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Novel all-arthroscopic biceps tenodesis technique incorporated into rotator cuff repair—two hundred cases with minimum 2-year follow-up

Grayson W. Poff, BS, John Broyles, BS, Cooper Mashburn, BS, Spencer Shore, BS, Edwin E. Spencer Jr., MD*

Knoxville Orthopedic Clinic, Shoulder and Elbow Division, Knoxville, TN, USA

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Background: Biceps tendon pathology is a common source of pain in the shoulder. It is frequently seen in conjunction with symptomatic rotator cuff tears. Biceps tendon management during arthroscopic rotator cuff repairs can be achieved via tenodesis with various techniques or tenotomy. Tenodesis of the biceps generally results in less deformity and reduced exertion-related cramping. However, most techniques require the addition of some type of hardware to provide fixation for the biceps tendon, which adds cost, time, and complexity. This study presents a technique for an all-arthroscopic bicep tenodesis performed in conjunction with a double-row rotator cuff repair, requiring no additional hardware.

Methods: This study is a retrospective review of data that were prospectively collected for 200 consecutive patients for whom the procedure was performed. Patients were seen postoperatively at 2 weeks, 6 weeks, 4 months, and 6 months and in addition massive rotator cuff repairs were seen at 8 months. Additionally all patients were contacted at a minimum 2-year follow-up to access for the presence deformity, the American Shoulder and Elbow Surgeons (ASES) score, and SANE score. Descriptive statistics and comparisons to known minimal clinical important differences (MCIDs) for the patient recorded outcome measures were recorded.

Results: Two hundred patients were included in the study and 152 responded to the telephone interviews. The mean age of the patients at the time of surgery was 65.3 year old (standard deviation ± 9.1, range of 46-84), and the mean postoperative phone interview was 3.2 years postsurgery (standard deviation of ± 1.0, range of 2-5 years). The average ASES score improved from 52.6 to 94.6, which is 3 times greater than the minimal clinical important difference. The average postoperative SANE score was 94. Seven procedures out of the 200 were labeled as failures due to 1 patient's nonsatisfaction with the procedure and 3 for a Popeye deformity and 3 that had a revision RCR.

Discussion: The described method of an arthroscopic biceps tenodesis performed with a rotator cuff repair uses no extra hardware, requires minimal additional operative time, and is clinically effective. At a minimum 2-year follow-up, the all-arthroscopic biceps tenodesis in conjunction with a double-row rotator cuff repair resulted in a marked improvement in their ASES score with a 3.5% failure rate.

Conclusion: The all-arthroscopic bicep tenodesis performed in conjunction with a double-row rotator cuff repair demonstrated improved clinical outcome, without requiring any additional hardware to tenodese the biceps, at a minimum 2-year follow-up.

Long head of the biceps tendon (LHBT) is an extremely common cause of shoulder pain and dysfunction, and is frequently associated with rotator cuff tears.[2,3,8,12,14,16] It has been reported that up to 76% of patients with complete rotator cuff tears (RCTs) had concomitant pathology in the long head of the biceps tendon (LHBT).[6] These lesions can include fraying, hypertrophy, interstitial tearing, and subluxation secondary to pulley lesions. Most biceps pain can be attributed to secondary inflammation in conjunction with other glenohumeral joint pathologies.[2,4,12] Surgical treatment options include tenodesis or tenotomy. Both are viable options for treatment of LHBT lesions, but tenodesis has been associated with a decreased chance of exertional muscle cramping and cosmetic

This study received IRB exemption through Covenant Health Institutional Review Board #2022-248.

*Corresponding author: Edwin E. Spencer, Jr., MD, Knoxville Orthopedic Clinic, 260 Fort Sanders W Blvd, Knoxville, TN 37922, USA.

E-mail address: spencershoulder13@gmail.com (E.E. Spencer).

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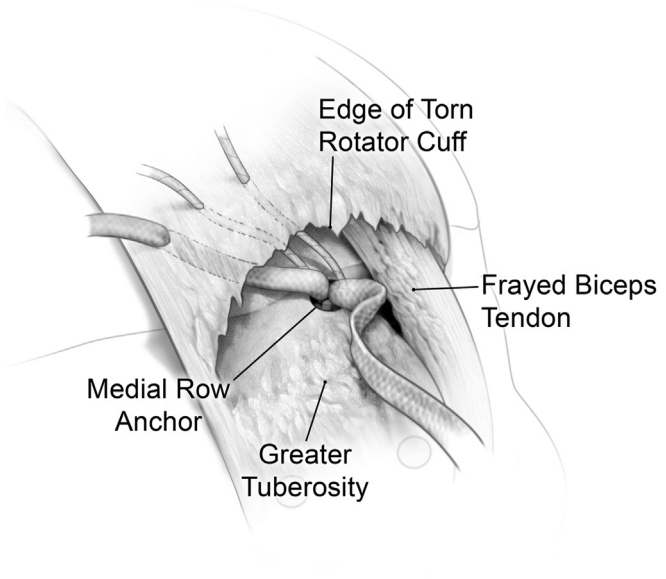

Figure 1 Lateral view of the shoulder after placement of the medial anchor and passing the suture and tapes through the rotator cuff tissue.

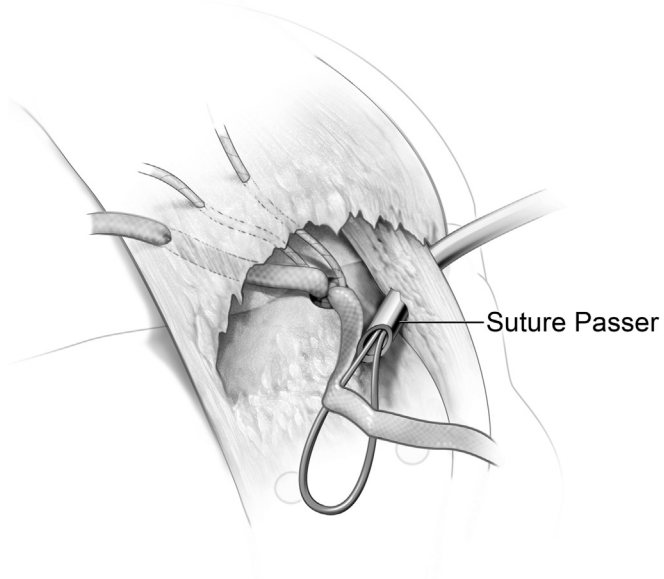

Figure 2 Passing the anterior tape through the biceps tendon to perform the first locking hitch.

deformity.[2,5] For this reason, tenodesis has emerged as the operative treatment of choice for LHBT pathology in some regions, especially when associated with RCTs. Multiple methods for tenodesing the LHBT have been described utilizing both open and all-arthroscopic techniques. These techniques usually include the use of suture anchors, interference screws, buttons or securing the tendon to the surrounding soft tissue. We describe an all-arthroscopic, suprapectoral biceps tenodesis with a concomitant rotator cuff repair requiring no additional hardware.

Surgical technique

A standard posterior portal is created and the glenohumeral joint is evaluated. The author insufflates the joint with 60 cc of air to examine all the structures. This allows very good visualization and allows the surgeon to determine the next portal placement. If there is a full thickness tear of the supraspinatus, an anterolateral portal is created. An 18-gauge spinal needle is used to localize the correct site for the anterolateral portal, ensuring instruments can easily access the rotator cuff, upper portion of the bicipital groove, biceps tendon, and greater tuberosity. Once the portal is created, the water is turned on and the biceps tendon can be evaluated again. If the biceps tendon is significantly frayed, subluxed, or unstable then the decision is made to tenodese the biceps. The greater tuberosity and intertubercular groove are lightly decorticated, making sure to extend the decortication 2 cm down the bicipital groove. Access to the groove can be facilitated by creating a rotator cuff interval portal and using a probe to pull the tendon medially preventing it from getting caught up in the burr or shaver. This can be performed viewing from within the glenohumeral joint. The burr is introduced from the anterolateral portal just off the anterolateral aspect of the acromion.

Once the tuberosity and groove are decorticated, the scope is redirected into the subacromial space and a bursectomy and decompression are performed if necessary. A posterolateral portal is created and that will be the viewing portal. A medial anchor is then placed at the medial portion of the greater tuberosity just posterior to the bicipital groove. This technique works best with medial anchors that have 2 tapes and 2 sutures that both slide. A curved suture shuttle/passing device with a retrievable loop is utilized to pass the sutures and tapes through the tissue in retrograde fashion.

This can be performed in massive tears with 2 or 3 medial anchors, but it is the most anterior anchor that is used to tenodese the biceps. Once the anchors are placed, tapes/sutures are passed through the rotator cuff, working from posterior to anterior so that the last tape is the most anterior one, closest to the biceps (Fig. 1). This tape is passed through the biceps tendon from the rotator cuff interval portal (Fig. 2). The tape is not pulled all the way taught, rather a loop is left proximal to the tendon (Fig. 3). The retriever is placed through the loop and used to grasp the tape on the other side and pulled through the loop, thus locking the tape under the loop (Figs. 4 and 5). This step is repeated 3 times to place 3 locking tape loops in the tendon to whipstitch the biceps (Fig. 6). It is important to note that these tape loops are started distally by pulling the biceps tendon into the RCT and progressing proximally towards the joint. The second loop is passed all the way around the biceps tendon to get circumferential fixation.

Once the biceps is whipstitched with 3 locking loops, the free end of the tape/suture is passed through the anterior rotator cuff tissue and biceps as shown in Fig. 6. The posterior tape from the anterior anchor is then tensioned to pull the biceps tendon down to the bone, “setting” the biceps tendon in the groove. The medial mattress sutures are then tied down.

All the medial mattress sutures are tied and then the lateral row anchors are placed after gathering all the respective sutures and tapes (Fig. 7). Finally, the scope is redirected into the glenohumeral joint and the biceps tendon is visualized and released from its origin. The excess biceps tendon stump is then débrided.

Materials and methods

The inclusion criteria for this study were adult patients with a repairable rotator cuff tear with concomitant biceps pathology that had no previous surgery, minimal to no concomitant arthritis, and required no additional procedures such as a distal clavicular

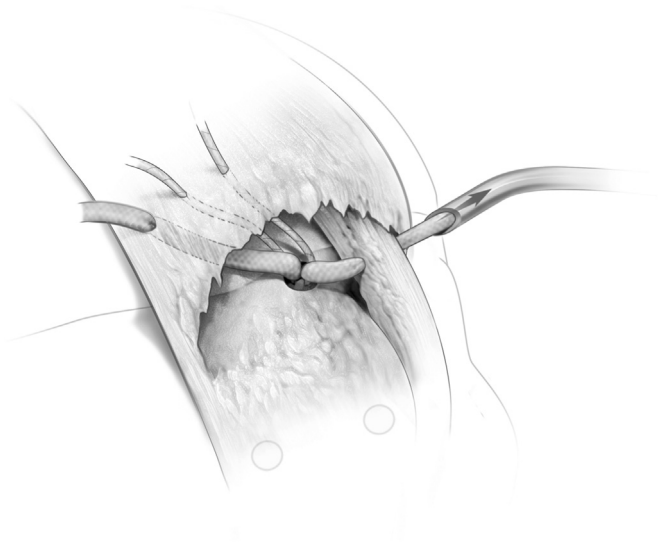

Figure 3 The tape is shuttled through the biceps tendon and out the anterior cannula.

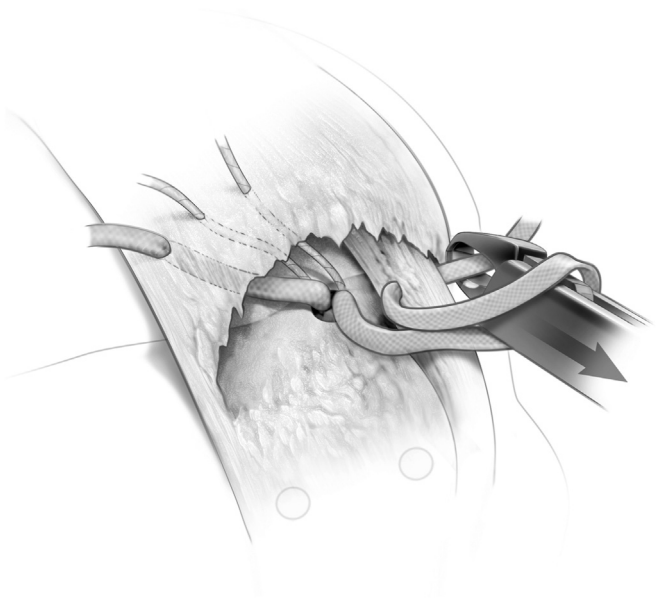

Figure 4 A retriever is used to pull the tape through the loop formed when shuttling the tape out of the joint.

resection. Two hundred consecutive procedures performed by the senior surgeon from January 1, 2017 to March 30, 2020 met the inclusion criteria. All patients had routine postoperative examinations at 2 weeks, 6 weeks, 4 months, and 6 months. In addition, massive rotator cuff repair patients were seen 8 months postoperatively. At each postoperative visit, the presence of deformity and range of motion were recorded in addition to American Shoulder and Elbow Surgeons (ASES) and SANE scores at the final clinical visit. These patients were additionally called at a minimum of two years after the procedure in order to obtain an ASES score, SANE rating, and questioned for the presence of deformity. Two patients sustained fractures to the extremity and were omitted from the study, 3 patients declined to be interviewed, and 43 patients provided no response to the repeated phone call attempts.

There were 132 male patients and 116 procedures were on the right shoulder. The mean age of the patients at the time of surgery was 65.3 years (standard deviation of ± 9.1 years, range of 46-84 year old), and the mean time from surgery to phone interview was 3.2 years (standard deviation of ± 1.0, range of 2-5 years). Each value and reported physical examination were then entered into a single database for storage.

A distribution-based approach was chosen to calculate minimal clinical important differences (MCIDs) due to the lack of diverse answers given to the anchor question that would classify patients into different study cohorts (only 7 patients out of the 200 would be listed in an unsatisfied cohort). The established distribution-based approach for MCIDs performed by Eguia et al[6] after a subpectoral biceps tenodesis was used for the study. This approach yielded a MCID of 13 for ASES scores for this study which matched the exact value from the study performed by Eguia et al.

Results

The mean preoperative ASES score was 52.6 (SD = 17.5) which increased to a mean of 92.4 (SD = 12.4) at the final clinical follow-up and increased to 94.6 (SD = 10.2) in the 152 that completed the telephone interview. Seventy-five percent of the patients recorded a postoperative ASES score that was above 96. The average postoperative SANE score was 96 including the patient that was not satisfied with the procedure (0 SANE rating) and the 3 recurrent rotator cuff tears. Although there were no preoperative SANE scores, 75% of the patients reported having full utilization of their shoulder postoperatively with a 100 SANE score. In addition, a failed procedure was defined as an ASES score that was lower than the MCID from the average postoperative ASES score for the group or visual evidence of a rupture of the long head of the biceps tendon (Popeye deformity). Only 7 of the 200 patients were labeled as failures (3.5% failure rate). One patient was dissatisfied with the outcome of the surgery due to his current discomfort levels, while 3 others had a Popeye deformity. The patient who was dissatisfied with the outcome of the procedure due to discomfort also stated that part of their complaint involved the possible development of arthritis. This patient had a medium size rotator cuff repair and no significant arthritis at the time of surgery and declined to return for a postoperative MRI. This self-diagnosis has not been verified in the shoulder, but it is noted that this patient has dealt with 2 unrelated myocardial infarctions. Of the 3 patients with the Popeye deformities, 1 had a massive RCR and 2 had medium sized RCRs and none had any complaints or limitations other than the cosmetic deformity and none desired any further surgery.

An additional 3 patients required a revision rotator cuff repair and were considered failures although none had a biceps deformity. One was a recurrent tear as a result of a noted biological problem (rheumatoid arthritis) and 2 were the result of a traumatic injury.

In this cohort there were 146 medium size tears (single tendon) and 54 massive rotator cuff tears. In accordance with Gerber and Schumaier et al,[13] massive rotator cuff tears were defined as having 2 or more tendons being torn. In general, the single tendon supraspinatus tears required 1 medial anchor and 2 lateral row anchors while the massive 2 tendon tears of the supraspinatus and infraspinatus or subscapularis required 2 medial anchors and two lateral row anchors. We also analyzed the results by tear size and found that the ASES score improved from 51.3 to 94.9 in the medium size tear group and from 48.2 to 92.5 in the massive repair group. Of those that required revision, there were 2 medium size tears and 1 massive tear.

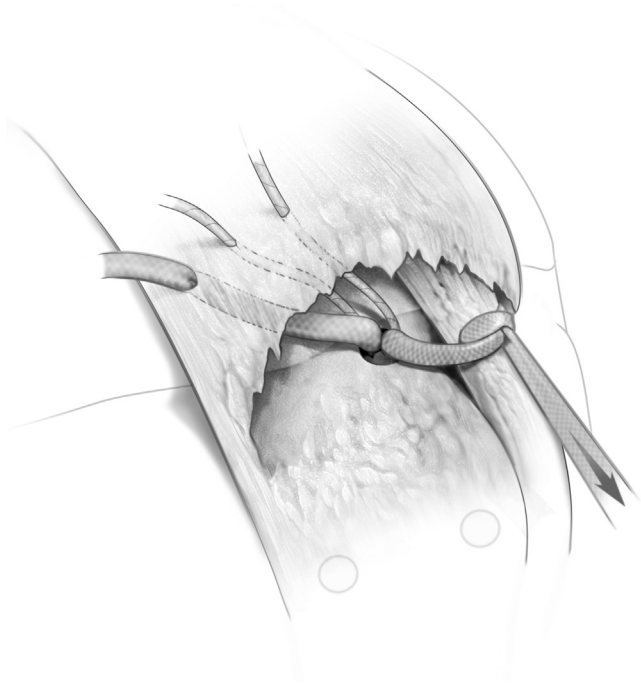

Figure 5 The locking hitch is pulled taught.

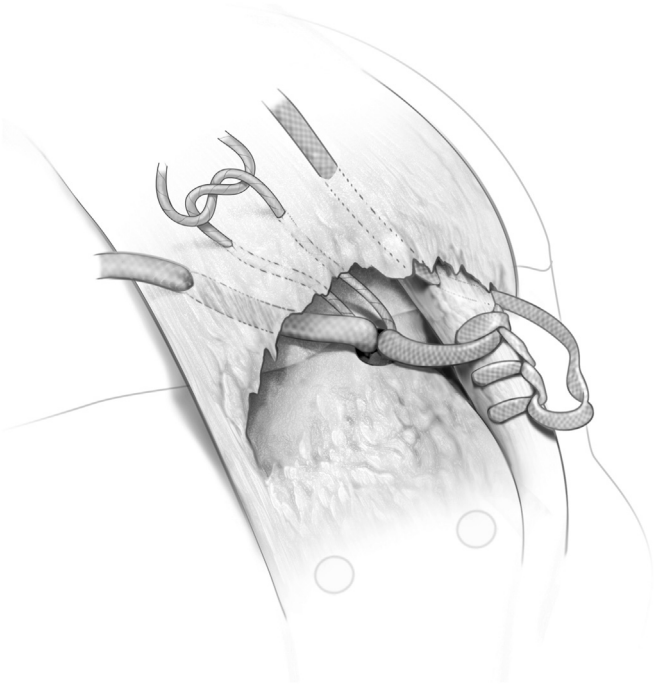

Figure 6 Whipstitched biceps tendon with anterior tape passed back through the medial portion of the biceps tendon and then the rotator cuff tissue.

Discussion

The authors present a simple, efficient, and reproducible technique for tenodesing the long head of the biceps at the proximal aspect of the bicipital groove. Incorporating the biceps tenodesis into the rotator cuff repair offers a number of benefits over traditional methods of biceps tenodesis. First, the procedure can be performed in conjunction with an arthroscopic rotator cuff repair without any extra cost since no additional anchors are required to securely tenodese the biceps. This adds very little time to the procedure, does not require any additional portals, and requires only a few extra suture passes, making it fast, efficient, and cost effective. Second, securing the biceps before releasing it from the superior glenoid tubercle keeps the biceps at its anatomic resting length and prevents the tenodesis from being overtensioned or undertensioned. Finally, this technique provides good biologic and biomechanical fixation by providing a decorticated groove into which the biceps can heal and a whipstitch fixation with a tape. The suture tape is first whipstitched through the biceps tendon and then passed back through the rotator cuff, resulting in double-row fixation for both the biceps and rotator cuff. Double-row fixation has been demonstrated to provide the strongest fixation of RCTs.[1,5,9,10] Decortication of the bicipital groove prior to anchor placement allows for tendon-to bone healing.

It is not entirely clear why a biceps tenodesis relieves bicep related pain, however it has been well demonstrated in the literature that biceps tenodesis significantly decreases the motion of the biceps tendon in the bicipital groove throughout all planes of shoulder motion.[7,16] The presented technique is a suprapectoral tenodesis and thus changes the point of origin of the LHB to the upper portion of the groove. The LHB therefore has no angular motion and is now only crossing one joint in the direct line of action of its intended purpose at the elbow. With this change in the point of origin, the authors have not experienced any significant “groove pain”. The absence of “groove pain” was determined at the latest clinical follow-up and supported by the increase in ASES scores. This could be secondary to the direct line of action of the tenodesis, or the decortication of the groove that allows for a large and robust healing area, or possibly secondary to bone marrow extending down the groove and thus bathing the tendon in marrow contents.

Bicipital tendon pathology is frequently identified in conjunction with rotator cuff tears, with up to 85% of acute ruptures of the long head of the biceps tendon associated with at least a partial thickness rotator cuff tear.[3,10,11,14-16] Additional data have shown that pathology in the LHB occurs in approximately 63% of patients with posterosuperior rotator cuff tears.[3] Based on these data, we know that pathology in the LHB is frequently seen with RCTs making this technique very applicable to clinical practice.

The clinical follow-up in this case series was out to 6 months in medium sized tears and 8 months in massive tears. Telephone interview was available in 152 patients at a minimum of 2 years after surgery. When failure or Popeye deformities did occur, they were recognized at the 6-week visit in 2 cases and the 4-month visit in one case indicating that these failures occur early in the recovery. We did not have any deformities noted after the 4-month postoperative visit even in those that had a recurrent rotator cuff tear diagnosed later for any cause. Upon review of the failures, 2 were noted to have very degenerative biceps tendons with significant fraying that had at least one pass cut through the biceps tendon while the other one was noted to have medial fraying secondary to pulley mechanism attenuation. In cases where the biceps is significantly frayed and the tape is cutting through tendon, a better option might be either tenotomy or open subpectoral biceps tenodesis.

Although there were failures in our study, Eguia et al[6] concluded that the MCID in the ASES score with a subpectoral biceps tenodesis was 13. In our series of 200 patients, there was an average 41.8 improvement in the ASES score which is 3 times greater than the reported MCID indicating that it clinically effective.

As we move to a value based health-care model, surgical techniques that address the pathology in a cost-effective manner should be employed. This includes both time in the OR and the use

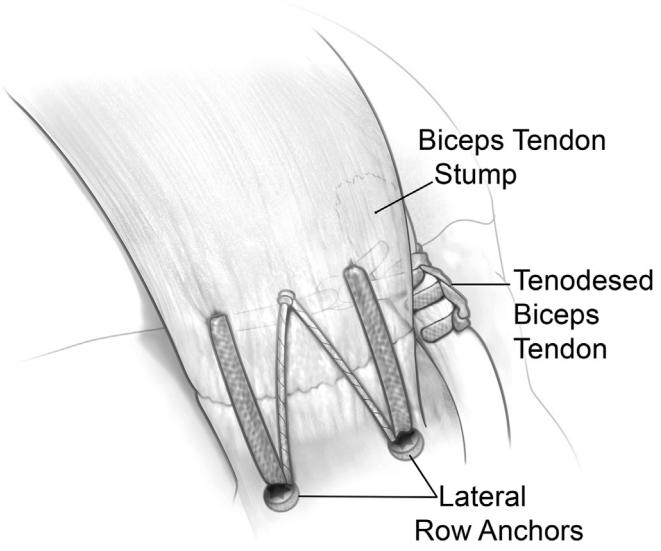

Figure 7 Completed repair after placement of lateral row anchors and securing sutures/tapes and debriding the remaining biceps tendon, leaving the tendon stump just medial to the tenodesis.

of any additional materials whether that is implants or other disposables. This technique has proven to be not only clinically effective, with a 3.5% failure rate, but also financially effective as there are no other additional implants with minimal additional time in the OR. Some centers prefer RCR techniques other than the double row described in this paper. It is conceivable that this technique could be used with a single row repair whipstitching the biceps tendon as described and securing it to the anterior cuff, but it might not be as strong. It might be more effectively used with the arthroscopic transosseous repair technique which creates a double-row configuration.

The limitations of this technique is that the RCT has to be large enough to visualize and surgically manipulate the biceps tendon through the RCT. The RCT needs to be large enough to require 1 anchor medially and some lateral fixation as well. If the tear is too small to require dual row fixation and the biceps tendon is pathologic, then the author will perform an open subpectoral biceps tenodesis.

This study has several limitations including its retrospective nature (although data collected prospectively), 2-year follow-up was limited to 152 patients, although no failures were seen after 4 months, and SANE scores were not available preoperatively. Another limitation is the phone interview follow-up and relying on the patients to determine if they had a noticeable deformity in the operative arm relative to the nonoperative arm. An actual patient visit as opposed to a telephone interview would have been desirable, but so few patients would agree to come in that we defaulted to telephone interviews after the 6-8 month clinical follow-up. Also the ASES and SANE scores might not be the best methods to detect “groove pain” but they are validated patient recorded outcome measures. In addition, there were no follow-up imaging studies. The data may also not be generalizable because all operations were performed by a single shoulder surgeon.

Conclusion

This all-arthroscopic bicep tenodesis performed in conjunction with a double-row rotator cuff repair is safe and effective with good clinical and functional results. Among these cases, it has displayed a significant and reliable improvement in patients’ pain and function levels with a 3.5% failure rate. Further benefits include that it does not require any additional anchors/fixation, takes only a few extra minutes to perform, and provides reliable fixation with no additional portals.

Disclaimers:

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Conflicts of interest: Edwin E Spencer Jr MD is a consultant for Smith Nephew and receives funds by teaching visiting surgeons and sales representatives. The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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