# A Cadaveric Analysis of Tunnel Position Created Using Flexible Versus Rigid Instrumentation in a Single-Incision Distal Biceps Tendon Repair

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**Purpose:** This study was designed to determine whether the use of a flexible guide pin and reamer through an anterior single-incision approach would allow for a more anatomic insertion point on the radial tuberosity when compared with the traditional rigid instrumentation used for cortical button fixation. **Methods:** Seven matched pairs of fresh-frozen cadaveric upper extremity specimens were used in this study. One specimen from each matched pair was randomly assigned to undergo a simulated repair using the standard instrumentation required for a cortical button fixation device, and the other specimens were assigned to undergo the same repair using a 42° anterior cruciate ligament femoral guide with a flexible guide pin and reamer. Each specimen from both groups was positioned with the elbow in 90° of flexion and the forearm maximally supinated during guide pin insertion. The proximal portion of the radius was then harvested from the specimen and scanned using micro—computed tomography (micro-CT). Tunnel position between the 2 techniques was compared with the center of the native tendon footprint. **Results:** The mean percentage of the reamed entry hole within the tendon footprint was significantly less using rigid instrumentation (36.35%) compared with flexible instrumentation (67.29%) ($P =$ .043). Furthermore, when flexible reamers were used (mean offset ratio, 0.17), the resultant tunnel was positioned in a significantly more central position within the radial shaft (i.e., the offset ratio was lower) compared with rigid reamers (mean offset ratio, 0.35) ($P = .043$). The entry hole was found to be significantly more posterior relative to the center of the anatomic footprint for the flexible reamer group (mean, 0.21 mm anterior) compared with the rigid reamer group (mean, 3.22 mm anterior) ($P = .028$). There was no difference in tunnel length between the 2 groups. **Conclusions:** The use of a flexible guide pin and reamer allows for a more anatomically positioned repair than does rigid instrumentation through a single-incision approach. **Clinical Relevance:** This surgical technique allows for a more anatomic re-creation of the distal biceps tendon insertion while maintaining the benefits of a single limited anterior exposure.

Distal biceps tendon ruptures are an infrequent injury, with a reported incidence of 1.2 ruptures per 100,000 patients per year.[1] The typical patient is a 30- to 60-year-old man with involvement of the dominant arm.[1-3] Injuries typically occur from a forceful eccentric load applied to a flexed and supinated forearm. The pathophysiologic process is not well understood, and multiple predisposing factors to this injury pattern have been proposed.

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Operative treatment has shown results that are superior to nonoperative treatment with regard to improving supination strength (35% to 55%), flexion strength (20% to 36%), and supination endurance (40% to 86%).[4-6] Historically, operative management has been described using either a single- or 2-incision technique. The 2-incision technique was created in an effort to decrease the rate of neurologic injury secondary to the extensive surgical dissection and retraction required by the single-incision approach.[7,8] The use of 2 incisions also provides improved access to the posterior aspect of the radial tuberosity, and cadaveric studies have shown that the posterolateral incision allows for a more anatomic reinsertion point for the ruptured biceps tendon.[7,9,10] Despite these advantages, there are reports of significant complications when using a 2-incision technique, including postoperative neurologic injury, complex regional pain syndrome, and, most importantly heterotopic ossification and radioulnar synostosis.[6,11-16]

With the advent of suture anchors and more recently cortical button fixation devices (e.g., EndoButton; Smith & Nephew, Andover, MA), a single-incision repair is now possible without the considerable dissection and morbidity that was previously required with the anterior approach.[17-19] The cortical button technique initially described by Bain et al.[17] creates a strong repair that allows for early active mobilization in the postoperative period. Although other fixation options exist for a single-incision anterior approach, biomechanical testing has shown that the cortical button technique has the highest peak load to failure rate when compared with suture anchors, transosseous sutures, or interference screws.[20-23] In addition, subsequent clinical studies have found an excellent return of supination strength (82% to 99%) and flexion strength (80% to 101%) as well as high rates of patient satisfaction and low rates of complications using this technique.[17-19,24]

Because of the limited surgical window and use of rigid instrumentation when using the single anterior incision, the tendon position tends to be more anterior and outside the anatomic footprint when compared with the position achieved with a 2-incision technique.[9] Reinserting the tendon in a more anatomic and posterior position is felt to contribute to the restoration of the windlass mechanism and forearm supination biomechanics.[10,25] The purpose of the current study was to determine whether the use of a flexible guide pin and reamer through an anterior single-incision approach would allow for a more anatomic insertion point on the radial tuberosity when compared with the traditional rigid instrumentation used for cortical button fixation. Our hypothesis was that flexible instrumentation would allow for an insertion point that overlaps significantly more with the anatomic footprint compared with that seen with standard rigid instrumentation.

## Methods

Seven matched pairs of fresh-frozen cadaveric upper extremity specimens were used from 5 women and 2 men. The mean age of the specimens was 57.1 years (range, 22 to 92 years). There were no signs of previous surgery or trauma around the elbow for any of the specimens. All specimens were found to have symmetrical motion at the elbow. Approval for the study was granted by our institutional ethics review board.

A standard anterior approach to the antecubital fossa was performed on all the specimens using a longitudinal incision along the medial border of the mobile wad. Deep dissection exposed the biceps tendon, which was followed down to the radial tuberosity. The tendon was transected using a scalpel, leaving a 1- to 2-mm stump of tissue still attached to the radial tuberosity. Right-angle retractors were used to aid exposure of the bicipital tuberosity. One arm from each matched pair was randomly assigned to undergo a simulated repair using the standard instrumentation required for the cortical fixation device (EndoButton, Smith & Nephew, Andover, MA). With the elbow flexed to 90° and the forearm in the maximal amount of supination allowed by the specimen, a standard rigid 2.4-mm drill-tip passing pin (Acufex Director Drill Guide, Smith & Nephew, Andover, MA) was placed on the radial tuberosity as far ulnar and posterior as the incision and right angle retractors would allow. The pin was angled radially and then inserted in an anterior to posterior direction through the cortices of the radius and out through the soft tissues on the posterolateral aspect of the forearm. A straight 8-mm cannulated drill bit (Acufex Director) was advanced over the rigid guide pin to create a unicortical recess in the anterior cortex for the tendon. A rigid 4.5-mm cannulated drill bit (Acufex Director) was then used to drill through the opposite cortex of the radius to allow passage of the EndoButton for cortical fixation at the time of repair. The same technique was used on the remaining arm from each matched pair; however, a flexible 2.4-mm passing pin (Clancy Anatomic Cruciate Guide/Flexible Drill System, Smith & Nephew, Andover, MA) was inserted through the bicipital tuberosity using a 42° curved femoral guide (Fig 1), and a flexible cannulated 8-mm and 4.5-mm reamer were used instead of a standard rigid reamer (Clancy Anatomic Cruciate Guide/Flexible Drill System).

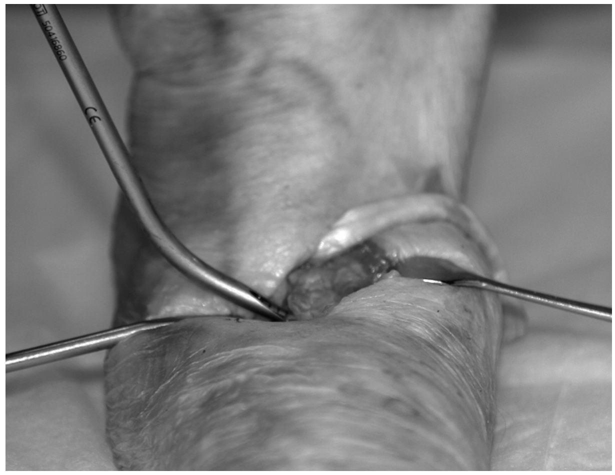

**Fig 1.** Flexible 2.4-mm passing pin inserted through the bicipital tuberosity using a 42° curved femoral guide.

Each radius was cut 1 cm distal to the biceps tuberosity and removed from each specimen. A 0.5-mm steel wire was then used to outline the periphery of the distal biceps tendon footprint on the tuberosity. All the radii sections were scanned with a SkyScan 1172 micro–computed tomography (micro-CT) scanner (Bruker MicroCT, Kontich, Belgium) at 85 kV and with a resolution of 27.3 µm. SkyScan DataViewer, version 1.4.3 (Bruker MicroCT), was used to analyze all the scans and identify the specific slides needed to measure our outcome parameters. Measurements were subsequently performed using ImageJ 1.46r (Wayne Rasband, National Institutes of Health).