Single-Incision Anatomic Repair Technique for Distal Biceps Tendon Rupture Using Tunneling Device

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Abstract: Distal biceps tendon ruptures are uncommon and generally occur in men aged 30 to 50 years in their dominant arm as a result of a strong eccentric load. Numerous surgical exposures and methods of fixation exist for repair of a ruptured distal biceps tendon. The goal of surgical management is to restore the anatomic footprint of the biceps tendon on the radial tuberosity to maximize flexion strength, supination strength, and muscle endurance. When compared with 2-incision repair techniques, single-incision repairs historically may not have restored the anatomic footprint of the distal biceps. Single-incision repair with the ArthroTunneler is a safe and effective technique that provides the anatomic restoration of a 2-incision approach with the decreased complication profile of a single-incision approach and does not require suture anchors, buttons, screws, or other implants.

Distal biceps tendon ruptures are an uncommon occurrence, with an incidence of 1.2 cases per 100,000 per year.[1] The injuries typically occur to men aged 30 to 50 years when an unconventional load is placed on a partially flexed upper extremity, resulting in an unexpected eccentric load on the biceps tendon.[2] Clinically, these patients present with pain and bruising in the distal arm and proximal forearm along with decreased flexion and supination strength. Physical examination shows a space in the antecubital fossa normally occupied by the biceps tendon that is more prominent during flexion. Imaging studies, including ultrasound or magnetic resonance imaging, may confirm the diagnosis. However, the clinical history combined with the physical examination is typically sufficient for diagnosis.[3]

Multiple factors must be considered when deciding on operative versus nonoperative management. In older and inactive patients or in patients with multiple medical comorbidities, conservative management may be considered. In patients who are seeking to restore muscle endurance, flexion strength, and supination strength, surgical intervention is indicated.[4] Surgical approaches are aimed at restoring the biceps tendon on the anatomic footprint of the dorsal and ulnar aspect of the radial tuberosity, as Forthman et al.[5] have described (Fig 1). There are numerous approaches and techniques available for distal biceps rupture repair. Approaches include a single-incision anterior approach or 2-incision posterior approach, and fixation techniques include use of a tenodesis screw, the tension slide technique with a cortical EndoButton (Smith & Nephew Endoscopy, Andover, MA), suture anchors, and a double-incision bone tunnel[2,6] (Fig 2). Currently, there is no consensus on surgical repair technique. Each approach has a unique complication profile.[7-10] Two-incision techniques tend to have higher overall rates of complications, including heterotopic ossification and radioulnar synostosis.[11] Single-incision techniques tend to have higher rates of neurapraxia.

We describe a single-incision technique that allows for restoration of the biceps anatomic footprint with tendon contact with the dorsal and ulnar aspect of the radial tuberosity while minimizing the complications associated with the 2-incision technique. To accomplish this, the surgeon must use a tunnel creation device that allows passage of the sutures through 2 drill tunnels through the radial tuberosity, allowing the tendon to be placed at the most dorsal and ulnar aspect of the radial tuberosity and allowing the biceps tendon to be sewn directly to the radial tuberosity.

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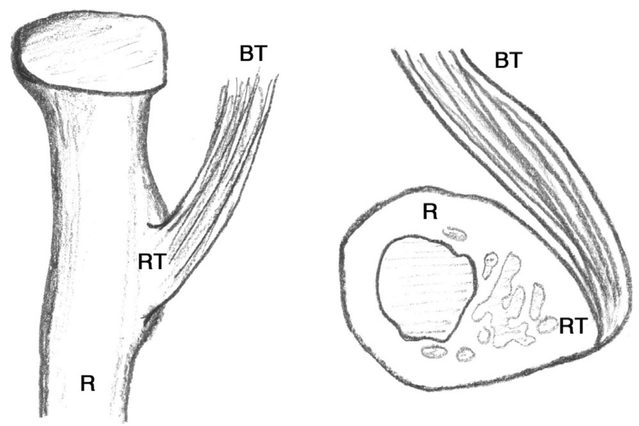

Fig 1. Superior and cross-sectional views of the normal anatomic insertion of the distal biceps tendon (BT) into the medial aspect of the right radial tuberosity (RT) in a patient in the supine position. (R, radius.)

Surgical Technique

The patient is placed in the supine position with the arm on the hand table (Video 1). The arm is then prepared and draped in a sterile fashion. The arm is exsanguinated and the sterile tourniquet inflated. A standard anterior approach to the anterior aspect of the antecubital fossa is performed. An incision line is marked starting at the antecubital fossa and extending distally roughly 4 cm on the ulnar border of the brachioradialis. Tenotomy scissors are used to dissect along the medial border of the brachioradialis. Attention should be made to identify and protect the lateral antebrachial cutaneous nerve and radial artery laterally while protecting the medial nerve and ulnar artery medially. Branches of the recurrent radial artery may be identified and ligated. Dissection is continued deep between the pronator teres ulnarly and brachioradialis laterally until the radial tuberosity is identified. The distal biceps tendon, which is often retracted proximally, should be identified, debrided, and prepared using nonabsorbable No. 2 braided polyblend suture (FiberWire; Arthrex, Naples, FL) with a locking whipstitch configuration.

The radial tuberosity should be debrided, and the ArthroTunneler device from the TunnelPro system (Tornier, Bloomington, MN) is placed around the ulnar side of the radial tuberosity (Fig 3A). The nitinol loop from the device is deployed. We believe that slight ulnar deviation from the center of the radial tuberosity while in maximal supination is an ideal location for the drill holes. The first hole should be drilled in a bicortical manner through the radial tuberosity by use of the 2.5-mm drill provided in the kit (Tornier) through the ArthroTunneler device. A free suture is passed using the provided Suture Inserter and passed through the ArthroTunneler, drill hole, and nitinol loop (Fig 3B). The nitinol loop is then used to capture the free suture on the posterior aspect of the radius. This passing suture is used to retrieve one free suture end from the locking whipstitch on the distal biceps tendon (Fig 3C). The free suture end from the biceps tendon is passed from the deep dorsal drill hole and pulled out through the drill hole in the volar cortex.

These steps are repeated for a second drill hole that is spaced approximately 8 to 10 mm from the first drill hole on the radial tuberosity. The second suture from the biceps tendon should then be passed through the second drill hole and retrieved using the passing suture loop in a similar fashion (Fig 3D). There should be one free suture from the end of the distal biceps through

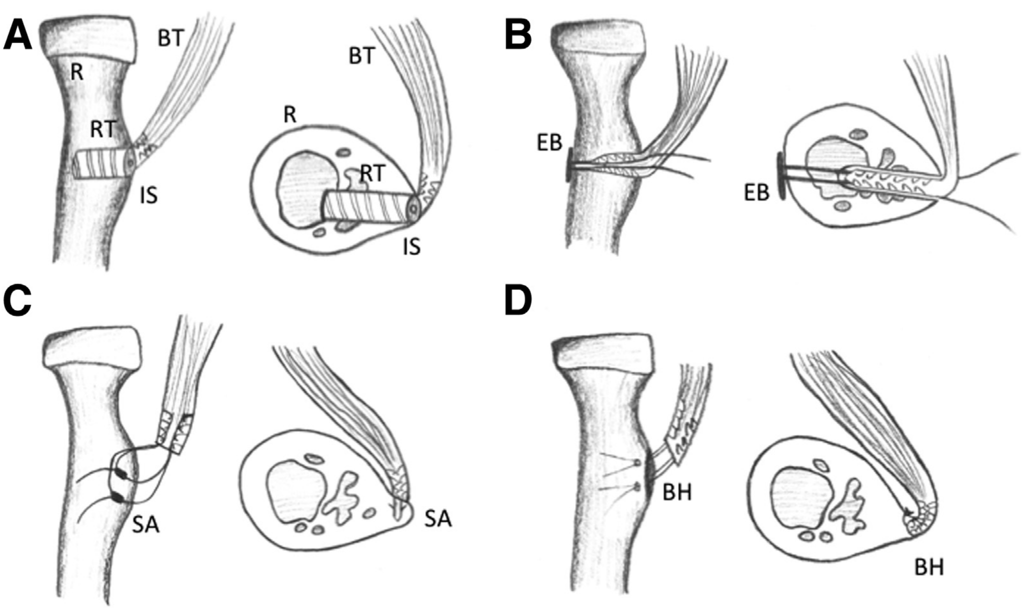

Fig 2. Superior and cross-sectional views of fixation techniques for repair of a right distal biceps tendon rupture in a patient in the supine position, including single-incision approaches. (A) Tenodesis screw. (B) Tension slide technique with cortical EndoButton (EB). (C) Suture anchor (SA). (D) Double-incision bone tunnel. (BH, burr hole; BT, biceps tendon; IS, interference screw; R, radius; RT, radial tuberosity.)

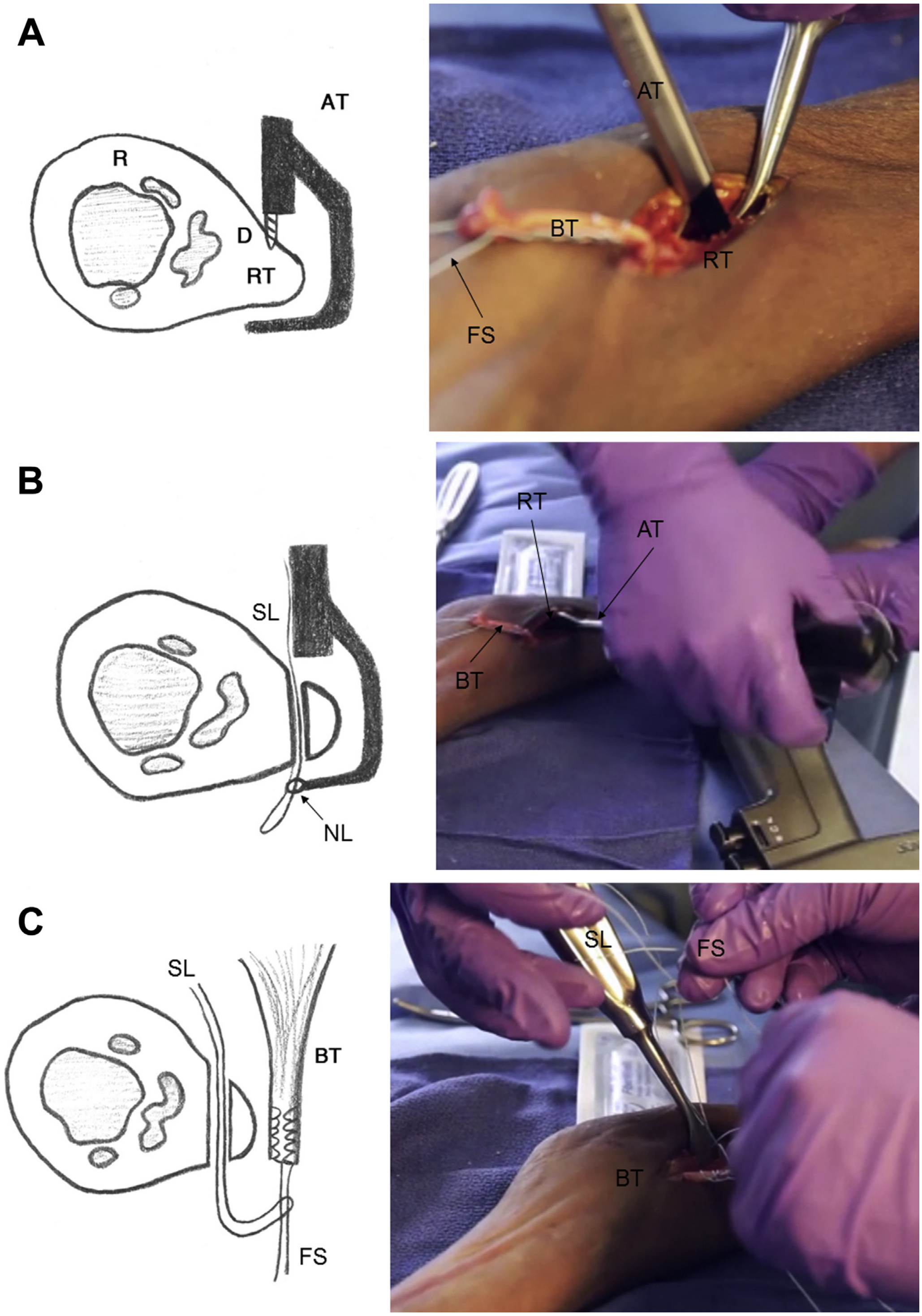

Fig 3. Single-incision anatomic technique for repair of the right distal biceps tendon rupture using the ArthroTunneler device in a patient in the supine position. (A) Placement of ArthroTunneler and drilling of radial tuberosity. (B) Passing of suture loop through drill hole and retrieval with nitinol loop. (C) Capturing of biceps tendon free suture with suture loop. (D) Superior view of drill tunnels and suture retrieval. (E) Cross-sectional and superior views of distal biceps tendon reduction and fixation. (AT, ArthroTunneler; BT, biceps tendon; D, drill; FS, free suture; NL, nitinol loop; R, radius; RT, radial tuberosity; SK, suture knot; SL, suture loop.)

each drill hole with the suture passed through the radial tuberosity from posterior to anterior. As these sutures are pulled, the biceps tendon is reduced to the lateral footprint on the ulnar aspect of the radial tuberosity. The two free suture ends of the distal biceps tendon are then tied around the biceps tendon that is reduced on the tuberosity (Fig 3E). This creates a double row—like construct with a more anatomic footprint because the

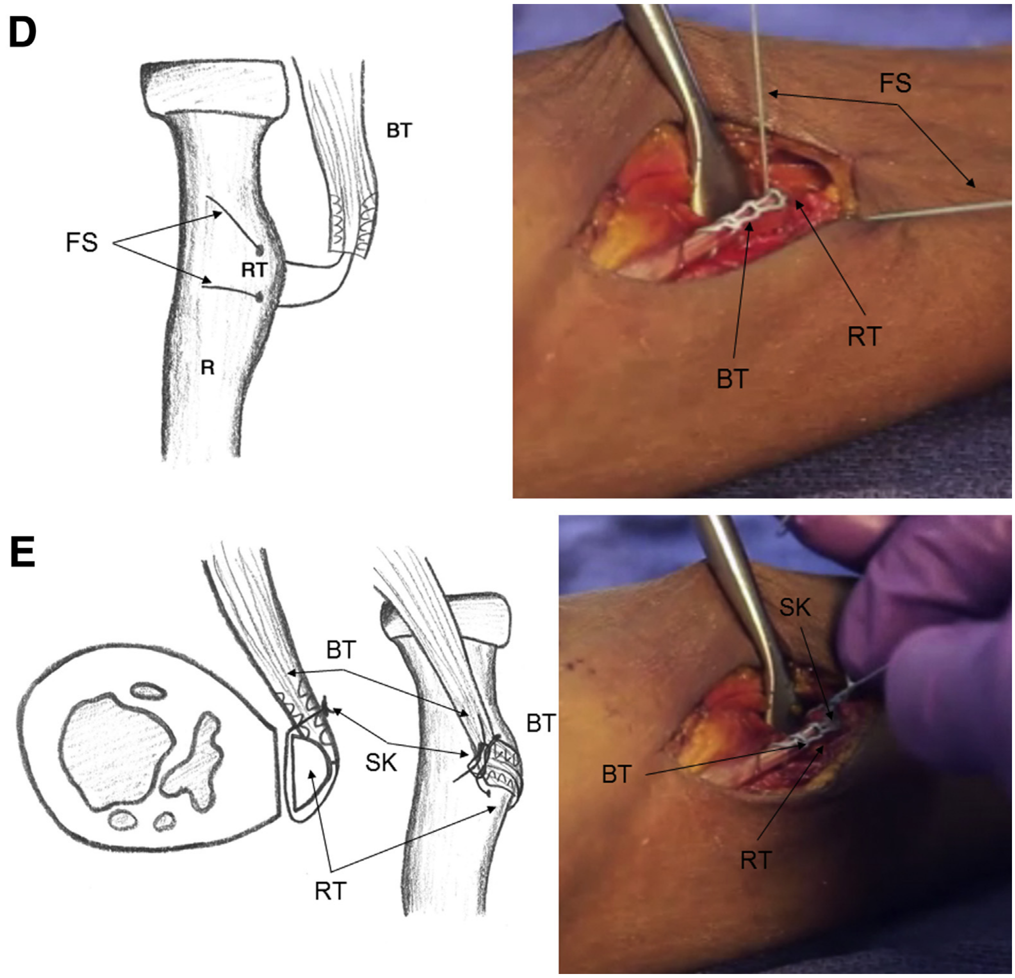

Fig 3. *(continued).*

medial edge of the tendon is taut and secured by being passed medially around the radial tuberosity and the lateral part of the footprint is secured by the sutures tied over the tendon through the drill holes. A list of surgical pearls and pitfalls is presented in Table 1. The tourniquet is then deflated, and hemostasis is assessed. The wound is flushed with copious irrigation and is closed. The patient is placed in a sling.

Discussion

Distal biceps tendon insertion on the radial tuberosity can be accomplished using numerous surgical approaches. The goal of surgical intervention is to increase flexion, supination strength, and muscle endurance while minimizing complications. Classically, 2-incision approaches have been described to achieve a better anatomic footprint on the more dorsal and ulnar aspect of the radial tuberosity when compared with single-incision approaches.[12,13]

Hansen et al.,[12] Jobin et al.,[14] and Schmidt et al.[15] have expressed concern that the single-incision anterior approach, even with pin placement in hyper-supination, does not restore the biceps tendon at its anatomic footprint. The result is reduced mechanical advantage for supination. Alsheikh et al.[16] concluded that single-incision fixation with the EndoButton is able to achieve more anatomic positioning using a flexible guide pin when compared with rigid instrumentation. We believe

Table 1. Pearls and Pitfalls

Pearls
Identification and protection of the lateral antebrachial cutaneous nerve and radial artery laterally during dissection
Identification and protection of the median nerve and ulnar artery medially during dissection
Orientation of the suture inserter such that the flat end is in line with the axis of the retractor loop
Pitfalls
Improper retractor placement with increased soft tissue may result in neurapraxia.
Placement of the tunnels on the outermost aspect of the radial tuberosity may result in compromised bone strength with the biceps tendon.
Care must be taken not to plunge the drill as the surgeon passes through the second cortex to reduce risk of injury to the posterior interosseous nerve.

that the single-incision approach using the ArthroTunneler allows for a more dorsal and ulnar placement of the biceps tendon on the radial tuberosity to restore anatomic placement, maximizing supination and flexion.

Overall, the complication rate for distal biceps repair may approach 25%.[11] Typical complications include neurapraxia, such as dysfunction of the posterior interosseous nerve and lateral antebrachial cutaneous nerve most likely caused by compression of the nerves between the retractor and bone.[17,18] This can be minimized by limiting the amount of tissue present between the bone and retractor and ensuring proper retractor placement. Other complications include heterotopic ossification and radioulnar synostosis, which is thought to arise from a posterior incision technique that disrupts the interosseous membrane.[19,20] This can be responsible for postoperative limitations in range of motion and may require revision surgery.

Watson et al.[11] studied the complication rates for distal biceps repair and found higher overall complication rates for 2-incision techniques versus single-incision techniques (25.7% vs 23.9%). Single-incision techniques have been shown to have higher rates of neurapraxia (11.6% vs 5.8%), whereas 2-incision approaches have a higher occurrence of heterotopic ossification (7.0% vs 3.1%) and radioulnar synostosis (2.3% vs 0.0%). Amin et al.[21] also found higher rates of heterotopic ossification (7.2% vs 3.2%) and radioulnar synostosis (2.2% vs 0.0%) when comparing the 2-incision approach with the single-incision approach.

This article describes our technique for repair of a ruptured distal biceps tendon. Care should be taken to identify and protect the neurovascular structures both medially and laterally from compression by retractors to limit the most common single-incision complication of neurapraxia. The advantages of this technique are as follows: The surgeon can precisely place the bone tunnels to maximize dorsal and ulnar placement on the radial tuberosity, and the single-incision approach reduces the possibility of heterotopic ossification and radioulnar synostosis. In our experience with this technique, we have encountered good patient satisfaction with no complications; however, a formal outcomes study needs to be conducted. Single-incision repair of distal biceps rupture using the ArthroTunneler is a safe and effective technique allowing the surgeon to perform an anatomic distal biceps repair with a single-incision approach.

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