Technical Note

Arthroscopic Tenodesis of the Long Head Biceps Tendon Using a Double Lasso-Loop Suture Anchor Configuration

Alexander Beletsky, B.A., Jourdan M. Cancienne, M.D., Timothy Leroux, M.D., Brandon J. Manderle, M.D., Jorge Chahla, M.D., Ph.D., and Nikhil N. Verma, M.D.

Abstract: Multiple different techniques exist for performing a biceps tenodesis, and the literature has yet to define a particular technique as superior with respect to outcomes. Factors as the center of various clinical and biomechanical studies include analyzing arthroscopic versus open techniques, optimal fixation sites, and the use specific fixation devices (i.e., anchor, screw). This article details an all-arthroscopic approach for proximal tenodesis of the long head of the biceps tendon (LHBT) using a 2-portal method in a minimally invasive manner. Optimal biomechanical fixation of the LHBT is achieve by using 2 suture anchors in the creation of a dual lasso-loop configuration at the level of the bicipital groove. Technical pearls with respect to optimal arthroscopic viewing, efficient identification of the LHBT and subsequent release from the bicipital groove, and appropriate use of suture anchors for lasso-loop creation are presented for review. Two specific technical advantages of this technique include 2 fixation points for the LHBT to minimize failure risk, and smaller drill holes when compared with commonly performed tenodesis screw techniques to theoretically limit humeral fracture risk.

The long head biceps tendon (LHBT), originating from the supraglenoid tubercle at it courses through the bicipital groove, has been implicated as a pain generator in the shoulder.[1] Although nonoperative treatment options can be pursued for symptom management, tenodesis—or detachment of the LHBT from the supraglenoid tubercle in favor of distal reattachment—is commonly performed to decrease anterior shoulder pain in physically active patients.[2] Two common approaches for performing a

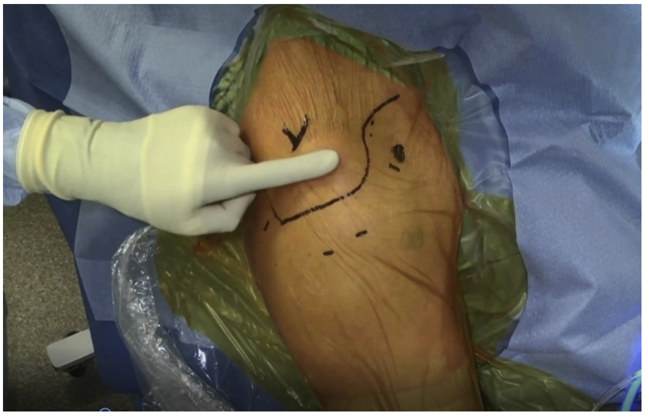

Fig 1. Patient's right shoulder positioned in the beach chair position. The acromioclavicular joint and outline of the acromion are general landmarks that can help orient one's self to the anterior, lateral, and posterior aspects of the shoulder. The anterior portal sites are marked just medial to the medial edge of the deltoid, with 2 lateral subacromial portal sites placed laterally through the deltoid tendon.

From the Division of Sports Medicine, Midwest Orthopaedics at Rush, Rush University Medical Center, Chicago, Illinois, U.S.A.

The authors report the following potential conflict of interest or source of funding: N.K.V. reports personal fees and non-financial support from Arthrex, non-financial support and other from Arthroscopy, *personal fees from DJ Orthopaedics, personal fees from Orthospace, non-financial support and other from Vindico Medical-Orthopedics Hyperguide, outside the submitted work; in addition, N.K.V. has a patent with Smith & Nephew—instrumentation with royalties paid to Smith & Nephew and is a board or committee member for the American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association of North America; has stock or stock options in Cymedica and Omeros; editorial or governing board of the* Journal of Knee Surgery*: is a paid consultant and has stock or stock options with Minivasive; and is on the editorial or governing board of SLACK Incorporated. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received March 22, 2019; accepted May 27, 2019.

Address correspondence to Nikhil N. Verma, M.D., Division of Sports Medicine, Midwest Orthopaedics at Rush, Rush University Medical Center, 1611 West Harrison St, Suite 300, Chicago, IL 60612, U.S.A. E-mail: nikhil.verma@rushortho.com

2212-6287/19382

https://doi.org/10.1016/j.eats.2019.05.028

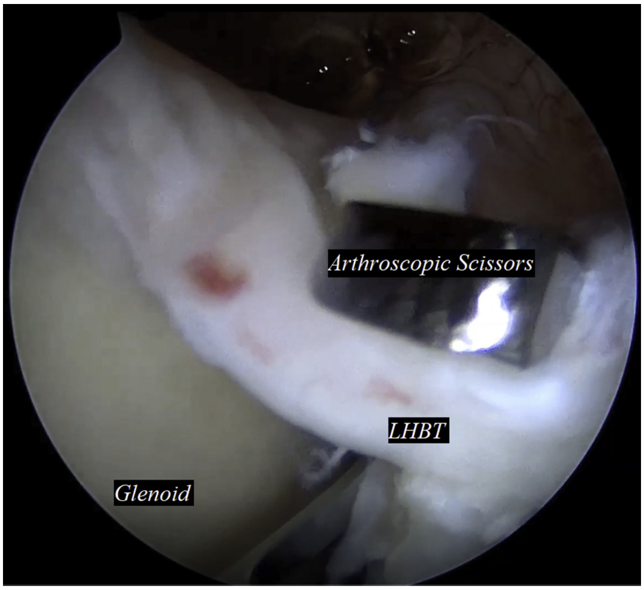

Fig 2. Patient's right shoulder positioned in the beach chair position. Transection of the LHBT from superior glenoid insertion. Viewing from the posterior portal, arthroscopic scissors are placed through the anterior portal into the glenohumeral joint to allow for transection of the LHBT from its insertion onto the superior glenoid. The anterior portal is preferred to optimize tendon visualization during transection. Following transection, the remaining soft-tissue stump is debrided from the superior glenoid. (LHBT, long head biceps tendon.)

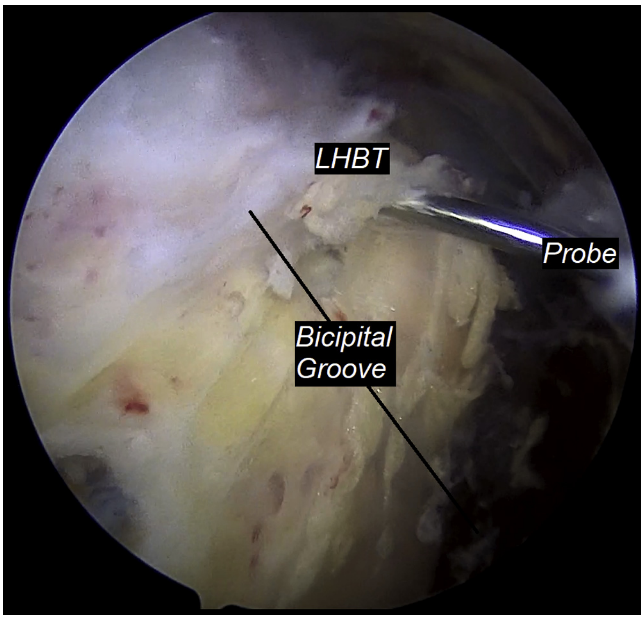

Fig 3. Patient's right shoulder positioned in the beach chair position. Biceps tendon identification. Following transection of the LHBT, and viewing from a standard lateral portal, the greater and lesser tuberosities are palpated with a hardened alloy probe from the anterior portal. Once the position of the intertubercular groove is identified, the metal probe is used to confirm the presence of soft tissue within the groove. The pictured anchor in the bottom left corner is from a previous rotator cuff repair. (LHBT, long head biceps tendon.)

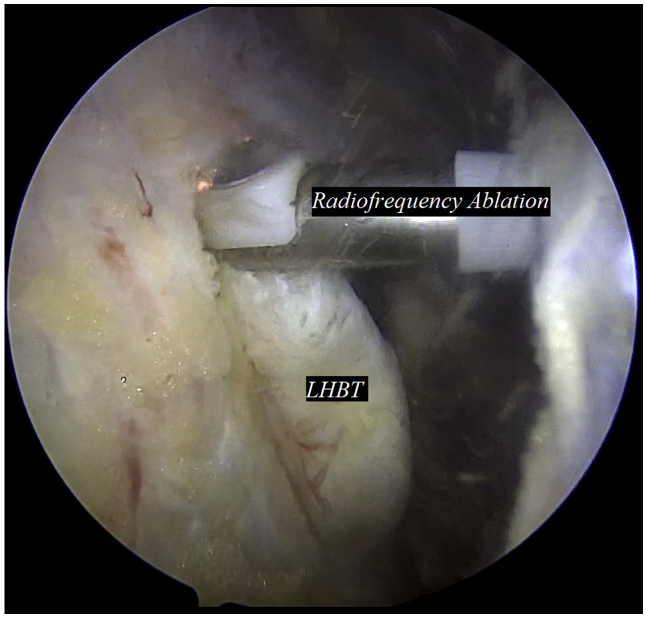

Fig 4. Patient's right shoulder positioned in the beach chair position. Radiofrequency ablation of LHBT. Viewing from the standard lateral portal, an arthroscopic radiofrequency ablation device is introduced through the anterior portal. The location of the intertubercular groove is once again confirmed by palpating in between the greater and lesser tuberosities, followed by ablation to release the transected end of the LHBT from the groove. (LHBT, long head biceps tendon.)

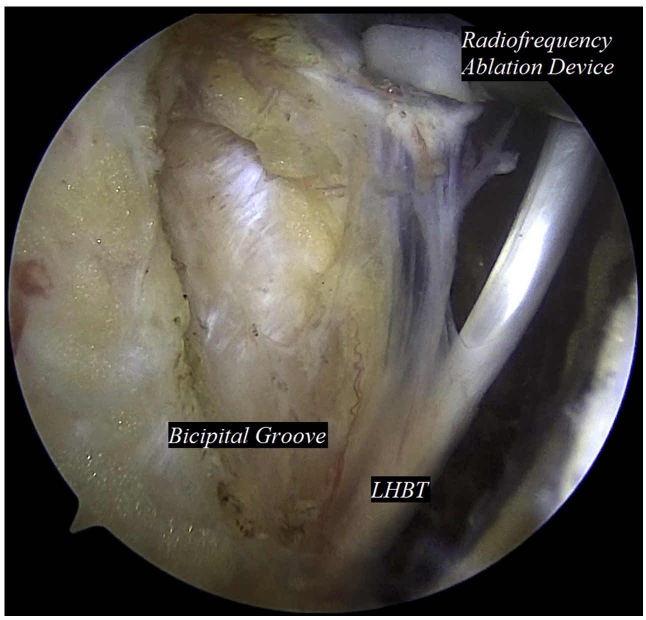

Fig 5. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. Radiofrequency ablation of LHBT. An arthroscopic grasper is introduced from the posterior portal and is used to tension the free end of the LHBT anteriorly away from the intertubercular groove. Soft tissue remaining within the intertubercular groove is then debrided until the shallow bony surface of the groove is reached to allow for anchor placement. (LHBT, long head biceps tendon.)

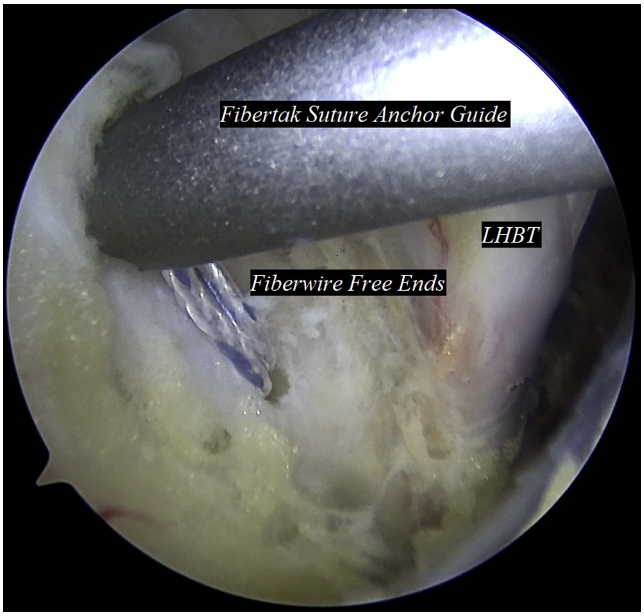

Fig 6. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. First suture anchor placement—inferior site. Pictured is the placement of the first of two 2.6-mm knotless FiberTak suture anchors at the inferior aspect of the bicipital groove, with 2 free FiberWire ends emerging from the suture anchors at the site of anchor placement. One free FiberWire end will be mobilized laterally deep to the LHBT to create a loop, while the Fiberwire end will be grasped and run through the LHBT itself using a Penetrator device. (LHBT, long head biceps tendon.)

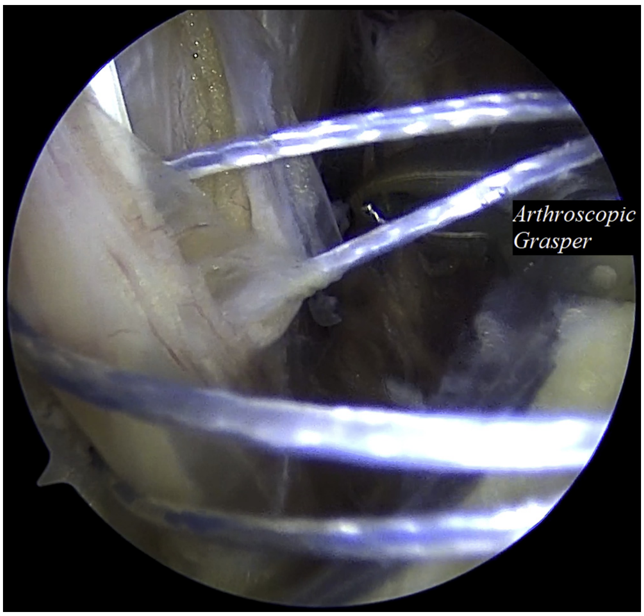

Fig 7. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. Lasso-loop creation. An arthroscopic grasper is used to grasp one free FiberWire end and mobilize it laterally under the LHBT such that a loop appears along the medial. Grasping the same free FiberWire end along the lateral edge of the LHBT and bringing it through the loop results in the creation of a "lasso loop" that securely grasps the tendon to fixate it. (LHBT, long head biceps tendon.)

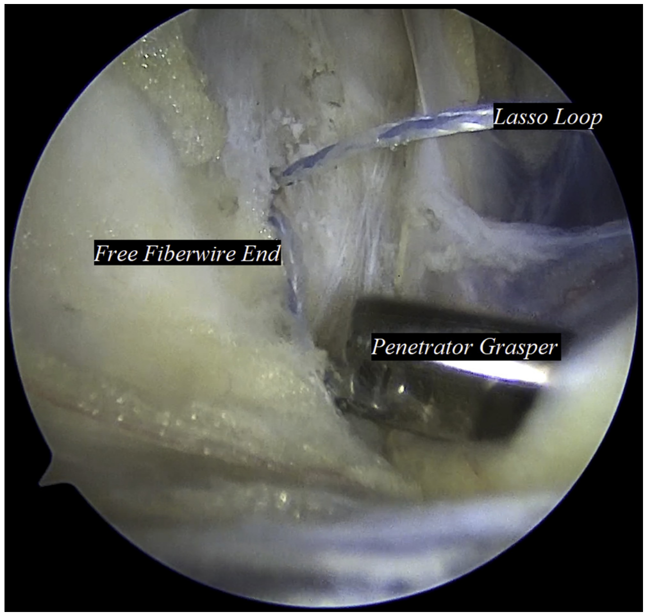

Fig 8. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. LHBT penetration and FiberWire retrieval. A Penetrator retrieval device is used to pierce the LHBT just inferior to the lasso-loop site and retrieve the remaining free FiberWire end. This end is pulled through the small piercing in the LHBT such that both FiberWire ends emerge from the anterior portal site. (LHBT, long head biceps tendon.)

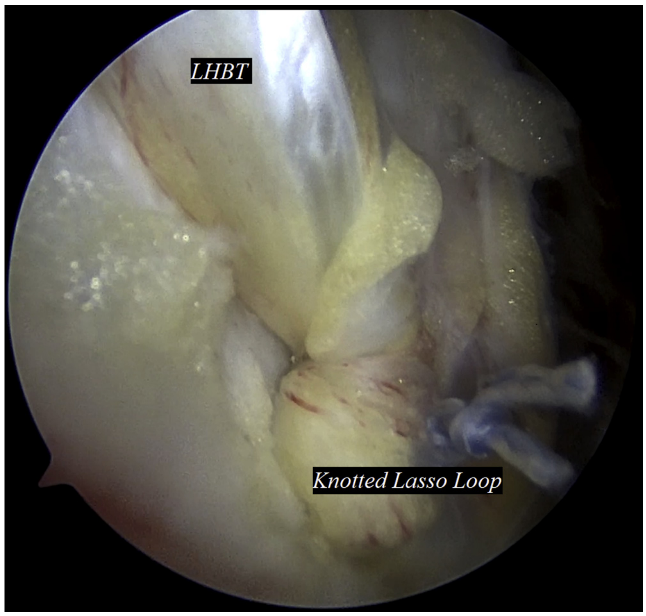

Fig 9. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. Knotted lasso loop—inferior fixation point. A single-hole arthroscopic knot Pusher is used to tie down knots in an alternating post fashion, securing the first lasso loop on a more distal portion of the LHBT. After the creation of 3 to 5 knots providing adequate fixation, an arthroscopic suture cutter is used to cut the free FiberWire ends just distal to the distal knot. (LHBT, long head biceps tendon.)

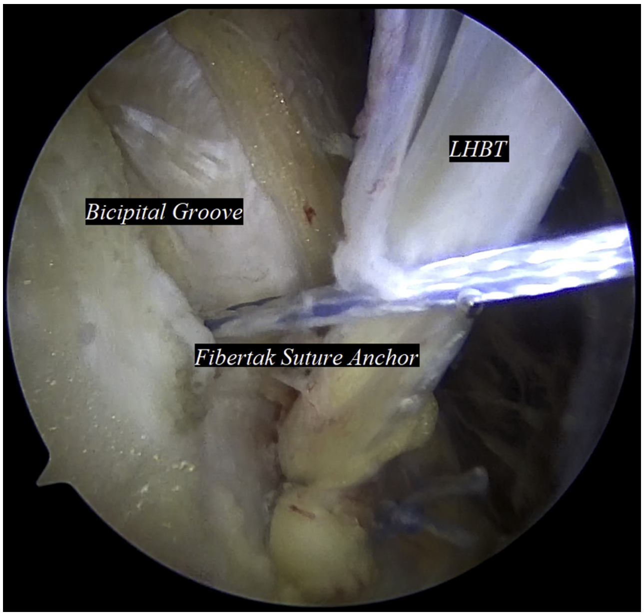

Fig 10. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. Second suture anchor placement—superior placement site. A second 2.6-mm knotless FiberTak suture anchor is placed 3 to 5 cm superior to the inferior anchor placement site within the bicipital groove. Careful attention must be paid to the site of anchor placement such that no soft tissue will prevent appropriate anchor deployment. Careful ablation of the groove on initial release of the LHBT from the groove helps to ensure no further ablation is necessary. (LHBT, long head biceps tendon.)

biceps tenodesis include an open subpectoral and arthroscopic suprapectoral approach, with neither approach demonstrated to be superior.[3]

Nonetheless, other technical aspects of the biceps tenodesis have been under study, including the role of fixation type, drill hole size, drill hole placement, and optimal knot-tying. The 3 most commonly used fixation implants include interference screws, suture anchors, and soft-tissue tenodesis.[2] Recent biomechanical data have suggested the possibility of superior biomechanical performance for a 2-suture anchor technique when compared with interference screw fixation (263.2 N vs 159.4 N, $P < .01$).[4] With regard to drill hole placement, recent work has suggested the use of a low suprapectoral position, given concern for retained tendon causing persistent groove pain.[5] Lastly, suture anchor constructs using lasso loops have demonstrated superior load-to-failure while allowing close approximation of the length-tension.[6] We present a technical guide to an all-arthroscopic suprapectoral biceps tenodesis using a double suture anchor lasso-loop construct. The goal of the technique is to use evidence-based methods to provide optimal biomechanical support while best approximating native length−tension relationships and alleviating patient pain.

Surgical Technique

Patient Positioning and Landmark Identification

This technique is performed with the patient in a beach chair position (Video 1), with the operative arm positioned to 45° of flexion, 30° of abduction, and slight external rotation using a fully articulating limb positioning instrument (Smith & Nephew, Andover, MA). Bony landmarks and subacromial portal placements are marked before portal creation (Fig 1). A standard posterior portal is placed at the posterolateral corner of the acromion to allow for examination of the intra-articular pathology of the LHBT. The most common indications for biceps tenodesis are generally partial tear, instability, tenosynovitis, SLAP tear, and a clinical examination positive for anterior shoulder pain (i.e., bicipital groove pain, Yerguson's, Speed's, O'Brien's tests).[1]

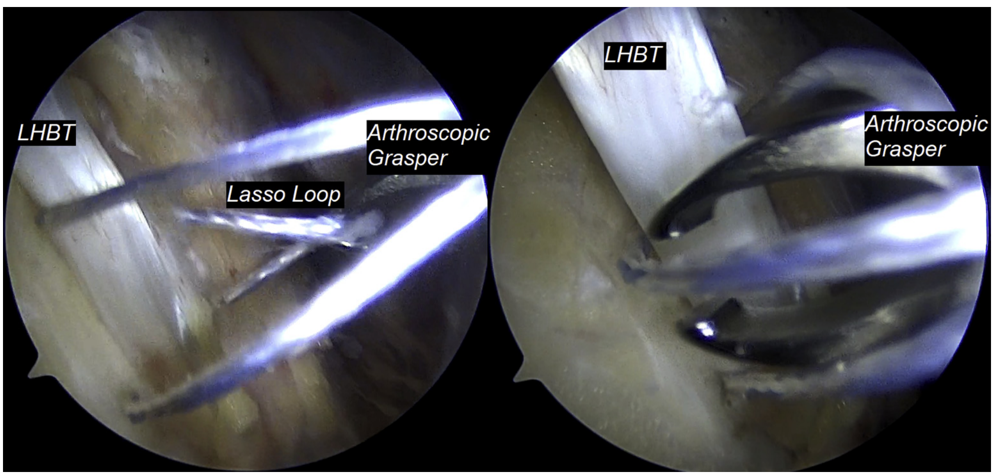

Fig 11. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. Creation of the second lasso loop. After deployment, one free FiberWire end is grasped using an arthroscopic grasper and brought medially underneath the LHBT before an arthroscopic grasper is brought through the resultant loop. Pulling the grasped FiberWire end through the anterior portal site create the second lasso loop above the site of superior suture anchor placement. Together, this create the double lasso-loop construct for LHBT fixation. (LHBT, long head biceps tendon.)

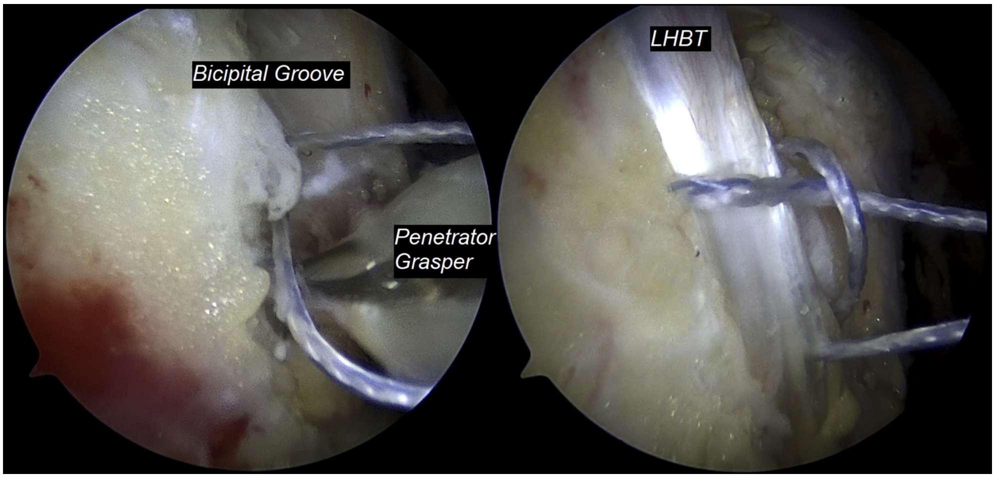

Fig 12. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. LHBT penetration and suture retrieval. In a fashion similar to the creation of the inferior lasso loop, a Penetrator grasper device is used to pierce the LHBT just distal to the site of superior lasso-loop fixation. The remaining free FiberWire end is then brought through the LHBT and through the anterior portal prior to fixation. (LHBT, long head biceps tendon.)

LHBT: Identification and Transection

Viewing the glenoid face from a standard posterior portal, the LHBT is identified at its insertion onto the superior glenoid and assessed for tears and tenosynovitic change. A spinal needle is placed anteriorly to approximate anterior portal placement, followed by introduction of arthroscopic scissors into the glenohumeral joint for LHBT transection (Fig 2). Following transection, an arthroscopic shaver (Arthrex, Naples, FL) is introduced through the anterior portal to debride the remaining soft-tissue stump of the LHBT insertion.

Following transection, the remaining LHBT is identified by viewing the anterior aspect of the humeral head from a lateral portal. A subacromial bursectomy may be performed at this time to optimize visualization. Palpation with a metal probe can help identify the intertubercular groove, and the LHBT should be tensioned with a probe to confirm anatomical position (Fig 3). A radiofrequency ablation device is then introduced through the anterior portal to (1) confirm the presence of the LHBT between the lesser and greater tuberosity, and (2) release the LHBT from the bicipital groove (Fig 4).

Suture Anchor Placement and Dual Lasso-Loop Construct

Once released, the LHBT is then tensioned anteriorly using an arthroscopic grasper from the posterior portal, and remaining soft tissue within the intertubercular groove is ablated (Fig 5). Maintaining anterior tension on the LHBT, a 2.6-mm single-loaded FiberTak suture anchor (Arthrex) is placed first inferiorly and superiorly thereafter within the groove (Fig 6). Following placement, the emerging FiberWire sutures (Arthrex) are tensioned to ensure appropriate strength. An arthroscopic grasper is introduced through the anterior portal to mobilize one free FiberWire end medially across the LHBT until a loop is created. The grasper is then passed laterally through the loop, and same free FiberWire end

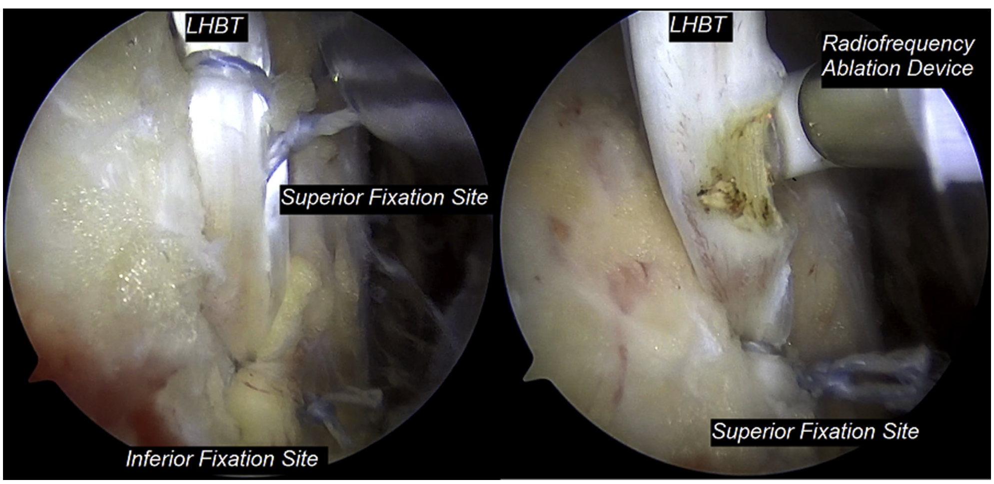

Fig 13. Patient's right shoulder positioned in the beach chair position and viewing through a lateral portal. Double lasso-loop construct and distal biceps excision. The double lasso-loop construct is finalized with the tying of a second knot in an alternating post fashion using a standard knot pusher. Tissue proximal to the second lasso suture site, but distal to the excision point from the superior glenoid is freed and excised using a radiofrequency ablation device to complete the arthroscopic double lasso-loop biceps tenodesis technique.

Table 1. Common Pitfalls and Technical Pearls

Common Pitfalls	Technical Pearls
Inappropriate length−tension relationship for the biceps tendon.	Position the operative arm at 45° abduction, 30° forward flexion, 10-20° external rotation.
	Fixation site just distal to bicipital groove.
Suboptimal biomechanical fixation of LHBT to humeral fixation point.	Use double lasso-loop construct to create 2 points of fixation.
	Tension suture anchors by hand after placement to confirm appropriate anchor deployment.
	Use alternating post technique to securely tie square knots.
Difficulty identifying the LHBT within the bicipital groove.	Use a harden alloy probe to examine the tension of the LHBT.
	Palpate the anterior aspect of the greater and lesser tuberosities until you locate a bony depression with soft tissue.
	Use local landmarks (i.e., superior border of the pectoralis major tendon).
Insufficient arthroscopic view of glenohumeral joint or rotator cuff interval.	Use radiofrequency ablation liberally due to high vascularity at base of bicipital groove.
	Increase arthroscopic fluid pump pressure.
	Grasper should be used from posterior portal to manipulate tendon and facilitate suture passage.

LHBT, long head biceps tendon.

is grasped on the lateral side and pulled through the loop (Fig 7). Inferior to the loop site, a Penetrator Grasper device is used to pierce the LHBT and grasp the remaining free FiberWire end (Fig 8).

With 2 ends (i.e., one lasso looped, the second penetrating through the LHBT) emerging from the anterior portal site, a standard arthroscopic knot pusher is used to tie knots in an alternating post fashion (Fig 9). A second 2.6-mm FiberTak suture anchor is placed 3 to 5 cm superiorly, followed by creation of a second lasso-loop configuration, using the aforementioned methodology (Figs 10-12). Fixation of the second lasso loop with arthroscopic knots completes the double-loop fixation construct (Fig 13). The radiofrequency ablation device is used thereafter to excise remaining LHBT tissue between its transection point just distal to the superior glenoid and the superior anchor fixation point (Fig 13).

Discussion

When compared with open subpectoral techniques, arthroscopic suprapectoral techniques such as the one presented in this technical guide provide distinct advantages, including minimal dissection area and scar formation, lack of need for a qualified assistant to aid in retraction, decreased fracture risk based on level of fixation, and decreased risk of neurovascular injury.[7,8] Advantages must be considered in the context of the necessary learning curve, and in the context that an optimal fixation device (i.e., suture anchor, biotenodesis screw) or optimal technique (i.e., subpectoral vs suprapectoral) have yet to be established for biceps tenodesis.[2,9] Technique-associated pitfalls and corresponding pearls are reviewed in Table 1. Technical advantages include 2 independent points of LHBT fixation, limited scar formation, and institutional data supporting decreased failure rates (i.e., Popeye deformity, revision surgery) and improved outcomes compared with single suture anchor approach. Recent studies have also suggested decreased short-term complication rates associated with the arthroscopic approach.[10]

The 3 primary disadvantages include increased operative time (particularly in those newly implementing the technique), cost, and the suprapectoral tenodesis site, which increases concern for the incorporation of poor-quality tendon into the tenodesis site (Table 2).[11-15] Risks associated with the technique include arthrofibrosis and bony fracture, particularly

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Provides 2 points of bony fixation (superior and inferior).	Cost.
Standard 3-portal system that limits scar formation compared with open subpectoral approach.	Increased operative time, particularly in those newly practicing the technique.
Institutional single-surgeon data suggest decreased failure rates when compared with single suture anchor approach at 6-month follow-up.	Risk of overtensioning.[11]
Limited risk of iatrogenic brachial plexus injury associated with open subpectoral approaches.[12]	Possibility of greater incidence of persistent pain[13] and postoperative stiffness.[14]
Theoretical advantage in increasing biomechanical fixation strength when distributing forces across 2 fixation points when compared with single-anchor approach.	Distal tenodesis raises concern for an area of poor-quality tendon used in tenodesis.
Smaller drill holes than screw-based techniques, theoretically minimizing fracture risk.[15]	
Arthroscopic portal use limits scar formation.	

if the suture anchors are placed too close to one another (i.e., 3 to 5 cm recommended). Previous studies have also reported increased risk of overtensioning the biceps tenodesis and decreased force to failure[11]; however, further studies are necessary to determine whether the same risks apply to a double-suture anchor model. Important limitations to consider include (1) significant learning curve, particularly with respect to the creation of the double lasso-loop construct; (2) possible difficulty managing localized bleeding; and (3) an inability to change LBHT tensioning after the fixation of the inferior first anchor point.

References

1. Creech MJ, Yeung M, Denkers M, Simunovic N, Athwal GS, Ayeni OR. Surgical indications for long head biceps tenodesis: A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2016;24:2156-2166.
2. Werner B, Burrus MT, Miller MD, Brockmeier SF. Tenodesis of the long head of the biceps: A review of indications, techniques, and outcomes. *JBJS Rev* 2014;2.
3. Mazzocca AD, Bicos J, Santangelo S, Romeo AA, Arciero RA. The biomechanical evaluation of four fixation techniques for proximal biceps tenodesis. *Arthroscopy* 2005;21:1296-1306.
4. Papp DF, Skelley NW, Sutter EG, et al. Biomechanical evaluation of open suture anchor fixation versus interference screw for biceps tenodesis. *Orthopedics* 2011;34:e275-e278.
5. Romeo AA, Mazzocca AD, Tauro JC. Arthroscopic biceps tenodesis. *Arthroscopy* 2004;20:206-213.
6. Vestermark G, Hartigan D, Piasecki D, et al. Biceps tenodesis: Biomechanical assessment of 3 arthroscopic suprapectoral techniques. *Orthopedics* 2017;40:e1009-e1016.
7. Daoud J, Aouad D, Abdelnour H, Hanna R, El Rassi G. Technique for arthroscopic long head of biceps tenodesis using anchor with fork tip eyelet. *Arthrosc Tech* 2018;7:e299-e305.
8. Sethi PM, Vadasdi K, Greene RT, Vitale MA, Duong M, Miller SR. Safety of open suprapectoral and subpectoral biceps tenodesis: An anatomic assessment of risk for neurologic injury. *J Shoulder Elbow Surg* 2015;24:138-142.
9. Werner BC, Evans CL, Holzgrefe RE, et al. Arthroscopic suprapectoral and open subpectoral biceps tenodesis: A comparison of minimum 2-year clinical outcomes. *Am J Sports Med* 2014;42:2583-2590.
10. Gowd AK, Liu JN, Garcia GH, et al. Open biceps tenodesis associated with slightly greater rate of 30-day complications than arthroscopic: A propensity-matched analysis. *Arthroscopy* 2019;35:1044-1049.
11. Werner BC, Lyons ML, Evans CL, et al. Arthroscopic suprapectoral and open subpectoral biceps tenodesis: A comparison of restoration of length-tension and mechanical strength between techniques. *Arthroscopy* 2015;31:620-627.
12. Rhee PC, Spinner RJ, Bishop AT, Shin AY. Iatrogenic brachial plexus injuries associated with open subpectoral biceps tenodesis: A report of 4 cases. *Am J Sports Med* 2013;41:2048-2053.
13. Lutton DM, Gruson KI, Harrison AK, Gladstone JN, Flatow EL. Where to tenodese the biceps: Proximal or distal? *Clin Orthop Relat Res* 2011;469:1050-1055.
14. Werner BC, Pehlivan HC, Hart JM, et al. Increased incidence of postoperative stiffness after arthroscopic compared with open biceps tenodesis. *Arthroscopy* 2014;30:1075-1084.
15. Sears BW, Spencer EE, Getz CL. Humeral fracture following subpectoral biceps tenodesis in 2 active, healthy patients. *J Shoulder Elbow Surg* 2011;20:e7-e11.