

Subpectoral Biceps Tenodesis Using an All-Suture Anchor



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Abstract: Long head biceps tendon pathology is a substantial contributor to anterior shoulder pain and often requires surgical intervention to offer a return to normal functionality. Surgical treatment options consist of both open and arthroscopic tenodesis or tenotomy of the long head biceps brachii. Several techniques exist for tenodesis and tenotomy of the biceps, although current debate continues regarding which surgical approach is the optimal intervention for symptomatic bicep pathology. In this technical note, we describe a subpectoral biceps tenodesis of the long head bicep tendon using an all-suture anchor. Our technique offers the advantages of using an all-suture anchor that incorporates a self-tensioning mechanism with direct visualization of the tendon during biceps tenodesis and anchor insertion.

The long head of the biceps tendon (LHBT) is an intra-articular structure within the glenohumeral joint, originating from the superior labrum and supraglenoid tubercle that exits the joint at the bicipital groove.¹ LHBT pathology is a common source of anterior shoulder pain and can be functionally debilitating for the patient, necessitating further treatment options that may require surgery.¹ Surgical treatment of LHBT pathology consists of an arthroscopic debridement of the shoulder joint associated with either an open or arthroscopic tenotomy or tenodesis.^{1,2} Both treatment options are viable and can offer satisfactory functional outcomes, although current debate exists over the

optimal surgical approach for symptomatic LHBT pathology.²⁻⁶

Multiple techniques for open and arthroscopic biceps tenodesis have been reported that adequately treat symptomatic LHBT pathology.³⁻⁹ A 2015 study by Werner et al.¹⁰ reported an increasing trend in arthroscopic and open bicep tenodesis incidence, noting a 1.7-fold increase over a 3-year period from 2008 to 2011. The use of an all-suture anchor for biceps tenodesis has been documented in current literature, and a 2018 article by Lansdown et al.⁹ highlights this technique through an arthroscopy-only suprapectoral approach. The purpose of this technical note is to present and highlight the efficacy of subpectoral biceps tenodesis of the LHBT using an all-suture anchor. Our proposed technique has the advantages of using a single suture anchor that incorporates a self-tensioning mechanism. In addition, the surgeon has direct visualization of the LHBT during tenodesis and anchor insertion, ensuring more accuracy in approximation of the length-tension relationship of the biceps.

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Surgical Technique

Preoperative Assessment

Preoperative assessment of biceps pathology consists of a detailed patient history and physical examination. The patient's physical examination was significant for a positive O'Brien's test result and Speed's test result and tenderness to palpation over the bicipital groove. The patient reported minimal improvement with physical

therapy and a cortisone injection of the biceps tendon. Magnetic resonance images were obtained to evaluate the biceps tendon, revealing mild intrasubstance signal of the superior labrum and edema surrounding the LHBT as shown in [Figure 1](#).

Patient Positioning and Preparation

Patient is initially positioned supine and general anesthesia is administered. Because the patient presented with refractory biceps tendinitis of the left shoulder, the patient is placed in the right lateral decubitus position with a lateral wedge. Final patient positioning is shown in [Figure 2](#). All bony prominences are padded appropriately, and the left upper extremity is prepped and draped in the usual sterile fashion. While maintaining sterility, the extremity is suspended with an Arthrex arm holder (Arthrex, Naples, FL) with 10 pounds of weight for traction.

Diagnostic Arthroscopy

Landmarks of the shoulder are identified and marked, including the acromion and coracoid. A no. 11 blade is used to create a standard posterior portal located at the posterolateral corner of the acromion, and a scope sheath is inserted into the glenohumeral space with a blunt trocar. The trocar is removed from the scope sheath, and a 30° 4.0 mm arthroscope is inserted, allowing the physician to initiate the diagnostic arthroscopy. The biceps tendon is visualized from its origin at the superior labrum as it exits the joint at the bicipital groove ([Fig 3](#)). A standard anterior portal is needle localization with an 18-gauge needle through the rotator cuff interval, and a no. 11 blade is used to create the portal. The 18-gauge spinal needle is inserted percutaneously through the anterolateral aspect of the shoulder, and it is used to pierce the LHBT immediately distal to its origin. The stylet of the spinal needle is

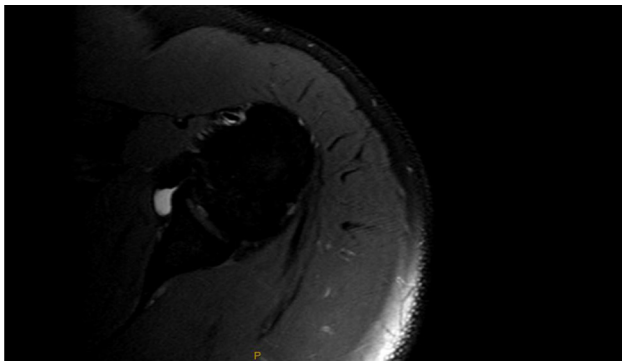


Fig 1. Axial magnetic resonance image (MRI) of the left shoulder. MRI showed a well-seated long head of the biceps tendon within the bicipital groove with moderate edema within the bicipital sheath. Other findings not shown in the figure above included a mild intrasubstance signal and irregularity along the superior labrum.



Fig 2. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position. The left upper extremity suspended with an arm holder on 10 pounds of traction. Before creating the posterior portal, landmarks are identified and marked, including the acromion, coracoid, and approximate location of the posterior portal.

removed while keeping the cannula hub through the biceps tendon. Before tenotomy of the biceps tendon, the biceps tendon is marked with a 0 polydioxanone (PDS) suture that is fed through the cannula hub. A retriever is then used to guide the suture tails out of the anterior portal. Electrocautery is placed through the anterior portal to detach the LHBT from the superior labrum, and the LHBT is visualized as it retracts through the bicipital groove ([Fig 4](#)).

Open Biceps Tenodesis

Once tenotomy of the LHBT is performed, the arthroscopic portion of the case is completed. The left upper extremity is released from suspension and is



Fig 3. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position. Diagnostic arthroscopy of the left shoulder is performed. A 30° arthroscope placed through the posterior portal, and the long head of the biceps tendon is visualized and probed.

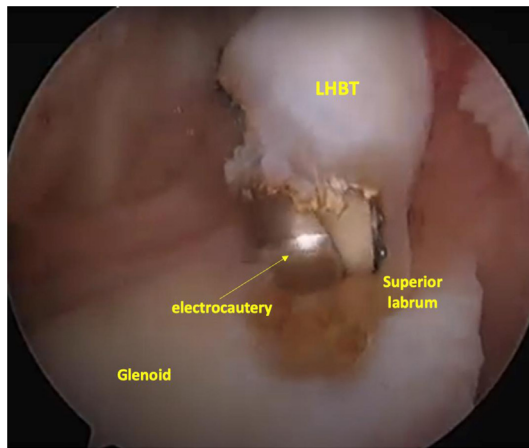


Fig 4. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position. While visualizing the biceps tendon from the posterior portal with the 30° arthroscope, electrocautery is used to detach the long head of the biceps tendon (LHBT) from the superior labrum/supraglenoid tubercle.

supported in extension by an assistant. The bicipital groove is located with palpation, and a no. 15 blade is used to create a 7 mm incision inferior to the pectoralis major at the inferior axillary space (Fig 5). While dissecting through the subcutaneous tissue and fascial tissue, the inferior border of the pectoralis major is identified and blunt retractors are placed medially and laterally, assisting with visualization of the LHBT. A right-angle forceps removes the tendon from the bicipital groove, and the PDS suture is removed from the tendon. While tension is placed on the LHBT with an Allis clamp, the tendon is whipstitched with a

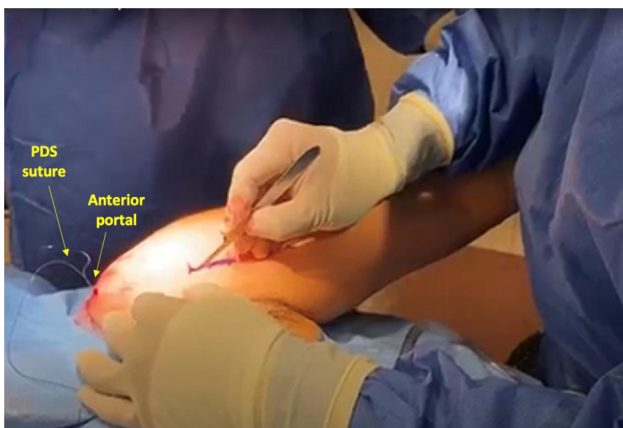


Fig 5. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position, and the left upper extremity is released from the Arthrex arm holder. The arm is placed in extension, and the biceps tendon is palpated in the bicipital groove. A 7.5 cm incision is made at the inferior border of the pectoralis major at the inferior axillary space with a no. 15 blade.

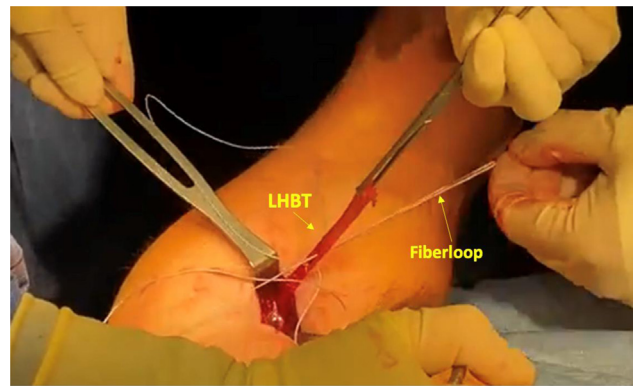


Fig 6. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left upper extremity is supported in extension by an assistant. The long head of the biceps tendon is removed from the bicipital groove, and it is held at its proximal end with an Allis clamp. A FiberLoop suture is used to whipstitch the tendon distal to proximal. The end of the FiberLink is cut, creating 2 free suture tails (not shown).

FiberLoop suture (Arthrex) as shown in Figure 6. The looped portion of the FiberLink is cut, creating 2 free suture tails. The proximal end of the tendon is cut and removed once the length-tension relationship is determined. A drill guide is placed within the bicipital groove, and a gentle tap from a mallet secures the guide's position (Fig 7). A drill is loaded with a 2.6 mm spade tip pin, and the pin is placed in the drill guide to create a unicortical hole (Fig 8). Keeping the guide in place, the all-suture FiberTak anchor is inserted through the drill hole with a mallet (Fig 9). The orange tab on the FiberTak instrument inserter is removed, which allows complete removal of the inserter. The FiberLink sutures from the soft suture anchor are gently tugged, deploying, and securing the anchor (Fig 10). One limb of the whipstitched suture is inserted in one of the looped ends of the FiberLink suture (Fig 11). The opposite end of the same FiberLink suture is pulled, shuttling the whipstitched suture through the soft suture anchor. This is repeated with the other limb of the whipstitched suture. Once completed, both limbs of the whipstitched suture are shuttled through the soft suture anchor. A free needle is used to place one of the sutures through the biceps tendon (Fig 12). Both limbs of the suture are gradually tensioned, and the tendon is visualized as it reduces onto the bicipital groove. A series of knots are placed over the construct, securing the biceps tenodesis, and the excess suture is cut. A drawing of this system is shown in Figure 13.

Final Examination and Postoperative Care

The length-tension relationship is confirmed with flexion and extension of the elbow while palpating the LHBT. Arthroscopic portals are closed with nylon

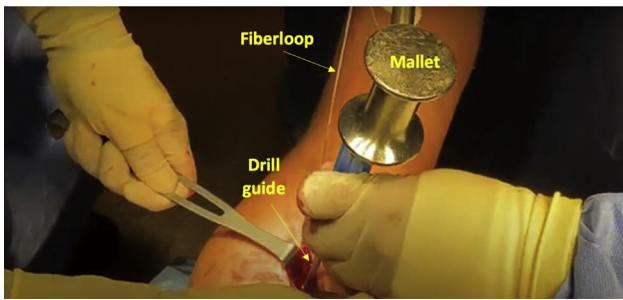


Fig 7. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left extremity is supported in extension by an assistant. The drill guide is positioned within the bicipital groove and a mallet is used to gently tap the guide into position.

sutures, and the axillary incision is closed with a series of Vicryl and Monocryl sutures. Standard dressings are applied, and the patient's arm is placed in an abductor sling and is immobilized for 4 weeks. The patient is instructed to initiate passive range of motion exercises and to avoid active flexion and supination of the elbow, allowing the tenodesis sufficient time to heal. At 4 to 6 weeks, the patient may begin active range of motion exercises and begin progressive strengthening at 8 weeks. The full list of pearls and pitfalls for this technique are available in [Table 1](#).

Discussion

The LHBT is a common source of anterior shoulder pain. LHBT pathologies include inflammation of the tendon or its sheath, traumatic lesions, and instability associated with subscapularis or supraspinatus tendon tears.^{1,11,12}

Conservative management of LHBT-related pain symptoms consists of activity modification, physical therapy, modalities, hydrocortisone injections along the transverse humeral ligament, and nonsteroidal anti-inflammatory medications.^{11,13,14} Surgical treatment is indicated for partial-thickness tears of greater than 50%



Fig 8. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left extremity is supported in extension by an assistant. With the drill guide positioned within the bicipital groove, a drill is used to create a unicortical hole in the humerus.

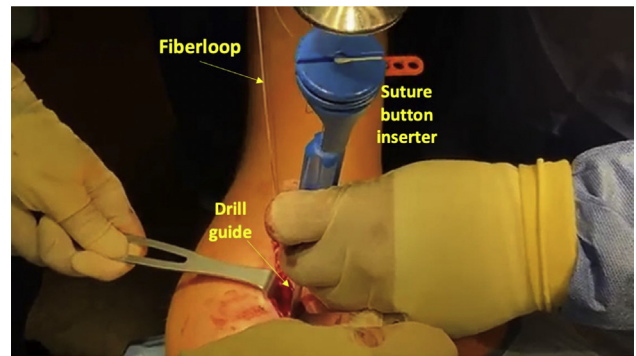


Fig 9. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left extremity is supported in extension by an assistant. With the drill guide positioned within the bicipital groove, the all-suture FiberTak anchor is placed within the unicortical drill hole with a mallet. Once the anchor is placed, the orange tab above the anchor inserter handle is removed, which releases the instrument inserter handle from the anchor.

or failure to resolve symptoms after 3 months of conservative treatment.^{11,15}

Surgical management of LHBT pathologies consists of a tenotomy or tenodesis. During a tenotomy, the LHBT is dissected at its origin at the superior labrum and retracted into the bicipital groove.¹⁶ During a tenodesis, the LHBT is dissected and reattached to the humerus or a shoulder tendon. Tenotomy is a simple, rapid operation requiring no hardware implantation, but is associated with a higher incidence of the "pop-eye" deformity because the LHBT is not re-fixedated after dissection.^{11,14,17-20} Reattachment of the LHBT during tenodesis preserves its length-tension relationship and



Fig 10. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left extremity is supported in extension by an assistant. After the instrument is removed and the all-suture anchor is placed in the unicortical hole within the bicipital groove, the FiberLink suture tails from the device are gently pulled, deploying the anchor beneath the cortical surface of the humerus.

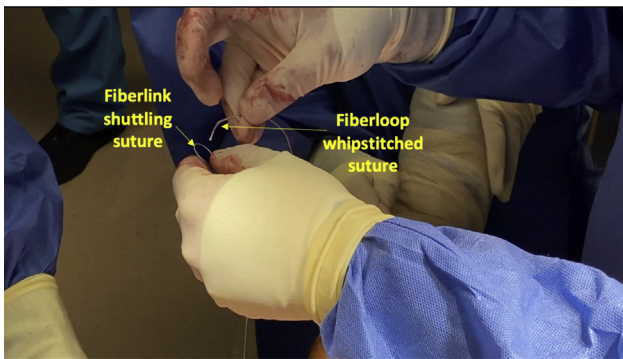


Fig 11. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left extremity is supported in extension by an assistant. One limb of the whipstitched suture is placed through the looped end of the FiberLink suture (shown). The opposite end of the FiberLink suture is pulled, shuttling the one limb of the FiberLoop through the all-suture anchor (not shown). This step is repeated with the other limb of the whipstitched suture and the other shuttling FiberLink suture.

decreases the propensity for postoperative biceps muscle atrophy.^{12,18} Relative to tenotomy, tenodesis is associated with a higher risk of postoperative humeral fractures and intraoperative neurovascular injury. At-risk neurovascular structures include the musculocutaneous nerve, radial nerve, and deep brachial arteries.^{12,21} The risk of injury to these structures, because of their proximity to the tenodesis site, can be mitigated by externally rotating the shoulder during the procedure.²¹ Most comparative studies of tenotomy and tenodesis demonstrate no statistically significant differences in postoperative upper extremity function, range of motion, or strength with forearm supination and elbow flexion.^{17-20,22} Several meta-analyses note a decreased incidence of postoperative pain and cramping in tenodesis patients relative to tenotomy patients.^{11,17}

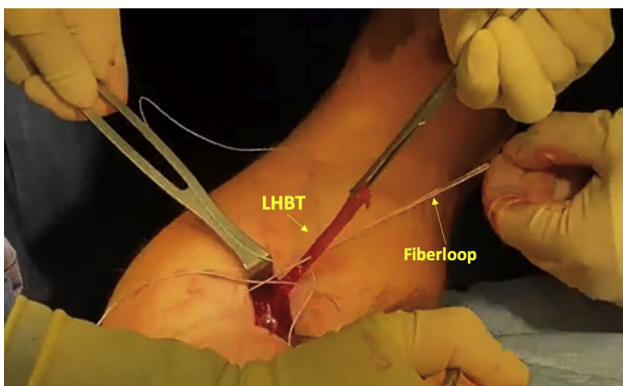


Fig 12. Intraoperative image of the left shoulder and arm with the patient positioned in the right lateral decubitus position and the left extremity is supported in extension by an assistant. Once both limbs of the FiberLoop suture are shuttled through the all-suture anchor, one limb of the suture is placed through the biceps tendon with a free needle.

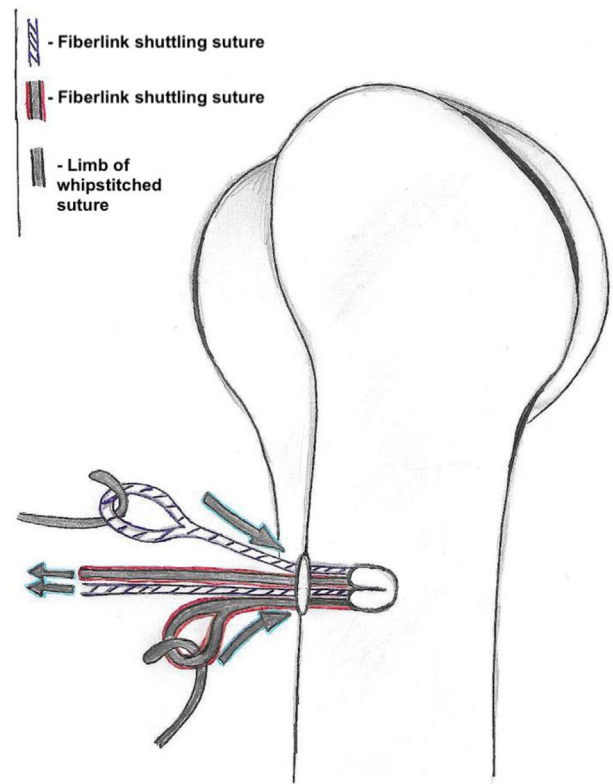


Fig 13. Illustration of the final biceps tenodesis construct. One limb of the whipstitched suture is inserted in one of the looped ends of the FiberLink suture. The opposite end of the same FiberLink suture is pulled, shuttling the whipstitched suture through the anchor. The same process is repeated with the remaining FiberLink suture to ensure that the anchor is set.

Patel et al.¹⁶ outline 4 considerations for surgeons performing tenodesis procedures: method of LHBT fixation, intraosseous versus extraosseous fixation, position of the reattached tendon relative to the pectoralis major, and whether to perform an open or arthroscopic procedure. One common tenodesis technique involves drilling a humeral bone tunnel and securing the LHBT with an interference screw. This approach has a low failure rate reported in the literature, with the risk of potential complications including neurovascular injury, immune reaction to the bioabsorbable screw, and postoperative humeral fracture considered minimal.^{12,21,23,24} A second technique secures the LHBT to the humerus using a cortical button, such as the Arthrex BicepsButton, Königsee Suture Plate, or Arthrex FiberTak Button.^{5,7} This approach is associated with minimal LHBT trauma and a low risk of humeral fracture because a bone tunnel with a small diameter is used.⁷ A third, less-common technique entails pulling the LHBT through 2 or 3 humeral holes drilled underneath the pectoralis tendon. The LHBT is fixated with sutures and without hardware implantation.

Table 1. Pearls and Pitfalls

| Pearls | |
|---|--|
| Before whipstitching the LHBT, visualize the tendon with flexion and extension of the elbow to determine the tension-length relationship, the amount of proximal tendon to remove, and the location of humeral drilling | |
| Have surgical assistant support the upper extremity in extension throughout the procedure | |
| Ensure that anchor is properly seated within unicortical humeral drill hole by firmly tugging on FiberLink suture from the anchor | |
| Place an adequate amount of the whipstitched suture within the looped end of the shuttling suture and pull the opposite end of the same shuttling suture | |
| Pitfalls | |
| Maintain external rotation on the upper extremity to avoid at-risk structures | |
| Avoid tensioning whipstitched limbs until one of the limbs is placed in the LHBT with a free needle | |
| Recheck the tenodesis with gentle flexion and extension of the arm, and determine that the tension-length is well established with palpation and direct visualization of the LHBT | |

LHBT, long head of the biceps tendon.

Advantages of this technique include technical simplicity and a high degree of control over LHBT tension.^{12,15}

Several tenodesis techniques involve fixation of the LHBT to soft-tissue structures in the shoulder. Franceschi et al.²⁵ describe an arthroscopic tenodesis where the LHBT is secured to the rotator cuff using suture anchors. Alternatively, the LHBT may be sutured to the conjoint tendon of the short head of biceps in an arthroscopic or minimally-open procedure.^{26,27} Although tenodesis is typically performed minimally-open or open, arthroscopic techniques using interference screw, suture anchor, and soft-tissue fixation have been documented.²⁶⁻³⁰ Arthroscopic tenodesis is not indicated for all LHBT pathologies; minimally-open or open procedures are necessary if the LHBT is retracted or fully ruptured.^{28,29}

This technical note and accompanying technical video (Video 1) describe an open biceps tenodesis with subpectoral fixation using the Arthrex FiberTak Anchor Implant System. Unlike suprapectoral fixation of the LHBT, subpectoral fixation addresses symptoms associated with extra-articular lesions of the bicipital tunnel.²⁶ Subpectoral fixation carries increased risk of neurovascular injury and humeral fracture relative to suprapectoral fixation, although our technique does not use interference screws, which are often associated with humeral fractures.²⁶ Although considered more invasive, an open tenodesis allows for more direct visualization of the LHBT and button placement than an arthroscopic procedure. Our technique attaches the LHBT to the proximal humerus using an all-suture anchor, decreasing the risks of osteolysis, chondrolysis, anchor drilling, and fatigue fractures that may be associated with traditional suture anchors.³¹⁻³³

Finally, LHBT tension is adjusted using a tension-slide technique, which provides a higher degree of control over the tension than interference screw fixation.

This surgical technique carries minimal risk of LHBT trauma but is considered complex and associated with several potential pitfalls. The unicortical hole must be placed in the center of the proximal humerus and drilled perpendicular to the humeral periosteum to mitigate risk of postoperative humeral fracture. This procedure also carries a higher risk of wound complications, higher reoperation, and nerve injury rates after surgery than a tenotomy or arthroscopic tenodesis.^{34,35} The FiberTak anchor and drill guide are peel-packed and built for single usage, rendering this technique more expensive than procedures without implanted hardware. Finally, the postoperative rehabilitation of 6 weeks in a stable sling with restrictions on active elbow flexion is longer than the rehabilitation required after tenotomy.^{36,37} A complete list of this surgical technique's advantages and disadvantages is included in Table 2.

To our knowledge, this technical note is the first to describe an open biceps tenodesis with subpectoral fixation using the Arthrex FiberTak Anchor Implant System. This technique minimizes risk of intraoperative trauma to the LHBT and postoperative loss of upper extremity function. We recommend this procedure for treatment of all LHBT pathologies.

Table 2. Advantages and Disadvantages

| Advantages | |
|--|--|
| Application of an all-suture anchor eliminates risks and adverse effects associated with traditional suture anchors | |
| Reduced risk of "pop-eye" deformity in the operative extremity with biceps tenodesis approach compared to biceps tenotomy | |
| Tension length relationship adequately restored with tenodesis of LHBT thus reduced risk of forearm supination deficit | |
| Postoperative rehabilitation includes 6 weeks of the operative extremity non-weightbearing in a sling, thus decreasing injury and concomitant shoulder pathology after surgery | |
| An open biceps tenodesis offers direct visualization of the LHBT during tenodesis and anchor insertion compared to a more limited visual working space inherent in the arthroscopic tenodesis approach | |
| Disadvantages | |
| Technically challenging. Because 2 FiberLink shuttling sutures are involved for each whipstitched limb, suture management is crucial for proper shuttling | |
| Open biceps tenodesis is more costly compared to alternative approaches (i.e., tenotomy, arthroscopic tenodesis) | |
| Postoperative recovery period for a tenodesis is longer and involves limiting active flexion and supination. Recovery for a tenotomy has fewer restrictions and is more convenient for most patients | |

LHBT, long head biceps tendon.

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