Technical Note

Single-Portal Proximal Biceps Tenodesis Using an All-Suture Anchor

Malte Holschen, M.D., Benjamin Bockmann, M.D., Tobias L. Schulte, Prof., M.D., Kai-Axel Wit, M.D., and Jörn Steinbeck, Prof., M.D.

Abstract: The long head of the biceps is an important pain generator of the shoulder joint. Pathologies of the long head of the biceps involve superior labrum anterior to posterior lesions, pulley lesions, partial tears of the biceps tendon, biceps tendinitis, and medial biceps subluxation caused by full-thickness subscapularis tendon tears. Treatment of an inflamed or injured long head of the biceps by either tenotomy or tenodesis is often mandatory during shoulder arthroscopy to avoid persisting pain and possible revision procedures. In comparison with a tenotomy of the biceps tendon, a biceps tenodesis preserves the tension, anatomy, and cosmesis of the biceps muscle. The presented technique demonstrates a single portal technique for a proximal biceps tenodesis in the bicipital groove using an all-suture anchor.

Pathologies of the long head of the biceps (LHB) lead may result in pain and functional impairment of the shoulder joint.1 Besides sole biceps tendonitis, injuries, or degenerative lesions like SLAP lesions, partial tears of the LHB also can lead to lead pain and inflammation.2-4 Pulley lesions and adjacent rotator cuff tears, especially those of the subscapularis tendon, lead to instability of the LHB in the rotator interval.5,6 Over the time the unstable LHB degenerates and loses its initial round structure to change to a flat and thick structure (hourglass phenomenon).7 Additional degenerative changes of the cartilage below an unstable biceps tendon have been described.8 Ongoing degeneration may finally end in partial or complete tears of the LHB.9 Overhead athletes are often affected by pathologies of the LHB.10

During rotator cuff repair, management of the LHB by tenotomy or tenodesis should be considered to avoid pain and stiffness caused by postoperative biceps tendonitis.11 Rotator cuff repair may lead to pain and stiffness caused by chronic biceps tendonitis due to an altered anatomy of the rotator interval or irritating sutures in the supraspinatus or subscapularis tendon. In particular, larger rotator cuff tears may require additional biceps tenotomy or tenodesis to protect the repaired rotator cuff from an unstable biceps tendon.

Several possibilities for management of these LHB lesions exist.11,12 The easiest and fastest way is a tenotomy of the LHB at the supraglenoid tubercle. However, biceps tenotomy is related to certain potential disadvantages:

- the biceps muscle belly may drop distally and become more prominent (Popeye sign)13;
- potential biceps muscle cramping may occur13; and
- reduced power during forearm supination may occur.13

The presented technique avoids these disadvantages, because the LHB is fixed to the most proximal entrance of the bicipital groove and thus protected from moving distally. In comparison with other techniques used for biceps tenodesis like suprapectoral biceps tenodesis in the middle or the inferior part of the bicipital groove or subpectoral tenodesis, the presented technique is probably the fastest and the easiest way to prevent the LHB from moving distally.

The whole procedure can be performed under direct intra-articular visualization. Next to the posterior

From Orthopedic Practice Clinic (OPPK), Münster (M.H., K.-A.W., J.S.); and the Department for Orthopaedic Surgery, University Hospital, Bochum (B.B., T.L.S.), Germany.

The authors report the following potential conflicts of interest or sources of funding: K.-A.W. and J.S. report personal fees from Arthrex, outside the submitted work. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received October 18, 2021; accepted November 22, 2021.

Address correspondence to Malte Holschen, M.D., Schürbusch 55, 48143 Münster, Germany. E-mail: holmal@web.de
© 2021 THE AUTHORS. Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
2212-6287/21499
https://doi.org/10.1016/j.eats.2021.11.023

Arthroscopy Techniques, Vol 11, No 4 (April), 2022: pp e497-e503
e497
viewing portal, only one more anterolateral portal is mandatory to perform the tenodesis. In comparison with standard rotator cuff anchors or biceps tenodesis screws, the presented technique works with an all-suture anchor, which is easy to apply and which does neither require large implants or large drill holes.

**Surgical Technique (With Video Illustration)**

**Patient Positioning and Anesthesia**

The patient is placed in a beach-chair position on a standard surgical table. The affected arm is supported in an arm holder (TRIMANO FORTIS; Arthrex, Naples, FL) in neutral forward flexion and rotation. The operation is conducted with the patient under general anesthesia and an additional interscalene brachial plexus block. The systolic blood pressure is kept below a systolic maximum of 100 mm Hg to prevent excessive bleeding.

**Intra-Articular Assessment of the Biceps Tendon**

The arthroscope is introduced through a standard posterior portal and the joint is assessed systematically. Special regard is given to rotator interval lesions, chondral defects located on the humeral head below the LHB, SLAP lesions, anterior-superior rotator cuff tears, and biceps tendonitis. In cases of rotator cuff tears located closely to the LHB (supraspinatus tendon tear or subscapularis tendon tear), the stability of the LHB is assessed by internal and external rotation of the arm. A probe inserted through the rotator interval or through an anterior portal may be helpful to visualize medial or posterior instability of the LHB. Medial instability occurs in cases of subscapularis tendon tears, whereas posterior instability is caused by supraspinatus tendon tears. An arthroscopic grasper may be helpful to pull the LHB out of the bicipital groove to confirm biceps tendonitis. In cases of a wide canal, the arthroscope can be moved into the proximal sulcus of the LHB to confirm synovitis and inflammation.

**Biceps Tenodesis**

When indicated, suprapectoral intra-articular tenodesis of the LHB is performed through a 1.5-cm anterolateral portal. The rotator interval is located with a spinal needle in an outside-in fashion above the long head of the biceps tendon (LHB) through an anterolateral portal. The image also shows the supraspinatus tendon (SSP) and the superior aspect of the humeral head (HH).

![Fig 1. Arthroscopic view of a left shoulder in the beach-chair position. The arthroscope is located in a standard posterior viewing portal. The rotator interval (RI) is located with a spinal needle (black arrow) in an outside-in fashion above the long head of the biceps tendon (LHB) through an anterolateral portal. The image also shows the supraspinatus tendon (SSP) and the superior aspect of the humeral head (HH).](image1)

![Fig 2. Arthroscopic view of a left shoulder in the beach-chair position. The arthroscope is located in a standard posterior viewing portal. The long head of the biceps tendon (LHB) tendon is grasped with a Kocher clamp (black arrow) inserted through the anterolateral portal prior to biceps tenotomy. The subscapularis tendon (SSC) is located anteriorly to the humeral head (HH).](image2)
If the LHB gets lost, tenotomy or subpectoral tenodesis should be considered. After pulling the LHB out of the anterolateral portal, it is secured with a second Kocher clamp above skin level and shortened by 2 cm (Fig 5). The proximal portion of the bicipital groove needs to be debrided with a shaver or a burr to create a bleeding bed. The cortical bone should not be removed entirely during this step to avoid pulling out of the suture anchor. If mandatory, a radiofrequency device may be inserted to perform synovectomy in the bicipital groove and in the rotator interval region to avoid postoperative pain.

Subsequently, a spear with a blunt tip obturator is inserted through the anterolateral portal (Fig 6). After perpendicular placement onto the bone bed of the bicipital groove, the obturator is removed and a 1.6-mm depth stop drill is introduced to create a bone socket. After removal of the drill, an all-suture anchor (Fiber-Tak Soft Anchor; Arthrex) is impacted into the bone socket with an inserter handle. By pulling the inserter handle with the sutures, the anchor is set into the bone (Fig 7). Two suture limbs of the all-suture anchor (FiberWire #2; Arthrex) remain above skin level after spear and inserter handle have been removed. One of the sutures is used to arm the LHB with Krackow stitches using a standard surgical needle (Fig 8). The Kocher clamp needs to be removed after this step.

By pulling the free suture limb, which has not been used for tendon arming, the LHB is fixed to the bone bed. The pulling suture is used as the post for knot-tying with 7 alternating half hitches. The tendon is visualized through the posterior portal during knot tying. A suture cutter is employed to cut the sutures 0.5 cm above the bone.
last knot under arthroscopic control (Fig 9). The described technique is presented in Video 1.

A probe inserted through the anterolateral portal confirms the correct tension of the LHB. If no further procedures like rotator cuff repair or subacromial decompression are mandatory, the procedure may be finished with standard skin closure and wound dressing.

Fig 6. Extra-articular view of a left shoulder in beach chair position from lateral. A spear with a blunt tip obturator is inserted through the anterolateral portal, while the biceps tendon is secured with a Kocher clamp.

Fig 7. Intra-articular view of an all-suture anchor and its suture tails (black arrow) in the bicipital groove (BG) below the rotator interval (RI). The image shows a left shoulder. The arthroscope is located in a standard posterior viewing portal. The anchor was inserted through an anterolateral portal.

Fig 8. Extra-articular view of a left shoulder in beach chair position from lateral. One limb of the all-suture anchors is employed for arming of the biceps tendon.

Fig 9. Final view of the completed suprapectoral tenodesis of the long head of the biceps (LHB) during cutting the sutures after knot tying (black arrow). The LHB is fixed to the entrance of the bicipital groove in the direct neighborhood of the rotator interval (RI), the superior glenohumeral ligament (SGHL), the humeral head (HH), and the supraspinatus tendon (SSP). The image shows a left shoulder. The arthroscope is located in a standard posterior viewing portal. The suture cutter was inserted through an anterolateral portal.
A Kocher clamp grabs the mid-portion of the intra-articular biceps instability after a surgical procedure. In particular, an important procedure to avoid persistent pain and an increased risk for infection caused by contact with the skin. However, infections after supraperiosteal biceps tenodesis are very rare. Pulling the LHB above the skin level is advantageous, because tendon arming is facilitated and more stable (Krackow stitches). In addition, all-arthroscopic supraperiosteal tenodesis techniques, in particular when performed under extra-articular visualization, are surgically more demanding and less reproducible for unexperienced shoulder surgeons. Subperiosteal biceps tenodesis has its own advantages and disadvantages. A relevant clinical difference between supraperiosteal and subperiosteal biceps tenodesis has not been observed in a recent literature review. The most important advantage is that the LHB is completely removed from its canal and the area underneath the insertion of the pectoralis major tendon. In patients with significant tenderness along the inferior part of the bicipital canal and the pectoralis major insertion during physical examination, subperiosteal biceps tenodesis may be beneficial. However, this technique has some disadvantages: There is an increased risk for neurovascular injuries in the axillary fold and an increased risk for infection. If larger drill tunnels are established in the proximal diaphysis of the humerus, there is also a risk for humeral shaft fractures.

Advantages and disadvantages of the described technique for supraperiosteal tenodesis using an all-suture anchor are summarized in Table 1. Although our presented technique is easy to apply and reproducible, it is related to certain risks like losing the biceps tendon in the bicipital canal and for displacement of the all-suture anchor. It is important to create an anterolateral portal, which is located directly above the biceps tendon in the proximal part of its canal and which does not involve the anterosuperior rotator cuff. If the incisions are too small, the biceps tendon may get lost during extraction above skin level. Thus, it is crucial to secure the tendon.
with the tip of a Kocher clamp under arthroscopic visualization before the tenotomy is carried out. After tenotomy, gentle pulling and rotation of the clamp will facilitate extracting the LHB above skin level. Then, it is very important to use a second Kocher clamp to grab the most distal part of the tendon above the skin level with the proximal part of the clamp. This makes sure, that the construct is temporarily fixed above skin level to perform subsequent anchor placement and tendon arming.

As mentioned, the shaver should not remove the whole cortical bone in the proximal bicipital groove to guarantee optimal stability of the all-suture anchor. In cases of poor spongious bone, the anchor may pull out during tensioning or knot tying. If the anchor is pulled out, the LHB can be fixed with a subpectoral tenodesis or it may be fixed with a knotless suture anchor in the bicipital groove. For this procedure, the LHB is pulled above skin level with the 2 suture limbs and secured with a Kocher clamp. The sutures and the anchor are removed from the LHB before a nonabsorbable suture is applied with Krackow stitches. After tapping a hole into the proximal bicipital groove, the LHB is fixed with a knotless suture anchor under arthroscopic visualization.

It is important to control the mobility of the 2 suture limbs in the anchor eyelet prior to tendon arming. After tendon arming the other suture limb is used to pull the LHB onto the bone bed in the bicipital groove. This step needs to be visualized carefully to make sure that the tendon does not get trapped above the rotator interval. A switching stick may be helpful to gently manipulate the LHB, if the tendon is trapped above the rotator interval. This problem does not occur, if the incisions are large enough.

Pearls and pitfalls are summarized in Table 2. The main advantage of the described technique is a fast and easy fixation of the LHB in the proximal bicipital groove using a small implant. Next to the described intraoperative risks like losing the tendon after tenotomy or dislocation of the suture anchor, persistent pain in the bicipital canal is a major concern. Usually, these symptoms will subside after a while. However, patients need to be informed about this risk before the surgical procedure.

The describe technique should not be performed in cases of poor bone quality and poor quality of the LHB, especially in elderly patients. These patients should be considered for biceps tenotomy. If the LHB has become very thick during a yearlong degenerative process, suprapectoral tenodesis may be beneficial, because pulling the tendon out of its canal during subpectoral tenodesis may be impossible and likely leads to tearing of the distal portion of the tendon. A summary of advantages, risks and limitations is shown in Table 3.

### Table 3. Advantages, Risks, and Limitations of a Single-Portal Proximal Biceps Tenodesis Using an All-Suture Anchor

| Advantages                                                                 | Risks                                                                                           | Limitations                                                                                     |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Easy to learn and to apply                                                 | Anchor dislocation                                                                            | Poor tissue quality of the biceps tendon may lead to early failure                              |
| Optimized visualization of relevant anatomical structures (bicipital groove, biceps tendon, rotator interval) | Dislocation of the biceps tendon                                                               | Poor bone quality in the bicipital groove may lead to anchor dislocation                         |
| Secure anchor placement                                                    | Persistent pain in the bicipital groove                                                        | Pulling the tendon above skin level may hindered in obese patients                              |
| Strong fixation construct                                                  | Shoulder stiffness                                                                             | This technique is inapplicable in cases of a torn biceps tendon                                |

The describe technique should not be performed in cases of poor bone quality and poor quality of the LHB, especially in elderly patients. These patients should be considered for biceps tenotomy. If the LHB has become very thick during a yearlong degenerative process, suprapectoral tenodesis may be beneficial, because pulling the tendon out of its canal during subpectoral tenodesis may be impossible and likely leads to tearing of the distal portion of the tendon. A summary of advantages, risks and limitations is shown in Table 3.

### References

1. Elser F, Braun S, Dewing CB, Giphart JE, Millett PJ. Anatomy, function, injuries, and treatment of the long head of the biceps brachii tendon. *Arthroscopy* 2011;27:581-592.
2. Kibler WB, Sciascia A. Current practice for the surgical treatment of SLAP lesions: A systematic review. *Arthroscopy* 2016;32:669-683.
3. Streit JJ, Shishani Y, Rodgers M, Gobezie R. Tendinopathy of the long head of the biceps tendon: Histopathologic analysis of the extra-articular biceps tendon and tenosynovium. *Open Access J Sports Med* 2015;6:63-70.
4. Sahu D, Fullick R, Giannakos A, Lafosse L. Sentinel sign: A sign of biceps tendon which indicates the presence of subscapularis tendon rupture. *Knee Surg Sports Traumatol Arthrosc* 2016;24:3745-3749.
5. Barile A, Lanni G, Conti L, et al. Lesions of the biceps pulley as cause of anterosuperior impingement of the shoulder in the athlete: Potentials and limits of MR arthrography compared with arthroscopy. *Radiol Med* 2013;118:112-122.
6. Godeneche A, Nove-Josserand L, Audébert S, et al. Relationship between subscapularis tears and injuries to the biceps pulley. *Knee Surg Sports Traumatol Arthrosc* 2017;25:2214-22120.
7. Boileau P, Ahrens PM, Hatzidakis AM. Entrapment of the long head of the biceps tendon: the hourglass biceps—a cause of pain and locking of the shoulder. *J Shoulder Elbow Surg* 2004;13:249-257.
8. Castagna A, Mouhsine E, Conti M, et al. Chondral print on humeral head: An indirect sign of long head biceps tendon instability. *Knee Surg Sports Traumatol Arthrosc* 2007;15:645-648.
9. Longo UG, Lopini M, Marineo G, Khan WS, Maffulli N, Denaro V. Tendinopathy of the tendon of the long head of the biceps. *Sports Med Arthrosc* 2011;19:321-332.
10. Chalmers PN, Verma NN. Proximal biceps in overhead athletes. Clin Sports Med 2016;35:163-179.
11. Patel KV, Bravman J, Vidal A, Chrisman A, McCarty E. Biceps tenotomy versus tenodesis. Clin Sports Med 2016;35:93-111.
12. Gombera MM, Kahlenberg CA, Nair R, Saltzman MD, Terry MA. All-arthroscopic suprapectoral versus open subpectoral tenodesis of the long head of the biceps brachii. Am J Sports Med 2015;43:1077-1083.
13. Liu H, Song X, Liu P, Yu H, Zhang Q, Guo W. Clinical outcomes of arthroscopic tenodesis versus tenotomy for long head of the biceps tendon lesions: A systematic review and meta-analysis of randomized clinical trials and cohort studies. Orthop J Sports Med 2021;9:2325967121993805.
14. Ntalos D, Huber G, Sellenschloh K, et al. All-suture anchor pullout results in decreased bone damage and depends on cortical thickness. Knee Surg Sports Traumatol Arthrosc 2021;29:2212-2219.
15. Meeks BD, Meeks NM, Froehle AW, Wareing E, Bonner KF. Patient satisfaction after biceps tenotomy. Orthop J Sports Med 2017;5:2325967117707737.
16. Anil U, Hurley ET, Kingery MT, Pauzenberger L, Mullett H, Strauss EJ. Surgical treatment for long head of the biceps tendinopathy: A network meta-analysis. J Shoulder Elbow Surg 2020;29:1289-1295.
17. Smuin DM, Vannatta E, Ammerman B, Stauch CM, Lewis GS, Dhawan A. Increased load to failure in biceps tenodesis with all-suture suture anchor compared with interference screw: A cadaveric biomechanical study. Arthroscopy 2021;37:3016-3021.
18. Dekker TJ, Peebles LA, Preuss FR, Goldenberg BT, Dornan GJ, Provancher MT. A systematic review and meta-analysis of biceps tenodesis fixation strengths: Fixation type and location are biomechanically equivalent. Arthroscopy 2020;36:3081-3091.
19. Hughes JD, Gibbs CM, Drummond M, et al. Failure rates and clinical outcomes after treatment for long-head biceps brachii tendon pathology: A comparison of three treatment types. JSES Int 2021;5:630-635.
20. Rudisill SS, Best MJ, O’Donnell EA. Clinical outcomes of revision biceps tenodesis for failed long head of biceps surgery: A systematic review. Arthroscopy 2021;37:3529-3536.
21. Kelly BJ, Reynolds AW, Schimoler PJ, Kharlamov A, Miller MC, Akhavan S. Measurements of tendon movement within the bicipital groove after suprapectoral intra-articular biceps tenodesis in a cadaveric model. Orthop J Sports Med 2021;9:2325967120977538.
22. van Deurzen DFP, Gurnani N, Alta TDW, Willems JH, Osnienk R, van den Bekerom MPJ. Suprapectoral versus subpectoral tenodesis for Long head biceps brachii tendinopathy: A systematic review and meta-analysis. Orthop Traumatol Surg Res 2020;106:693-700.
23. Gifford A, Tauro T, Haunschild E, Okoroha K, Cole BJ. Mini-open subpectoral biceps tenodesis using all-suture anchor. Arthrosc Tech 2020;9:e445-e451.
24. Milenin O, Sergienko R, Razumov A. Arthroscopic proximal subpectoral tenodesis of the long head of the biceps. Arthrosc Tech 2021;10:e1-e7.
25. Nuelle CW, Sheean A, Tucker CJ. Subpectoral biceps tenodesis of the shoulder: Indications and technique options. Arthroscopy 2020;36:2352-2353.