Subpectoral Biceps Tenodesis for Tenosynovitis of the Long Head of the Biceps in Active Patients Younger Than 45 Years Old

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Purpose: The objective of this study was to assess the outcomes after subpectoral biceps tenodesis (BT) for long head of the biceps (LHB) tenosynovitis in active patients <45 years old. **Methods:** This was an Institutional Review Board–approved, retrospective outcomes study with prospectively collected data. Patients treated with subpectoral BT were included if they met the following criteria: age <45 years, anterior shoulder pain with arthroscopically confirmed LHB tenosynovitis, no concomitant procedures other than debridement and decompression procedures, and minimum 2 years out from surgery. Patients were excluded from analysis if they refused participation. The American Shoulder and Elbow Surgeons (ASES), Short Form-12, Quick Disabilities of the Arm, Shoulder and Hand, Single Assessment Numeric Evaluation, and pain scores as well as sports participation preoperatively and at a minimum of 2 years postoperatively were obtained. Pre- and postoperative scores were compared using paired samples *t*-test and Wilcoxon signed-rank test. **Results:** Thirty patients met the inclusion criteria. Two of these patients refused to participate in follow-up and were excluded from analysis. Of the remaining 28 patients (17 male, 11 female; 37.0 ± 8.0 years), minimum 2-year outcomes were available for 24 (13 males, 11 females: 37.7 ± 8.2 years; 85.7%). Mean follow-up was 3.1 years (range, 2.0 to 7.3 years). There were significant improvements in all outcome measures including ASES score ($P < .001$), with a postoperative mean of 95.8 ± 7.8, visual analog scale "pain today" ($P < .001$), and pain affecting activities of daily living ($P < .001$). Seventeen of 20 (85%) patients who answered the question about postoperative sport participation were able to return to sport. Mean patient satisfaction was 9.2/10 (standard deviation, +1.7). There were no postoperative complications such as Popeye deformity or cramping. There were no clinical failures. **Conclusions:** Subpectoral BT is an excellent treatment option for active patients <45 years old with LHB tenosynovitis and chronic anterior shoulder pain, resulting in decreased pain, improved function, high satisfaction, and improved quality of life. **Level of Evidence:** Level IV, therapeutic case series.

Isolated tenosynovitis of the long head of the biceps (LHB) tendon is an uncommon finding that can be the cause of chronic anterior shoulder pain resulting in limited function.[1-7] LHB tenosynovitis in active patients is most commonly found in conjunction with impingement syndrome, but the exact cause is not known.[7-9] LHB tenosynovitis has previously been associated with repetitive movement and overuse, such as from sports activities, acute trauma, variations in bicipital groove morphology, and inflammation of nearby glenohumeral structures.[8-13] It has been proposed that older patients develop LHB tenosynovitis due to the degeneration of the LHB tendon, which commonly occurs concurrently with rotator cuff tears.[7,13] Conversely, LHB tenosynovitis in isolation is rare and occurs most frequently in active patients with resultant shoulder pain and dysfunction.[7,13]

Initial management of LHB tenosynovitis consists of nonoperative treatment that includes nonsteroidal anti-inflammatory drugs, physiotherapy, and corticosteroid injections. Surgery can be considered in cases that have

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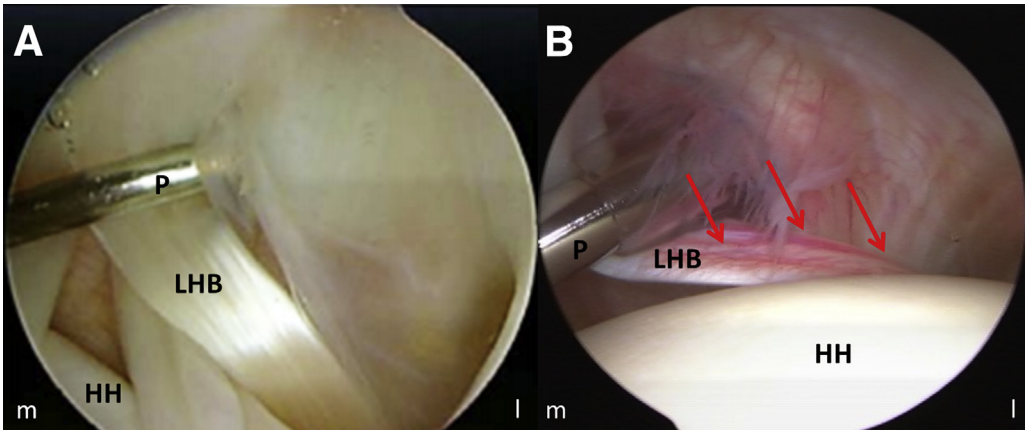

Fig 1. Right shoulder, posterior viewing portal. Intraoperative arthroscopic images of the long head of the biceps tendon (A) in a 51-year-old female without tenosynovitis and (B) in a 42-year-old female with tenosynovitis (red arrows). (HH, humeral head; l, lateral; m, medial; P, probe.)

failed a trial of conservative treatment with persistent shoulder pain and dysfunction.[3-5] Intraoperatively, tenosynovitis of the LHB presents with vascular injection and reddening of the tendon and sheath, thickening of the tendon, and edema between the LHB tendon and sheath.[5] The 2 recommended surgical treatment options are biceps tenotomy and tenodesis.[3-5] While there is no consensus on which LHB surgical technique is superior,[14-18] several studies have shown that LHB tenodesis, in contrast to tenotomy, has a lower complication rate, better shoulder function, and less postoperative cramping pain and deformity, with better cosmesis.[14-21] Subsequently, tenodesis seems to be the more appropriate intervention for an active population with biceps pathology. Biceps tenodesis (BT) can be performed in either a suprapectoral or subpectoral technique based mainly on surgeon preference.

Recently, there have been multiple outcomes studies for BT treatment of LHB tenosynovitis in conjunction with other LHB pathology and rotator cuff tears.[22-26] However, in the last 2 decades there has been a lack of outcome studies for BT treatment of LHB tenosynovitis without any other concomitant reparative or reconstructive procedures.[27-31] The objective of this study was to assess the outcomes after subpectoral BT for LHB tenosynovitis in active patients <45 years old. It was hypothesized that subpectoral BT for LHB tenosynovitis in active patients would result in reduced pain and improved functional outcomes.

Methods

Study Population

Institutional Review Board approval was obtained prior to the start of the study. Retrospective review of a single surgeon's database was performed for patients treated with subpectoral BT between January 2006 and October 2013 who met the following inclusion criteria: <45 years of age, anterior shoulder pain with arthroscopically confirmed LHB tenosynovitis (Fig 1), and a minimum period of 2 years from index surgery. Patients who required concomitant reparative or reconstructive procedures were not included, but patients with concomitant debridement and subacromial/subcoracoid/acromioclavicular decompression were included. Although patients with concomitant nonreparative/nonreconstructive procedures were included, the leading clinical diagnosis was LHB tenosynovitis. Patients who refused to participate were excluded from the study and from final analysis. All attempts were made to obtain patient-reported outcomes measures, consisting of the American Shoulder and Elbow Surgeons (ASES) shoulder score, Short-Form 12 (SF-12) Physical Component Summary (PCS) and Mental Component Summary (MCS), Quick Disabilities of the Arm, Shoulder and Hand (Quick-DASH), Single Assessment Numeric Evaluation (SANE), and 2 pain scores, preoperatively and after a minimum 2-year follow-up postoperatively. Visual analog scale (VAS) "pain today" was recorded on scale of 0 to 10 with 0 = no pain, and 10 = very bad pain. Pain with activities of daily living (ADLs) was recorded on a scale of 0 to 3 with 0 = none, 1 = mild, 2 = moderate, and 3 = severe pain. A question on sports participation was asked with answer choices all relative to preinjury level: (1) above or equal to, (2) slightly below, (3) moderately below, (4) significantly below, (5) cannot compete in usual sport, and (6) cannot compete in any sports. Answer choices 1 and 2 were judged to qualify as return to sport. Postoperative patient satisfaction scores were also obtained at latest follow-up. Clinical failure was defined as the need for revision biceps surgery or no improvement in "pain today" score at latest follow-up.

Preoperative Evaluation

All patients presented with complaints of anterior shoulder pain, with or without a history of a specific

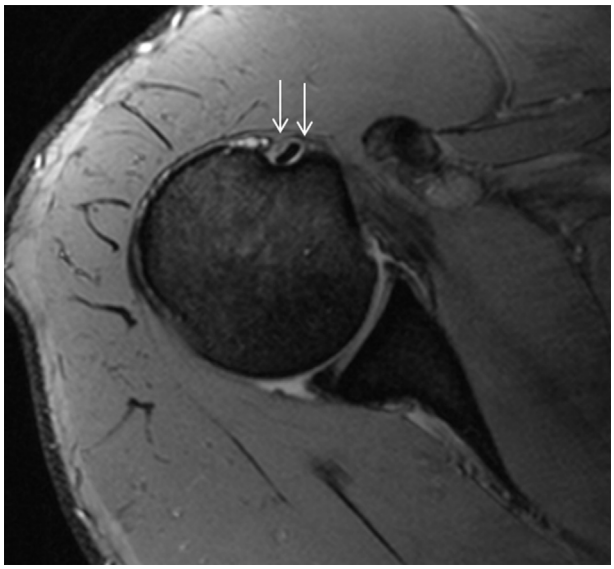

Fig 2. Right shoulder of a 42-year-old male with long head of the biceps (LHB) tenosynovitis demonstrated by increased signal around the LHB tendon (white arrows) on T2-weighted magnetic resonance imaging, axial view.

traumatic incident. On physical exam, tenderness was always elicited when directly palpating the LHB tendon in the bicipital groove.[32] Speed's, O'Brien's, and Yergason's tests were inconsistent among patients, with a mix of positive and negative results. Signs of impingement were positive in most patients. Significant rotator cuff weakness or positive provocative rotator cuff tests were not seen, but pain was sometimes elicited during these particular tests. Instability tests were always negative.

Standard radiographs with anteroposterior, lateral, outlet, and axillary views were obtained for all patients. These demonstrated no fractures or dislocations. There were no abnormalities of the bicipital groove noted. Subsequent magnetic resonance imaging (MRI), which was read by a musculoskeletal radiologist and the senior surgeon (P.J.M.), usually demonstrated a suspicious LHB tendon with increased signal suggesting inflammation and tenosynovitis (Fig 2). No significant pathologies involving other glenohumeral structures were seen, such as full-thickness rotator cuff tears, superior labral from anterior to posterior (SLAP) tears type 2 or higher, or tears of the anterior or posterior labrum.

All patients were diagnosed preoperatively with LHB tenosynovitis and first underwent a trial of nonoperative treatment consisting of some combination of rest, ice, anti-inflammatories, physical therapy, and corticosteroid injections for at least 3 months before surgery was considered. Injections were given in the LHB tendon sheath, under ultrasound guidance in more recent years, if given in our clinic; however, not everyone opted for this treatment. The other patients who received it elsewhere did so prior to coming to our clinic.

Surgical intervention primarily for treatment of LHB tenosynovitis was indicated after failed nonoperative management demonstrated by persistent shoulder pain and dysfunction, coupled with physical exam and MRI findings suggesting LHB pathology. All patients underwent subpectoral BT.

Surgical Technique

After identifying and extracting the LHB, it was whip-stitched close to the musculocutaneous junction.[33] Next, a 7- or 8-mm socket was created in the bicipital groove.[34] This was created as proximal as possible to make the socket more in the metaphyseal portion of the humerus, and it was created centrally in the bicipital groove so as not to weaken the bone.[35] The LHB tendon was then secured using a polyetheretherketone tenodesis screw of the same diameter (7 × 10 mm, or 8 × 12 mm; Arthrex, Naples, FL). The suture was tied to add more stability and prevent slippage of the tendon next to the interference screw. The incision was then closed in standard fashion.

Statistical Methods

Statistical analyses were performed using SPSS version 11.0 (SPSS, Chicago, IL). Pre- and postoperative scores were compared using either the paired samples *t*-test or Wilcoxon signed-rank test based on normality of distribution according to the one-sample Kolmogorov-Smirnov test.

Results

Between January 2006 and October 2013, the senior surgeon performed 1,184 subpectoral BTs in total. Thirty shoulders in 30 patients (19 male, 11 female;

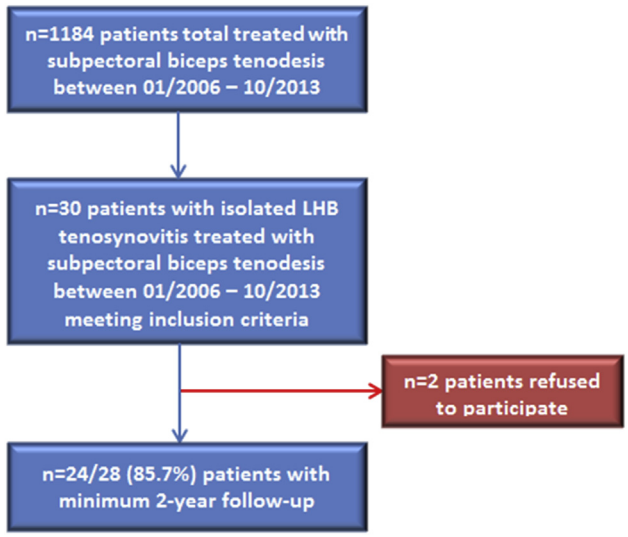

Fig 3. Flowchart showing patients who underwent subpectoral biceps tenodesis leading to the final group of long head of the biceps tenosynovitis patients with minimum 2-year follow-up.

Table 1. Concomitant Procedures Performed With Subpectoral Biceps Tenodesis for Patients With Long Head of the Biceps Tenosynovitis Who Had Minimum 2-year Postoperative Follow-up

Concomitant Pathology	Concomitant Procedures (24 patients)	No. of Concomitant Procedures
Subacromial impingement	Subacromial decompression ± acromioplasty	24
Subcoracoid impingement	Subcoracoid decompression	2
Partial-thickness rotator cuff tear <50%	Debridement of supraspinatus partial tear	7
	Debridement of subscapularis partial tear	1
Labrum fraying	Debridement of labrum	10
	Superior labral from anterior to posterior type 1 = 8 Anterior = 1 Posterior = 1	
Anterior cruciate joint degenerative changes	Distal clavicle resection	3
	Total no. of concomitant procedures	47 (mean of 2.0 per patient)

mean age 36.7 ± 7.9 years) met the inclusion criteria for LHB tenosynovitis (Fig 3). Two of the 30 included patients refused follow-up participation and were excluded from analysis. All attempts were made to retrieve follow-up from the remaining 28 patients. However, 4/28 patients were lost to follow-up and, thus, minimum 2-year outcomes were available for 24 of 28 patients (85.7%). Mean follow-up was 3.1 years (range, 2.0 to 7.3 years). Mean duration of symptoms prior to surgery was 2.0 years.

In addition to subpectoral BT, most patients had at least one concomitant procedure during the surgery, usually a subacromial decompression with or without another nonreparative or nonreconstructive procedure (Table 1). On average, each patient had 2.0 concomitant procedures along with their subpectoral BT.

There were significant improvements in postoperative ASES shoulder score, SF-12 PCS and MCS, QuickDASH, SANE, and VAS "pain today" ($P < .05$; Table 2). There was also a significant postoperative improvement in pain affecting ADLs ($P = .001$). The median preoperative level of sports participation was significantly below the preinjury level (range, slightly below preinjury level to cannot compete in any sports). Seventeen of 20 (85%) patients who answered the question about postoperative sport participation reported a return to sport. Median patient satisfaction was 10 out of 10 (range, 4 to 10), and mean patient satisfaction was 9.2 ± 1.7. Three of the 24 patients (12.5%) continued to have "pain today" (score >0; range, 1 to 3) at latest follow-up. None of the patients in this study had postoperative complications or clinical failure. There were no Popeye deformities postoperatively.

Discussion

The most important finding of this study was that subpectoral BT for treatment of LHB tenosynovitis in active patients <45 years old after failed nonoperative treatment resulted in excellent outcomes demonstrated by significant improvement in function and decreased pain. Patients were able to participate in daily activities and return to their usual sporting activities. Most patients were very satisfied with the outcome of the surgery.

The outcomes of treatment specific for LHB tenosynovitis are scarce. In the last 2 decades, the majority of studies evaluated tenosynovitis in combination with

Table 2. Comparison of Pre- and Postoperative Outcome Parameters for Patients With Long Head of the Biceps Tenosynovitis Treated With Subpectoral Biceps Tenodesis

Outcome Measure	Preoperative	Postoperative	Significance, *P*
American Shoulder and Elbow Surgeons score	59.9 ± 16.4	95.8 ± 7.8	<.001*
Single Assessment Numeric Evaluation	59.0 ± 22.0	89.2 ± 19.3	=.003*
Quick Disabilities of the Arm, Shoulder and Hand	33.3 ± 18.2	6.9 ± 11.5	<.001*
Short Form-12 Physical Component Summary	43.2 ± 8.4	54.7 ± 5.5	<.001*
Short Form-12 Mental Component Summary	48.7 ± 10.3	53.4 ± 6.1	=.045*
Visual analog scale pain today (0 = no pain; 10 = very bad pain)			
Mean	3.8 ± 1.8	0.25 ± 0.74	<.001*
Median	4 (range 0-7)	0 (range 0-3)	
Pain affecting activities of daily living (0 = none, 3 = severe)	1.7 ± 0.8	0.3 ± 0.5	<.001*
Patient satisfaction			
Mean	—	9.2 ± 1.7	—
Median	—	10 (range, 4-10)	—

*Significant difference.

rotator cuff tears, SLAP tears, and other pathology requiring additional reparative or reconstructive procedures. Prior to that, there have been a few studies without standardized measures evaluating patients in small numbers. This is understandable as LHB tenosynovitis without another major pathology is fairly rare. It is usually seen in active patients performing repetitive motion that leads to irritation of the LHB tendon. While the mechanism is not exactly understood, tenosynovitis can appear at any point along the LHB tendon.

Although outcomes for BT treatment of LHB tenosynovitis without other concomitant reparative or reconstructive procedures have been limited in the last 2 decades, there have been a couple recent studies evaluating corticosteroid treatment and tenotomy treatment of LHB tenosynovitis without any other major pathology. Corticosteroid injections significantly improved pain and functional outcomes with ultrasound-guided administration having superior outcomes due to improved accuracy over the more common administration without imaging guidance.[36,37] However, in a recent prospective randomized study, up to 20% of the patients still had persistent symptoms after a series of 3 injections and went on to surgery.[36] In a retrospective study, Kelly et al.[38] described the outcomes of 40 patients at a mean of 2.7 years after arthroscopic tenotomy for LHB tendinitis, of which only 9 patients were treated for isolated LHB tendinitis. Tenotomy resulted in 89% success of pain relief with significant improvements in postoperative ASES shoulder score (mean, 87.8), L'Insalata, and University of California at Los Angeles scores. Patients had a mean satisfaction of 3.8 out of 5, with 8 reporting good to excellent outcomes and one reporting poor outcome. However, 5 patients (55.6%) had a Popeye sign and 4 patients (44.4%) had postoperative fatigue discomfort.

In this study, outcomes were presented for active patients treated with subpectoral BT for LHB tenosynovitis without any other reparative or reconstructive procedure. While most patients had other nonreparative or nonreconstructive procedures, this should not take away from the results of the study. These procedures, especially subacromial decompression to treat impingement, have been shown in other studies to have no significant effect on clinical and functional outcomes when combined with other reparative or reconstructive procedures such as rotator cuff repair.[39-44] It is plausible that the results of this study could have been achieved without the concomitant procedures performed in these patients.

Since we could not find any studies specifically evaluating BT as a treatment for LHB tenosynovitis published in the last 2 decades to compare to the present study, we have summarized the results of older studies that have looked exclusively at the outcomes of patients with LHB tenosynovitis treated with BT[27,30,31] and studies that examined patients with tenosynovitis as a subset of a larger, heterogenous biceps pathology population.[28,29] These studies showed postoperative improvements reflected by reduced pain and increased function[27-31]; however, there were a considerable number of patients who reported persistent symptoms and nonsatisfactory results, with some requiring further surgery. All of these studies employed a suprapectoral tenodesis technique. Concerns have been raised about residual pathology in the bicipital groove with this approach.[45] The LHB tendon originates at the supraglenoid tubercle and the superior labrum, then courses distally through the intraarticular space over the humeral head and exits the joint towards the bicipital groove.[3,4] The extra-articular portion begins at the bicipital groove where it is stabilized by the biceps reflection pulley.[46] The more distal part of the LHB tendon is enveloped by a synovial sheath beginning at the bicipital groove. The suprapectoral technique subsequently would fail to address this anatomic region, whereas, the subpectoral technique directly removes all pathology of the LHB tendon.[47-49]

Although there has been work in the literature showing no significant difference between the outcomes of suprapectoral and subpectoral BT techniques for treatment of different pathologies, some studies have shown that there can be persistent symptoms after suprapectoral techniques.[50-52] The sensory innervation of the LHB tendon has been shown to be asymmetrically distributed in 3 major zones with the proximal third zone the most innervated and the middle and distal third zones progressively less innervated.[53] Thus, pathologies of the proximal portion of the LHB tendon, such as articular tenosynovitis, are likely to be the most painful; however, more distal pathology can still cause problems for patients. Especially in the context of tenosynovitis, the subpectoral technique may have an advantage over other more proximal techniques due to the possibility of ongoing tenosynovitis, within and distal to the bicipital groove.[45,48,54] Surgeons must have a high degree of clinical suspicion when arthroscopically evaluating the LHB tendon in a patient with chronic anterior shoulder pain since more distal aspects of the tendon cannot be properly visualized.[55-57]

Limitations

This study evaluated the outcomes of subpectoral BT for patients with isolated LHB tenosynovitis. While the strengths of this study include the clear indication for surgery and a consistent surgical technique, this study does have several limitations in addition to those inherent in a retrospective case series evaluating an uncommon pathologic condition. First, the rarity of the condition limited the study size. Second, while this study attempted to isolate the clinical impact of BT by excluding patients who had concomitant reparative or

reconstructive procedures, it is still possible that the other procedures such as subacromial decompression, acromioplasty, and debridement of the rotator cuff may have influenced the results. Third, there was no control group or another treatment group, such as a tenotomy group or suprapectoral tenodesis group, to directly compare the outcomes in this particular condition as the senior surgeon's preference is for a subpectoral technique to treat patients. The fact that all patients had chronic symptoms after a failed nonoperative course of treatment, and that there was such a pronounced improvement in the outcomes, makes a natural history or placebo effect less likely. Also, body mass index or height and weight were not recorded consistently preoperatively in the documentation we have access to but instead were reported in the part of documentation from the hospital side that is not "covered" by our Institutional Review Board approval so that we were not able to include body mass index in our analysis. Lastly, the ASES shoulder score and other general shoulder scores used have not been specifically validated for this biceps condition.

Conclusions

Subpectoral BT is an excellent treatment option for active patients <45 years old with LHB tenosynovitis and chronic anterior shoulder pain resulting in decreased pain, improved function, high satisfaction, and improved quality of life.

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