TECHNIQUE

Anatomical Repair of the Distal Biceps Tendon Using the Tension-Slide Technique

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ABSTRACT

Rupture of the distal biceps brachii tendon has received significant attention in the recent literature as a result of increased incidence, improvements in diagnosis, and the numerous methods of fixation. The current controversies that surround distal biceps repair include the following: single versus dual incision, anatomical footprint restoration versus nonanatomical repair, type of fixation, and the amount of restriction on early range of motion. We describe a modified cortical button repair, the tension-slide technique, which allows for a transverse anterior incision and the ability to tension the repair through the anterior incision. There is no need to pre-determine the length of suture between the button and the biceps, no suture diastasis between button and tendon, and eliminates the technical concern regarding the button flipping.
Keywords: distal biceps, cortical button, tension-slide

Various techniques have been described to repair the distal biceps tendon.[1–7] An optimal technique would incorporate a limited 1-incision technique with maximal strength and minimal gapping of the tendon repair to allow early range of motion. We describe the modified use of a cortical button, the tension-slide technique, which allows for a transverse anterior incision and the ability to tension and repair the tendon through the anterior incision.

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Bain[1] significantly contributed to distal biceps repair with the initial description of repair using an Endobutton. The Endobutton, a cortical button, has yielded the strongest repair in load to failure testing and is a frequently used fixation device.[6] The fundamental problem with the existing cortical button technique is that the surgeon has to predetermine the length of suture between the button and the biceps; this is often imperfect. When the current cortical button technique is performed flawlessly, the tendon will sit in the intramedullary canal of the bone, with an obligatory minimum 7 mm of suture bridging the tendon to the bone. Once this construct is cycled, if there is as little as 3-mm displacement, the construct is separated by a full 1 cm (Fig. 1). A diastasis between the bone and tendon could compromise the strength and subsequent healing of the tendon. Furthermore, this technique also hinges on flipping of the button without difficulty and passing a beath pin without injuring the posterior interosseus nerve (PIN); this too can prove to be challenging. Additionally, the button tendon construct may have to be passed with the arm in some degree of flexion, which may obscure visualization, and the tendon may subsequently bunch up against the proximal cortex on the bone. Displacement of as little as 1 mm in this setting creates a potential healing problem. The effect of the tendon pistoning in the bone socket also raises concerns with respect to direct tendon to bone healing. The following technique uses Bain's approach and concept but improves upon the inherent flaws with the existing biceps repair using a cortical button (Fig. 2).

Early range of motion and early return to activities of daily living is an ever present theme in orthopedic surgery. Without complete confidence in the strength of fixation, the surgeons' ability to allow early motion is

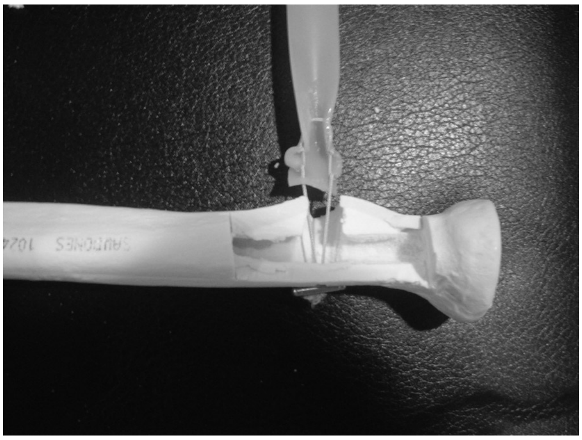

FIGURE 1. Cross-sectional image of diastasis between the biceps and radial tuberosity after cycling. This gapping can result in catastrophic failure of the cortical button construct when the tendon is not well seated in the bone.

significantly undermined. We recommend immediate and unrestricted range of motion with this technique.

We propose a standardized technique that reliably seats the tendon against the distal cortex of the bone socket, maximizing the surface area for bone to tendon healing. The technique takes advantage of cortical fixation but has the unique advantage of minimizing gap formation and minimizes surgical dissection by performing the surgery through a single-incision technique.

TECHNIQUE

The patient is placed supine on a regular operating room table. A tourniquet is applied, not regularly inflated. A 4-cm incision is made transversely, approximately 3 cm distal to the elbow flexion crease (Fig. 3). The lateral antebrachial cutaneous nerve is identified and retracted laterally (Fig. 4). The retracted distal end of the biceps tendon is identified, often preceded by a small hematoma or seroma. The biceps tendon may be "milked" from the wound when not readily identified. The distal end of the biceps tendon is minimally debrided. One No. 2 polyester (Fiberwire, Arthex, Naples, Fla) suture is used to secure the distal 2.5 cm of the biceps tendon in Krackow locking loop fashion. Care should be taken to have even suture tails at the end of the repair. Alternatively, the whipstitch may be placed with a Fiberloop; this configuration is an effective time-saving maneuver (Fig. 5). A line is marked on the tendon 1 cm from the end; this helps to visualize the tendon when it is docked in the tuberosity later in the case.

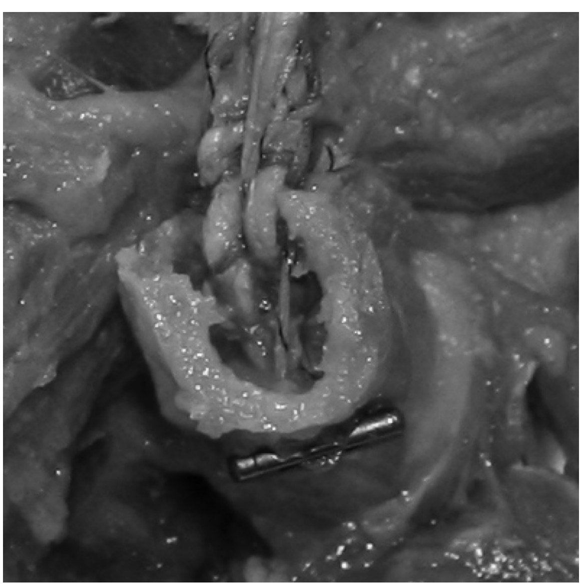

FIGURE 2. Cross-section of the radius and distal biceps with a tension-slide repair using No. 2 suture and a button. The biceps tendon is flushed against the posterior cortex of the bone, with no suture diastasis.

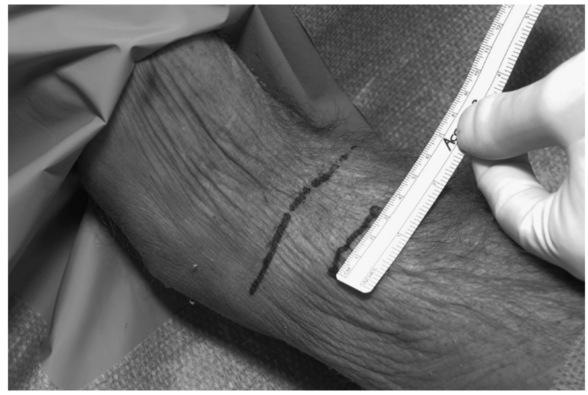

FIGURE 3. Transverse incision distal to antecubital fossa associated with repair, distal to marked flexion crease.

The suture is then threaded through the button. The first strand is fed through the right hole then back through the left hole. Then, the opposite is performed with the other tail of the same suture, with the strand being fed through the left hole then back through the right hole. The end result is to have the strands facing toward the

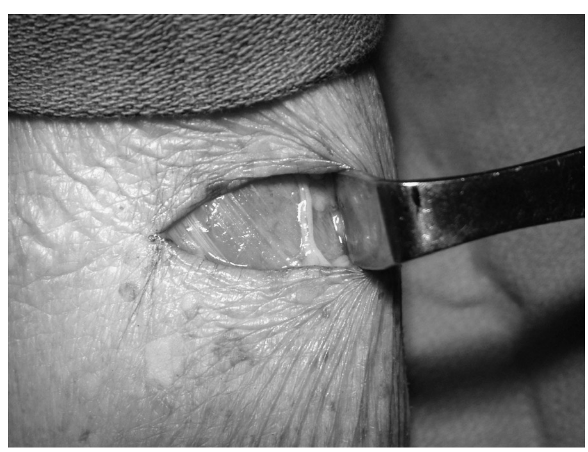

FIGURE 4. Identification of the lateral antebrachial cutaneous nerve.

FIGURE 5. The distal end of the tendon is debrided and whipstitched.

distal biceps tendon (Fig. 6). Approximately, 4 to 5 cm of space between the button and the end of the biceps tendon should be available to allow for manipulating the button through the radial tuberosity.

With the elbow in full extension and full supination, the radial tuberosity is exposed and debrided of remaining tissue. Subperiosteal placement of baby Homan retractors on each side of the radial tuberosity will minimize the risk of nerve injury; a retractor in the soft tissue can compress the PIN (Fig. 7). We prefer to place the first retractor on the ulnar side of the tuberosity and carefully visualize the lateral tuberosity placement because this is in proximity to the PIN.

A 3.0-mm guide pin is then drilled through the central aspect of the radial tuberosity from anterior to posterior (Fig. 8). Fluoroscopy may be used to confirm pin placement in the radial tuberosity. It is important to aim slightly ulnar; a 30-degree ulnar-directed tunnel maximizes the distance away from the PIN. Using an 8.0-mm cannulated

FIGURE 6. The suture is then threaded through the button. The first strand is fed through the right hole then back through the left hole. Then, the opposite is performed with the other tail of the same suture, with the strand being fed through the left hole, then back through the right hole. The end result is to have the strands facing toward the distal biceps tendon.

FIGURE 7. The radial tuberosity is identified. Care taken not to overzealously retract the tissue. Subperiosteal placement of Hohmann retractors decreases nerve injury; inadvertent placement of a retractor laterally risks injury to the PIN. The original biceps attachment is marked with ink.

reamer, the anterior cortex and intramedullary canal are then reamed to allow for flush seating of the end of the distal biceps tendon (Fig. 9). Copious irrigation of the wound to remove bone dust and fragments is routinely performed at this point (Fig. 10). A button inserter, which holds the button, is then used to pass the biceps button through the tuberosity, minimizing the risk of nerve injury. The button is released from the holder, and a tactile release of the button is appreciated (Fig. 11). Fluoroscopy may be used to visualize the button at the end of this step.

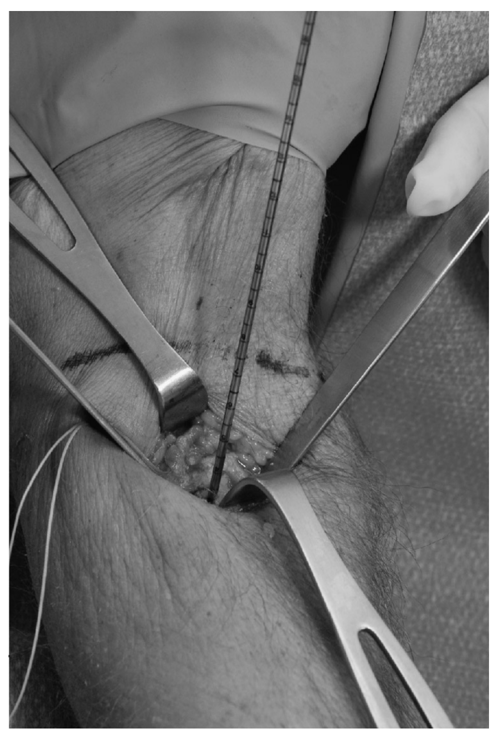

FIGURE 8. A bicortical guide pin is placed through the tuberosity.

FIGURE 9. An 8-mm unicortical hole is created with a reamer.

The button is tested at this point by pulling back on the suture limbs.

One limb of each suture is then grasped in each hand and slowly tensioned. As this is performed, the biceps will dock itself in the prepared bone socket. It helps to flex the arm to 20 to 30 degrees so that the tendon slides into the bony socket. If the arm is maintained in full extension, the vector of the sutures as they pass into the radius aligns the proximal aspect of the hole, and the sutures can abrade on the bone; with slight elbow flexion, care is taken not to abrade the suture over the posterior radial cortex (Fig. 12). The blue line previously marked 1 cm from the end of the tendon may serve as additional visual confirmation that the biceps is docked.

In a rare low-demand patient, or a situation where dual implants cannot be used, a free needle may then be used to pass one end of one of the No. 2 polyester sutures through the biceps tendon closest to the biceps tuberosity to complete the repair (Figs. 13 and 14). In addition to this step, we routinely use an interference screw measuring 7 × 10–mm, which is then inserted on the radial side, and the suture limbs are tied over the screw. This screw is left flush with the anterior cortex (Fig. 15). The elbow should be taken through a full range of motion to ensure that the tendon is secure.

FIGURE 10. Copious irrigation to remove all debris is important.

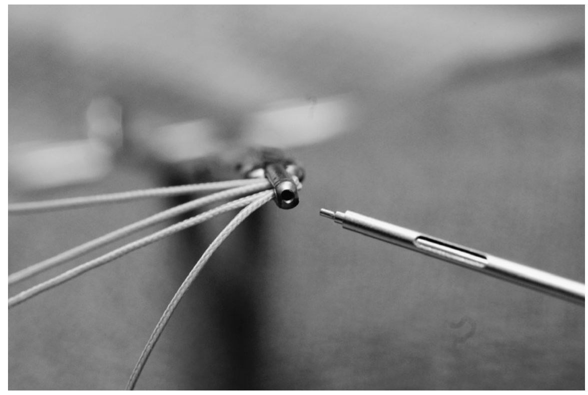

FIGURE 11. The button, loaded with sutures, is visualized from its side, with the tip of the button handle ready to engage and then pass the button through the radial tuberosity.

The wound is closed; and a soft dressing, applied. The patient may be placed in a sling for comfort.

Caution must be taken for tears that are more than 4 weeks old or tears that have inelastic tendons when using this technique. To avoid suture breakage in this setting, it is important to pull the suture in line with the tendon (much like aligning a cannula with arthroscopic knots) and to avoid the suture dragging over the posterior cortex of the radius.

In situation where the construct does not slide easily, a "rescue suture" is applied. After the aforementioned preparation, a single heavy suture is placed through the tendon. Care is taken to make sure the suture slides. The rescue suture is then passed through the hole in the radial tuberosity with a Keith needle and pulled out percutaneously. The rescue suture can then be tensioned (in line with the biceps) to help guide the reduction. Once

FIGURE 12. One limb of each suture is then grasped in each hand and slowly tensioned. As this is performed, the biceps will dock itself in the prepared bone socket. It helps to flex the arm to 20 to 30 degrees so that the tendon slides into the bony socket.

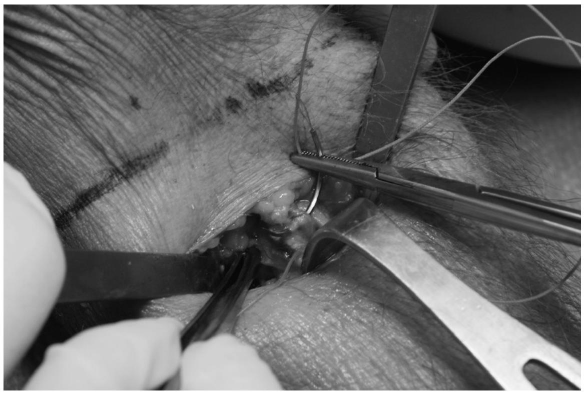

FIGURE 13. The biceps is now docked in the tuberosity and is sutured in place.

the construct is affixed, the rescue suture can be pulled out of the forearm and discarded.

DISCUSSION

Most authors agree that the distal biceps should be repaired in healthy active individuals.[1–4] The current issues surround single versus dual incision, footprint restoration, type of fixation and early range of motion.

The debate surrounding the single-incision versus dual-incision technique for the distal biceps is beyond the scope of this paper. The anterior transverse incision has been previously described with minimal dissection and few complications.[3,4] The addition of a button passer in our technique eliminates the need to pass a beath pin or needle through the forearm, further minimizing the risk of nerve injury.

The understanding of the distal biceps anatomy has also been recently elucidated. The distal biceps is not a cylindrical tendon that inserts over a wide footprint. It is a ribbonlike insertion that attaches on the ulnar side of the tuberosity over a 21 × 7–mm footprint. Although the clinical importance of recreating normal biceps anatomy is unclear, it stands to reason that anatomical restoration of the intact biceps is desirable.[8] This is probably not accomplished by placing a tendon into a bone socket and tying over a bridge alone. As such, the placement of an interference screw in the tuberosity (on the radial side of the tendon) may be important in helping to restore the preinjury anatomy with particular respect to the ulnar position of the tendon. The screw further allows for proximal cortical fixation, and the button completes dual cortex fixation of the tendon, the longtime parallel goal for fracture fixation. Furthermore, interference screw fixation has been histologically linked with direct tendon to bone healing.[1] Theoretical concerns about screw resorption, osteolysis, and a weakened tunnel may exist but have not yet had clinical significance. This may create an interest in an inert or biocomposite screw.

Early or immediate range of motion is likely to be linked with strength of repair. Mazzocca et al[6] compared 4 techniques of distal biceps repair. Using a biomechanical model, bone tunnel, Endobutton, suture anchor, and interference screw techniques were compared. The Endobutton technique had the statistically significant highest load to failure (440 N) as compared with suture anchor (381 N), bone tunnel (310 N), and the interference screw (232 N). The Endobutton, however, had the second highest displacement (3.42 mm) as compared with the bone tunnel (3.55 mm), suture anchor (2.33 mm), and interference screw (2.14 mm).[6] In our tension-slide technique, theoretically, gap formation is minimized as the surgeon is able to tension the distal biceps tendon/button complex through the anterior incision, thus setting the button flush against the posterior aspect of the radial tuberosity. By minimizing the gap formation and continuing to have the highest load to failure, the tension-slide technique would be an optimum procedure to repair a distal biceps tendon rupture.

We have early biomechanical and clinical data to support this technique. Our laboratory data suggest favorable performance of this construct with respect to gap formation after cyclical loading and subsequent load to failure

FIGURE 14. In a deep forearm, an arthroscopic knot pusher device can help tie down the sutures.

FIGURE 15. Repaired distal biceps. The interference screw is placed on the radial side of the bone tunnel to recreate the ulnar-sided attachment.

FIGURE 16. Radiograph showing button flipped on tuberosity.

when compared with standard cortical button technique and superior performance with respect to suture anchor and bone tunnel repairs. This technique maintains all of the strength of the cortical button fixation and has less motion at the repair site.

Our clinical series consist of 13 procedures on male patients (age, 36–51 years), with mean follow-up of 6 months (range, 3–14 months). All cases were acute (<6 weeks). We used the biceps button and interference screw in all the patients in this series but had used the tension-slide technique with a button alone in 4 prior patients without complication. There were no intraoperative complications, and we found that surgery was significantly easier when performed within 2 weeks of the injury. Patients were placed in a soft dressing, and active supination and pronation were recommended. Patients were permitted to use the arm in active flexion and extension as tolerated but were restricted to lift nothing more than a coffee cup for the first 2 weeks. All patients regained full supination, pronation, flexion, and extension. All regained full range of motion and function. Only 1 patient went to physical therapy. Functional strength returned at approximately 8 weeks postoperative, but formal strength testing is not undertaken until the end of 1 year postoperative. There were 2 postoperative complications, 1 case with transient lateral antebrachial nerve paresthesia and 1 rerupture. The lateral antebrachial nerve paresthesia resolved by 6 weeks after operation. The patient with the rerupture was doing extremely well until he experienced an 8-foot fall off a wall and injured his arm at 4 weeks postoperatively. This patient underwent a similar revision procedure without complication; the rupture occurred as tendon pulled through suture, suggesting that the weakest link in the fixation was the tendon and not the fixation devices.

Patients returned to work as soon as comfortable for nonlaborers, usually less than 2 weeks for driving. Strength training was initiated at 6 weeks postoperative; several patients were noncompliant and started lifting earlier without complication. Return to heavy labor was restricted to 12 weeks postoperative.

The tension-slide technique is a useful modification of existing techniques to repair distal biceps tendon ruptures. The advantages of the technique include a small 1-incision anterior approach, the ability to tension the repair from the anterior incision, and the use of the strength of cortical button fixation. There is no need to predetermine the length of suture between the button and the biceps and no concern about the button flipping. We have also started all of our patients on immediate activities of daily living and unrestricted range of motion with no brace or sling after surgery.

We present a technique that takes and restores the biceps anatomy to the ulnar side of the radial tuberosity, takes advantage of superior biomechanics, relies on dual cortex fixation, and allows immediate postoperative range of motion (Fig. 16). Our early experience with this technique has yielded superior clinical results.

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