Primary repair of retracted distal biceps tendon ruptures in extreme flexion

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Background: Distal biceps tendon ruptures may have tendinous retraction, making primary repair difficult and calling into question the need for graft reconstruction. The decision for when to primarily fix or augment high-flexion repairs has not been addressed. We hypothesized high-flexion repairs would have good outcomes without graft augmentation. The purpose of this study was to examine allograft use and outcomes of distal biceps tendon ruptures requiring repair in greater than 60° of flexion.

Methods: This was a retrospective case-control study of 188 distal biceps tendon repairs; of these, 19 chronic and 4 acute cases were identified with repairs of >60° of flexion using a 2-incision technique. Graft need, complications, and Mayo Elbow Performance Score to assess function, were examined with a record review. Patients were surveyed regarding return to work and subjective satisfaction. A control group matched for surgeon, chronicity, and age, but without a high-flexion repair, was compared with cases by using the Student paired t test.

Results: Graft augmentation was used in 1 patient with poor tendon quality. The Mayo Elbow Performance Score was 100 for all 23 patients, with extension/flexion range of motion from 3° to 138°. All were subjectively “very satisfied/satisfied,” with full work return, yet 3 reported mild fatigability. There were 4 complications: 3 transient lateral antebrachial cutaneous neurapraxias and 1 rerupture at the myotendinous junction after retrauma. Differences between cases and controls were not statistically significant.

Conclusion: Contracted distal biceps tendons may be reliably reattached to their anatomic insertion with up to 90° of elbow flexion. This lessens the need for reconstruction in such circumstances.

Level of evidence: Level III, Case Control Design, Treatment Study.

Keywords: Distal biceps tendon repair; chronic biceps rupture; outcomes; allograft reconstruction; high-flexion repair; tendon retraction

Distal biceps tendon ruptures are relatively rare injuries, with a reported incidence of 1.2 per 100,000 persons per year. They represent between 3% and 10% of all biceps ruptures. A preponderance of injuries occurs in male laborers or athletes aged between 30 and 60 years, with a broad peak in the fourth and fifth decades. Furthermore, smokers are at 7.5-times the risk as non-smokers to sustain such an injury. Tendon hypo-vascularity and intrinsic degeneration due to mechanical impingement have both been purported contributors to rupture.
The surgical treatment of these injuries became common after repair was found to have a better return of strength compared with nonoperative management. The ideal surgical technique for primary repair continues to be debated, but that operative treatment is superior to nonoperative treatment for endurance and return of strength in flexion (30% improvement) and supination (40% improvement) is generally accepted.1,16,17

Early repair is advocated because of the higher rate of complications reported when surgery is delayed.10 Unfortunately, surgery may be delayed for several reasons, including delayed diagnosis. Chronic distal biceps tendon ruptures are typically associated with substantial retraction and poor tendon quality, which can also rarely occur in acute injuries.3,10 Augmented reconstruction with various graft materials has been reported for the treatment of these injuries because primary repair typically substantially limits the amount of passive elbow extension at the time of surgery and the ability of the tendon to reach its anatomic footprint. However, some stress relaxation of the primary repaired biceps occurs over time, and the threshold to decide between repair and augmented reconstruction is largely unknown.

Concerns with repairing a distal biceps tendon rupture in high flexion include the possibility of re rupture or residual flexion contracture. However, the outcome and complications of primary distal biceps repair in high flexion has not, to date, been specifically addressed. The purposes of this study were to compare distal biceps tendon ruptures repaired in greater than 60° of flexion (high-flexion group) with a control-matched group of primary repairs performed in less than 30° of flexion with regards to (1) need for graft augmentation, (2) functional results, (3) subjective patient satisfaction, (4) return to work, and (5) complications, specifically, rupture and residual flexion contracture. The specific questions being addressed were:

1. Are grafts needed for high tension/flexion repairs?
2. Are functional and subjective outcomes comparable to those not requiring repair in high flexion?
3. Is there an increased incidence of rupture or residual flexion contracture if repaired in high flexion?

Materials and methods

Patients

This was a case-control study in which a retrospective record review was performed on 188 consecutive distal biceps tendon repairs performed at our institution during a 10-year period using a 2-incision repair technique. The electronic medical records of all repairs, including operative notes, were reviewed to identify those satisfying our acceptance criterion. Twenty-three primary repairs had been performed in at least 60° of flexion and form the basis of the high-flexion group. These 23 elbows were matched by age, surgeon, and chronicity of injury to 23 separate patients whose distal biceps had been repaired in 30° of flexion or less.

The high-flexion group included 22 men and 1 woman, with a mean age at the time of surgery of 50 years (range, 33-67 years), who had undergone 19 chronic and 4 acute repairs. Acute injuries were defined as being repaired within 3 weeks of the injury, and chronic injuries were those repaired after 3 weeks. The mean time between injury and surgery for chronic injuries was 21 weeks (range, 4 to 112 weeks) and for acute injuries was 12 days (range, 7-14 days).

The control group included 5 acute and 18 chronic injuries, all primarily repaired in 30° of flexion or less (range, 0°-30°). There were 22 men and 1 woman, with a mean age at the time of surgery of 48 years (range, 30-63 years). The mean time between injury and surgery for chronic injuries was 7 weeks (range, 4-18 weeks) and for acute injuries was 6 days (range, 1-10 days).

Surgical technique

All primary repairs in the high-flexion and control groups were repaired using the Mayo modified 2-incision technique as described by Morrey et al.16 After a general anesthetic is administered, the surgical site undergoes sterile preparation, and a drape is applied. A transverse incision is made in the antecubital fossa, and the dissection is carried down to the biceps tendon remnant. Care is taken to protect the lateral antebrachial cutaneous nerve as it exits laterally between the biceps and the brachialis muscles.

In chronic cases, the tendon may be scarred proximally, but in several of the patients included in the study, it was found near an intact lacertus fibrosis and scarred to it in some cases (Fig. 1). The quality and position of the tendon and myotendinous unit and whether the lacertus remained intact varied for each of the cases and is documented in Tables I and II. A consistent finding for all repairs, whether acute or chronic, was that there was tendon attenuation and shortening from its normal length and bulk. The lacertus was torn in 16 cases, intact in 6, and partially torn in 1.

Once the tendon is identified, it is assessed for quality. In some instances, the tendon fibers are completely absent, with no distinct tendon stump at the lower end of the biceps muscle belly; allograft augmentation is oftentimes used in those situations. For the elbows included in this study, the amount of remaining tendon after...
Table I  Biceps tendon repairs in greater than 60° of flexion

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R, female; L, left; LABCN, lateral antebrachial cutaneous neuropathy; M, male; Pt, patient; R, right; ROM, range of motion.
light debridement was deemed to be sufficient for primary repair, albeit in more flexion than is typically preferred. This was determined by whether 2 sutures with 4 locking loops could be passed from distal to proximal or whether approximately 4 cm of normal tendon remained after debridement. Two heavy nonabsorbable sutures of #5 Ethibond (Ethicon, Somerville, NJ, USA) or #2 FiberWire (Arthrex, Naples, FL, USA) were placed through the tendon stump with 4 throws in a Krackow locking-stitch configuration such that 4 strands emerge from the end. The myotendinous unit was then assessed for excursion by pulling on the sutures, allowing a controlled stretch. Additional dissection was done as needed to ensure the biceps is not scarred to the underlying brachialis muscle.

Next, the track to the radial tuberosity is identified. This is done quite readily in acute cases but requires more careful dissection in chronic cases. The recurrent branch of the radial artery is ligated or cauterized when needed. Once the tuberosity is identified, a curved Kelly clamp is used to pass around the tuberosity and identify the point for a counter incision on the forearm. The forearm is pronated to protect the posterior interosseous nerve. A small incision is made over the Kelly clamp, and the extensor carpi ulnaris muscle is split bluntly down to the tuberosity, with the arm maintained in pronation and avoiding subperiosteal dissection of the supinator muscle. A docking technique is used by excavating the radial tuberosity with a burr. Three drill holes are created, and the tendon is passed into the excavated tuberosity. The sutures are drawn through and tied over the bony bridges.

Once the repair is complete, a gentle stretch is performed with direct examination of the repair. The amount of passive elbow extension that occurs with gravity after this stretch is measured with a goniometer and documented in the operative report to guide postoperative care. For the 23 elbows included in the high-flexion group, passive elbow extension with gravity at the end of the repair was between 60° and 70° in 5 elbows, 70° and 80° in 10 elbows, 80° and 90° in 4 elbows, and exceeded 90° in 4 elbows. In the control group, 7 elbows passively extended to 30°, 5 elbows to 20°, 5 elbows to 10°, and 6 elbows extended to 0°.

Graft augmentation was required in patient 23 of the high-flexion group due to a diminutive tendon and discontinuity of the long and short heads of the biceps. This resulted in a complete rupture of the musculotendinous juncture of the medial half of the short head of the biceps and an in-continuity, but stretched yet attenuated long head tendon laterally (Fig. 2). Heavy #5 Ethibond suture and an Achilles tendon graft were used to sew the short head to the tendon mechanism. The graft was placed over both the short and long heads and was wrapped circumferentially around the biceps tendon for reconstruction (Fig. 3). The muscle itself was contracted and did not allow for full excursion even after restoration of a normal tendon length, thus necessitating repair in high flexion.

### Postoperative care

Postoperatively, the elbow is immobilized in a posterior plaster splint or in a locked brace in 90° of flexion with neutral pronation-supination for the first 2 weeks, depending on the degree of swelling. At week 2, patients are allowed to increase elbow extension in the brace each week in 10° increments starting from the initial flexion position. Patients are encouraged to work on
active extension and passive flexion exercises, as well as on pronation and supination exercises in 90° of flexion. Brace protection is discontinued once extension is restored to at least 20°, which typically occurs between 6 and 8 weeks. Weight training for strengthening is started at 3 months, with unrestricted return to all activities at 6 months.

**Patient evaluation**

All patients were evaluated at 2 weeks, 6 weeks, 3 months, and at least 1 year after surgery. Pain, range of motion, and strength in flexion and supination were documented at each clinical visit. Complications were recorded. For the purposes of this study, at most recent follow-up, all patients were interviewed at office visits (18 elbows) or by telephone call (5 elbows) regarding subjective satisfaction and return to work or other activities. Subjective satisfaction was rated as “very disappointed,” “disappointed,” “neither disappointed or satisfied,” “satisfied,” or “very satisfied.” Active motion was measured with a handheld goniometer, and strength testing was completed clinically at each visit. The Mayo Elbow Performance Score (MEPS) was calculated from the clinical evaluation and the patient-reported survey to assess function. Discrete data were assessed for statistical relevance between study patients and controls with a Student t test. Differences occurring with less than 5% likelihood to be by chance were considered significant.

**Results**

**Clinical results**

The clinical results of all elbows included in the high-flexion group are summarized in Tables I and II. At the most recent follow-up, all patients reported no or mild pain, and were subjectively “very satisfied” (20 patients) or “satisfied” (3 patients) with the outcome, even though 3 individuals reported some fatigue. All patients reported full return to work with no restrictions. Average range of motion was from 3° (range, 0°-20°) of extension to 138° (range, 130°-145°) of flexion. No flexion contractures were noted. The patient with 20° of flexion had coexistent osteoarthritis and a bony block to motion at 20°. Average pronation was 82° (range, 70°-90°), and average supination was 78° (range, 50°-90°). Physical examination identified 2 patients with subtle weakness in both flexion and supination (4+/5).

**Complications**

Complications included 3 transient lateral antebrachial cutaneous neuropathies and 1 rerupture. This rerupture occurred in patient 11 as a result of significant trauma 13 days postoperatively that involved a fall from a wheelchair where the forearm was caught on the arm of the wheelchair and the repair subjected to the patient’s full body weight. The patient had been in a motor vehicle accident 10 years prior that resulting in paraplegia. The patient was not taking any statins or fluoroquinolones and had no other risk factors for rupture at the time of either injury. At the time of reoperation, the site of tendon-to-bone attachment was intact. The rupture was found proximally at the myotendinous junction and was augmented with an Achilles tendon allograft.

No contractures, synostoses, or other persistent neurologic deficits occurred in the high-flexion group. There were 4 complications in the control group, including transient radial nerve dysfunction (3 elbows) and transient lateral antebrachial cutaneous paresthesias (1 elbow). One patient had persistent unexplained pain. There were no reruptures in the control group.

**Comparisons between the high-flexion and the control groups**

There were no statistically significant differences between the high-flexion and the control groups for pain, MEPS (including range of motion), subjective satisfaction, return to work, strength, or complications (P = .53).
Discussion

Substantial retraction of the biceps muscle-tendon unit is commonly encountered in the surgical treatment of chronic distal biceps tendon injuries. Several authors have reported various techniques for augmented reconstruction of chronic, retracted injuries. However, the amount of retraction deemed substantial enough to require augmented reconstruction rather than primary repair has not been addressed, and for the most part, is a subjective decision on the part of the surgeon.

Retracted distal biceps tendon injuries can be treated by primary repair to the radial tuberosity as long as residual tendon length is sufficient to allow traction through sutures. Several biomechanical studies have recently addressed the optimum number of throws and the suture configuration for optimal holding power, which confirmed the basis of our decision not to use an allograft if there was sufficient tendon to allow for 4 throws of a Krackow suture. In fact, these studies would suggest that 2 throws would be sufficient for repair. Nevertheless, when a retracted distal biceps tendon is repaired primarily, the elbow cannot be fully extended at the end of the procedure. In theory, primary repair of the distal biceps in a high degree of flexion could lead to a higher risk of rerupture or permanent flexion contractures if the biceps muscle-tendon unit does not stretch to length over time. Hence, this led to the widespread use and acceptance of graft augmentation in this situation. To our knowledge, however, no study has investigated the outcome of retracted distal biceps tendon ruptures repaired primarily in a high degree of flexion.

The results of our study seem to indicate that distal biceps tendon injuries repaired primarily at a high degree of flexion do stretch over time, without a higher rate of rerupture or permanent flexion contracture, or other complications. All patients included in our study experienced pain relief and improved function, return to work with no restrictions, and were subjectively satisfied with their outcome, including the only patient in this series covered under Worker’s Compensation.

Although no guidelines exist on what degree of tension is acceptable in the biceps myotendinous unit after repair, the biceps has a remarkable ability to stress relax over time after contracture without undue sequelae. The stress-relaxation, as in limb-lengthening surgery, is due to the addition of sarcomeres in-series as the muscle is stretched over time. Importantly, this addition of sarcomeres in-series does not result in a lower force-generation capacity.

This ability of the biceps to lengthen through the muscle fibers makes rerupture of the tendon repair quite uncommon. In fact, we were only able to identify 1 case report of rerupture after repair. The authors of this study reasonably postulated that this was most likely due to protective rehabilitation programs, the load sharing of surrounding muscles, such as the brachialis in flexion and supinator in supination, and reflex inhibition after surgery. In contrast to this single report of failure at the bone-tendon junction, our study did not identify an undue risk of rerupture at the tuberosity but instead at the myotendinous junction. However, both may have been, in theory, due to a taut muscle predisposing to tear with the high load across the myotendinous unit.

Similar to the case report, our case occurred early after surgery and both were repaired in substantial flexion initially (90° in our patient and 70° in the case report) due to the chronicity of the injury. We therefore believe that because the time required for effective stress relaxation of the biceps is unknown, caution should be exercised early in the rehabilitation process to avoid any concentric or eccentric forces in supination or flexion to protect the repair and the myotendinous junction. This treatment philosophy was followed because the risk of flexion contracture appears to be negligible based on our data, and the protective rehabilitation program after surgery should allow for tendon healing and also a return to normal motion.

Achilles allograft augmentation was required in 1 patient included in the high-flexion group. However, this patient was still considered part of the study group because the allograft was required to address a partial rupture at the myotendinous junction, as an independent and secondary lesion, as opposed to difficulty in reaching the footprint at the tuberosity. As a result of our experience accumulated over time and documented in this study, we no longer base the need to consider an augmented reconstruction on the amount of retraction but on the quality of the residual tendon and the ability to reattach the tendon to the tuberosity. We do consent all patients presenting with a chronic injury for primary repair and augmented reconstruction, and the final decision to proceed with either technique is made intraoperatively and on the chronicity of the repair.

One limitation of our study, in addition to the limitations of any retrospective study, was the reliance solely on clinical examination for strength documentation at follow-up. Despite this limitation, our primary goal was to determine the need for allograft augmentation and whether contractures or reruptures occurred with greater frequency without augmentation after primary repair of a retracted distal biceps tendon in high flexion. After a thorough review of 188 patients over 12 years, we identified only 23 patients repaired in high flexion. Therefore, this circumstance is uncommon enough (12%) that a long-term prospective study would be required to address muscle strength directly.

The strengths of this study include the use of the same surgical technique and postoperative protocol for all patients, the lack of patients lost to follow-up, and the comparisons with a matched control group.
Conclusion

Retracted distal biceps tendon ruptures repaired primarily seem to do well despite requiring a high degree of flexion for the tendon to reach its footprint at the radial tuberosity. During postoperative recovery, the biceps muscle lengthens over time, leading to a low rate of rerupture and flexion contracture. Over time, our practice has evolved to a less common use of allograft augmentation, which is reserved for patients with very poor or absent residual tendon at the time of surgery, regardless of the chronicity of the injury.

Primary distal biceps tendon repairs performed in 60°-90° of flexion can have excellent outcomes and a low rate of serious complications. Graft augmentation should be determined by the quality of the tendon rather than by the amount of biceps retraction.

References