Ultrasound Imaging of Achilles tendon rupture: what a resident radiologist needs to know in the Emergency Department

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Purpose

Ultrasonography (US) is the modality of choice to initially assess muscle and tendon trauma. The purpose of this presentation is to illustrate:

1. Normal US-appearance of muscle and musculotendinous-unit (MTU) complex anatomy of Achilles tendon (AT)
2. Imaging characteristics involving AT injuries, and
3. Possible pitfalls

Methods and Materials

A broad range of abnormalities can present as Achilles pain. A pictorial review of patients referred to our department is presented.

Technique of examination

- Ultrasound examination of the Achilles tendon is performed using a high-frequency linear transducer (7-13 MHz).
- The patient is prone with feet extending over the end of the table. Alternatively, examination in the supine position with the knee flexed and the lower limb externally rotated may offer the advantage of increased sensitivity for low-grade vascularity as the Achilles is under less tension in this position.
- The Achilles tendon is scanned in the longitudinal and axial planes from its myotendinous junction to its calcaneal insertion. Dynamic scanning with plantar and dorsi flexing may aid in the evaluation of tears.
- While scanning the Achilles tendon on short-axis planes, tilt the probe on each side of the tendon to assess the peritendinous envelope. Measure the size of the Achilles tendon only on transverse planes.
- Check the retroachilles and the retrocalcaneal bursae.
- Vascularity should be assessed using power Doppler with 'low-velocity' settings, with care taken not to obliterate small vessels because of excessive transducer pressure.

Results

1. Anatomy
Achilles tendon (AT) extends from the musculotendinous junctions (medial and lateral heads of the gastrocnemius and soleus muscles) to the posterior surface of the calcaneus (the site of its insertion). Fig. 1 on page 7 Fig. 2 on page 8.

- **Gastrocnemius muscle** (GM) has two heads, the medial and lateral that arise from the posterior aspects of the medial and lateral femoral condyles. The two heads coalesce as they descend and form AT approximately 15 cm above the calcaneum.
- **Soleus muscle** (SM) arises from the posterior proximal tibia and fibula deep into the (GM) and forms a tendon that fuses with the gastrocnemius component of the Achilles approximately 5-6 cm above the calcaneal insertion.

Retrocalcaneal bursa lies between the distal AT and the posterior process of the superior calcaneum just above AT calcaneal insertion. It is a protective structure that allows AT to glide over the postero-superior corner of the calcaneus. It may normally contain up to 3 mm of fluid. Fig. 1 on page 7.

Retroachilles bursa is a potential bursa that is superficial (posterior) to AT at the level of its insertion to calcaneum. In normal individuals, there is no fluid in this bursa. Fig. 1 on page 7.

Plantaris tendon. Plantaris muscle arises from the posterior lateral femoral condyle. Its thin tendon forms in the upper calf, runs between the medial GM and SM and inserts on the posteromedial calcaneus lying along the medial aspect of AT. It is absent in 7% of the population as a normal variant. Fig. 2 on page 8.

Paratenon/Peritenon. AT has no true synovial sheath but is encased in a loose connective tissue that aids tendon glide and supports vasculature. Peritenon continuous proximally with the fascial envelope of GM and SM, and blends distally with the periosteum of the calcaneus. Fig. 3 on page 10.

Pre-Achilles or Kager's fat pad Fig. 4 on page 10, Fig. 5 on page 11 is a triangle of fat lying anterior to AT. Its boundaries are flexor hallucis longus muscle/tendon, achilles tendon and calcaneus. Normally is clean without edema/fibrosis.

2. Sonographic anatomy:

Sagittal sonographic image Fig. 6 on page 12.

Normal AT (yellow margins in image) is demonstrated as a well-defined homogenous ribbon-like structure with a fine parallel fibrillary pattern of tendon fibres. AT is outlined by a straight hypoechoic border representing the paratenon. Hyperechoic lines within the tendon create 6 - 8 hyperechoic bands that represent acoustic borders between twisted collagen fibrils and intervening connective tissue.
On power Doppler imaging, vascularity should be absent from the normal AT and paratenon.

Dynamic examination: active and passive flexion during sagittal plane scanning will demonstrate the smooth gliding of a normal tendon.

Axial sonographic image

On axial images the hyperechoic lines within the tendon present a punctuated or 'honeycomb' pattern. Note the thin hypoechoic paratenon surrounding AT. The distal soleus muscle is seen to insert onto AT via a tendon slip. Plantaris tendon may be noted on the medial margin of AT.

AT measures 5mm thick and 13mm wide in adults. It broadens and flattens as it descends to its insertion on the calcaneum and has a maximal thickness of 4-6.7 mm but this may be increased in athletes.

3. Injuries

Achilles tendon rupture

- often occurs in the so-called 'weekend warrior' whose intermittent participation in sports punctuate a sedentary lifestyle
- more likely to occur on the left side (the 'push off' foot in sports such as sprinting)
- blood flow diminished in an area 2-6 cm above calcaneal insertion- most tears occur here
- second commonest location is at the musculotendinous junction à these tears are not amenable to surgical repair
- tendon can still function with as little as 25% of the fibers intact
- tears due to steroid injection abuse occur 2 - 4 weeks after last injection

Acute Achilles rupture

- typically presents with sudden calf pain during forced loading of the tendon
- often a history of a feeling of being 'kicked in the back of the calf'
- sometimes an audible snap is reported

Physical examination

- bruising, swelling, a palpable defect in the tendon, weak plantar flexion
- Thompson or Simmonds test
  - The patient lies prone with the feet over the end of the examination table
  - The examiner squeezes the calf
• Deformation of the soleus elevates the AT dorsally à provided the AT is intact plantar flexion of the foot is produced

• **Matles test:**
  • The patient lies prone and then actively flexes both knees to 90° together.
  • Where AT is torn the affected foot will fall into relative dorsiflexion. This may in part be due to haematoma filling in a palpable defect and the recruitment of medial and lateral ankle tendons masking the weakness of the plantar flexion.

23% of acute AT ruptures are reported to be missed on initial clinical examination.

Although the diagnosis of acute complete rupture is usually suggested clinically, chronic tears may be overlooked clinically, because intervening scar tissue may fill the normally palpable defect and collateral muscles may give a false negative Thompson test (a positive test occurs when the foot fails to plantarflex on squeezing the calf).

**Ultrasound imaging**

Aims of ultrasound imaging in acute AT rupture are:

1. to confirm the diagnosis of Achilles tendon tear
2. to distinguish between partial and complete tears
3. to identify the level of a complete tear and
4. to estimate of the size of the gap

**Partial thickness tear** (probably better termed focal tendinopathy) may have a variable appearance:

• tendon thickening (>10-15 mm in the anterior-posterior dimension)
• abnormal intratendinous echotexture
• a clear discontinuity in one portion of the tendon fibres, while other fibres remain intact
• interstitial defects within the tendon, such as hypo- or anechoic clefts
• areas of localised thinning
• contour abnormalities
• peritendinous fluid
• localised increased blood flow

On dynamic ultrasound assessment, partial tears should demonstrate the gliding of a partially torn tendon as a single unit, rather than the separation of tendon ends seen in complete tears.

**Full-thickness / complete tear** is characterized by: Fig. 7 on page 13 Fig. 8 on page 13
• complete focal disruption: complete focal discontinuity of tendon fibres (Figure 8)
• tendon retraction: the two ends of the torn tendon are retracted and a gap is created between them (Figure 8)
• into the aforementioned gap there may be:
  • herniation of the pre-Achilles (Kager’s) fat pad (Figure 8)
  • in acute phase, fluid which is compressible and enhances the conspicuity of the tear (Figure 9)
  • later, debris and organizing haematoma that may be of variable appearance
  • in chronic healed tear, reflective fibrous scar tissue
  • Posterior acoustic shadowing from the torn tendon ends (refraction artifact)

• Visualization of the plantaris tendon. An intact plantaris tendon may move into an AT defect making it more easily visualized in a complete tear.

Along with clinical factors, these data will determine whether surgical or conservative management is most appropriate. Where surgery is contemplated, preoperative planning is optimized by a description of the level of the tear, measurement of the gap and identification of the presence of plantaris (which may be used as a graft).

**Pitfalls in ultrasound imaging**

1. Anisotropy (asterisk in Fig. 6 on page 12)
   • Caused: where the insonating beam loses perpendicularity with the tendon fibres (particularly close to the distal insertion of the AT where the fibres curve anteriorly towards the calcaneum)
   • Appearance: AT appears artefactually hyperechoic à this may lead to a misdiagnosis of tendinopathy or partial tearing
   • Suggested technique to resolve the problem: Rock the transducer to return the insonating beam perpendicular to the tendon. Beam steering or compound imaging (the image is formed from the addition of echo pulses steered at multiple angles from the transducer)

2. Misinterpretation of a complete AT tear as a partial tear because of the presence of an intact plantaris lying within the AT gap
   • Suggested technique: carefully follow the plantaris fibres, and identify it as a separate tendon from the AT. It is easiest to find it on the medial side of the distal AT approximately 1cm above the insertion.
3. Not identification of a complete AT tear when debris and organizing haematoma of variable appearance fill the tendon gap. Then, the tendon ends may be difficult to define on static images.

   • Suggested technique: Gentle dorsi/plantar flexion movements à the tendon remains slack, the gap opens up and the proximal tendon doesn't move

4. Acoustic shadowing ie calcification in AT Fig. 9 on page 14

5. Reverberation artifact

   • Caused: high amplitude reflection of the US beam ie intratendinous sutures
   • Appearance: bright double linear echoes (rail-like lines)

**Tendinosis**

Tendinosis typically appears as fusiform hypoechoic swelling of the tendon without disruption of the fibers Fig. 10 on page 14. Hyperemia may be present due to hypervascularity, not secondary to inflammation, hence the term “tendonosis” is used rather than tendinitis.

**Peritendinitis**

Isoechoic soft-tissue thickening or hypoechoic fluid surrounding the Achilles tendon indicates peritendinitis.

**Bursitis** Fig. 11 on page 15

The bursa contains more fluid than normal, becomes thick walled and hyperaemic. Bursitis is often associated with deep surface AT tendinopathy.

**Images for this section:**
Fig. 1: Ankle anatomy
Fig. 2: Achilles tendon anatomy

Fig. 3: Achilles tendon anatomy
Fig. 6

Fig. 7: Achilles tendon full thickness tear (sagittal image)
Fig. 8: Achilles tendon full thickness tear (axial image)

Fig. 9: Calcifications in Achilles tendon
Fig. 10: Tendinopathy
**Fig. 11**: Bursitis of retrocalcaneal bursa
Conclusion

Dynamic-US is superior to MRI in differential diagnosis between partial and complete tendon tear by nicely imaging tendon retraction (compatible with complete tendon rupture).

Doppler-US can evaluate the vascularity grade of muscle/tendon, assess the reparative process and soft tissue inflammation.

Advantages of sonographic-imaging include low cost, wide availability, contralateral comparison and dynamic examination.

To summarize, US examination is able to detect and characterize Achilles tendon injury playing a major role in preoperative assessment and follow-up monitoring. MRI is the method of choice, when cartilage, bone marrow or more extended soft tissue imaging is necessary.

References


Personal Information