Original Article

Revision Subpectoral Biceps Tenodesis Demonstrates a High Patient Satisfaction and Good Functional Outcomes

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Purpose: To clinically evaluate a subset of patients who underwent a revision subpectoral biceps tenodesis for a clinically failed proximal biceps tenodesis. **Methods:** This is a retrospective case series of patients with at least 2-year follow-up who had undergone a revision biceps tenodesis after clinical failure of a proximal biceps tenodesis between January 2008 and February 2020 by a single surgeon. Patients who underwent concomitant procedures, such as revision cuff repair, were excluded. Patients with a minimum of 2 years duration status postrevision subpectoral tenodesis were contacted for informed consent and outcome data, which included Simple Shoulder Test, American Shoulder and Elbow Surgeons score, visual analog scale for pain, and subjective reporting of arm weakness and satisfaction. **Results:** Fourteen patients were initially identified as meeting inclusion criteria with a minimum 2-year follow-up achieved for 11 of 14 patients (78.5% follow-up). The mean follow-up time was 8.1 years (range, 2.7-14.8 years). After the primary biceps tenodesis, a mean of 8.0 ± 9.6 months passed before the revision subpectoral biceps tenodesis was performed. The average postoperative active forward elevation and adducted external rotation were 159 ± 7° and 47 ± 17°, respectively. The mean ± standard deviation (range) follow-up American Shoulder and Elbow Surgeons score was 79 ± 23 (30-100), Simple Shoulder Test was 11 ± 2 (7-12), and visual analog scale for pain was 2.6 ± 2.8 (0-9). All 11 patients reported being satisfied with their operation and would elect to have the operation again. **Conclusions:** Revision subpectoral biceps tenodesis is a viable procedure for addressing patients with persistent pain following initial proximal biceps tenodesis. Although some persistent pain is common, revision subpectoral biceps tenodesis demonstrates a high patient satisfaction and good functional outcomes. **Level of Evidence:** Level IV, therapeutic case series.

Injury to the long head of the biceps tendon (LHBT) is a common cause of shoulder pain and decreased shoulder function.[1-3] In addition, LHBT tendinitis is commonly associated with other shoulder pathologies such as rotator cuff disorders and SLAP lesions, which complicates management.[4,5] Treatment varies depending on the severity of presentation, ranging from nonoperative management with physical therapy to surgical treatment.[1,4] Surgical techniques vary, with arthroscopic biceps tenodesis becoming an increasingly prevalent treatment option that has been shown to provide reliable pain relief in cases involving the LHBT.[6,7] Although the biceps tenodesis is a common procedure with generally good outcomes, cramping,

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pain, and re-rupture are reported complications that can result in the need for an additional operation in 2% to 15% of cases.[8-11] Reasons for cramping and pain could be due to failure to restore the appropriate length−tension relationship when performing a proximal biceps tenodesis or residual inflamed synovium localized distally in the bicipital groove that is not removed during a proximal biceps tenodesis.[10,11]

Revision methods and outcomes for failed tenodesis are not well studied, and previous studies have had variable results.[12,13] One method is revision tenodesis through a subpectoral approach, with some studies showing patient satisfaction ranging from 88% to 100% with improvements in Single Assessment Numeric Evaluation, American Shoulder and Elbow Surgeons (ASES) score, and visual analog scale (VAS) for pain.[8,12] Despite these results, other studies have shown complication rates as high as 48%, with additional operations required in 4% of cases.[14] Due to the relatively high success of biceps tenodesis in general, there is limited literature regarding revision subpectoral biceps tenodesis outcomes after a failed proximal biceps tenodesis.

The purpose of this study is to clinically evaluate a subset of patients who underwent a revision subpectoral biceps tenodesis for a clinically failed proximal biceps tenodesis. Our hypothesis was that revision subpectoral biceps tenodesis would be a valuable treatment for persistent pain following previous failed proximal biceps tenodesis as measured by VAS for pain, Simple Shoulder Test (SST), ASES score, and patient satisfaction.

Methods

This is a retrospective case series. Following institutional review board approval (University of Utah protocol #00155839), patients who had undergone a revision subpectoral biceps tenodesis were identified at a large, academic orthopaedic center by a single surgeon (R.Z.T.) between January 2008 and February 2022 via use of Current Procedural Terminology coding (23430).

Data Collection

Patients with a surgical history of a revision subpectoral biceps tenodesis due to persistent pain after a proximal bicep tenodesis were included. Patients who underwent concomitant procedures with the revision biceps tenodesis, such as revision cuff repair, were excluded. Patients were indicated for revision subpectoral tenodesis if they had a previous proximal biceps tenodesis, had localized pain and tenderness on physical examination directly over the long head of the biceps, and they had a positive response with improvement of pain to an ultrasound-guided injection of local anesthetic into the biceps groove at the proximal tenodesis site. For the patients meeting our inclusion criteria, further chart review identified demographics for age, sex, body mass index, smoking status, date of the initial proximal biceps tenodesis and the revision subpectoral biceps tenodesis, final postoperative active forward elevation, and final postoperative adducted external rotation. Patients at least 2 years' duration status postrevision subpectoral biceps tenodesis were contacted for informed consent and outcome data collection including the SST, ASES score, VAS for pain, and subjective reporting of if they were satisfied with the operation, if they would undergo the procedure again and if they had any residual weakness in the arm. The level of prior tenodesis was defined using the system of Hassan et al.: Zone 1 - articular margin to the distal margin of the subscapularis; Zone 2 - extending from distal margin of the subscapularis to the proximal margin of the pectoralis major; Zone 3 - subpectoral.[15]

Surgical Technique

In the case of a failed proximal biceps tenodesis, no arthroscopy is required. A 4-cm incision is made centered over the inferior border of the pectoralis muscle. The pectoralis muscle is laterally retracted. The short head of the biceps and coracobrachialis are medially retracted to identify the long-head biceps tendon in the groove. With superior retraction on the pectoralis, the biceps tendon is cut as proximal as possible. This will typically leave a 1- to 1.5-cm section of biceps tendon proximal to the musculotendinous junction. Two drill holes for Mitek G4 Superanchors (DePuy Mitek, Raynham, MA) are then placed in the groove separated by approximately 1.5 cm with one proximal and one distal. The location of the proximal drill hole is determined by fully extending the elbow and then positioning the remnant of the long-head tendon in the groove such that the proximal extent of the tendon is the location of where the proximal drill hole is placed with minimal tension placed on the tendon. This will ensure not to overtension the tenodesis and avoid postoperative tenodesis site pain. The inferior drill hole is placed approximately 1.5 cm distal to the proximal hole. All remaining synovitis is removed from the residual tendon and the bone such that there is exposed bone in the biceps groove for the tendon to heal in an onlay fashion. A number 2 high-strength suture is passed in a Krackow fashion from proximal to distal to this in the remaining tendon and a second number 2 suture is passed in a distal to proximal in the remaining tendon in a Bunnell fashion. One limb of each suture is passed onto one Mitek G4 Superanchor (DePuy Mitek) and the anchor with the suture passing from proximal to distal is impacted into the proximal hole and the anchor with the suture passing from distal to proximal is impacted into the distal hole.

Each suture is then tied to complete the tenodesis apposing approximately 1.5 cm of residual tendon to the surface of the biceps groove. The remaining residual biceps tendon from the prior tenodesis proximally is left in the groove without removal.

Statistical Analysis

Planned statistical analyses with data normality determination using the Kolmogorov–Smirnov test was performed. Demographics and outcome data were compared with paired Student's *t*-tests or related-samples Wilcoxon signed rank tests based upon data normality. Categorical data were compared by Fisher exact tests.

Results

Patient Demographics

Of the 14 patients who met the inclusion criteria and were initially selected, 2 patients were found to have had a concomitant procedure on the biceps tenodesis arm and 1 patient was lost to follow-up. This gave us a follow-up rate of 78.5% (11/14) (Table 1). The average time from revision subpectoral biceps tenodesis to the date patients were contacted for patient-reported outcomes was 8.1 ± 4.6 years (range, 2.7-14.8 years). The average age was 42.2 ± 9.8 (26.0-57.8) years at the time of revision subpectoral biceps tenodesis. There were 6 female and 5 male patients included, and the average body mass index was 28.93 ± 5.14 (range, 21.26-36.04). Four patients had a previous smoking history, and one was an active smoker. The revision subpectoral biceps tenodesis was performed after a mean of 8.0 ± 9.6 months after the primary proximal biceps tenodesis. Six of the primary procedures were performed by the surgeon performing the revision, whereas 5 patients had their primary procedure performed by a surgeon other than the surgeon performing the revision. Magnetic resonance imaging before revision procedure was performed in all patients confirming and intact rotator cuff in all patients. The primary procedures included 3 patients with a suture-only repair of the biceps in the subacromial space in the rotator cuff interval, subacromial tenodesis using an anchor in 2 patients, subacromial tenodesis using a screw in 1 patient, suprapectoral tenodesis using a bone tunnel only technique in 1 patient, suprapectoral tenodesis using an anchor in 1 patient, suprapectoral using a screw in 1 patient, subpectoral using an anchor in 1 patient, and subpectoral using a screw in 1 patient. Overall, 6 patients had their primary tenodesis in Zone 1, 3 patients had their primary tenodesis in Zone 2, and 2 patients had their primary tenodesis in Zone 3.[15]

Table 1. Patient Demographics and PROs

					Time: Primary to Revision Tenodesis, mo	Time: Revision Tenodesis to PROs, y	Post Operative AFE	Postoperative ADER	PROs					
Patient	Age, y	Sex	BMI	Smoking Status					ASES Score	SST	VAS	Satisfaction	Reoperation	Weakness
1	25.9	M	29.5	Never	0.73	14.83	160	45	95	12	1	Y	Y	N
2	30.1	M	23.4	Never	1.33	14.35	160	40	72	12	4	Y	Y	N
3	39.4	F	35.4	Prior	0.63	13.74	160	30	68	11	4	Y	Y	N
4	48.3	M	28.7	Prior	18.67	10.01	160	80	100	12	0	Y	Y	N
5	53.9	F	31.7	Prior	29.57	8.27	160	45	58	7	4	Y	Y	N
6	48.8	M	32.1	Never	1.4	8.08	140	45	78	12	4	Y	Y	N
7	41.7	F	21.3	Never	5.13	4.54	160	70	100	12	0	Y	Y	N
8	39.5	F	36	Active	7.07	4.24	170	80	100	12	0	Y	Y	N
9	33.5	F	32.3	Never	9.17	4.24	160	30	72	10	3	Y	Y	N
10	44.5	F	24.9	Prior	14.13	4.08	160	40	30	9	9	Y	Y	N
11	57.8	M	22.9	Never	2	2.69	160	50	100	12	0	Y	Y	N

ADER, adduction and external rotation; AFE, active forward elevation; ASES, American Shoulder and Elbow Surgeons; BMI, body mass index, F, female; M, male; N, no; PROs, patient-reported outcomes; SST, Simple Shoulder Test; VAS, visual analog scale; Y, yes.

Outcome Scores

The mean postoperative active forward elevation was 159 ± 7°, and the mean adducted external rotation was 47 ± 17° at final follow-up. The average outcome scores at final follow-up were 79 ± 23 (30-100) for the ASES score, 11 ± 2 (7-12) for the SST, and 2.6 ± 2.8 (0-9) for the VAS for pain. All 11 patients reported being satisfied with their operation and would elect to have the operation again. In addition, none of the 11 patients reported any residual arm weakness.

Discussion

The most important finding of this study is that patients reported high satisfaction after revision biceps tenodesis, suggesting that patients can do well after failed primary tenodesis. In this study, we examined the outcomes of 11 revision subpectoral biceps tenodesis procedures after a failed proximal biceps tenodesis. Our results support high satisfaction rates, with 100% (11/11) of our patients stating they were both satisfied with their revision surgery as well as 100% (11/11) stating that they would have surgery again if indicated. We also report generally good outcomes, with an average ASES score of 79, average SST of 11, and average VAS for pain of 2.6. Despite the high satisfaction rates, a significant number of patients still had some pain (6/11 patients reporting a VAS pain >3). The data are comparable with previous reports of revision biceps tenodesis. Savin et al.[14] reported an 88% satisfaction rate but also reported a complication rate of 48%, with 24% of their patients having persistent pain with VAS for pain >3. Gregory et al.[16] similarly reported that although only 1 of their patients was dissatisfied with the surgery, 53% reported persistent pain, and 33.3% were considered failures, with a UCLA score less than 27. Overall, these results suggest that patients who undergo this procedure should be advised that some continued pain is a likely outcome although improved function and satisfaction are predictable. It is difficult to determine the source of this residual pain as there are numerous pathologies associated with the shoulder that could obscure the beneficial effects of the tenodesis revision.[17-19]

There was a large difference in the time between the original tenodesis and the revision tenodesis, with 5 of our patients having revision surgery within 2 months of the original surgery whereas 6 had a revision surgery greater than 5 months after the original procedure. Pain after initial biceps tenodesis was the indication for a revision tenodesis in all patients. Persistent pain following biceps tenodesis suggests the possible presence of hidden extra-articular "bicipital tunnel" lesions. Some studies have suggested that these extra-articular biceps lesions are possible causes of persistent pain following biceps tenodesis.[20,21] Taylor et al.[22] found that 47% of chronically symptomatic biceps tenodesis patients had extra-articular bicipital tunnel lesions that would not have been visualizable on diagnostic arthroscopy. The possible presence of extra-articular pathology supports the treatment with the subpectoral location for revision. Another possible reason for persistent pain after a tenodesis is overtensioning, and this may also have contributed to residual pain in these patients after their primary tenodesis. In attempt to eliminate these 2 etiologies of pain during the revision procedure, all synovium was removed from the residual tendon that was repaired as well as synovium in the groove where the repair was to be performed during the revision procedure and an attempt was made to not overtension by positioning the tendon at maximal length with the elbow extended. It was also determined that removal of the tissue in the groove proximal to the revision tenodesis site was not required.

Although biceps tenodesis is generally very successful, clinical failures of a tenodesis do occur. A 2019 study looked at 15,257 patients who underwent biceps tenodesis, and of those, a total of 282(1.8%) required a tenodesis revision.[23] Because of the relatively high success rate of a biceps tenodesis there is a lack of data on the outcomes of a revision biceps tenodesis. Although Euler et al.[24] didn't look exclusively at revision tenodesis surgeries, they did report on 7 patients who had a revision tenodesis after a failed previous long-head biceps tenodesis and found high patient satisfaction and no reported complications. An additional study analyzing revision tenodesis surgeries, albeit for failed initial tenotomy and not a failed tenodesis, found that 90% of patients returned to full activity and reported a mean 37.8% improvement in Single Assessment Numeric Evaluation scores and a 61.7% mean improvement in postoperative WORC scores compared with preoperative.[3] Our data would support that a revision subpectoral tenodesis is a reasonable treatment option for the uncommon complication of a failed proximal biceps tenodesis.

Limitations

Our study has several limitations. First, as a retrospective study, it is subject to the inherent biases of retrospective studies. Second, there is a lack of preoperative shoulder outcome scores to compare to postoperative to evaluate functional improvement. Third, our inclusion criteria limited us to 11 patients. A large sample size is relatively hard to achieve as biceps tenodesis is generally a very successful surgery and as such there are few revisions required.

Conclusions

Revision subpectoral biceps tenodesis is a viable procedure for addressing patients with persistent pain following initial proximal biceps tenodesis. Although some persistent pain is common, revision subpectoral

biceps tenodesis demonstrates a high patient satisfaction and good functional outcomes.

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