Technical Note

Distal Biceps Repair Using an All-Suture Anchor Technique

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Abstract: Distal biceps ruptures are common injuries that lead to significant decrease in elbow supination strength and pain. This Technical Note describes a single-incision distal biceps tendon repair using 2 knotless suture anchors. This technique is easily reproducible, is efficient, and has the unique benefits of decreasing the risk of heterotopic ossification and damage to neurovascular structure while providing similar outcomes to other described fixation techniques.

Distal biceps tendon ruptures are uncommon injuries and are thought to most commonly occur during eccentric loading of the biceps tendon.[1,2] The classic mechanism of injury occurs when the elbow is forcefully extended from an already-flexed position.[3] It has been estimated that the annual incidence of distal bicep tendon ruptures occurs at a rate of 1.2 per 100,000 patients and more commonly affect the dominant extremity.[1] The biceps tendon has an integral role in supination and flexion of the elbow and is the strongest elbow supinator. Nonoperative management results in significant loss in elbow supination strength. Thus, operative intervention is the standard of care and has shown superior functional outcomes with increased supination and flexion strength.[4-7]

Multiple different types of operative interventions have been proposed. However, there is no clear consensus on the ideal method of fixation. Both 1- and 2-incision techniques have been proposed. The 1-incision technique has an increased risk of nerve injury; however, the 2-incision technique requires crossing the interosseous membrane and has greater rates of radioulnar synostosis.[8,9] A recent systematic review compared multiple different fixation strategies and showed that bone tunnel and cortical button fixation demonstrated significantly lower complication rates compared with suture anchor and intraosseous screw technique.[10] Another systematic review evaluating different fixation techniques demonstrated cortical button fixation provided a greater load to failure compared with bone tunnels, intraosseous screws, and suture anchors. However, more recent studies have shown all-suture anchors to have decreased complication rates and have been shown to have similar clinical outcomes compared with other fixation techniques.[3,11-13] Table 1 describes the advantages and disadvantages of this surgical technique. We propose a novel technique with the benefits of decreasing the risk of injury to the posterior interosseous nerve, decreasing the risk of heterotopic ossification, while providing similar functional outcomes compared to other fixation strategies.

Surgical Technique (With Video Illustration)

The patient is placed supine on the operating table and the operative extremity is placed on an arm table. A tourniquet may be used, either sterile or unsterile, depending on degree of retraction of the biceps tendon and the patient's body habitus. After exsanguination of the upper extremity and insufflation of the tourniquet, a transverse 3.5-cm incision is used directly over radial tuberosity just distal to the antecubital fossa (Fig 1). If

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Table 1. Advantages and Disadvantages of This Technique

Advantages	Disadvantages
Restoration of supination and flexion strength with simple reproducibility	Risk of damage to lateral antebrachial cutaneous nerve
Decreased risk of heterotopic ossification using a one-incision technique	Open approach with scar
Similar construct strength compared with other techniques	

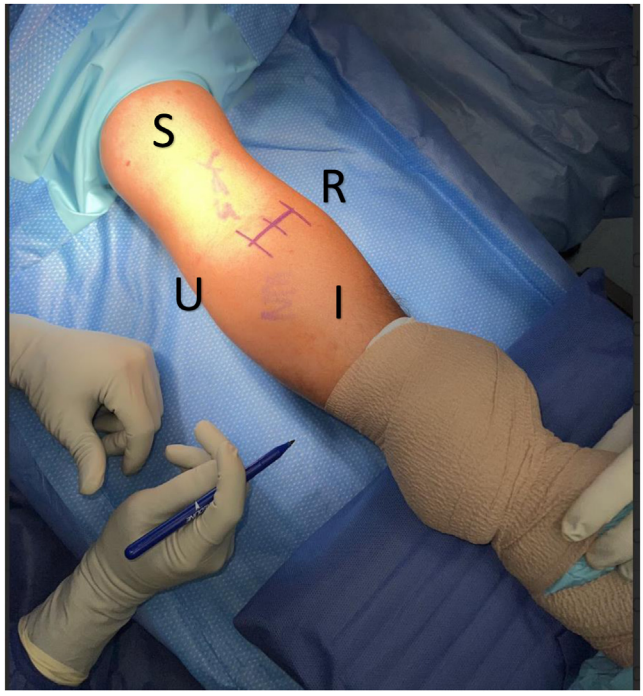

Fig 1. In a left upper extremity, the patient is placed in the supine position. An arm board is used to support the left upper extremity. A nonsterile tourniquet is placed over the proximal brachium. A sterile stockinette and Coban are used to cover the hand and wrist. The superior (S), inferior (I), radial (R), and ulnar (U) aspects of the limb are identified and confirmed and all anatomic landmarks are identified. A standard 3-cm transverse incision is planned out just distal to the antebrachial fossa and over the radial tuberosity.

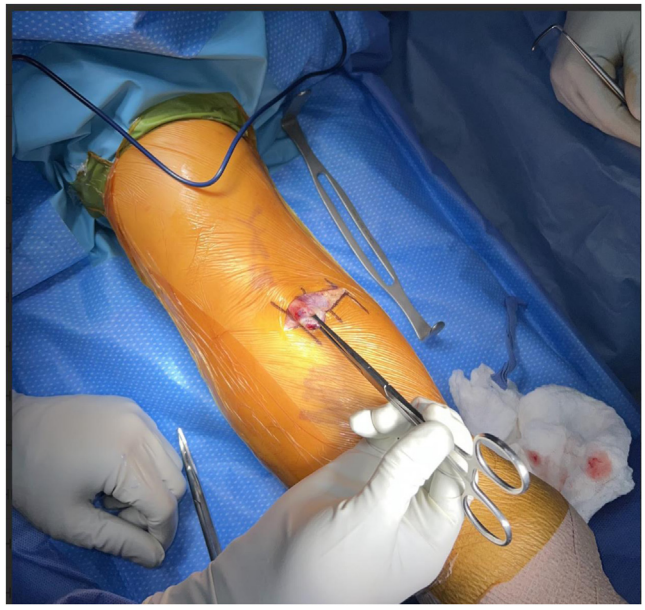

Fig 2. In the left upper extremity, the transverse incision is made with a 15-blade scalpel. The antebrachial fascia is incised and the interval between pronator teres and brachioradialis is identified. Deep dissection with tenotomy scissors to identify the distal biceps ruptured tendon stump. The lateral antebrachial cutaneous nerve is identified and protected throughout the entirety of the case. The distal biceps tendon stump is then grasped with an Allis clamp. Blunt dissection with the surgeon's finger is used to free up the tendon proximally from scar tissue for improved mobilization. The distal biceps stump is then mobilized outside of the surgical wound.

significant tendon retraction is present, a second small horizonal incision proximally. Great care is taken to keep the arm in a supinated position for protection of neurovascular structures and exposure of radial tuberosity.

The skin is incised with a 15-blade scalpel and antebrachial fascia is sharply incised. The interval between brachioradialis and pronator teres is identified. Careful dissection with tenotomy scissors is performed to identify the tendon stump. The lateral antebrachial cutaneous nerve is visualized and protected throughout the entirety of the case. Dissection is taken down and the distal biceps tendon stump is identified and grasped with an Allis clamp (Fig 2). Blunt finger dissection is used to free up the tendon from any scar tissue to assist with mobilization. Next, the tendon is prepared using a #2 FiberLoop suture (Arthrex, Naples, FL) in a whipstitch fashion (Fig 3). The last pass of the suture is backtracked one throw to lock the suture. The loop is then cut and tied to make a closed loop.

We then palpate distally and find the path of the biceps tendon down to its insertion at the radial tuberosity. Mini Hohmann retractors are then placed with great caution on the radial and ulnar side of the radial tuberosity for adequate visualization of the distal biceps tendon insertion footprint (Fig 4). If residual biceps tendon remains at its insertion, this is removed sharply with a scalpel and key elevator. Once the insertion site is prepared, a 1.8-mm knotless FiberTak (Arthrex) anchor is placed unicortically at the most distal aspect of the

Fig 3. In the left upper extremity, the distal biceps tendon is sufficiently mobilized and brought outside of the surgical wound. The tendon is then prepared with a #2 FiberLoop suture (Arthrex). Starting in the most distal aspect of the tendon, the suture is whipstitched up and down both sides of the tendon in a Krakow fashion. The last pass of the suture is backtracked one throw to lock the suture. Once the suture is complete, there will be 2 limbs available at the end of the tendon.

Fig 4. In the left upper extremity, the distal biceps tendon is satisfactorily prepared with suture. The surgeon then carefully palpates distally finding the path of the distal biceps tendon to the radial tuberosity. Mini Hohmann retractors are placed with great caution on the radial and ulnar side of the radial tuberosity and biceps insertion for visualization of the radial tuberosity. If residual biceps tendon scarring remains at its insertion, this is sharply removed with a combination of a scalpel and key elevator for preparation of the repair.

native biceps footprint. This is malleted into place and set. A second 1.8-mm knotless FiberTak (Arthrex) anchor is placed unicortically at the proximal aspect of the distal biceps footprint, which is approximately 2 cm proximal to the other anchor. The previous whipstitch is then grasped and tension is pulled on the prepared distal biceps tendon. The repair stitch from the more distal anchor is then passed through distal end of prepared biceps tendon using a free needle (Fig 5). This is then passed through the knotless anchor using a passing stitch but not fully tightened down. Next, the repair stitch from proximal anchor is passed through distal biceps approximately 1.5- to 2-cm proximal to the distal aspect of prepared tendon stump (Fig 6). The looped end of the passing suture is passed under the tendon before passing the repair stitch for more compression. The repair stitch is then shuttled through the knotless anchor, however, not fully tightened. The knotless anchors are then tightened sequentially, distal first, then proximal. We alternate back and forth between 2 anchors for final tightening. The repair stitch from distal anchor is then tied to the 2 remaining sutures from the whipstitch for backup fixation (Fig 7). The excess suture is then cut.

We then irrigate and the tourniquet is let down and hemostasis is achieved. The repaired biceps tendon is inspected one final time (Fig 8). After confirming adequate hemostasis, we then close in a layered fashion using 3-0 MONOCRYL and a running 3-0 PROLENE suture. A sterile dressing is applied, and a well-padded posterior splint in 70° to 80° of flexion. Please see Video 1 for in depth detail of the surgical technique.

Postoperatively, the patient is kept in a splint for 2 weeks. Physical therapy starts at 2 weeks with passive motion. The patient is kept in a brace until week 6. Passive and active assisted supination and flexion start at week 3. Full motion should be present by end of week 6. Biceps isometrics are started at week 8, isotonics are started at week 10, with eccentrics started at week 12-14. Restrictions are expected to be lifted depending on patients demands at 16-26 weeks. Plyometric exercises are started at week 16 postoperatively.

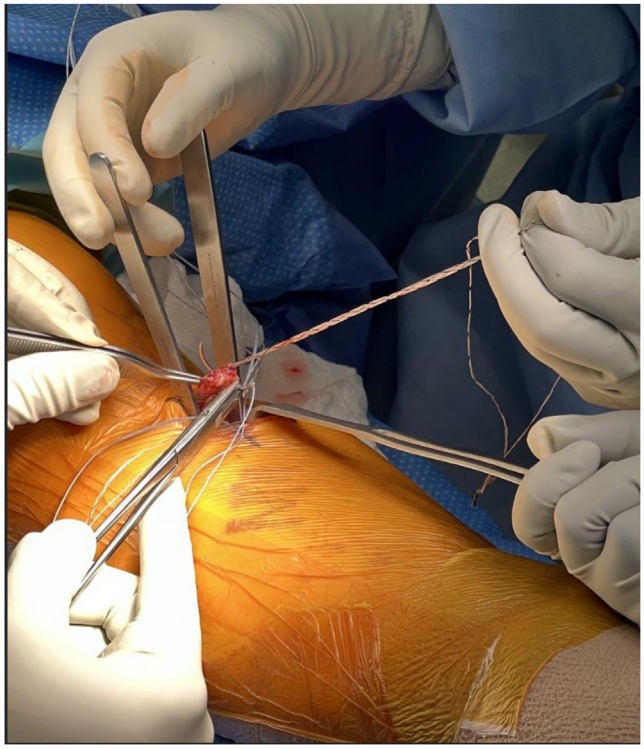

Fig 5. In the left upper extremity, after the two 1.8-mm knotless FiberTak (Arthrex) have been placed in the radial tuberosity, The surgeon grasps the last locked loop of the previously placed suture to pull tension on the biceps tendon for ease of the repair stitch placement. The repair stitch from the most distal FiberTak (Arthrex) is passed through the distal end of the prepared biceps tendon using a free needle. This is then passed through the knotless anchor passing stitch, but not yet fully tightened down.

Fig 6. In the left upper extremity, after the more distal FiberTak (Arthrex) anchor repair stitch has been placed and prepared, the more proximal knotless anchor repair stitch is used. The repair stitch is placed proximal in the tendon approximately 2 cm proximal to the most distal aspect of the biceps tendon stump. The looped end of the passing suture is then passed under the tendon before passing the repair stitch in order to pull the repair stitch around the tendon to allow for more compression. The repair stitch is then then shuttled through the knotless anchor but not fully tightened.

Discussion/Conclusion

There is no clear consensus on the ideal method of fixation for distal biceps tendon rupture. Currently, the 4 main fixation methods include suture anchors, cortical buttons, intraosseous screws, and bone tunnels. Although there are multiple different strategies for surgical management of distal biceps ruptures that obtain satisfactory patient outcomes, we provide a novel technique that maintains the advantages of the one-incision technique while allowing for decreased complications and more consistent fixation compared with other current suture anchor and button techniques.

Using a one-incision technique, this has a decreased risk of radioulnar synostosis compared with a 2-incision technique, as well as the decreased complications and improved cosmesis from not having a separate surgical site.[8,9] In addition, recent meta-analysis has shown increased postoperative pronation range of motion compared with the 2-incision technique. This is thought to be due to dissection of the supinator required by the 2-incision technique, resulting in increased postoperative fibrosis.[14] Initial studies demonstrated greater risk of nerve injury in the one incision technique; however, recent developments in fixation devices limit the need for extensive dissection of the cubital fossa and now demonstrate low level of transient nerve injury.[15]

The small, 1.8-mm all-suture anchor mitigates the risks associated with other fixation devices, without sacrificing strength of fixation. A recent study by Otto et al.[13] showed no significant difference in mean peak failure load or repair construct stiffness between titanium suture anchor and all suture anchors. A recent meta-analysis demonstrated no significant difference in postoperative strength ratio to the uninjured limb with flexion and supination strength when comparing cortical buttons, suture anchors, and transosseous suture.[14] The use of a knotless suture anchor compared

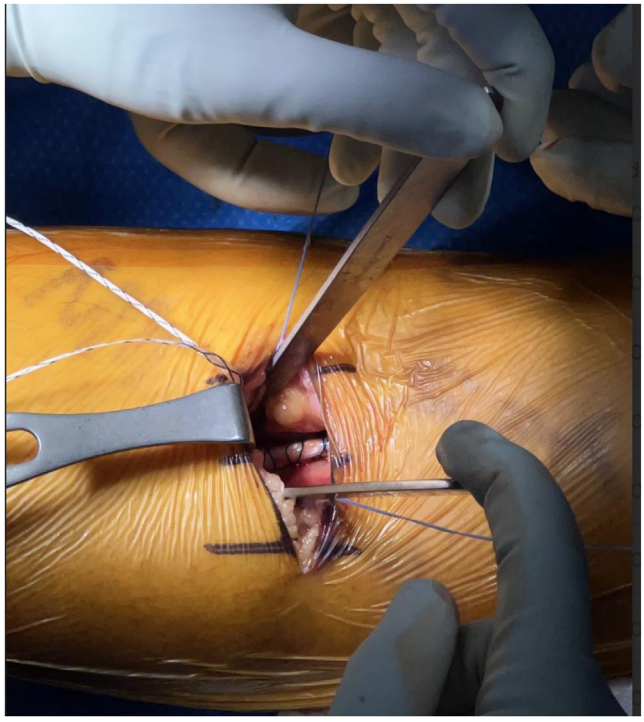

Fig 7. In the left upper extremity, the 2 repair stitches have been fully prepared. The knotless anchors are tightened sequentially starting with the most distal repair stitch and then finally the more proximal repair stitch. Sequential tightening is performed between the more distal and more proximal repair stitches to allow for maximal tightening. The repair stitch from the more distal anchor is then tied to the 2 remaining sutures (more proximal anchor repair stitch and whipstitch) for backup fixation.

Fig 8. In the left upper extremity, the 2 repair stitches have been fully prepared. The knotless anchors are tightened sequentially starting with the most distal repair stitch and then finally the more proximal repair stitch. Sequential tightening is performed between the more distal and more proximal repair stitches to allow for maximal tightening. The repair stitch from the more distal anchor is then tied to the 2 remaining sutures (more proximal anchor repair stitch and whipstitch) for backup fixation. The excess suture is then cut with a short 2- to 5-mm tail.

with an inlay intraosseous screw decreases radial neck fracture risk, as well as radial tuberosity osteolysis.[16] This has been related to the substantially sized bone tunnel required for interference screws, without significant clinical benefit.[17] In addition, this onlay technique significantly reduces the stress riser effect of a bone socket especially important in contact athletes. Two-anchor fixation also allows ease of sequentially tightening anchors and reducing tendon to footprint in various degrees of elbow flexion as the tear and degree of retraction and scaring dictate. With our knotless suture anchor technique, there is no need to reduce the biceps tendon into bone, which can be especially important in chronic, retracted tears. Finally, due to the small size of the 1.8-mm anchors setting the anchor unicortically is made much easier than a larger soft anchor or cortical button, significantly simplifying this sometimes-problematic step in the case. Our fixation strategy for distal biceps ruptures provides efficiency, reproducibility, increased safety, and adequate strength to allow for accelerated rehabilitation.

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