Diagnosis

Biceps Tendon Rupture at the Radial Tuberosity

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The sagittal T2-weighted magnetic resonance image (MRI) in Figure 1 shows complete disruption of the distal biceps tendon with 3.5-cm retraction proximal to the radial tuberosity attachment. A small high T2-signal fluid collection is present in the tendon gap with regional edema, but no hematoma (Figure 1).

The biceps brachii has complex anatomy including two sites of tendinous origin on the scapula and a single insertion site on the radius. Thus, this muscle-tendon unit contributes to function both at the shoulder girdle and the elbow. Although proximal tendon injuries are relatively common, resulting from a variety of acute and chronic pathologies, distal tendon tears near the radial insertion account for only 3% of biceps tendon injuries.¹ However, distal injuries are significant clinically, resulting in loss of elbow supination strength and, to a lesser extent, loss of flexion strength.

ANATOMY

The biceps muscle is contained in the anterior compartment of the arm. Two heads of the muscle exist. The long head originates at the supraglenoid tubercle of the scapula. The tendon passes through the synovial cavity of the shoulder joint into an osseofibrous tunnel at the anterior humeral head within a synovial sheath. The short head originates at the coracoid process of the scapula. The tendon traverses anterior to the axillary muscles, nerves, and vessels. The muscle belly of the biceps brachii lies on the anterior arm with the long head lateral to the short head. The muscle belly is closely associated with the musculocutaneous nerve and the brachialis muscle, that are located just posterior to the biceps. The two muscle bellies unite proximal to the insertion on the radial tuberosity. Although it is not uniformly accepted, new studies show that there may be 2 insertion sites on the tuberosity corresponding to the long and short heads.

At the musculotendinous junction, the tendon condensation is plaque-like and oriented in the coronal plane. As the ten-
don further condenses to a dense cord-like structure traversing the elbow joint, the fibers rotate 90° before fanning out to cover a 3-cm portion of the radial tuberosity. The length of the elongated segment of tendon from the musculotendinous junction to the tubercle is approximately 7 cm. Additionally, proximal to the cubital fossa a portion of the tendon branches medially, forming a broad sheet called the bicipital aponeurosis (largetus fibrosus) that fuses with the deeper fascia of the forearm medially so that indirect attachment to the ulna exists.

The main action of the biceps muscle is strong supination of the forearm when the elbow is flexed. Minor actions include elbow flexion especially when the forearm is supinated. The muscle provides minimal glenohumeral joint flexion. Innervation is from the musculocutaneous nerve, which originates from the C-5, C-6, and C-7 neural levels.

Mechanisms of Injury

Most distal tendon disruptions occur near the insertion, 1 to 2 cm proximal to the radial tuberosity, leaving a small tendon remnant at the tubercle. Musculotendinous tears are uncommon. Distal biceps tendon injuries can result from direct penetrating trauma or indirect trauma. Complete tears usually are associated with a single traumatic event, with the upper extremity acting against resistance to a large force, typically when eccentric muscle contraction occurs while the elbow is flexed near 90° (such as when catching an object falling from a height) or hyperextended (such as striking a fastball with a bat). Partial tears more often are the result of chronic repetitive tendon injury (such as impingement secondary to enthesopathic proliferation at the radial tuberosity). Tendon degeneration and inflammation due to chronic diseases such as rheumatoid arthritis or diabetes also predispose the tendon to injury from minor trauma. Finally, the risk of partial tears transforming to complete tears is increased in patients who have had steroid injections or taken anabolic steroids.

Presentation

Acute traumatic tears of the distal biceps tendon typically are dominant arm injuries in men aged 50 to 60 years. Younger patients are affected when predisposing pathology such as anabolic steroid use or connective tissue disease exists. At the time of acute tendon rupture, patients hear a “pop” and experience a sudden decrease in elbow flexion strength. Distal avulsions with retraction result in a focal mass-like swelling and a palpable defect in the cubital fossa. However, associated hemorrhage and swelling frequently mask these findings. Rupture without retraction, due to an intact aponeurosis or partial tear, is more difficult to diagnose on physical examination. Strength shows forearm supination weakness in 90° of elbow flexion. Loss of elbow flexion strength as an isolated sign is unreliable, as numerous additional muscle groups exist that can compensate for the biceps contribution to flexion strength.

In an equivocal physical examination, imaging is critical to distinguish partial from complete tendon injuries, and thus, determine appropriate management.

Radiology

Radiographs serve as a screening device by excluding other injuries including fractures. Uncommonly, an acute avulsed fragment from the radial tuberosity is shown, or irregular calcifications adjacent to the radial tuberosity indicate chronic tendinopathy. This finding, however, does not exclude a superimposed acute injury.

Ultrasound

Ultrasound is sensitive for biceps tendon injuries and has...
Ultrasound is best performed at the volar cubital fossa with the elbow in slight flexion so the distal tendon can be palpated. Once localized, the tendon can be followed longitudinally to the radial tuberosity. The radial tuberosity is best viewed by placing the arm in supination. The normal tendon has a tubular shape with uniform width, and longitudinally oriented hyperechoic striations (Figure 2). There is a bright reflector interface between the fat in the fascial plane and the tendon. The tendon fans mildly as it approaches the attachment to the tubercle, where echogenicity is relatively decreased.

A complete tear without retraction appears as a focal disruption with a measurable gap and identifiable tendon margins (Figure 3). However, if significant tendon retraction exists, a fragment of tendon may be still present at the tubercle. Imaging must be completed proximally to locate the retracted tendon margin, if possible. With acute rupture, regional anatomy may be altered due to distortion by edema and hemorrhage or a focal hematoma.

Tendon echogenicity will be reduced or the longitudinal order will be lost when a partial tear exists. The tendon may be thickened or thinned with an irregular or wavy contour. Associated hemorrhage tends to be less prominent than with a complete tear, but still may distort regional landmarks.

**Magnetic Resonance Imaging**

Magnetic resonance imaging is sensitive for both diagnosing and grading distal biceps tendon tears. Magnetic resonance imaging accuracy was reported as high as 100% in one 15-patient series. An advantage compared to ultrasound is the ability to evaluate all regional structures and show additional or alternative pathologies. Disadvantages include absolute contraindications for MRI, long length of study time, and expense.

The normal, plaque-like musculotendinous junction of the biceps appears as a cord-like, signal-void structure as the tendon courses anterior to the elbow joint line (Figure 4). On axial images, the tendon is well demonstrated as it dives into the central fascial plane at the antecubital fossa and approaches the radial tuberosity (Figure 5). The distal tendon may have minimal intrasubstance intermediate signal as it fans to attach to the tuberosity.

With complete tendon rupture, discontinuity of the cord usually is in proximity to the radial tubercle. In the absence of retraction, the gap is measured and recorded. High T2-signal fluid filling the defect may also tuck along the tendon remnants. Therefore, fat-suppressed sequences increase the sensitivity for detecting complete rupture (Figure 6). Retraction due to rupture may be minimized if the aponeurosis is still intact. Le Huec et al. showed that retraction of <8 cm correlated with an intact aponeurosis. When significant retraction is present, proximal imaging is necessary to localize the tendon margin and measure the gap. In acute rupture, large amounts of edema and hemorrhage in the anterior soft tissues of the antecubital fossa and marginal upper arm appear as ill-defined, infiltrating high T2 signal and well-defined high T2 signal focal fluid collections. The biceps muscle also may appear infil-
Fibers are still attached to the radial tuberosity (arrow). Partial tears of the distal biceps tendon with marked thickening proximal to the radial tubercle with intra-substance high T2 signal intensity fatty infiltration on T1-weighted sequences can have secondary signs of decreased muscle bulk due to atrophy, seen as high signal intensity fatty infiltration on T1-weighted sequences.

Partial thickness tears are less dramatic, with little or no fluid and edema marginal to the biceps tendon (Figures 7 and 8). The tendon may show fusiform thickening with intermediate intrasubstance signal abnormality (Figures 9 and 10). This also is a common appearance when underlying chronic tendinopathy exists. Alternatively, focal thinning of the tendon substance may occur with little signal abnormality.

Imaging usually is completed in the axial plane with the arm extended. The study should extend from the biceps musculotendinous junction through the radial tuberosity. Alternative planes also may be of benefit. Sagittal imaging can potentially visualize the amount of retraction on a single image, but is not as reliable as axial imaging.

A position specifically for identification of biceps tendon tears has the acronym “FABS” (flexed elbow, abducted shoulder, forearm supinated). The patient lies prone with arm overhead, elbow flexed 90°, and forearm supinated with the thumb pointing superiorly. This positioning induces biceps contraction, pulling the distal tendon taught and allowing a longitudinal view of the tendon on a single image slice. This positioning also promotes separation of fibers and greater sensitivity for diagnosing partial tears, and enhances depiction of the biceps tendon near the insertion on the radial tuberosity.2

Treatment

Complete tendon rupture traditionally is repaired using a two-incision, limited anterior approach to elongate the retracted tendon to the radial tuberosity. Described fixation methods include bone tunnels, suture anchors, and endobuttons. Surgical outcome for restoration of flexion strength is improved when repair is performed within three weeks of injury. If intervention is delayed, the tendon may progressively retract, or the tendon may fibrose and adhere to marginal structures including the brachialis muscle. Potential complications of surgery include ectopic bone formation, posterior interosseous nerve palsy, and occasionally radioulnar synostosis.

Partial tears usually are treated conservatively with local analgesics or steroids, or both. For patients who do not respond to nonoperative treatment, tendon debridement with reinsertion can provide symptomatic improvement.

Conclusion

Distal biceps tendon injuries are less common than proximal injuries but can have significant impact on activities of daily living when involving the dominant arm. These injuries usually are diagnosed or suspected on physical examination. Radiographs are almost always initially obtained but are most useful for excluding alternative diagnoses. Ultrasound and MRI can provide information for both diagnosis and patient management. Ultrasound has many advantages including dynamic imaging and ease of obtaining contralateral comparison. Magnetic resonance imaging has the highest sensitivity in demonstrating tendon injury while also evaluating regional structures. Specific patient positioning for MRI can increase the sensitivity for diagnosing subtle partial tears. Imaging can be invaluable for differentiating partial from complete tears and for planning management of the injury.

References
