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 disadvantages 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 supperolateral 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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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 anchor placement.

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 | | |

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 | |
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 tendon (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
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 supraperiosteal tenodesis.5,6 The risk of infection is roughly 4 times greater (subpectoral 2.3% compared with 0.6% arthroscopic).4 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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