Ultrasonography of Complications in Surgical Repair of the Distal Biceps Brachii Tendon

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The occurrence of tears of the distal biceps brachii tendon (DBBT) was previously estimated at 3% of all DBBT ruptures, but their frequency recently increased to 10%, probably due to multifactorial causes, such as increased use of body building, contacts sports, anabolic steroids, and smoking, but also due to increased imaging opportunities, such as ultrasonography (US) and magnetic resonance (MRI).[1] The most common pathologic mechanism leading to DBBT rupture is simultaneous powerful contraction of the muscle and passive extension of the elbow. Distal biceps brachii tendon tears are generally well tolerated in daily activities and in sedentary individuals, but they can limit elbow supination and flexion in dynamic individuals or athletes. Although partial tears are usually treated conservatively, complete tears mostly require surgical repair, which provides better functional results.[2] A variety of surgical techniques can be used with varying outcomes.[3–5] The best technique would achieve optimal anatomic repair and rapid and efficient mobilization as well as lead to fewer complications.[6] Postoperative complications related to DBBT repair, such as heterotopic ossification, nerve injury, and tendon rerupture, occur in 15% to 40% of patients.[7–10]

In our clinical practice, we noted that clinicians and radiologists may remain relatively unaware of surgical techniques and their possible complications. As a result, non-negligible queries regarding inappropriate imaging or inconclusive examinations may follow.[11,12] In this pictorial essay, we describe the US anatomy of the DBBT and adjacent structures, the US appearance of DBBT tears, and the basic techniques for surgical repair of the DBBT. Then we discuss the role of standard radiography and US in the detection of postsurgical complications and their advantages over other imaging modalities, such as computed tomography and MRI.

Normal Distal Biceps Brachii Tendon: Anatomy and Imaging Appearance

In most individuals, the DBBT is composed of two separate tendons. The first is issued from the long head of the biceps muscle, originating at the supraglenoid tuberosity, whereas the second is issued from the short head, originating at the coracoid process. These tendons intersect distally in a clockwise direction to the left and in the

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This pictorial essay presents the ultrasonographic anatomy of native and ruptured distal biceps brachii tendons and their ultrasonographic appearance after surgical repair and in cases of postoperative complications.

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Abbreviations
DBBT, distal biceps brachii tendon; MRI, magnetic resonance imaging; US, ultrasonography

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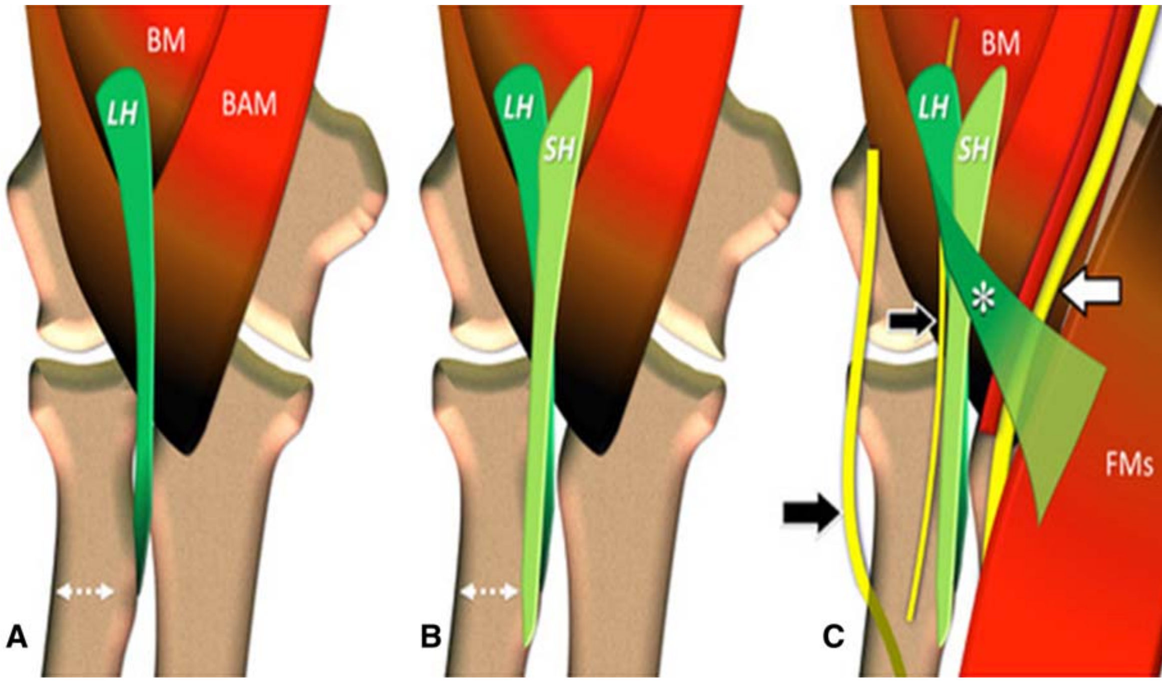
Figure 1. Normal DBBT anatomy. The schemas illustrate, from a deep level to the surface, the course and relationships of DBBTs, lacertus fibrosus, and nerves in the antecubital fossa. Schema **A** shows the tendon issued from the long head of the biceps muscle (LH), which is inserted on the ulnar side of the radial tuberosity. Schema **B** shows the tendon issued from the short head of the biceps muscle (SH), which is inserted on the anterior and distal side of the radial tuberosity, on top of the long-head tendon. Schema **C** shows the lacertus fibrosus (asterisk), which extends from the long head to the superficial flexor muscles (FMs) and covers the median nerve (white arrow). Two other nerves are close to the DBBT: the motor branch of the radial nerve (posterior interosseous nerve; black arrow) and the cutaneous lateral antebrachial nerve, a branch of the musculocutaneous nerve (black and white arrow). The double dotted arrows in schemas **A** and **B** indicate the insertional topography of the long and short heads on the radial tuberosity. The long-head insertion is more posterior than the short-head insertion. BAM indicates brachialis muscle; and BM, biceps muscle.



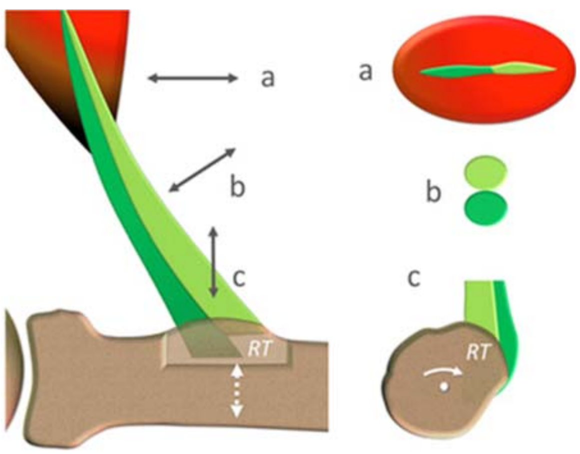
opposite direction to the right and are inserted with a 2×14-mm footprint on the ulnar side of the radial tuberosity (Figures 1–4).[13] The tendon of the short head inserts more distally than that of the long head. This peculiar anatomy has important biomechanical implications: the short head contributes mainly to elbow flexion, whereas the long head contributes more to elbow supination.[14,15] The lacertus fibrosus is a fibrous expansion that originates from the radial side of the myotendinous junction of the long head, overlies and stabilizes the short head, and blends with the antebrachial fascia at the level of the flexor muscles of the forearm (Figures 1 and 4).[14,16] Vascularization of the DBBT usually depends on the brachial artery proximally and the recurrent radial artery, which crosses the tendon and usually runs superficial to it, distally.[17] In addition, a hypovascular zone with an average size of 2 cm was observed by Seiler et al[18] between the distal myotendinous junction and the distal end of the DBBT, and it could explain the higher prevalence of ruptures at this location.[3] The DBBT's preinsertional location is between the proximal ulna and the radial tuberosity. Anatomic studies have shown that the distance separating the two bones is reduced by nearly half during pronation (3.3 mm) and increases during supination (8.3 mm).[19] This peculiar topography could represent a potential source of mechanical conflict for both native and operated tendons, especially when anchors are used (Figure 5).[20]

Because of their close relationship with the DBBT, adjacent nerves can be injured during surgical repair of the tendon. The lateral antebrachial cutaneous nerve can be damaged during surgical incision, whereas the median nerve and posterior interosseous nerve are at risk during tendon fixation (Figure 1).[21]

Ideally, radiographs with an anteroposterior view in supination and lateral view image the radial tuberosity, adjacent soft tissues, and ulnoradial distance (Figure

6).[22] The US appearance of the biceps brachii has been illustrated from the shoulder to the elbow by Brasseur.[23] A detailed US approach to the lacertus fibrosus has been described by Konschake et al.[24] However, the technique for US examination of the DBBT at the elbow has been standardized by Tagliafico et al.[15,25] Anterior transverse and longitudinal views are realized on a fully extended elbow, following the schemas presented in Figures 1 and 2. For optimal longitudinal views, the transducer pressure should be gently increased, and the US beam should be as parallel as possible to the tendon to avoid anisotropy. Slight pronosupination movements usually enable one to distinguish the components of the DBBT. However, it is much easier to distinguish them from a transverse view using anisotropic artifacts viewed at different inclinations of the transducer, which affect the echogenicity of the tendons (Figures 3 and 4). When elbow extension is not possible because of pain or stiffness, other complementary approaches may be useful to evaluate the DBBT, such as a medial longitudinal approach (using the pronator teres muscle as acoustic window) for its distal portion or a posterior transverse approach with the elbow in full flexion (using pronosupination movements) for its insertion into the radial tuberosity. Anterior transverse views during pronosupination movements are helpful for evaluating the distance between the ulna and radial tuberosity (Figure 5). This figure illustrates also why the DBBT insertion may be observed through a posterior approach during pronation.

Figure 2. Normal DBBT anatomy. Longitudinal and transverse schemas at the right elbow illustrate the distal intersection of the long- and short-head tendons, their counterclockwise twisting, and insertion at the footprint on the ulnar side of the radial tuberosity (RT). The double dotted arrows indicate the insertional topography of the long and short heads on the radial tuberosity. The long-head insertion is more posterior than the short-head insertion. Levels a, b, and c indicate the US appearance of the DBBT in Figure 3.



When normal, the DBBT features sharp borders, with an oval shape and an internal homogeneous hyperechoic fibrillar pattern. The bicipitoradial bursa, overlying the distal part of the DBBT, is not visible on US in the absence of effusion. No fluid can be found inside the normal antecubital synovial bursa (Figures 3 and 4).[25]

Ruptured DBBT: Pathophysiologic Mechanisms and Imaging Appearance

Distal biceps brachii tendon ruptures typically occur in the dominant arm of men between 30 and 60 years who

Figure 3. Normal DBBT on US. The distal intersection of the long- and short-head tendons is illustrated in successive transverse US images from proximal to distal (**A–C**) at the right elbow, as shown in Figure 2. The two tendons (short head, white arrows; and long head, dashed arrows) twist counterclockwise on the right side (clockwise on the left side) and insert on the ulnar side of the radial tuberosity (RT). FMs indicates superficial flexor muscles; Hd, distal humerus; Hp, proximal humerus; U, ulna; and dotted blue lines in **B**, distance between the radial tuberosity and ulna.

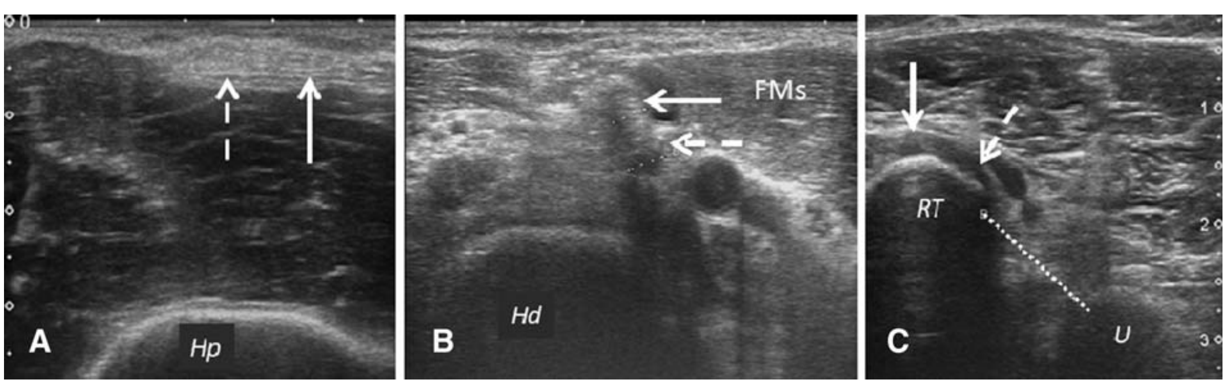
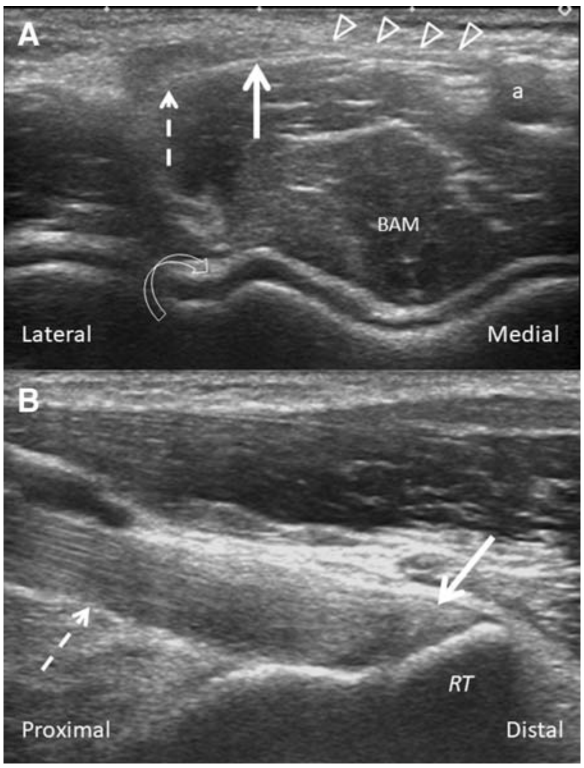


Figure 4. Normal DBBT on US. Transverse (**A**) and longitudinal (**B**) US images of the right elbow depict the DBBT as a flat ovoid hyperechoic structure from a transverse view and a fibrillar hyperechoic band with sharp parallel borders from a longitudinal view. The tendon issued from the short head (white arrows) is more medial and superficial than the tendon issued from the long head (dashed arrows). It inserts also more distally on the radial tuberosity (RT). From the transverse view, it is also possible to observe the thin lacertus fibrosus (arrowheads). Note that no fluid is observed in front of the humeral cartilage (curved arrow). Letter a indicates brachial artery; and BAM, brachialis muscle.



apply an intense extension force to the anterior aspect of the forearm with the elbow in an active flexed position.[26] Various conditions can predispose one to DBBT rupture, such as tendon degeneration and hypovascularity, mechanical conflicts with bony spurs at the radial tuberosity, and use of tobacco or anabolic steroids.[5] The most common pathologic mechanism leading to DBBT rupture is simultaneous powerful contraction of the muscle and passive extension of the elbow. Clinical diagnosis of DBBT rupture is generally easy. The patient will present with a sharp pain in the anterior aspect of the elbow as well as local swelling and bruising. Physical examination will show local tenderness and a decrease in the strength of flexion and supination of the forearm, and a hook test will be positive.[27]

Ultrasonography and MRI can show a tear and can be used to assess its severity. Both techniques provide details about the extension of the rupture to a single head (short- or long-head rupture) and extension to the lacertus fibrosus as well as evaluate the degree of tendon retraction (Figures 7 and 8).[23] Retraction of the belly muscle usually occurs when the lacertus fibrosus is torn or partial rupture of the long head has occurred, and it does not occur when only the short head is torn, probably because the latter is contiguous with the lacertus fibrosus.[15,24] In addition, US enables one to differentiate between full and partial tears via posterior acoustic shadowing, which is present in 97% of full tears. However, an absence of shadowing does not effectively exclude the possibility of a partial tear.[28] In case of partial tears, other US findings, such as irregular margins of the tendon and thickening or hypoechogenicity of the torn fibers, must be used for diagnosis (Figure 9). Identification of partial tears may affect the choice of the treatment; surgery may be reserved for repair of a full tear.[15]

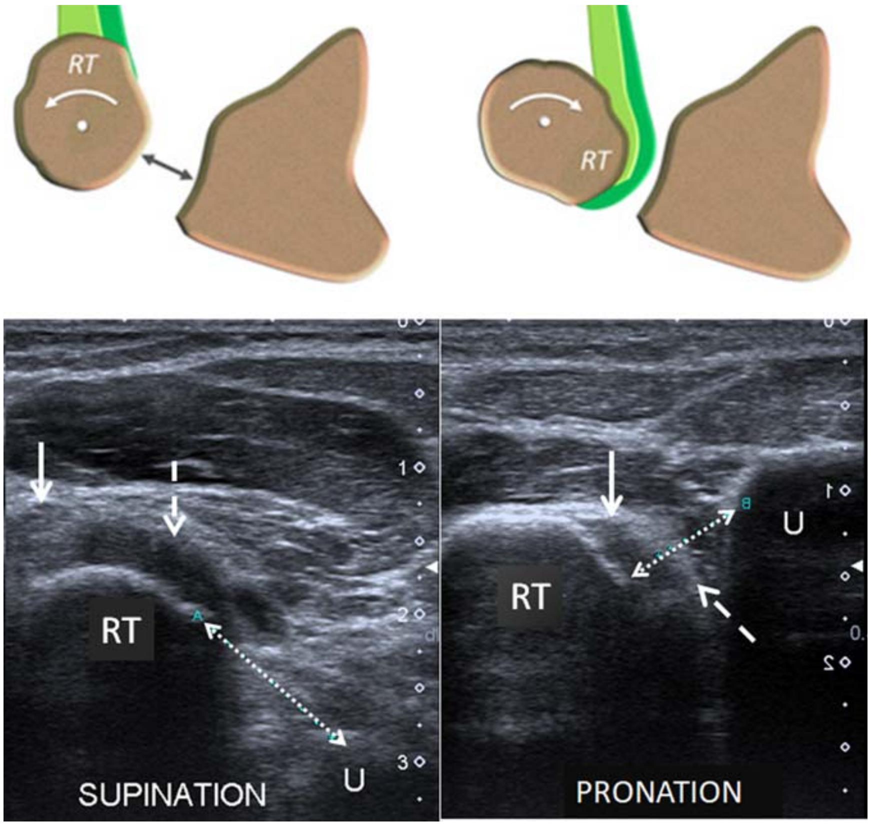
Surgical Repair of the DBBT: Techniques

Several surgical techniques for tenorrhaphy are possible, either endoscopically or in open surgery with a single or double incision.[29] The preferred technique at our institution is open surgery with a single incision and Endobutton (Smith & Nephew, London, England) fixation. Repair involves several steps: cutaneous incision, capture of the tendon stump, debridement, suture and calibration of the tendon, preparation of the Endobutton, drilling of the tunnel bone, passage and positioning of the Endobutton, testing, and closing of the incision. The major steps of surgery are tendon preparation, tunnel drilling, and positioning of the Endobutton (Figure 10).

Normal Imaging Appearance of the Postoperative DBBT

Standard radiographs enable good assessment of the radius. An additional supine view permits optimal visualization of the radial tuberosity, fixation site, surgical material, and bone tunnel.[22] The diameter of the tunnel depends on the size of the repaired tendon, but it is commonly about 7 to 8 mm. Its mean volume is estimated to be 640 mm^3 according to early postoperative

Figure 5. Ulnoradial distance. Schemas (top) and US images (bottom) illustrate the dynamic variation of the distance (dotted double arrows) between the radial tuberosity (RT) and ulna during supination and pronation. The reduced distance during pronation (bottom right) may induce mechanical conflict with a pathologic or repaired DBBT. Notice, in supination, the modification in the topography and isotropy of both components of the DBBT, which enables differentiation between the short head (hyperechoic; white arrows) and long head (hypoechoic; dashed arrows). U indicates ulna.



computed tomographic scans. Endobutton fixation causes the tunnel to decrease in size and, finally, disappear (Figure 11). On the contrary, fixation by bioabsorbable screws may lead to an increase in the caliber of the bone tunnel over time.[29–32] Although no significant correlation between bone tunnel volume and functional outcome has been established, severe foreign body osteolysis may be observed around such screws, which requires surgical revision.[33]

A postoperative US examination of the repaired DBBT should include visualization of the tendon, bones (especially the radius), Endobutton, supinator muscle, and anterior nerves, especially the posterior interosseous nerve and lateral antebrachial cutaneous nerve (Figures 1 and 12). The appearance of a repaired tendon varies according to the function of the surgical technique, which ideally should be determined before US. As a general rule, normal operated tendons are always larger than native tendons. This thickening is irreversible and occurs between 3 and 6 months after the intervention.[34] A normal operated tendon is continuous, with the suture material clearly visible, and features a round section in axial images, even if its contours are irregular. Its hyperechoic fibrillar echo texture becomes heterogeneous because of small hypoechoic areas around the sutures or small calcareous deposits. An intratendinous Doppler signal can be recorded between the first and third months after an operation.[34] Decreased mobility and elasticity of the tendon may also be observed within the first few months.[35] The bone tunnel is not assessed by US, although its opening may be incidentally depicted as a cortical defect at the tip of the radial tuberosity. The Endobutton is clearly shown on the opposite side of the radial tuberosity as a thin hyperechoic structure parallel

Figure 6. Conventional radiographs. Anteroposterior (**A**), with supination (**B**), and lateral (**C**) radiographs ideally show the radial tuberosity (RT), radioulnar distance (double arrow), and adjacent soft tissues.

to the cortex, which is associated with posterior reverberation artifacts (Figures 11 and 12).[36] Occasionally, some small heterotopic calcium deposits may be visible within the supinator muscle. Ultrasonography can show these small deposits better than radiographs. In addition, US can easily evaluate local nerves when using a high-frequency transducer and the correct examination technique. The lateral antebrachial cutaneous nerve and posterior interosseous nerve can be easily followed by up-and-down translations of the transducer. When pathologic changes are found, longitudinal US and a contralateral examination are performed. In addition, dynamic evaluation of the nerve's relationship with orthopedic material is helpful in determining a nerve abnormality or conflict. When a posterior interosseous nerve injury is suspected, it is also important to compare the volume and echogenicity of extensor muscles in both forearms to evaluate possible muscle edema or atrophy.[37]

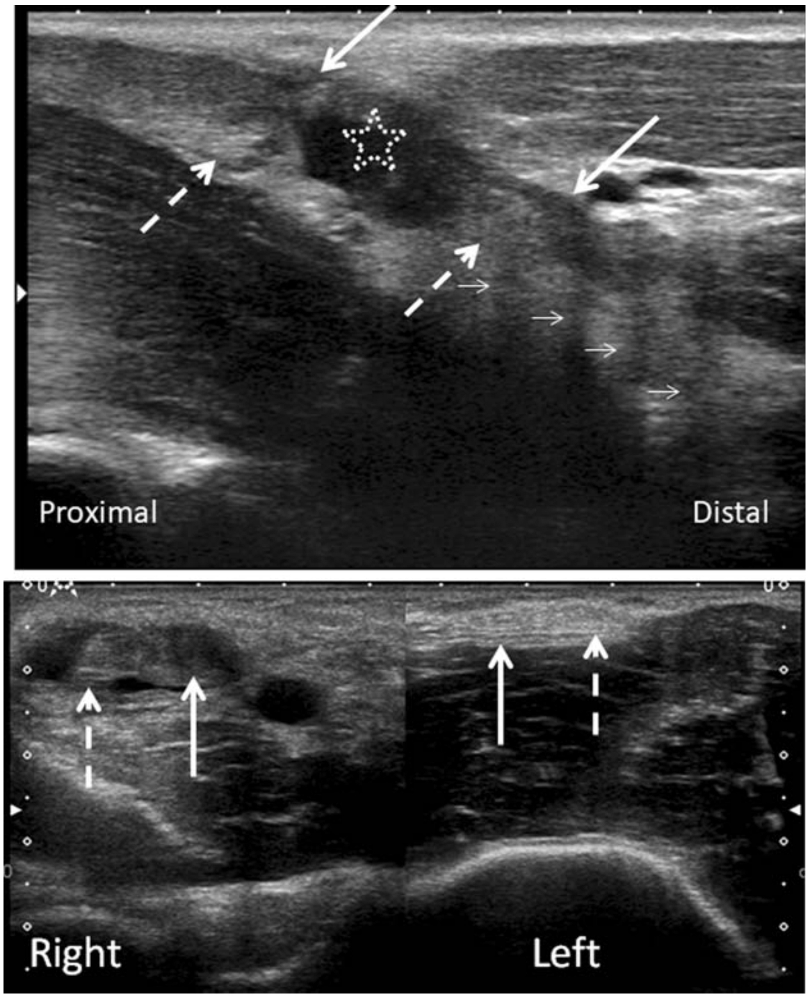
Imaging Appearance of Surgical Complications

The most common complications related to surgical repair of DBBT tears are listed in Table 1. Apart from complex regional painful syndrome, weakness, stiffness, and wound problems, the main complications are nerve damage, heterotopic ossification, and tendon rerupture. Their frequency varies according to the surgical procedure performed. For example, tendon rerupture is more frequent with procedures involving anchors or transosseous screws; lateral antebrachial cutaneous nerve lesions are more frequent when a single anterior incision is made; posterior interosseous nerve lesions are more frequent in techniques involving the Endobutton; and heterotopic ossification is more frequent for a double-incision technique.[1,9,30]

Heterotopic Ossification

Heterotopic ossification, a well-known complication of surgical repair of the DBBT, results from tunnel drilling at the level of the radial tuberosity and transformation of mesenchymal cells, which are contained within blood and bone marrow, into osteoblasts. This complication may develop within several weeks after surgery and is clinically suspected when patients present with elbow stiffness, limited supination, and, occasionally, a palpable mass at the anterior aspect of the proximal forearm. It can occur at 3 different locations: (1) within the supinator muscle, close to the radial tuberosity, in the case of insufficient intraoperative washing; (2) at the opposite side of the radial tuberosity, in the case of extensive

Figure 7. Full DBBT tear. On top, the longitudinal US image illustrates a fully torn DBBT. Hypoechoic fluid (star) is observed between the edges of the ruptured tendon. There is also a disparity in the caliber and echo texture between the proximal and distal sides of the tendon. Both the short head (white arrows) and long head (dashed arrows) of the tendon appear to be thickened and hypoechoic or heterogeneous at the proximal edge of the rupture and thinned and heterogeneous at its distal edge. Note the posterior acoustic shadowing (small white arrows) behind the ruptured DBBT. This additional finding is pathognomonic of a full tear. On bottom, the transverse US images of the same patient compare the right pathologic elbow with the normal left elbow. This comparison makes diagnosis of the tear easier. Note the fluid (star) surrounding the thickened short head (white arrows) and long head (dashed arrows).



drilling, resulting in cortical effraction; and (3) close to the proximal radioulnar joint, in the case of a proximal interosseous membrane lesion. In the third location, proximal radioulnar synostosis may also develop.[9,38] Ultrasonography shows heterotopic ossification earlier than does radiography, showing hyperechoic nodules or streaks with posterior acoustic attenuation within muscles.[9,10,39] Indomethacin and radiotherapy have been used in an effort to prevent heterotopic ossification.[40] Early excision (ie, before 12 months after surgery) is recommended, especially for large ossification (Figure 13).[41]

Nerve Damage

Two nerves are particularly vulnerable in DBBT repair: the lateral antebrachial cutaneous nerve and posterior interosseous nerve. Although the most frequent issue related to these nerves is transient neurapraxia, it is not rare to observe paresis or paralysis, especially for the posterior interosseous nerve, either early in the

Figure 8. Full DBBT tear. Transverse US image (**A**) of the same patient in Figure 7 shows a thickened but intact lacertus fibrosus, which explains the absence of the Popeye retraction. The lacertus fibrosus overlies the short head (white arrow) and blends with the antebrachial fascia (arrowheads) at the level of the superficial flexor muscles of the forearm. Transverse US image (**B**) of another patient with a full tear and Popeye retraction show rupture of the DBBT (arrows) and the lacertus fibrosus (arrowheads), as confirmed by transverse T1-weighted MRI (**C**). The white and dotted arrows point out short and long heads, respectively. Compare this figure with the schema in Figure 1 and normal US in Figure 4. FMs indicates superficial flexor muscle.

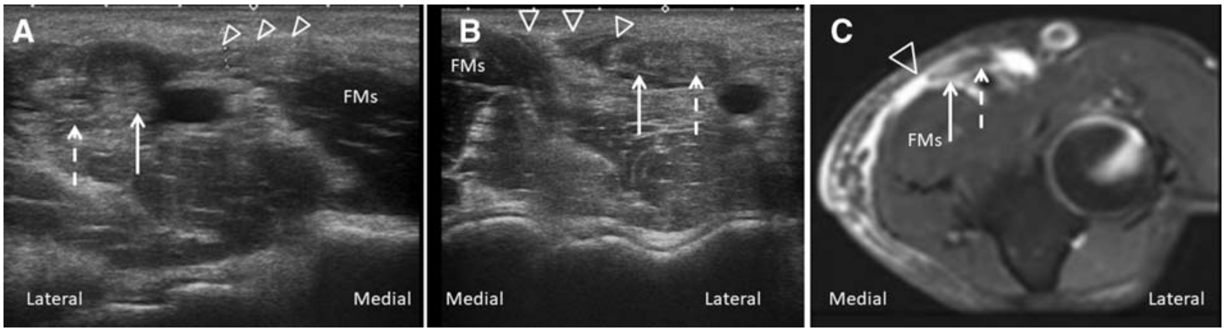


Figure 9. Partial DBBT tears. Longitudinal US images of 2 different patients illustrate that partial tears may involve either the short head (**A**, white arrows) or long head (**B**, dashed arrows), whereas the other head of the tendon is almost normal. Clinical diagnosis of a partial tear is not easy. In addition to local pain or cutaneous hematoma, rupture of the SH usually induces weakness in elbow flexion (**A**), whereas rupture of the long head (**B**) usually results in loss of supination. Ultrasonographic diagnosis of a partial tear is not easy either in large part because of tendon twisting. In **A**, note the unretracted thinning of the ruptured SH and small distal hypoechoic collections (thin arrow), and in **B**, note the hypoechoic fluid around the insertion of the ruptured LH (thin arrow). Although the short-head insertion looks normal (thick arrow), thickening of the proximal part of the short head in **B** may indicate degenerative tendinosis (curved arrow). RT indicates radial tuberosity.

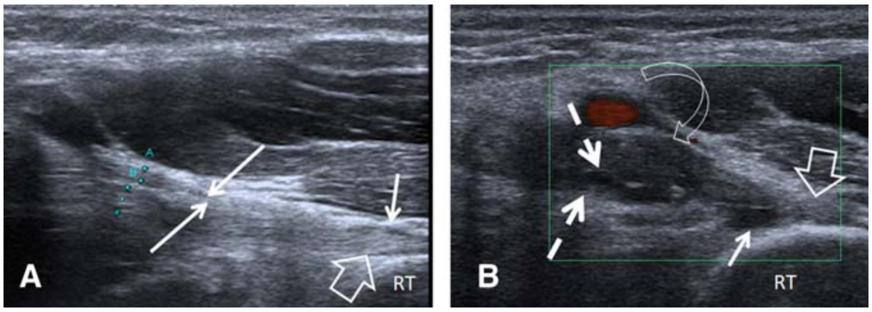


Figure 10. Major steps of surgery to repair the DBBT. Surgical views illustrate 3 major steps of DBBT repair: tendon repair and preparation of the Endobutton (**A**), tunnel drilling (**B**), and tendon fixation with the Endobutton in place (**C**). Small arrows indicate suture material; and white arrows, Endobutton.

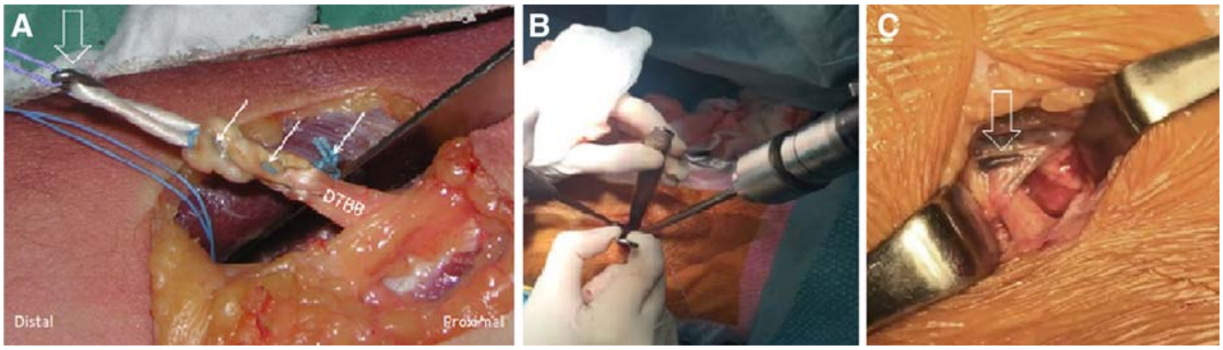


Figure 11. Normal postoperative radiographs. Lateral radiographs in a normal postoperative status at 1 day (**A**) and 1 year (**B**) after surgery. The tunnel within the radial tuberosity is clearly visible as a cylindrical bone defect with regular margins in **A** (thin arrows) and looks almost completely filled in **B** (thick arrows). In **B**, note the depression on the superficial cortex of the radial tuberosity (asterisk) caused by drilling of the tunnel, which is probably visible because of better radiographic positioning of the humeral condyles in **B** than in **A** (curved arrows).

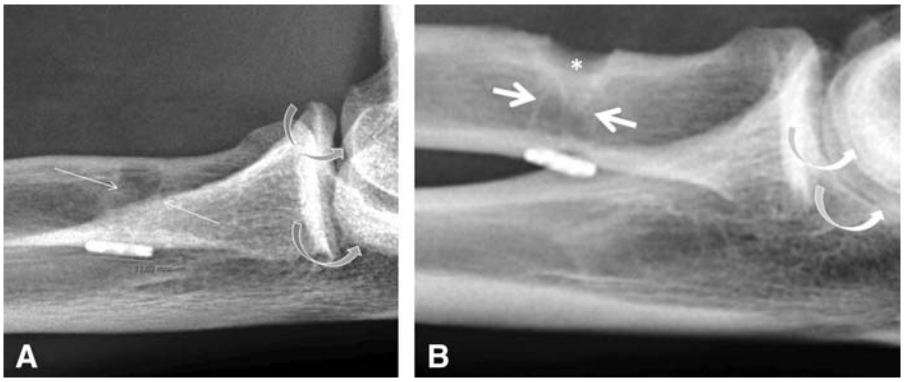


Figure 12. Recommended 4-step US. A 4-step US examination is recommended after DTBB repair (**A–D**). The tendon is depicted from a longitudinal view (**A**); the proximal radius and Endobutton are depicted from transverse and longitudinal views (**B** and **C**); the supinator muscle is depicted from transverse and longitudinal views (**B** and **C**); and the nerves are depicted from transverse and longitudinal views (**C** and **D**). The Endobutton (large arrows) is visible in the posterior transverse US image (**B**). Note in **A** the regular and thin acoustic shadows caused by the suture material (thin arrows). Nerves are indicated in **C** and **D** with thick arrows. The posterior interosseous nerve is localized within the supinator muscle in **B** and **C**, and the lateral cutaneous antebrachial nerve is localized close to the cephalic vein (thin arrow) and DBBT (asterisk) in **D**. Sd indicates deep portion of the supinator muscle; and Ss, superficial portion of the supinator muscle.

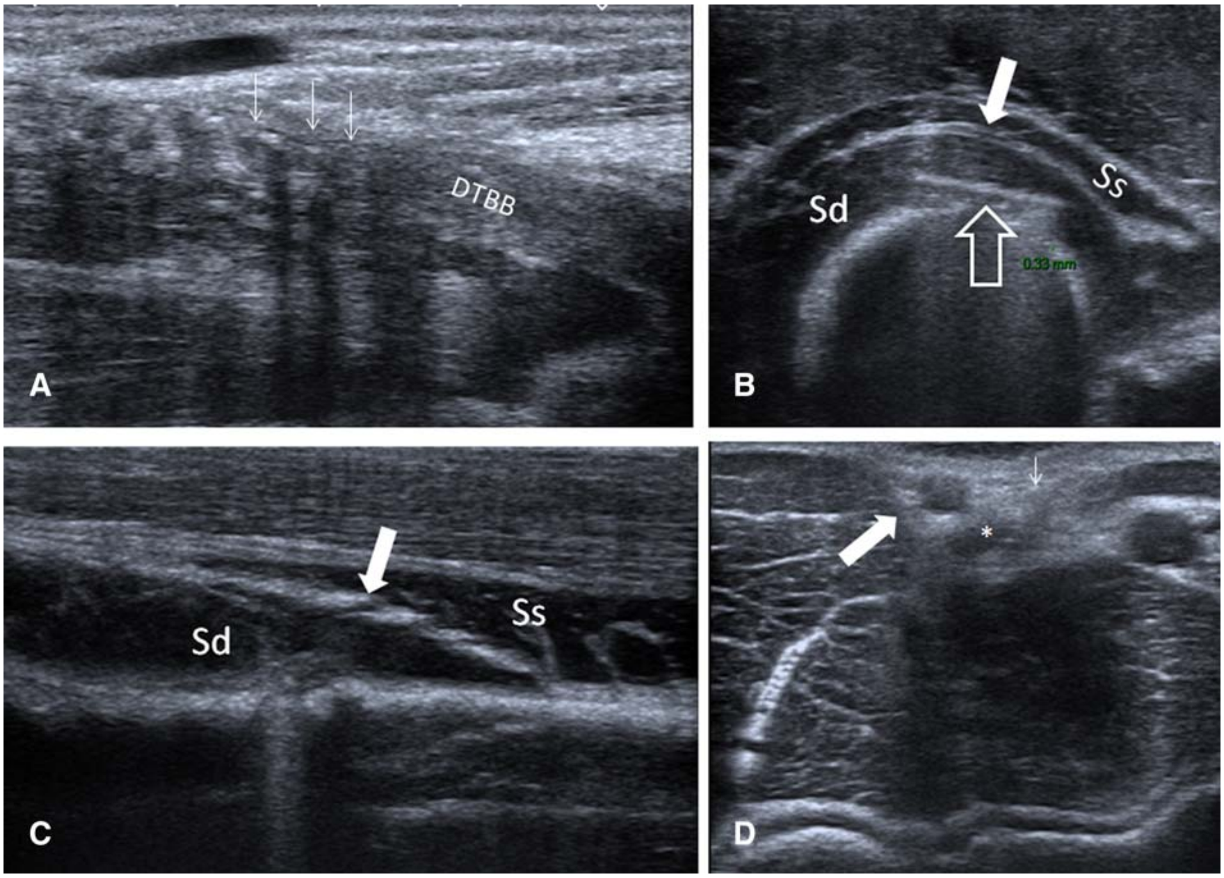
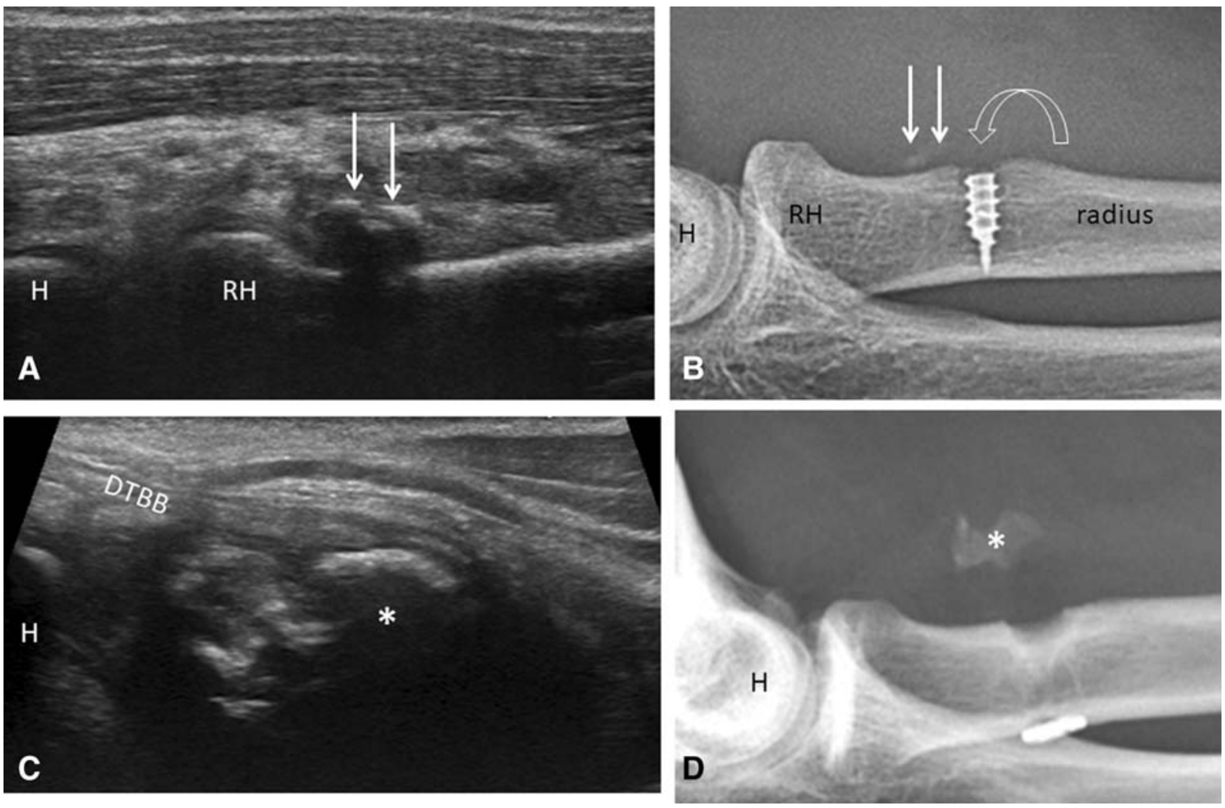


Table 1. Common Complications Related to Surgical Repair of DBBT Tears

Complication	%	Type of Surgery
Neurologic	10–15	Anterior access path, Endobutton
Heterotopic ossifications	0–50	Insufficient lavage, double incision
Reruptures	1–5	Anchors, interference screws
Wound problems	2–30	Not specific to biceps repair
Stiffness	4	Nonanatomic repair
Complex regional pain syndrome	2	Bone drilling, plaster
Radial neck fracture	1 report	Too proximal drilling

Figure 13. Heterotopic ossification. Longitudinal US images (**A** and **C**) and lateral radiographs (**B** and **D**) of 2 different patients (**A** and **B, C** and **D**) illustrate the complementary roles of radiography and US. In the first patient (**A** and **B**), the repaired DBBT is fixed with an interference screw that is entirely visible in the radiograph. The cortical defect (curved arrow) at the point of entrance of the screw may remain undetected by US, especially in the presence of heterotopic ossification. The second patient (**C** and **D**) had stiffness and reduced elbow extension. He also felt the impression of a hard mass in his anterior elbow. A longitudinal US image (**C**) and lateral radiograph (**D**) illustrate a large heterotopic ossification (asterisk) that lifts up the biceps tendon. Care must be taken during US because ossification induces acoustic shadowing that prevents visualization of the area underneath the soft tissues of bone surfaces. H indicates humerus; and RH, radial head.



postoperative phase or after withdrawal of the splint, which is generally authorized 2 weeks after surgery. In a series of 280 patients who received primary repair of the DBBT, Nigro et al[31] observed 9 cases of posterior interosseous nerve paralysis, which represented 3.2% of the operated patients. The susceptibility of the posterior interosseous nerve to surgical lesions is dependent on the anatomic proximity (sometimes < 5 mm) of the nerve to the radial tuberosity and radial neck. Posterior interosseous nerve damage may be caused by inadequate guidance from the surgical guide, intraoperative traction on the nerve, an epineurium lesion that is secondary

Figure 14. lateral antebrachial cutaneous nerve (LABCN) neuroma. This 45-year-old patient underwent surgery to repair a fully torn DBBT at another hospital 2 years previously. He had severe pain and numbness in the anterolateral part of his forearm for the previous few months. As the clinical picture shows, a scar and numerous tattoos are present on his skin as well as a "cordlike" biceps tendon (asterisk). The transverse US image (**A**) shows a superficial hypoechoic mass close to the cephalic vein (VC) on the lateral side of the biceps tendon (BB) at the level of the cutaneous scar. The longitudinal US image (**B**) shows that the upper and lower parts of the mass are connected to the nerve, enabling diagnosis of a lateral cutaneous antebrachial neuroma (NEVROME).

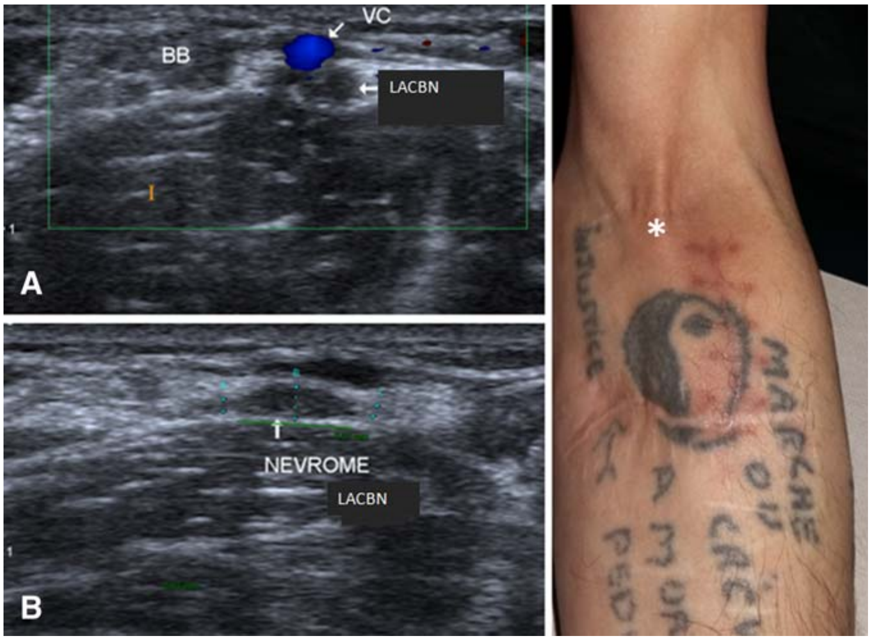
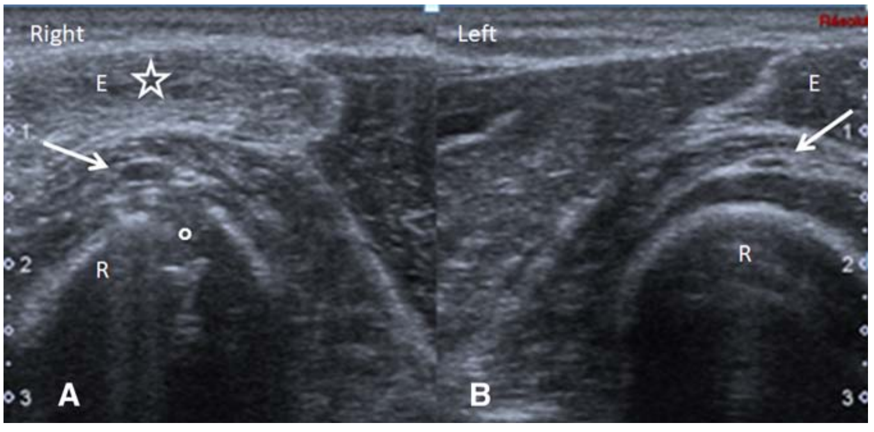


Figure 15. Transitory posterior interosseous nerve neurapraxia. After DBBT repair and plaster removal, the patient had an extension deficit of his right wrist and hand. Radiographs did not show any abnormality; thus, US was requested. Comparative transverse US images (**A** and **B**) show thickening of the right posterior interosseous nerve (thin arrows), hyperechoic thickening of the right extensor muscles (E, star), and a cortical defect of the right radius (R, o) at the level of the supinator muscle. Recovery was fully achieved after 4 weeks in this case of transitory neurapraxia.



during drilling of the bone tunnel, or, rarely, trapping of the nerve under the Endobutton.[31,42] Ultrasonography can identify the cause of nerve dysfunction and guide appropriate surgical repair (Figures 14–17). The time required for recovery of nerve function varies widely but is usually between 3 and 5 months, sometimes reaching

Figure 16. Posterior interosseous nerve injury. In this patient, hand and wrist extension paresis was worsening. Radiograph (**B**) shows that the Endobutton (open arrow) is abnormally positioned. Transverse US image (**A**) reveals small ossifications (arrow) within the supinator muscle that are barely visible in the radiograph. Transverse (**C**) and longitudinal (**D**) US images show a thickened posterior interosseous nerve (dashed arrows) with an irregular contour and distortion of the fascicular pattern (curved arrows). Hyperechoic and heterogeneous thickening of the extensor muscles (**E**) is also shown. It was decided that the patient should undergo surgery. R indicates radial head.

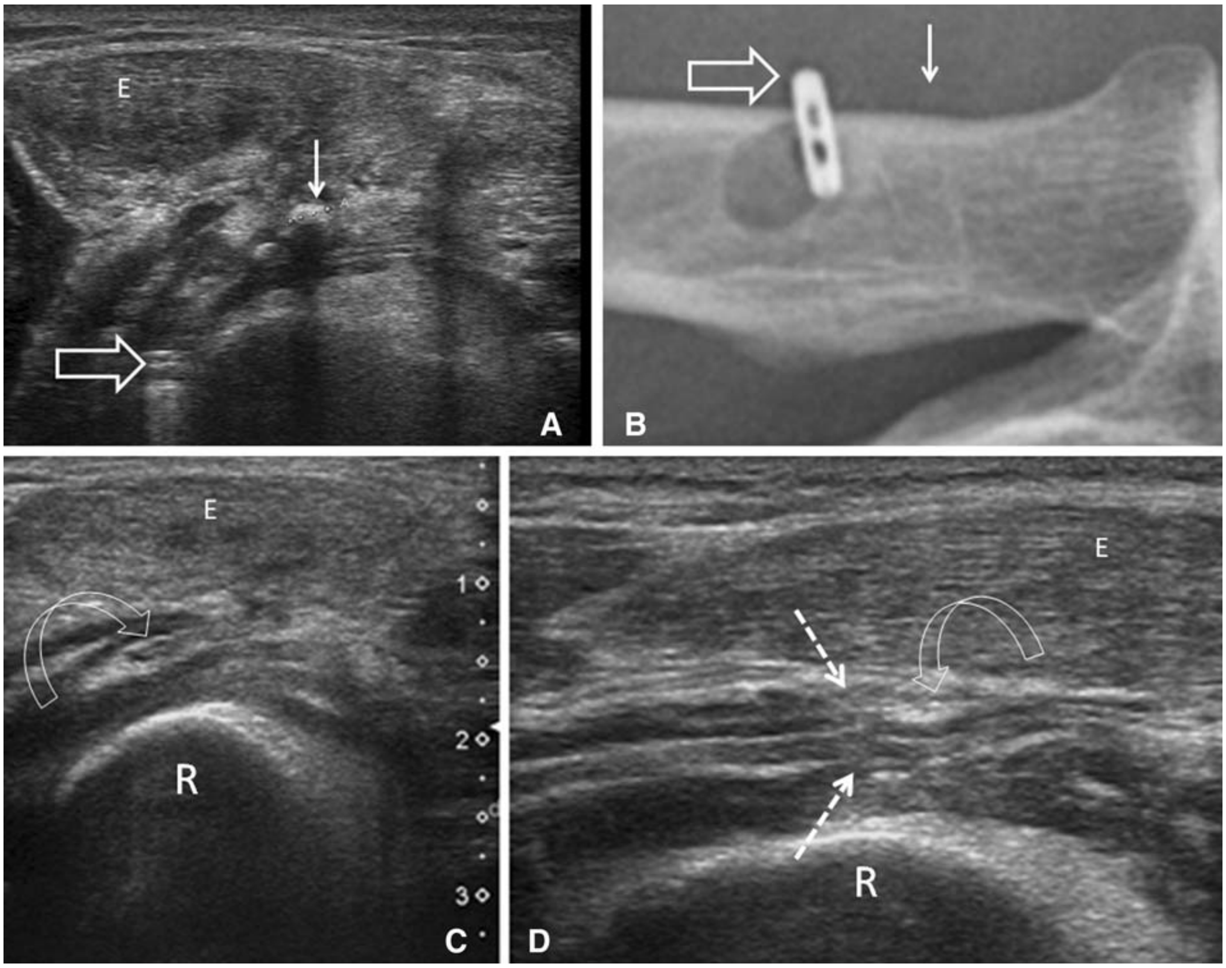
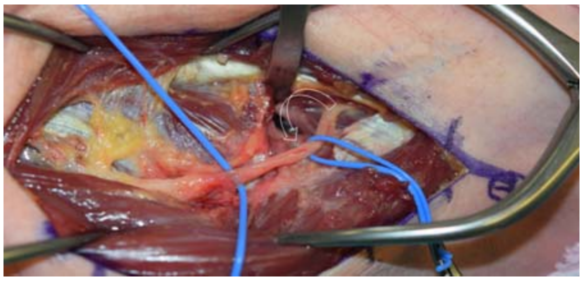


Figure 17. Posterior interosseous nerve injury. Surgery confirms the localized section of the epineurium (curved arrow) of the posterior interosseous nerve (between blue cords) as shown by US. Posterior interosseous nerve neurolysis under optical magnification was performed, and slow recovery was observed after 6 months.

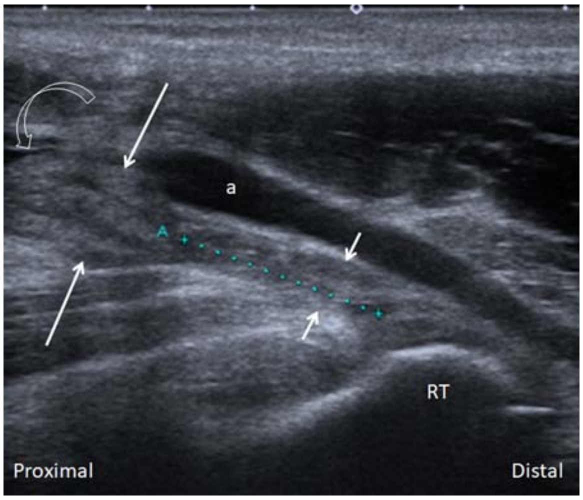


1 year.[31] Nerves (ie, radial, posterior interosseous nerve, median nerve, and lateral antebrachial cutaneous nerve) are generally well analyzed by US, especially when located in the vicinity of orthopedic material, a repaired tendon, or bone (ie, posterior interosseous and median nerves) and when very small and superficial (ie, lateral antebrachial cutaneous nerve).[25]

Rerupture

Classically, rerupture occurs within 3 weeks after surgery and is typically the result of inappropriate (ie, too early or excessive) rehabilitation.[10,30] A retrospective study of 177 patients and 190 DBBT primary repairs with a

Figure 18. Distal biceps brachii tendon rerupture. In this patient, who previously underwent surgery with a transosseous screw to repair DBBT rupture a few years previously in another country, presented with pain and flexion weakness after sports training. A longitudinal US image reveals disparity of the tendon caliber with proximal thickening (long arrows) and more than 50% thinning of the distal tendon (short arrows). Note that there is some fluid around the proximal tendon (curved arrow) as well as the heterogeneous aspect of the distal tendon. A indicates brachial artery; and RT, radial tuberosity.



follow-up time of 9 years featured a 1.5% rate of rerupture.[30] However, diagnosis of a rerupture may be clinically difficult, and imaging may be required.[43] Beyond 6 months after surgery, US depiction of tendon thinning, a liquid collection in or around the operated tendon that reaches more than 50% of the thickness of the tendon, and intratendinous Doppler signals indicate poor healing or rerupture (Figure 18).[34] Magnetic resonance imaging, another modality, is very sensitive for diagnosing complete tears but less sensitive for diagnosing partial tears.[43,44] In addition, after surgery, difficulty in achieving optimal positioning of the elbow as well as artifacts induced by metal orthopedic material may decrease the sensitivity of MRI.[45–47]

Conclusions

During follow-up with patients who underwent surgery to repair a DBBT rupture, combined use of standard radiography and US helps in the diagnosis of postoperative complications. Some of these complications have minor consequences, such as small heterotopic ossification. However, nerve lesions or tendon rerupture should be diagnosed as soon as possible. Radiography remains the first step in a standard postoperative examination of the elbow after DBBT repair. However, US is advantageous for detecting nerve lesions or tendon reruptures. In experienced hands, unlike MRI, US also enables a comparative and dynamic evaluation, with the absence of contraindications, higher availability, and cost-effectiveness.

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