Technical Note

Mini-Open Subpectoral Biceps Tenodesis Using a Suture Anchor with Bone-Bridge Backup

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Abstract: Pathology of the long head of the biceps tendon is a known cause of anterior shoulder pain. Current surgical management options include tenotomy and tenodesis. Tenodesis can be performed arthroscopically or as an open procedure. Arthroscopic tenodesis typically uses a suprapectoral attachment, which may fail to address tendon pathology in the bicipital groove. Open tenodesis carries iatrogenic risk to neurovascular structures and a fracture risk while drilling, as well as the morbidity of an open procedure. This technique paper describes a mini-open subpectoral approach using a suture anchor and bone bridge backup for dual fixation. Use of a suture anchor instead of an interference screw reduces drill hole diameter reducing the risk of iatrogenic humeral fracture. Dual fixation provides a robust repair which may be of use for athletic patients desiring an accelerated recovery.

Introduction

Pathology of the long head of the biceps tendon (LHBT) is a known cause of anterior shoulder pain. In the 1800s, Monteggia[1] and Soden[2] were among the first to identify and report on the LHBT as a source of shoulder pathology. They were followed in 1936 by Meyer, who described primary LHBT tendinopathy.[3]

As understanding of LHBT pathology has advanced; so too have surgical techniques. In 1990, Patte et al.[4] discovered that spontaneous rupture of the LHBT alleviated pain in patients with massive, irreparable rotator cuff tears. They pioneered arthroscopic tenotomy of the LHBT as an effective procedure for the management of symptomatic LHBT pathology. However, tenotomy impacts the length−tension relationship of the biceps and can result in a Popeye deformity.[5] Furthermore, tenotomy can result in loss of elbow flexion and supination strength as well as fatigue and cramping of the biceps.[5-10] These complications, as well as the development of novel techniques and devices, have contributed to the adoption of biceps tenodesis (BT). Indeed, data from the American Board of Orthopaedic Surgery indicate that the incidence of BT is increasing, outpacing tenotomy.[11]

Current consensus has largely settled on tenotomy and BT as the mainstays of surgical intervention; however, there is currently no gold-standard technique for BT.[12-17] Previous BT technique papers have discussed the use of suture anchors (SA), interference screws, cortical buttons, suture bone bridges (BB), and soft-tissue tenodesis as fixation methods.[18-26] This technique paper is the first to describe a mini-open subpectoral tenodesis with dual fixation using a SA and BB backup.

Surgical Technique (With Video Illustration)

A demonstration of the min-open subpectoral BT with a bone bridge backup is available in Video 1. The advantages and disadvantages of this technique are provided in Table 1. Important pearls and pitfalls are provided in Table 2.

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Table 1. Mini-Open Subpectoral Biceps Tenodesis With Dual Fixation Using a Suture Anchor and Bone-Bridge Backup

Advantages	Disadvantages
• Allows for tensioning of biceps tendon before final suturing • Dual fixation results in a robust repair • Suture anchor and suture bridge require smaller diameter drilling	• Technically challenging • Risk of fracture at drill sites • Theoretical risk of suture bridge bone erosion • Increased operative time • Risk of iatrogenic neurovascular injury • Morbidity of open procedure

Patient Setup

The patient is positioned in the beach-chair position (Fig 1). The bony prominences are well-padded and a tourniquet is applied. The upper extremity is then prepped and draped in the usual sterile fashion.

Shoulder Arthroscopy

A posterior portal is made, and a diagnostic arthroscopy of the glenohumeral joint is performed. Any concomitant shoulder pathology is identified and addressed. To fully examine the LHBT, the operative elbow is extended with rotation and elevation of the shoulder. If the tendon is diseased but not completely ruptured, it is released proximally (Video 1).

Approach to the Bicipital Groove

The bicipital groove is palpated. A 7.5-cm incision line is marked out in the anterior axillary space at the inferior border of the pectoralis major (Fig 2). A #15 blade is used to make the incision. Dissection is performed through the subcutaneous and fascial tissue planes until the inferior border of the pectoralis major is reached. The arm is externally rotated 20°. The pectoralis major is retracted superiorly. The LHBT is palpated in the bicipital groove (Fig 3).

Release of the LHBT

Retractors are placed subperiosteally along the lateral and medial borders of the humerus. Electrocautery is used to release and remove the distal biceps tendon sheath. Right angle forceps are used to release the ruptured LHBT from the groove (Fig 4).

Table 2. Pearls and Pitfalls of this Technique of Mini-Open Subpectoral Biceps Tenodesis With Dual Fixation Using a Suture Anchor and Bone-Bridge Backup

Pearls	Pitfalls
• Externally rotate arm to decrease iatrogenic risk to neurovascular structures	• Technically challenging • Passing material under coracoid threatens musculocutaneous nerve • Theoretical risk of suture eroding through base of coracoid

Fig 1. Intraoperative image of the right shoulder and arm. The patient is positioned in the beach-chair position with a TRIMANO adapter (Arthrex).

Suturing the LHBT

A clamp is applied to the free end of the LHBT. The tendon is whipstitched using a FiberLink suture (Arthrex, Naples, FL). The looped end of the suture is cut to create 3 free tails.

Drilling

Tendon tension for the tenodesis is approximated to the bicipital groove. The bone is prepared for drilling with electrocautery and Cobb elevator. A 5.5-mm reamer is used to drill a unicortical hole at the approximated location in the bicipital groove. The drill site for the BB backup is localized 5 mm superior to the tenodesis hole. The BB hole is drilled unicortically using a 2.4-mm drill.

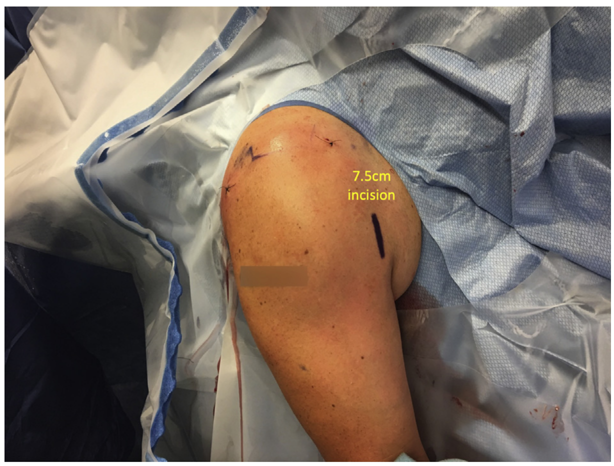

Fig 2. Intraoperative image of the right shoulder and arm with the patient positioned in the beach-chair position. After diagnostic arthroscopy and (if needed) proximal release of the long head of the biceps tendon (LHBT), a 7.5-cm incision line is marked out in the anterior axillary space at the inferior border of the pectoralis major.

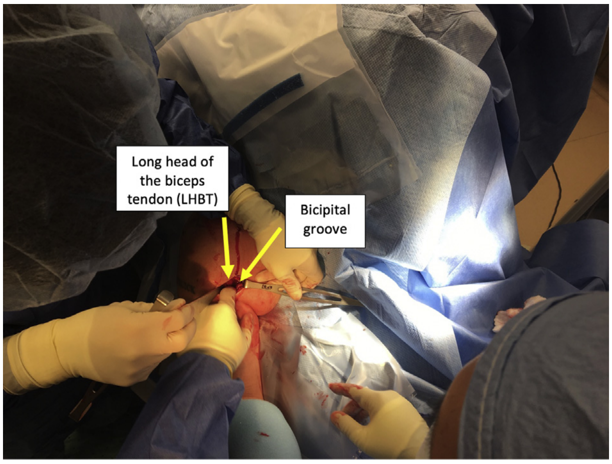

Fig 3. Intraoperative image of the right shoulder and arm with the patient positioned in the beach chair position. After dissection through tissue planes retraction increases the size of the field and allows for exposure of the bicipital groove. The long head of the biceps tendon (LHBT) is palpated in the bicipital groove after exposing the bicipital groove.

Sizing Tendon

The tendon is sized using the sizer on the 5.5-mm SwiveLock anchor (Arthrex) (Fig 5). If the tendon is larger than 6 mm, it may need to be trimmed. The suture tails from the whipstitched tendon are loaded onto the anchor.

Passing Suture

A suture passing flag (Fig 6) is used to shuttle one end of the FiberLink suture in through the 5.5-mm hole and out through the proximal 2.4-mm hole. A nitinol micro suture lasso may be used instead for passing (Fig 7). The second FiberLink suture end is reverse-shuttled in through the 2.4-mm hole and out of the 5.5-mm hole. This results in one suture end exiting from the 2.4-mm hole and another exiting from the 5.5-mm hole (Fig 8).

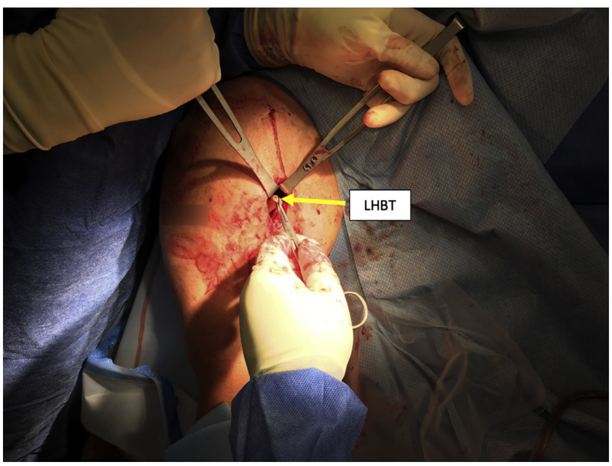

Fig 4. Intraoperative image of the right shoulder and arm from the side with the patient positioned in the beach chair position. The long head of the biceps tendon (LHBT) is released from the bicipital groove using right angle forceps. The LHBT can now be whipstitched using FiberLink suture (Arthrex).

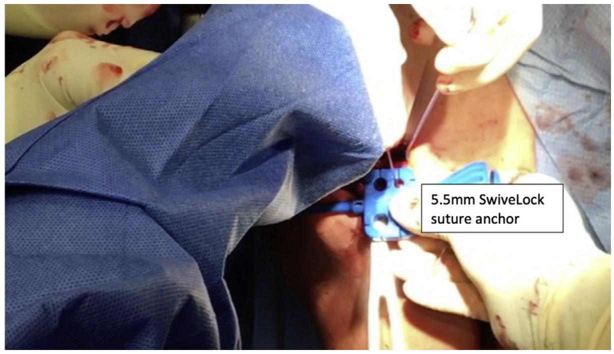

Fig 5. Intraoperative image of the right shoulder and arm with the patient positioned in the beach chair position. The whipstitched long head of the biceps tendon (LHBT) diameter is measured using the sizer on the 5.5 mm SwiveLock suture anchor (Arthrex). The LHBT may be trimmed if required.

Securing the Tenodesis

The 2 suture tails are tensioned to dunk the biceps tendon into the distal 5.5-mm hole. Tension is maintained on the sutures as the anchor is screwed into the 5.5-mm hole to secure the tenodesis. One free suture end is loaded onto a free needle and passed through the tendon at the tenodesis site in the bicipital groove. This is repeated with the other free suture end. The sutures are tied down onto the tendon with a surgeon's knot. The excess suture is cut completing the tenodesis procedure. The arm may be gently flexed and extended at this point to confirm the integrity of the repair.

Postoperative Care

The patient is placed in sling immobilization for 4 weeks. After the first postoperative visit, patients

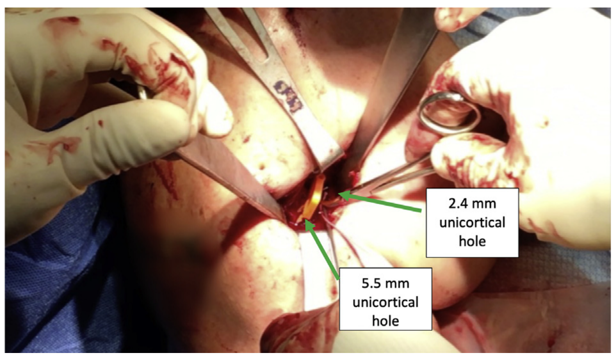

Fig 6. Intraoperative image of the right shoulder and arm with the patient positioned in the beach-chair position. After drilling unicortical holes, a suture passing flag is used to shuttle one end of the FiberLink suture in through the 5.5-mm unicortical hole and out through the proximal 2.4-mm unicortical hole.

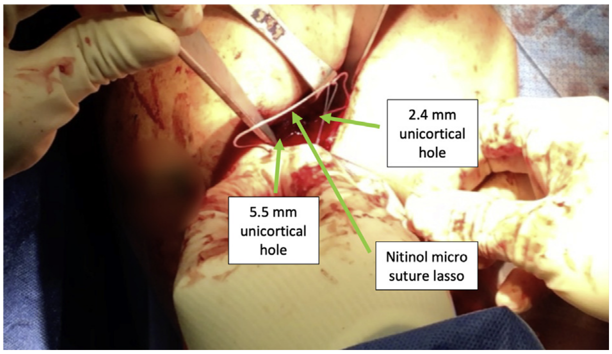

Fig 7. Intraoperative image of the right shoulder and arm with the patient positioned in the beach chair position. A nitinol micro suture lasso also may be used to shuttle suture through the unicortical holes. This can be technically challenging.

begin physical therapy with progression from passive to active-assisted to active non-resisted range of motion. Light biceps strengthening is started at 8 weeks.

Discussion

The LHBT arises from the superior glenoid labrum and the supraglenoid tubercle. It then courses intra-articularly over the head of the humerus until it enters the bicipital groove. The extra-articular portion is stabilized by a capsuloligamentous complex comprised of the coracohumeral ligament, superior glenohumeral ligament, the upper border of the subscapularis, the anterior supraspinatus. This complex forms the "biceps pulley." The extra-articular tendon can be described in 3 zones: (1) articular margin to the distal margin of subscapularis, (2) distal margin of subscapularis to proximal margin of pectoralis major, (3) the subpectoralis region.[27] This distinction is important as extra-articular LHBT lesions in zones 2 and 3 can be missed during shoulder arthroscopy resulting in persistent postoperative pain.[27-29] This is highlighted when considering whether to perform a suprapectoral or subpectoral tenodesis.

Arthroscopic suprapectoral biceps tenodesis (ASPBT) carries advantages. First, it is predominantly an arthroscopic procedure and thus avoids the risks of open surgery.[9,16,26,27,30-32] Furthermore, ASPBT is thought to carry reduced risk of iatrogenic humeral fracture due to a larger humeral width at the tenodesis site.[17,31,33] Overmann et al.[34] reviewed 15,085 BT and reported a humeral fracture incidence of <0.1%. All fractures arose from an open subpectoral biceps tenodesis technique (OSPBT).[34] The authors suggest that drill holes in the humerus act as stress risers which decreases humeral resistance to torsional stress and increases the risk of fracture.[34] Our technique reduces this risk by using SA, which have comparable fixation to conventional interference screws and require a narrower diameter drill.[35] Another advantage of ASPBT is that sites are further away from the brachial plexus and deep brachial artery.[16,31] We address this risk by externally rotating the arm, which has been demonstrated by Dickens et al.[36] to increase the distance between the tenodesis site and the musculocutaneous nerve. Furthermore, Gifford et al.[37] reported that the risk of injuring the musculocutaneous nerve for a mini-OSPBT is minimized with limited and careful medial retraction.

Despite these advantages, some studies report the potential for persistent postoperative pain with ASPBT. Yi et al.[38] reported significant decreases in visual analog scale scores and bicipital groove tenderness at 3 months when comparing OSPBT versus ASPBT but noted no difference at final follow-up. This persistent anterior shoulder pain has led to some authors reporting increased revision rates with ASPBT.[39,40] The LHBT has been found to contain a network of sensory and sympathetic nerve fibres with greater innervation of the proximal tendon.[41] Furthermore, histological analysis by Moon et al.[28] found that 80% of LHBT demonstrated degenerative changes greater than 5 cm distal from the glenoid tubercle. ASPBT may fail to address these proximal lesions as well as underlying bicipital groove pathology thereby resulting in persistent postoperative pain and increased revision rates. However, more recent studies suggest that there is no difference in outcome between ASPBT or OSPBT. In their 2019 review of 598 patients, Hurley et al.[42] found no significant difference in outcomes between ASPBT and OSPBT. Similarly, a 2019 review of 15,527 patients undergoing BT by Forsythe et al.[43] found no significant difference in revision rates between ASPBT and OSPBT

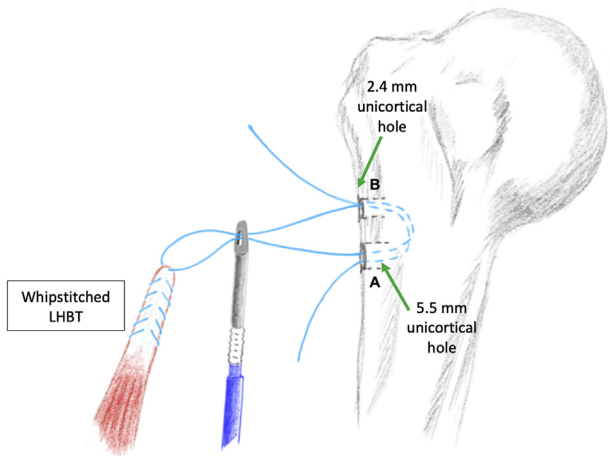

Fig 8. Schematic of the final tenodesis construct. The suture tails from the whipstitched long head of the biceps tendon (LHBT) (left) are passed through the eyelet of the 5.5-mm SwiveLock suture anchor (Arthrex) (middle). One suture tail is passed in through the inferior 5.5-mm hole (A) and out through the superior 2.4-mm hole (B). The other suture tail is passed in through the superior 2.4-mm hole and out through the inferior 5.5-mm hole, creating a suture bridge.

(1.8% vs. 1.9%, $P = .5$). Furthermore, a 2020 meta-analysis by Deng et al.[44] concluded no significant difference in functional ASES and Constant scores and postoperative complications when comparing an open versus arthroscopic BT approach. Although there remains some conflict in the literature regarding the overall clinical differences between an arthroscopic versus open tenodesis approach, a cost-analysis comparing each approach concluded that an open approach was associated with lower costs with an estimates up to $5000 in cost savings.[45]

In their 2018 study Liechti et al.[46] examined whether range of motion restrictions were necessary following a dual-fixation BT with a button and interference screw. Their patients (n = 109) were placed in a sling after surgery, given no postoperative restrictions, and physical therapy was started immediately following surgery.[46] The authors reported a 2.2% revision rate at 3.5 year follow-up, which is comparable with the literature.[46] However, they also reported that functional outcomes were similar to other rehabilitation protocols.[46]

Our technique offers a compromise between strong fixation and minimal humeral drilling providing a robust dual fixation. This is of particular interest when treating highly active patients desiring an accelerated rehabilitation and return to activity.

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