Review Article

Surgical Treatment of Distal Biceps Rupture

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Abstract

Rupture of the distal biceps tendon accounts for 10% of all biceps brachii ruptures. Injuries typically occur in the dominant elbow of men aged 40 to 49 years during eccentric contraction of the biceps. Degenerative changes, decreased vascularity, and tendon impingement may precede rupture. Although nonsurgical management is an option, healthy, active persons with distal biceps tendon ruptures benefit from early surgical repair, gaining improved strength in forearm supination and, to a lesser degree, elbow flexion. Biomechanical studies have tested the strength and displacement of various repairs; the suspensory cortical button technique exhibits maximum peak load to failure in vitro, and suture anchor and interosseous screw techniques yield the least displacement. Surgical complications include sensory and motor neurapraxia, infection, and heterotopic ossification. Current trends in postoperative rehabilitation include an early return to motion and to activities of daily living.

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Dr. Dodds or an immediate family member is a member of a speakers' bureau or has made paid presentations on behalf of Integra and Medartis and serves as a paid consultant to or is an employee of Replication Medical. Dr. Ahmad or an immediate family member has received research or institutional support from Acumed, Arthrex, and Zimmer. Dr. Sethi or an immediate family member has received royalties from Arthrex and has received research or institutional support from Arthrex. Neither Dr. Sutton nor an immediate family member has received anything of value from or owns stock in a commercial company or institution related directly or indirectly to the subject of this article.

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Rupture of the distal biceps tendon historically represented about 3% of biceps ruptures;[1] however, recent data suggest the incidence may be closer to 10%.[2] Prior to 1995, there were 53 published articles concerning the distal biceps, in contrast to more than 70 new publications on this topic over the past 3 years, reflecting an incidence trend or a possible increase in detection. In the appropriate patient, surgical repair of the distal biceps insertion reliably regains both supination and flexion strength. Many repair techniques have been developed over the past decade to match the structural properties of an intact tendon, with a goal of initiating early functional recovery.

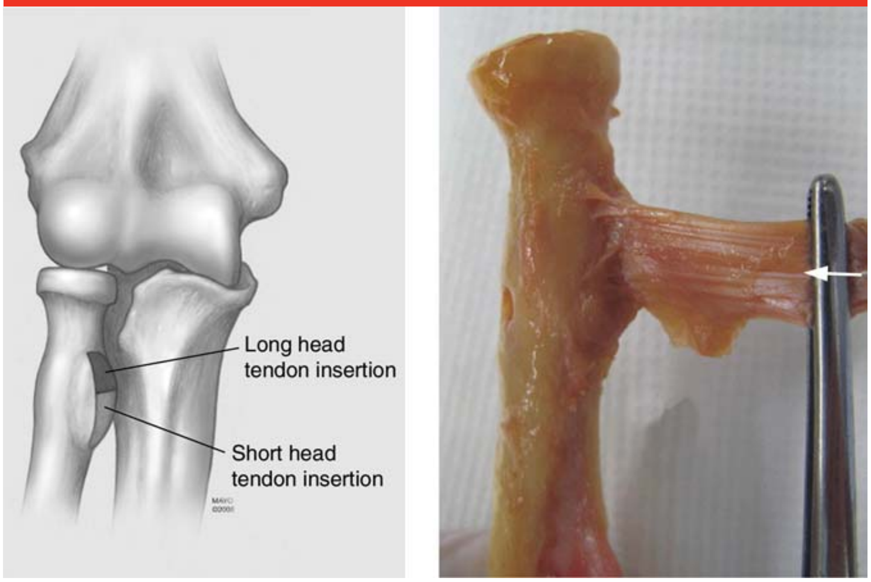
Demographics

The incidence of distal biceps rupture is 1.2 per 100,000 persons per year.[2] Injuries tend to occur in the dominant elbow (86%) of men (93%) in their 40s.[1] Only 29% of these patients were considered to be athletically active or have physically demanding occupations at the time of injury. Injuries occurred from excessive eccentric tension as the arm was forced from a flexed to an extended position. There have been only case reports of women with distal biceps tendon ruptures.[3] There is a statistically significant 7.5 times greater risk of distal biceps tendon ruptures in persons who smoke.[2]

Anatomy

The bicipital tuberosity has a mean length of 22 to 24 mm and a mean width of 15 to 19 mm at the proximal radius.[4,5] The average length of the biceps tendon insertion on the tu-

Figure 1



A, Illustration of the long- and short-head biceps tendon insertions on the bicipital tuberosity. The mean average cadaver footprint area of the long head of the tendon is 48 mm^2 and of the short head of the tendon, 60 mm^2. **B,** Clinical photograph of a cadaver specimen demonstrates the separation between the short and long heads of the distal tendons (arrow). (Panel A reproduced with permission from the Mayo Foundation of Medical Education and Research, Rochester, MN. Panel B reproduced with permission from Athwal GS, Steinmann SP, Rispoli DM: The distal biceps tendon: Footprint and relevant clinical anatomy. *J Hand Surg Am* 2007;32:1225-1229.)

Figure 2

Clinical photograph demonstrating proximal retraction of the muscle belly in a complete distal biceps tendon rupture.

berosity is 21 mm, with an average width of 7 mm, indicating that the tendon insertion does not occupy the entire bicipital tuberosity.[4,5]

Cadaver studies demonstrate that the distal biceps tendon possesses two distinct insertions. The short head attaches distally on the radial tuberosity, and the long head attaches proximally on the radial tuberosity (Figure 1). The biceps tendon inserts like a ribbon at the ulnar side of the lesser tuberosity, rather than as a cylinder on the center of the tuberosity. The distal insertion of the short head positions it to be a more powerful flexor of the elbow, and the insertion of the long head on the tuberosity farther from the axis of rotation of the forearm increases leverage for supination. The left tendon spirals clockwise and the right tendon, counterclockwise.[6] The lacertus fibrosus typically originates from the distal short head of the biceps tendon.[7]

Patient History and Physical Examination

Persons with distal biceps rupture often experience a painful "pop" at the time of injury as they eccentrically load their distal biceps tendon. Physical examination findings include varying degrees of proximal retraction of the muscle belly (Figure 2), change in contour, and medial ecchymosis. Weakness and pain, primarily in supination, are hallmarks of the injury. Despite loss of distal biceps continuity, the readily palpable lacertus fibrosis may remain intact. The underlying brachialis tendon may also be mistaken for the biceps. One particularly reliable examination technique, the hook test, is performed by asking the patient to actively flex the elbow to 90° and to fully supinate the forearm (Figure 3). The examiner then uses her or his index finger to hook the lateral edge of the biceps tendon. With an intact or even partially intact biceps tendon, the finger can be inserted 1 cm beneath the tendon. When there is no cordlike structure under which the examiner may hook a finger, the biceps tendon is not in continuity. The hook test was found to have a sensitivity and specificity of 100%.[8]

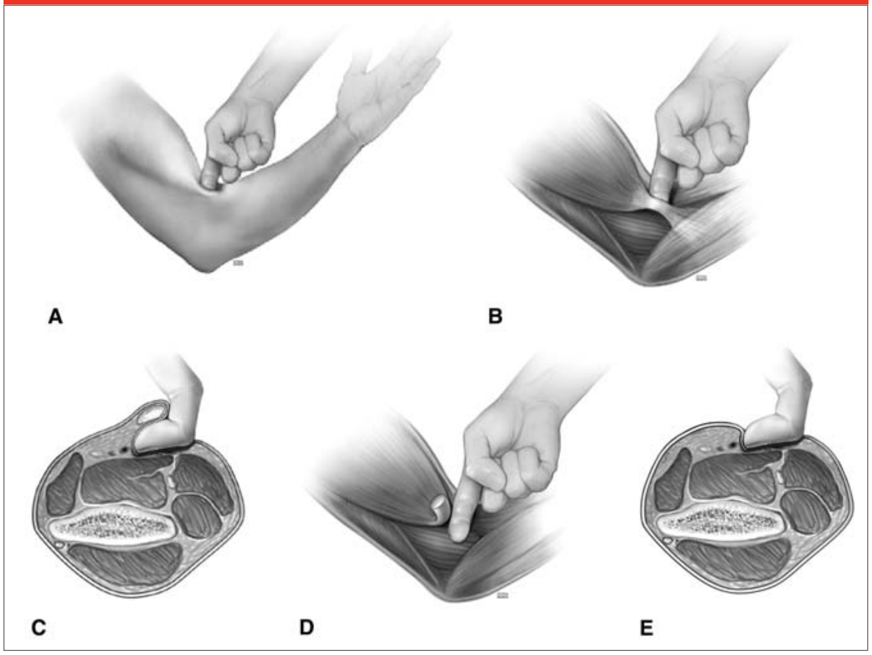
Imaging

Radiographs can, on occasion, show a small fleck or avulsion of bone from the radial tuberosity, but they are primarily used to rule out associated elbow injuries.[9] MRI is used when the diagnosis is unclear (Figure 4), when the tear is thought to be at the myotendinous junction, for evaluation of retraction in a chronic tear, or for a suspected partial biceps tendon rupture (Figure 5). Ultrasonography may also be effective.[10]

Management

There is a role for nonsurgical management of distal biceps tears in the low-demand or medically infirm patient. Numerous reports of painless function with weakness and early

Figure 3



Illustrations of the hook test for a distal biceps tendon avulsion. **A,** The test is performed with the elbow flexed to 90° and the forearm fully supinated to the end point. Medial (**B**) and axial (**C**) views of the intact hook test. When the biceps tendon is intact, it is possible to fully insert a finger under the lateral edge of the biceps tendon approximately 1 cm or more, depending on the relative size of the patient's muscles and the examiner's finger. The finger passes between the biceps tendon and underlying brachialis muscle from anterolateral to posteromedial. Medial (**D**) and axial (**E**) views of the abnormal hook test. With a complete avulsion of the distal biceps tendon, the hook test finding is abnormal, indicated by the absence of a cordlike structure spanning the antecubital fossa behind which to hook the examiner's finger. (Reproduced with permission from the Mayo Foundation of Medical Education and Research, Rochester, MN.)

Figure 4

A sagittal T2-weighted magnetic resonance image demonstrating a 6-cm retracted distal biceps tendon rupture. The white arrow shows the level of the ulnar edge of the bicipital tuberosity of the proximal radius (which is not in view); the black arrow points out the distal edge of the ruptured tendon.

fatigue in supination (eg, inability to use a screwdriver) are associated with nonsurgical treatment. If the lacertus fibrosis is intact, the functional deficits of biceps rupture may be minimized in a low-demand patient.

Results with surgical repair have been superior to nonsurgical treatment in terms of restoring elbow flexion strength (30% improved), supination strength (40% improved), and upper extremity endurance.[11] Ideally, surgical treatment should occur within a few weeks from the date of injury; further delay may preclude a straightforward, primary repair. A more extensile approach may be required in a chronic rupture to capture the retracted and scarred distal biceps tendon.

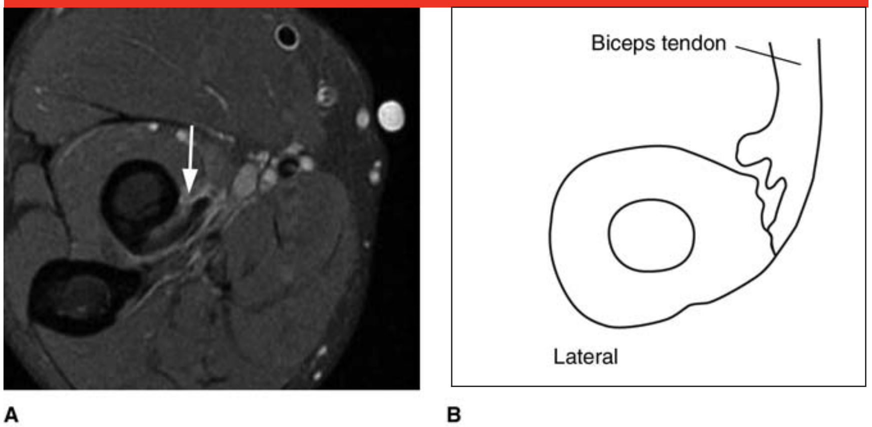
Surgical Approach

Historically, repair of the distal biceps was performed through an extensile anterior, or Henry, approach.[12] The exposure starts with a curved longitudinal incision, with the deep interval lateral to the biceps tendon; the leash of radial recurrent vessels is ligated to increase the exposure. The two-incision approach of Boyd and Anderson[13] was developed in an attempt to minimize the high rate of neurologic injury associated with the Henry approach. Kelly et al[14] further modified this approach to a muscle-splitting posterior approach to address occurrence of radioulnar synostosis.

Single-incision

The anterior single-incision approach was initially described as an extended S-shaped Henry approach centered on the antecubital fossa and has been associated with a high rate of neurologic complications.[15] The advent of newer fixation methods has facilitated a less invasive, safer approach through a limited antecubital fossa incision,[10] exploiting the interval between the brachioradialis and pronator teres with radial (lateral) retraction of the brachioradialis and medial retraction of the pronator teres. The lateral antebrachial cutaneous nerve is identified as it exits between the biceps and the brachialis at the antecubital fossa. Ligation of the recurrent

Figure 5



A T2-weighted magnetic resonance image (**A**) and matching line drawing (**B**) demonstrating a partial thickness tear (arrow, panel A) of the distal biceps tendon.

branch of the radial artery minimizes hematoma formation and may protect against heterotopic ossification (HO). The posterior interosseous nerve (PIN) is protected by means of limiting forceful lateral retraction and maintaining supination.

Dual-incision

The two-incision technique originally used an S-shaped anterior antecubital incision. Alternatively, a small tranverse incision may be used. After the biceps is identified, the radial tuberosity is palpated, and a curved forceps is placed in the interosseous space and palpated on the dorsal proximal forearm. Kelly et al[14] modified the Boyd-Anderson approach by using a dorsal approach that splits the extensor carpi ulnaris muscle and avoids dissection of the supinator with the goal of reducing synostosis. Pronation of the forearm protects the PIN, which often is not visualized.

Endoscopic

Endoscopic techniques to evaluate and potentially repair the distal biceps tendon have been described to assist with visualization of the distal biceps tendon. For example, in a partial biceps tendon tear, the tendon can be visualized endoscopically down to its insertion site, the extent of the tear evaluated, and the tendon repaired as indicated.[16]

Comparison of Exposures

El-Hawary et al[15] compared a single anterior incision with a modified dual-incision technique for repair of distal biceps tendon ruptures. The single-incision group regained more flexion (142.8° versus 131.1°). Complications occurred in four of nine patients in the single-incision group; most of these were lateral antebrachial cutaneous nerve paresthesias, and one was HO. The single complication in the two-incision group was transient superficial radial nerve paresthesia.

Fifty-three patients were evaluated by McKee et al[17] to review the results of a single anterior transverse incision approach. Four complications were reported: one wound infection, two transient paresthesias in the lateral antebrachial cutaneous nerve distribution, and one PIN palsy that resolved in 6 weeks. There were no instances of proximal radioulnar HO, synostosis, motion loss, tendon rerupture, or permanent nerve injury. The authors concluded that this was a safe technique.

Kelly et al[14] compared an extended Henry anterior incision with a limited anterior transverse incision when the modified two-incision technique was used. When the distal biceps tendon was repaired through an extended anterior incision, 5 of 60 patients had lateral antebrachial cutaneous or superficial radial nerve paresthesia, and 6 patients suffered anterior elbow pain. None of these complications occurred with a small anterior transverse incision, suggesting that the intact overlying skin may decrease the degree of traction on these nerves during deep retraction. Balabaud et al[10] used an anterior transverse incision with no radial nerve or synostosis complications. Despite the successful outcomes for the modified limited two-incision approach, occurrence of HO is still reported in the literature.[18]

The results described here demonstrate that the surgical approach to the distal biceps tendon has evolved. Both single- and dual-incision approaches have been modified to be minimally invasive. With a better understanding of biceps anatomy, improved methods of fixation, and careful retractor placement, complications can be minimized for both approaches.

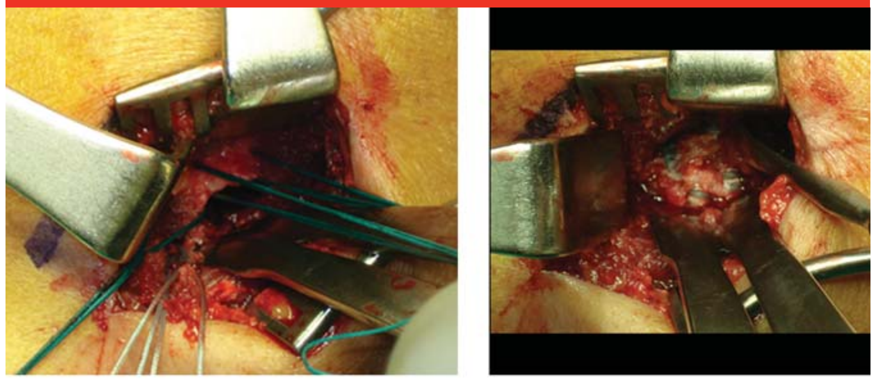
Distal Biceps Fixation Techniques

The repaired distal biceps insertion needs to withstand, at a minimum, 50 N of physiologic force, which is the force on the distal biceps tendon when the elbow is flexed to 90° against gravity.[19] When a 1-kg object is held, the force when the elbow is at 90° is 112 N.[20] The force necessary to rupture the distal biceps is approximately 204 N.[21]

Bone Tunnel

A two-incision, muscle-splitting approach is used for the bone tunnel technique. The radial tuberosity is exposed. A No. 2 polyester suture is sewn using a locking loop technique to harness 2 to 4 cm of the distal tendon. A guide pin is then drilled through the center of the tuberosity, and an acorn reamer or burr is used to ream through the anterior cortex to recreate a slot of varying depth. Two or three 2-mm diameter holes are drilled 1 cm apart through the lateral, far side of the radius. The polyester sutures are passed and tied across the bone bridge, via the posterior incision (Figure 6).

Figure 6



A B

A, Intraoperative photograph of a dorsal approach to the radial tuberosity with the socket prepared and three 2-mm diameter holes drilled for tensioning and fixation. **B,** Completed repair.

Suture Anchor

The suture anchor technique uses a single-incision approach that is either transverse or longitudinal extensile (ie, Henry). The radial tuberosity is débrided and scuffed (but not decorticated) to prepare for bone-to-tendon healing. Two suture anchors are inserted into the biceps tuberosity, one distal and one proximal and both toward the ulnar edge of the tuberosity. The distal anchor is tied first so that the tendon is brought out to length. Next, the sutures of the proximal anchor are tied. This repair sequence maximizes tendon-to-bone contact and surface area and effectively recreates the footprint of the distal biceps insertion. When suture anchors are selected for repair, there is no drilling of the far cortex, thus reducing risk of direct iatrogenic PIN injury.

Intraosseous Screw Fixation

The intraosseous technique uses a single-incision approach that is either transverse or an extended Henry approach. The radial tuberosity is exposed. A No. 2 polyester suture is sewn in a whipstitch fashion into the ruptured tendon end. A guide pin is then drilled through the center of the tuberosity, and an acorn reamer is used to ream through the anterior cortex. The suture is passed through a bioabsorbable tenodesis screw and screwdriver, and the distal end of the tendon is brought to the tip of the screwdriver. The screw and tendon are inserted into the hole and screwed down flush to the tuberosity. The remaining ends of the suture are secured by means of tying them over the screw.

Suspensory Cortical Button

Bain et al[22] initially described the EndoButton (Smith & Nephew Endoscopy, Andover, MA) fixation technique. A cortical window is made in the radial tuberosity with a high-speed burr. The window should be made as ulnar (medial) as possible, so that the tendon is fixed into its anatomic location. The wound should be irrigated to minimize the formation of HO from the bone dust generated by the burr.

A polyester suture is used to secure the tendon to the two central holes of the button. A whipstitch is placed into the tendon (Figure 7); 2 to 3 mm is left between the button and the free end of the tendon to allow the button to be passed through the dorsal cortex of the radius. With the elbow in supination, a Beath pin is passed through a 4.2-mm bicortical hole, then through the skin of the posterior forearm. Tension is applied to the sutures to deliver the button, and the sutures are toggled and pulled to reinforce that the button is locked in the subperiosteal space on the dorsal aspect of the radius. Fluoroscopy should be used to confirm placement. The elbow is flexed to ensure that the tendon fixation is secure.

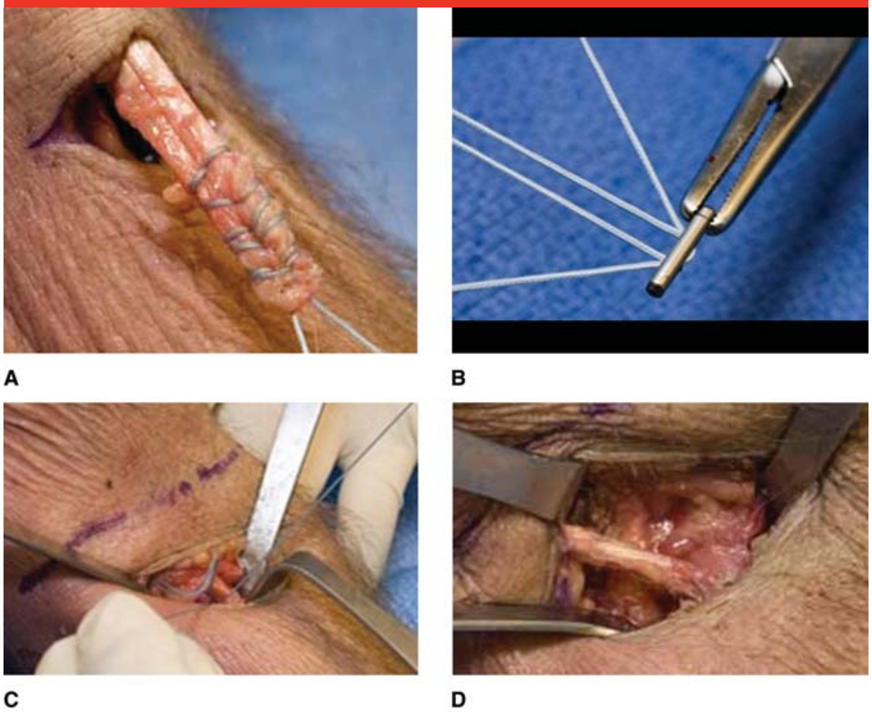
All of these techniques have been reported with and without the use of spot fluoroscopy. The bicipital tuberosity has significant anatomic variation. We recommend the routine use of fluoroscopy to confirm accurate anatomic tunnel placement because a proximal placement can lead to radial neck fracture.

Comparison of Techniques

Biomechanical Studies

Transosseous suture fixation, or bone tunnel fixation, is the standard of treatment for distal biceps repair.[1]

Figure 7



Intraoperative photographs of the tension-slide technique, a modification of the suspensory cortical button technique. **A,** The distal end of the biceps tendon is minimally débrided and whipstitched. 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 procedure. **B,** The suture is threaded through the button. The result is to have the strands facing toward the distal biceps tendon. With the use of an 8.0-mm cannulated reamer, the anterior cortex and intramedullary canal are then reamed to allow for flush seating of the end of the distal biceps tendon. A button inserter, which holds the button, is then used to pass the biceps button through the tuberosity, minimizing the risk of nerve injury. **C,** The suture strands are tensioned, allowing the cortical button to abut the posterior cortex. **D,** A 7- × 10-mm headless, bioabsorbable interference screw is inserted on the radial side, and the suture limbs are tied over the screw. This screw is left flush with the anterior cortex.

Various modes of failure have been reported for the bone tunnel technique, including breakage of the sutures and sutures cutting through the bony bridge at the suture-bone interface.[23] A biomechanical study using 10 paired fresh-frozen cadaver specimens concluded that the two-incision bone tunnel technique for distal biceps repair was significantly stiffer in all specimens than repair using one suture anchor. Suture anchor techniques failed by pull-out of the single anchor or by breakage of the suture.[24]

In a study by Lemos et al[25] that evaluated suture anchor fixation with two suture anchors and traditional bone tunnel fixation in nine matched-pair, fresh-frozen elbow specimens, the two suture anchors yielded a peak load to failure of 263 N; the value for bone tunnel fixation was 203 N ($P < 0.05$). The authors reported that, based on yield strength in vitro, suture anchor fixation with two anchors offered an acceptable, if not superior, alternative to bone tunnel fixation for repair of distal biceps tendon ruptures.

Idler et al[21] compared bone tunnel technique with interference screws in a biomechanical model. They found no statistical difference in the mean failure strength between the bone tunnel fixation group (216 N) and the interference screw technique (192 N). Catastrophic failure of the interference screw technique has been reported to occur in cadaver specimens, with the tendon and screw pulling out as a unit, often fracturing the radial wall.

The EndoButton technique has been demonstrated to have the highest peak load to failure in multiple studies. Kettler et al[23] compared the linear load to failure for techniques in formalin-preserved cadavers. They concluded that an EndoButton-based method yielded the highest failure load, 270 N ($P < 0.05$), compared with techniques that used TwinFix-QuickT 5.0-mm suture anchors (Smith & Nephew, Memphis, TN), FASTak II 2.4-mm suture anchors (Arthrex, Naples, FL), or transosseous No. 2 Ethibond sutures (Ethicon, Somerville, NJ). Mean failure load of the transosseous suture technique was 210 N, and that of the TwinFix-QuickT 5.0-mm was 57 N. These results were similar to the failure load of 250 N reported for the EndoButton compared with 210 N for suture anchors in a study by Spang et al.[26] The EndoButton tended to fail by breakage of the suture when No. 2 Ethibond was used.[23]

Mazzocca et al[27] conducted a biomechanical study measuring cyclical load to failure in four techniques for distal biceps brachii tendon repair. The EndoButton technique had a statistically significant ($P < 0.001$) highest load to failure (440 N) compared with suture anchor (381 N), bone tunnel (310 N), and the interference screw (232 N).

Displacement after cyclical loading has varied with repair techniques in biomechanical studies and could have consequences in the setting of early postoperative range of motion (ROM) and healing. Spang et al[26] demonstrated in 11 fresh-frozen cadaver elbows that standard techniques with EndoButton fixation yielded 2.59 mm of displacement after only 1,000 cycles; the suture anchor group had 2.05 mm of displacement. Mazzocca et al[27] reported that the EndoButton technique had the second highest displacement (3.42 mm) compared with the bone tunnel (3.55 mm), suture anchor (2.33 mm), and interference screw (2.15 mm) methods. Close to 30% of suture anchor repairs in this series failed during cyclic loading. A recent study comparing two suture types fixed to a bone tunnel detected 6.8 to 6.9 mm of tendon displacement before failure.[28] Findings suggest that pistoning of the tendon occurred during early motion with all of these methods. This macromotion could delay or inhibit direct tendon healing.

Clinical Studies

Most clinical investigations have been conducted on bone tunnel and suture anchor techniques. Only clinical case reports have been published on intraosseous screw fixation.[29] Overall, studies on the suture anchor technique tended to report less motion loss and a greater recovery of strength and endurance.

The Boyd-Anderson repair, using bone tunnels, was evaluated in 21 distal biceps ruptures.[30] Diminished motion occurred in 19% of elbows with regard to rotation and in 5% of elbows with regard to flexion. Endurance was evaluated, showing deficits in supination in 38% of elbows and deficits in flexion in 33% of elbows. A 35% complication rate occurred, with HO being the most common complication.

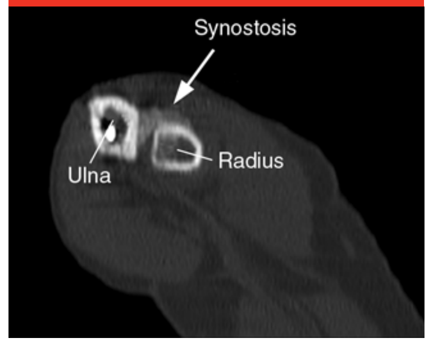
Suture anchor repairs have been reported with a 1° to 5.3° loss of extension, 3° to 6.2° loss of flexion, 1° to 11° loss of pronation, and 2° to 6.4° loss of supination after 6 months to 7 years of follow-up.[17,31] Flexion in supination strength was measured to be 82.1% that of the injured side.[31] Mean Disabilities of the Arm, Shoulder, and Hand score was 14.45. Of 53 patients who underwent suture anchor repair, 46 had excellent and 7 had good results according to Andrews-Carson scores.[32]

In a prospective study by Balabaud et al[10] of surgery for nine distal biceps ruptures using an anterior approach with suture anchor repair, all patients were satisfied with their results and had full ranges of elbow and forearm motion. A retrospective study by Weinstein et al[33] had similar findings, with all patients satisfied with the results. Isokinetic testing demonstrated a 6% strength deficit in the former study[10] and <5% in the latter.[33]

In a study comparing the modified Boyd-Anderson technique with the suture anchor technique, the suture anchor technique regained more flexion than did the two-incision group (142.8° versus 131.1°, respectively).[15] There was no difference between groups in supination motion, supination strength, or flexion strength. Recovery of flexion strength was initially more rapid for the two-incision group.

Peeters et al[34] recently reported results using the EndoButton technique in a series of 26 patients. The average Mayo Elbow Performance Score was 94 points after evaluation, including radiographs and isokinetic testing. Strength recovery was 80% for flexion and 91% for supination. Two patients developed radiographically detected HO; however, they were asymptomatic. The EndoButton disengaged in three patients without evidence of functional outcome deficit.

Figure 8



Axial CT scan demonstrating radioulnar synostosis, a complication of distal biceps tendon repair.

Complications

Lateral antebrachial cutaneous nerve paresthesia is the most common complication of distal biceps repair and is usually the consequence of aggressive retraction. This can be avoided by toeing in the retractor. Injury to the PIN and radial nerve paresthesias have also been reported and are best avoided by careful treatment of the lateral soft tissue. Neurapraxias are usually self-resolving in distal biceps repairs. Rerupture of the distal biceps outside the perioperative period is uncommon.

Synostosis presents in the earlier stages with pain and swelling, leading to loss of rotation, primarily supination. Three-dimensional imaging (ie, CT) provides for localization of the ectopic ossification as well as a map for surgical approach. Excision of HO and contracture release may be performed as soon as the soft tissue has become quiescent. In severe cases, the tendon has to be released from the encasing bone and reattached (Figure 8).

Wysocki and Cohen[35] compared patients requiring excision of HO with those having an uncomplicated repair. In comparison with the normal uninvolved side, patients who developed HO lost an average of 9° of forearm pronation ($P < 0.01$). No differences were observed in the results of the Disabilities of the Arm, Shoulder, and Hand questionnaire, endurance strength, or isokinetic torque.

Postoperative Care

Patients are traditionally immobilized in a posterior splint for the first 1 to 2 weeks after surgery to allow for wound healing and to let swelling diminish. Gravity-assisted flexion and extension may be started at this point. Light strengthening is resumed at approximately 8 weeks, with an expected return to heavy activities at 3 to 5 months, depending on the patient. Recently, studies have advocated early allowance of ROM. Cheung et al[36] concluded that immediate postoperative ROM after a two-incision bone tunnel repair of the distal biceps tendon leads to early gain of extension and has no deleterious effect on healing or strength. In two recent clinical studies in which patients were allowed immediate, unbraced, active motion after distal biceps repair, no complications were reported; in both studies, patients were treated with a soft dressing only.[18,22]

Partial Biceps Rupture

Partial tears of the distal biceps are more common than previously reported, a finding that may arise from increased access to MRI.[33] Partial distal biceps tears can be painful and require a prolonged recovery. Patients report deep pain in the antecubital fossa with activity. Examination of the injury reveals a palpable distal biceps tendon, which may be solidly hooked by the examiner's finger but is frequently tender. Pain on resisted supination is helpful to confirm the diagnosis because flexion is often unaffected. MRI demonstrates incomplete rupture of the distal biceps insertion.

Initial treatment consists of nonsteroidal anti-inflammatory drugs and physical therapy. Only after failure of nonsurgical management should surgery be considered. Débridement alone is less likely to be successful. Patients with tears involving <50% of the biceps tendon have been successfully treated with nonsurgical management or with débridement of the surrounding synovitis, whereas patients with tears involving >50% of the biceps tendon frequently benefit from repair.[16]

Detachment of the partial tear with repair of the distal biceps insertion may be the optimal solution. A single-incision dorsal approach may be used. With this technique, the supinator is split longitudinally, exposing the underlying biceps tendon at its insertion site. Stay sutures are placed in the most proximal portion of the biceps that is visible in the wound, and the tendon is pulled down and out of the wound. The biceps tendon is advanced distally through the posterior wound and sharply débrided. The tendon is repaired through a standard bone tunnel approach. Interference fixation with a tenodesis screw is also an option in this setting. Results comparable to traditional repair have been reported with all techniques.[37] An endoscopic approach has been described both to evaluate the extent of the partial biceps tendon tear as well as to aid in repairing tears that involve >50% of the tendon.[16]

Chronic Ruptures

Chronic tears of the distal biceps are often the result of a missed diagnosis. Tears older than 6 weeks can become surgically challenging; once 12 weeks have passed, tissue retraction, loss of elasticity, and early atrophy can preclude reattachment of the tendon to the bone.[38] Affected patients rarely report pain, but will present with loss of supination strength. In young active patients with chronic or unrecognized tears and significant weakness, delayed reconstruction of the distal biceps insertion is a viable treatment option.[38] MRI confirms not only the diagnosis but also the location of the tear because muscle-tendon junction tears do occur.

Repair is done through an extensile anterior approach because localization of the distal biceps stump can be more challenging in chronic situations. Although it is sometimes possible to reduce the tendon stump to the tuberosity with the elbow in flexion, interposition grafting may be required when the distal tendon is retracted and not elastic. A gentle progressive rehabilitation to slowly stretch out the biceps and its distal tendon follows this type of repair. Interposition grafting, with autograft (semitendinosus tendon)[39] or allograft (Achilles tendon)[38] (Figure 9), has demonstrated satisfactory patient outcomes with improvement in strength. Hamstring autograft augmentations are typically woven through the proximal muscle, whereas the Achilles tendon allograft (with or without bone block attachment to the tuberosity) should be sewn circumferentially around the proximal muscle belly.

Authors' Preferred Technique for Acute Ruptures, With Treatment Pearls

We use the tension slide technique[40] for acute repairs. We converted to a single-incision approach after treating synostosis following muscle-splitting dual-incision approaches, having observed the pain associated with disrupting the interosseous membrane and appreciating the superior biomechanics of the cortical button.[22] Initially, we used the previously described technique of Bain et al[22] but found it challenging to accurately predetermine the length of suture between the button and the biceps. In the laboratory, we have also observed pistoning at the repair site with the Bain technique.

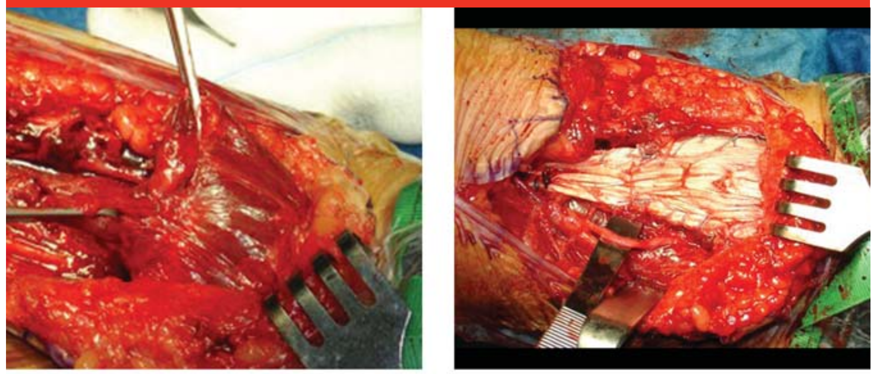
Surgical repair within 2 weeks of injury allows for blunt or finger dissection to follow the biceps sheath down to the tuberosity with relative ease. As time between surgery and injury elapses, this plane closes and the amount of dissection increases. The tendon stump occasionally is retracted and not immediately identifiable. A seroma often directs the surgeon to the location of the biceps stump and, once verified, the proximal biceps stump can be milked out of the wound.

To limit hematoma and possible HO, radial recurrent vessels should be ligated as the exposure is performed, and copious irrigation should be applied to remove all debris. Injury to the PIN can be minimized with a cautious approach to the tuberosity. With the forearm fully supinated, dissection should start on the ulnar aspect of the radial tuberosity to elevate any of the supinator and remain subperisoteal. Lateral retractors can then be placed, with a soft-tissue sleeve protecting the PIN.

Fluoroscopy can be of assistance to determine tunnel or fixation placement; a tendency is to be too proximal. Proximal placement may result in a decrease of the moment arm or fracture through the radial neck. Repairing the tendon on the ulnar side of the tuberosity to mimic anatomy potentially increases future supination strength of the forearm.

The advantages of the tension slide technique include the ability to tension the repair from an anterior incision, minimal displacement of the tendon after fixation is complete, and the strength of cortical button fixation.[40] In addition, with anterior tensioning, there is no need to predetermine the length of suture between the button and the biceps (Figure 7). Patients are placed in a soft dressing and are immediately allowed to resume simple activities of daily living without restriction on ROM. Physical therapy is rarely used. No patient in our case series with this technique suffered failure of fixation with immediate active motion.[40,41]

Figure 9



A B

A, Intraoperative photograph of a chronic distal biceps rupture in a 27-year-old man. The rupture had occurred 9 months previous to the time of surgery. There was no stump to work with and significant retraction of the tear. **B,** The fascial expansion of the Achilles tendon is circumferentially sewn into the proximal muscle belly. The patient regained muscle contour and supination strength.

Summary

Careful attention to history and a methodical physical examination are essential components of diagnosing distal biceps ruptures. Healthy, active persons with distal biceps tendon ruptures may benefit from early surgical repair, which reliably allows patients to regain a high level of function. Anatomic studies demonstrate that the biceps does not have a cylindrical insertion on the radial tuberosity but rather a ribbonlike insertion on the ulnar aspect of the tuberosity. Biomechanical studies suggest that suspensory cortical button fixation is the strongest method of repair. Both single- and dual-incision approaches can lead to successful clinical outcomes. Loss of forearm rotation, HO, radioulnar synostosis, and nerve injury can occur with both approaches. Clinical studies have demonstrated good and excellent results with both surgical approaches and the various methods of fixation. Postoperative protocols are trending toward early ROM.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 12, 13, 16, 26, and 29-35 are level I/II prospective studies. The remaining references are case-control case series or expert opinion studies.

Citation numbers printed in **bold type** indicate references published within the past 5 years.

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