Repair and Rehabilitation of Distal Biceps Ruptures

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Etiology: Distal biceps tendon ruptures, which account for approximately 10% of all biceps ruptures, typically occur after a sudden, unexpected extension force to the flexed arm. Most injuries are complete ruptures, with the tendon avulsing from the radial tuberosity. Tearing of the bicipital aponeurosis may or may not occur. Patients are usually men between the ages of 30 and 60 years; complete rupture has been reported in a woman in only one instance. Although most patients are asymptomatic before rupture, it is thought that preexisting chronic degeneration plays a role in most, if not all, injuries. Mechanical impingement (decreased radioulnar distance resulting in less space available for the tendon) is also cited as a potential cause. More than 4 in 5 injuries occur in the dominant arm, and ruptures are 7.5 times more likely in smoker.

Treatment and Repair Techniques: Surgical reinsertion of the biceps tendon to the radial tuberosity is considered the treatment of choice for most complete ruptures (and for partial tears that have failed nonoperative management). Nonoperative management is typically considered only for elderly, low-demand patients, or for those too ill to consider surgical intervention. Patients who choose nonoperative treatment typically lose 20% to 30% of arm flexion and 30% to 50% of supination strength and may suffer chronic activity-related arm and forearm pain. Recently, however, some authors have questioned the severity of disability associated with nonoperative management.

Outcomes: In general, most studies describe excellent clinical outcomes irrespective of fixation method. Two-incision techniques may result in slightly greater flexion strength and may better restore supination strength, by virtue of positioning the repair more posteriorly, in a more anatomic position, on the tuberosity than the one-incision methods.

Rehabilitation: With improvement in surgical techniques, and greater knowledge of pull out and failure complications, current rehabilitation progressions have advanced. As mentioned, the native distal bicep tendon has a strength of 200 to 225 N. The present literature suggests that surgical fixation with the Endobutton technique has a failure load of 259 ± 28 N, obviously higher than the natural attachment. However, there should always be caution with any aggressive protocol, and communication with the physician is imperative. Particularly with a distal biceps repair, it will be very important to know the level of tendon retraction, tissue quality, and security of fixation that the surgeon was able to achieve. With this knowledge, the rehabilitation may move slower, or more quickly, but the most important factor in progression of this patient population postoperatively is the achievement of clinical milestones. Protocols are a good guideline for rehabilitation but should rarely be used as an exact recipe. The rehabilitation after repair of the distal biceps tendon has undergone evolution, but basic principles still hold true. Progression can be guided by a protocol but should be largely based on communication between physician and rehabilitation specialist. As with any surgery, parameters and outcomes may vary based on the severity of the injury and the ability of the surgeon to achieve ideal fixation. No 2 surgeries are exactly alike, but safe rehabilitation guidelines can be established for any patient with the right attention to detail.

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Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Website, www.shoulderelbowsurgery.com.

Key Words: distal biceps rupture, repair, rehabilitation

(*Tech Should Surg* 2014;15: 25–27)

ANATOMY

The biceps muscle is the most superficial muscle in the volar arm, with a single distal tendon attachment. This tendon runs deep through the antecubital fossa to attach at the radial tuberosity. A secondary distal attachment, the bicipital aponeurosis, arises from the medial aspect of the musculotendinous junction and after coursing medially, blends with the forearm fascia. The biceps is the most important supinator of the forearm and assists the brachialis with elbow flexion, particularly when the forearm is supinated.[1] The strength of the distal biceps attachment is approximately 200 to 225 N.[2,3]

The distal biceps is critically related to a number of significant neurovascular structures, the most important being the lateral antebrachial cutaneous nerve and the posterior interosseous nerve. The lateral antebrachial cutaneous nerve is the terminal branch of the musculocutaneous nerve and crosses the elbow in the subcutaneous tissue where anterior incisions for repair are typically placed. The posterior interosseous nerve (PIN) is the deep (motor) branch of the radial nerve and courses around the lateral radius in close proximity to the approach used for 2-incision repairs and to the site of transradial drilling trajectory in 1-incision techniques. In addition to these structures, the median nerve, brachial artery, and brachial vein all lie medial to the distal biceps tendon beneath the bicipital aponeurosis.

ETIOLOGY

Distal biceps tendon ruptures, which account for approximately 10% of all biceps ruptures, typically occur after a sudden, unexpected extension force to the flexed arm.[4] Most injuries are complete ruptures, with the tendon avulsing from the radial tuberosity. Tearing of the bicipital aponeurosis may or may not occur. Patients are usually men between the ages of 30 and 60 years; complete rupture has been reported in a woman in only one instance.[5] Although most patients are asymptomatic before rupture, it is thought that preexisting chronic degeneration plays a role in most, if not all, injuries.[6] Mechanical impingement (decreased radioulnar distance resulting in less space available for the tendon) is also cited as a potential cause.[7] More than 4 in 5 injuries occur in the dominant arm, and ruptures are 7.5 times more likely in smokers.[8]

CLINICAL EVALUATION

Patients typically report a sudden and painful tearing sensation in the elbow occurring while attempting to lift an overly heavy or immobile object. Severe initial pain is rapidly replaced by a dull aching, which may last for weeks. Extensive ecchymosis may develop. On comparison with the contralateral limb, physical examination will demonstrate a defect in the antecubital fossa, with retraction of the biceps into the proximal arm during active elbow flexion. The "Hook Test," in which the examiner attempts to digitally hook the intact tendon, is reported to be 100% specific and sensitive.[9] Weakness, with or without pain, is usually evident with elbow flexion and supination. Plain radiographs are typically normal. Most, if not all, complete ruptures can be diagnosed without magnetic resonance imaging or ultrasound, although these may be useful in uncertain cases, or in instances of suspected partial tears.

TREATMENT AND REPAIR TECHNIQUES

Surgical reinsertion of the biceps tendon to the radial tuberosity is considered the treatment of choice for most complete ruptures (as well as for partial tears that have failed nonoperative management). Nonoperative management is typically considered only for elderly, low-demand patients, or for those too ill to consider surgical intervention. Patients who choose nonoperative treatment typically lose 20% to 30% of arm flexion and 30% to 50% of supination strength and may suffer chronic activity-related arm and forearm pain.[7,10–13] Recently, however, the severity of disability associated with nonoperative management has been questioned.[14]

Surgical repair is best undertaken within 3 to 4 weeks of injury; repair delayed beyond this time may require graft augmentation because of tendon retraction and loss of tendon length. A number of approaches and methods have been described for reattachment. The standard of treatment is a "two-incision" technique, which uses a small anterior antecubital incision to retrieve and prepare the tendon, which is then passed through the bicipital sheath to a muscle splitting, second incision on the dorsal forearm.[12] Through this second incision, the tendon is typically repaired into a burr hole on the radial tuberosity and secured transosseously with sutures over a bony bridge through adjacent drill holes. Single, or "one-incision" techniques utilize only a larger anterior forearm incision, through which the tendon is repaired to the radius using a variety of implants, including suture anchors, button devices, and interference screws.[15–17] Some surgeons have used interference screws or anchors with the 2-incision method.[18] There are also reports of endoscopic evaluation and fixation.[19,20]

Results of studies comparing repair strength among these different techniques are variable. In general, fixation through bone tunnels is thought to provide fixation strength approximately equal, if not greater, to that of the native biceps attachment, whereas Endobutton-type devices provide stronger initial strength in most studies.[2,21–23] Interference screws alone may or may not be weaker than other techniques and seem to most closely recreate native load and stiffness.[2,3,22] In nearly all studies, suture anchor techniques appear to provide inferior biomechanical properties.[3] Newer techniques that use a hybrid fixation with both a button-type device and an interference screw likely provide the greatest initial fixation strength and lowest gap formation.[7,24,25]

COMPLICATIONS AND OUTCOMES

Overall complication rates are similar among the different repair techniques.[3] Historically, the most common intraoperative complications depended on the surgical approach used. Injury to the antebrachial cutaneous nerve is more commonly associated with 1-incision techniques, whereas heterotopic ossification, synostosis, and loss of forearm rotation are more likely associated with 2-incision methods.[26] The latter method is also more closely associated with PIN injury, although 1-incision techniques that drill through the far cortex of the radius (ie, button fixation) may also cause PIN injury.[27,28] The great majority of nerve injuries are transient. Both techniques pose a small risk of radius fracture, arterial injury, and rerupture. Overall complication rates are higher when repair is delayed.[27,29]

In general, most studies describe excellent clinical outcomes irrespective of fixation method.[30] Two-incision techniques may result in slightly greater flexion strength and may better restore supination strength, by virtue of positioning the repair more posteriorly, in a more anatomic position, on the tuberosity than the 1-incision methods.[18,26,31]

REHABILITATION

Although limited research exists regarding the rehabilitation process after distal biceps repair, there has been an evolution of thinking in recent years. Until recently, typical therapy protocols would consist of a period of immobilization and protection for 2 weeks with various bracing options. Weeks 2 to 4 would then allow for the brace to be unlocked from 0 to 90 degrees. Passive pronation would be allowed in this time to neutral only, and passive supination would be allowed to full range of motion. It was not until week 4 when the brace was removed and full passive ranges were to be gradually achieved. These recommendations were not based upon peer reviewed evidence but rather upon typical accepted tissue healing guidelines. The belief was that active range of motion and submaximal resistance was not safe to complete until the patient was 8 weeks postoperative because of the knowledge that soft tissue healing generally takes 8 to 12 weeks to complete.[32]

With improvement in surgical techniques, and greater knowledge of pull out and failure complications, current rehabilitation progressions have advanced. As mentioned, the native distal bicep tendon has a strength of 200 to 225 N. The present literature suggests that surgical fixation with the Endobutton technique has a failure load of 259 ± 28 N, obviously higher than the natural attachment.[33] However, there should always be caution with any aggressive protocol, and communication with the physician is imperative. In particular, with a distal biceps repair, it will be very important to know the level of tendon retraction, tissue quality, and security of fixation that the surgeon was able to achieve. With this knowledge, the rehabilitation may move slower, or more quickly, but the most important factor in progression of this patient population postoperatively is the achievement of clinical milestones. Protocols are a good guideline for rehabilitation but should rarely be used as an exact recipe.

Surgical repair is considered to be the best method for restoring flexion and supination strength after distal biceps rupture, and most patients will regain full functional return.[33,34] There are also few complications generally associated with distal biceps repair, paramount of which is delay from time of rupture to surgical intervention.[34] However, as with any range of motion limitation, heterotopic ossification can also occur. With this in mind, and with improved surgical fixation, current rehabilitation protocols demonstrate allowance of earlier safe active range of motion in hope of preventing such occurrences. In fact, Spencer et al[35] found that unrestricted range of motion after 2 weeks following Endo-Button repair showed no significant difference in final range of motion or scores on the Disabilities of Arm Shoulder and Hand index. Full range of motion was achieved at 4.38 weeks with no occurrence of rerupture. Another study by Cil et al[36] used a transosseous suture repair and showed a full return of range of motion and minimal loss of strength with using a sling for comfort only for 1 to 2 days. Patients in this study were encouraged to begin passive range of motion in pronation and supination and active range of motion throughout all cardinal planes with the goal of full range of motion as soon as possible. There were no reruptures in this study with full activity resumed after 3 months.

The rehabilitation after repair of the distal biceps tendon has undergone an evolution, but basic principles still hold true. Progression can be guided by a protocol but should be largely based on communication between physician and rehabilitation specialist. As with any surgery, parameters and outcomes may vary based on the severity of the injury and the ability of the surgeon to achieve ideal fixation. No 2 surgeries are exactly alike, but safe rehabilitation guidelines can be established for any patient with the right attention to detail.

Refer to appendix 1 (Supplemental Digital Content 1, http://links.lww.com/TSES/A17) for Rehabilitation guidelines following distal biceps repair.

Refer to appendix 2 (Supplemental Digital Content 2, http://links.lww.com/TSES/A18) for Late phase exercise progressions:

(1) Bridges performed with the patient's shoulders on a BOSU with plyometric ball chest passes.
(2) Unilateral chest pass with trunk rotations.
(3) Upper quarter Y-balance on slider.[37]
(4) Upper extremity closed chain on an exercise ball with manual alternating isometrics and rhythmic stabilization.
(5) Plyometric push-ups on a wall with manual assist.

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