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Arthroscopic Treatment of Isolated Type II SLAP Lesions

Biceps Tenodesis as an Alternative to Reinsertion

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Background: Overhead athletes report an inconsistent return to their previous level of sport and satisfaction after arthroscopic SLAP lesion repair.

Hypothesis: Arthroscopic biceps tenodesis offers a viable alternative to the repair of an isolated type II SLAP lesion.

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

Methods: Twenty-five consecutive patients operated for an isolated type II SLAP lesion between 2000 and 2004 were evaluated at a mean of 35 months postoperatively (range, 24-69). Patients with associated instability, rotator cuff rupture, posterosuperior impingement, or previous shoulder surgery were excluded. Ten patients (10 men) with an average age of 37 years (range, 19-57) had a SLAP repair performed with suture anchors. Fifteen patients (9 men and 6 women) with an average age of 52 years (range, 28-64) underwent arthroscopic biceps tenodesis performed with an absorbable interference screw. Arthroscopic diagnosis and treatment were performed by a single experienced shoulder surgeon, and all patients were reviewed by an independent examiner.

Results: In the repair group, the Constant score improved from 65 to 83 points; however, 60% (6 of 10) of the patients were disappointed because of persistent pain or inability to return to their previous level of sports participation. In the tenodesis group, the Constant score improved from 59 to 89 points, and 93% (14/15) were satisfied or very satisfied. Thirteen patients (87%) were able to return to their previous level of sports participation following biceps tenodesis, compared with only 20% (2 of 10) after SLAP repair (P = .01). Four patients with failed SLAP repairs underwent subsequent biceps tenodesis, resulting in a successful outcome and a full return to their previous level of sports activity.

Conclusion: Arthroscopic biceps tenodesis can be considered an effective alternative to the repair of a type II SLAP lesion, allowing patients to return to a presurgical level of activity and sports participation. The results of biceps reinsertion are disappointing compared with biceps tenodesis. Furthermore, biceps tenodesis may provide a viable alternative for the salvage of a failed SLAP repair. As the age of the 2 treatment groups differed, these findings should be confirmed by future studies.

Keywords: SLAP lesion; reinsertion; biceps tenodesis; arthroscopy

Glenoid labral tears involving the long head of the biceps were initially described by Andrews et al[2] in 1985, who noted an association between these lesions and overhead sports activities. In 1990, Snyder et al[33] further classified these labral tears and coined the term "SLAP lesion" for superior-labrum-anterior-and-posterior (SLAP) lesion. Their prevalence varies depending on the patient population studied but has been reported to be between 1.2% and 23%. However, their cause is often uncertain. Other than a distinct traumatic event, sporting activities are the most common cause of SLAP lesions.[3,13,18,20,21,33] Type II SLAP lesions correspond to a detached biceps anchor from the superior glenoid, accounting for the majority of described SLAP lesions (41%) and occur most commonly in overhead athletes.[4,23,32,33] Although such lesions are often associated with other shoulder injuries such as rotator cuff tears, glenohumeral instability, or

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internal impingement, they can also be found as an isolated lesion and a primary cause of shoulder pain.[20,22]

Because arthroscopic debridement yields inconsistent results, arthroscopic repair is now considered the standard treatment.[12,17,23] Various methods of fixation have demonstrated successful functional results in 75% to 97% of series.[11,17,21-23,27,30-33] Overhead athletes, in contrast, report inconsistent return to their previous level of sports participation, as well as inconsistent subjective patient satisfaction. Ide et al[14] were able to report a 60% to 75% rate of return to previous level of sports following arthroscopic SLAP repair; however, Kim et al[18] reported only a 22% rate in their series. In our early experience with SLAP repairs, we observed similarly disappointing results as Kim et al, with respect to both reported patient satisfaction and return to previous level of sports participation. By comparison, arthroscopic biceps tenodesis using interference screw fixation to treat biceps lesions associated with rotator cuff tears has yielded satisfying results.[5-8]

On the basis of this experience, we hypothesized that arthroscopic biceps tenodesis could be used as an alternative to reinsertion, that is, repair, of isolated unstable type II SLAP lesions. The purpose of the present prospective outcome study was to evaluate and compare the results of biceps tenodesis and repair of isolated type II SLAP lesions. Our objectives were as follows: (1) to compare the objective outcomes of biceps tenodesis with those of SLAP repair as measured by the Constant score, (2) to analyze the subjective outcomes with the use of patient satisfaction scores, and (3) to evaluate the return of patients to previous levels of sports participation.[9]

MATERIALS AND METHODS

Study Design

This is a prospective study with the approval of the local ethics committee. Inclusion criteria included (1) shoulder pain interfering with either strenuous activities or sports participation; (2) symptoms unresponsive to at least 6 months of nonoperative treatment, including activity modification, anti-inflammatory medication, and a formal rehabilitation regimen; and (3) an isolated type II SLAP tear confirmed by intraoperative arthroscopic assessment.

Exclusion criteria included (1) associated glenohumeral instability, (2) a rotator cuff tear (either greater than 50% partial thickness or full thickness), (3) posterosuperior glenoid impingement (as defined by Walch et al as a throwing athlete with contact between the articular surface of the supraspinatus and the posterosuperior labrum with the arm in a throwing position at arthroscopy, evidenced as a deep partial-thickness supraspinatus tear and/or a posterosuperior labral tear), (4) biceps tendinopathy, and (5) previous ipsilateral shoulder surgery.[35] Patients who underwent a debridement of their SLAP lesion were also excluded. All patients who were included in the study were arthroscopically treated for an isolated type II SLAP lesion between January 2000 and April 2004 by the senior author and had a minimum follow-up of 2 years.

All patients provided written informed consent before undergoing the procedure. Patients were aware that either a SLAP reinsertion or a biceps tenodesis could be performed at the time of surgery. The risks and benefits of both procedures were explained to the patients, and they were aware that their data could be used for research purposes. The patients were told that the goal of both procedures was to relieve their shoulder pain for them to return to their previous level of sports. The treatment option was chosen by the surgeon depending on the age of the patient. A biceps tenodesis was performed in older patients, particularly those over the age of 30 years. However, several SLAP reinsertions were performed in older patients early in the study. Similarly, several biceps tenodeses were performed on younger patients later in the study. This reflects an evolution of our preference to perform a biceps tenodesis in older or less active patients and reserving SLAP reinsertion for younger or more active athletes. No randomization was performed.

Surgical Procedure and Perioperative Management

All patients underwent diagnostic arthroscopy in the beach-chair position with general anesthesia and an interscalene nerve block. Arthroscopic diagnosis and treatment were performed by a single experienced shoulder surgeon. Arthroscopic evaluation confirmed the diagnosis and ruled out other pathologic changes including increased translation, Bankart lesions, Hill-Sachs lesions, biceps tendinopathy, and partial- or full-thickness rotator cuff tears.

In the reinsertion group, the SLAP repair was performed using resorbable suture anchors (Panalok, DePuy Mitek, Raynham, Massachusetts) placed at the 11- and 1-o'clock positions on the glenoid. After debridement of the unstable labral flaps and abrasion of a nonarticular bony bed, suture anchors were inserted into the glenoid rim at an angle of approximately 45°. A single vertical stitch from each anchor was placed around the labrum and secured with a sliding arthroscopic knot to secure the labrum to the glenoid (Figure 1). In the tenodesis group, all patients underwent arthroscopic biceps tenodesis according to the technique described by Boileau et al[7,8] using interference screw fixation (Figure 2). After biceps tenotomy, the tendon is exteriorized and doubled on a suture; the biceps tendon is then pulled into a humeral socket drilled at the top of the bicipital groove and fixed using a bioabsorbable interference screw (Tenoscrew, Phusis, Tornier, Stafford, Texas) under arthroscopic control.[7,8] Neither procedure changed throughout the course of the study. No other arthroscopic procedures were performed during the surgery (acromioplasty, etc).

Postoperatively a sling was used for 4 weeks, and all patients were prescribed the same postoperative rehabilitation protocol under the supervision of a physical therapist. As soon as the immediate postoperative pain subsided, patients initiated a submaximal isometric strengthening program for the deltoid muscle. Elbow, wrist, and finger mobilization as well as gentle pendulum exercises were performed for 5 minutes, 5 times daily, starting on postoperative day 1. Three weeks postoperatively, passive- and active-assisted range of motion exercises

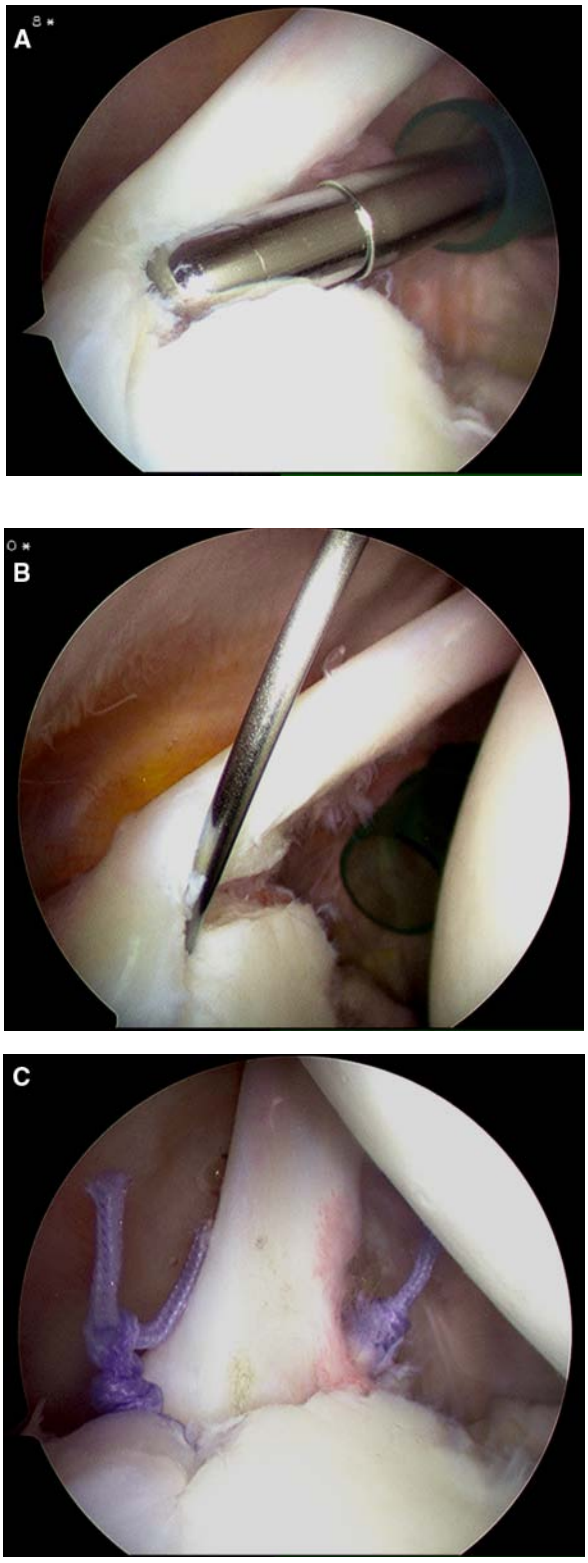

Figure 1. Arthroscopic SLAP repair using suture anchors. After debridement of the unstable labral flaps and abrasion of a nonarticular bony bed (A), 2 resorbable suture anchors are inserted into the glenoid rim at the 11- and 1-o'clock positions on the glenoid at an angle of approximately 45° (B). A single simple vertical stitch from each anchor is placed around the labrum and secured with a sliding arthroscopic knot to secure the labrum to the glenoid (C).

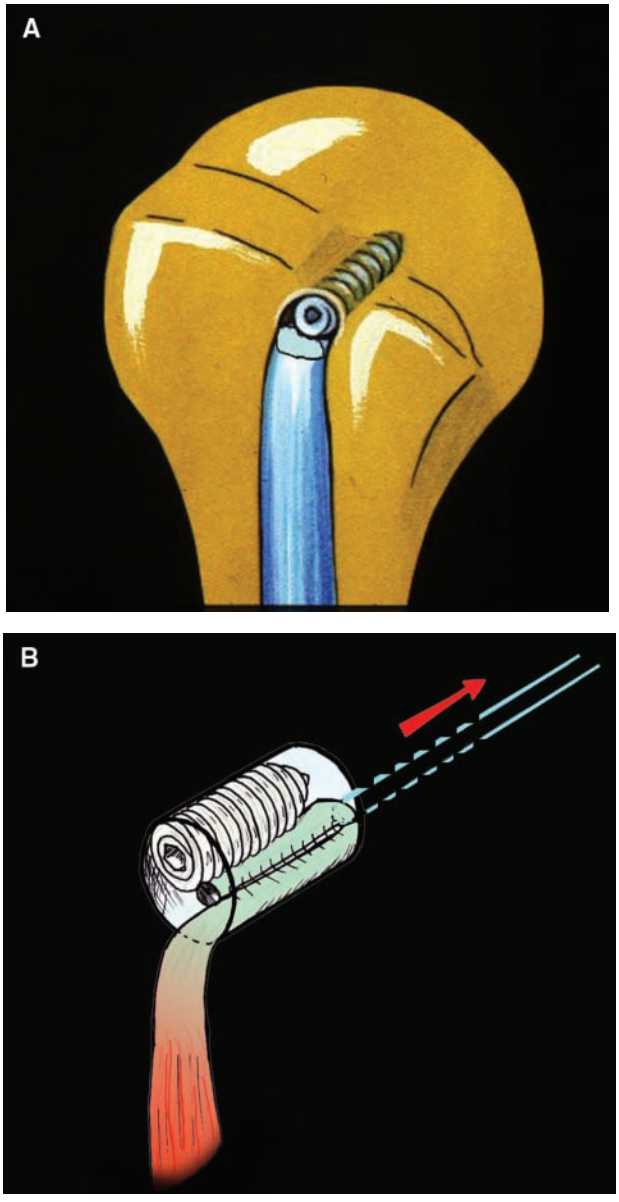

Figure 2. Arthroscopic biceps tenodesis technique using interference screw fixation. A socket is drilled at the top of the bicipital groove (A); a bioabsorbable interference screw placed on the doubled part of the tendon provides fixation (B).

were initiated. Six weeks postoperatively, patients began progressive strengthening of their rotator cuff and scapular stabilizers. Three months postoperatively, a sport-specific exercise program was begun for collegiate- and professional-level athletes. Full return to throwing sports was allowed between 4 to 6 months postoperatively. This was the same for either procedure and remained unchanged throughout the course of the study.

Outcomes Assessment

Postoperative assessment was performed by an independent observer (S.P.) at a mean of 35 months (range, 24-69). No patients were lost to follow-up. Subjective satisfaction was assessed using a 4-point scale (very satisfied, satisfied,

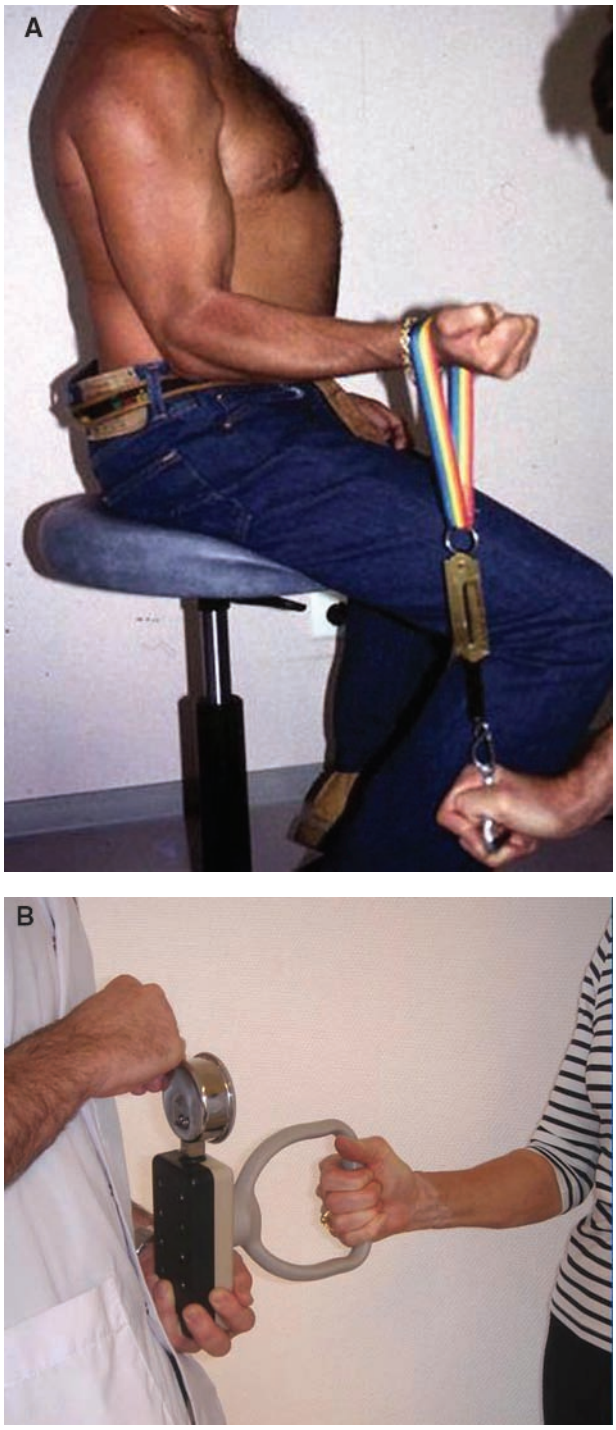

Figure 3. Mechanical dynamometers were used to measure strengths in elbow flexion (A) and forearm supination (B).

disappointed, or dissatisfied). The return to preinjury level of sports participation was also assessed. Pain was evaluated using a visual analog scale (VAS), and functional outcome was assessed with the use of the Constant score.[11] Elbow flexion and forearm supination strengths (Figure 3) were also evaluated using mechanical dynamometers (Direct Pesage, Esmans, France).

TABLE 1
Patient Characteristics for the 2 Groups[a]

	SLAP Repair	Biceps Tenodesis	*P* Value
N = 25	10	15	NS
Age, y	37 (19-57)	52 (28-64)	<.001
Sex	10 M	6 W / 9 M	NS
Side	10 R	11 R / 4 L	NS
Dominant arm	9	12	NS
Preoperative pain (VAS)	6.10 ± 1.78	6.57 ± 1.85	NS
Preoperative Constant score	65	59	NS
Follow-up time, mo	35 (24-69)	34 (24-68)	NS

[a]NS, not significant; M, men; W, women; R, right; L, left; VAS, visual analog scale. Ranges in parentheses.

Statistical Analysis

Statistical analysis was performed using nonparametric testing for linked samples (Wilcoxon test).[26] Quantitative data were compared between the 2 groups using a Mann-Whitney test, and qualitative data were compared using a Fisher exact test.[26] All calculations assumed 2-tailed tests and a significance level of $P < .05$. Statistical analysis was performed using SPSS software (version 12, Chicago, Illinois).

RESULTS

Patient Demographics

Twenty-five consecutive patients met the inclusion and exclusion criteria. Ten patients had an arthroscopic SLAP repair using suture anchors, and 15 patients had an arthroscopic biceps tenodesis using a bioabsorbable interference screw. Patient characteristics were statistically comparable between the 2 groups except for age, which was higher in the tenodesis group ($P < .001$) (Table 1). No patients were lost to follow-up.

Among the 25 patients, 14 (60%) reported a clear trauma: a fall on an outstretched arm (6 cases), a fall with direct impact on the shoulder (6 cases), or a traction injury to the ipsilateral arm (2 cases). The primary patient complaint was shoulder pain at rest as well as during overhead activities. The mean pain score measured on a VAS was 6.4 (range, 4-10). The average duration of symptoms before surgery was 15 months (range, 8-60). Shoulder pain was initially treated with medications and physical therapy for at least 6 months. Eleven patients (46%) underwent subacromial injection with cortisone before surgery.

Nineteen patients (76%) were regularly participating in a sport that was frequently associated with inducing shoulder injury and, in particular, SLAP lesions. Four patients regularly participated in a contact sport, and 15

TABLE 2
Preoperative Type and Level of Sport

	SLAP Repair (n = 10)	Biceps Tenodesis (n = 15)
Preoperative type of sport		
No sport	1	3
No risk	0	2
Contact sport	2	2
Overhead sport	7	8
Preoperative level of sport		
No sport	1	3
Recreational	0	1
Collegiate	4	5
Professional	5	6

patients participated in an overhead sport. Preoperatively, 9 patients participated at a collegiate level, and 11 patients participated at a professional level. Each treatment group had similar preoperative type and level of sport activity (Table 2).

In 11 cases (46%), the diagnosis of a type II SLAP lesion was suspected on preoperative images obtained from computed tomography (CT) arthrograms (10 cases) and magnetic resonance (MR) arthrograms (1 case). In the remaining cases, the diagnosis was made intraoperatively by direct observation with the arthroscope. An isolated type II SLAP tear was confirmed by intraoperative arthroscopic assessment in all 25 cases.

Arthroscopic Treatment

Comparative results were obtained with both techniques (arthroscopic SLAP repair and biceps tenodesis) (Table 3). No intraoperative complications, nerve deficits, or wound infections occurred in any patient. Each subscore of the Constant score was statistically similar between the SLAP repair and biceps tenodesis groups (pain: 11.7 vs 14.1; mobility: 39.1 vs 39.5; strength: 19.1 vs 17.5; $P > .05$), except for the activity subscore, which was statistically higher (ie, better) in the tenodesis group (16.3 vs 19.5; $P < .001$). However, a power analysis revealed that we did not have sufficient power to determine that there was no difference between the 2 groups for the other parameters of the Constant score (power < .8).

Subjectively, in the repair group, 6 of 10 patients (60%) were either disappointed or dissatisfied (3 were disappointed, and 3 were dissatisfied) because of pain or an inability to return to their previous level of sports participation. The 4 remaining patients were very satisfied. In the tenodesis group, 1 patient was disappointed (due to residual pain), 2 were satisfied, and 12 were very satisfied. In the tenodesis group, 13 patients (87%) were able to return to their previous level of sport, compared with only 2 patients (20%) after SLAP repair ($P = .011$).

No revision surgery was required in the tenodesis group, whereas in the repair group, 4 dissatisfied patients (40%) required revision surgery. Revision surgery was performed in these patients because of residual pain with overhead activities that precluded sports participation. None of the patients who underwent revision surgery reported any reinjury. The reoperations after failed repair were performed at a mean of 15 months (range, 12-26). In the 4 reoperated patients, arthroscopic exploration revealed a biceps anchor well attached to the superior glenoid rim. In 3 patients, the intra-articular portion of the biceps tendon was normal, while in the third patient, the tendon was found to be delaminated and attached with some fibrous bands to the capsule (Figure 4). Revision surgery consisted of a biceps tenodesis in the groove with an interference screw and resulted in a successful return of all 3 patients to their previous levels of sports participation.

TABLE 3
Comparative Results With Both Surgical Techniques[a]

	SLAP Repair (N = 10)	Biceps Tenodesis (N = 15)	*P* Value
Pain	11.7 ± 2.1	14.1 ± 1.9	NS
Activity	16.3 ± 3	19.5 ± 2.5	.023
Mobility	39.1 ± 4.3	39.5 ± 4.5	NS
Strength	19.1 ± 2.7	17.5 ± 3.4	NS
Constant score	83 ± 5.2	89 ± 4.7	NS
Patient satisfaction (very satisfied or satisfied)	4/10	14/15	.006
Return to previous sport level	2/10	13/15	.011
Reoperation	4	0	
Strength in elbow flexion, kg	15.6	15.1	NS
Strength in forearm supination, kg	6.6	6.5	NS

[a]NS, not significant.

DISCUSSION

The present study confirms our hypothesis that arthroscopic biceps tenodesis using an interference screw technique is a reliable alternative to labrum reinsertion using suture anchors in unstable isolated type II SLAP lesions, even for overhead athletes. Furthermore, this study demonstrates that subjective patient satisfaction and the rate of return to previous level of sport are significantly better after biceps tenodesis than after SLAP repair. Of the patients who underwent SLAP repair, only 40% (4 of 10) were satisfied, and only 20% (2 of 10) could return to their previous level of sports participation. In contrast, 93% (14 of 15) of patients who underwent arthroscopic biceps tenodesis were satisfied with the procedure, and 87% (13 of 15) returned to their previous level of sports participation ($P = .01$).

In this series, 6 patients in the repair group reported persistent pain, particularly during overhead sports activities. For 3 of these 6 patients, an arthroscopic biceps tenodesis was performed, which resulted in the successful return to their previous levels of sports participation. By contrast, no patient who underwent arthroscopic biceps

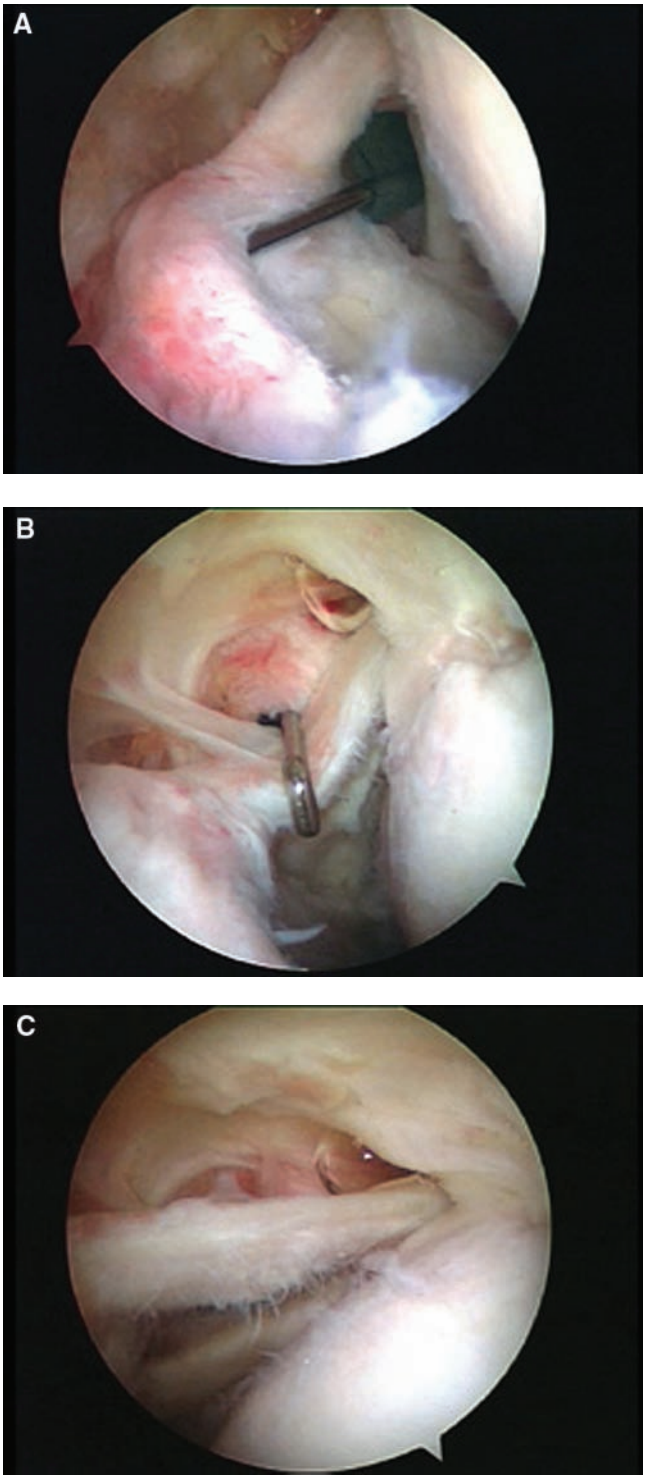

Figure 4. Second-look arthroscopy after failed SLAP repair with absorbable anchor and sutures. The biceps anchor is well fixed (A), there is a fibrous band between the biceps and capsule (B), and the deep surface of the biceps tendon appears delaminated (C).

tenodesis required reoperation. Our study suggests that arthroscopic biceps tenodesis can be used as a successful salvage procedure in the case of a failed SLAP repair.

Our results demonstrate an unexpectedly low rate of patient satisfaction (40%) and return to previous level of sport (20%) after arthroscopic SLAP repair. Our results differ from most studies but are similar to those of Kim et al,[17] who reported only a 22% rate of return of patients to their previous level of sports participation after arthroscopic SLAP repair. The question then arises as to why some patients have pain limiting overhead sports activities following SLAP repair. One explanation may be traction on the superior labrum during overhead activities, which has been described as the origin in creation and extension of type II SLAP lesions.[4,9,23,34] It has been shown by Alpantaki et al[1] that the tendon of the long head of the biceps is innervated by a dense network of sensory sympathetic fibers, particularly in the proximal portion of the tendon, which may play a role in the pathogenesis of shoulder pain. This nerve density may explain the residual pain after arthroscopic SLAP repair. In 1 reoperated patient, the intra-articular portion of the long head of the biceps (LHB) was found to be delaminated and could explain the recurrence of shoulder pain (Figure 3). However, in the 2 other reoperated patients, the biceps tendon and anchor were normal. Another explanation for recurrent shoulder pain is that, despite the use of absorbable suture anchors to reinsert the superior labrum, SLAP repair may create too rigid fixation of the superior labrum. In another study, we performed a dynamic observation of the shoulder under arthroscopy and found that the superior labrum and biceps anchor are mobile structures during shoulder elevation, abduction, and rotation.[15] Thus, the medial rolling of the biceps anchor during abduction/external rotation (ie, a throwing movement) may be lost after a rigid superior labrum repair, resulting in shoulder pain.

To our knowledge, biceps tenodesis for type II SLAP lesions has not been previously reported. Therefore, we cannot directly compare our results with any previous series for this technique. Our study has shown that range of motion and shoulder and elbow strength after tenodesis are unaltered, allowing for a return to a presurgical level of activity. Biomechanical studies have shown that interference screw fixation provides stronger fixation when compared with suture alone or suture anchor fixation.[8,16,24,28] Therefore, the results of the present study should not be extrapolated to other techniques of biceps tenodesis or to biceps tenotomy. Failure of a biceps tenodesis, due to inadequate fixation, with a resultant "Popeye sign" in an athlete may be cosmetically unacceptable and, more importantly, may compromise strength in flexion and supination of the elbow.[5]

The role of the LHB in shoulder function has been debated and continues to be controversial.[9,25,29] Removal of the intra-articular portion of the biceps in a throwing or overhead athlete may be a concern for the surgeon. The results of the present series, however, as well as our previous experience with this technique in the cuff-deficient shoulder, show that

arthroscopic biceps tenodesis does not result in proximal humeral migration or anterior instability.[5-8] More importantly, by removing a pain generator, it may be possible to restore normal kinematics to the athlete's shoulder.

Our study has some potential strengths. Contrary to other studies that often incorporate other associated shoulder lesions (instability, rotator cuff lesions, or internal impingement), our series only contains patients with isolated type II SLAP lesions.[2,10,18,19,22,34,35] It is well known that SLAP lesions can coexist with other lesions in the shoulder.[20] However, as mentioned by Kim et al,[18] when a SLAP lesion coexists with other clinical syndromes or anatomical pathological entities, it becomes difficult, if not impossible, to know if the success or failure of a given treatment is due to the management of the SLAP lesion itself or to the management of the other pathological entities. All patients with additional associated shoulder lesions have been excluded from the present study. All patients who had an additional associated procedure during the index surgery, like an acromioplasty or a Mumford procedure, were also excluded from the study. Another strength of the study is that all patients were treated by a single experienced surgeon using the same standardized techniques with the same implants. Finally, the patients were evaluated by an independent observer using standard evaluation scores, at a minimum of 2 years after surgery, and no patients were lost to follow-up in the study period.

Limitations of this study include the nonrandomized design and relatively small sample size. The small number of patients only reflects the surgeon's desire to avoid an overdiagnosis of SLAP lesions, resulting in a carefully selected patient population with isolated type II SLAP lesions. Another potential weakness is that the 2 groups of patients were not statistically comparable for age, with the patients being older in the tenodesis group. This can be explained by the fact that, early in the series, we were apprehensive to propose a biceps tenodesis, except only to the oldest patients. The tenodesis group could be a lower demand population and thus have better outcomes. As well, due to the small number of patients, we were unable to match patients according to age or level of sports participation. Finally, we used only a single outcome score, the Constant score. At the time this study began, we were only routinely using this outcome measure. However, use of additional outcome measures may have improved the study.

In conclusion, arthroscopic biceps tenodesis using an interference screw technique is an effective alternative to suture anchor repair of an isolated type II SLAP lesion. This procedure, by resolving shoulder pain during overhead activities, allows patients to return to their previous level of sport activities in approximately 90% of cases. A high rate of patient satisfaction can also be anticipated because of an ability to maintain shoulder range of motion and strength from a presurgical level, thus allowing a return to preinjury sports participation. By contrast, the results of arthroscopic repair of type II SLAP lesions are disappointing because of poor subjective outcomes, unexpectedly low rates of return to previous sports participation, and persistent pain during overhead activities. While a prospective randomized trial would be necessary to evaluate the respective places of SLAP repair and biceps tenodesis in the treatment of isolated type II SLAP lesions, we currently preferentially perform a biceps tenodesis in older patients (more than 30 years old) and a SLAP repair in younger patients (less than 30 years old). Furthermore, we believe that arthroscopic biceps tenodesis can be an excellent salvage procedure for cases of failed SLAP repair, but further investigation is necessary.

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