Technical Note

KAToB: Knotless All-Arthroscopic Intraarticular Tenodesis of the Biceps, An Efficient, Simple, Reproducible Technique

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Abstract: Biceps tenodesis is a commonly performed procedure. It can be done using a multitude of fixation methods, at multiple locations, and either open or arthroscopic, with little if any clinical differences in the literature. Yet, many techniques have drawbacks in the risk of complications or in the technical ease. Here we present what we have found to be an efficient, simple, reproducible technique: KAToB, Knotless All-arthroscopic intraarticular Tenodesis of the Biceps using a knotless anchor at the articular margin. This technique minimizes the risk of nerve injury, infection, and fracture; has good clinical outcomes; and has a low rate of failure.

Introduction (With Video Illustration)

Despite the success of biceps tenodesis, there is no consensus on the optimal site of tenodesis or the optimal method for fixation of the tendon.[1] Locations include intra-articular, the bicipital groove, the conjoined tendon, and subpectoral; fixation includes all-suture anchors, knotless anchors, screw-in anchors with knot tying, interference screws, and cortical buttons. In addition, each combination of location and fixation can be done both arthroscopically and open. Given the similar patient-reported outcomes between techniques,[1-3] surgeons are likely choosing their location, method, and approach based on theoretical advantages and disadvantanges as well as personal preferences.

Our preference is to modify an existing technique that is an all-arthroscopic, all-intra-articular, knotless fixation at the top of the groove.[4] It is simple, fast, and efficient and is done entirely through the anterior portal without the need to exteriorize the tendon. It carries a low risk of infection,[1] has a low risk of nerve injury,[5,6] and has no known risk of humeral fracture. The surgeon can recreate anatomic length or choose to lengthen the tendon based on the location of suturing. In addition, despite concerns about retaining the extra-articular tendon, there is no difference in anterior shoulder pain with proximal or distal tenodesis.[3] Importantly, it is a strong method of fixation with a low risk of clinical failure (Table 1).[4] We present the KAToB technique: Knotless All-arthroscopic intra-articular Tenodesis of the Biceps (Video 1).

Surgical Technique

Positioning

The patient is placed in the lateral position with a bean bag. The body is rolled slightly posteriorly, roughly 10 to 20°, to allow easier access for work on the anterior shoulder. The arm is suspended in balanced traction using the SPIDER (Smith & Nephew, Andover, MA) in 30° of elevation in the scapular plane.

Portal Placement

The anterior portal is localized in the rotator interval, ensuring access to the entire biceps tendon and the superolateral aspect of the lesser tuberosity (Table 2). More lateral placement of the portal can facilitate direct access to the proximal aspect of the bicipital groove, but this requires violation of the comma tissue, which we prefer to avoid.

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Table 1. Advantages and Disadvantages

Advantages	Disadvantages	Risks
All arthroscopic	Theoretical risk of groove pain from the extraarticular tendon	Groove pain
Efficient, uses a single anterior portal	Typically, not possible if biceps already avulsed	Fixation failure
Does not require exteriorization of tendon		
Good tendon fixation even with poor tissue quality		
Minimal risk of nerve injury compared with subpectoral tenodesis		
Lower risk of infection than open tenodesis		
No known risk of fracture		
Simple to incorporate an upper border subscapularis repair		

After inserting an 8.0-mm Dri-Lok Cannula (Stryker, Greenwood Village, CO), it is important to reassess its position before suturing. If it does not allow simultaneous access to the biceps and the top of the lesser tuberosity, this can be easily adjusted, by slightly withdrawing it out of the capsule and using the ablator or shaver to open the lateral aspect of the interval tissue further to allow better access once the cannula is reinserted.

Suturing and Tenotomy

The tendon is secured all-arthroscopically through the anterior portal without the need to exteriorize it. A suture-shuttling device that holds a length of suture within the device allows tissue penetration and suture shuttling to occur within a single portal without the need for a nitinol passing wire as an intermediary step. The surgeon can choose to recreate anatomic length and tension on the tendon by suturing it as far distal as possible, adjacent to the eventual anchor placement. Or, the surgeon can choose to tenodese the biceps in a lengthened, less-tensioned state by securing it further proximally by the labrum.

The mid aspect of a 1.2-mm XBraidTT tape (Stryker) is pulled into a 45° up-curved SlingShot suture passer (Stryker). Via the anterior portal, the Slingshot is advanced through the biceps tendon as eccentrically as possible to allow the suture to go around as much of the tendon as possible (Fig 1A). We prefer to penetrate the tendon rather than simply looping around it on this first pass, as this minimizes the suture inadvertently slipping during subsequent steps. The suture is then deployed, the SlingShot is withdrawn, and it is then used to retrieve the free, looped end of the suture. A racking hitch loop is made on the free, looped end, the 2 tails are pulled through the loop and pulled to secure the racking hitch down onto the tendon. One free tail of XBraidTT tape is loaded into the SlingShot for another pass for additional tendon fixation. It is ideally passed distal to the first pass (Fig 1B), and it is retrieved around the tendon in the opposite direction of the first pass.

The tendon is then tenotomized proximal to the sutures (Fig 1C) and the stump is debrided with a shaver (Fig 1D). Either before or after tenotomy, the low setting of the ablation wand is used to induce expansion of the cut end of the tendon to minimize the risk of suture slippage.

Anchor Placement

We use a knotless anchor with an decoupled eyelet and screw (Omega; Stryker). Because of its location, the bone socket is not directly visualized, as it is typically directly over the horizon of the humeral head. With the decoupled eyelet and screw, once the eyelet, loaded with the sutures, is inserted, the sutures entering and exiting the bone socket serve as a guiding path to the

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Ensure anterior portal has access to distal part of biceps and to top of lesser tuberosity	Inability to access both the tendon and the anchor insertion site from the cannula, and not correcting it before suturing
Correct poor cannula position before suturing by withdrawing cannula out of rotator interval slightly, debriding lateral side of interval opening, and reinserting the cannula	Capturing thin segments of tendon with suture passes
Fully tighten each pass of suture before proceeding	Not tightening suture before the next pass
Expand free end of tendon using thermal shrinkage to minimize risk of suture slippage	Cutting suture before or during tenotomy
If needed, use a posterior pull on proximal humerus, and possibly a 70° arthroscope, to aid visualization during anchor insertion	
If needed, externally rotate the humerus to allow better vector for anchor insertion	

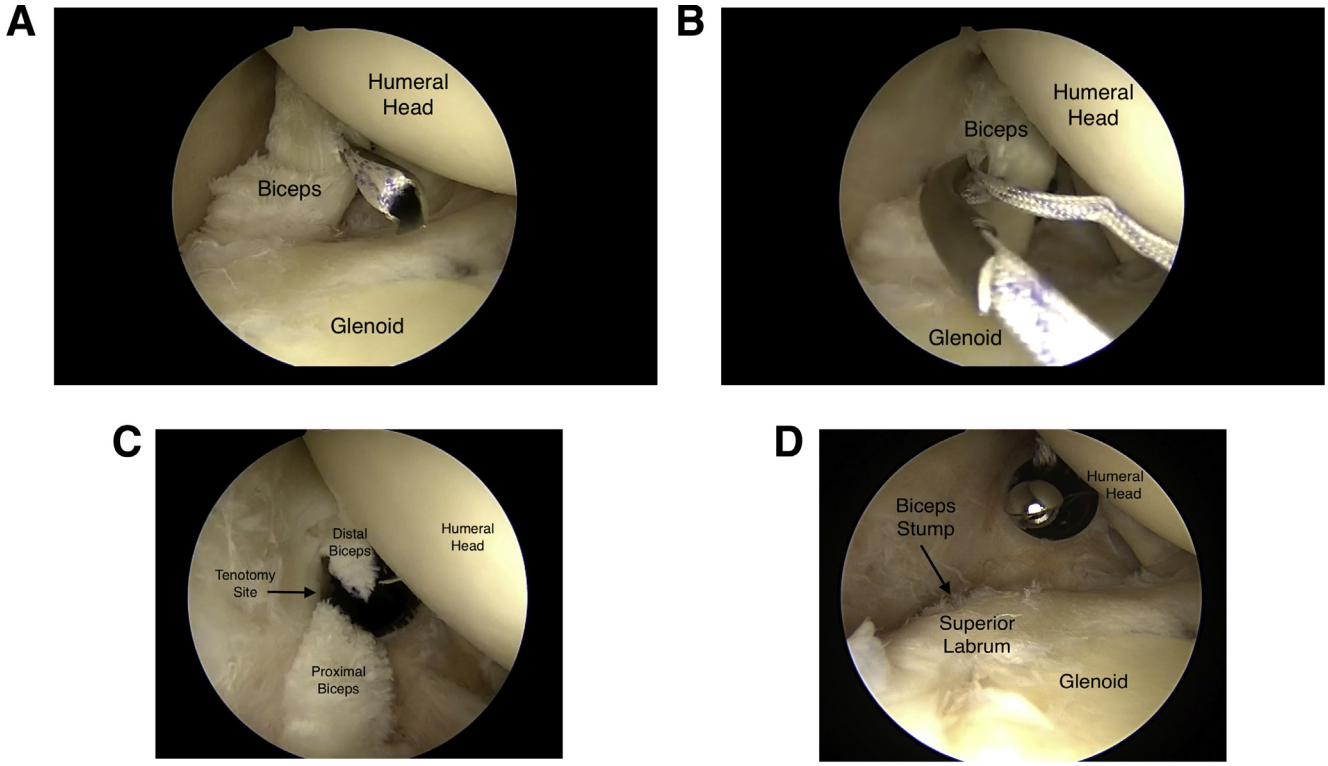

Fig 1. Tendon fixation. Arthroscopic views of a right glenohumeral joint in the lateral position from a posterior viewing portal. (A) A suture-shuttling device, a 45° up-curved SlingShot, is used to advance the middle of a 1.2-mm suture tape through the biceps tendon, as eccentrically as possible to capture as much of the tendon as possible. The suture is deployed, and the SlingShot is used to retrieve the suture around the tendon. The free tails are passed through the retrieved loop and a racking hitch is performed to secure the tendon. This first pass is through, rather than around, the tendon to minimize slippage during the remainder of the procedure. We prefer to secure the tendon as close to the bicipital groove as possible, as this is where the anchor will go, recreating anatomic length. To secure the tendon slightly off-tension, the suture can be passed closer to the labrum. (B) The SlingShot is used to advance one of the free tails through the tendon again for an additional point of fixation. This should be distal to the first pass and should loop the tendon in the opposite direction as the first pass. (C) The biceps tendon is cut using arthroscopic scissors proximal to the sutures roughly 5 to 10 mm to minimize the risk of cutting the sutures and the risk of suture slippage off the end of the tendon. (D) The remaining proximal biceps stump is debrided with a shaver back to the labrum.

hole. When using other knotless anchors, to facilitate finding the hole, the surgeon should consider removing any tissue covering the hole with the ablator, using a posterior push on the humeral head, possibly coloring the punch with methylene blue to leave a mark at the entrance, and/or even using a 70° arthroscope to facilitate visualization of the socket. After a few cases, these maneuvers are typically not needed.

To facilitate a better vector for anchor insertion, the humerus can be externally rotated. After eyelet insertion, the screw tip is inserted into the aperture, and tension is applied to the sutures to pull on the eyelet to seat it into the cancellous bone. Because of its asymmetrical design, it will turn and deflect into the cancellous bone into its final resting position. The surgeon then follows the exiting sutures back down to the bone socket (Fig 2A). We typically use the 3.9-mm screw (Fig 2B) in younger patients, but in patients with osteopenia, or when an upper border subscapularis repair is incorporated into the same anchor, we use the 4.75-mm screw. With the tip of the anchor in the socket, the sutures are definitively tensioned individually, and the screw is inserted flush with the cortex. The handle is removed, and the sutures are cut flush with the bone. This leaves the stump in the field of view in the normal intraarticular position of the native tendon (Fig 2C).

Discussion

KAToB (Knotless All-arthroscopic intraarticular Tenodesis Of the Biceps) is a simple, reliable technique that is intended to minimize the risk of many potential complications and drawbacks of other techniques without compromising the clinical outcome. The anchor is placed along the superior aspect of the lesser tuberosity/the superior aspect of the bicipital groove, which does not place the nerves at risk and may have a reduced risk of fracture, given that it is metaphyseal bone. The tendon is never exteriorized, nor does the bicipital sheath have to be opened. Suturing the tendon before it is

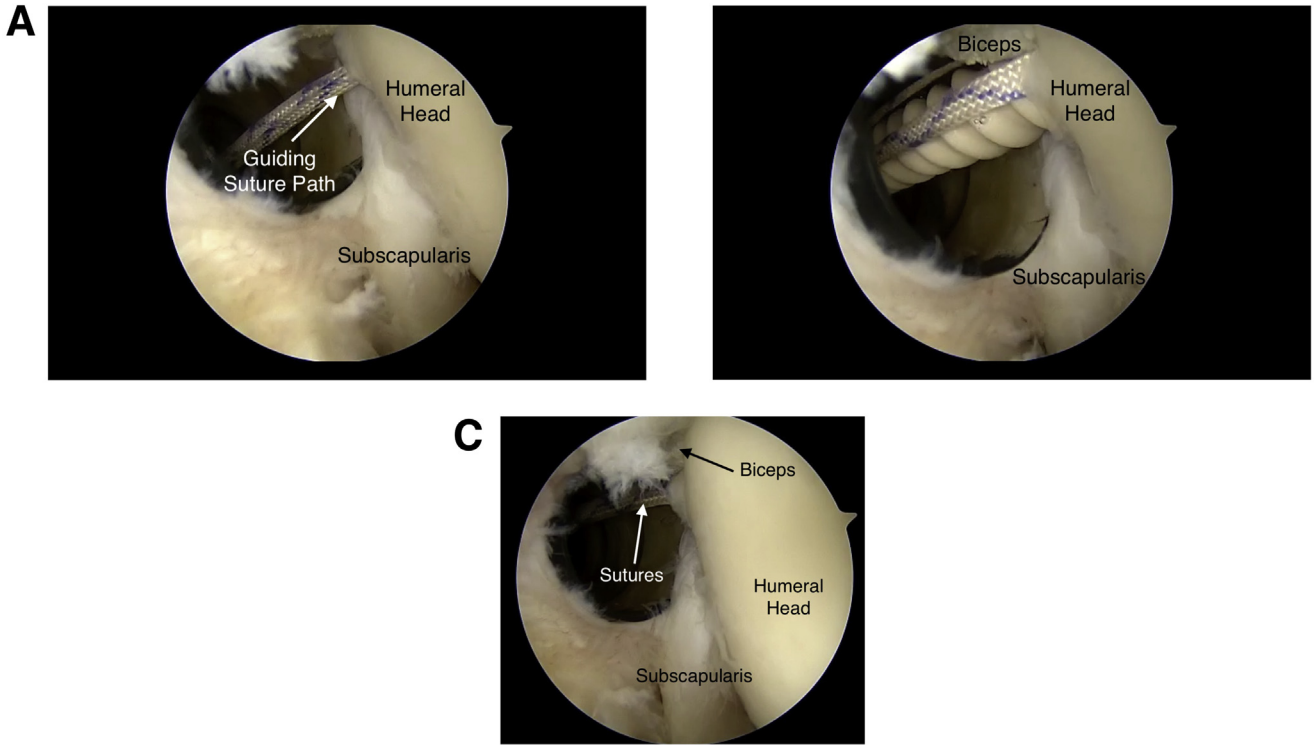

Fig 2. Anchor insertion. Arthroscopic views of a right glenohumeral joint in the lateral position from a posterior viewing portal. (A) An anchor that has a decoupled eyelet and anchor facilitates this procedure because the bone socket that would be created with a punch is never directly visualized. The self-punching eyelet, with sutures, are inserted first, and the sutures are used as a guiding path back to the bone socket. (B) The sutures are tensioned, and the screw is inserted flush with the cortex. (C) Final view of the biceps tenodesis before cutting the sutures.

tenotomized protects against overtensioning, and the surgeon can choose to keep anatomic length or lengthen the tendon based on whether the tendon is sutured distally near the site of tenodesis or proximally closer to the labrum. In addition, with an all-arthroscopic technique, the risk of infection remains low.[1]

Most importantly, there are no differences in functional outcomes or the failure rates between techniques described in literature.[1-3] Despite concerns about retaining the extra-articular portion of the biceps tendon, there is no difference in anterior shoulder pain between proximal and subpectoral tenodesis,[2,7] likely because there is no motion of the tendon within the groove after the tenodesis.[8] In addition, there is a low rate of tenodesis failure and Popeye deformity (0/59 cases).[4]

In contrast, subpectoral tenodesis carries real risks of potentially serious complications. The musculocutaneous nerve and brachial plexus are in close proximity, and injury to these nerves occurs 3 to 8 times more often with subpectoral than suprapectoral tenodesis.[5,6] The risk of infection is roughly 4 times greater (subpectoral 2.3% compared with 0.6% arthroscopic).[1] In addition, the creation of drill hole in this area of high-stress diaphyseal bone leads to a 20% to 30% reduction in the torsional strength of the humerus and can lead to humeral shaft fracture.[9-11] If done arthroscopically within the bicipital groove, setting the correct length and tension can be difficult and, on average, overtensions the biceps by 2.2 cm.[12] Furthermore, exposing the bicipital groove arthroscopically can be difficult when encountering the circumflex and arcuate vessels. Most techniques for intra-articular tenodesis require exteriorizing the tendon to secure it with suture before fixation, which can be difficult and introduces the risk of trapping fibers of the deltoid. In addition, one study showed that interference screws have a greater failure rate clinically than suture anchors do.[13]

The potential limitation of this technique is that it leaves the extra-articular portion of the tendon within the bicipital groove. This is a potential source of pain; however, the tendon is no longer moving within the groove.[13] This immobilization is likely responsible for the pain relief. Importantly, there is no difference in anterior shoulder pain between a proximal or distal tenodesis.[12]

We have found the KAToB technique to be an efficient, simple, reproducible technique for which the authors have found a high rate of clinical success and a low risk of complications.

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