Anatomic Single-Incision Repair of Distal Biceps Tendon Ruptures Using Flexible Reamers

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Abstract: Distal biceps tendon ruptures are treated operatively in active healthy individuals. Treatment consists of either single- or double-incision techniques, each with its own set of advantages and complications. The double incision was traditionally preferred for a more anatomic reattachment of the distal biceps tendon, but there has been renewed interest in the single-incision anterior approach given its lower risk for heterotopic ossification. However, current single-incision techniques cannot achieve anatomic reconstruction of the distal biceps because of a restricted operational angle with standard rigid instruments. The purpose of this study was to introduce a single-incision technique using flexible instrumentation, flexible guide pins, and flexible reamers that allows for an insertion point that better approximates the anatomic footprint of the distal biceps on the tuberosity. This offers the theoretical advantage of restoring forearm supination mechanics, while still maintaining the benefits of a single limited anterior exposure.

A avulsion of the distal biceps tendon is a relatively uncommon injury and has been estimated to represent 3% of all biceps ruptures.\(^1\) In an average population, the incidence is 1.2 ruptures per 100,000 persons per year, with men between the ages of 30 and 60 years most frequently affected.\(^1\)\(^-\)\(^3\) Operative management is the mainstay treatment in active healthy individuals and consists of either single- or double-incision techniques, each with its own set of advantages and complications. Historically, the single-incision anterior approach was associated with an increased incidence of posterior interosseous nerve injuries, likely due to the extensive dissection and manipulation near the brachioradialis muscle.\(^4\)\(^-\)\(^6\) In 1961, Boyd and Anderson\(^6\) introduced a double-incision technique involving a posterolateral approach that used a smaller anterior incision and offered a more anatomic reattachment of the distal biceps tendon; however, there were cases of heterotopic ossification causing loss of range of motion.\(^6\) In an effort to address this complication, the technique has been modified to splitting the extensor carpi ulnaris and extensor digitorum communis, rather than separation of the anconeus from the ulna.\(^7\)\(^,\)\(^8\) But there are still reports of high complications, including postoperative radioulnar synostosis, symptomatic heterotopic ossification, nerve dysfunction, and complex regional pain syndrome.\(^9\)\(^-\)\(^13\) Thus, there is a need to continue to develop techniques to improve patient outcomes.

Recently, there has been renewed interest in the anterior single-incision approach because of advances in cortical fixation devices, such as the EndoButton (Smith & Nephew, Andover, MA), and lower risk of heterotopic ossification and radioulnar synostosis.\(^14\)\(^-\)\(^16\) However, achieving an anatomic restoration of the distal biceps footprint continues to be a major challenge with the single-incision approach. This is due to the restricted operational angle when using standard rigid instruments, resulting in guide pin placement that is more anterior to the position of the native tendon footprint.\(^17\)\(^,\)\(^18\) Schmidt et al.\(^15\) have shown that anterior positioning impairs native tendon supination biomechanics and the windlass mechanism, decreasing overall supination moments and supination function. To address this issue, our group recently proposed a modification of the single-incision technique using flexible...
guide pins and reamers (Fig 1). In a cadaver model, we showed that flexible instruments could improve placement of the tendon socket by allowing the tunnel to be drilled closer to the anatomic footprint with a flexible reamer compared with a standard rigid instrument (mean 0.22 and 3.22 mm anterior to footprint, respectively, $P = .028$). We also showed that the flexible reamer compared with a rigid one provided a more central tunnel position on the radial shaft (mean offset 0.17 and 0.35 mm, respectively, $P = .043$), another factor important for preserving tendon wrapping and supination function.17,19

Expanding on our previous work,20 the purpose of the present study was to introduce and describe our single-incision technique that uses flexible guide pins and flexible reamers to allow for an insertion point on the tuberosity that better approximates the anatomic footprint of the distal biceps.

Surgical Technique

Surgical Exposure

Our single-incision anterior approach with a flexible reamer technique is described for clinical use (Video 1). The elbow is positioned supine with the arm resting on a hand table. A standard anterior approach to the antecubital fossa is performed using either an oblique incision or the senior author’s (P.A.M.) preference of an L-shaped incision with a 2-cm longitudinal limb parallel to the ulnar border of the mobile wad and a 2-cm transverse limb 2 cm distal to the antecubital flexion crease. During superficial dissection, the lateral antebrachial cutaneous nerve is identified and protected. The biceps bursa is identified and followed down to the bare biceps tuberosity. The retracted biceps tendon is found by blunt dissection proximal to the transverse limb of the incision. Once the tendon end is identified, adhesions are released and the tendon is milked distally into the incision. Typically, if the lacertus fibrosis is still intact, the tendon does not retract very far proximally. In chronic cases, or in cases with significant tendon retraction, we have occasionally used a second proximal longitudinal incision just distal to the biceps muscle belly to facilitate retrieval.

Bicep Tendon Identification and Preparation

The mobilized free end of the tendon is delivered from the wound and the diseased part of the tendon is resected until fresh healthy tendon fibers are obtained. A running whipstitch with no. 2 high—tensile strength suture is started 2.5 cm from the tendon end, extended distally to the tendon end, passed through the central holes of the EndoButton, and passed back up into the tendon, leaving a 4-mm loop of suture with the EndoButton. A second no. 2 high—tensile strength suture is passed in the same manner through the tendon and button orthogonally to the first suture (Fig 2A). Care is taken to start and finish the sutures on the undersurface of the biceps tendon to avoid creating a knot stack that is palpable through the skin. With the button attached to the tendon, the tendon is temporarily placed subcutaneously proximally while work is begun on the biceps tuberosity.

Bone Tunnel With Flexible Instrumentation

Right-angle retractors can be used to aid exposure of the bicipital tuberosity. Keeping the forearm in maximal supination, a 2.4-mm flexible passing pin is inserted using a custom modified 42° curved Clancy femoral guide (InVentures; Smith & Nephew) through the tuberosity, and just barely out the opposite cortex of the radius (Fig 2B). The use of an angled and curved guide allows for a starting point that is centered on the tuberosity within the anatomic footprint, with the pin being directed radially. A unicortical recess for the tendon is then created in the anterior cortex using a flexible cannulated reamer of the appropriate size for the prepared biceps tendon—typically a 7- or 8-mm reamer (Fig 2C). A 4.5-mm cannulated flexible drill bit is then passed over the guide pin and used to drill through the opposite cortex of the radius. Using the flexible reamers also creates tunnels that are more perpendicular to the long axis of the radius and thus minimizes the risk of cortical blowout and fracture that could potentially occur with the use of straight rigid reamers (Fig 1). An appropriately sized chest tube can be cut to size placed over the flexible 4.5-mm drill and reamer to be used as a clear “see-through” soft tissue protector to prevent damage to the anterior neurovascular structures.

Tendon Reattachment

With the elbow flexed at 90° and the forearm maximally supinated, a rigid 2.4-mm guide pin (Acufex Director Set for ACL Reconstruction; Smith & Nephew)
is then passed out the posterior aspect of the forearm by hand directing as ulnar as possible to minimize potential injury to the posterior interosseous nerve. Two sutures of different colors are then threaded through each of the 2 outer holes of the EndoButton. Both of these sutures (all 4 suture ends) can then be passed through the eye of the guide pin, which is then pulled out through the posterior aspect of the forearm. The button can then be pulled through the radius using both suture ends of the same color to act as the leading strand. Once the button has cleared the opposite cortex, the second set of sutures attached to the trailing end is used to flip the button perpendicular to the tunnel orifice, like pulling on the strings of a marionette. Once the tendon is seated in the tuberosity, fluoroscopy can be used to confirm that the button has passed through the posterior cortex and is lying flat on the opposite cortical surface (Fig 2D). The guide sutures can then be pulled out through the skin and the wound irrigated and closed.

**Postoperative Rehabilitation**

The postoperative rehabilitation follows the standard protocol for distal biceps tendon repair. In our institution, the patient is placed in sling for comfort immediately after the surgery. No immobilization is used. Immediate range of motion is instituted in the safe range of motion established at surgery, which is

| Advantages | Disadvantages |
|------------|---------------|
| More anatomic reinsertion of distal biceps tendon better preserves forearm supination | Learning curve |
| Bone tunnels that are perpendicular to the long axis of the radius will minimize the risk of cortical blowout and fracture | Availability of flexible instrumentation |
| Avoids muscle-splitting to limit risk of heterotopic ossification | Surgeon should be accustomed to using flexible reamers |

**Table 1. Advantages and Disadvantages of Single-Incision Technique With Flexible Instrumentation**
typically unrestricted in acute cases. We recommend early active assisted and passive flexion and supination with active extension and pronation beginning at 2 weeks. Typically the patient will start biceps strengthening at 12 weeks. Patients are seen postoperatively at 2 and 6 weeks, and have their final visit at 16 to 20 weeks. Return to full unrestricted activity occurs at 20 weeks.

### Discussion

Anatomic reconstruction of the distal biceps is challenging with current single-incision techniques that employ rigid reamers. The present study describes a technique for distal biceps tendon repair using a curved guide and flexible guide pin that allows a more posterior and ulnar starting point than a straight pin because of the constrained angle of insertion from the anterior surrounding soft tissues and noble structures. This enables reattachment closer to the native tendon footprint while maintaining the benefits of a single-incision approach.²⁰

The advantages and risks to our technique are listed in Tables 1 and 2. The advantage to re-creation of the biceps tendon insertion near the anatomic footprint allows us to better preserve tendon wrapping and supination biomechanics to optimize supination function. The flexible reamer also allows for a more central position of the reamed bone tunnel within the radius, which helps to decrease the chance of a cortical wall blowout and fracture when reaming the radius for tendon reinsertion. The risks associated with our single-incision flexible reamer technique is similar to the current technique of repairing distal biceps tendon ruptures using straight guide pins and the EndoButton fixation device. Particularly, a theoretical risk of injury to the posterior interosseous nerve remains. However, in our experience, we have not observed visible damage to the posterior interosseous nerve in clinical cases or in anatomic dissections.

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### Table 2. Pearls and Pitfalls of Single-Incision Technique With Flexible Instrumentation

| Pearls | Pitfalls |
|---|---|
| • Chest tube over drill and reamer, can be used as a clear “see-through” soft tissue protector to prevent damage to the anterior neurovascular structures | • Surgeon must minimize manipulation near the brachioradialis muscle to avoid lateral antebrachial cutaneous nerve injury. |
| • Keep forearm maximally supinated to protect the posterior interosseous nerve | • Keep forearm maximally supinated to protect the posterior interosseous nerve |
| • Rarely, extensive tendon retraction may need a second proximal longitudinal incision just distal to the biceps muscle belly for tendon retrieval | • Rarely, extensive tendon retraction may need a second proximal longitudinal incision just distal to the biceps muscle belly for tendon retrieval |

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