


CLINICAL ARTICLE

Arthroscopic Modified Double-Row Biceps Tenodesis versus Labral Repair for the Treatment of Isolated Type II SLAP Lesions in Non-Overhead Athletes

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Abstract

Objective: To evaluate the postoperative efficacy and the clinical outcomes of arthroscopic modified double-row biceps tenodesis versus labral repair.

Methods: A retrospective study was conducted in 56 patients with isolated type II superior labrum anterior and posterior (SLAP) lesions from March 2015 to November 2018. Thirty patients (male:female = 17:13) were treated with labral repair, and 26 patients (male:female = 15:11) were treated with modified double-row biceps tenodesis. The average age of the labral repair group and the modified double-row biceps tenodesis group were 42.8 ± 10.6 and 40.9 ± 10.2 years, respectively. Pre- and postoperative assessments with the visual analog scale (VAS), University of California Los Angeles (UCLA), and American Shoulder and Elbow Surgeons (ASES) scores were compared between the two treatment groups. Additional outcome measures included patient satisfaction, the time to return to previous activities, workers' compensation status, and postoperative complications.

Results: At a 2-year follow-up, the tenodesis group showed significant differences in postoperative VAS (1.5 to 1.8, respectively; $p = 0.008$), patient satisfaction (92.3% vs. 46.7%, $p < 0.001$), and recovery time to return to their previous activities (6.8 ± 1.8 vs. 8.1 ± 1.5 , $p = 0.007$) compared to the labral repair group; however, there was no significant difference in postoperative ASES and UCLA scores between the two groups. Additionally, one patient in the tenodesis group developed persistent postoperative stiffness, which was resolved by conservative treatment. In the labral repair group, two patients presented with persistent postoperative night pain, three developed persistent postoperative stiffness, and two required a subsequent capsular release.

Conclusions: Compared with the labral repair group, the arthroscopic modified double-row biceps tenodesis showed more encouraging postoperative pain reduction, earlier recovery to previous activities, and higher patient satisfaction.

Key words: biceps sheath; complication; labral repair; modified double-row biceps tenodesis; superior labrum anterior and posterior lesions

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Introduction

Superior labrum anterior and posterior (SLAP) lesions were originally described by Andrews *et al.*¹ in 1985 and then further classified into four types by Snyder *et al.*² in 1990. Of all the subtypes, type II SLAP lesions are the most common, accounting for 55% of all diagnosed lesions. These are characterized by the detachment of the superior labrum and biceps anchor from the glenoid, which can cause chronic shoulder pain and disability, especially in overhead athletes such as pitchers and volleyball players²⁻⁴.

While SLAP lesions have been described for decades, the exact cause remains unknown to this day. Several theories regarding the etiology of SLAP lesions have been proposed, such as traction injury to the biceps tendon, which can cause inferior subluxation of the humeral head that significantly deteriorates the SLAP lesions, direct compression loads, and repetitive overhead activities caused by internal impingement between the labrum and the undersurface of the rotator cuff when the arm is in abduction and external rotation. This cascade of factors eventually leads to labral failure *via* the “peel-back” mechanism⁵⁻⁷.

Labral repair is believed to restore the anatomical structure of the shoulder and its dynamic and static stability^{8,9}. Traditionally, labral repair is the preferred surgical procedure for type II SLAP lesions^{8,10-12}. However, the variability in results (from 40% [good] to 94% [excellent]), the rate at which patients can return to their sport (from 20% to 94%), prognosis, and postoperative complications has left some patients dissatisfied⁸. Additionally, several studies have shown poor results in patients older than 35 to 40 years, those involved in overhead throwing activities, and those with workers' compensation claims^{11,13-15}. Consequently, arthroscopic biceps tenodesis for the treatment of type II SLAP lesions has been receiving increased attention due to its superior outcomes, such as improved patient satisfaction, fewer postoperative complications, a higher rate of returning to their sport, and better cost-effectiveness compared to labral repair^{10,16-18}. Some evidence demonstrates that biceps tenodesis can be performed as an alternative procedure to remove traction, diffusing it as a pain generator within the glenohumeral joint and reducing the “peel-back” of the superior labrum^{8,9}. Biceps tenodesis is also recommended as the preferred surgical procedure for middle-aged patients due to the increased risk of postoperative stiffness and vascular insufficiency in the superior labrum¹⁸⁻²⁰. It has also been reported that biceps tenodesis is widely applied in revision surgery for cases where labral repair has failed²¹.

The vascular supply region of the superior glenoid labrum comes from the suprascapular artery, circumflex scapular branch of the subscapular artery, and posterior humeral circumflex artery. Since the vascularity in the anterior, anterosuperior, and superior regions of the labrum is relatively deficient, they are more vulnerable to damage and have impaired healing potential²². Functionally, some believe that the proximal biceps tendon plays an important role as a humeral head depressor or anterior stabilizer, while others

believe that it may play a less important biomechanical role in the shoulder for non-overhead athletes. Additionally, some evidence suggests that the biceps tendon is essentially a vestigial structure. Biceps tenodesis rarely affects the kinematics of the glenohumeral joint and can also maintain the length-tension relationship of the long head of the biceps tendon (LHBT), which is an option worth considering for isolated type II SLAP lesions²³⁻²⁵.

Currently, the most popular approaches include open subpectoral and arthroscopic suprapectoral biceps tenodesis, while the most common fixation methods include suture anchors, interference screws, and soft-tissue tenodesis, but no study has specified which is the most preferred²⁶⁻²⁸. While biceps tenodesis has certain advantages in the treatment of type II SLAP lesions, there was a difference in the failure rate of the different methods in a long-term study by Sanders *et al.*²⁹. The study showed satisfactory short-term results for more than 15 methods of tenodesis, but long-term results showed failure rates of 30% to 50% and a reoperation rate of 15%, which is not encouraging. In the study, they hypothesized that the biceps sheath should be fully released and/or the irritated synovium and nerve components should be removed from mechanical stimuli, explaining the lower revision rates in the group with released biceps sheath than those in the group without released biceps sheath. In terms of pathophysiology, the movement of the biceps tendon in a narrow tunnel may lead to swelling and bunching of the tendon fibers, which may result in peripheral structural edema and synovitis inflammation. Currently, several studies have compared the functional outcomes and postoperative complications between labral repair and biceps tenodesis. However, few of these studies describe in detail the specific surgical techniques used.

Our hypothesis was that the results would be similar between the different groups. This study aimed to: (i) introduce the details and key steps of the arthroscopic modified double-row biceps tenodesis; (ii) evaluate the feasibility and the clinical efficiency of the technique compared with labral repair; and (iii) explore its advantages to provide guidance for physicians in clinical applications.

Methods

Inclusion and Exclusion Criteria

The inclusion criteria were as follows: (i) clinical symptoms and physical examination suggested the presence of type II SLAP lesions; (ii) magnetic resonance imaging suggested the presence of isolated type II SLAP lesions; and (iii) the diagnosis should ultimately be verified at arthroscopy.

The exclusion criteria were as follows: (i) partial or full-thickness rotator cuff tears; (ii) previous surgery for SLAP lesions or recurrent shoulder dislocation; (iii) special groups with high requirements for activities such as overhead athletes; (iv) arthritis of the glenohumeral or acromioclavicular joints; (v) intra-articular chondral damage; or (vi) other shoulder joint diseases. The study was approved by

the hospital ethics committee and has been conducted in accordance with the principles set forth in the Helsinki Declaration.

Patient Enrolment

This retrospective study was conducted in 56 patients with isolated type II SLAP lesions treated by one experienced surgeon between March 2015 and November 2018; all patients were non-overhead athletes with a unilateral SLAP injury. A total of 30 patients (male:female = 17:13) were treated with labral repair, with a mean follow-up of 25.8 ± 5.3 months (range, 14–34 months). The remaining 26 patients (male:female = 15:11) were treated with modified double-row biceps tenodesis, with a mean follow-up of 23.6 ± 3.8 months (range, 17–31 months).

Outcome Measures

For all patients enrolled in this study, the preoperative data were recorded and assessed through preoperative physical examination and medical records, and at the final follow-up, postoperative data were recorded through telephone inquiries and outpatient follow-up questionnaires. Preoperative and postoperative assessments with the visual analog scale (VAS), University of California, Los Angeles (UCLA) score, and American Shoulder and Elbow Surgeons (ASES) score were compared between the two treatment groups. Additional outcome measures included patient satisfaction, the time to return to previous activities, workers' compensation status, and postoperative complications. The baseline characteristics for the patients are summarized in Table 1.

Visual Analog Score (VAS)

VAS score was used to indicate the degree of pain, and has been proven to be sensitive and comparable. A horizontal line of 10 cm was drawn on paper, and one end of the horizontal line was 0, meaning no pain. The other end was 10, signifying severe pain. The middle part represented different levels of pain.

University of California, Los Angeles (UCLA) Scores

In this scoring system, pain and function were rated independently, on a scale of 0 to 10. A score of 1 represented the worst possible score, while a score of 10 represented the best possible score. A score of 10 also meant the shoulder joint was normal. The range of motion of the shoulder, muscle strength, and patient satisfaction were also included in the scoring system and each given a maximum of 5 points. So, this modified UCLA shoulder scoring system had a total of 35 possible points. Results were classified as excellent (34–35), good (28–33), fair (21–27), and poor (20 and below).

American Shoulder and Elbow Surgeons (ASES) Scores

This is a converted percentage system in which the patient evaluates the portion of pain (50%) and accumulates daily activities (50%) as the scoring component. Patients self-assessed for pain, stability, and daily activities, while the doctor evaluated the sections for activity, physical signs, strength tests, and stability. Although historically, this was based on the patient and physician's subjective and objective comprehensive evaluations, the current scoring is solely based on the patient's subjective score including pain (50%) and living function (50%), allowing a maximum score of 100. The higher the score, the better the shoulder function. The pain scale was separately evaluated by VAS.

Surgical Technique

Labral Repair Group

Patients who underwent surgery were placed in the lateral decubitus position, with the operative arm in approximately 20° to 30° of abduction and 20° of forward flexion, while a weight traction device of 5 to 10 lbs was used (Star Sleeve Traction System; Arthrex, Naples, FL, USA). All procedures were routinely performed under general anesthesia by a senior surgeon. Body surface markings were made before the portal was established.

During labral repair, following diagnostic arthroscopic evaluation through a standard posterior viewing portal

TABLE 1 Patient characteristics in the SLAP repair and biceps tenodesis groups

Characteristics	Repair (n = 30)	Tenodesis (n = 26)	t value	P value
Age, years	42.8 ± 10.6	40.9 ± 10.2	-0.702	0.49
Sex, no. (%)				
Male	17(56.7)	15(57.7)		0.94
Female	13(43.3)	11(42.3)		
Body mass index, kg/m ²	26.2 ± 2.9	26.5 ± 2.4	0.428	0.67
Surgery on the dominant arm, no. (%)	20(66.7)	15(57.7)		0.49
Follow-up, months	25.8 ± 5.3	23.6 ± 3.8	-1.716	0.09
Workers compensation, no. (%)	1(3.3)	2(7.7)		0.47
Preoperative VAS (mean ± SD)	7.1 ± 1.4	7.3 ± 1.4	0.372	0.71
Preoperative UCLA (mean ± SD)	7.4 ± 0.9	7.4 ± 0.9	-0.213	0.83
Preoperative ASES (mean ± SD)	34.3 ± 6.2	32.9 ± 5.4	0.346	0.35

Abbreviations: ASES, American Shoulder & Elbow Surgeons score; SD, standard deviation; UCLA, University of California Los Angeles score; VAS, visual analog scale.

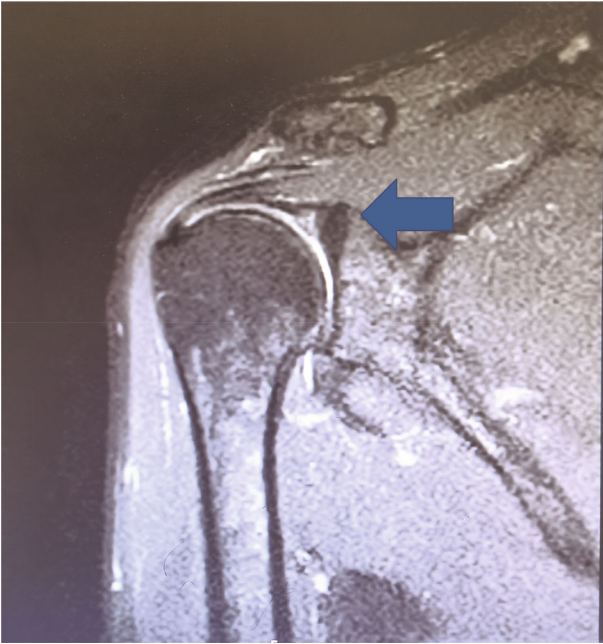


Fig. 1 Preoperative radiographic images. The blue arrows indicate the type II superior labrum anterior and posterior (SLAP) lesion.



Fig. 2 Intraoperative arthroscopic photograph showing type II superior labrum anterior and posterior (SLAP) lesion.

(Figures 1 and 2), an anterior portal was created using a spinal needle as a guide to pinpoint the placement through the rotator interval, which is close to the biceps tendon, to create an optimal angle to the superior labrum and facilitate anchor placement and suture passage. After the diagnosis and evaluation of the intra-articular condition, we used a motorized shaver to debride the superior glenoid rim, creating a

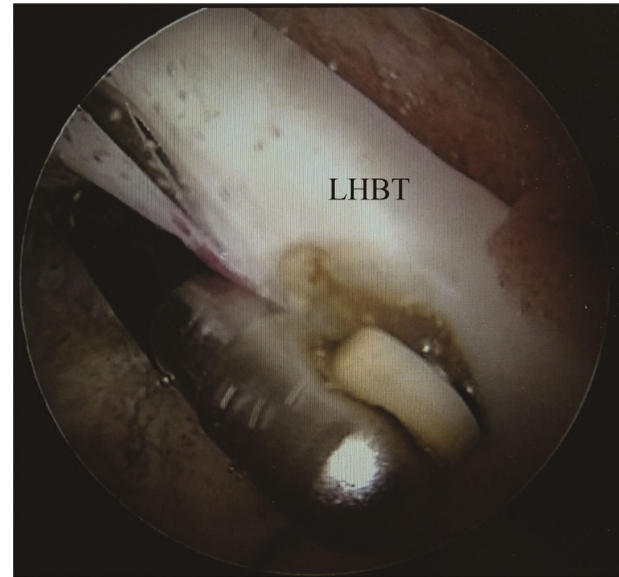


Fig. 3 A spinal needle was used to penetrate the long head of the biceps tendon (LHBT) to maintain the LHBT position and facilitate accurate positioning of the bicipital groove of the LHBT.

bleeding osseous surface for tissue healing. Intraoperative care was taken to prevent excessive debridement, which can result in damage to the superior labral structures. In total, one or two bioabsorbable suture anchors were inserted posterior to the roots of the biceps tendon. Care was taken to place all the knots above the articular surface, and the suture was created through the labral tissue as the knotted post limb had sufficient tension.

Modified Double-Row Biceps Tenodesis Group

During biceps tenodesis, after diagnostic arthroscopic evaluation through a standard posterior portal (Figures 1 and 2), a probe was used to evaluate the superior labrum through the anterior viewing portal. Once the diagnosis of type II SLAP lesion was established, a spinal needle was used to penetrate the LHBT in the articular cavity to maintain the position of the LHBT and to facilitate the accurate positioning of the LHBT in the bicipital groove in the subacromial space. Biceps tenotomy was then performed from the superior labral attachment with a radiofrequency ablation device (Smith & Nephew, Watford, England) (Figure 3). The stability of the superior labrum was evaluated after biceps tendon transection, and the remaining soft-tissue stump was debrided from the superior glenoid to create a stable and smooth surface. The position of the LHBT in the bicipital groove was then confirmed with a spinal needle through the anterolateral portal. After the reconfirmation of the LHBT, the inflamed soft-tissue and synovium in the bicipital groove were thoroughly debrided using a radiofrequency ablation device to the junction of muscle and tendon until the fresh bleeding bony surface was reached (Figure 4A) to release

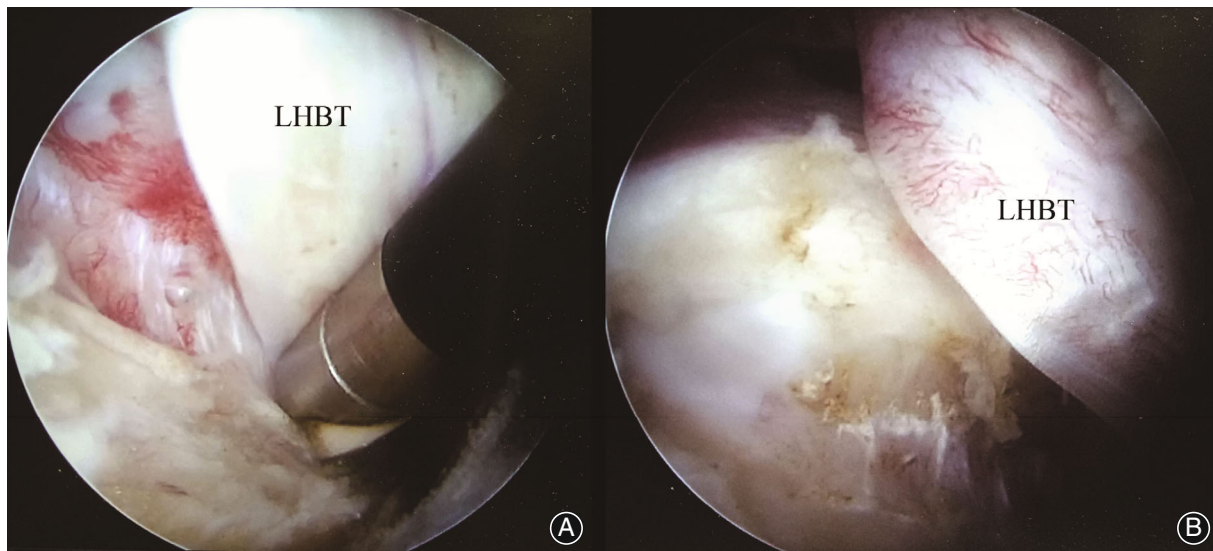


Fig. 4 The biceps groove inflamed soft tissue and synovium were thoroughly debrided (A) and the long head of the biceps tendon (LHBT) released from the intertubercular groove (B).

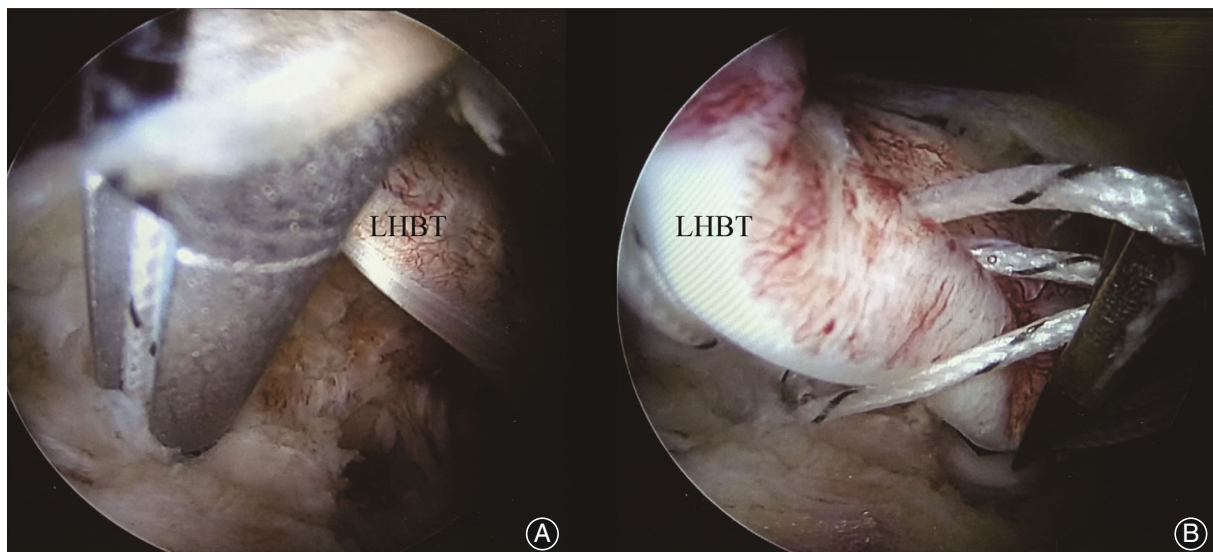


Fig. 5 The superiorly double-loaded suture anchor was implanted (A). The long head of the biceps tendon (LHBT) was penetrated, and one of the suture limbs went through the tendon to create a suture loop (B)

LHBT from the bicipital groove and to prepare for the implantation of anchors (Figure 4B).

After release, the tension and direction of the LHBT were subsequently determined using an arthroscopic grasper. The superiorly double-loaded suture anchor (5.5 mm AR-1927BCF-45, corkscrew; Arthrex, Naples, FL, USA) was implanted into the bicipital groove approximately 1 cm away from the starting position through the anterolateral portal, after which one of the sutures was pulled out (Figure 5A). A

penetrator grasper device (Arthrex, Naples, FL, USA) was utilized to penetrate the LHBT. One of the limbs was used to go through the tendon and to make a suture loop, while the other limb was used to pull through the suture loop (Figure 5B). Both limbs were pulled to the anterior portal to be knotted. The second suture anchor was then implanted approximately 1 cm inferiorly (Figure 6A) and one of the sutures was pulled out. The suture strands from the superiorly and inferiorly implanted anchors were drawn to the

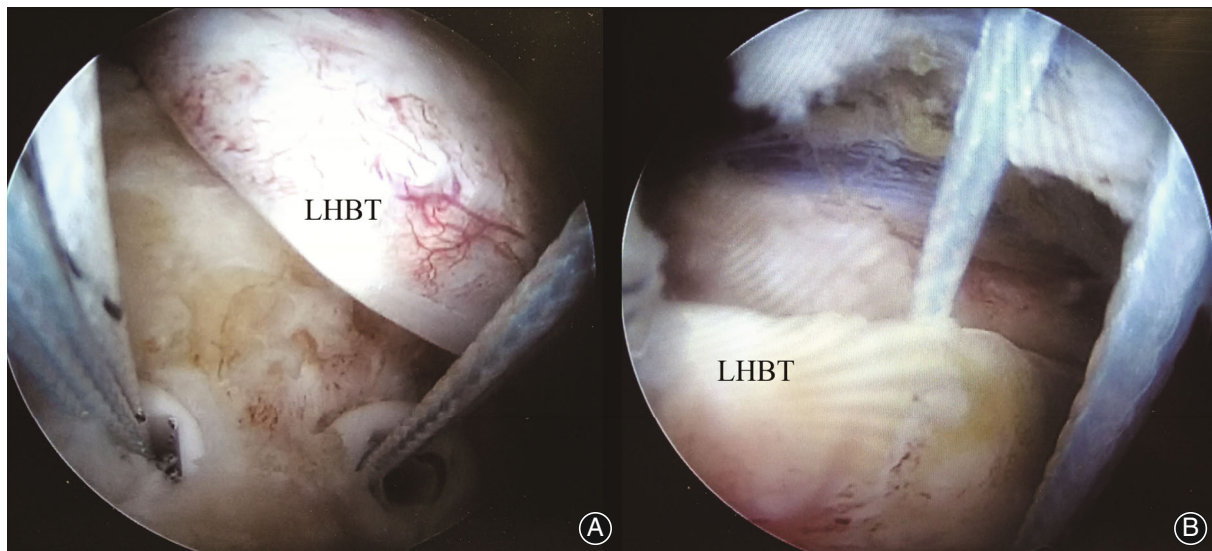


Fig. 6 The second suture anchor was implanted (A), and one of the sutures was pulled out (B).

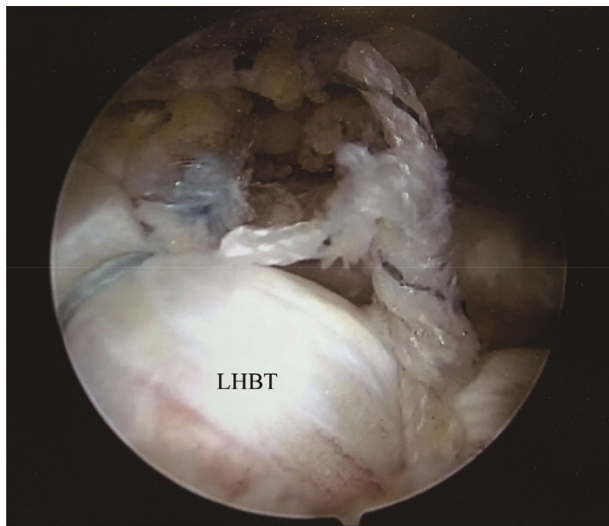


Fig. 7 Intraoperative arthroscopic photograph of patient with type II superior labrum anterior and posterior (SLAP) lesion treated with modified double-row biceps tenodesis.

anterolateral portal and tightened using standard suture techniques (Figure 6B). Finally, the radiofrequency ablation device was used to address the residual tissues around the bicipital groove and the proximal end of the LHBT (Figure 7). A schematic diagram of the arthroscopic modified double-row biceps tenodesis is shown below (Figure 8).

For both procedures, once the pathology of the biceps tendon root was addressed, the arthroscope was transferred to a standard lateral portal to evaluate the pathology of the subacromial space and rotator cuff. Subacromial

decompression can be performed, if necessary, via standard anterolateral accessory portals. All patients were secured with a sling before leaving the operating room.

Postoperative Rehabilitation

Labral Repair Group

Patients in all groups were given standard, but individualized, rehabilitation strategies. In the labral repair group, patients were asked to immobilize with a sling for 4 weeks postoperatively. Active elbow, wrist, and gentle pendulum movements were allowed on the first day after surgery, passive forward flexion of the affected shoulder was allowed 4 weeks postoperatively, and strength training was allowed 6 weeks postoperatively. Routine work and physical activity were allowed to begin 3 months postoperatively.

Modified Double-Row Biceps Tenodesis Group

Patients did not need an external fixation device postoperatively. Active wrist, finger, and gentle pendulum movements were allowed on the first day after surgery and strength training was allowed 4 weeks postoperatively. Routine work and physical activity were allowed to begin 3 months postoperatively.

Statistical Analyses

Continuous variables were expressed as means and standard deviations. All statistical analyses were conducted using the IBM SPSS Statistics for Windows, Version 19.0. (IBM Corp., Armonk, NY, USA). Two-tailed t tests or the Mann-Whitney *U*-test was conducted to compare the pre- and postoperative difference, such as in the VAS, ASES, and UCLA scores. The chi-square test was used to calculate *p* values for classified data and expressed in frequencies and

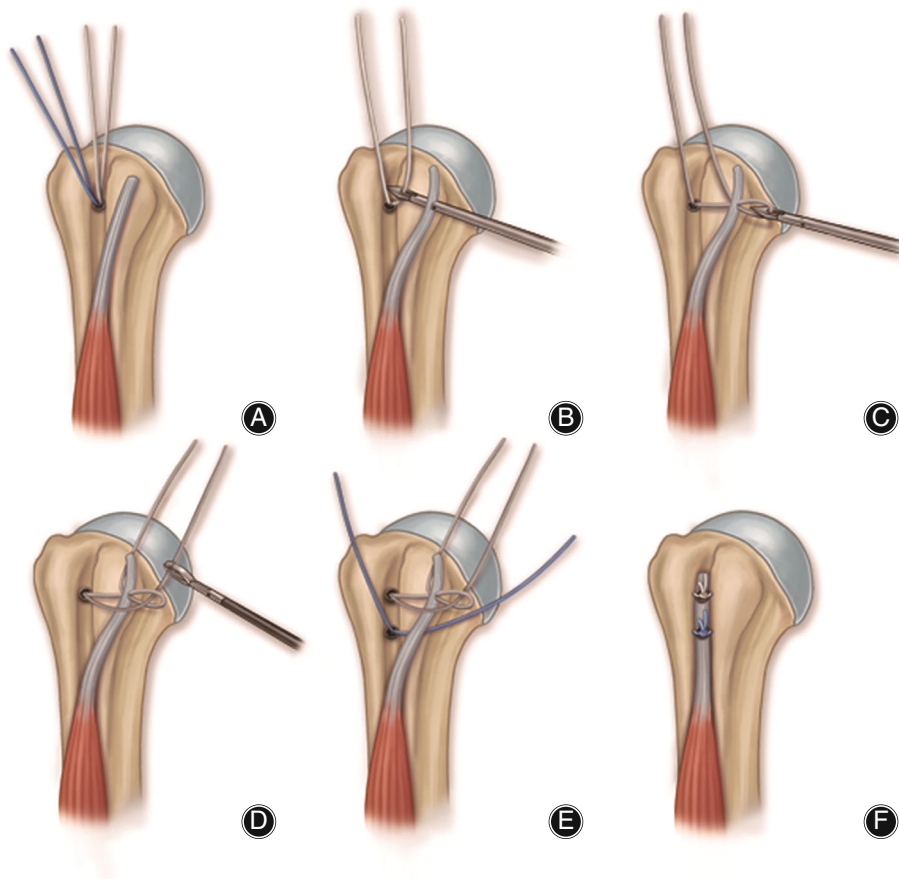


Fig. 8 Schematic diagram of the arthroscopic modified double-row biceps tenodesis: (A) The superiorly double-loaded suture anchor was implanted; (B) A penetrator grasper device was used to penetrate the long head of the biceps tendon (LHBT); (C, D) One of the limbs was used to go through the tendon and to make a suture loop, while the other limb was used to pull through the suture loop; (E) The second suture anchor was then implanted; (F) The suture strands from the superiorly and inferiorly implanted anchors were tightened using standard suture techniques and cut off.

TABLE 2 Comparison of functional outcome and patient satisfaction between the SLAP repair and biceps tenodesis groups

Outcome measure	Repair (n = 30)	Tenodesis (n = 26)	t value	p value
Postoperative VAS (mean ± SD)	1.8 ± 0.4	1.5 ± 0.5	-2.766	0.008*
VAS improvement (mean ± SD)	5.3 ± 1.5	5.8 ± 1.4	1.248	0.22
Postoperative UCLA (mean ± SD)	30.5 ± 3.0	30.7 ± 3.3	0.270	0.79*
UCLA improvement (mean ± SD)	23.0 ± 2.7	23.3 ± 3.2	-0.926	0.36
Postoperative ASES (mean ± SD)	85.8 ± 5.3	82.9 ± 8.9	0.104	0.10*
ASES improvement (mean ± SD)	51.5 ± 4.5	50.0 ± 6.9	0.345	0.73
Patient Satisfaction, no. (%)	14 (46.7)	24 (92.3)		<0.001
Return to previous sports, no. (%)	25 (83.3)	25 (96.2)		0.12
Time to return to sports, months	8.1 ± 1.5	6.8 ± 1.8	-2.876	0.007
Complication (reoperation), no.	1 (0)	5 (2)		0.12

Abbreviations: ASES, American Shoulder & Elbow Surgeons score; SD, standard deviation; UCLA, University of California Los Angeles score; VAS, visual analog scale.; * Statistical significance compared with preoperative data ($p < 0.05$).

percentages. p values of less than 0.05 were considered significant.

Results

Follow-Up

We had a nearly 2-year follow-up period for 56 patients with isolated type II SLAP lesions. The average follow-up period

of the labral repair group was 25.8 ± 5.3 months, with 23.6 ± 3.8 months for the modified double-row biceps tenodesis group ($p = 0.09$) (Table 1).

General Results

There were no significant differences in demographic data including age, sex, body mass index, surgery on dominant arm, follow-up time, and workers' compensation between

the labral repair group and the modified double-row biceps tenodesis group (Table 1, $p > 0.05$).

Visual Analog Scale (VAS) Scores

There were no significant differences in preoperative VAS scores between the two groups (Table 1). The VAS score of the repair group decreased from 7.1 ± 1.4 preoperatively to 1.8 ± 0.4 . In the tenodesis group, the VAS score changed from 7.3 ± 1.4 preoperatively to 1.5 ± 0.5 . Compared with the preoperative scores, patients in both groups received significant pain relief at the final follow-up ($p < 0.05$). However, the postoperative VAS score of the tenodesis group was significantly better than that of the repair group (1.5 and 1.8, respectively; $p = 0.008$) (Table 2).

University of California, Los Angeles (UCLA) Scores

The UCLA scores of both the repair and tenodesis groups significantly improved from 7.4 ± 0.9 to 30.5 ± 3.0 and 7.4 ± 0.9 to 30.7 ± 3.3 , respectively ($p < 0.05$). However, the postoperative scores of the two groups were not significantly different (Table 2, $p = 0.79$).

American Shoulder and Elbow Surgeons (ASES) scores

There were no significant differences in preoperative ASES between the two groups (Table 1). The ASES significantly improved from 34.3 ± 6.2 to 85.8 ± 5.3 and 32.9 ± 5.4 to 82.9 ± 8.9 in the repair and tenodesis groups, respectively ($p < 0.05$). However, the postoperative scores of the two groups were not significantly different (Table 2, $p = 0.10$).

Clinical Evaluation

Overall, 96.2% of patients in the tenodesis group and 83.3% of patients in the labral repair group returned to their previous sports ($p = 0.12$). Compared with the labral repair group, the modified double-row biceps tenodesis group showed significant differences in patient satisfaction (92.3% vs. 46.7%, $p < 0.001$) and recovery time to return to their previous activities (6.8 ± 1.8 vs. 8.1 ± 1.5 , $p = 0.007$). There was no statistically significant difference in workers' compensation status (3.3% vs. 7.7%, $p = 0.47$) between the different surgery methods. The comparison of the functional outcomes and patient satisfaction between the two groups is summarized in Table 2.

Complications

None of the patients had complications such as infection at the surgical site, Popeye deformity, tendon rupture, or implant site failure. One patient in the tenodesis group developed persistent postoperative stiffness, which was solved by conservative treatment. Two cases in the labral repair group presented with persistent postoperative night pain, three developed persistent postoperative stiffness, and two required a subsequent capsular release. Although complications occurred more frequently in the labral repair group than in the tenodesis group, there was no significant

difference between the two groups (3.3% vs. 19.2%, $p = 0.12$).

Discussion

Theoretical Advantages and Key Steps of Arthroscopic Modified Double-Row Biceps Tenodesis

A biomechanical study of cadavers undergoing biceps tenodesis showed that the double-suture-anchor fixation technique provided superior load-to-failure forces (263.2 N vs. 159.4 N) and biomechanical performance to the interference screw fixation technique³⁰. Additionally, compared to the single suture anchor approach, this technique can effectively increase the stability of the fixed position of the tendon while reducing the cutting effect of the fixed position on the tendon, thus reducing the risk of rupture. In this study, no complications such as tendon rupture occurred during postoperative follow-up in either group. Although the minimum failure load required for clinically reliable biceps tenodesis is unknown, the suture anchor with lasso loop technique has been reported to show superior load-to-failure forces³¹.

There are multiple structures around the shoulder joint, and a particular pathology usually does not occur alone. Anterior shoulder pain is often associated with instability of the LHBT and lesions of the biceps tendon pulley. One prospective cohort study reported that biceps tendon pulley lesions occurred in 32.4% of patients undergoing shoulder arthroscopic surgery, and Braun *et al.* postulated that SLAP lesions were significantly related to anteromedial ($p < 0.008$) and posterolateral pulley tears ($p < 0.021$)³². Generally, due to the limitations of imaging techniques and the negligence of clinical surgeons, biceps pulley lesions are not properly handled during SLAP surgery, which we postulate is one of the reasons for persistent postoperative pain and even an increased rate of surgical failure.

Taylor *et al.*²³ mentioned that lesions affecting the LHBT are not predominantly limited to the proximal LHBT. Furthermore, 45% of intra-articular LHBT lesion patients had a hidden bicipital tunnel lesion; however, only labral repair and proximal tenodesis may leave residual tunnel lesions. In one of their cadaveric studies, Taylor *et al.* pointed out that the bicipital tunnel is a confined space consisting of three distinct zones. Zones 1 and 2 differ from Zone 3 due to the presence of synovium. Between Zones 2 and 3, near the proximal margin of the pectoralis major tendon, there is an apparent bottleneck. This natural structure may cause bicipital tunnel syndrome due to a variety of diseases that cause space-occupying disease. Therefore, decompression of both Zones 1 and 2 should be fully considered when performing relevant surgical techniques. Diagnostic arthroscopy fails to adequately assess lesions of the biceps-labral complex, especially for lesions in Zone 2, which are hidden from arthroscopic view above, and open sub-pectoral intervention view below. Several studies focused on

the clinical relevance of extra-articular bicipital tunnel lesions^{33,34}. This provides a reliable theoretical support to prove that the failure of partial tenodesis methods is caused by residual synovium tissue and neural elements in the biceps tunnel. In our study, we noted the need to carefully debride the inflamed soft-tissue and synovium in the biceps groove and release the LHBT from the intertubercular groove.

Less Pain, Earlier Recovery, and Higher Satisfaction of the Modified Double-Row Biceps Tenodesis

At the 2-year follow-up, the tenodesis group showed significant differences in the postoperative VAS score, patient satisfaction, and recovery time to return to their previous activities compared to the labral repair group. Thus, our findings support a satisfactory surgical outcome through the double-row fixation technique combined with a thorough releasing of the bicipital tunnel. Additionally, patients treated with labral repair had a higher rate of postoperative complications and patient dissatisfaction.

A previous study of 225 young, active patients undergoing SLAP repair reported a 37% failure rate and a 28% reoperation rate¹⁵. Similar to our findings, there were two cases in the labral repair group that presented with persistent postoperative night pain and three cases developed persistent postoperative stiffness, of which one required a subsequent capsular release. Familiari *et al.*⁷ concluded that the treatment of SLAP lesions should fully consider the variable relationship between the labrum tissue and the glenohumeral ligaments, as any errant repair method for these variants may result in a significant impact on the external rotation function of the shoulder. Similarly, McCulloch *et al.*³⁵ reported that the anterior anchor to the biceps had a great impact on external rotation function; however, one or two anchors posterior to the biceps did not affect the rotation function of glenohumeral joint. In this study, all anchors were implanted posterior to the roots of the biceps tendon in the labral repair group. Additionally, the proper fixation of the labrum tissue, the absence of excessive intraoperative debridement, and the maintenance of the normal structure surrounding the superior labral tissues may be the reasons there were no significant difference in postoperative ASES and UCLA scores between the two groups, but this needs to be further confirmed by long-term follow-up.

An Alternative and Reliable Surgical Procedure with More Encouraging and Safer Outcomes

The most important findings of the present study were that, by comparing the clinical efficacy evaluations of arthroscopic modified double-row biceps tenodesis and labral repair, the former showed more encouraging postoperative pain reduction, earlier recovery to previous activities, and higher patient satisfaction, providing a theoretical and clinical reference for

clinicians to use in decision-making. Furthermore, the tenodesis we investigated has the advantages of minimal dissection area and scar formation, since smaller drill holes with the proper distance between the two fixation sites can effectively reduce the risk of fracture and lower the risk of neurovascular injury, which can shorten the recovery period and provide conditions for early functional exercise. The above advantages were also reported to be effective in reducing surgical complications^{26,36}.

There is still no consensus on the types of treatment that patients of different ages should receive for isolated type II SLAP lesions¹². A previous study suggested that labral repair should be performed for young and active patients, particularly those younger than 35 years of age or those with healthy-appearing labrum tissue³⁷. However, a study with a minimum 2-year follow-up period³⁸ reported that biceps tenodesis could be an alternative to labral repair in younger patients when the patient has surgical indications. In this study, patients who underwent tenodesis when they were younger than 25 years of age were satisfied with the results, with 73% of patients returning to their previous level of sport and having a low risk of revision rate. However, due to the relatively small number of young patients, we did not perform a subgroup analysis on this group of patients. Nevertheless, a recent study on patients aged between 15–40 showed that primary arthroscopic biceps tenodesis can be considered a viable alternative for isolated type II SLAP lesions and the indications for arthroscopic biceps tenodesis can be safely extended to young, active patients³⁹. More studies are needed to further assess the clinical efficacy of modified double-row biceps tenodesis versus labral repair retrospectively to accurately guide physicians in making clinical decisions.

Limitations

The study has the following limitations. Firstly, this is a non-randomized retrospective study; thus, high-quality randomized controlled trials with larger sample sizes are needed for further clinical verification. Secondly, to further evaluate the advantages of the present procedure, research comparing it with other types of biceps tenodesis are required. Finally, this study had a relatively small sample size, which limited subgroup analysis by sex, age, and so on.

Conclusions

Both arthroscopic modified double-row biceps tenodesis and labral repair had benefits in pain reduction and recovery of shoulder function for isolated type II SLAP lesions. Arthroscopic modified double-row biceps tenodesis showed more encouraging postoperative pain reduction, earlier recovery to previous activities, and higher patient satisfaction compared with labral repair; therefore, it can be considered as an alternative option for isolated type II SLAP lesions.

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