# Tendon Evaluation With Ultrasonography

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## Ultrasound provides detailed and dynamic assessment of tendons, increasing the diagnostic accuracy of injuries, especially when physical examination is equivocal.

The vast majority of musculotendinous injuries occur secondary to violent contraction or excessive stretching.[1] Ligamentous injuries, on the other hand, are due to an abnormal motion of joints. The magnitude of inciting forces results in a spectrum of pathology, ranging from a minor tear to a complete disruption of structures.

Ultrasonography provides a detailed assessment of soft tissue anatomy and dynamic functionality, and in some instances can be comparable or even superior to magnetic resonance imaging[2] because the structural characteristics of certain tendons make them ideal for imaging via ultrasonography. We describe some of these characteristics and highlight their utility in diagnostic imaging.

### Anatomical Structure

Tendons consist of tightly packed type I collagen fibers forming subfascicles that are arranged in a parallel distribution as fascicles. These bundles are held together by loose soft tissue, and the entire structure is covered by a thick fibroelastic epitendineum sheath. This linear distribution of structures yields a uniquely linear "fibrillary" pattern when viewed along the

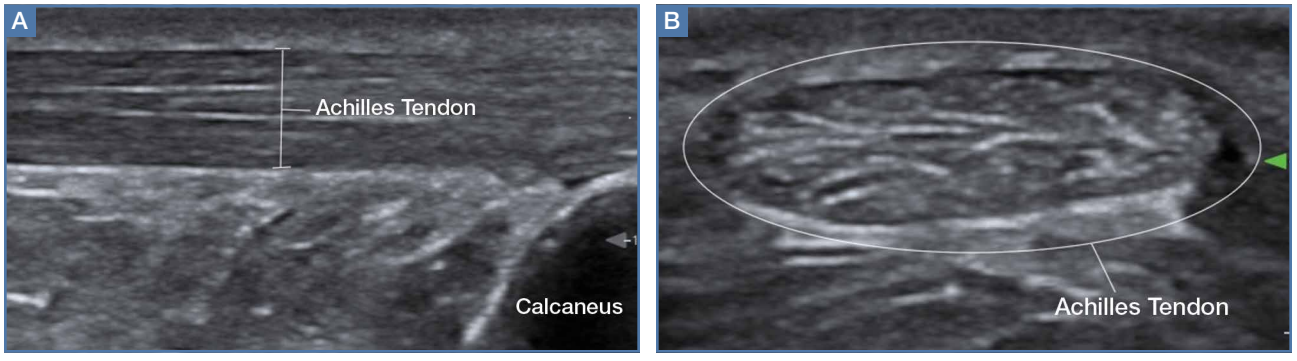


**Figure 1.** (**A**) Long-axis and (**B**) short-axis views of the Achilles tendon. The hyperechoic fibrillary and speckled patterns are noted with the probe held at a 90° angle.

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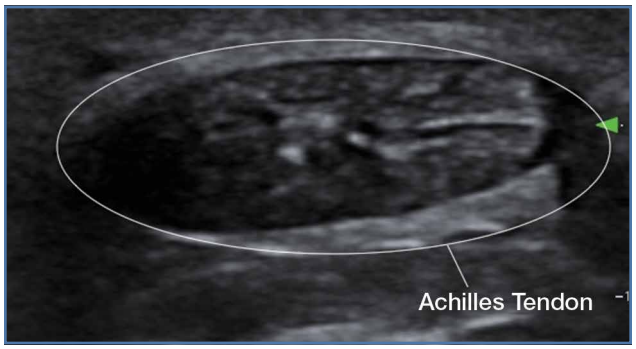


Figure 2. Short-axis view of the Achilles tendon using a nonperpendicular probe angle. The structure appears hypoechoic with relative loss of the speckled appearance.

longitudinal axis of the structure (**Figure 1a**). In the short-axis view, the tendon appears as a well-circumscribed structure with speckled pattern of hyperechoic foci (**Figure 1b**).[3]

## Imaging Technique

The optimal scanning technique involves the use of a high-frequency linear transducer. Higher frequencies yield more detailed images, but may be limited in patients with deeper structures due to body habitus. A key concept in tendon evaluation is an artifact known as "anisotropy." This refers to change in appearance of the tendon based on the incident angle of the ultrasound beam. For example, when the probe is held perpendicular to the structure of interest, parallel fibers will reflect the emitted beam toward the probe and thus appear as hyperechoic and speckled, a characteristic of these fibers **(Figures 1a** and **1b**). Contrarily, if the probe is held at a nonperpendicular angle, the reflected beam will not return to the probe, resulting in a hypoechoic appearance (**Figure 2**).

## Pathology

Tendon strains result in varying degrees of fibrous tearing. These tears can range from first-degree tears (a few

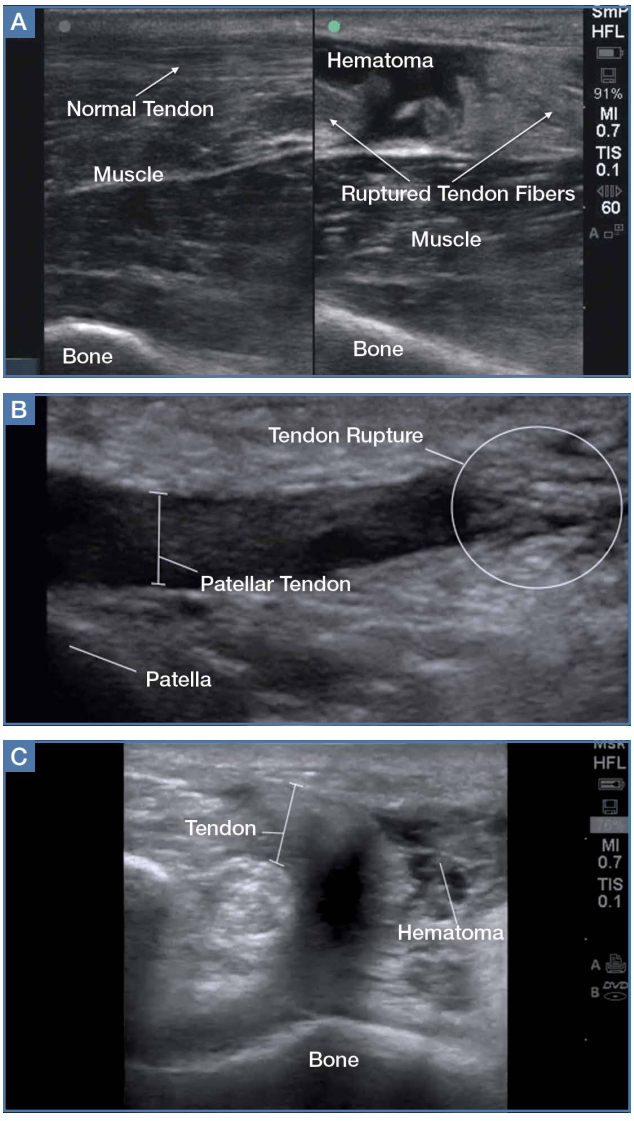


Figure 3. (**A**) Long-axis view demonstrating a near complete tear of tendon with hematoma formation. (**B**) Long-axis view demonstrating a partial tear of the patellar tendon. (**C**) Long-axis view demonstrating full-thickness rupture of the patellar tendon. Note the relative continuity in the overall structure of the tendon as compared to complete tears.

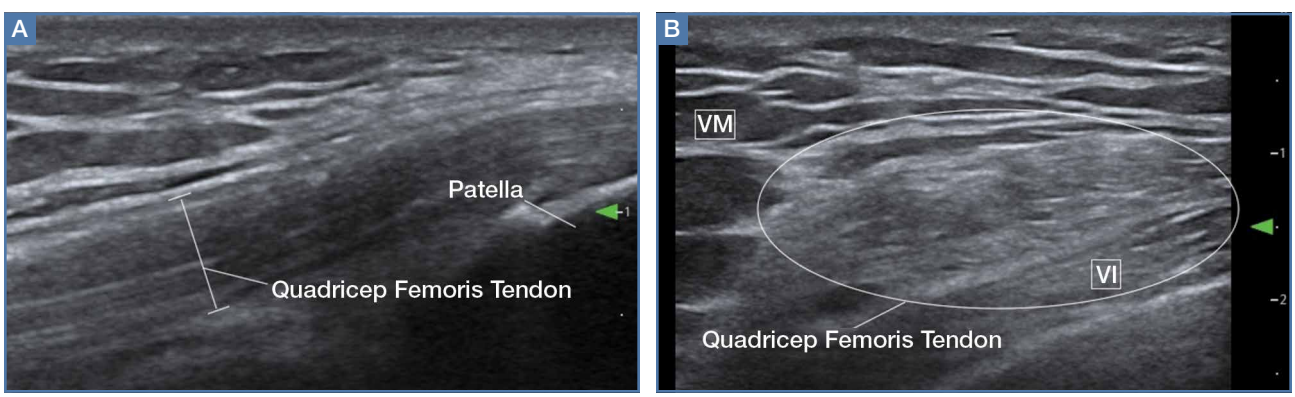


Figure 4. (**A**) Long-axis and (**B**) short-axis views of the quadriceps femoris tendon. Notice the vastus medialis (VM) and vastus intermedius (VI) muscles.

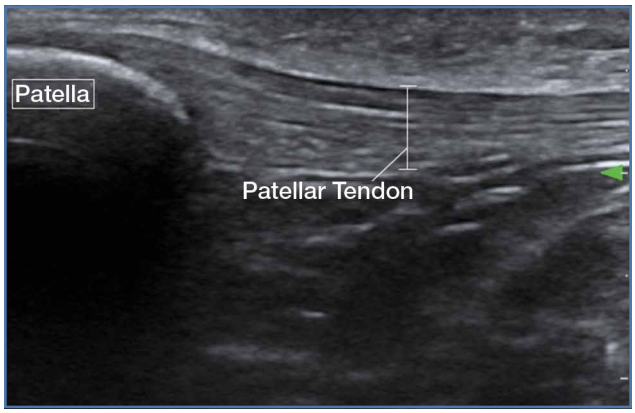


Figure 5. Long-axis view of the patellar tendon.

fibers) to third-degree tears (complete disruption). Partial tears result in focal hematoma formation (**Figure 3a**) at the region of disruption, appearing on ultrasound as a hypoechoic fluid collection within a hyperechoic fibrillary or speckled tendon structure. If the disruption occurs along the surface of the tendon, a focus of anechoic fluid may be seen surrounding the tendon. Complete tendon ruptures, on the other hand, appear as a hypoechoic void with retracted tendon fragments visualized on either side[4] (**Figures 3b** and **3c**). Although complete tears can be more apparent clinically in areas in which a group of tendons performs a cohesive movement (ie, rotator cuff), ultrasound can significantly reduce the rate of delayed diagnosis when physical examination is equivocal.

In the appropriate clinical setting, ultrasonography can provide rapid and dynamic assessment of musculotendinous injuries. Lower extremity injuries, including those affecting the Achilles (**Figure 1**), quadriceps, (**Figures 4a** and **4b**) and patellar tendons (**Figure 5**), are easier clinical applications. Assessment of rotator cuff tendons, although more difficult, can provide a specific assessment of shoulder pain.[5] In such scenarios, ultrasound can serve a very useful role as an adjunct to the physical examination.

An important point to recognize is that tendons will appear hypoechoic at the insertion point on bone (anthesis) due to increased curvature resulting in lack of anisotropy. This can appear as a pathological finding, but can be accounted for by simply performing a heel-toe or tilt maneuver to arrange the beam perpendicular to the tendon fibers **(Figures 6a** and **6b**).

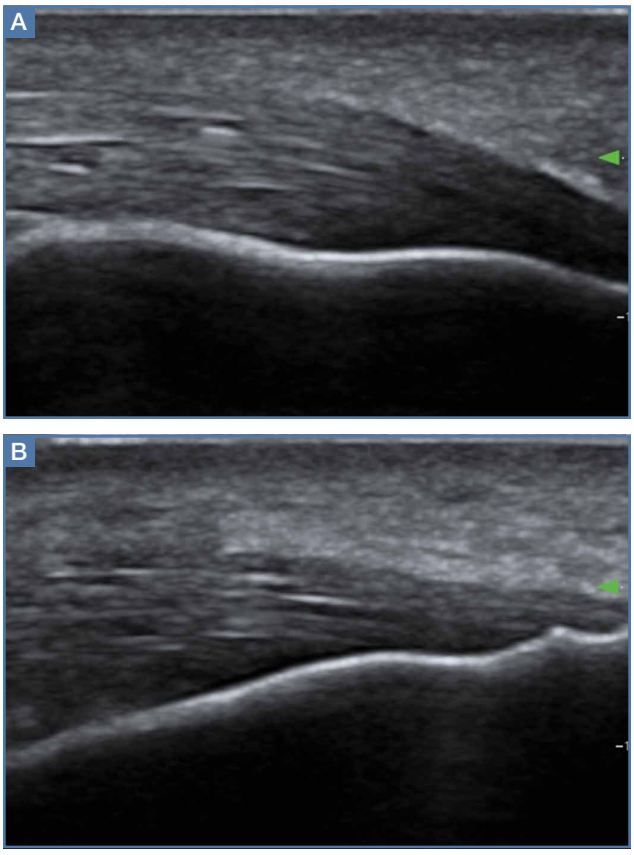


Figure 6. (**A**) Long-axis view demonstrating hypoechoic appearance of Achilles tendon anthesis due to curvature of the terminal tendon fibers. (**B**) Long-axis view demonstrating resolution of hypoechoic appearance by adjusting incident angle via a heel-toe maneuver.

## Summary

Musculotendinous injuries many times present as nonspecific symptoms of pain and/or swelling. In the case of an equivocal physical examination, musculotendinous injuries can be diagnosed with increased accuracy through the use of ultrasound. Understanding the artifactual component of tendon ultrasound can aid the clinician in diagnosing these injuries, enhancing patient care and satisfaction.

## References

1. Geiderman J, Katz D. Geneneral principles in orthopedic injuries. In: Marx JA, Hockberger RS, Walls RM, Biros MH, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. Philadelphia, PA: Elsevier Saunders; 2014:49:511-533.
2. Jacobson, Jon A. Musculoskeletal sonography and MR imaging. A role for both imaging methods. *Radiol Clin North Am*. 1999;37(4):713-735.
3. O'Neill J, ed. *Musculoskeletal Ultrasound: Anatomy and Technique*. New York, NY: Springer Science+Business Media. 2008:3-17.
4. Dawson M, Mallin M. *Introduction to bedside ultrasound*. Vol 1. Emergency ultrasound solutions. Lexington, KY: Emergency Ultrasound Solutions; 2012;25:245-248. https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0009/327852/Introduction_to_Bedside_Ultrasound_Volume_1_-_Matt_and_Mike.pdf. Accessed April 12, 2017.
5. Tran G, Hensor EM, Ray A, Kingsbury SR, O'Connor P, Conaghan PG. Ultrasound-detected pathologies cluster into groups with different clinical outcomes: data from 3000 community referrals for shoulder pain. *Arthritis Res Ther*. 2017;19(1):30. doi:10.1186/s13075-017-1235-y.