RadioGraphics

Disorders of the Distal Biceps Brachii Tendon[1]

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Pathologic conditions of the distal biceps brachii tendon are of clinical interest, with partial and complete tears being the most common. However, the anatomy of the distal biceps brachii tendon makes imaging of the distal tendon somewhat difficult. An innovation in patient positioning for magnetic resonance (MR) imaging of the distal biceps tendon was recently described in which the patient lies prone with the arm overhead, the elbow flexed to 90°, and the forearm supinated, so that the thumb points superiorly. The acronym FABS (*f*lexed elbow, *ab*ducted shoulder, forearm *s*upinated) has been used to describe this position. The FABS position creates tension in the tendon and minimizes its obliquity and rotation, resulting in a "true" longitudinal view of the tendon. MR imaging and, to a lesser extent, ultrasonography are useful in visualizing the distal tendon and in detecting other pathologic conditions in the cubital fossa. Partial tears are usually characterized by enlargement and abnormal contour of the tendon, along with abnormal intratendinous signal intensity. In complete tears, there is discontinuity and, if the bicipital aponeurosis is also disrupted, retraction. Imaging with FABS positioning can complement conventional MR imaging, especially in the axial plane, in the assessment of the distal biceps tendon.

Abbreviation: FABS = *f*lexed elbow, *ab*ducted shoulder, forearm *s*upinated

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Introduction

The biceps brachii muscle is one of the main flexors and supinators of the elbow, and disorders involving this muscle often give rise to significant morbidity. Injury of the distal biceps tendon is much less common than injury occurring proximally and can present imaging challenges arising from the complex anatomic course of the tendon. In this article, we review the relevant anatomy of the distal biceps tendon and discuss optimal techniques for magnetic resonance (MR) imaging and ultrasonography (US) of the tendon. We also discuss and illustrate tears and other pathologic conditions (tendinopathy, enthesophyte formation, cubital bursitis) of the distal biceps tendon as well as appropriate treatment options.

Normal Anatomy

The distal biceps tendon is typically a flat tendon, forming about 7 cm above the elbow joint (Fig 1) (2), with the flat surface of the tendon facing anteriorly. As the tendon courses distally, it moves obliquely from anterior to posterior and from medial to lateral, twisting 90° so that the anterior surface faces laterally. The tendon expands at its attachment to the radial tuberosity, spreading over an area of 3 cm^2 (3). It also attaches to the bicipital aponeurosis, which descends medially to insert onto the subcutaneous border of the upper ulna via the deep fascia of the forearm.

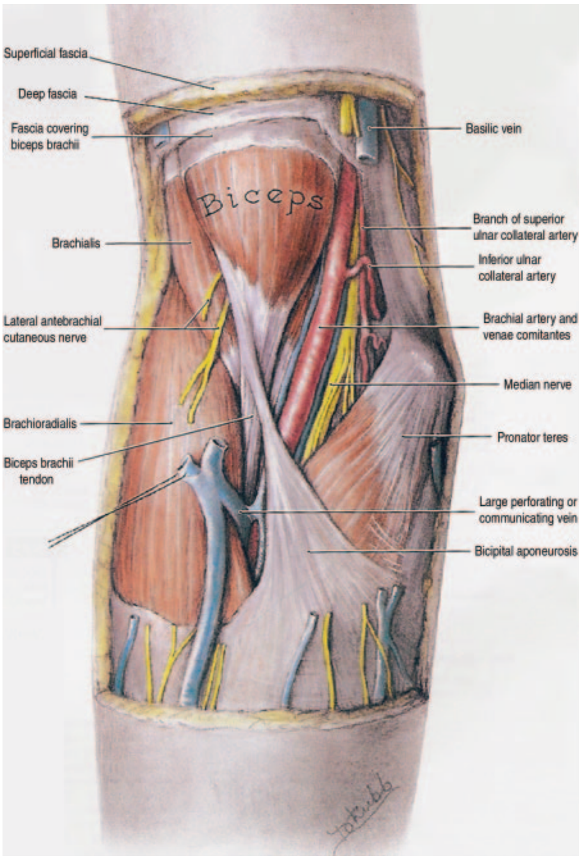

Figure 1. Drawing (cubital fossa dissection) illustrates the biceps tendon and adjacent structures. (Reprinted, with permission, from reference 1.)

Imaging Techniques

Magnetic Resonance Imaging

Traditionally, optimal MR imaging of the distal biceps tendon is performed in the axial plane, often with the patient's arm extended. Longitudinal views are difficult to obtain because of the oblique course of the tendon. A recently described innovation in patient positioning for MR imaging of the distal biceps tendon minimizes this difficulty (4). For this procedure, the patient lies prone with the arm overhead, the elbow flexed to 90°, and the forearm supinated, so that the thumb points superiorly. The acronym FABS—*f*lexed elbow, *ab*ducted shoulder, forearm *s*upinated—has been used to describe this imaging technique (Figs 2, 3).

With FABS positioning, a longitudinal view of the tendon, often in one section, is obtained, and partial volume averaging effects due to the oblique course of the tendon are minimized. Flexion of the elbow results in contraction of the biceps muscle belly; thus, the tendon is taut. FABS imaging provides a detailed view of the distal biceps tendon, including the difficult-to-assess region near its insertion on the radial tuberosity (Fig 4), and is often helpful in differentiating partial from complete tears. The "center-of-the-magnet" position of the elbow makes fat-suppressed imaging optimal, improving visualization of small amounts of fluid (Fig 5). The FABS view is obtained in addition to conventional views specifically to evaluate disease of the distal biceps brachii tendon.

Figure 2. Photograph illustrates the FABS position. (Reprinted, with permission, from reference 4.)

Figure 3. Localization image shows a FABS view with planned sections oriented perpendicular to the radial shaft. (Reprinted, with permission, from reference 4.)

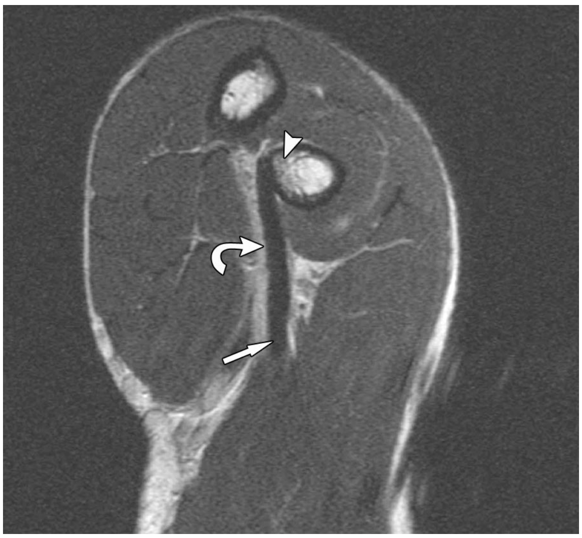

Figure 4. Fast spin-echo proton-density–weighted MR image (repetition time msec/echo time msec = 3000/34) obtained with the patient in the FABS position shows a normal distal biceps tendon (curved arrow), the musculotendinous junction (straight arrow), and the radial tuberosity (arrowhead). (Reprinted, with permission, from reference 4.)

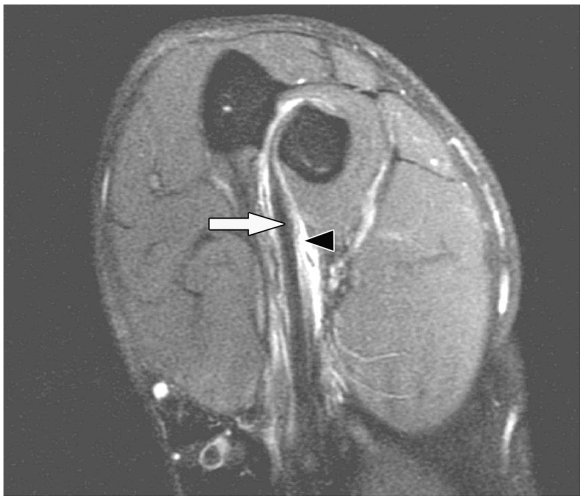

Figure 5. Fat-suppressed fast spin-echo proton-density–weighted MR image (3000/45) demonstrates a minor partial tear of the distal biceps tendon (arrow) with a trace of peritendinous fluid (arrowhead). (Reprinted, with permission, from reference 4.)

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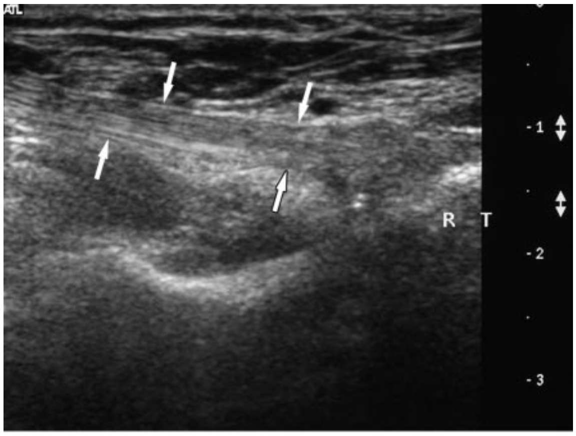
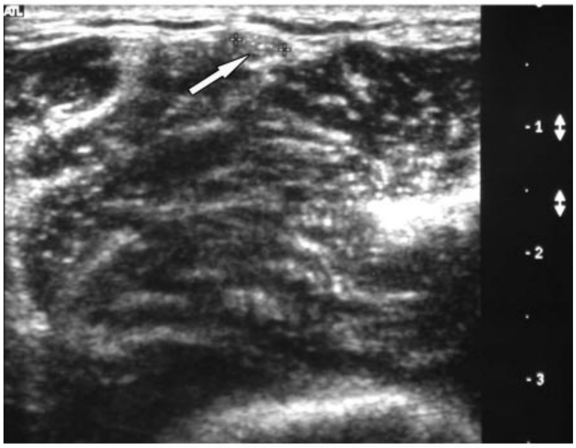


7a.



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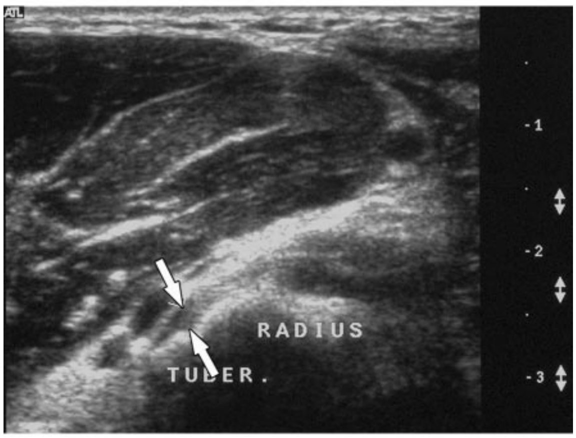


8.

Figures 6–8. **(6)** Photograph illustrates the scanning technique for obtaining a longitudinal US image from the volar surface of the left arm. **(7)** Longitudinal **(a)** and transverse **(b)** US images show a normal distal biceps tendon (arrows). **(8)** Transverse US image obtained from the volar aspect of the arm shows a normal distal biceps tendon. Note that the tendon is visible to its insertion site on the radial tuberosity (arrows).

Ultrasonography

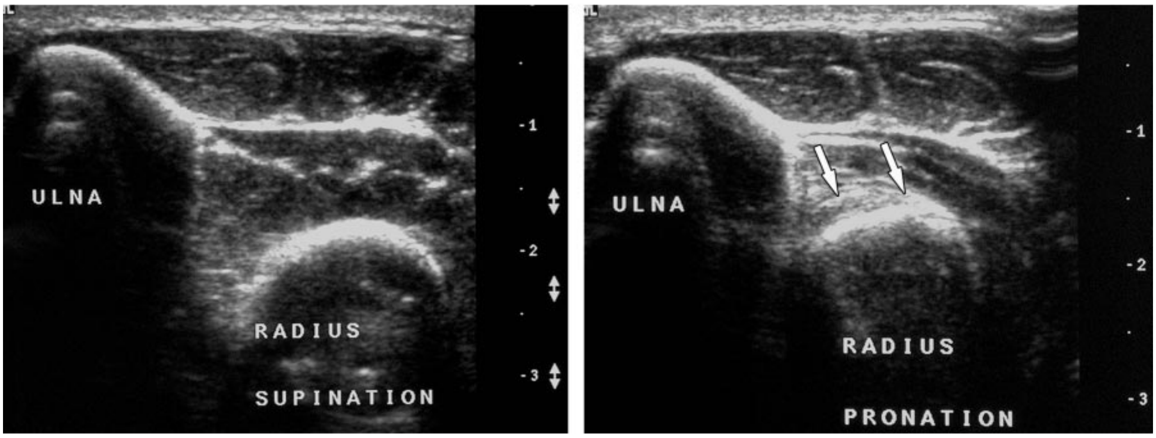
US has many advantages: It is less expensive and more rapidly performed than MR imaging and can be performed even when there are relative contraindications for MR imaging. US also has the advantages of allowing *(a)* easy comparison with the contralateral side and *(b)* the use of dynamic imaging. However, demonstration of the entire tendon at US is less reliable, particularly demonstration of the distal tendon at its insertion site. Other disadvantages of US are that it is less reproducible, more operator dependent, and (because it is a more focused study) less likely to help detect other disease at the elbow than is MR imaging.

US is performed from the volar aspect of the elbow, where the tendon and free edge of the bicipital aponeurosis are often palpable in the anterior cubital fossa. Real-time scanning allows easy optimization of imaging in the longitudinal and perpendicular axial planes. Imaging is best performed with the forearm in supination, since this brings the radial tuberosity into view on the medial aspect of the radius (Figs 6–8). Dynamic imaging (with slight supination-pronation or flexion-extension) can be performed and is especially useful in differentiating complete from partial tears.

Occasionally, the inserting distal tendon can be demonstrated from the dorsal aspect of the upper forearm. Pronation and supination are used to identify the tendon as it inserts on the radial tuberosity: When the arm is pronated, the tuberosity and the inserting distal tendon rotate into view on scans that are obtained from the dorsal aspect (Figs 9, 10) (5).

9.

Figures 9, 10. **(9)** Photograph illustrates the scanning technique for obtaining a transverse US image of the pronated arm from the dorsal aspect. (Reprinted, with permission, from reference 5.) **(10)** US images obtained from the dorsal aspect with the arm in supination **(a)** and pronation **(b)** show the distal insertion site of the biceps tendon (arrows in **b**). Note that in supination the radial tuberosity is not seen, whereas in pronation it lies close to the probe. (Reprinted, with permission, from reference 5.)



10a. 10b.

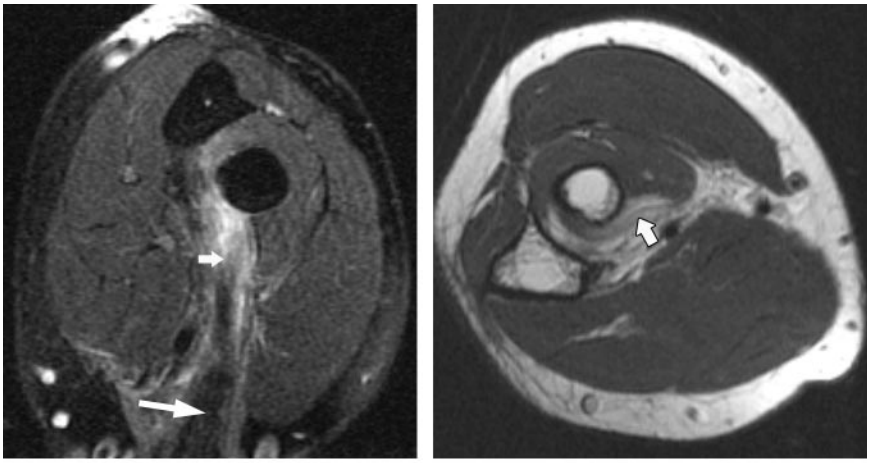
Tears of the Distal Biceps Tendon

Complete rupture of the distal biceps tendon is often an avulsion from the radial attachment and clinically evident. However, differentiation of complete from partial tears is sometimes difficult clinically, particularly if the bicipital aponeurosis remains intact. Precise delineation of the extent of the abnormality can aid in the management of complete tears without retraction or of partial tears (6).

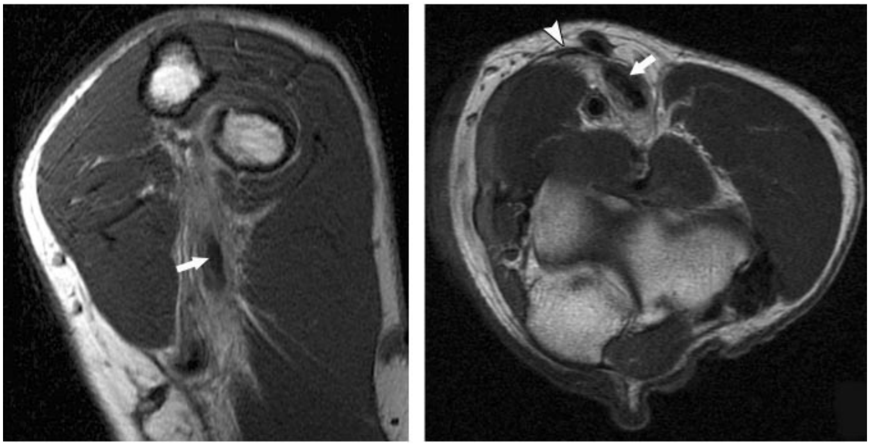
Complete tears are usually associated with a single traumatic event, often involving a fairly large force (40 kg or more) acting against resistance from an elbow flexed to 90° (7). Partial tears are often precipitated by minor trauma or not even associated with a traumatic event (8); the latter situation suggests preexisting degeneration in the tendon.

Most tears occur 1–2 cm above the radial tuberosity, where there is relative hypovascularity and a histologic structural transition point (3, 7,8). Degeneration secondary to hypoxic tendinopathy occurs in this region. With increasing age, there is a progressive decrease in perfusion, elasticity, and hydration, and the processes of tendon repair slow further. Mechanical impingement during pronation (9) and irritation by an osteophyte-enthesophyte at the radial tuberosity (a common finding) may also lead to tears of the distal biceps tendon (7,9).

In complete rupture of the distal biceps tendon, there is discontinuity with or without retraction. The longitudinal view of the tendon

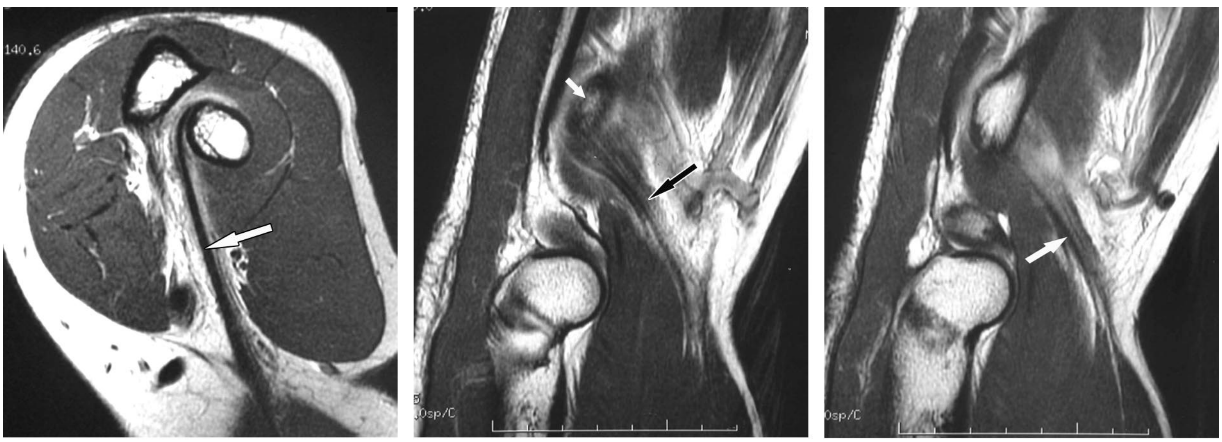


11a. 11b.



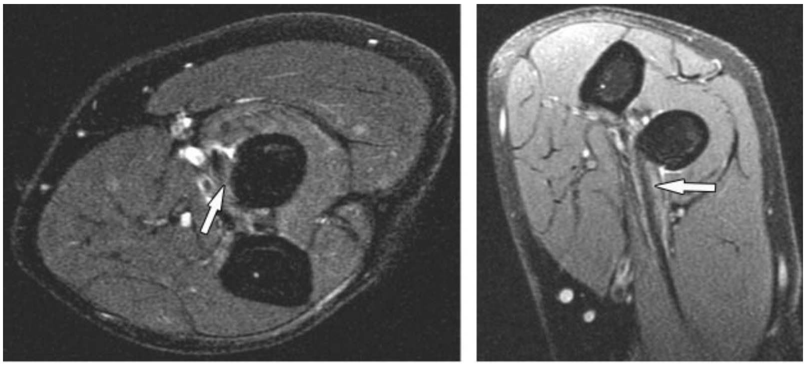
12a. 12b.

Figures 11, 12. **(11)** FABS fat-suppressed **(a)** and axial **(b)** fast spin-echo proton-density–weighted MR images show a complete tear of the distal biceps tendon. Note the thickened proximal part of the tendon (long arrow in **a**) and the discontinuity starting 2 cm proximal to the radial tuberosity (short arrow in **a**). Note also the nonvisualization of the tendon close to its insertion site (arrow in **b**). **(12)** FABS **(a)** and axial **(b)** fast spin-echo proton-density–weighted MR images demonstrate a complete tear of the distal biceps tendon with an intact bicipital aponeurosis (arrowhead in **b**). Note that the aponeurosis extends from an enlarged proximal tendon (arrow).



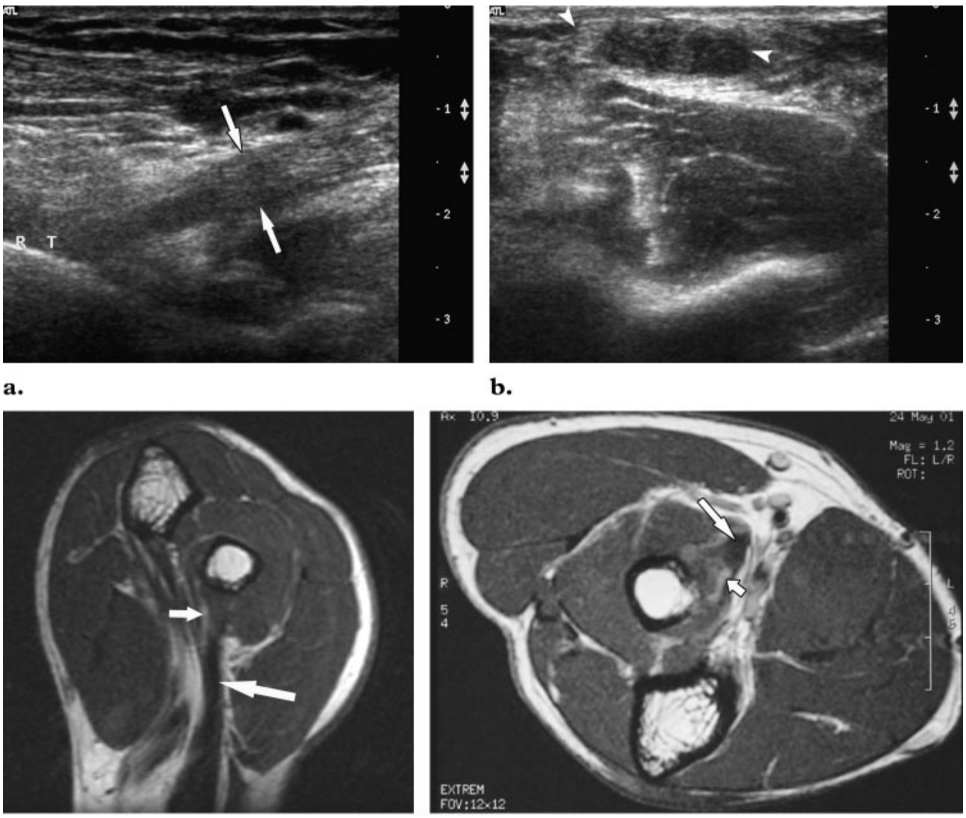
a. b. c.

Figure 13. FABS **(a)** and sagittal **(b, c)** fast spin-echo proton-density–weighted MR images show a minor partial tear of the distal biceps tendon. Arrow in **a**, black arrow in **b**, and arrow in **c** indicate the tendon; white arrow in **b** indicates the radial tuberosity. Note the partial volume averaging effect in **b** and **c**, which makes confident diagnosis difficult on sagittal views. However, the intratendinous signal intensity and peritendinous fluid seen on the FABS view tend to help confirm the diagnosis of a minor partial tear.



a. b.

Figure 14. Axial **(a)** and FABS fat-suppressed **(b)** fast spin-echo proton-density–weighted MR images show a minor partial tear of the distal biceps tendon close to its insertion site on the radial tuberosity. Note the abnormal intratendinous signal intensity of the tear (arrow).



a. b. c. d.

Figure 15. **(a, b)** Longitudinal **(a)** and transverse **(b)** US images show a moderate partial tear of the distal biceps tendon (arrows in **a**, arrowheads in **b**). **(c, d)** FABS **(c)** and axial **(d)** fast spin-echo proton-density–weighted MR images show the partial tear. Note the tendon thickening (long arrow) and the abnormal intratendinous signal intensity (short arrow).

acquired with FABS imaging often best demonstrates the discontinuity (Fig 11). The proximal tendon is enlarged and demonstrates abnormal signal intensity. If the bicipital aponeurosis is intact, there may be no retraction, and at clinical examination the patient may even appear to retain some flexion and supination capability. The axial view is best for appreciating an intact bicipital aponeurosis (Fig 12).

US, particularly dynamic imaging, can be used to confirm continuity of the tendon or the abnormal movement of a disconnected proximal tendon, but this region is not always well demonstrated. In a well-developed, muscular forearm in which the tendon is deeper, or in the acute setting in which hemorrhage may obscure detail, the course of the distal tendon can be difficult to visualize.

In partial tears, findings include a change (usually an increase) in caliber and abnormal contour of the tendon. Abnormal intratendinous signal intensity is seen at MR imaging. The US equivalent, reduced echogenicity, is often more difficult to confidently assess. Peritendinous fluid (edema, bursitis, or hemorrhage) may also be visible (Figs 13–15) (10–12).

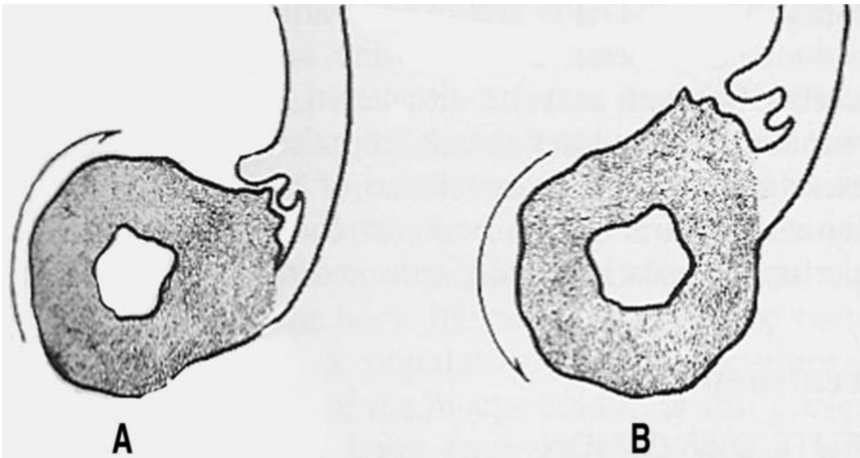
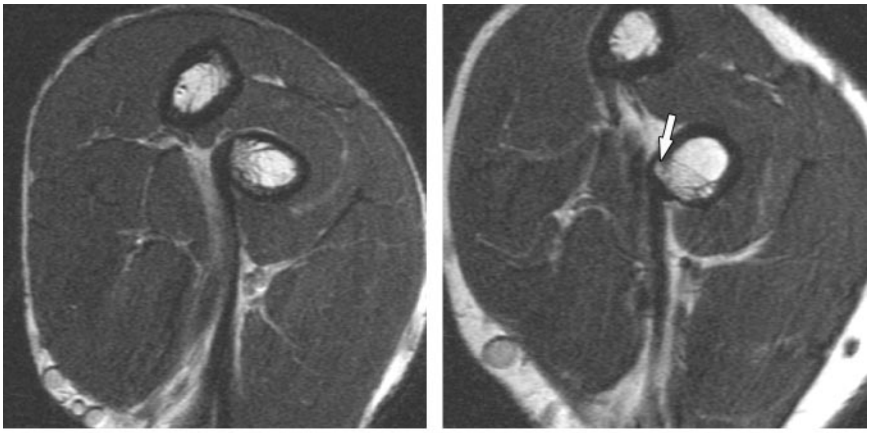


Figure 16. Diagrams illustrate cross-sectional views of a spur at the radial tuberosity causing tendon degeneration. In pronation *(A)*, the sharp margin of the spur impinges on the tendon. In supination *(B)*, the tendon is no longer in contact with the spur. (Reprinted, with permission, from reference 13.)



a. **b.**

Figure 17. **(a)** FABS MR image obtained in a young volunteer shows a normal distal biceps tendon. **(b)** MR image obtained in an older asymptomatic volunteer shows a small spur at the insertion site of the tendon (arrow).

Other Related Pathologic Conditions

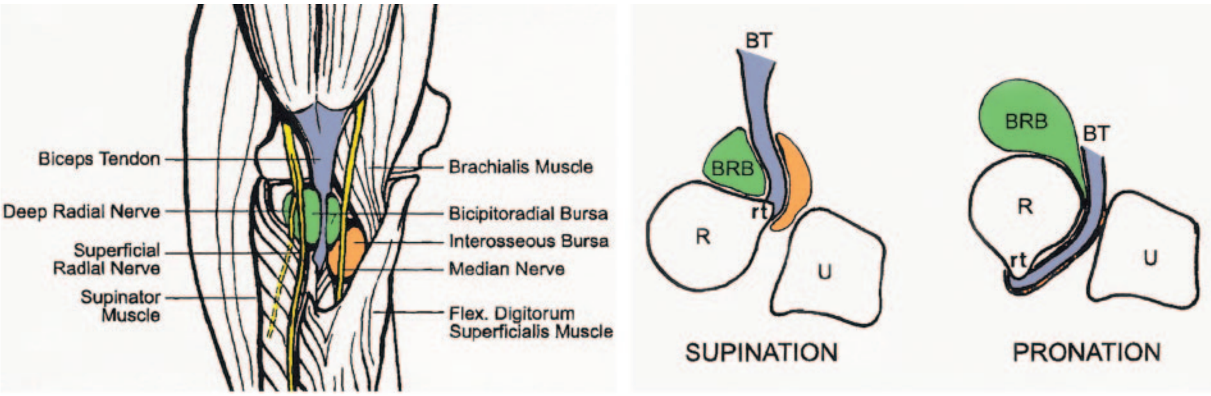
Enthesophyte formation at the radial tuberosity is common and is thought to be a contributing factor in some tears of the distal biceps tendon (Figs 16, 17) (13).

The bicipitoradial bursa lies between the distal biceps tendon and the anterior part of the radial tuberosity (Fig 18). As the forearm moves from supination to pronation, the radial tuberosity rotates from a medial to a posterior position. The biceps tendon curls around the radius, compressing the interposed bursa. Medial to the bicipitoradial bursa and lying in contact with the interosseous membrane is the interosseous bursa. When normal, neither bursa is visible at US or MR imaging. Rarely, enlargement of the bursae may cause compression of the median or posterior interosseous nerves (14).

Cubital bursitis is diagnosed by identifying a well-defined cystic lesion in the vicinity of either the bicipitoradial or the interosseous bursa. This condition may result from repeated mechanical trauma (15), inflammatory arthropathies, infection, chemical synovitis, bone proliferation, or synovial chondromatosis (14). The most common cause of cubital bursitis is thought to be repeated mechanical trauma, which is often associated with partial tears of the tendon (Fig 19).

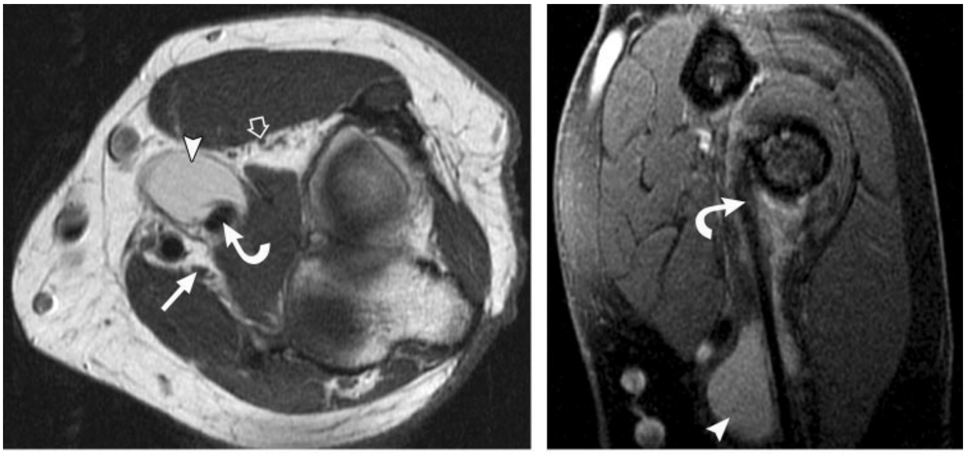
Treatment

The treatment of choice for complete rupture of the distal biceps tendon is early surgical repair (7,16–19). The techniques used in this treatment vary. Some surgeons use an anterior approach only, with a suture anchor to reattach the tendon to the radial tuberosity (Fig 20).



a. b.

Figure 18. Drawings illustrate the relationship of the bursae to the nerves **(a)** and changes that occur as the forearm moves from supination to pronation **(b)**. *BRB* = bicipitoradial bursa, *BT* = biceps tendon, *R* = radius, *rt* = radial tuberosity, *U* = ulna. (Reprinted, with permission, from reference 2.)



a. b.

Figure 19. Axial **(a)** and FABS fat-suppressed **(b)** fast spin-echo proton-density–weighted MR images show bursitis associated with a partial tendon tear. Note the fluid collection in the bicipitoradial bursa (arrowhead), with abnormal intratendinous signal intensity in the partial tear close to the insertion site of the tendon (curved arrow in **a**, arrow in **b**). Straight solid arrow in **a** indicates the median nerve, open arrow in **a** indicates the posterior interosseous nerve.

Figure 20. Radiograph shows a previously repaired biceps tendon with suture anchors in place. Note the minor heterotopic bone formation (arrow).

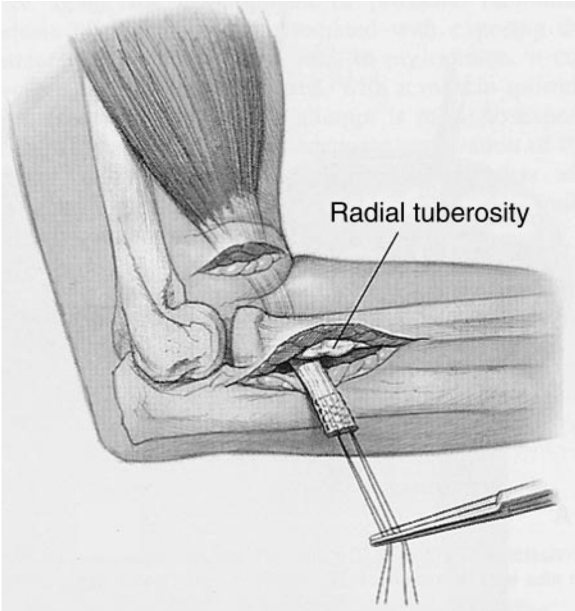


Figure 21. Drawing illustrates the two-incision technique for treatment of complete rupture of the distal biceps tendon. The detached tendon is milked out through a transverse incision of the antecubital space. The tendon is then trimmed and an incision made dorsolaterally to allow exposure of the radial tuberosity, which is then excavated. Finally, the tendon is brought through the previous tract and reinserted onto the tuberosity. (Reprinted, with permission, from reference 7.)

Figure 22. FABS fast spin-echo proton-density–weighted MR image shows a surgically repaired tendon. Note the bone defect at the radial tuberosity (arrow) and the diffuse enlargement and abnormal signal intensity of the successfully repaired tendon (arrowheads).

Figure 23. Computed tomographic scan shows imaging-guided injection of a steroid and local anesthetic around the biceps tendon (arrow).

Many surgeons use a two-incision technique, a limited anterior approach that allows the proximal stump to be fed down and reattached into a small excavation on the radial tuberosity. The tuberosity is reached by using a muscle-splitting approach from the dorsal aspect of the forearm, carefully avoiding the posterior interosseous nerve (Fig 21) (7).

The repaired tendon is abnormally enlarged and demonstrates mixed signal intensity (Fig 22). Complications include ectopic bone formation (Fig 20), occasionally with radioulnar synostosis and posterior interosseous nerve palsy.

Partial tears are often treated conservatively with local or systemic analgesics. Imaging-guided injection of a steroid or local anesthetic can provide symptomatic relief (Fig 23). If symptoms persist, complete removal of the remaining fibers (thereby converting the tear from a partial to a complete tear), debridement of the distal tendon, and reattachment as performed for a complete tear are sometimes necessary.

Conclusions

Although less common than disease at the shoulder insertion site of the long head of the biceps brachii tendon, pathologic conditions at the distal biceps brachii tendon are of clinical interest. US and MR imaging can provide useful information regarding these clinical problems. Acquisition of a FABS view can complement MR imaging in the assessment of this tendon.

References

1. Agur AMR, Lee MJ, eds. Grant's atlas of anatomy. 10th ed. Baltimore, Md: Lippincott Williams & Wilkins, 1999; 461.
2. Skaf AY, Boutin RD, Dantas RW, et al. Bicipitoradial bursitis: MR imaging findings in eight patients and anatomic data from contrast material opacification of bursae followed by routine radiography and MR imaging in cadavers. Radiology 1999;212:111–116.
3. Koch S, Tillmann B. The distal tendon of the biceps brachii: structure and clinical correlations. Anat Anz 1995;177:467–474.
4. Giuffrè BM, Moss MJ. Optimal positioning for MRI of the distal biceps brachii tendon: flexed abducted supinated view. AJR Am J Roentgenol 2004;182:944–946.
5. Giuffrè BM, Lisle D. Tear of the distal biceps brachii tendon: a new method of ultrasound evaluation. Australas Radiol (in press).
6. Falchook FS, Zlatkin MB, Erbacher GE, Moulton JS, Bisset GS, Murphy BJ. Rupture of the distal biceps tendon: evaluation with MR imaging. Radiology 1994;190:659–663.
7. Morrey BF. Injury of the flexors of the elbow: biceps in tendon injury. In: Lampert R, ed. The elbow and its disorders. 3rd ed. Philadelphia, Pa: Saunders, 2000; 468–478.
8. Vardakas DG, Musgrave DS, Varitimidis SE, Goebel F, Sotereanos DG. Partial rupture of the distal biceps tendon. J Shoulder Elbow Surg 2001; 10:377–379.
9. Seiler JG, Parker LM, Chamberland PD, Sherbourne GM, Carpenter WA. The distal biceps tendon: two potential mechanisms involved in its rupture—arterial supply and mechanical impingement. J Shoulder Elbow Surg 1995;4:149–156.
10. Miller TT, Adler RS. Sonography of tears of the distal biceps tendon. AJR Am J Roentgenol 2000; 175:1081–1086.
11. Durr HR, Stabler A, Pfahler M, Matzko M, Refior HJ. Partial ruptures of the distal biceps tendon. Clin Orthop 2000;374:195–200.
12. Williams BD, Schweitzer ME, Weishaupt D, et al. Partial tears of the distal biceps tendon: MR appearance and associated clinical findings. Skeletal Radiol 2001;30:560–564.
13. Davis WM, Yassine Z. An etiological factor in tear of the distal tendon of the biceps brachii: a report of two cases. J Bone Joint Surg Am 1956;38-A: 1365–1368.
14. Liessi G, Cesari S, Spaliviero B, Dell'Antonio C, Avventi P. The US, CT and MR findings of cubital bursitis: a report of five cases. Skeletal Radiol 1996;25:471–475.
15. Karanjia ND, Stiles PJ. Cubital bursitis. J Bone Joint Surg Br 1988;70:832–833.
16. Agins HJ, Chess JL, Hoekstra DV, Teitge RA. Rupture of the distal insertion of the biceps brachii tendon. Clin Orthop 1988;234:34–38.
17. Baker BE, Bierwagen D. Rupture of the distal tendon of the biceps brachii: operative versus non-operative treatment. J Bone Joint Surg Am 1985; 67:414–417.
18. Norman WH. Repair of avulsion of insertion of biceps brachii tendon. Clin Orthop 1985;193: 189–194.
19. Louis DS, Hankin FM, Eckenrode JF, Smith PA, Wojtys EM. Distal biceps brachii tendon avulsion: a simplified method of operative repair. Am J Sports Med 1986;14:234–236.