Sonography of Tears of the Distal Biceps Tendon

OBJECTIVE. The objective of this study was to describe the sonographic appearance of tears of the distal biceps brachii tendon.

CONCLUSION. Sonography can reveal complete and partial tears of the distal biceps tendon, thus providing an alternative technique to MR imaging.

Rupture of the distal tendon of the biceps brachii muscle is rare, accounting for only 3% of all biceps tendon tears [1, 2]. Distal biceps tendon rupture is usually easily diagnosed on physical examination, presenting as a palpable defect in the antecubital fossa, a palpable mass in the anterior aspect of the arm corresponding to the retracted tendon, and a weakness of flexion and supination. Clinical diagnosis may be more difficult, however, in cases of partial tear or in cases of rupture that are not retracted because of an intact aponeurosis [2, 3].

MR imaging has been advocated for examination of distal biceps tendon injuries [3–5], with a complete tear diagnosed by the absence of the tendon at its insertion, various degrees of tendon retraction, and edema or hemorrhage in the tendon sheath. Although MR imaging is the gold standard for the imaging evaluation of the elbow, sonography is less expensive and more rapidly performed, and the contralateral normal elbow is readily available for comparison. The purpose of this study was to describe the sonographic appearances of injuries of the distal biceps tendons in seven patients.

Materials and Methods

The sonographic examinations of seven men (average age, 51 years; range, 46–62 years), retrospectively collected from two institutions over a 2-year period, constitute this report. Five patients were recreational athletes, one was a competitive amateur power lifter, and one was a manual laborer. The mechanism of injury in all patients was eccentric contraction of the elbow due to either a sudden flexion jerk of the elbow against a fixed weight or actual forced extension of the flexed elbow. All patients described a popping sensation at the time of injury, immediately followed by pain, weakness of flexion, and swelling.

After physical examination, all seven patients were referred by orthopedic surgeons for imaging of clinically suspected tears of the distal biceps tendon; five patients were referred for sonography and two for MR imaging. The latter two patients agreed to undergo additional sonography, performed without charge, after the MR examination, with the MR imaging results known to the radiologist who performed the sonography. One of the five patients referred for sonography subsequently underwent MR imaging for confirmation of the findings before surgery. Thus, all seven patients underwent sonography and three also underwent MR imaging.

We performed sonography in four patients on an HDI 3000 unit (Advanced Technology Laboratories, Bothell, WA) using a 7–4-MHz linear transducer; this transducer has a variable frequency that automatically adjusts on the basis of the focal zone and image depth selected. We then performed sonography in two patients: one on a Spectra unit (Diasonics, Milpitas, CA) with a 7–4-MHz linear transducer and one on a Logic 700 unit (General Electric Medical Systems, Milwaukee, WI) with a 7.5–9-MHz linear transducer.

The patients were seated facing the operator, with their affected upper extremity in front of them and their elbow slightly flexed; their forearm was supinated and supported by the operator. The transducer was on the oblique plane slightlyinfer-
olaterally to the long axis of the forearm for longitudinal images and perpendicular to the long axis for transverse images (Fig. 1). Dynamic scanning during supination-pronation or flexion-extension was not performed; however, the patient’s forearm was maximally supinated to bring the tendinous insertion on the radial tuberosity into view. The use of real-time scanning facilitated optimal visualization of the longitudinal course of the tendon. The normal distal biceps tendon of the contralateral elbow was scanned for comparison in four patients.

MR imaging was performed on a 1.5-T scanner (Signa Horizon; General Electric Medical Systems). In two patients T1-weighted spin-echo sequences (TR range/TE range, 400–600/11–20; matrix size, 256 × 192; field of view, 12–14 cm; slice thickness, 3 mm with no interslice gap; and signal averaged, 1–1.5) and frequency-selective fat-suppressed fast spin-echo sequences (TR range/TEeff range, 3000–5500/35–57; echo train length, eight; matrix size, 256 × 192; field of view, 12–14 cm; slice thickness, 3 mm with no interslice gap; and signals averaged, two) were performed in planes axial and sagittal to the elbow. In the third patient, an axial fast spin-echo sequence (TR/TEeff, 4800/32; slice thickness, 4.5 mm) and sagittal fast spin-echo sequences (4250/34; slice thickness, 3 mm; and 4000/32; slice thickness, 6 mm) were performed with echo train length, eight; matrix size, 512 × 512; field of view, 16; and signals averaged, one.

The imaging criteria for rupture were tendinous discontinuity with or without retraction, with surrounding hypoechoic fluid on sonography, and high-signal-intensity fluid on T2-weighted images. Partial tear was diagnosed with either technique by thickening or thinning of the tendon and contour irregularity or waviness, but without complete tendinous discontinuity.

The average time from injury to imaging was 8 days (range, 1–21 days), from imaging to surgery was 8 days (range, 4–14 days), and from injury to operation was 17 days (range, 5–35 days) (Table 1). Six of the seven patients underwent surgical repairs by their referring orthopedic surgeons, who were aware of the imaging results. One patient in whom sonography revealed a partial tear was treated conservatively.

**Results**

Four patients had complete rupture of the distal biceps tendon, manifest as tendinous discontinuity, retraction, and hypoechoic fluid in the gap, all confirmed surgically (Table 1). The discontinuity and tendon retraction were best appreciated on longitudinal images (Figs. 2 and 3). In the fifth patient, almost the entire tendon was retracted approximately 5 cm to the level of the radiocapitellar joint, but a thin strand of tendon appeared to remain attached to the radial tuberosity on both the MR images and the sonograms (Fig. 4). This patient’s injury was prospectively reported as an extensive partial tear bordering on complete rupture, but by the time surgery was performed 12 days later, the tendon was described by the surgeon as completely ruptured. The distal biceps tendons in the last two patients were thickened and wavy but could be traced to their attachments on the radial tuberosities on both longitudinal and transverse images (Fig. 5). These cases were interpreted as partial tears, one of which

TABLE I: Average Time from Injury to Imaging and from Imaging to Surgery

<table>
<thead>
<tr>
<th>Patient Age</th>
<th>Clinical Diagnosis</th>
<th>Imaging Intervala</th>
<th>Sonography</th>
<th>MR Imaging</th>
<th>Surgical Intervalb</th>
<th>Surgery</th>
<th>Aponeurosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>Rupture</td>
<td>3 weeks</td>
<td>Rupture with 3-cm retraction</td>
<td>Rupture with 3-cm retraction</td>
<td>2 weeks</td>
<td>Rupture with retraction</td>
<td>Torn</td>
</tr>
<tr>
<td>51</td>
<td>Rupture</td>
<td>3 days</td>
<td>Rupture with 3-cm retraction</td>
<td>—</td>
<td>7 days</td>
<td>Rupture with retraction above elbow joint</td>
<td>Torn</td>
</tr>
<tr>
<td>46</td>
<td>Partial tear</td>
<td>4 days</td>
<td>Rupture with 3-cm retraction</td>
<td>Rupture with 5-cm retraction</td>
<td>6 days</td>
<td>Rupture with retraction</td>
<td>Intact</td>
</tr>
<tr>
<td>62</td>
<td>Rupture</td>
<td>1 day</td>
<td>Rupture with 5-cm retraction</td>
<td>Rupture with 5-cm retraction</td>
<td>4 days</td>
<td>Rupture with retraction</td>
<td>Torn</td>
</tr>
<tr>
<td>44</td>
<td>Rupture</td>
<td>3 weeks</td>
<td>High-grade partial with 3-cm retraction</td>
<td>High-grade partial with 4-cm retraction</td>
<td>12 days</td>
<td>Rupture with retraction</td>
<td>Intact</td>
</tr>
<tr>
<td>57</td>
<td>Partial tear</td>
<td>4 days</td>
<td>Partial tear</td>
<td>—</td>
<td>4 days</td>
<td>Partial tear</td>
<td>Not operated</td>
</tr>
<tr>
<td>47</td>
<td>High-grade partial vs rupture</td>
<td>4 days</td>
<td>Partial tear</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note.—Dash (—) indicates procedure was not performed.

aTime between injury and imaging.

bTime between imaging and surgery.
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was surgically confirmed and the other of which was treated conservatively.

Treatment of two of the seven patients was altered by sonography. In one of the patients, the initial clinical impression was a partial tear of the distal biceps tendon, which was instead shown sonographically to be a complete rupture. The treatment was changed from conservative to operative, and the rupture was confirmed. In another patient, in whom surgery was planned for a clinically suspected high-grade partial tear or rupture, sonography revealed a partial tear with most of the tendon intact. The patient was treated conservatively with nonsteroidal antiinflammatory medication and physical therapy and showed improvement at a 1-month follow-up clinical examination (he

Fig. 2.—47-year-old man with surgically proven rupture and retraction of distal biceps tendon. A, Longitudinal sonogram of contralateral normal right elbow shows distal biceps tendon (short arrows) inserting on bicipital tuberosity (long arrow). Distal aspect of tendon has areas of decreased echogenicity due to anisotropy. Note radial head (H) and radial neck (N).

B, Longitudinal sonogram of affected left elbow shows torn and retracted tendon edge (black arrow) with hypoechoic fluid (f) in gap. Note radial head (H), radial neck (N), and bicipital tuberosity (white arrow).

C, Sagittal fat-suppressed fast spin-echo T2-weighted MR image (TR/TEeff, 4000/45; echo train length, eight) of affected left elbow shows torn and retracted tendon (straight black arrow) and surrounding high-signal-intensity edema and hemorrhage (curved black arrow). Note capitellum (C), radial head (H), radial neck (N), and bicipital tuberosity (white arrow).

Fig. 3.—51-year-old man with surgically confirmed ruptured and retracted distal biceps tendon. Longitudinal sonogram at level proximal to elbow joint shows retracted tendon edge (arrow) with hypoechoic fluid (f) in gap. Note brachialis muscle (B). Contralateral elbow was not scanned.
was lost to further follow-up). In the remaining five patients, MR imaging of injury to the distal biceps tendon confirmed the clinical impression and did not change the treatment.

**Discussion**

The mechanism of injury of the distal biceps tendon is usually forced extension against a flexed elbow. The usefulness of MR imaging for evaluating suspected injury of the distal biceps tendon has been described [3–5], with a reported accuracy of 100% in 24 patients combined from two series who had surgical confirmation of partial or complete tears [4, 5]. Our report cannot address the accuracy of sonography for the evaluation of distal biceps tendon injury because of its retrospective nature, the nonblinded sonographic examinations in two instances, and the small number of patients.

Fitzgerald et al. [4] reported that MR imaging altered the treatment in eight of 21 patients in their series. In our series, two of seven patients had their treatment altered by the sonographic findings, with treatment changed from conservative to surgical in one and vice versa in another. The imaging appearances of our other five patients confirmed the surgeons' decisions to operate rather than to alter treatment. If our series had been larger and had patients with equivocal physical findings, sonography might have been more influential in treatment.

Complete rupture is manifest on both sonography and MR imaging as the absence of...
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the distal tendon from its insertion site, with various amounts of tendon retraction and fluid in the gap [4, 5]. The amount of tendon retraction is best assessed on the sagittal images [4]. Le Huec et al. [3], in a series of 10 patients with distal tendon rupture assessed on MR imaging, reported that a tendon retraction of less than 8 cm correlated with an intact aponeurosis, whereas a retraction of more than 8 cm indicated a torn aponeurosis. Our experience was different because two of our patients had a retraction of less than 8 cm on sonography and MR imaging but had a torn aponeurosis at surgery (Table 1).

Lozano and Alonso [6] described the sonography of a single patient with distal biceps tendon injury. Although the appearance in their patient was similar to that of our patients, with tendinous discontinuity, edema, and hemorrhage in the tendon gap, the authors of that report stated that the tendinous discontinuity was best appreciated on the axial images; in contrast, we believe that longitudinal scanning is better for showing tendon discontinuity and estimation of the amount of tendon retraction because both the torn retracted tendon edge and the radial tuberosity can be depicted on a single image.

The MR imaging literature suggests that partial tears of the distal tendon are best assessed

Fig. 5.—57-year-old man with surgically confirmed partial tear of distal biceps tendon.
A, Longitudinal sonogram of contralateral normal right elbow shows biceps tendon (thin arrows) inserting on bicicipital tuberosity (thick arrow). Note radial head (H) and radial neck (N).
B, Longitudinal sonogram of affected left elbow shows thickened and wavy tendon (thin arrows) inserting on tuberosity (thick arrow). Note radial head (H) and radial neck (N).
C, Transverse sonogram of normal right elbow shows tendon (black arrows) inserting on tuberosity (white arrow). Tendon is hypoechoic because of anisotropy. Image was photographed reversed to facilitate comparison with Figure 4D.
D, Transverse sonogram of affected left elbow shows thickened and echogenic distal tendon (black arrows) inserting on tuberosity (white arrow).
Miller and Adler

in the axial plane, revealed by abnormal intratendinous signal intensity and either thinning or thickening of the tendon, depending on the severity of the injury [4, 5]. Conversely, in our two patients with partial tears, the thickening and altered echogenicity of the tendon were appreciated in both the axial and longitudinal planes, whereas the irregular contour was only appreciated longitudinally. Fitzgerald et al. [4] stated that the assessment of tendon thickness on MR imaging is based on the reviewer’s experience with normal biceps tendons, but with sonography, the presumably normal contralateral elbow is available for comparison. When dealing with an intact but thickened distal tendon, we cannot make a distinction between mild interstitial partial tear and degenerative tendinosis with either technique; however, in the clinical setting of acute pain after the typical mechanism of injury, one may suspect a partial tear. An irregular or wavy contour sonographically further suggests a partial tear.

An advantage of sonography is its ability to optimize the imaging plane with real-time scanning to best display tendon abnormality, particularly the irregular longitudinal profile of the partially torn tendon. When scanning axially at the tendinous insertion, the forearm should be maximally supinated to bring the bicipital tuberosity of the radius to a level as superficial as possible, and the linear transducer may be “heel-toed” or pressed into the interosseous space. Sonography should be performed in both planes.

A limitation of sonography is its dependence on the skill and experience of the operator, but the patient’s contralateral elbow may be used as a guide to the normal appearance. A potential pitfall on the axial image is the hypoechoic appearance of the distal tendon at its insertion because of anisotropy [7] (Fig. 5), mimicking an absent retracted tendon. However, in a true case of rupture, fluid will be present in the region and the adjacent soft-tissue planes may be distorted. Turning the transducer longitudinally can verify or deny the rupture. The hypoechoic distal tendon can be differentiated from a distended bicipitoradial bursa by the tendon’s ability to be tracked proximally in the axial plane or by its elongation in the longitudinal plane. Moreover, the bicipitoradial bursa lies between the biceps tendon attachment and the radial head, and, if distended, will be visualized lateral to the biceps tendon attachment and anterior to the radius [8].

In summary, sonography showed both partial tears and retracted ruptures of the distal biceps tendon in a small group of patients. Larger series investigating the accuracy of sonography of this rare injury are necessary to determine if sonography can be used either for screening of suspected distal biceps tendon injury or for people who cannot undergo MR imaging.

References