Technical Note

All-Arthroscopic Anatomic Length-Tension Biceps Tenodesis With Unicortical Button

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Abstract: The long head of the biceps tendon is a frequent cause of persistent anterior shoulder pain. Biceps tenodesis is a popular choice for surgical management of this pathology, with myriad approach and fixation variations described. We describe an all-arthroscopic suprapectoral biceps tenodesis in the anatomic length-tension relation using a unicortical button. This technique offers an alternative method that provides proper tendon fixation at anatomic length with minimized additional surgical morbidity and postoperative complications.

The long head of the biceps (LHB) tendon is a frequent pain generator in the shoulder that spans a spectrum of pathology including synovitis, groove inflammation, longitudinal tears, subluxation, and superior labrum complex lesions. Treatment for these lesions remains controversial, but tenotomy and tenodesis are the 2 main options. Tenodesis, although more technically complex, offers several advantages over tenotomy, including better cosmesis and a lower incidence of postoperative biceps cramping.

Several techniques for biceps tenodesis have been described across myriad approaches (all-arthroscopic vs axillary mini-open), locations (suprapectoral vs subpectoral), and fixation devices (interference screw vs button suspension vs all-suture fixation), each with its advantages and disadvantages. Regardless of the technique used, studies have shown the importance of restoring the anatomic length-tension relation after tenodesis to enable optimal strength restoration, maintain appropriate cosmesis, and limit increased strain on interference screws seen in over-tensioned repairs.[1,2] Postoperative fractures, rare but extremely morbid complications, have also been shown to occur after tenodesis procedures, particularly among fixation techniques that require a larger cortical aperture and in the denser bone of the proximal humeral diaphysis.[3-6]

We describe an all-arthroscopic suprapectoral biceps tenodesis in the anatomic length-tension relation using a unicortical button. A summary of the surgical technique is presented in Video 1, and a summary of clinical pearls is presented in Table 1.

Surgical Technique

The patient is placed in the lateral decubitus position with the use of a beanbag positioner and lateral traction arm holder (Smith & Nephew, Andover, MA). All bony prominences are padded, and an axillary roll is placed. A standard diagnostic arthroscopy is performed through a posterolateral portal. An anterior portal is established through an outside-in technique, and a probe is introduced into the glenohumeral joint. The superior labrum, biceps tendon anchor, biceps sheath, and rotator cuff tendon insertions are then evaluated, with intra-articular pathology addressed and the biceps tendon left intact for this portion of the procedure (Fig 1).

The arthroscope is moved from the glenohumeral joint into the subacromial space from the posterolateral portal. A complete bursectomy is performed to allow for visualization, and the arthroscope is progressed anteriorly. Once the arthroscope is in the anterior subdeltoid space, a further bursectomy is performed in the area overlying the bicipital groove (Fig 2). An accessory low anterior biceps portal is established with spine needle localization approximated 3 cm distal to the anterolateral

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Table 1. Pearls and Pitfalls of Anatomic Length-Tension Biceps Tenodesis

Pearls
A thorough anterior subdeltoid bursectomy is crucial to obtain adequate visualization of the groove and to provide working space for the tenodesis.
The trajectory for the low anterior accessory biceps portal should anticipate the angle for drilling and insertion of the unicortical biceps tenodesis button.
The surgeon should establish proximal control of the tendon at the level of anticipated fixation with the use of a midsubstance luggage-tag suture backed up by circumferential sutures prior to tenodesis.
Tenotomy should be performed at least 1 cm proximal to the tenodesis site to minimize the risk of tendon slippage.
Pitfalls
The luggage-tag suture must be passed through the midsubstance of the tendon; eccentric tagging increases the risk of suture cutout.
Drilling for the unicortical button not performed at the level of suture placement will affect the length-tension relation of the final tenodesis.

edge of the acromion and maintained with a PassPort cannula (Arthrex, Naples, FL) (Fig 3). To locate the LHB, palpation with the end of a shaver is used to define the lateral bony border of the bicipital groove and the tendon within. The transverse ligament can then be dissected from inferior to superior with a shaver lateral to the tendon to protect medially located neurovascular structures. A Scorpion suture passer (Arthrex) is introduced, and a No. 2 FiberWire (Arthrex) is placed through the midsubstance of the tendon in a luggage-tag configuration (Fig 4). The suture passer is then used to pass one of the free limbs circumferentially around the tendon, and sequential alternating half-hitches secure

Fig 2. With viewing from the posterior portal in the subacromial space and use of an accessory lateral subacromial working portal in a left shoulder, a full subacromial bursectomy is performed and carried anterolaterally down the anterior humerus to complete an anterior subdeltoid bursectomy and locate the long head of the biceps. (Bursa, anterior subdeltoid bursa; SS, supraspinatus tendon.)

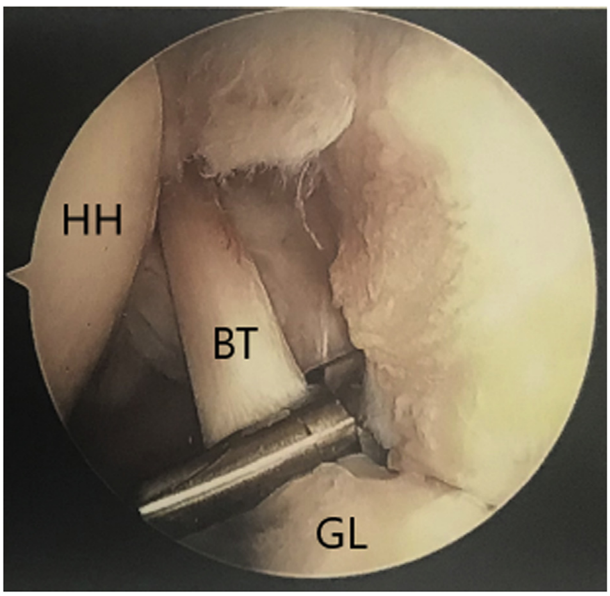

Fig 1. With intra-articular viewing from a standard posterior viewing portal using an anterior rotator interval portal in a left shoulder, a shaver is used to pull the biceps tendon (BT) into the joint, showing inflammation along the biceps tendon sheath. The biceps tendon remains intact at its anchor until tenodesis is completed. (GL, glenoid labrum; HH, humeral head.)

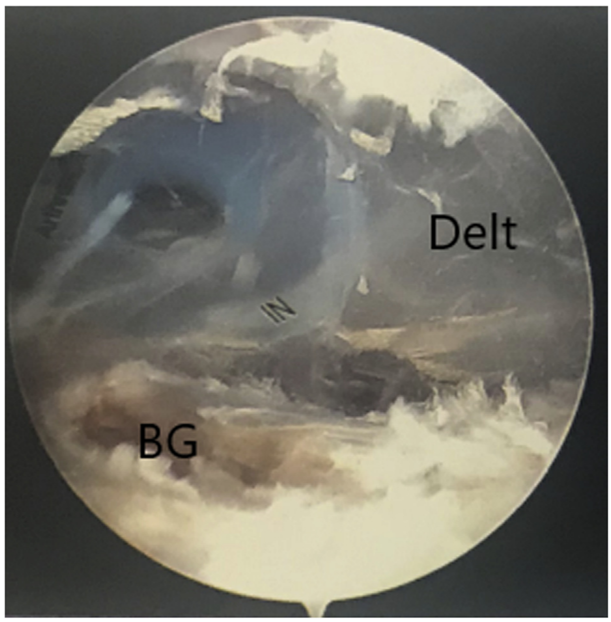

Fig 3. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, an accessory low anterior biceps portal is localized with a spinal needle approximately 3 cm distal to the anterolateral edge of the acromion and then maintained with an appropriately sized PassPort cannula. (BG, bicipital groove; Delt, anterior subdeltoid fascia.)

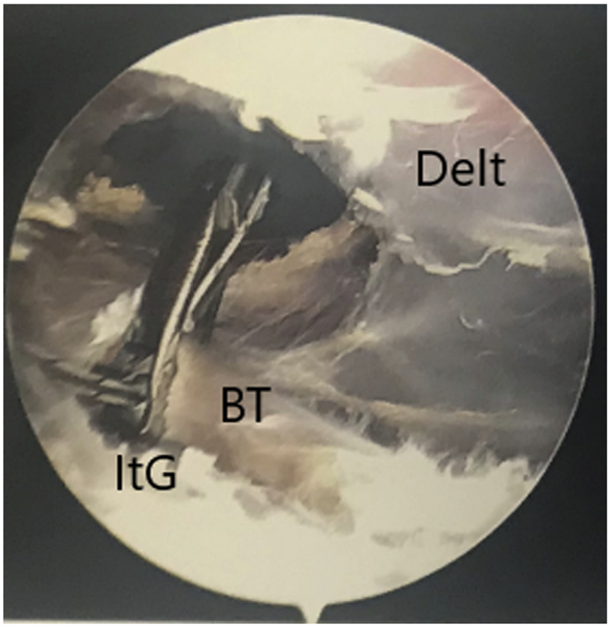

Fig 4. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, by use of the accessory biceps portal, a No. 2 FiberWire is placed through the midsubstance of the long head of the biceps tendon (BT) using a Scorpion suture passer. (Delt, subdeltoid fascia; ItG, intertubercular groove.)

the suture (Fig 5). A footed rasp is used to decorticate the anterior humeral surface and prepare the bed for tenodesis (Fig 6). A 3.2-mm drill pin is then inserted

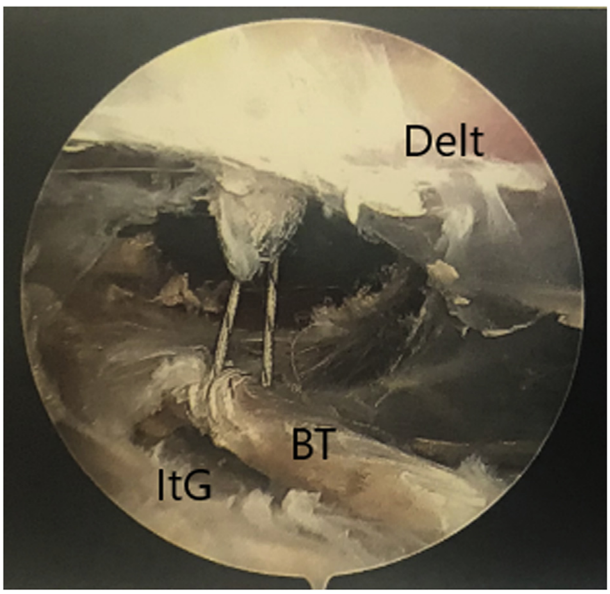

Fig 5. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, by use of the accessory biceps portal, the final suture configuration for the biceps tendon (BT) is shown with a luggage-tag suture through the midsubstance of the tendon, reinforced with a circumferential pass, and secured with alternating half-hitches. (Delt, subdeltoid fascia; ItG, intertubercular groove.)

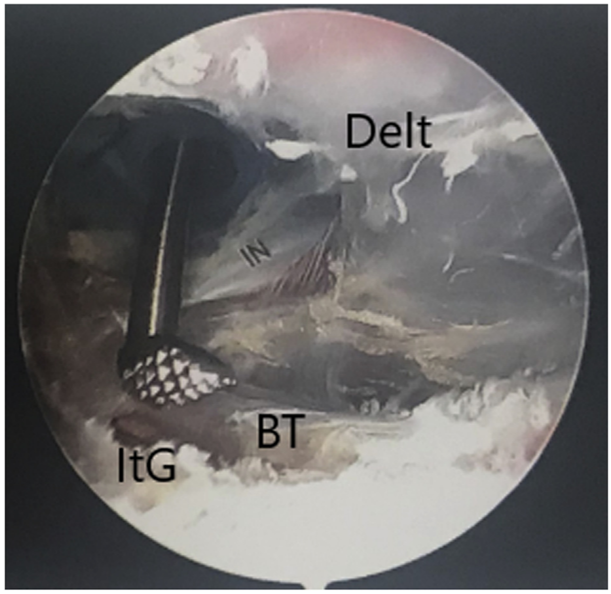

Fig 6. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, by use of the accessory biceps portal, a footed rasp is used to prepare the cortical bed of the intertubercular groove (ItG) to provide an abraded surface to which the post-tenodesis tendon can heal. (BT, biceps tendon; Delt, subdeltoid fascia.)

through the biceps accessory portal, and a unicortical pilot hole is created at the level of the previously passed suture (Fig 7). The free ends of suture are passed through opposing ends of a proximal tenodesis button

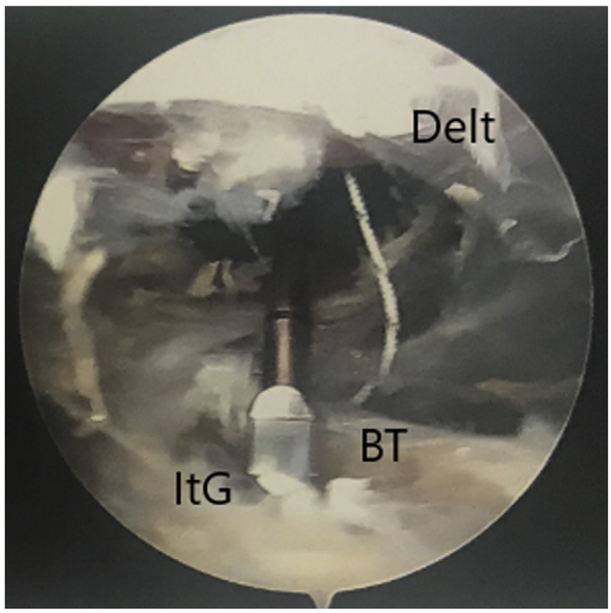

Fig 7. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, by use of the accessory biceps portal, a 3.2-mm drill pin is inserted and a unicortical window is made in the suprapectoral bicipital groove (ItG) adjacent to the level at which the biceps tendon (BT) has been secured with suture. (Delt, subdeltoid fascia.)

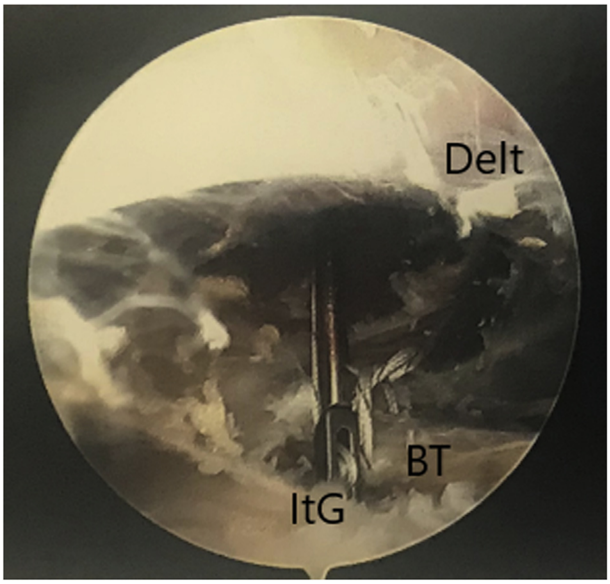

Fig 8. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, by use of the accessory biceps portal, an Arthrex proximal biceps tenodesis button is placed through the 3.2-mm unicortical window into the humeral canal. (BT, biceps tendon; Delt, subdeltoid fascia; ItG, intertubercular groove.)

(Arthrex) that is then positioned in the humeral canal (Fig 8). Once the button is confirmed to have flipped, the free suture limbs are tensioned and secured in anatomic

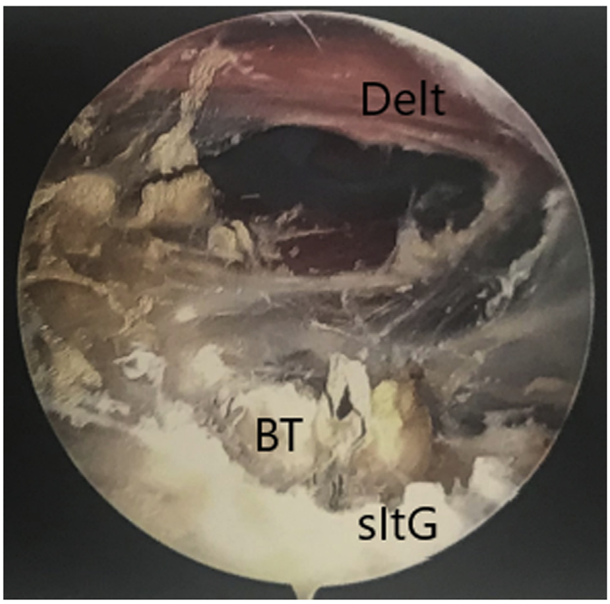

Fig 9. With viewing from the posterior portal in the anterior subdeltoid space in a left shoulder, once the button has passed into the canal and is noted to have flipped, the construct can be secured in place with the use of alternating half-hitches. Through the accessory biceps portal, electrocautery can then be used to detach the remnant tendon superior to the tenodesis site. (BT, biceps tendon; Delt, anterior deltoid; sItG, superior intertubercular groove.)

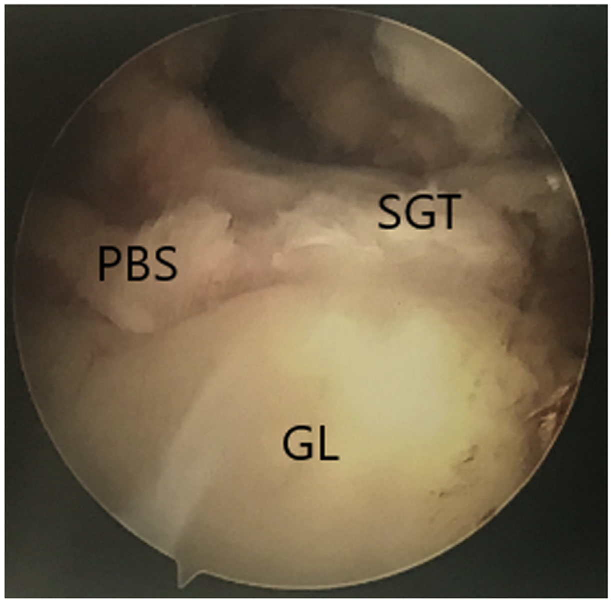

Fig 10. The camera is returned to the glenohumeral joint through the posterior viewing portal in a left shoulder, and electrocautery is used to release the proximal biceps tendon stump (PBS) from its origin on the supraglenoid tubercle (SGT). The free tendon remnant is then removed from the shoulder and discarded. (GL, glenoid.)

position. The tendon is then transected with electrocautery just proximal to the tenodesis site (Fig 9). The arthroscope is replaced in the glenohumeral joint, electrocautery is used to release the biceps tendon off the superior labrum, and the residual proximal biceps is removed (Fig 10).

Discussion

This article describes an all-arthroscopic suprapectoral biceps tenodesis technique. This technique intends to maintain the anatomic length-tension relationship while minimizing the risk of potential postoperative proximal humeral fracture (Table 2).

Table 2. Advantages and Disadvantages of Anatomic Length-Tension Biceps Tenodesis

Advantages
Ensures anatomic length-tension relation is preserved
Theoretical decrease in postoperative fracture risk with smaller metaphyseal cortical window
Tenodesis site anchors into dense metaphyseal bone
Improved cosmesis with minimal incision burden
Minimally invasive
Disadvantages
Technically challenging
Requires return to intra-articular space after further tenodesis
Increased arthroscopic working time leads to further muscle distension and fluid extravasation
No difference in clinical or functional outcomes compared with open subpectoral procedures

Table 3. Risks and Benefits of Anatomic Length-Tension Biceps Tenodesis

Risks
Iatrogenic rotator cuff damage when re-entering intra-articular space
Benefits
Anatomic length-tension relation maintained
Able to remove all tissue from bicipital groove to minimize recurrent anterior shoulder pain postoperatively
No open incisions
Improved cosmesis
Able to perform with standard arthroscopic techniques at same time as other arthroscopic procedures

Maintenance of the biceps length-tension relation remains a crucial yet difficult goal for optimal postoperative outcomes. Complete disruption of the length-tension relation seen after biceps tenotomy, although appropriate for older, lower-demand patients, is associated with several cosmetic and functional consequences. Up to 45% of all patients and 75% of men experience a resultant Popeye deformity after biceps tenotomy, and nearly half experience weakness in elbow flexion. One in 10 patients complains of cramping in the operative extremity, 8% of patients experience persistent anterior shoulder pain, and there is a nearly 4-fold increased risk of Popeye deformity after tenotomy in male patients.[1] The cosmetic and functional implications of complete loss of the biceps length-tension relation highlight the importance of accurately maintaining anatomic biceps length, especially in young, high-demand patients.

An anatomic location for the tenodesis site has significant implications for restoration of the length-tension relation. In an anatomic study, Jarrett et al.[7] showed that the musculotendinous junction of the LHB is on average 3.1 cm proximal to the interior border of the pectoralis major tendon. Suprapectoral tenodesis is advantageous for retaining the appropriate length-tension relation because this suggests subpectoral tenodesis sites would be prone to under-tensioning the muscle. Over-tensioning of the muscle unit also has a significant impact on the strength of the fixation construct and has been shown through biomechanical evaluation to result in both decreased load to failure and an increased incidence of failure through implant pullout.[8] Unlike other techniques that require the length-tension relation to be estimated from anatomic landmarks or techniques that describe temporary tendon suture tagging to maintain length, which can be affected by arm positioning or treatment of other concomitant pathology, this technique ensures anatomic restoration of the length-tension relation. Performing tenodesis of the proximal biceps to the humerus prior to releasing it proximally ensures anatomic positioning, and affixing the tendon to the prepared bed on the humeral cortical surface removes any variations in tensioning that can occur from intraosseous placement of the tendon at the time of tenodesis fixation.

A peri-implant proximal humeral fracture is a rare but morbid complication associated with biceps tenodesis procedures.[5] A database study of over 15,000 tenodeses showed that humeral fractures after biceps tenodesis have an incidence of less than 0.1%, but of the patients in whom this complication does occur, 25% require open reduction—internal fixation of the fracture and 33% do not regain full shoulder range of motion.[6] Erdle et al.[3] described 3 postoperative fractures in patients who underwent subpectoral tenodesis with differing implants performed by different surgeons. The biceps was secured with 8-mm interference screws in 2 patients and with a bicortical biceps button in 1; however, all 3 surgical techniques required cortical apertures greater than 6 mm and resulted in spiral fractures that incorporated the prior defect. Biomechanical evaluation of humeri after tenodesis has corroborated these clinical findings. Beason et al.[9] evaluated the torsion-to-failure limits of humeri that underwent subpectoral tenodesis with 6.25- and 8-mm interference screws versus intact controls. They found a significant decrease in maximum torque loads to failure in the humeri with cortical holes compared with intact specimens, but there was no significant difference between the 6.25- and 8-mm screw sizes. Khalid et al.[4] compared matched humeri after subpectoral tenodesis with 6.25-mm interference screws or a unicortical proximal biceps button through a 3.2-mm drill hole. They found that the unicortical button afforded a higher maximal torque to failure and higher energy absorbed prior to fracture than the 6.25-mm interference screw. De Villiers et al.[10] used fourth-generation composite humeri to evaluate the effect of screw location and found that screws with more distal placement for biceps tenodesis led to decreased maximal torque to failure. It can be hypothesized from these clinical and biomechanical studies that a unicortical button implant placed through a 3.2-mm hole in the dense proximal metaphysis of the suprapectoral biceps minimizes any stress risers seen with larger and more distally placed implants and thereby significantly decreases the risk of this excessively morbid complication.

The described technique requires advanced arthroscopic surgical skills to perform an all-inside biceps tenodesis but confers several benefits to the patient (Table 3). It provides for a true anatomic tenodesis to ensure the proper length-tension relation to the biceps. This technique minimizes the potential risk of postoperative fracture because implant fixation is achieved in the proximal suprapectoral metaphysis through a small, 3.2-mm unicortical window. Patients are provided excellent cosmesis with low additional surgical morbidity and a minimal increase in surgical time. Therefore, this technique is an effective treatment for biceps pathology and a good option for an active, high-demand patient.

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