future studies in gymnasts and other athletes while promoting more accurate data reporting when determining RTS rates.

There has yet to be a consensus on the ideal treatment of SLAP tears in young athletes. Varying results in the literature have prevented definitive recommendations for this demographic group.^{11,20,24,25,30} While previous studies have shown similar postoperative kinematics after biceps tenodesis and SLAP repairs in pitchers, no studies to date have evaluated postoperative kinematics in gymnasts.⁵ Reasons for a relative paucity of research on gymnasts are unknown, but their unique demands on the upper

extremity warrant further evaluation. Our study suggests that, when indicated, biceps tenodesis is an effective treatment for SLAP tears in high-level gymnasts aged ≤ 25 years. RTS rates and PROs are satisfactory at a minimum of 2-year follow-up.

Strengths and Limitations

The strengths of this study add to the limited literature focusing exclusively on PROs and RTS after biceps tenodesis in collegiate gymnasts aged ≤ 25 years. It offers unique insights into the functional status of this demographic group at a minimum 2-year follow-up and sets the stage for future studies to further evaluate gymnast outcomes after treatment.

A limitation of this study was that patients were called ≥ 2 years after surgery, which could introduce recall bias in their satisfaction and functional reporting. Although we had a very specific patient cohort, our findings should be interpreted in light of our small sample size and may not be representative of the true sex distribution present in gymnastics. In addition, a power analysis was not performed. Some patients included in this study had concomitant procedures, which could introduce bias when assessing RTS and PROs. Additionally, a single surgeon at an academic institution performed all operations on high-level athletes, which may limit the generalizability of our results.

CONCLUSION

Biceps tenodesis was an effective treatment for SLAP tears in high-level gymnasts aged ≤ 25 years. Patients had satisfactory RTS rates as well as PROs at a minimum 2-year follow-up.

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