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Clinical Analysis for Arthroscopic Intra-articular Bicipital Tenodesis: A Prospective Cohort Study

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Abstract

Introduction: It was considered that the long head of the biceps (LHB) tendon was a common source of anterior shoulder pain. The inflammatory pathophysiology was thought to be the most common. Treatment approaches such as conservative, physical therapy, and surgery were allocated. The most prevalent surgical methods were biceps tenotomy and tenodesis.

Aim of the study: To detect the clinical outcomes after arthroscopic supratentorial bicipital tenodesis using suture anchors.

Subjects and methods: From June 2019 to December 2021, we conducted a prospective cohort study on 25 patients who presented with anterior shoulder pain due to pathology in the LHB. Participants were recruited for arthroscopic supra-pectoral tenodesis and were followed up at six and 12 months. We used the Constant-Murley score to detect clinical and functional outcomes, which encompassed four domains: pain, strength, range of motion, and activities of daily life. We also calculated the frequency of the Popeye sign, which represented LHB rupture.

Results: Patients could have a significant improvement in the Constant-Murley score postoperatively at both six and 12 months compared with the preoperative values, with a postoperative mean of 82.8 (79 - 89) at six months and 85.18 (82 - 93) at 12 months. Also, they achieved significant improvement in each of its components; pain, ADL, stability, and motility at six months compared with the baseline values. Additionally, only four patients developed the Popeye sign.

Conclusion: The supra-pectoral tenodesis was an efficient surgery for treating LHB tendon pain with minor adverse effects. It has the potential to significantly raise the CMS score after six months and one year. Furthermore, only a few patients got the Popeye sign.

Key words: LHB; supra-pectoral tenodesis; Constant-Murley score.

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1. Introduction

The ventral part of the upper arm has a thick, large muscle called the biceps brachii. The muscle has two heads. The caput longum (long head) and caput breve (short head) of the muscle [1]. The short head arises from the tip of the coracoid process, whereas the long head arises

from the glenoid or scapula's supraglenoid tubercle (tuberculum supra-glenoidal). Both heads run distally and form a muscular belly before tapering over the anterior part of the elbow and inserting onto the forearm fascia and radial tuberosity through the bicipital aponeurosis [2, 3].

The main function of the biceps brachii muscle is to be a powerful forearm supinator but a poor elbow flexor [4]. According to biomechanics, the shoulder joint's dynamic stability is dependent on the LHB tendon [5]. The tendon serves at least a passive stabilizing function in the shoulder [6]. Although it is well known that the LHB tendon helps with elbow supination and flexion as well as resistance to superior movement of the humeral head at the shoulder joint, its precise function is still unknown [7].

Anterior shoulder pain is frequently connected to the LHB tendon. Repetitive traction, glenohumeral rotation, and friction are examples of mechanical causes [8]. Due to its proximity to the glenohumeral joint's synovial lining, the bicipital sheath is itself susceptible to tenosynovial inflammation [9]. With neuropeptides like calcitonin gene-related peptide and substance P, the LHB tendon's upper part has a rich sympathetic innervation network [10]. These elements are found in the sensory nerves in this area of the tendon [11]. This sympathetic network is known to display vasodilatory alterations due to the neurogenic inflammatory process in the LHB tendon [12]. These changes may be crucial in the chronic phase of pathophysiology impacting the LHB tendon [13].

Several methods have been used to treat the LHB tendon, including non-surgical and surgical management [14]. Regarding non-surgical management, non-steroidal anti-inflammatory drugs combined with rest are the first line of treatment [15]. Physical therapy programs focused on the underlying cause are another management option [16]. Also, steroid injection with ultrasonography guidance is a different method for the management of the LHB tendon [17].

Surgical management is another option for the management of LHB tendons. Tenotomy and tenodesis are two treatment choices for a patient with an injured or painful LHB tendon [18]. Although tenotomy has been found to reduce pain, the arm may develop an undesirable cosmetic deformity due to the procedure [19]. Consequently, many tenodesis procedures for transferring the origin of the LHB to the proximal humerus have been established. Open and arthroscopic procedures for treating LHB disease have been reported [20]. The use of biceps tenodesis has lately grown. The tenotomy involved only the release of the LHB tendon from the supraglenoid tubercle [21]. At the same time, tenodesis involved the steps of tenotomy beside the reattachment of the LHB tendon distally along its course [22].

Biceps tenotomy has the advantages of being quicker, simpler, and less expensive. Tenotomy also eliminates some of the difficulties associated with biceps tenodesis, including technical and hardware issues, chronic shoulder discomfort, humeral fracture, neurovascular damage, delayed failure, complicated regional pain syndrome, and other intrinsic surgical hazards [23]. The creation of a "popeye" sign, shoulder pain, biceps muscular cramping and discomfort, and biceps muscle weakening with particular exercises are all disadvantages of biceps tenotomy [24]. However, many shoulder surgeons believe that tenodesis is a superior option for younger patients with demanding physical conditions and for patients who are concerned about cosmetic appearance because of the possible advantage of enhanced cosmesis brought on by a lower probability of developing a "Popeye" deformity.

Additionally, tenodesis presents a decreased risk of postoperative biceps cramps or spasms compared to tenotomy [25].

Fixation options for biceps tenodesis include soft tissue fixation, all-suture anchors, interference fixation, and suspensory fixation [26]. In this study, we report an all-arthroscopic supra-pectoral biceps tenodesis with an all-suture anchor and aim to detect the clinical outcomes after an arthroscopic supra-pectoral bicipital tenodesis using suture anchors.

2. Subjects and methods

2.1. Subjects

From June 2019 to December 2021, we identified individuals who presented with anterior shoulder pain. The Scientific Research Ethics Committee granted ethical permission. In addition, each participant signed an informed consent form. We selected patients based on the following criteria: Patients were 18 years of age or older; males and females were included, and they presented with anterior shoulder pain due to bicipital lesions, either isolated or with concomitant small or medium-sized rotator cuff tears or subacromial impingement in the form of tenosynovitis, partial or full thickness tears, and subluxation. We also excluded patients who met any of the following criteria: Patients under the age of 18 have bilateral lesions accompanied with significant rotator cuff tears Preoperative glenohumeral arthritis-related range of motion loss and shoulder arthroplasty were performed concurrently.

According to our inclusion criteria, 25 patients were included in the study. All patients were candidates for supra-pectoral bicipital tenodesis and followed up at two endpoints: six months and one year.

2.2. Preoperative management

All patients were examined clinically preoperatively. Also, they were assessed on the CMS. Moreover, they were a candidate for magnetic resonance imaging (MRI) on the affected shoulder to detect the bicipital pathology and any concomitant shoulder lesion.

2.3. Operative interference

Patients were recruited for the supra-pectoral biceps tenodesis. The operation was done under general anesthesia. Then, we followed the steps of supra-pectoral biceps tenodesis published by Lansdown et al. [27]. Patients were settled in the beach chair position, and the targeted shoulder was sterilely prepped and draped.

2.4. Exposure to the LHB tendon and arranging for tenodesis

We used a 30° arthroscope of the standard posterior portal to perform the glenohumeral diagnostic arthroscopy. Then, we systematically evaluated the intra-articular structures and ensured the pathology of LHB by inspecting the extra-articular part of the tendon. Next, whenever we decided to do biceps tenodesis, we performed a tenotomy by changing the arthroscopic entry to the subacromial space and releasing biceps from the transverse humeral ligament.

2.5. Placing the anchor and finishing the tenodesis

We distally inserted the all-suture anchor through the anterolateral portal (2 cm inferolateral to the anterior stranded portal) to the fibrocartilage end of the groove. We might use a single or double-loaded anchor. Also, we used the bird peak penetrator, passed it from the medial to the lateral end of the tendon, and created a loop medially to the tendon. We passed the bird peak penetrator for the second time with the attached limb through the loop and created a knop to stabilize the tendon. Moreover, we would do this procedure again if we selected the

double-loaded implant. We tied the knots to protect the biceps while we withdrew the cannula. (Figs. 3 and 4)

We remained with the tendon without cutting until we finished the tenodesis to get the proper tension. After that, we cut suture limbs and truncated the proximal stump of the LHB tendon using a radiofrequency ablation device (Fig. 5). The free proximal stump (approximately 3–4 cm in length) was removed using the posterior portal with the tissue grasper.

2.6. Postoperative management and follow-up

We used an abduction arm sling on the patient's arm after surgery and for four weeks. Also, we recommended doing exercises of the pendulum and elbow and wrist range of motion. Additionally, we instructed the patients to stop doing any active biceps exercises for six weeks postoperatively. During the period of six to 12 weeks postoperatively, patients could start gentle strength training. At 12 weeks, patients could do their activities. Using the CMS, we clinically examined the patients six months and one year after surgery.

2.7. Study variables and outcomes

We followed up with patients at two endpoints: six months and one year postoperatively. We used the Constant-Murley score (CMS) as a measure for our clinical and functional outcomes as a primary outcome [28]. The original score was developed in 1987. It estimated pain, activities of daily living (ADL), range of motion (ROM), mobility, and strength of the affected shoulder. The patients filled out the pain and ADL, while ROM and strength were evaluated and filled out by the surgeon. Also, different modifications were applied to the questionnaire, such as measuring the pain by using the Visual Analog Scale (VAS) [29]. The total score ranged from zero, representing the worst score of shoulder function, to 100, representing the best. The score of pain was 15 points, ADL was 20 points, ROM was 40 points (ten for each of the four active motions), and strength was 25 points [30]. We also identified the incidence of popeye among patients postoperatively to represent our secondary outcome. The Popeye sign was assumed to be commonly reported after orthopaedic surgery and to be a classic sign of the rupture of the LHB tendon [31].

2.8. Statistical analysis

We performed the statistical analysis using Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA). We adjusted the significance of statistical analysis at $P \leq 0.05$. Descriptive statistics were performed as follows; qualitative data were presented as median (range), while quantitative data were presented as frequency (percentage). We used the two-way repeated measures ANOVA and the Bonferroni post hoc test to identify significance at different endpoints.

3. Results

3.1. Demographics of the patients

Our study included 25 patients with an average age of 54 years (between 32 and 69 years). Thirteen patients (52%) included in the study were males, while twelve patients were females (48%). 17 patients were operated on the dominant upper limb, while eight patients were operated on the non-dominant upper limb. Thirteen patients included in the study had an associated rotator cuff tear (RCT). Four patients had associated SLAP lesions. Six patients had associated impingement syndrome, while two patients had isolated bicipital lesions. (**Table 1**).

Table 1: Demographic characteristics of the population (N= 25 patients).

Variables		Median (Range)
Age		54 (32 – 69)
Gender	Males	13 (52%)
	Females	12 (48%)
Dominant limb	Yes	17 (68%)
	No	8 (32%)
Associated injuries	RCT	13 (52%)
	SLAP injuries	4 (16%)
	Impingement syndrome	6 (24%)
Isolated bicipital lesion		2 (8%)

3.2. Constant-Murley score (CMS)

Patients had an average preoperative CMS score of 51 (46–56). Fortunately, they had significant improvements at both endpoints compared with the preoperative values (*P<0.001*). At six months, they had an average of 82.8 (79–89), while at one year, they had an average of 85.18 (82–93) (**Table 2**).

Table 2: Constant-Murley score.

Preoperative		Postoperative				F	P value
		6 months	P1 value	1 year	P2 value		
Mean (SD)	51±3.24	82.8±3.19	*P<0.001*	85.18±3.35	*P<0.001*	1010.294*	*P <0.001*
Range	46 - 56	79 - 89		82 - 93			
Difference between six and 12 months		*P<0.001*					

SD; Standard Deviation and F; F test (ANOVA) with repeated measures, Significance between periods was done using Post Hoc Test (Bonferroni); P; P value for comparing different study groups

P1: P value for comparing between preoperative and postoperative six months

P2: P value for comparing between preoperative and postoperative 1 year

* Statistically significant at $p \leq 0.05$

3.3. Pain score

Patients had an average preoperative pain score of 6.44. It was significantly improved at both endpoints. They had an average pain score of 14.35 at six months and 14.7 at one year.

3.4. ADL score

Patients had an average preoperative ADL score of 10.06. It significantly improved after six months to 18.45. Also, at one year, the mean difference significantly improved compared with the values of preoperative and six months to be 19.17.

Mobility score

Patients had an average preoperative mobility score of 23.9. It significantly improved at six months to 37.8. Moreover, at one year, the mean difference was significantly improved compared with the values of preoperative and six months to be 39.4.

Strength score

Patients had an average preoperative strength score of 13.22. It was significantly improved at six months to 14.89 and at one year to 16.03. However, there was no difference between the values of six months and one year.

Postoperative Popeye sign

Four patients (16%) were complicated and showed the Popeye sign, while twenty-one patients (84%) were free.

4. Discussion

In our study, we enrolled 25 individuals with an average age of 54 years. Supra-pectoral tenodesis was necessary for all patients. Thirteen of them were men, and 17 had surgery on their dominant leg. In addition, 13 patients had RCT, four patients had SLAP lesions, and six patients had impingement syndrome. We checked in with the patients after six months and one year. Patients improved significantly in overall CMS score and each of its components at six months compared to baseline values, including pain, ADL, stability, and motility. In addition, only four patients displayed the Popeye sign.

Patients had significant improvements at both endpoints compared with the preoperative values. They had an average of 82.8 (79–89) at six months and 85.18 (82–93) at one year. We followed prospective research in which patients who underwent arthroscopic tenodesis experienced a substantial increase in the CMS after 14 months of follow-up, with a postoperative mean CMS of 89.1 and $P<0.05$ [32]. Also, an RCT that compared the outcomes of supra-pectoral tenodesis and arthroscopic tenotomy concluded that supra-pectoral tenodesis was superior to arthroscopic tenotomy as the mean CMS for patients in the biceps tenotomy cohort improved from 44 (95% CI, 39–48) to 73 (95% CI, 68–79), and that for patients in the biceps tenodesis cohort improved from 42 (95% CI, 37–48) to 78 (95% CI, 74–82) [33]. Additionally, a network meta-analysis revealed that performing supra-pectoral tenodesis instead of arthroscopic tenotomy resulted in a substantially larger mean difference in CMS (MD = 2.46, CI 0.23 to 4.69)

[34]. Moreover, a prospective study on patients with isolated biceps lesions allocated for supra-pectoral tenodesis showed significant improvements at all intervals compared with the preoperative values (*P<0.001*). They had mean scores of 79.4 (15.7) at three months, 82.8 (10.2) at six months, 84.6 (9.5) at 12 months, and 84 (7) at 24 months [35]. Warner et al. performed a study that evaluated both arthroscopic supra-pectoral biceps tenodesis and open supra-pectoral biceps tenodesis and found that after three years of follow-up, the mean CMS of arthroscopic supra-pectoral biceps tenodesis was 90.7 and 91.8 for open supra-pectoral biceps tenodesis [36]. Also, Chiu et al. found the same results, as the CMS significantly improved from 23.4 ± 11 preoperatively to 80.7 ± 5.2 postoperatively after 24 months [37].

Both endpoints revealed a considerable improvement in the patients. At six months, their average pain score was 14.35; at a year, it was 14.7. We followed a prospective trial in which patients who underwent arthroscopic tenodesis experienced a significant VAS improvement after 14 months of follow-up (preoperative pain score was 3.6 (3.5), whereas postoperative pain score was 11.2 (2.2; *P<0.001*). [32]. In 2021, Cabarcas et al. assessed the outcomes of arthroscopic supra-pectoral only biceps tenodesis and revealed that there was a significant improvement in the pain score after 6 months of follow-up (preoperative pain score was 6.1 ± 2.4 and postoperative pain score was 3.1 ± 2.3) [38]. Also, Chiu et al. found the same results as the pain score significantly improved from 7.3 ± 1.1 preoperatively to 1.8 ± 0.6 postoperatively after 24 months [37].

Patients significantly improved at six months, with a mean score of 18.45. Also, the mean difference significantly improved at one year compared with the preoperative and six-month values to 19.17. Additionally, a prospective study on patients who had isolated biceps lesions and were recruited for supra-pectoral tenodesis showed significant improvements at all intervals compared with the preoperative values (*P<0.001*). They had mean scores of 15.6 (4.6) at three months, 17.4 (3.9) at six months, 17.2 (3.4) at 12 months, and 18 (2.5) at 24 months [35].

Patients significantly improved at six months, with a mean score of 37.8. Moreover, at one year, the mean difference was significantly improved compared with the values of preoperative and six months to be 39.4. Besides, a prospective study on patients who had isolated biceps lesions and were recruited for supra-pectoral tenodesis showed significant improvements at all intervals compared with the preoperative values. They had mean scores of 35.1 (6.2) at three months (*P= 0.003*), 37.2 (3.7) at six months (*P<0.001*), 38.9 (2.5) at 12 months (*P<0.001*) and 39.2 (2.1) at 24 months (P<0.001) [35]. In addition, a case series study including 50 patients with biceps lesions revealed substantial improvement in postoperative mobility scores compared with preoperative values after six months [38].

Patients significantly improved at six months with a mean score of 14.89 and at one year with 16.03. However, there was no difference between the values of six months and one year. In addition, a case series study including 50 patients with biceps lesions reported results that were consistent with our findings as they showed substantial improvement (*P=0.002*) in postoperative strength score compared with the preoperative values after six months [38]. Also, a prospective study on patients with isolated biceps pathology recruited for supra-pectoral tenodesis showed no differences between the preoperative and all postoperative values at

different intervals: three, six, 12, and 24 months [35].

Four patients (16%) were complicated and experienced the Popeye sign, while twenty-one patients (84%) were free. We were in line with the results of the network meta-analysis, where the supra-pectoral tenodesis showed better significant odds than the arthroscopic tenotomy (OR = 0.51, CI 0.21 to 1.25) [34]. An RCT that compared the outcomes of supra-pectoral tenodesis and arthroscopic tenotomy found that Popeye deformity occurred in 47% of tenotomy patients and 33% of tenodesis patients (*P =0.17*) [33].

We could assess the arthroscopic supra-operative tenodesis approach and demonstrate its effectiveness in relieving LHB pain. However, we were constrained due to the nature of observational studies without interventions, the fact that the study was limited to a single arm, and the requirement for a larger sample size to generalize our findings. Also, we did not consider the effect of many factors on the outcomes of the procedures, such as controlled or uncontrolled diabetes, body mass index, smoking, different daily activities, and other associated conditions.

Conclusion

The supra-pectoral tenodesis was an efficient surgery for treating LHB tendon pain with minor adverse effects. It has the potential to significantly raise the CMS score after six months and one year. Furthermore, only a few patients got the Popeye sign.

Ethical approval: The Ethics Committee of Research at Helwan University's School of Medicine approved the current study.

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Conflicts of Interest: None declared.

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