Clinical Outcomes of an All-Arthroscopic Biceps Tenodesis Using the Anterolateral Anchor During Concomitant Double-Row Rotator Cuff Repair

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Background: Pathology of the long head of the biceps tendon frequently occurs concomitantly with rotator cuff tears, necessitating a surgical treatment, often in the form of a tenodesis procedure. Many techniques for a tenodesis exist; however, they often require additional implants or a separate incision.

Purpose: To report an average of 2-year outcomes of an all-arthroscopic biceps tenodesis employing the stay sutures from the anterolateral anchor during concomitant double-row rotator cuff repair (RCR).

Study Design: Case series; Level of evidence, 4.

Methods: Data were prospectively collected and retrospectively reviewed for all patients who underwent an all-arthroscopic biceps tenodesis during concomitant double-row RCR by the senior author between January 2014 and May 2018. Patients were included if they underwent this procedure and had baseline preoperative patient-reported outcomes (PROs) with a minimum of 1 year of postoperative PROs for the American Shoulder and Elbow Surgeons (ASES) score and visual analog scale (VAS) for pain score. Additionally, patient data, surgical history, postoperative complications, and satisfaction were reported.

Results: Fifteen patients were eligible for the study. There were 12 (80%) men and 3 (20%) women with a mean age of 50.0 years (range, 35-64 years). The mean follow-up time was 25.2 months (range, 13-63 months). Six of 15 (40%) patients also had an arthroscopic subscapularis repair performed. ASES shoulder scores improved from 37.1 preoperatively to 94.1 postoperatively ($P < .001$), and VAS scores improved from 6.4 preoperatively to 0.5 postoperatively ($P < .001$). One patient who underwent concomitant subscapularis repair reported continued anterior groove pain. No patients experienced biceps cramping, developed a deformity, or required a repeat operation at the final follow-up. Overall, 93.3% of the patients reported being highly satisfied with their surgery.

Conclusion: This study presents the clinical results of an all-arthroscopic technique for concomitant double-row RCR and biceps tenodesis, which resulted in high rates of patient satisfaction and significant improvement in reported shoulder outcome and pain scores. Additionally, this technique offers the potential benefits of avoiding a secondary incision, which may decrease surgical morbidity while also decreasing cost by eliminating the need for an extra, tenodesis-specific implant.

Keywords: biceps tenodesis; rotator cuff repair; shoulder arthroscopy; clinical outcomes

Pathology of the long head of the biceps (LHB) tendon commonly causes anterior shoulder pain and disability with forward flexion in up to two-thirds of patients with a rotator cuff tear.[18] Both biceps tenotomy and tenodesis have been successful yet highly debated techniques to treat LHB pathology. No differences in functional outcomes between tenotomy and tenodesis have been observed.[14]

Biceps tenotomy, a technically easier procedure to perform, has been associated with earlier improvement in postoperative pain but with a greater incidence of cosmetic deformity.[3,5,32] However, in young patients with higher demands, tenodesis is preferred to avoid atrophy, cramping, cosmetic deformity, and weakness in elbow flexion and supination.[15,26]

Several open and arthroscopic techniques for LHB tenodesis have been described and shown to provide satisfactory outcomes with no discernable clinical differences.[1,2,11] Gombera et al[12] compared patients undergoing an

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arthroscopic suprapectoral tenodesis with patients undergoing an open subpectoral tenodesis. They showed similar clinical outcomes and pain relief between both groups but claimed that an open subpectoral tenodesis may have a higher complication risk because it is more invasive. Neurovascular injury and deep infection have been reported with the use of open tenodesis techniques and can be mitigated through an arthroscopic approach.[22,25,31]

Similarly, numerous fixation techniques can be used, including a suture anchor, interference screw, bone tunnel, or cortical button.[9,13,19] Many biomechanical studies have evaluated these various fixation techniques; however, Park et al[23] demonstrated increased anatomic failure in patients with interference screw fixation versus suture anchor fixation but no functional difference.[7,24]

Rotator cuff repair (RCR) has become one of the most common orthopaedic surgeries performed in the United States, with an estimated cost of $1.2 to $1.6 billion annually.[6,8] Reducing costs associated with RCR can theoretically diminish overall health care expenditures.[4] Avoiding a biceps tenodesis–specific implant without compromising functional outcomes of the tenodesis during concomitant RCR may be a way to accomplish this.

The purpose of this study was to report short-term outcomes for an all-arthroscopic biceps tenodesis employing the stay sutures from the anterolateral anchor during concomitant double-row RCR. We hypothesized that this all-arthroscopic tenodesis would successfully alleviate anterior shoulder pain while minimizing complications and improving shoulder function.

METHODS

Patient Selection

This study was approved by the institutional review board. Data were prospectively collected and retrospectively reviewed for all patients who underwent an all-arthroscopic biceps tenodesis during concomitant double-row RCR by the senior author (D.V.) between January 2014 and May 2018. Patients were included if they underwent this procedure and had baseline preoperative patient-reported outcomes (PROs) with a minimum of 1 year of postoperative PROs for the American Shoulder and Elbow Surgeons (ASES) score and the visual analog scale (VAS) for pain score on a scale from 0 to 10 (0 = no pain; 10 = extreme pain). Excluded patients were those who did not have a minimum of 1 year of follow-up or who underwent the following: a single-row arthroscopic RCR, an open biceps tenodesis for an immobile LHB tendon, an open RCR, or previous ipsilateral shoulder surgery.

Clinical Evaluation

The senior author (D.V.) performed all preoperative physical examinations. Presence of LHB tendon pathology was characterized by pain during bicipital tunnel palpation and the active compression, Speed, and Yergason tests.[30] Presence of rotator cuff pathology was identified using active and passive range of motion and the empty-can, full-can, external rotation lag sign, Belly press, and liftoff tests.[16] Both rotator cuff and LHB pathology were confirmed on magnetic resonance imaging scans before surgery. The senior author also performed all postoperative examinations. Failure was defined as a deformity resulting from a ruptured tenodesis, continued anterior shoulder pain, or biceps cramping. Patients were then contacted by telephone or email for the collection of VAS for pain and ASES scores. Of the patients, 14 answered the questionnaires over the telephone, and 1 patient answered via email.

Surgical Technique

The surgical technique has been previously published.[20] The patient was placed in the beach-chair position, and standard posterior and anterior portals were established. After a standard diagnostic arthroscopy, thorough evaluation of the LHB tendon was performed. The tendon was probed and evaluated for a biceps pulley lesion, superior labrum anterior and posterior tear, medially subluxated tendon in the setting of a subscapularis tear, or intrasubstance tearing. If significant pathology was encountered and the tendon was confirmed to be mobile within the groove using a probe, an arthroscopic tenodesis was indicated, and a tenotomy was performed at the glenoid tubercle.

Once the rotator cuff had been repaired in a double-row configuration, the arm was positioned in approximately 30° of abduction and 20° to 30° of external rotation to help visualize the biceps tendon and groove (Figure 1). The biceps tendon was freed from the groove (Figure 2). A limb of one of the No. 2 FiberWire (Arthrex) stay sutures loaded in the anterolateral anchor was retrieved out of the lateral

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Ethical approval for this study was obtained from the University of Pittsburgh (study No. 19020323).

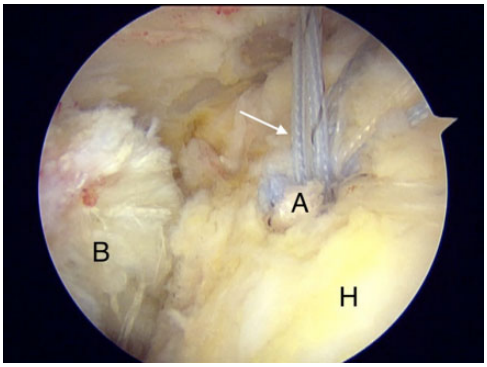

Figure 1. With the patient in the beach-chair position, viewing from the posterolateral portal, the anterolateral anchor was positioned adjacent to the biceps groove when placed for the double-row rotator cuff repair. The anchor was double loaded with 2 stay sutures (white arrow) that were kept in place to be used for later tenodesis. A, suture anchor; B, biceps tendon; H, humeral head. Reprinted from Meghpara et al[20] with permission from Elsevier.

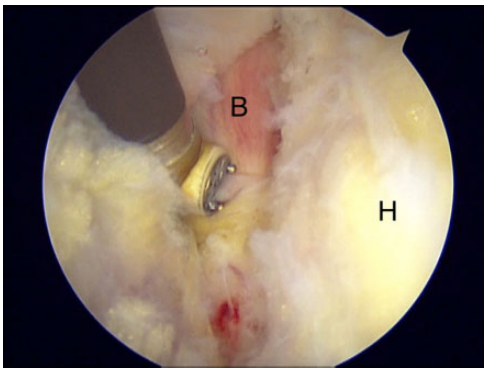

Figure 2. A radiofrequency ablation device was used to debride soft tissue surrounding the biceps groove as well as the biceps sheath and transverse humeral ligament. B, biceps tendon; H, humeral head. Reprinted from Meghpara et al[20] with permission from Elsevier.

portal and passed through the tendon in a cinch configuration using a self-retrieving suture passer approximately 4 cm distal on the tenotomized tendon. This was repeated with a limb of the second suture, which was placed just distal to the initial suture (Figure 3). Arthroscopic scissors were used to truncate excess tendon. Both sutures were arthroscopically tied using alternating half-hitch knots, which secured the tendon to the suture anchor to complete the tenodesis (Figure 4).

Rehabilitation Protocol

The arm was placed in a shoulder abductor sling for 6 weeks after surgery. Patients were encouraged to perform pendulum exercises along with elbow/wrist range of motion exercises during these 6 weeks. Range of motion of the shoulder and active biceps exercises were initiated after

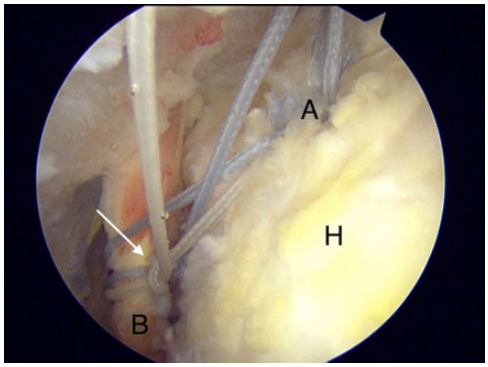

Figure 3. A self-retrieving suture passing device was used to deliver 1 limb of the stay suture approximately 4 cm distal on the tenotomized tendon in a cinch configuration (white arrow). This was repeated for the second stay suture in a similar fashion. A, suture anchor; B, biceps tendon; H, humeral head. Reprinted from Meghpara et al[20] with permission from Elsevier.

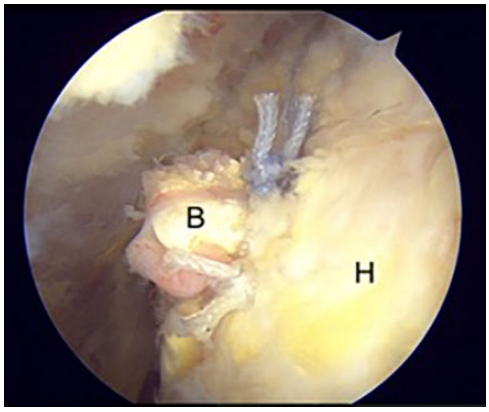

Figure 4. Both sutures were arthroscopically tied with alternating half-hitch knots to secure the tendon to the suture anchor, which completed the tenodesis. B, biceps tendon; H, humeral head. Reprinted from Meghpara et al[20] with permission from Elsevier.

6 weeks. At 12 weeks, biceps and rotator cuff strengthening was initiated.

Statistical Analysis

Statistical analysis was performed using Microsoft Excel (Version 16.41; Microsoft Corp). The VAS for pain and ASES scores were compared using the 2-tailed, unpaired t test. Statistical significance was set to $P < .05$.

RESULTS

After all inclusion and exclusion criteria were applied, there were a total of 15 patients eligible for the current study. Figure 5 demonstrates the patient selection process. The mean follow-up time was 25.2 months (range, 13-63 months). The

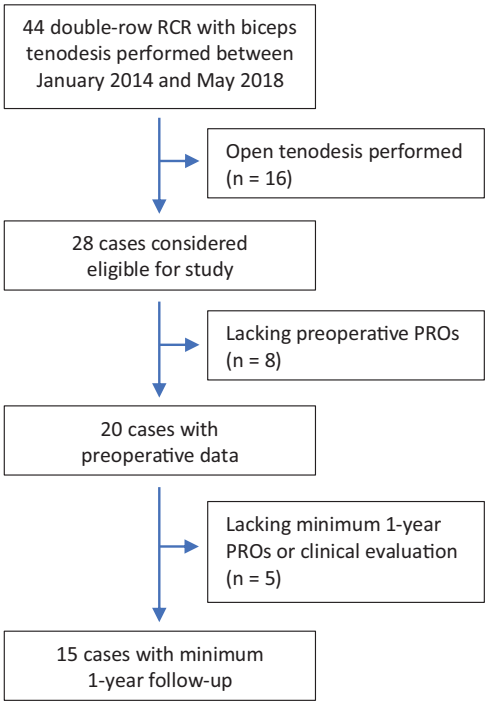

Figure 5. Patient selection process. PROs, patient-reported outcomes; RCR, rotator cuff repairs.

TABLE 1
Patient Characteristics[a]

Patient Characteristic	Value
Mean age, y	50.0 ± 9.4
Male	12 (80)
Female	3 (20)
Tobacco user	2 (13.3)
Workers' compensation	1 (6.7)[b]

[a]Data are presented as mean ± SD or n (%).
[b]The patient with workers' compensation status was also a tobacco user.

mean age (± SD) of patients in this study was 50.0 ± 9.4 years (range, 35-64 years). Twelve patients (80%) were men, while 3 (20%) of the patients were women (Table 1).

Six patients (40%) underwent an RCR employing a 1 × 1 configuration (1 medial and 1 lateral anchor) for isolated supraspinatus high grade partial-thickness tears, while 9 patients (60%) underwent a 2 × 2 repair (2 medial and 2 lateral anchors) for supraspinatus and partial infraspinatus full-thickness tears. Six patients (40%) underwent concomitant subscapularis repair. In 13 patients (86.7%), a concomitant subacromial decompression with acromioplasty was performed.

There was a significant improvement ($P < .001$) from preoperatively (mean score, 37.1) to the latest follow-up (mean score, 94.1) for ASES scores (Table 2). Additionally, there was a significant improvement ($P < .001$) from preoperatively (mean score, 6.4) to the latest follow-up (mean score, 0.5) for VAS for pain scores (Table 2).

TABLE 2
Preoperative and Latest Postoperative ASES and VAS for Pain Scores[a]

Outcome Score	Mean ± SD	Minimum	Median	Maximum	*P* Value
ASES					
Preop	37.1 ± 11.8	16.64	36.62	51.6	
Postop	94.1 ± 8.8	69.1	69.1	100	<.001
VAS					
Preop	6.4 ± 2.2	3	7	9.5	
Postop	0.45 ± 1.5	0	0	5	<.001

[a]ASES, American Shoulder and Elbow Surgeons; Preop, preoperative; Postop, postoperative; VAS, visual analog scale for pain.

No patients in this study experienced postoperative complications or required reoperation after their surgery. Additionally, no patients developed biceps cramping or a Popeye deformity in their follow-up period. Overall, 93.3% of the patients reported being highly satisfied with their surgery. One patient who underwent concomitant subscapularis repair was unsatisfied with continued anterior shoulder pain at the latest follow-up.

DISCUSSION

The introduced technique results in a high rate of patient satisfaction, with significant improvement in shoulder outcome scores and decreased pain. No patients in this series required reoperation, with no major complications reported postoperatively. Additionally, this technique obviates the need for an extra implant or separate incision, possibly decreasing surgical morbidity while reducing costs.

Previous studies have reported on patient outcomes after all-arthroscopic versus open biceps tenodesis.[1,12,13,18,33] Although open techniques tended to have higher rates of morbidity, including nerve injury and wound complications, no study detected a clinically significant difference between the 2 techniques.[1,12,13,18,33] Duerr et al[10] reported an increase in ASES scores from 42.6 preoperatively to 91.0 postoperatively with their described arthroscopic suprapectoral biceps tenodesis. Our results are similar to these previous studies in that those patients undergoing our all-arthroscopic technique had satisfactory clinical results with no complications at an average of 2 years of follow-up.

The current study's results also indicate that the proposed technique for combined tenodesis and RCR is effective in terms of PROs. Sallay and Reed[27] assessed baseline ASES scores in individuals without shoulder pathology. The study's findings revealed the mean ASES score in an asymptomatic population to be 92.2 ± 14, a value very similar to the outcomes of the current study (mean ASES score, 94.1 ± 8.8). Given these findings, the proposed technique appears to result in an ASES score at or slightly above baseline values within an asymptomatic population.

The risk of a stress riser and possible fracture has been reported with the use of an additional fixation device for a biceps tenodesis after subpectoral biceps tenodesis.[28] This can

be decreased by utilizing the anterolateral row anchor already present from an RCR. Additionally, this provides a cost-saving alternative, as it avoids the use of an additional biceps-specific implant. Given the expected rise in health care costs,[21] we consider cost-saving surgical techniques that maintain successful outcomes to be of particular value. Previous research has shown that an increased number of anchors are associated with higher direct costs.[6,17] By avoiding the use of an additional implant, this technique can help mitigate some of the added costs associated with shoulder surgery.

Previous research has shown that longer operative times are associated with increased costs in rotator cuff surgery.[17] This technique can be performed quickly, as it precludes the need for added surgical dissection, implant preparation, and incision closure. Thus, operative times as well as cost with this technique can be less when compared with open methods.

Our study is not without limitations. First, this technique is a proximal tenodesis that does not entirely address distal biceps pathology within zone 2 of the tunnel.[29] However, studies have shown no clinical difference between subpectoral and suprapectoral tenodesis techniques.[12,13] Second, patients with poor tissue quality or those in whom the biceps cannot be mobilized arthroscopically should not undergo this technique. Thus, there may have been selection bias regarding the patients who underwent this procedure. Third, selection as well as recall bias may occur, as these are known limitations of a retrospective study; however, all data were collected prospectively to limit this. Fourth, patients underwent several concomitant procedures, possibly confounding our results. This heterogeneity is meant to treat all pathology in the shoulder to minimize the risk of reoperation. Fifth, the sample size in this study was small. This precluded us from performing a subgroup analysis for those undergoing concomitant subscapularis repair or those with workers' compensation status and tobacco users. Sixth, we did not have a control group or an open biceps tenodesis group and thus could not make a comparative analysis. However, as discussed earlier, several studies have not encountered a clinical difference in outcomes between arthroscopic and open biceps tenodesis techniques.

CONCLUSION

This study presents the clinical results of an all-arthroscopic technique for concomitant double-row RCR and biceps tenodesis, which resulted in high rates of patient satisfaction and significant improvement in reported shoulder outcome and pain scores. Additionally, this technique offers the potential benefits of avoiding a secondary incision, which may decrease surgical morbidity while also decreasing cost by eliminating the need for an extra, tenodesis-specific implant.

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