Technical Note

Arthroscopic Subpectoral Tenodesis of the Long Head of the Biceps Brachii

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Abstract: The long head of the biceps brachii is a common pain generator in the shoulder that is often managed surgically with tenotomy or tenodesis. The clinical outcomes after tenotomy and tenodesis are comparable. However, tenodesis is preferred in the active population owing to complications associated with tenotomy, including cosmetic deformity, early fatigue, and cramping. Controversy surrounds both the approach and location of tenodesis. Both open and arthroscopic techniques have been described. An arthroscopic approach is used for tenodesis within the intertubercular groove between the humeral head articular margin and superior border of the pectoralis major but has the drawback of pathologic tendon retained in the groove. An open approach is generally reserved for subpectoral tenodesis, which has the advantage of no retained pathologic tendon but has the drawbacks of an open approach. We describe an all-arthroscopic technique for subpectoral tenodesis of the long head of the biceps brachii at the lower border of the pectoralis major.

Tendinopathy of the long head of the biceps brachii (LHB) is a common source of anterior shoulder pain.[1] Both LHB tenotomy and tenodesis produce good clinical outcomes, but there is concern over cosmetic deformity, early fatigue, cramping, and lower load to tendon failure after tenotomy compared with tenodesis.[2-5] For these reasons, tenodesis is often preferred in the active population.[6]

Controversy surrounds the surgical approach and location of LHB tenodesis. Both open and arthroscopic approaches exist and have associated benefits and drawbacks. An arthroscopic approach with proximal tenodesis has a lower risk of wound complications and nerve injury than an open approach.[7] However, LHB tenodesis at the articular margin of the humeral head may leave distal pathology present with associated pain.[8,9] An open approach is less technically demanding, has equivalent outcomes to an arthroscopic approach, can be performed in revision settings, and is classically performed in a subpectoral manner, which removes the whole tendon.[10,11] However, an open approach has a higher rate of wound complications and requires conversion to an open incision when most concomitant procedures completed with LHB tenodesis are performed arthroscopically.[7] Recent reports have described all-arthroscopic LHB tenodesis near the superior border of the pectoralis major (PM) tendon, but these techniques still leave 2 to 4.5 cm of LHB tendon (LHBT) present.[12,13] We describe an all-arthroscopic technique for subpectoral LHB tenodesis at the musculotendinous junction (MTJ) using suture anchor fixation to remove the whole tendon while maintaining a minimally invasive approach (Video 1).

Surgical Technique

Preoperative Workup

The workup for shoulder pain associated with LHBT pathology includes a detailed history, physical examination, and radiographs. A diagnostic injection to confirm the pain source is useful. Magnetic resonance imaging is indicated to identify abnormalities of the LHBT and commonly associated soft-tissue injuries such as rotator cuff pathology, subacromial bursitis, and superior labral pathology. If nonoperative management including physical therapy, oral analgesics, and injections is exhausted, then surgical management is indicated.

Surgical Positioning

After a general anesthetic is administered, an examination under anesthesia is completed. The patient is

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the positioned in the lateral decubitus position supported by a bean bag that can be deflated. The arm is placed in abduction and longitudinal traction using a 3-point shoulder distraction system (STAR Sleeve [AR-1600M]; Arthrex, Naples, FL). Standard posterior and anterosuperior (AS) portals are established in the usual fashion.[14]

Diagnostic Arthroscopy, LHB Tenotomy, and Concurrent Procedures

Diagnostic arthroscopy is performed. Preoperative imaging is correlated with intraoperative findings, specifically LHBT and associated soft-tissue pathology (Fig 1). With viewing from the posterior portal, the LHBT is cut at its proximal insertion using a radiofrequency ablator through the AS portal. The arthroscope is reestablished in the subacromial space, and a lateral working portal is placed under direct visualization by an outside-in technique. Concomitant arthroscopic procedures are completed using preferred techniques.

Reverse Field View and LHBT Mobilization

The arthroscope is placed into the subdeltoid space through the lateral portal. The viewing field is "reversed" to look down the anterolateral humeral shaft (Fig 2).[12] A shaver is placed in the AS portal and used to open the potential space between the humerus and overlying deltoid. The LHBT sheath is located on the medial aspect of the anterolateral humerus proximal to the upper border of the PM tendon. The LHBT can be differentiated from the medially located conjoined tendon by the inability to pass a shaver under the LHBT within its sheath while a shaver can easily pass under the conjoined tendon. A radiofrequency ablator is used to open the LHBT sheath to facilitate LHBT delivery into the subdeltoid space and separate it from the sheath (Fig 3). An arthroscopic retriever (KingFisher; Arthrex) is placed on the proximal cut end of the LHBT through the AS portal to provide tension to the tendon.

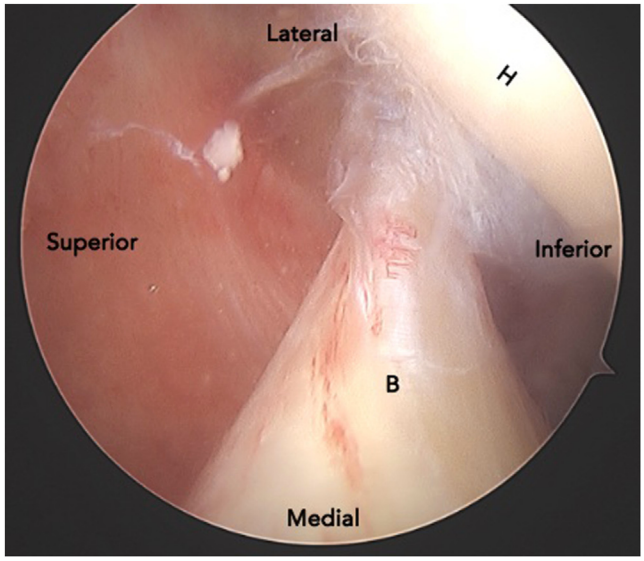

Fig 1. View from posterior portal of right shoulder in lateral decubitus position showing degeneration of long head of biceps brachii (B). (H, humeral head.)

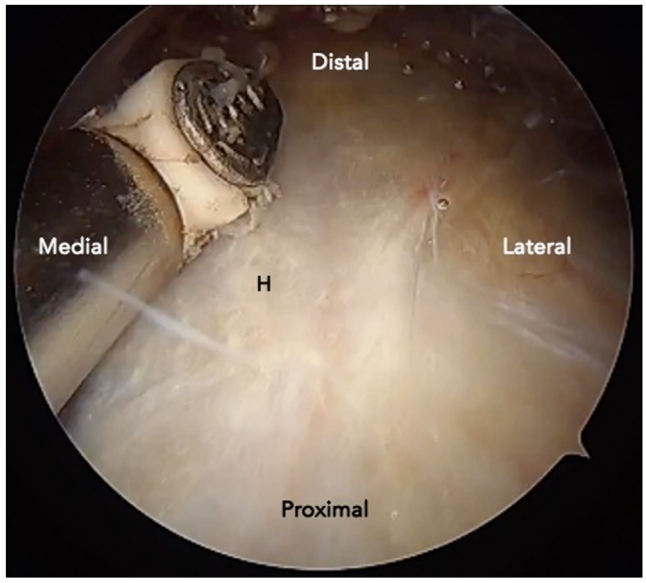

Fig 2. Reverse field view from lateral portal of right shoulder in lateral decubitus position. The arthroscope is placed in the subdeltoid space and oriented distally along the proximal humeral shaft (H).

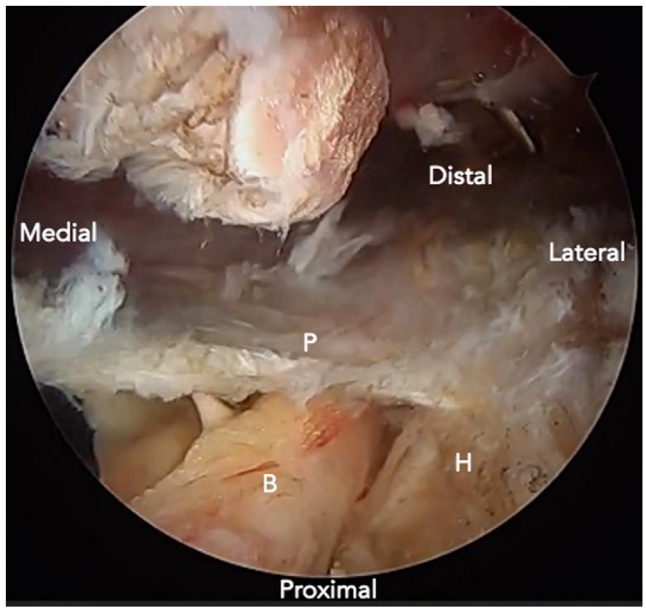

Fig 3. Reverse field view from lateral portal of right shoulder in lateral decubitus position. The long head of the biceps brachii sheath has been opened, and the tendon (B) is exposed. The tendon lies adjacent and medial to the humeral shaft (H) and deep to the upper border of the pectoralis major tendon (P).

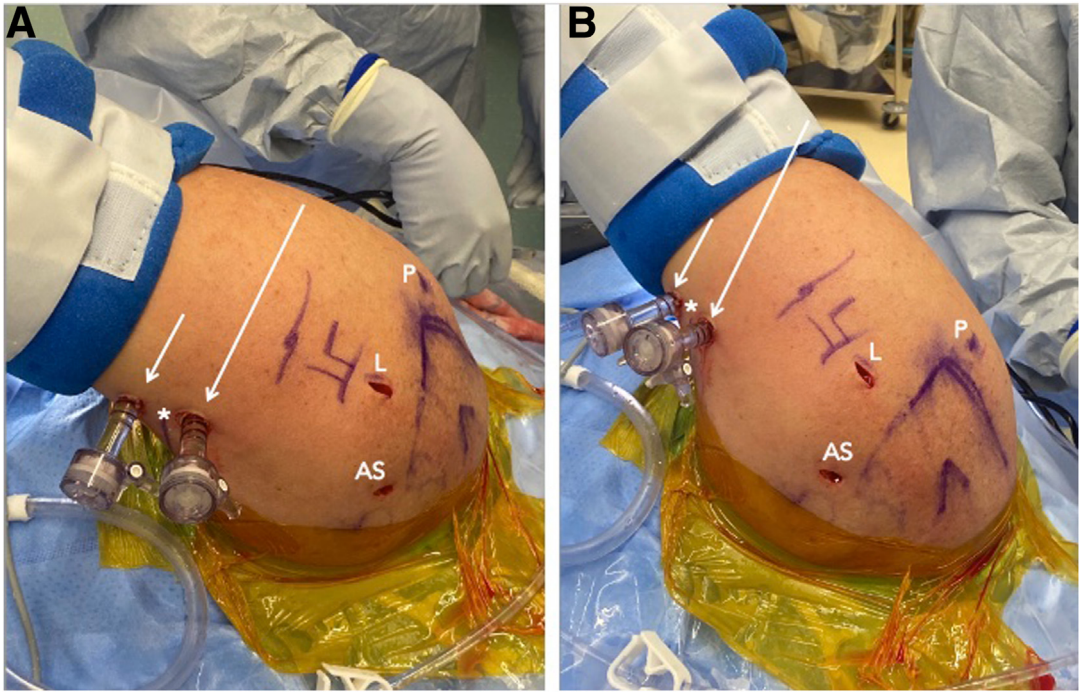

Fig 4. Right shoulder in lateral decubitus position during arthroscopy viewed while facing patient (A) and from patient's head (B). The proximal subpectoral accessory portal (long arrows) and distal subpectoral accessory portal (short arrows) are visible. The asterisks highlight a line drawn parallel to the lower border of the pectoralis major tendon, and the subpectoral accessory portals are staggered above and below this line. (AS, anterosuperior portal; L, lateral portal; P, posterior portal.)

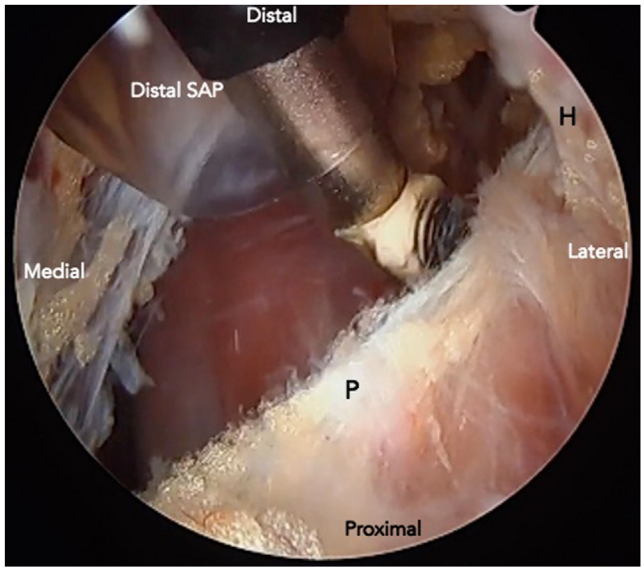

Fig 5. View from proximal subpectoral accessory portal of right shoulder in lateral decubitus position. A cannula is placed through the distal subpectoral portal (SAP). The proximal SAP is proximal to the lower border of the pectoralis major tendon (P), whereas the distal SAP is distal to the lower border of the pectoralis major tendon. The humeral shaft (H) is adjacent to the long head of the biceps brachii (not shown), which is deep to the pectoralis major tendon.

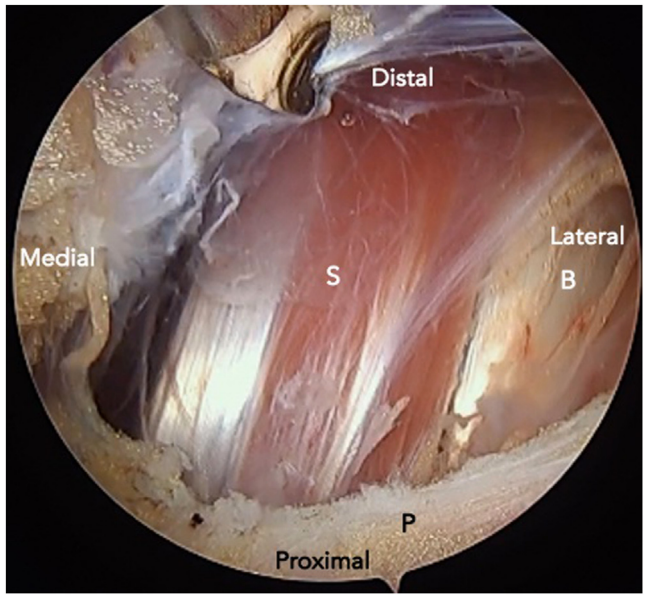

Fig 6. View from proximal subpectoral accessory portal of right shoulder in lateral decubitus position. The radiofrequency ablator is in the distal subpectoral accessory portal. The long head (B) and short head (S) of the biceps brachii are visualized adjacent to but distinct from each other and deep to the lower border of the pectoralis major tendon (P).

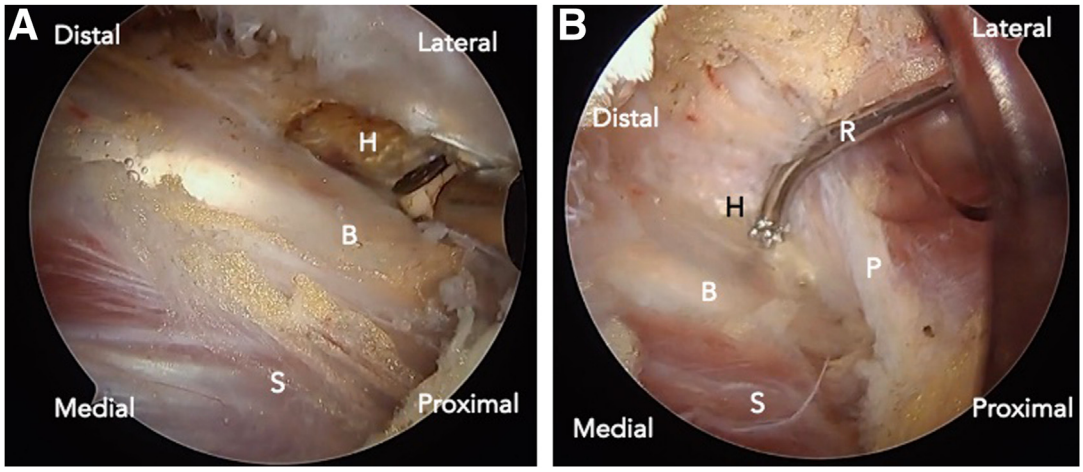

Fig 7. View from distal subpectoral accessory portal of right shoulder in lateral decubitus position. (A) The radiofrequency ablator, located in the proximal accessory portal, retracts the lower border of the pectoralis major tendon and prepares the suture anchor insertion site on the humeral shaft (H) for eventual tenodesis. The long head of the biceps brachii (B) is adjacent and medial to the humerus, and the short head of the biceps brachii (S) is adjacent and medial to the long head. (B) The rasp (R) is introduced through the cannula of the proximal subpectoral accessory portal for biological preparation of the tenodesis site on the humeral shaft (H). (P, pectoralis major tendon.)

Creation of Subpectoral Accessory Portals

The proximal humeral shaft is followed distally with the arthroscope and shaver. The PM tendon is 50 mm wide, and the MTJ of the LHB is located deep to and midway along the PM tendon width.[15] A subpectoral accessory portal (SAP) is created just superior to the lower PM tendon border and lateral to the deltopectoral interval using an outside-in technique (Fig 4). A second SAP is created just inferior to the lower PM tendon border and medial to the deltopectoral interval using an outside-in technique (Fig 5). The surgeon should avoid placing either portal directly through the deltopectoral interval to avoid the cephalic vein. The lower border of the PM tendon, LHBT without its associated sheath, and

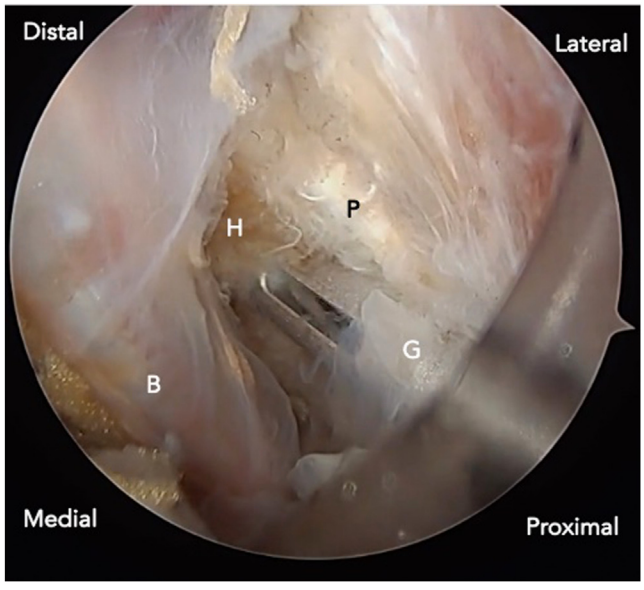

Fig 8. View from distal subpectoral accessory portal of right shoulder in lateral decubitus position. A 1.8-mm drill guide (G) is placed through the proximal subpectoral accessory portal and retracts the lower border of the pectoralis major tendon (P), and a pilot hole is drilled in the humeral shaft (H) for anchor placement. The anchor is placed adjacent to the long head of the biceps (B) tenodesis site.

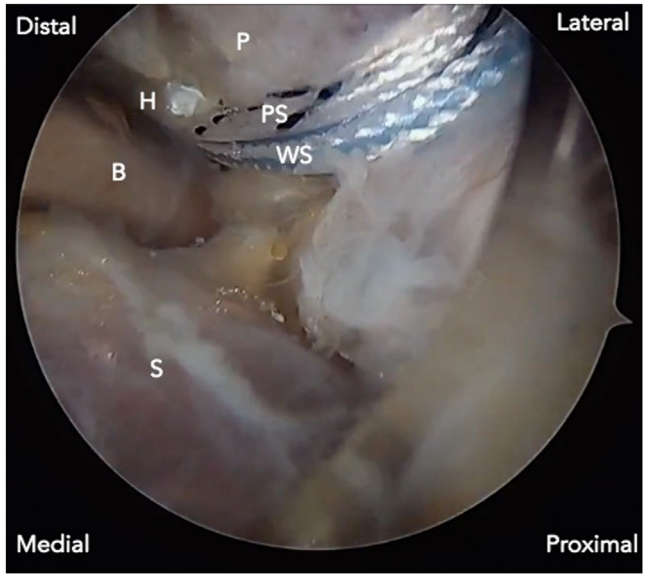

Fig 9. View from distal subpectoral accessory portal of right shoulder in lateral decubitus position. The suture anchor is placed in the humeral shaft (H) at the level of the long head of the biceps brachii (B) tenodesis, lateral to the short head of the biceps brachii (S). The black-and-white "passing stitch" (PS) and blue-and-white "working stitch" (WS) retracts the lower border of the pectoralis major tendon (P) and exit the lateral portal.

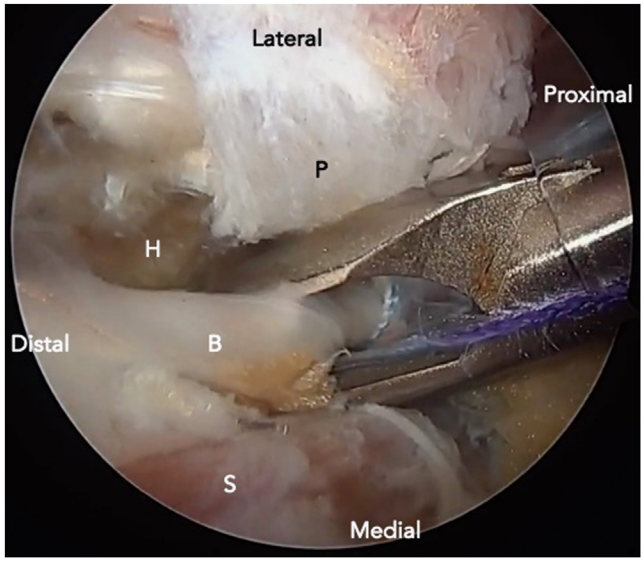

Fig 10. View from distal subpectoral accessory portal of right shoulder in lateral decubitus position. An arthroscopic suture passer retracts the lower border of the pectoralis major tendon (P), and 2 loops of the blue working suture are passed through the long head of the biceps (B) at different tendon depths in preparation for tenodesis at the previously prepared location on the humerus (H). The short head of the biceps brachii (S) remains medial and away from the tenodesis site.

separate short head of the biceps brachii medial to the LHBT should be visible from either SAP (Fig 6). The arthroscopic retriever on the LHBT stump can be pulled

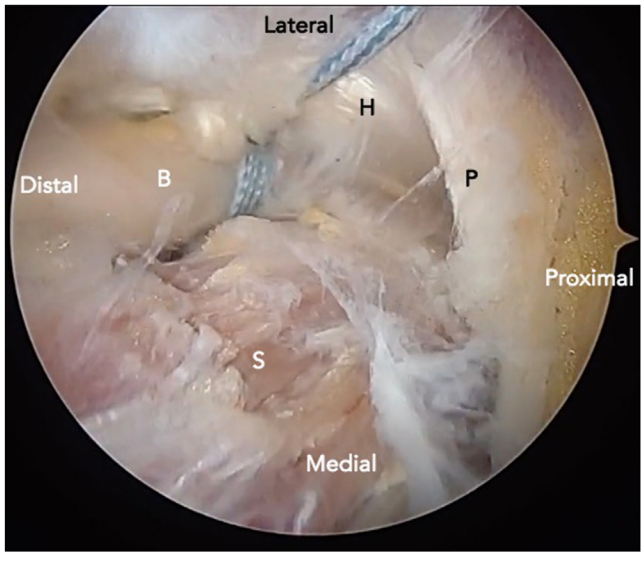

Fig 11. View from distal subpectoral accessory portal of right shoulder in lateral decubitus position. The blue working stitch is deployed through the suture anchor, and the knotless mechanism is tightened to cinch the long head of the biceps brachii (B) down to the tenodesis site on the humerus (H). The tenodesis is completed at or just proximal to the lower border of the pectoralis major tendon (P) and lateral to the short head of the biceps brachii (S).

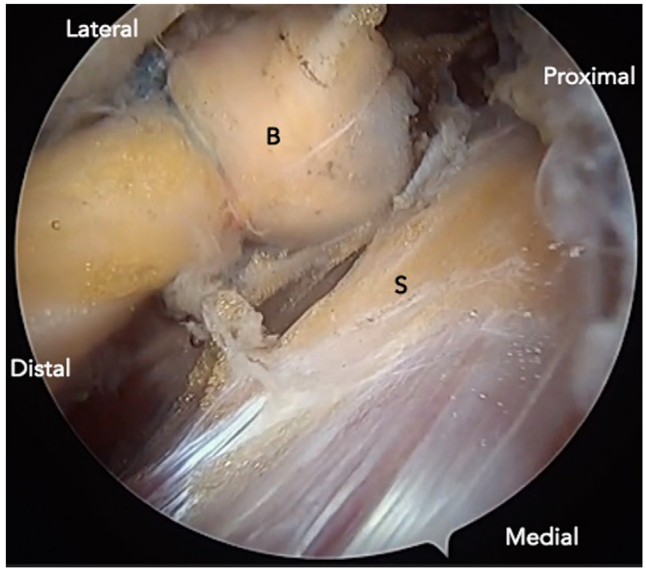

Fig 12. View from distal subpectoral accessory portal of right shoulder in lateral decubitus position. Tenodesis of the long head of the biceps brachii (B) is complete. The short head of the biceps brachii (S) remains medial and free from tenodesis.

to confirm its presence and separation of the LHBT from the short head. Two 7-mm cannulas are placed through the proximal SAP and distal SAP.

LHBT Control and Suture Anchor Placement

With the arthroscope in the distal SAP, the cortical bone proximal to the lower border of the PM tendon within the bicipital groove is biologically prepared (Fig 7). A 1.8-mm knotless suture anchor (FiberTak; Arthrex) is drilled and inserted at this location through the proximal SAP (Figs 8 and 9).

LHB Fixation and Excision

An arthroscopic grasper through the lateral portal retrieves the white passing sutures from the anchor. The blue working suture limb is passed twice in a figure-of-8 fashion at different depths through the LHBT at or just proximal to the MTJ via a suture passer (Scorpion; Arthrex) through the proximal SAP (Fig 10). A grasper through the proximal SAP retrieves the white passing suture limbs from the lateral portal. The blue working suture is placed through the loop of the white passing suture and delivered through the anchor to deploy the knotless mechanism. The LHBT is cinched down to bone, and excess suture is cut with an arthroscopic suture cutter (Fig 11). The LHBT is cut 5 mm proximal to the suture anchor via a radiofrequency ablator (Fig 12). The arthroscopic retriever should now remove the cut LHBT stump through the AS portal, along with the cannula. The excised LHBT will range from 80 to 100 mm (Fig 13).

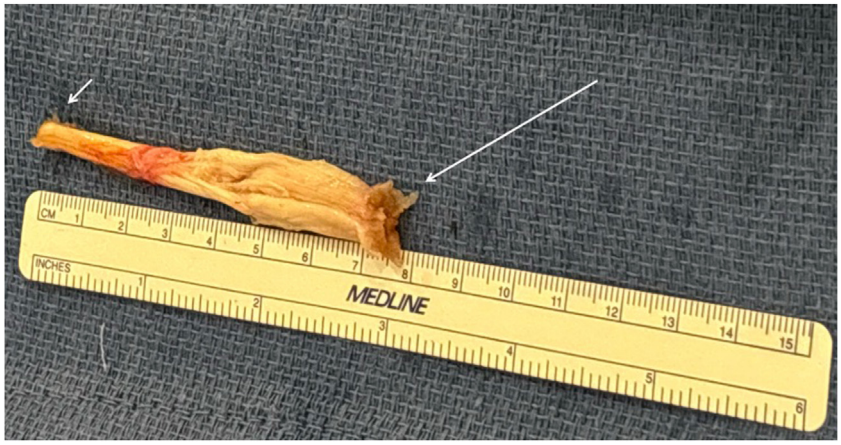

Fig 13. The long head of the biceps brachii tendon will range from 80 to 100 mm and is excised from the shoulder joint. The distal insertion (short arrow) and proximal insertion (long arrow) are indicated.

Rehabilitation Protocol

The rehabilitation protocol is dictated by the concomitant procedures completed. If an isolated tenodesis is performed, passive range of motion may begin immediately postoperatively, and progressive active range of motion may begin at 2 weeks, with active elbow flexion limited to "a cup of coffee" resistance until 6 weeks postoperatively. Full activity as tolerated may resume at 8 weeks postoperatively.

Table 1. Pearls and Pitfalls of Arthroscopic Subpectoral Tenodesis of Long Head of Biceps Brachii

Pearls	Pitfalls
The surgeon should clearly differentiate between the long and short heads of the biceps brachii at the upper and lower borders of the pectoralis major tendon by placing an arthroscopic grasper on the cut proximal insertion of the long head.	Failure to differentiate between the long and short heads of the biceps brachii may result in inappropriate tenodesis of the short head or neurovascular injury.
A shaver or ablator should be bluntly used to open the potential space in the subdeltoid region with use of the reverse field view.	Aggressive debridement of the deltoid fascia will result in early swelling and loss of visualization in the subdeltoid space.
With a marker, the surgeon should draw an extension of the lower border of the pectoralis major tendon on the anterior arm and place 1 SAP proximal and 1 SAP distal to the line using an outside-in technique.	Attempting SAP placement before clearly visualizing the lower border of the pectoralis major tendon insertion on the humerus will result in difficulty with accurate portal placement.
After deployment of the suture anchor knotless mechanism, the surgeon should cinch the long head of the biceps tendon down slowly and should correct any undesired loops of the working stitch to avoid submaximal tenodesis fixation strength.	Cutting the excess long head of the biceps tendon too close to the suture anchor leaves the tenodesis fixation at risk of failing over time. To avoid this, the surgeon should cut the tendon at least 5 mm proximal to the suture anchor.

SAP, subpectoral accessory portal.

Discussion

The optimal surgical approach and location of LHB tenodesis is unknown. Although an arthroscopic approach minimizes the complications associated with

Table 2. Advantages and Disadvantages of Common Fixation Strategies for Long Head of Biceps Tenodesis

	Suprapectoral	Subpectoral
Arthroscopic		
Advantages	May be faster in experienced hands Lower risk of wound complications or neurovascular injury	Lower theoretical risk of wound complications or neurovascular injury Removes whole tendon
Disadvantages	Does not completely remove pathologic tendon	Recently developed technique with potential for learning curve May be difficult in patients with large soft-tissue envelope
Open		
Advantages	Technically easier	Technically easier Removes whole tendon
Disadvantages	Must split deltoid Risk to axillary nerve Higher risk of wound complications May leave some pathologic tendon in situ	Higher risk of neurovascular injury and wound complications

an open approach, it historically does not completely address pathology at the distal aspect of the LHBT. The bicipital tunnel was previously separated into zones based on anatomic location and presence or absence of synovium: Zone 1 is defined as the articular margin to the distal subscapularis tendon; zone 2, the distal subscapularis tendon to the proximal PM tendon; and zone 3, the subpectoral region.[16] Taylor et al.[16] theorized that the superior border of the PM tendon may be a common location of pathology because it forms a significant bottleneck at the transition from zone 2 to zone 3. This is the first arthroscopic technique to describe a tenodesis distal to the zone 2—to—zone 3 transition to ensure complete removal of all LHBT pathology.

This report describes the rationale, technique, and limitations of arthroscopic subpectoral LHB tenodesis (Table 1). Benefits include an all-arthroscopic approach, which may be ideal in the context of commonly associated rotator cuff surgery, and complete excision of the LHBT (Table 2). Limitations include the initial learning curve, unfamiliar arthroscopic anatomy, and potential difficulty in visualizing the lower border of the PM tendon in large patients. Clinical studies are necessary to analyze the clinical outcomes and complications of the reported technique of arthroscopic subpectoral LHB tenodesis.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: J.M.T. reports a consulting or advisory relationship with Arthrex and DePuy Synthes Mitek Sports Medicine and reports board membership with Arthroscopy Association of North America. The other author (A.J.H.) declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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