**Distal Triceps Knotless Anatomic Footprint Repair: A New Technique**

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**Abstract:** Distal triceps rupture is a rare injury causing significant disability. Several techniques for treating distal triceps ruptures have been described using bone tunnels or suture anchors. More recent techniques have focused on re-creating the anatomic footprint of the distal triceps tendon. However, the increasing numbers of anchors used increase the risk to the articular surface, and all earlier techniques require knot tying and bulky knots beneath the thin posterior elbow soft-tissue envelope. We describe a technique combining the use of bone tunnels and a single suture anchor to create a knotless anatomic footprint repair of the distal triceps. By using this technique, we are able to create a tension-band construct that self-reinforces the anatomic repair and is very low profile while significantly decreasing risk to the articular surface.

Distal triceps tendon ruptures are rare injuries. In their review of 1,041 tendon injuries, Anzel et al. found 0.8% involved the distal triceps. Injury to the distal triceps is most often the result of an eccentric muscle contraction. Direct blows and lacerations have also been described as potential mechanisms of injury. Spontaneous triceps tendon ruptures have been described with associated systemic diseases (e.g., hyperparathyroidism), corticosteroid use and injection, or anabolic steroid use or abuse. High-risk populations include men and professional football players. Although most ruptures occur at the insertion to the olecranon, partial tears, musculotendinous junction tears, and muscle belly tears have also been described.

Standard traditional surgical treatment of triceps tendon ruptures is transosseous cruciate repair (Fig 1). One suture is placed in Krackow fashion in the distal triceps tendon, passed through crossed bone tunnels traversing the olecranon, and tied over a bone bridge. The results of this technique are mixed, with a rerupture rate of up to 21% in 1 study. A second, biomechanical study showed that triceps tendons after transosseous cruciate repair are significantly weaker than intact tendons, with a mean load to failure of 317 N versus 1,741 N.
With the expansion of the use of arthroscopic rotator cuff transosseous-equivalent repairs, techniques have been developed to mimic these techniques for the distal triceps. These techniques have included suture anchor single-row techniques and double-row techniques attempting to re-create the anatomic triceps footprint. Most recently, Yeh et al.\textsuperscript{12} compared the anatomic and biomechanical properties of the standard transosseous cruciate suture technique with both a single-row 2–suture anchor repair and their “anatomic” transosseous-equivalent repair method featuring 4 suture anchors in a double-row configuration. They showed...
better footprint coverage and decreased gap formation with their anatomic repair, as well as a trend toward increased load to yield that did not reach statistical significance.

The risks associated with all previously described suture anchor–based techniques include intra-articular ulnohumeral joint breach, knot failure, and bursal and cutaneous irritation by the subcutaneous knots needed to secure the repair. We describe a technique combining 2 bone tunnels and 1 knotless suture anchor (4.75-mm Biocomposite SwiveLock; Arthrex, Naples, FL) for an anatomic distal triceps repair. This repair has been shown in a biomechanical study by Clark et al.\textsuperscript{13} to offer properties superior to the gold standard transosseous cruciate repair while maintaining anatomic footprint coverage and compression. The use of a single anchor distal to the joint and a knotless technique significantly decreases the risk of iatrogenic injury. Furthermore, this repair functions as a tension-band construct in vivo. These attributes allow for accelerated rehabilitation and have the potential for improved healing, which will be studied in future clinical studies.

**Knotless Footprint Triceps Repair Technique**

**Soft-Tissue Preparation**

A standard posterior approach to the elbow is performed with the patient in the lateral or prone position, based on surgeon preference. The torn distal triceps tendon is identified, mobilized, and debrided of devitalized tissue. The proximal margin of the triceps tendon footprint is identified and marked superficial and deep to the tendon with a surgical marking pen. Two No. 2 Arthrex FiberWire sutures, 1 on the medial side and 1 on the lateral side, are then passed in locking Krackow fashion starting and ending at the anterior or deep aspect of the triceps tendon at the proximal footprint line (Fig 2A). Two Arthrex FiberLink sutures, 1 medial and 1 lateral, are then passed at the proximal footprint line, with the looped ends of these sutures exiting the posterior and superficial triceps tendon between the medial and lateral Krackow strand pairs, respectively (Fig 2B). This completes the tendon preparation.

**Bone Preparation**

The olecranon is then prepared. First, the triceps footprint is debrided to a clean bony bed that may be excoriated for improved healing response. Two parallel 2-mm drill tunnels are made from the proximal footprint distally to the dorsal ulnar surface. These tunnels should be far medial and lateral while avoiding penetration of the joint surface (Fig 3 A and B). The tunnels should be spread such that there is enough space between the dorsal ulna exit points to place a single 4.75-mm Biocomposite SwiveLock suture anchor between the 2-mm tunnels. The ulna is then predrilled and tapped for the 4.75-mm SwiveLock anchor, aiming away from the joint, starting between the exits of the 2-mm tunnels (Fig 3C). This completes the bone preparation.

**Suture Passage and Securing Tendon**

A suture shuttling device such as a Hewson suture (Smith & Nephew, Andover, MA) passer is then used for the initial suture passage. The 3 medial sutures, 1 FiberLink tail and the 2 tails from the medial Krackow stitch, are passed through the medial tunnel from proximal to distal, whereas the 3 lateral suture tails are passed through the lateral tunnel (Fig 4A). The medial strands are then marked with a marking pen. Conversely, as shown in Video 1, a mix of Arthrex FiberWire and TigerWire and Arthrex FiberLink and TigerLink sutures can be used to avoid confusion during this step. One tail each from the medial and lateral Krackow strands, now exiting the dorsal ulna, are then back-passed to the medial and lateral FiberLink loops (Fig 4B). The FiberLink suture tails, exiting the dorsal ulna, are then pulled, acting as shuttles for the 4 Krackow suture tails through the triceps and olecranon for a second time, creating a “box-and-x” footprint compression configuration (Fig 4C). The sutures are tensioned and carefully aligned over the distal triceps footprint tab. At this point, the suture ends are passed through the eyelet of the 4.75-mm Biocomposite SwiveLock.
SwiveLock suture anchor, with passage of 2 strands from medial to lateral and 2 strands from lateral to medial (Fig 5A). The anchor is then seated into the previously prepared hole (Fig 5B). The elbow is cycled, and the sutures undergo final tensioning. The anchor is then placed by screwing it into the olecranon until flush with the cortex for cortical compression, completing the repair (Fig 5C). Excess suture is cut, and a standard closure is performed. The patient undergoes splint placement at 90° of elbow flexion and neutral supination and pronation until the sutures are removed at 10 to 14 days postoperatively. As shown in Video 1,
this technique achieves significant footprint coverage and a stable platform on which to advance the patient through the postoperative rehabilitation period.

**Postoperative Protocol**

The patient’s elbow remains splinted until 10 to 14 days postoperatively, at which time the sutures are removed and the elbow is transitioned to a range of motion—type brace. Passive range of motion from 20° to 90° in the brace is then begun. Range of motion is progressed at 10° per week in both flexion and extension, with a goal of full motion by 6 to 8 weeks postoperatively. Active-assisted motion is allowed after 4 weeks, and finally, active motion is initiated after 8 weeks. Return to work or sports is not recommended until the operative side has reached full range of motion and at least 85% of the contralateral triceps strength.

**Discussion**

On the basis of biomechanical testing in a cadaveric model, knotless anatomic footprint repair of a distal triceps tendon tear has significantly higher load- and cycle-to-failure properties than the traditional transosseous cruciate repair and shows minimal repair-site motion. By keeping in mind the tips in Table 1,
early clinical results at our institution with this technique have been promising. The advantages of this technique include its superior biomechanical profile and the low-profile nature of the repair. The possible risks of this technique include soft-tissue envelope complications, bone tunnel failure, suture failure, implant failure, and fracture.

**Acknowledgment**

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**References**

1. Anzel SH, Covey KW, Weiner AD, Lipscomb PR. Disruption of muscles and tendons; an analysis of 1,014 cases. *Surgery* 1959;45:406-414.