Technical Note

Arthroscopic Suprapectoral Biceps Tenodesis: The "Double Secure Loop Technique" Using an All-Suture Anchor and an Arthroscopic Suture Passer

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Abstract: Although the long head of the biceps tendon is known to resist superior movement of the humeral head in the shoulder joint and assist flexion and supination of the elbow joint, its exact function remains unclear. Moreover, the ideal treatment of lesions of the long head of the biceps tendon such as tendinitis, subluxation, dislocation, and partial or complete rupture remains controversial. Various tenodesis methods have been introduced by many authors. This technique-based article aims to discuss tenodesis as an option for biceps tendon fixation.

Various options can be considered for biceps tendon fixation. Open and arthroscopic methods are available, and fixation can be achieved using an interference screw, keyhole fixation, suture anchor, or suture with surrounding soft tissue.[1-4] However, these conventional methods often leave scars due to open wounds and require the creation of additional arthroscopic portals for tenodesis.

It was previously reported that proximal tenodesis has 3 advantages over simple resection of the long head of the biceps tendon (LHBT): (1) fixation of the LHBT maintains its length and tension, thus preventing muscular atrophy; (2) the procedure maintains flexion and supination power, which are major functions of the elbow joint; and (3) the procedure less frequently results in a Popeye deformity.[5] Nevertheless, biceps tendon fixation procedures are often conducted with other arthroscopic procedures, such as synovectomy, capsular release, or rotator cuff repair, leading to prolonged operations. We aim to introduce the "double secure loop technique," a suprapectoral biceps tenodesis technique that enables easy and secure tenodesis using all-suture anchors and a suture passer (FastPass Scorpion; Arthrex, Naples, FL) without the need for additional skin incisions or arthroscopic portals (Video 1, Table 1).

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Surgical Technique

Patient Positioning

The patient's body is positioned in the lateral decubitus position on the operating table. The arm is flexed 30° and abducted 30°, and a shoulder positioning system (Spider Limb Positioner; Smith & Nephew, Andover, MA), which enables the arm position to be easily changed intraoperatively, is used.

Portal Placement and Tenotomy of LHBT

A 30° lens arthroscope is inserted into the posterior portal for arthroscopic assessment. Patients requiring tenodesis operations are selected based on their age and physical activity levels. First, the posterior portal of the glenohumeral joint is used as the viewing portal, whereas the anterior portal is used as the working portal into which an arthro-care device (Plasma Surgical Wand; Mechan, Sichuan, China) is inserted. Then, by use of the arthro-care device, thermal markings are made at the edge of the bicipital groove at normal LHBT tension (Fig 1A). Subsequently, the origin of the LHBT

Table 1. Pitfalls and Pearls

Surgical Step	Pitfall	Pearl
Glenohumeral joint management	Resection of the LHBT without marking causes difficulty in ensuring appropriate tension when confirming the site of fixation in the subacromial space.	Resection of the biceps tendon within the glenohumeral joint resolves superior labral and other lesions.
Soft-tissue release at bicipital groove	The technique may damage the ascending branch of the AHCA or subscapularis insertion anterior to the LHBT within the groove.	Exploration of the bicipital groove and resection of the transverse humeral ligament should be performed from the lateral side of the groove to minimize damage to the insertion of the subscapularis tendon.
Bone bed preparation	Excessive decortication during all-suture anchor insertion can cause implant pullout.	Decortication at the all-suture anchor insertion site should be minimized, whereas cancellous bone should be exposed at the LHBT insertion site.
Suture passing of LHBT	In cases of failed suture passage, using the same portion of the suture thread should be avoided because it can lead to breakage of the suture strand.	To prevent suture strand twisting, the non-working threads should be retrieved through the anterior portal and an assistant may pull the suture strand to create mild tension when manipulating the suture passer. During suture passage, the suture should pass slightly distal to the thermal marking on the LHBT to create appropriate tension.
Creation of double secure loop	Inappropriate tension on the LHBT can result in poor postoperative outcomes involving fixation failure or pain.	The opposite end of the suture strand used to make the 2 loops should be used as the post when creating the tie to create stable LHBT fixation.

AHCA, anterior humeral circumflex artery; LHBT, long head of biceps tendon.

is dissected, and an arthroscope shaver handpiece (Advantage Turbo; ConMed, Largo, FL) is used to trim the dissection site of the LHBT origin (Fig 1B). Finally, additional treatment of intra-articular lesions is conducted.

Management of Subacromial Space Including Acromioplasty and Rotator Cuff Repair

The arthroscope is inserted into the subacromial space through the posterior portal, and the posterior and anterior subdeltoid bursa is removed through the anterior portal. An additional lateral portal is created for use as the other working portal. After removal of the subacromial soft tissue, an acromioplasty is conducted. Subsequently, the arthroscope is moved to the posterolateral portal, and additional repair of the rotator cuff rupture is conducted using the suture passer and all-suture anchors.

Preparation of LHBT and Biceps Groove for Tenodesis

While the posterolateral view is being maintained, the bicipital groove and biceps tendon parenchyma are palpated using a probe or the back of the arthro-care device. The arthro-care device is used to resect the rotator interval, and the soft tissue is located (Fig 2A). A tendon grasper (Grasping Forceps; ConMed) (Fig 2B) is inserted through the posterior portal and used to hold the cut end of the LHBT. The thermal markings are confirmed for tensioning, and the tendon is pulled to an appropriate level of tension to confirm the site of fixation in the suprapectoral area. To ensure appropriate movement of the LHBT, the transhumeral ligament is resected and released sufficiently to the distal portion. An acromionizer (Large Hub; ConMed) (Fig 2C) is inserted through the anterior portal to provide decortication at the site of confirmed LHBT fixation to prepare the bone bed with appropriate exposure of cancellous bone.

Tendon Fixation

An all-suture anchor (Y-Knot RC All-Suture Anchor with 3 No. 2 Hi-Fi sutures; ConMed) is inserted perpendicularly to the floor of the prepared bone bed (Fig 3A); all suture threads are retrieved through the anterior portal to prevent interference with further surgical steps. One strand of the suture thread is moved to the lateral portal, which serves as the working portal, and the tendon grasper previously placed through the posterior portal is used to hold the cut end of the LHBT to maintain an appropriate level of tension. The grasper also holds the tendon in place while the needle is being passed through the suture passer. The grasper is pulled to maintain appropriate tension on the LHBT, the suture thread in the lateral portal is used to suture the center of the

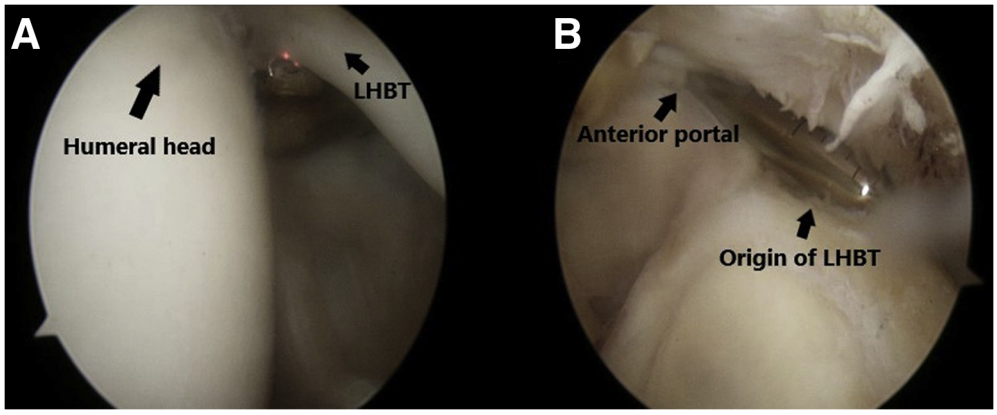

Fig 1. Glenohumeral joint in a left shoulder viewing from the posterior portal. (A) Thermal marking using an arthro-care device (Plasma Surgical Wand; Mechan, Sichuan, China) at the edge of the bicipital groove. The marking will be used as a reference to ensure appropriate tension when confirming the site of fixation in the subacromial space. (B) Trimming the dissection site of the long head of the biceps tendon (LHBT) origin through the anterior portal.

LHBT with a suture passer (Fig 3B), and the thread is passed slightly distal to the thermal markings. Subsequently, the suture thread is retrieved through the lateral portal and loaded again onto the suture passer (Fig 3C). The suture passer is then placed deeply to pass the LHBT (Fig 3D) and positioned such that the needle is pointing into an open space. The suture thread is wrapped around the LHBT (Fig 3E), and the procedure is repeated one more time. The opposite end of the suture strand is used to confirm that the LHBT is inserted into the bicipital groove; 4 to 5 simple ties are then made (Fig 3F). The grasper placed through the lateral portal is once again used to hold the fixed biceps tendon at appropriate tension. By use of a fiber wire of a different color, identical sutures and ties are made to create a double secure loop (Fig 4). Subsequently, the remnant fixed LHBT as cut with an arthro-care device or scissors to approximately 10 mm (Fig 5). The remnant LHBT is then removed through the lateral portal. The operation is completed after an appropriate level of tension of the LHBT is confirmed.

Postoperative Management and Rehabilitation

Interscalene blocks are used for postoperative pain management. Patients wear an upper-extremity abduction brace for 4 weeks postoperatively that is removed 2 to 3 times per day for non-painful, gentle passive range-of-motion exercises (shoulder joint flexion, external rotation, and internal rotation). The brace is removed at postoperative week 4, and physiotherapy to recover shoulder joint range of motion, including pendulum and pulley exercises, is provided. Patients are prohibited from performing forceful elbow flexion and heavy lifting for the first 6 weeks. Active range-of-motion exercises are initiated at postoperative week 8. After the shoulder joint range of motion returns to the normal range, muscle

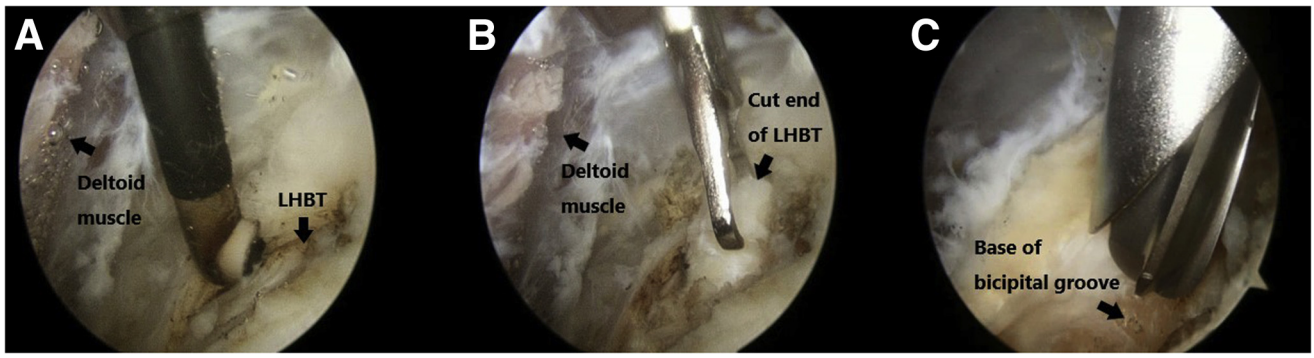

Fig 2. Subacromial space in the bicipital groove area in a left shoulder viewing from the posterolateral portal. (A) The rotator interval and the soft tissue covering the bicipital groove are removed with an arthro-care device. (B) A tendon grasper (Grasping Forceps; ConMed) is inserted to hold the cut end of the long head of the biceps tendon (LHBT). Whether the LHBT is freely movable should be confirmed. (C) Decortication is performed to prepare the bone bed, whereas cancellous bone is exposed at the site of LHBT fixation using an acromionizer.

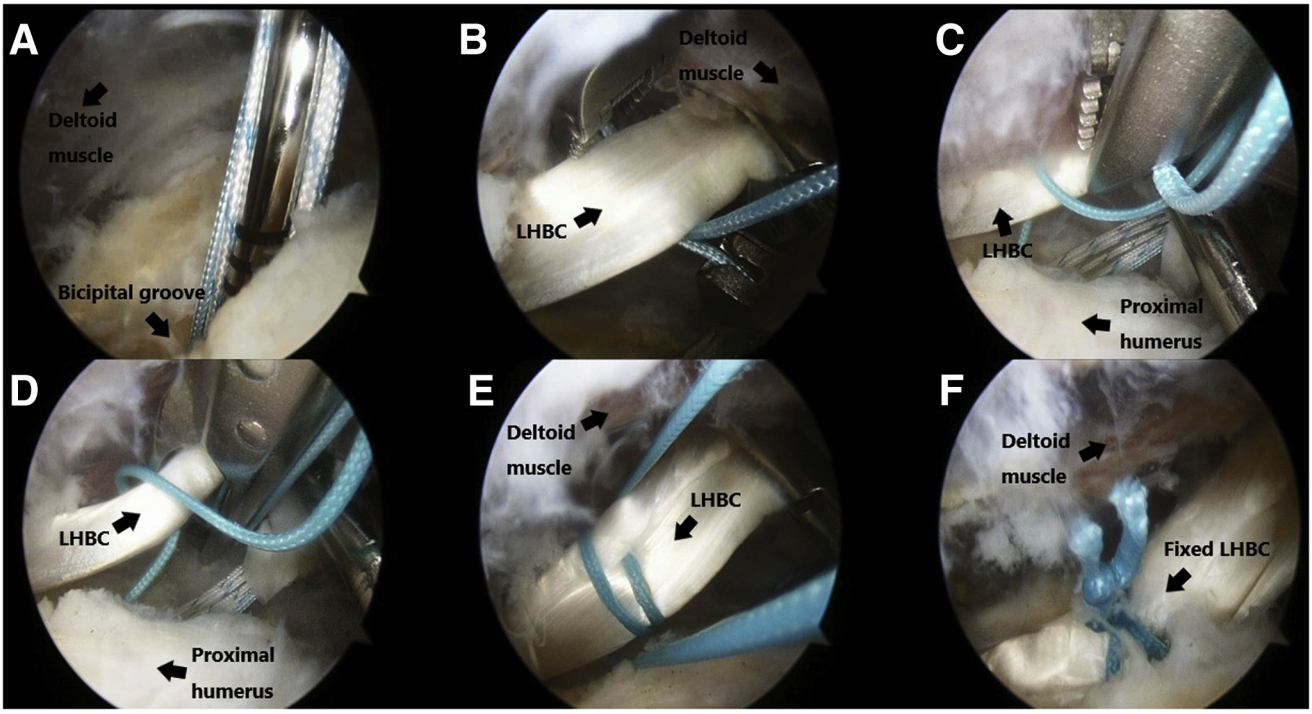

Fig 3. Tendon fixation in the subacromial space in the bicipital groove area in a left shoulder viewing from the posterolateral portal. (A) An all-suture anchor (Y-Knot RC All-Suture Anchor with 3 No. 2 Hi-Fi sutures) is inserted perpendicularly to the floor of the prepared bone bed. To prevent suture strand twisting, non-working threads are retrieved through the anterior portal. (B) Suturing of the long head of the biceps tendon (LHBT) is performed with a suture passer (Linvatec, Largo, FL) in the lateral portal. (C) The suture thread is loaded again onto the suture passer. (D) The suture passer is placed deeply to pass the LHBT. During manipulation of the suture passer, an assistant may pull the suture strand to create mild tension to prevent twisting. (E) The suture thread is wrapped around the LHBT. (F) Four or five simple ties are made and then cut by end-cutting scissors.

strengthening is initiated. After recovery of normal rotator cuff strength, the deltoid and periscapular muscles are strengthened to achieve normal shoulder joint function.

Discussion

LHBT lesions are common causes of shoulder joint pain, but their treatment remains controversial. In shoulder joint operations, if patients present with LHBT lesions or the LHBT causes their pain, proximal LHBT

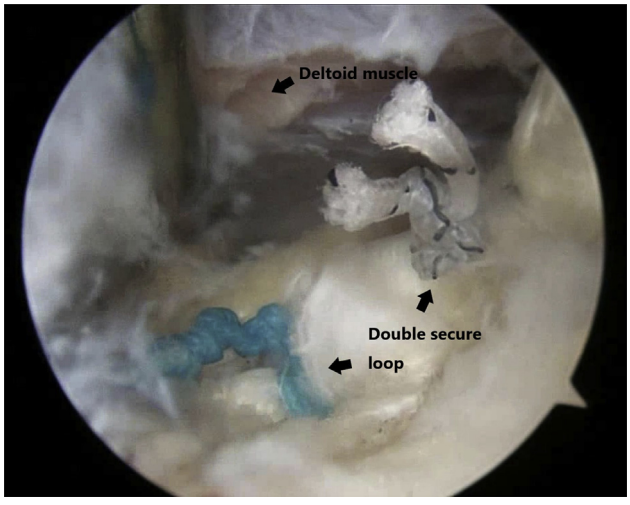

Fig 4. Tendon fixation in the subacromial space in the bicipital groove area in a left shoulder viewing from the posterolateral portal. One more fixation is made with a different-colored fiber wire, more proximal than the first.

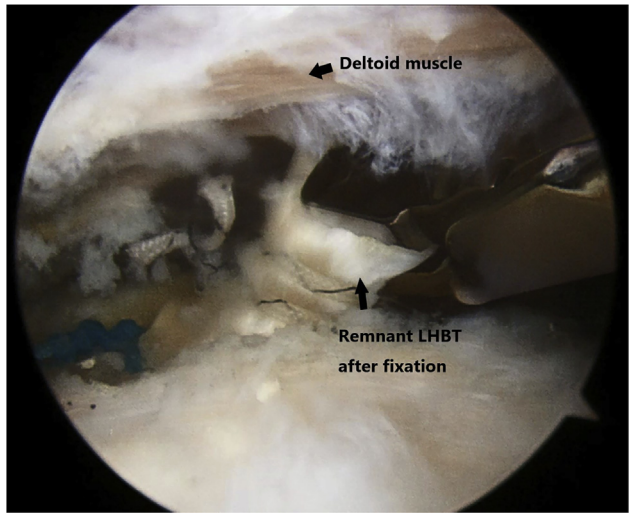

Fig 5. Tendon fixation in the subacromial space in the bicipital groove area in a left shoulder viewing from the posterolateral portal. After fixation, the remnant long head of the biceps tendon (LHBT) is cut with scissors.

Table 2. Advantages and Limitations

Advantages
Because the technique requires simple equipment and steps compared with other techniques, less experienced surgeons can easily perform biceps tenodesis.
One suture passer is required for rotator cuff repair and biceps tenodesis. The same portals can be used for rotator cuff repair with no need for additional incisions or portals.
Because only an all-suture anchor is used, there is a lower possibility of screw breakage or fracture.
Because only an all-suture anchor is used, there is a lower possibility of postoperative failure of biceps tenodesis or complications during implant pullout.
Because the all-suture anchor interferes minimally with magnetic resonance imaging, postoperative assessments are easy.
Limitations
If the quality of the LHBT is suboptimal, biceps tendon failure may occur distal to the double secure loop tie.
When the suture passer is manipulated through a single portal, the suture threads may be twisted.
Excessive decortication of the bicipital groove may lead to pullout of the all-suture anchor.

LHBT, long head of biceps tendon.

tenodesis or a tenotomy can be performed. In such cases, tenotomy can cause pain due to cramping or spasms and has shown more shoulder pain after surgery.[6] Open and arthroscopic approaches may be used for LHBT fixation, which can be achieved using interference screws, keyhole fixation, suture anchors, and sutures in the surrounding soft tissue.[1-4] Some authors have reported good outcomes of proximal fixation regardless of the specific LHBT fixation method used,[7] whereas others have reported poor outcomes from failure or persistent biceps pain after proximal tenodesis.[3] Frank et al.[8] performed a biomechanical study comparing interference screws with suture anchors and found that suture anchors showed good results in torsional stress. As such, the specific methods and efficacy of LHBT fixation remain controversial. Therefore, we aimed to introduce the double secure loop technique, a suprapectoral biceps tenodesis technique that enables easy and secure tenodesis using an all-suture anchor and a suture passer without the need for an additional skin incision or portal. Tenodesis using the all-suture anchor is simple and minimizes bone destruction at the fixation site, thus minimizing pain and enabling early rehabilitation. Moreover, it does not interfere with magnetic resonance imaging, which can be used postoperatively to evaluate the rotator cuff. In addition, the common complications of metal fixative devices, such as metal screws, can be avoided (Table 2).

In summary, the double secure loop technique with a suture passer using an all-suture anchor in biceps tenodesis can be considered an effective procedure. Through further studies, it may be necessary to investigate long-term outcomes in the future.

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