Ultrasonography for Rotator Cuff Injury

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Overview

Shoulder disorders are common, with as many as 20% of people experiencing shoulder problems at some stage in life. Shoulder disorders account for 5% of all consultations with family physicians. Of patients presenting with shoulder symptoms, 80% remain symptomatic 6 months later, and 50% have symptoms at 18 months. Shoulder pain is usually poorly localized, with the exception of pain occurring in the acromioclavicular joint. Ultrasonograms of rotator cuff injuries are shown in the images below.

Shoulder, rotator cuff injury (ultrasonography). Ultrasonographic view transverse to the long head of biceps tendon (arrow).

Shoulder, rotator cuff injury (ultrasonography). Ultrasonographic view longitudinal to the long head of biceps tendon (arrow).

In patients older than 40 years, the main causes of shoulder pain and/or functional deficit are adhesive capsulitis (frozen shoulder) and impingement and/or rotator cuff disease.

Ultrasonography has a proven role in assessing tendons of the rotator cuff. This examination is used to identify and classify pathology, and it can help clinicians in making decisions about ongoing management of the condition.

Ultrasonography is well tolerated and cost-effective. Its disadvantages include a long learning curve and reduced sensitivity in patients who are obese or who have severely restricted shoulder movement.

Preferred examination

Good-quality ultrasound equipment is essential to produce satisfactory images of the cuff tendons with good resolution. A high frequency (7- to 15-MHz) linear-array probe is required.

Examination techniques vary, with some operators preferring to face the patient and others preferring to stand behind, scanning over the patient's shoulder.
The long head of biceps tendon is examined within the intertubercular groove, in both the transverse and longitudinal planes, with the patient's arm in a neutral position and the elbow flexed to 90° (see the first 2 images below). The presence of fluid around the tendon is noted (see the third image below), and a search for fluid in the subdeltoid bursa is made. With the shoulder externally rotated, the subscapularis tendon is brought into view and examined in both planes, with the imager taking care not to misinterpret the multipennate nature of the tendon as an indication of a tear. A search for subluxation or dislocation of the long head of biceps tendon is made at this stage.

Then, the patient is asked to rotate the shoulder internally. This movement is achieved either by placing the forearm behind the back with the palm facing posteriorly or by placing the palm on the upper buttock. Both positions provide slightly different degrees of internal rotation and may be used in combination. The supraspinatus and infraspinatus tendons are now evaluated (as shown in the images below) in both the transverse and longitudinal planes. The presence of fluid in the bursa may be assessed again, as may the contour of the bony
surface of the humerus. The examination is completed by requesting the patient to place a hand on the contralateral shoulder. This position allows further assessment of the infraspinatus tendon if required, providing a view of the acromioclavicular joint under stress and a deep view of the spinoglenoid notch where ganglia or other mass lesions can cause compression of the suprascapular nerve.

Shoulder, rotator cuff injury (ultrasonography). Diagrammatic longitudinal view of the supraspinatus tendon.

Shoulder, rotator cuff injury (ultrasonography). Longitudinal ultrasonographic view of the normal supraspinatus tendon (compare with the previous image).

Shoulder, rotator cuff injury (ultrasonography). Diagrammatic transverse view of the supraspinatus tendon.

Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view of the normal supraspinatus tendon (compare with the previous image).
Dynamic evaluation of abduction can be performed by observing the supraspinatus tendon and bursa longitudinally as they retract deep to the coracoacromial ligament. Bunching of tissue or buckling of the ligament correlates with impingement.

**Limitations of techniques**

Successful use of ultrasound to examine the shoulder depends on the operator, machine, and patient factors. Knowledge of the relevant anatomy and pathologic appearances and experience in performing the technique are required of operators. Machine requirements are discussed above in Preferred Examination.

As in other regions of the body, ultrasonography of the shoulder is limited in obese patients, and views of the tendons are restricted in patients with severely limited range of movement. Ultrasonography cannot be used to directly image the subacromial space, and it provides no information about the inferior surface of the acromioclavicular joint. Ultrasonography can show the contour of bony surfaces, but no information can be obtained beneath the surface. The subacromial space is not accessible, and pathology, including the retracted end of a torn tendon, cannot be shown in this location. Ultrasonography is less sensitive than MRI to intrinsic changes within the tendon in the absence of a tear.[3]

Operators should be familiar with the effects of anisotropy, an artifact found on sonograms of tendons. Tendons consist of parallel collagen bundles that reflect transmitted sound. If the probe is not held with the surface parallel to the tendon, reflection is not back toward the probe, and the tendon may falsely appear hyporeflective. In other words, anisotropy occurs when the footprint of the ultrasound transducer is not parallel to the tendon and the ultrasound beam is not perpendicular to the long axis of the tendon. The resulting appearance may simulate that of disease (compare the images below).

Shoulder, rotator cuff injury (ultrasonography). Ultrasonographic view transverse to the long head of biceps tendon (arrow).
Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view of the long head of biceps tendon with probe angulation. The alteration in probe angle causes the ultrasound beam to intersect the tendon at an angle other than 90° and causes reduced reflectivity within the tendon resulting from anisotropic artifact.

**X-ray**

Radiographic examination may show degenerative changes in the acromioclavicular joint, particularly undersurface osteophyte or enthesophyte formation; these changes predispose the joint to impingement. However, the status of the cuff tendons cannot be assessed directly. Narrowing of the subacromial space may occur, as may sclerosis and irregularity of the greater tuberosity. In long-standing massive FTRCTs, secondary degenerative disease of the glenohumeral joint (eg, cuff arthropathy) may be seen, as in the image below.

Shoulder, rotator cuff injury (ultrasonography). Anteroposterior radiograph of the right shoulder showing features of chronic rotator cuff tear and secondary glenohumeral joint osteoarthritis.

**Ultrasound**

**Full-thickness rotator cuff tears**

Major ultrasonographic signs of FTRCT include loss of normal convexity of the superior tendon surface (see the first 2 images below) and discontinuity of tendon fibers from the articular to the bursal surface (see the third image below).[^4-8] The superficial tendon surface may be focally concave with an identifiable defect; alternately, it may just be flattened. In the latter case, a discrete defect may be more difficult to appreciate.
Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view of the supraspinatus tendon showing a full-thickness tear (arrows) with fiber discontinuity, loss of the normal tendon convexity, and fluid filling the gap.

Shoulder, rotator cuff injury (ultrasonography). Longitudinal ultrasonographic view of the supraspinatus tendon showing a full-thickness tear with loss of normal tendon convexity (arrow).

Shoulder, rotator cuff injury (ultrasonography). Longitudinal ultrasonographic view of the supraspinatus tendon showing a full-thickness tear (arrows) with fiber discontinuity and non-echogenic fluid filling the gap between the bursal and articular surfaces.

Both the subdeltoid bursa and the overlying deltoid muscle often can be seen dipping into the defect, which may be filled with fluid or mildly echogenic granulation tissue.

Pressure from the transducer can be used to exaggerate the defect and, in some patients, may demonstrate a tear that was not shown initially.

The dimensions of the tear should be measured.

Massive tears are recognized by complete absence of the tendon (see the image below). The space over the humeral head is filled by the deltoid muscle and a thickened subacromial-subdeltoid bursa. Initially, this appearance may cause the unwary sonographer to assume that the cuff is intact; however, this finding can easily be recognized by identifying the layers of tissue. The thickened bursa continues beyond the usual site of insertion on the greater tuberosity. [9]
Shoulder, rotator cuff injury (ultrasonography). Longitudinal ultrasonographic view showing an extensive full-thickness tear with retraction of the tendon. Fluid overlies the humerus and extends into the bursa (arrow).

**Partial-thickness rotator cuff tears**

Partial tears may be intrasubstance, or they can extend to either the bursal or articular surfaces of the tendon. Partial tears usually appear as focal areas of decreased or occasionally increased echogenicity within the tendon (see the image below). Focal changes in tendon reflectivity should be interpreted carefully to avoid misinterpretation of anisotropic artifact. The overlying tendon surface must retain its normal convexity. Any flattening or concavity indicates the presence of an FTRCT. Partial-thickness tears are less reliably detected than are FTRCTs, and their detection may not alter treatment.\(^1\)

Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view of the supraspinatus tendon showing an articular surface partial-thickness tear (arrow). Overlying bursal surface fibers are intact.

**Other findings**

Several other findings may be helpful in establishing the diagnosis of rotator cuff tear. These include fluid collections, prominence of the humeral cartilage surface, cortical irregularity and pits on the greater tuberosity, and calcific tendinitis.

Fluid may be identified in the subdeltoid bursa, as shown in the first image below, or within the glenohumeral joint surrounding the long head of biceps tendon within the bicipital groove, in the subscapularis recess, or in the posterior aspect of the joint deep to infraspinatus. The presence of fluid increases the likelihood of FTRCT. When fluid is present in both the bursa and the joint, as shown in the second image below, the positive predictive value for the presence of a cuff tear is 95%. Pressure from the transducer can displace fluid, and a careful search for fluid should be made with this in mind.
Shoulder, rotator cuff injury (ultrasonography). Longitudinal ultrasonographic view showing fluid within the subdeltoid bursa (arrow).

Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view showing the long head of biceps tendon surrounded by fluid (black arrow) and overlying fluid within the subdeltoid bursa (white arrow).

Prominence of the humeral cartilage surface is also known as the uncovered cartilage sign. This sign relates to the identification of a bright reflective line at the surface of cartilage overlying the humeral head in the presence of focal overlying fluid (see the image below). It can be associated with a localized full-thickness tear or partial-thickness tear involving the articular surface.

Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view of the supraspinatus tendon showing the uncovered cartilage sign (arrow).

Cortical irregularity and pits on the greater tuberosity: Findings often are associated with cuff tears and clinical impingement (see the image below).
Shoulder, rotator cuff injury (ultrasonography). Transverse ultrasonographic view of the supraspinatus tendon showing a full-thickness tear and underlying cortical irregularity (arrow).

Regarding calcific tendinitis, ultrasonography is sensitive at demonstrating focal calcium hydroxyapatite deposition within the cuff (see the images below).\textsuperscript{[11, 12]} This accumulation most commonly occurs within the supraspinatus tendon near the greater tuberosity insertion but may be seen in other cuff tendons. Typical appearances are of focal areas of increased reflectivity with posterior acoustic shadowing. Ultrasonographic findings are useful in confirming the involved tendon and in localizing deposits for percutaneous aspiration or irrigation.\textsuperscript{[13, 14, 15]}

Shoulder, rotator cuff injury (ultrasonography). Longitudinal ultrasonographic view of the supraspinatus tendon showing focal calcification with increased reflectivity from the superficial surface (arrow) and deeper acoustic shadowing.

Shoulder, rotator cuff injury (ultrasonography). Anteroposterior radiograph of the right shoulder showing calcific tendonitis (arrow).

**Degree of confidence**

The reported range of sensitivity and specificity for ultrasonography in detecting FTRCTs is 57-100\% and 50-100\%, respectively.\textsuperscript{[16]} In certain cases, the lower values reflected
investigator bias or poor-quality equipment. Recent studies involving current machines and skilled operators quote a high overall accuracy of 96%, a sensitivity of 100%, and a specificity of 85%.\textsuperscript{[17, 18]} For the detection of partial-thickness tears, sensitivity is suggested to be 93% and specificity, 94%.

**False positives/negatives**

Reduced echogenicity due to anisotropic artifact may be misinterpreted as abnormal, leading to a diagnosis of tear. Massive tears with complete tendon retraction beneath the acromion may be associated with thickening of the bursa. This can lead the unwary sonographer to assume that the tendon is intact unless the sonographer notes that this bursal thickening or pseudotendon does not insert on the greater tuberosity but continues beyond it deep to the deltoid muscle.

**Intervention**

Ultrasonography can easily be used to guide accurate needle placement for an injection of a local anesthetic or a corticosteroid into the subdeltoid bursa. This injection can be used to confirm impingement and to treat symptoms. If bubbles of gas subsequently are found within the glenohumeral joint, the presence of a full-thickness tear can be confirmed. Ultrasonography is also useful for guiding needle placement for aspiration and/or irrigation of deposits due to calcific tendonitis.\textsuperscript{[15]}

References


