Ultrasonography of the Ankle: a step-by-step guide

Poster No.:	C-1806
Congress:	ECR 2017
Type:	Educational Exhibit
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Keywords:	Motility, Education and training, Athletic injuries, Technical aspects, Education, Diagnostic procedure, Ultrasound, Musculoskeletal joint, Extremities, Anatomy
DOI:	10.1594/ecr2017/C-1806

Learning objectives

The purpose of this article is to review the normal ultrasound anatomy of the ankle joint and propose a checklist-based evaluation protocol. Didactic illustrations and iconographic documentation are used for the scanning technique, probe positioning and normal findings.

Background

Being the most frequently injured major joint amongst the general population, Imaging plays a crucial role in the evaluation of the ankle. The superficial location of most structures and the possibility of performing dynamic maneuvers during the exam means that ultrasound plays an important role in the management of patients with painful conditions of the ankle.

Findings and procedure details

The ankle can be subdivided into four major compartments: anterior, lateral, medial and posterior.

Each of these anatomic regions include key structures that are essential for the normal function of the ankle joint and that can be assessed by ultrasonography.

Anterior ankle

Key structures:

- Anterior tendons (extensor tendons and tibialis anterior)
- Deep peroneal nerve and anterior tibial vessels
- Anterior joint (tibiotalar) recess

Starting position:

To examine the anterior ankle, the patient should either be seated on the table with the knee flexed at 90° and the plantar surface of the foot flat on the table [Fig. 1] or lain supine with the foot free, allowing manipulation by the examiner.

Fig. 1: Starting position to evaluate the anterior ankle.

References: - Coimbra/PT

Anterior tendons

Place the probe on an axial plane over the dorsum of the ankle [Fig. 2] to examine the *tibialis anterior*, *extensor hallucis longus* and *extensor digitorum longus* (medial to lateral). These tendons must be followed from their myotendinous junction to their distal insertion onto the first cuneiform (tibialis anterior) and fingers (extensor tendons).

On this plane, the *extensor retinaculum* can be identified superficially and the neurovascular bundle (which includes the *deep peroneal nerve* and *anterior tibial vessels)* can be assessed deeply, between the extensor tendons.

Long axis scans can be useful when assessing distal bone insertions.

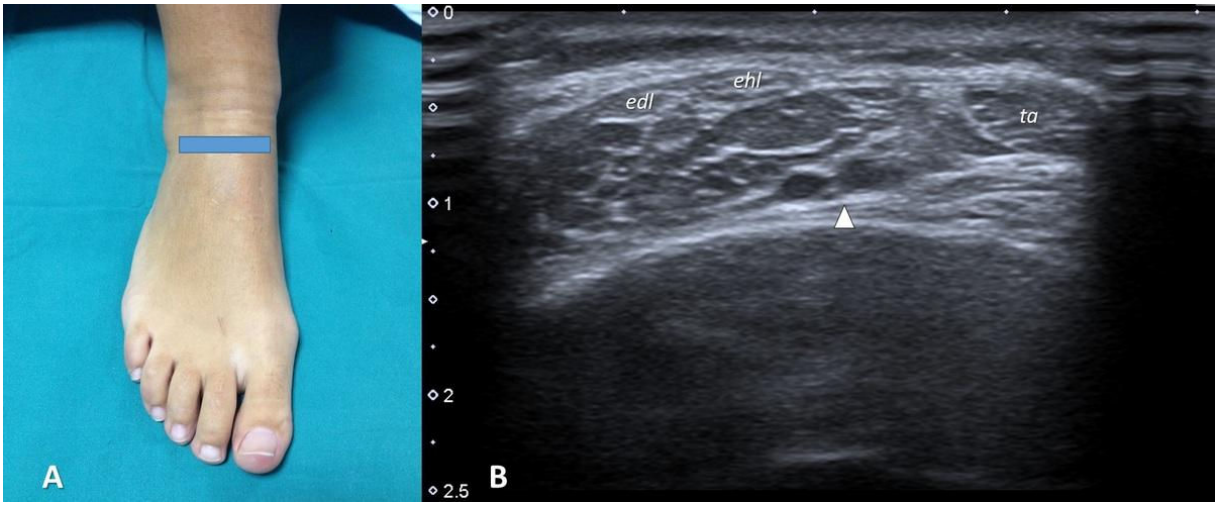

Fig. 2: A) Probe positioning for transverse scanning of the anterior ankle. B) Transverse ultrasound scan of tibialis anterior tendon (ta), extensor hallucis longus tendon (ehl), extensor digitorum longus tendon (edl) and the neurovascular bundle which includes the deep peroneal nerve and anterior tibial vessels (arrowhead).
References: - Coimbra/PT

Anterior joint (tibiotalar) recess

The probe should be placed on a mid longitudinal plane over the dorsum of the ankle, between the extensor tendons [Fig. 3]. The recess has a concave shape and contains the normal *fat pad* when not distended by fluid. *Talus' cartilage* may also be assessed

on this plane. Note that a small quantity of fluid is usually seen in its anterior part, which is a physiological finding.

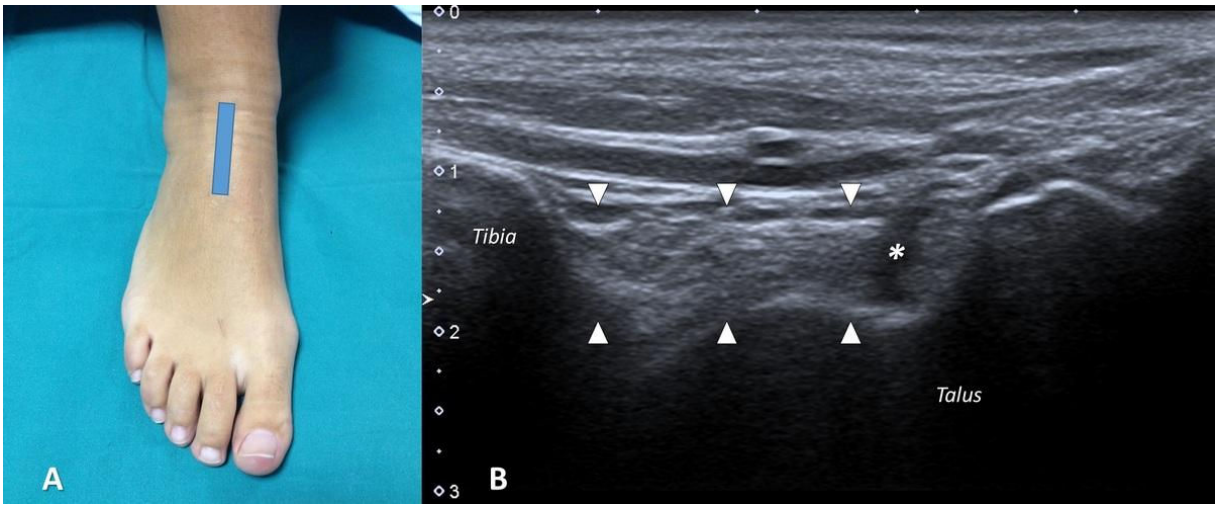

Fig. 3: A) Probe positioning for scanning the anterior joint recess. B) Longitudinal ultrasound scan of the anterior joint recess (arrowheads). Note the small amount of physiological fluid (asterisk) in its anterior part, which is a common finding.
References: - Coimbra/PT

Lateral ankle

Key structures:

- Anterior tibiofibular ligament
- Anterior talofibular ligament
- Calcaneofibular ligament
- Peroneal tendons

Starting position:

To examine the lateral ankle, the patient should either be seated on the table with the knee flexed at 90° and the foot slightly internally rotated [Fig. 4] or lain supine with the foot free, allowing manipulation by the examiner.

Fig. 4: Starting position to evaluate the lateral ankle.
References: - Coimbra/PT

Then, the tip of the lateral malleolus is an useful landmark to evaluate the lateral ligaments: one edge of the probe should be held over it, while the other edge is placed anteriorly (*anterior talofibular ligament*), rotated cranially (*anterior tibiofibular ligament*) or rotated caudally with dorsal flexion of the foot (*calcaneofibular ligament*) [Fig. 5].

Fig. 5: Animated image showing probe and foot positioning to evaluate the anterior talofibular, anterior tibiofibular and calcaneofibular ligaments. Note the lateral malleolus as an useful landmark.
References: - Coimbra/PT

Anterior talofibular ligament

Place the probe parallel to the sole of the foot, with one edge over the tip of the lateral malleolus and the other anteriorly to examine the *anterior talofibular ligament* [Fig. 6].

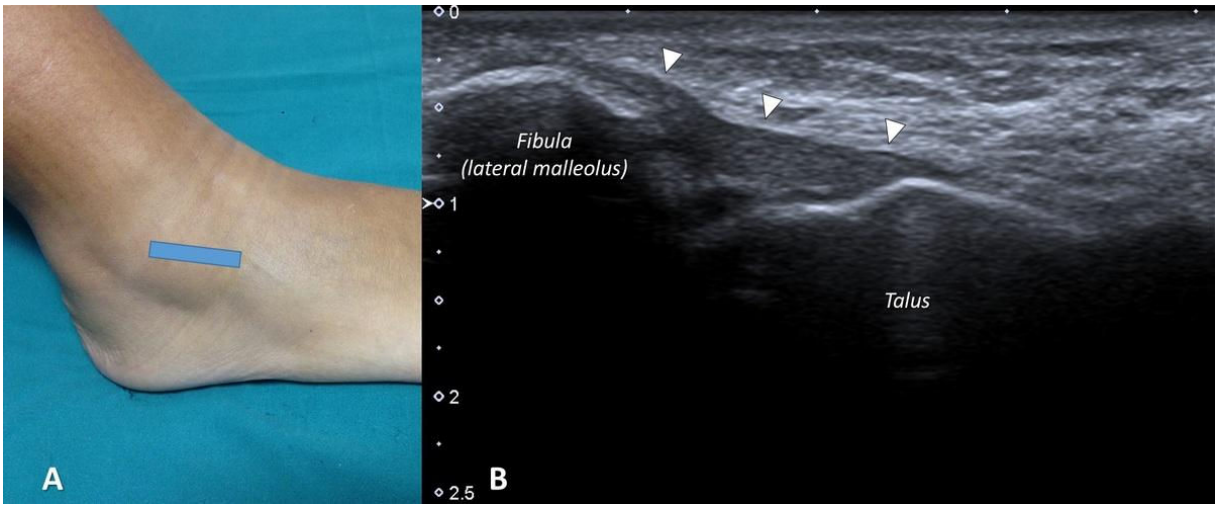

Fig. 6: A) Probe positioning for scanning the anterior talofibular ligament. B) Longitudinal ultrasound scan of the anterior talofibular ligament (arrowheads).
References: - Coimbra/PT

The functionality of this ligament can be tested by using the anterior drawer test [Fig. 7], which consists of pulling the foot anteriorly with plantar flexion and internal rotation and may help differentiate partial from full thickness tears.

Fig. 7: Photograph showing how to perform the anterior drawer test (stress position to evaluate the anterior talofibular ligament).
References: - Coimbra/PT

<u>Anterior tibiofibular ligament</u>

From the position used to evaluate the anterior talofibular ligament, rotate the anterior edge of the probe cranially to image the *anterior tibiofibular ligament* [Fig. 8].

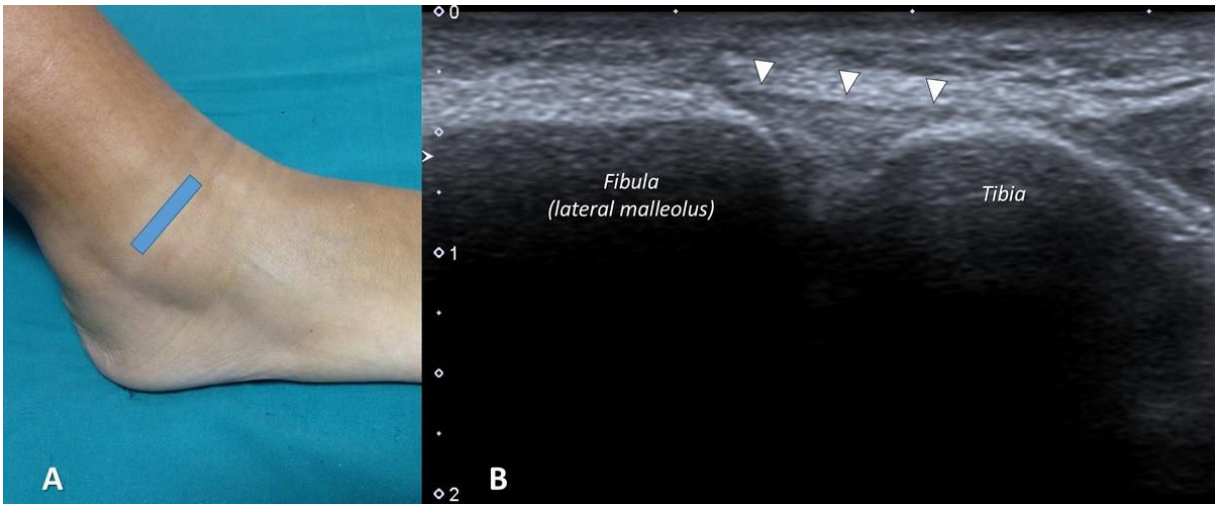

Fig. 8: A) Probe positioning for scanning the anterior tibiofibular ligament. B) Longitudinal ultrasound scan of the anterior tibiofibular ligament (arrowheads).
References: - Coimbra/PT

Calcaneofibular ligament

From the position used to evaluate the anterior talofibular ligament, rotate the anterior edge of the probe caudally until a coronal plane is reached (with a slight posterior tilt of the distal edge) in order to image the *calcaneofibular ligament* [Fig. 9]. As it exhibits a concave course, the foot should be flexed dorsally, thus straightening the ligament and allowing optimal visibility.

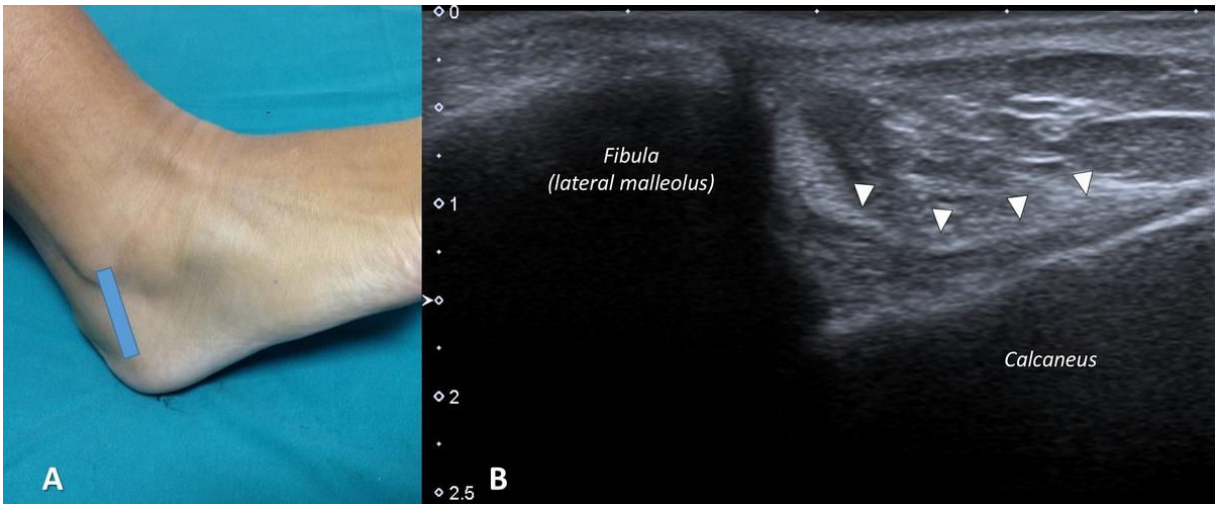

Fig. 9: A) Probe positioning for scanning the calcaneofibular ligament. B) Longitudinal ultrasound scan of the calcaneofibular ligament (arrowheads).
References: - Coimbra/PT

When the calcaneofibular ligament is intact, dorsiflexion displaces the peroneal tendons superficially. Absence of this displacement during forced dorsiflexion is an indirect sign of calcaneofibular ligament tear.

(Note: The *posterior inferior tibiofibular ligament,* that extends transversely from the posterior aspect of the lateral malleolus to the posterior tubercle of the tibial shaft, is not usually assessed during ultrasound evaluation. The main reasons are its very low visibility and the fact that it is rarely involved in ankle sprains.)

Peroneal tendons

The peroneal tendons should be assessed on sequenced short-axis planes, moving the probe along their course, which is cranio-caudal as they run posteriorly to the lateral malleolus but becomes progressively horizontal as they turn around the lateral malleolus' distal tip [Fig. 10].

Fig. 10: Probe positions for assessing sequenced short-axis scans along the course of the peroneal tendons.
References: - Coimbra/PT

The *peroneus brevis tendon* has a typical crescent appearance and is located deep to the oval shaped *peroneus longus tendon* [Figs. 11-13]. They should be followed from their myotendinous junction to the insertion of peroneus brevis onto the base of the fifth metatarsal bone. Long axis scans can be useful when assessing distal bone insertions.

The *superior* and *inferior peroneal retinaculum* should also be examined. Subluxation of the peroneals can be assessed by performing dorsiflexion and eversion while scanning the superior peroneal retinaculum (an axial plane at the level of the lateral malleolus).

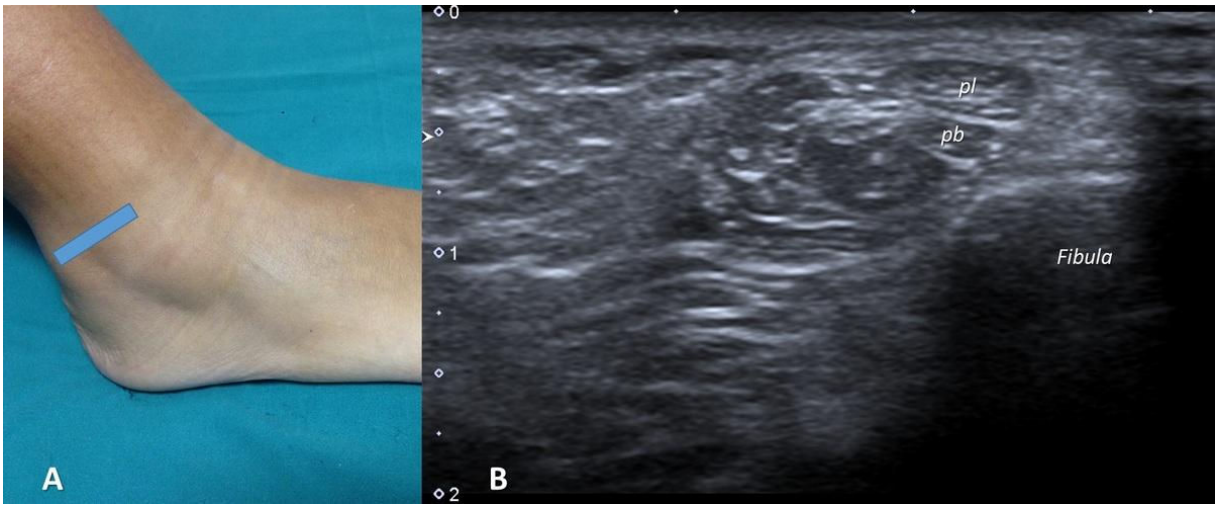

Fig. 11: A) Probe positioning for scanning the peroneal tendons at their course proximal to the lateral malleolus. B) Transverse ultrasound scan of the peroneus longus tendon (pl) and peroneus brevis tendon (pb).
References: - Coimbra/PT

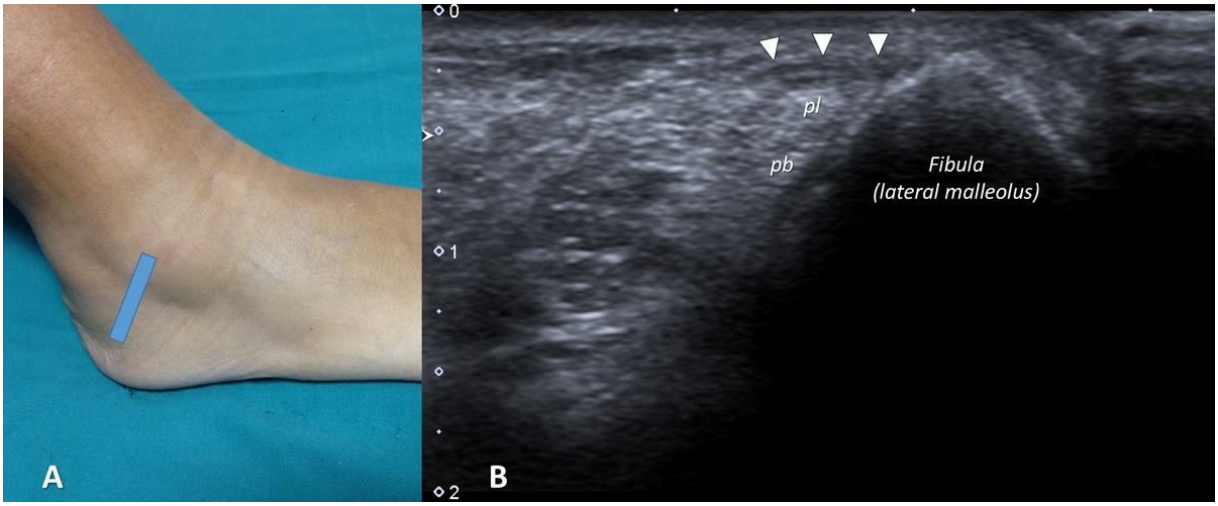

Fig. 12: A) Probe positioning for scanning the peroneal tendons at their course posterior to the lateral malleoulus, at the level of the superior retinaculum. B) Transverse ultrasound scan of the superior retinaculum (arrowheads), peroneus longus tendon (pl) and peroneus brevis tendon (pb).
References: - Coimbra/PT

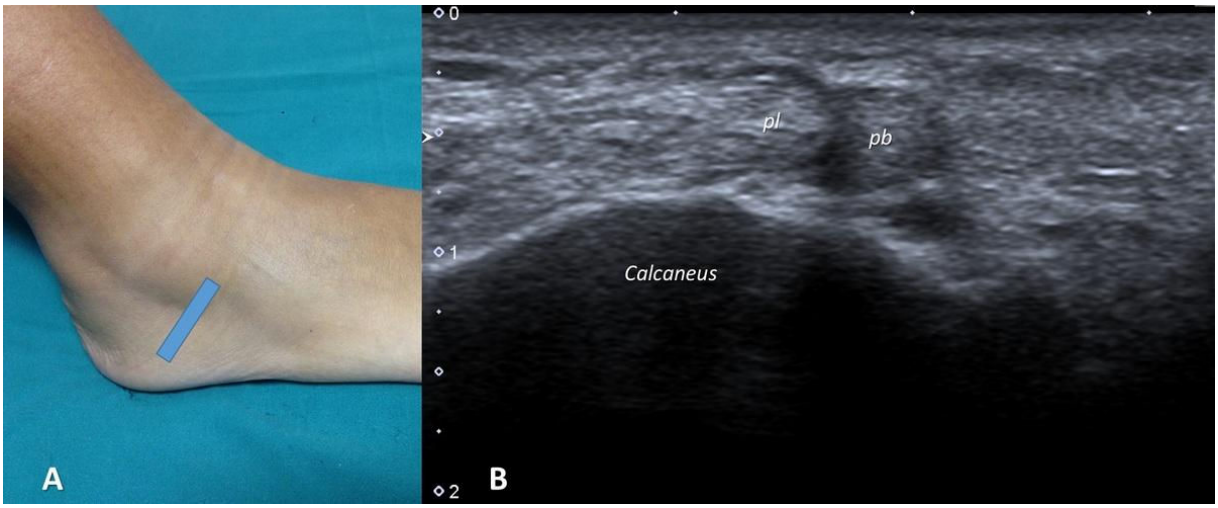

Fig. 13: A) Probe positioning for scanning the peroneal tendons at their course distal to the lateral malleolus. B) Transverse ultrasound scan of the peroneus longus tendon (pl) and peroneus brevis tendon (pb).
References: - Coimbra/PT

Medial ankle

Key structures:

- Deltoid ligament

- Anterior tibiotalar ligament

- Posterior tibiotalar ligament
- Tibiocalcaneal ligament
- Tibionavicular ligament

- Tarsal tunnel

- Medial tendons (flexor tendons and tibialis posterior)

- Tibial nerve and posterior tibial vessels

- Spring ligament complex

Starting position:

To examine the medial ankle, the patient should be seated on the table with the knee flexed at 90° and the foot slightly externally rotated [Fig. 14] or in a "frog-leg" position.

Alternatively, the patient may lie supine with the foot free, allowing manipulation by the examiner.

Fig. 14: Starting position to evaluate the medial ankle.
References: - Coimbra/PT

Deltoid ligament

The deltoid ligament can be roughly divided into three parts: an anterior bundle (anterior tibiotalar and tibionavicular ligaments), middle bundle (tibiocalcaneal ligament) and posterior bundle (posterior tibiotalar ligament).

To assess the middle and posterior bundles, dorsiflexion of the foot is essential to create tension in the ligament components, allowing optimal visibility. The anterior bundle is best seen in a neutral position or with slight plantar flexion [Fig. 15].

The tip of the medial malleolus (as it happens with its lateral counterpart) is an useful landmark when evaluating the deltoid ligament.

Fig. 15: Animated image showing probe and foot positioning to evaluate the anterior, middle and posterior bundles of the deltoid ligament. Note the medial malleolus as an useful landmark.
References: - Coimbra/PT

Hold the proximal edge of the probe over the tip of the malleolus, while placing the distal edge on a coronal plane, slightly posteriorly, to image the *posterior tibiotalar ligament* [Fig. 16].

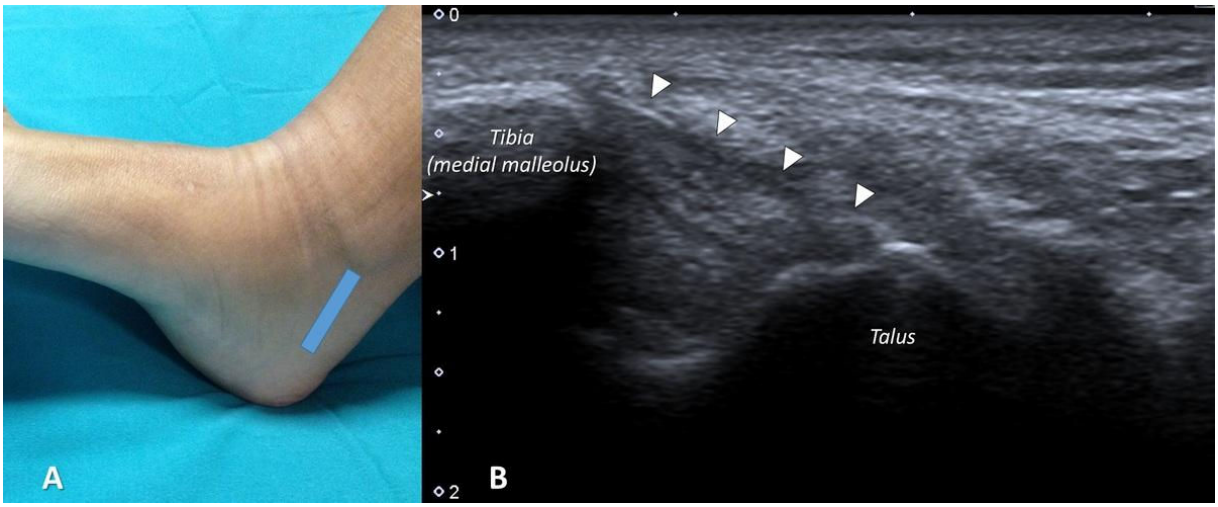

Fig. 16: A) Probe positioning for scanning the posterior bundle of the deltoid ligament. B) Longitudinal ultrasound scan of the posterior tibiotalar ligament (arrowheads).
References: - Coimbra/PT

Tilt the distal edge of the probe to a parallel / slightly anterior plane to image the *tibiocalcaneal ligament* [Fig. 17].

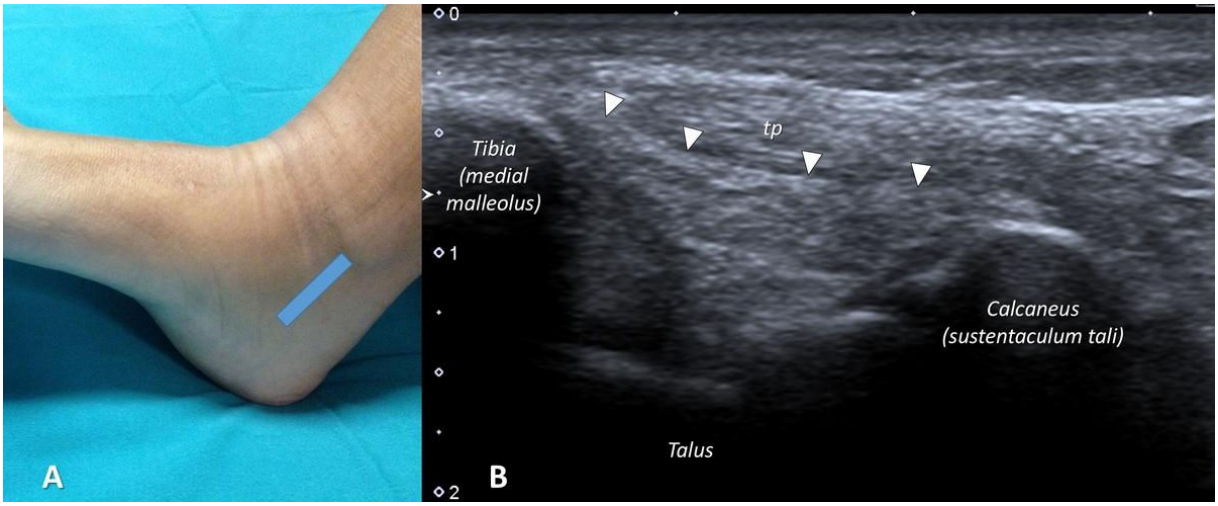

Fig. 17: A) Probe positioning for scanning the middle bundle of the deltoid ligament. B) Longitudinal ultrasound scan of the tibiocalcaneal ligament (arrowheads). Note the tibialis posterior tendon (tp) that runs superficially.
References: - Coimbra/PT

Then, keep rotating the distal edge anteriorly to evaluate the *anterior tibiotalar ligament* [Fig. 18] and the *tibionavicular ligament* [Fig. 19].

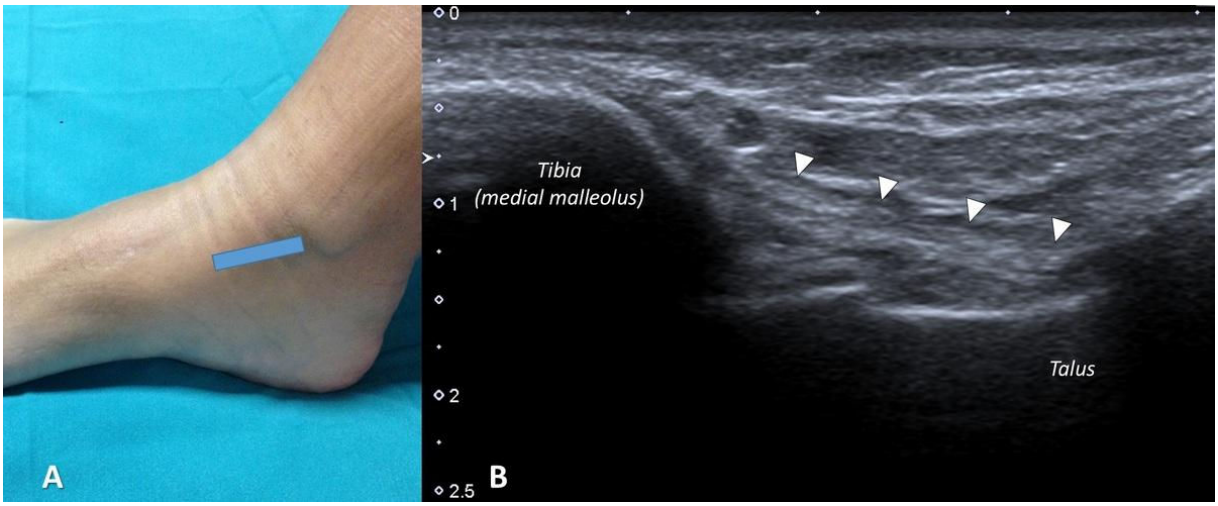

Fig. 18: A) Probe positioning for scanning the anterior tibiotalar ligament. B) Longitudinal ultrasound scan of the anterior tibiotalar ligament (arrowheads).
References: - Coimbra/PT

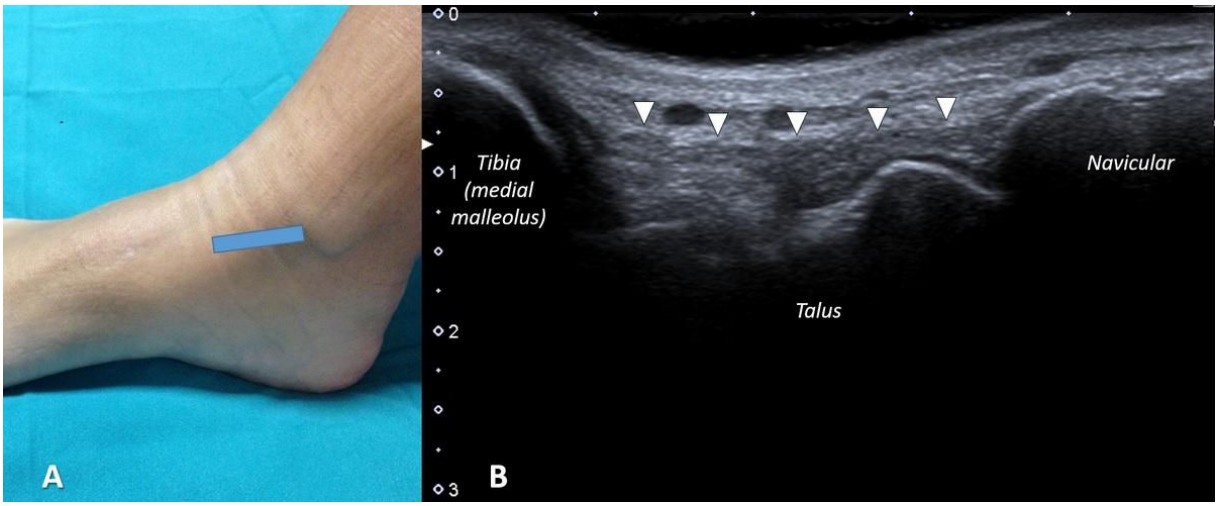

Fig. 19: A) Probe positioning for scanning the tibionavicular ligament. B) Longitudinal ultrasound scan of the tibionavicular ligament (arrowheads).
References: - Coimbra/PT

Tarsal tunnel

From medial to lateral, the structures contained in the tarsal tunnel are the *tibialis posterior tendon,* the *flexor digitorum longus tendon,* the neurovascular bundle (which includes the *tibial nerve* and *posterior tibial vessels)* and the *flexor hallucis longus tendon*.

The tarsal tunnel should be assessed on sequenced transverse planes along its course, posterior and inferior to the medial malleolus [Fig. 20].

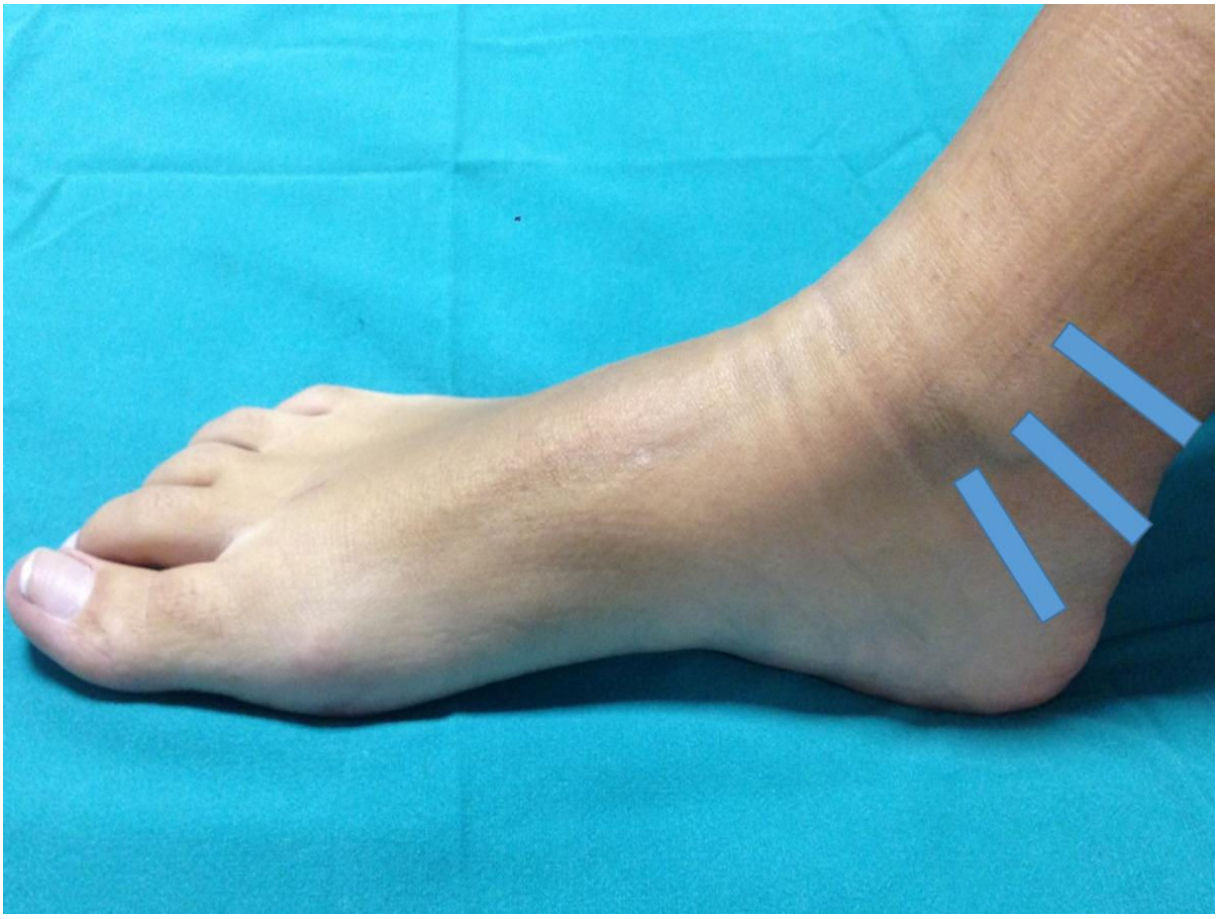

Fig. 20: Probe positions for assessing sequenced short-axis scans along the tarsal tunnel.
References: - Coimbra/PT

Follow the tibialis posterior, the flexor digitorum longus and (more posteriorly) the flexor hallucis longus from their myotendinous junction to their distal insertions on short-axis planes [Fig. 21]. Long axis scans can be useful when imaging distal bone insertions, namely the tibialis posterior tendon insertion on the navicular bone.

Assess the tibial nerve and posterior tibial vessels, located between the flexor digitorum longus and flexor hallucis longus tendons. The flexor retinaculum can be seen superficially, extending from the medial malleolus to the margin of the calcaneus.

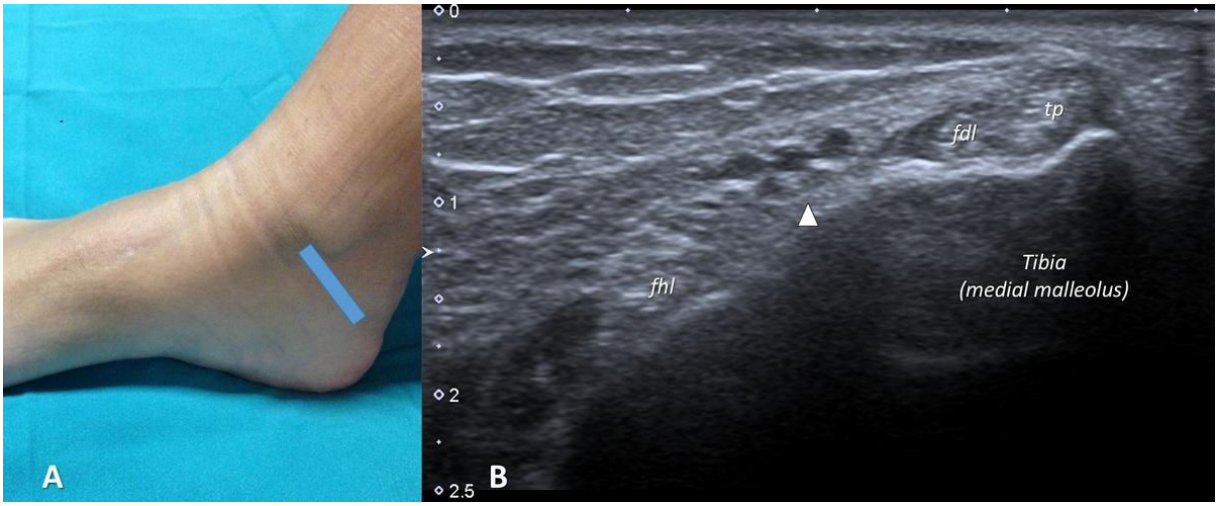

Fig. 21: A) Probe positioning for transverse scanning of the tarsal tunnel. B) Transverse ultrasound scan of tibialis posterior tendon (tp), flexor digitorum longus tendon (fdl), flexor hallucis longus tendon (fhl) and the neurovascular bundle which includes the tibial nerve and posterior tibial vessels (arrowhead).
References: - Coimbra/PT

Spring ligament complex

Also known as the plantar calcaneonavicular ligament, the spring ligament complex not only connects the calcaneus to the navicular bone but also stabilizes the medial arch of the foot and provides support to the head of the talus.

The *superomedial calcaneonavicular ligament* is its strongest and most important component, extending from the anterior margin of the sustentaculum tali of the calcaneus to the lateral surface of the navicular bone and, although difficult, can be assessed by ultrasonography.

Place the probe parallel to the plantar surface with one edge over the medial malleolus. Then, move the probe down to the level of the sustentaculum tali. Slightly tilting the distal edge superiorly towards the superomedial aspect of the navicular bone may help identify the ligament, that is located deeply to the tibialis posterior tendon [Figs. 22 and 23].

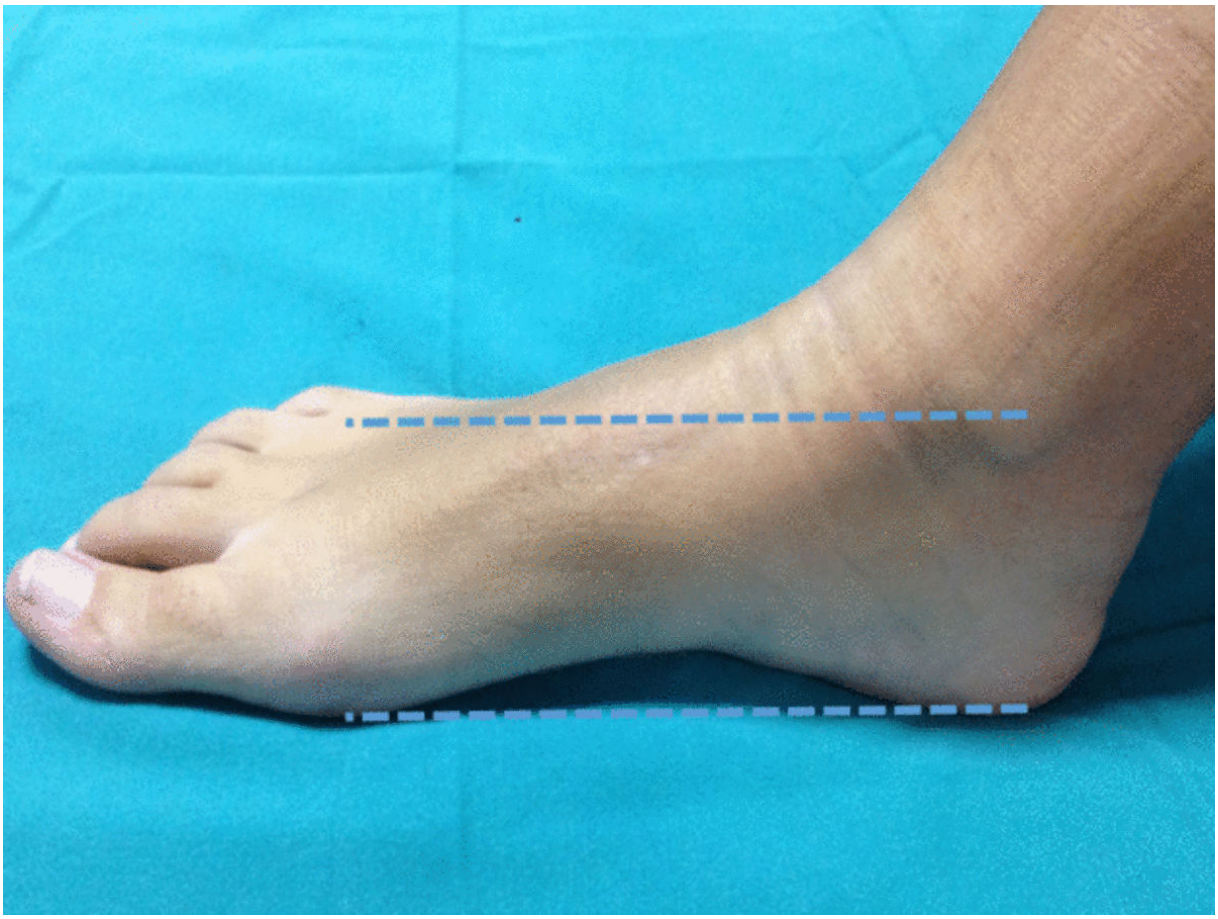

Fig. 22: Animated image showing probe positioning to evaluate the spring ligament.
References: - Coimbra/PT

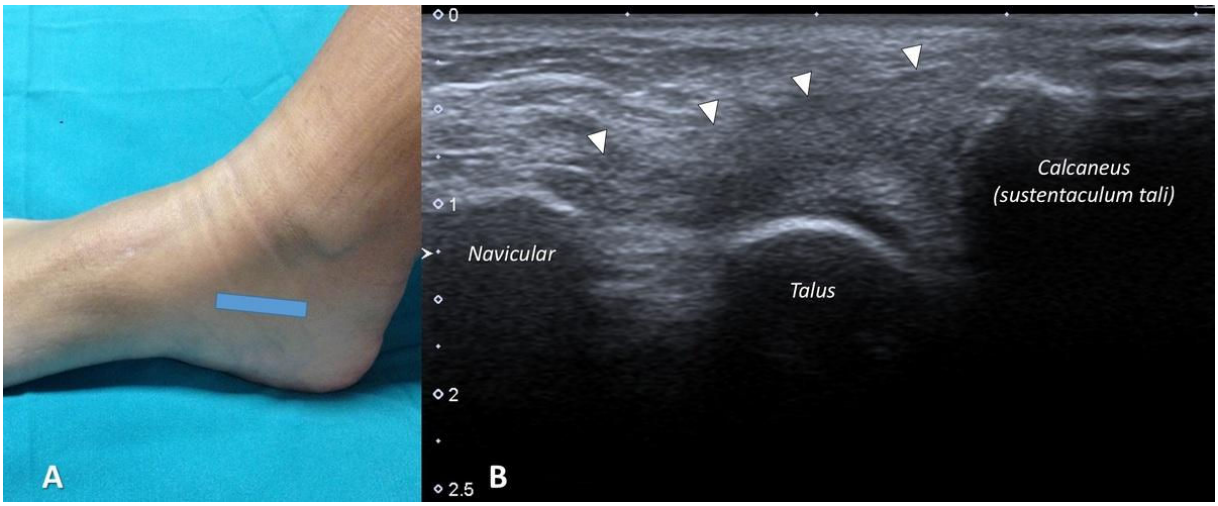

Fig. 23: A) Probe positioning for scanning the spring ligament. B) Longitudinal ultrasound scan of the superomedial calcaneonavicular ligament (arrowheads).

References: - Coimbra/PT

Posterior ankle

Key structures:

- Achilles tendon
- Posterior joint (tibiotalar) recess

Starting position:

To examine the posterior ankle the patient should lie prone with the foot free [Fig. 24], allowing manipulation by the examiner.

Fig. 24: Starting position to evaluate the posterior ankle.
References: - Coimbra/PT

Achilles tendon

The *Achilles tendon* should be assessed on sequenced short and long-axis scans along its course, from the myotendinous junction to the insertion on the calcaneus.

Short-axis planes are particularly important to assess its dimensions (longitudinal scans ofter overestimate them) and its peritendinous envelope [Fig. 25].

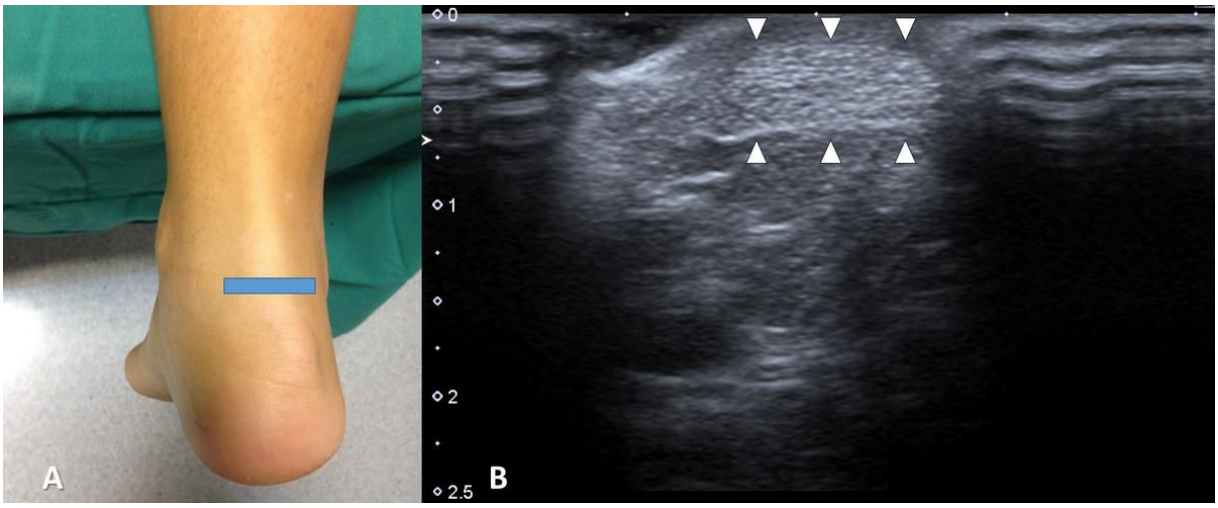

Fig. 25: A) Probe positioning for scanning the Achilles tendon. B) Transverse ultrasound scan of the Achilles tendon (arrowheads).
References: - Coimbra/PT

Long-axis planes are useful to evaluate its anatomic relationships and distal insertion [Fig. 26].

*Kager's fat pa*d is located deep to the tendon. At the level of the calcaneus, examine the *precalcaneal bursa* (superficial to the tendon) and the *retrocalcaneal bursa* (deep to the tendon).

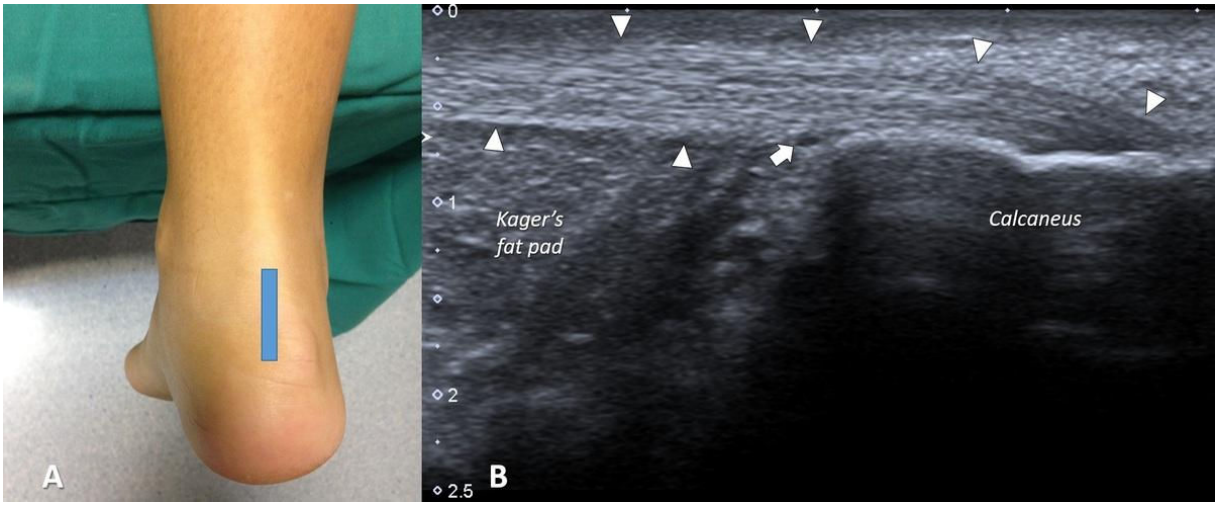

Fig. 26: A) Probe positioning for scanning the Achilles tendon. B) Longitudinal ultrasound scan of the Achilles tendon (arrowheads). Note the normal retrocalcaneal bursa (arrow).
References: - Coimbra/PT

Dynamic evaluation, by performing dorsiflexion and plantar flexion during the examination, is helpful to differentiate between partial and complete tears.

Posterior joint (tibiotalar) recess

From the position used to assess the Achilles tendon on a longitudinal plane, just above the calcaneus, move the probe medially in order to evaluate the posterior joint recess [Fig. 27].

Then, we can identify it as a concave recess deep to the flexor hallucis longus tendon, between the tibia and the talus.

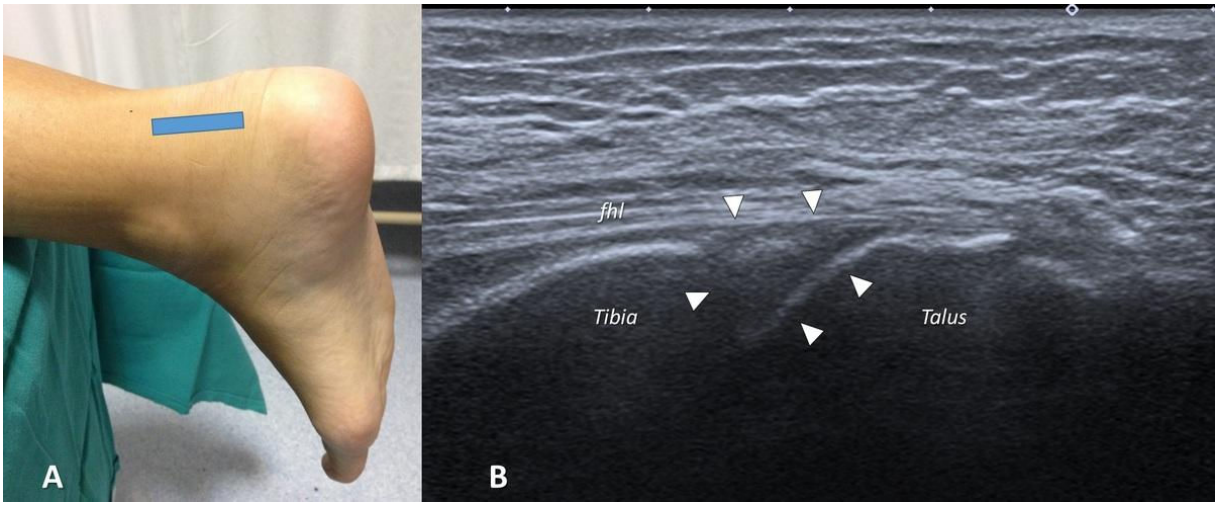

Fig. 27: A) Probe positioning for scanning the posterior joint recess. B) Longitudinal ultrasound scan of the posterior joint recess (arrowheads). Note the flexor hallucis longus tendon (fhl) which runs superficially.
References: - Coimbra/PT

Images for this section:

Fig. 1: Starting position to evaluate the anterior ankle.

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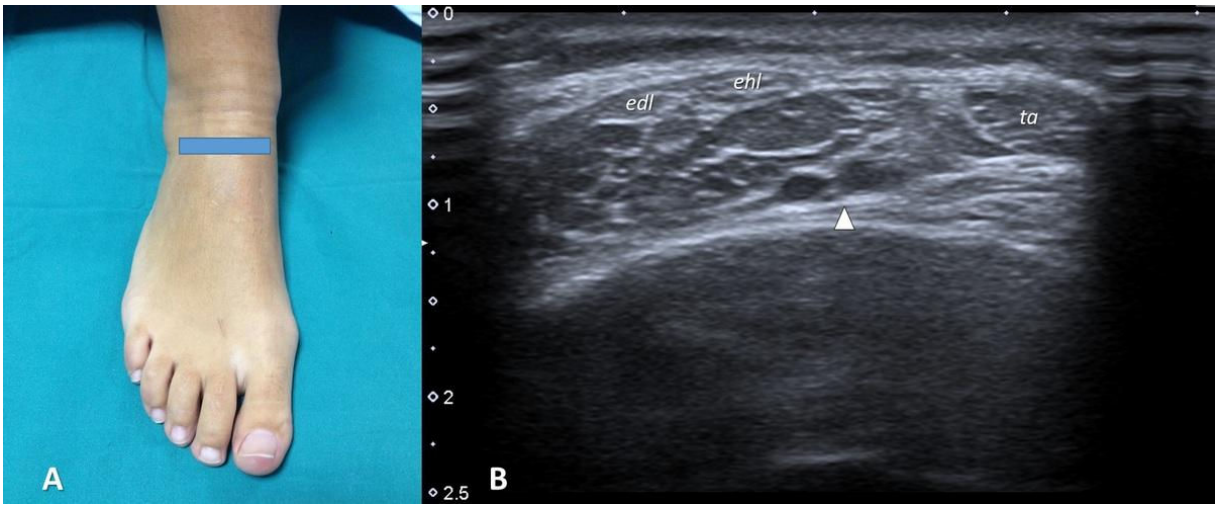

Fig. 2: A) Probe positioning for transverse scanning of the anterior ankle. B) Transverse ultrasound scan of tibialis anterior tendon (ta), extensor hallucis longus tendon (ehl), extensor digitorum longus tendon (edl) and the neurovascular bundle which includes the deep peroneal nerve and anterior tibial vessels (arrowhead).

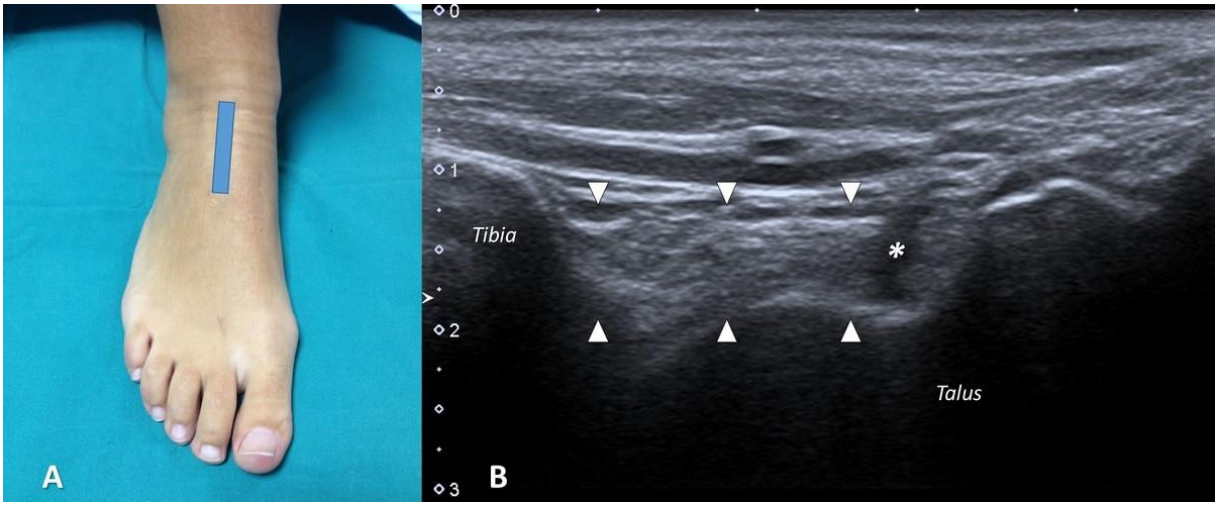

Fig. 3: A) Probe positioning for scanning the anterior joint recess. B) Longitudinal ultrasound scan of the anterior joint recess (arrowheads). Note the small amount of physiological fluid (asterisk) in its anterior part, which is a common finding.

Fig. 4: Starting position to evaluate the lateral ankle.

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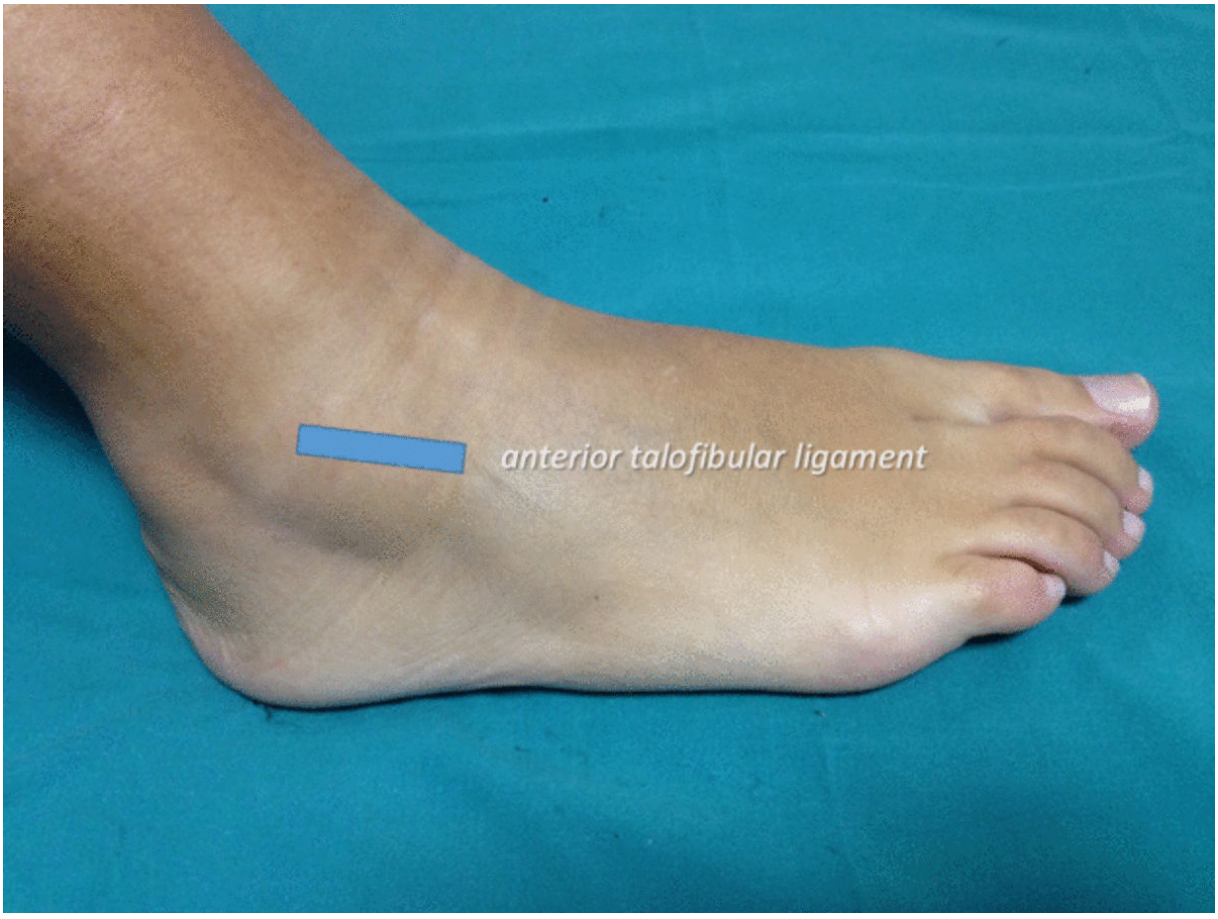

Fig. 5: Animated image showing probe and foot positioning to evaluate the anterior talofibular, anterior tibiofibular and calcaneofibular ligaments. Note the lateral malleolus as an useful landmark.

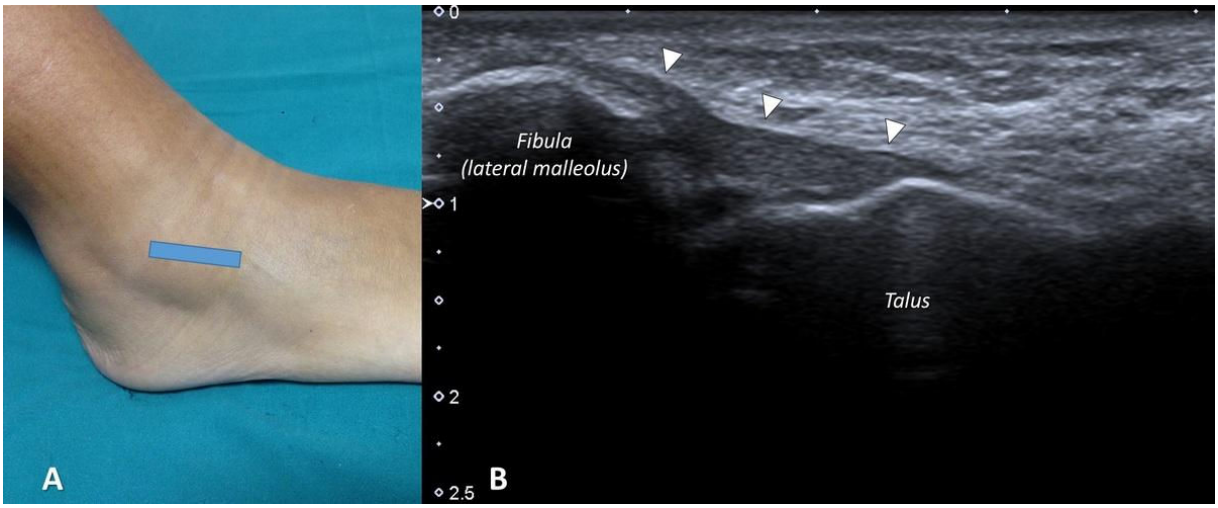

Fig. 6: A) Probe positioning for scanning the anterior talofibular ligament. B) Longitudinal ultrasound scan of the anterior talofibular ligament (arrowheads).

Fig. 7: Photograph showing how to perform the anterior drawer test (stress position to evaluate the anterior talofibular ligament).

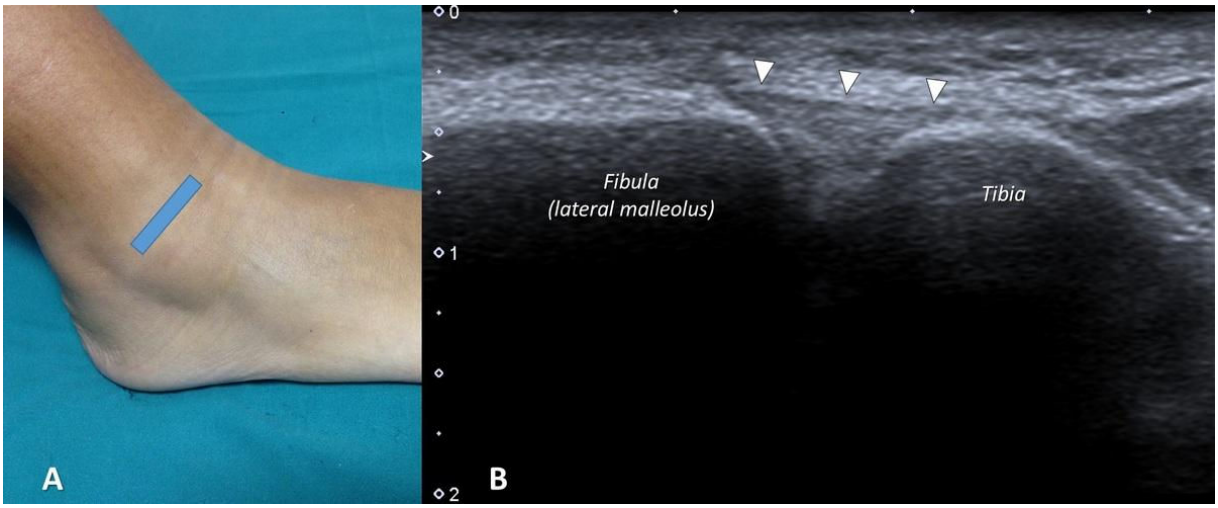

Fig. 8: A) Probe positioning for scanning the anterior tibiofibular ligament. B) Longitudinal ultrasound scan of the anterior tibiofibular ligament (arrowheads).

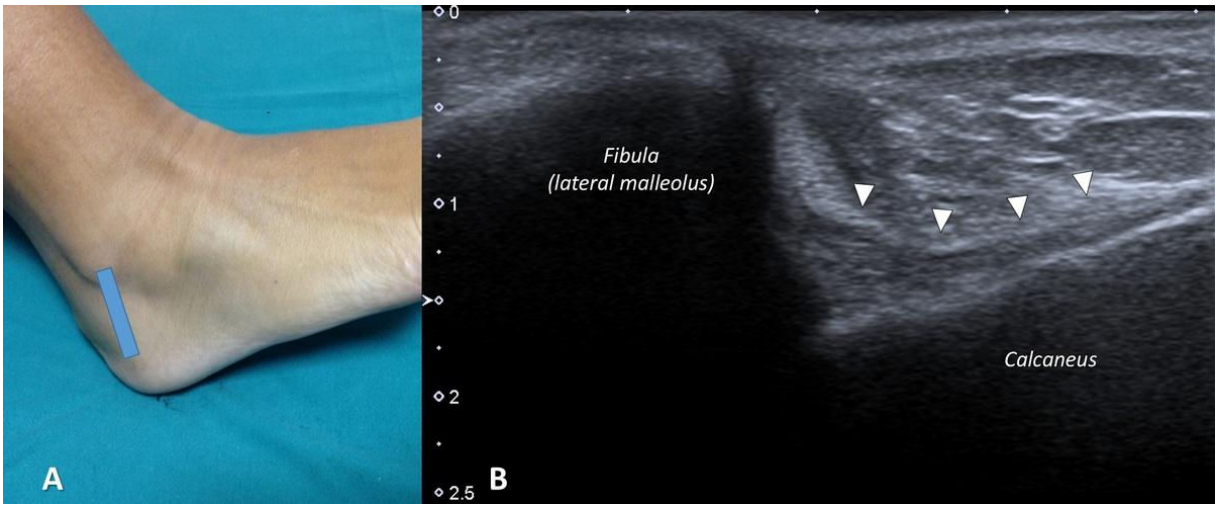

Fig. 9: A) Probe positioning for scanning the calcaneofibular ligament. B) Longitudinal ultrasound scan of the calcaneofibular ligament (arrowheads).

Fig. 10: Probe positions for assessing sequenced short-axis scans along the course of the peroneal tendons.

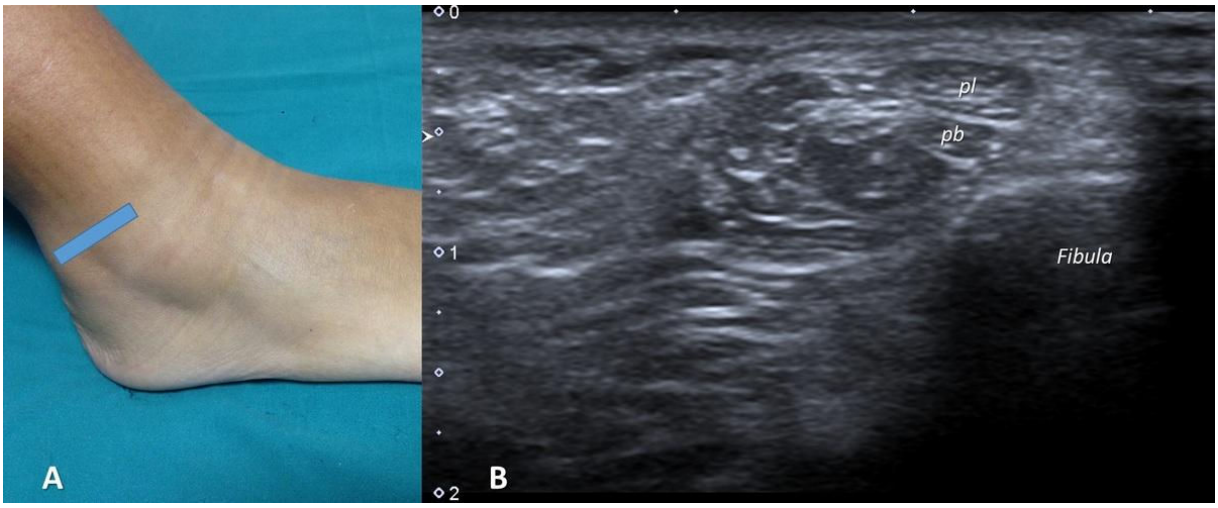

Fig. 11: A) Probe positioning for scanning the peroneal tendons at their course proximal to the lateral malleolus. B) Transverse ultrasound scan of the peroneus longus tendon (pl) and peroneus brevis tendon (pb).

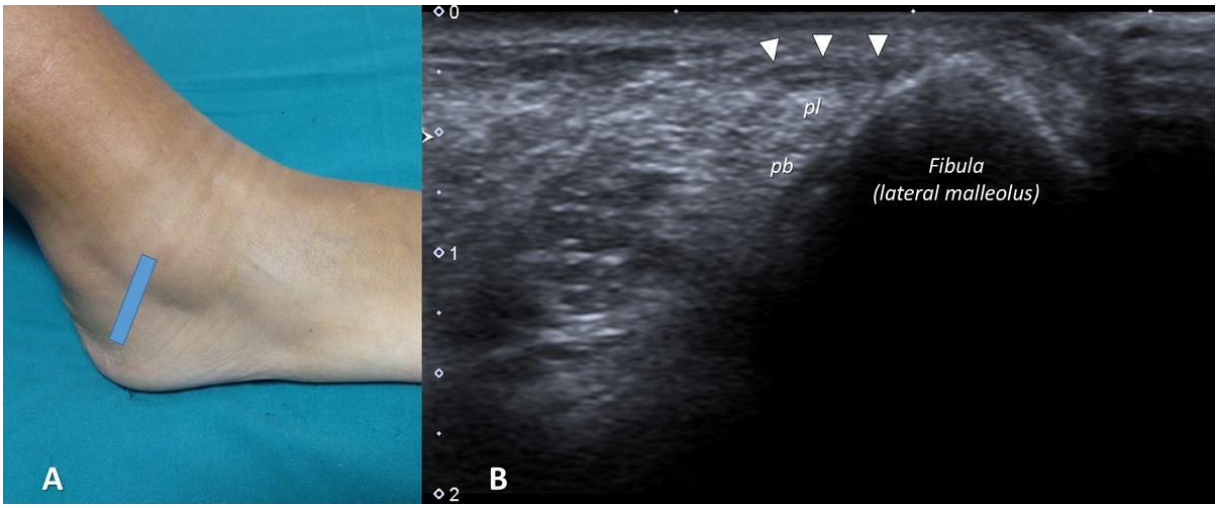

Fig. 12: A) Probe positioning for scanning the peroneal tendons at their course posterior to the lateral malleoulus, at the level of the superior retinaculum. B) Transverse ultrasound scan of the superior retinaculum (arrowheads), peroneus longus tendon (pl) and peroneus brevis tendon (pb).

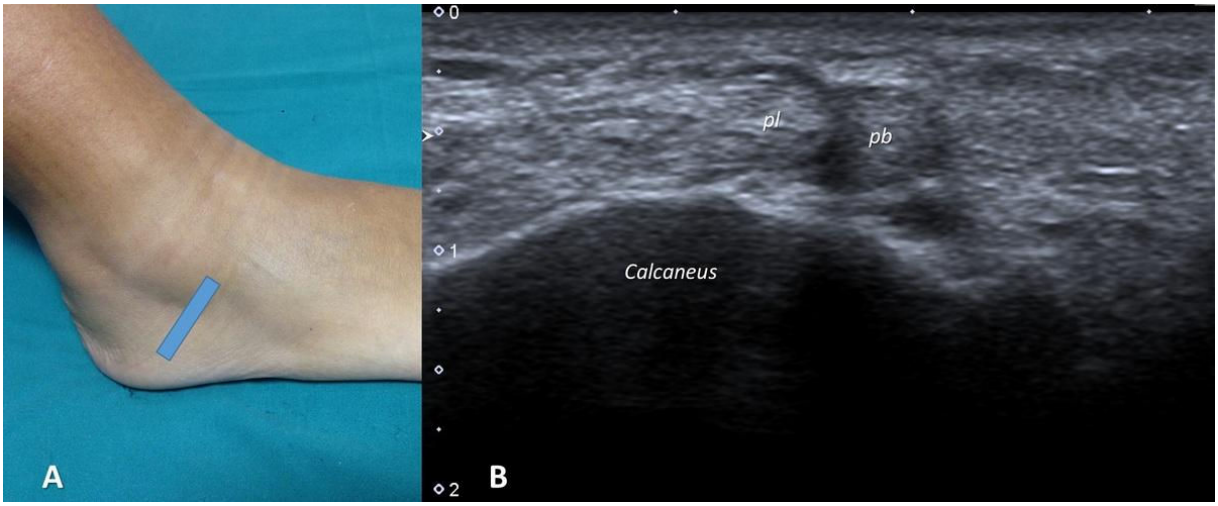

Fig. 13: A) Probe positioning for scanning the peroneal tendons at their course distal to the lateral malleolus. B) Transverse ultrasound scan of the peroneus longus tendon (pl) and peroneus brevis tendon (pb).

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Fig. 14: Starting position to evaluate the medial ankle.

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Fig. 15: Animated image showing probe and foot positioning to evaluate the anterior, middle and posterior bundles of the deltoid ligament. Note the medial malleolus as an useful landmark.

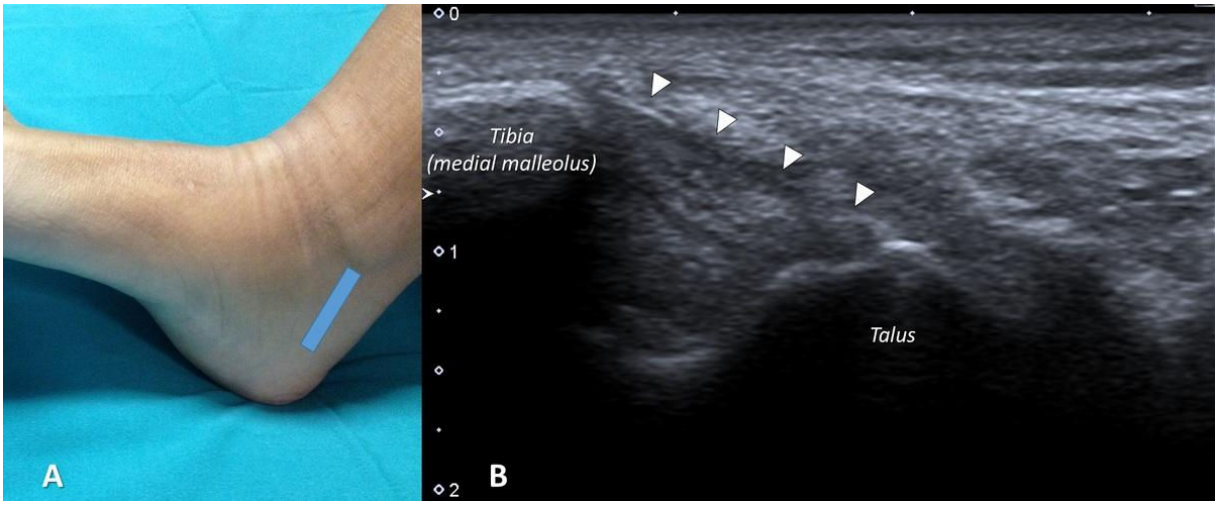

Fig. 16: A) Probe positioning for scanning the posterior bundle of the deltoid ligament. B) Longitudinal ultrasound scan of the posterior tibiotalar ligament (arrowheads).

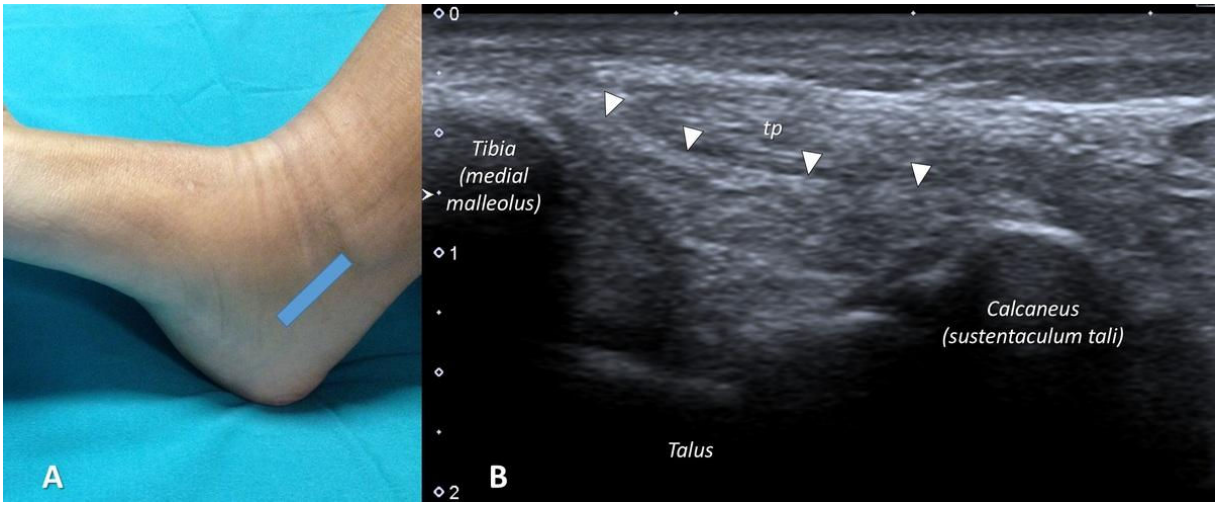

Fig. 17: A) Probe positioning for scanning the middle bundle of the deltoid ligament. B) Longitudinal ultrasound scan of the tibiocalcaneal ligament (arrowheads). Note the tibialis posterior tendon (tp) that runs superficially.

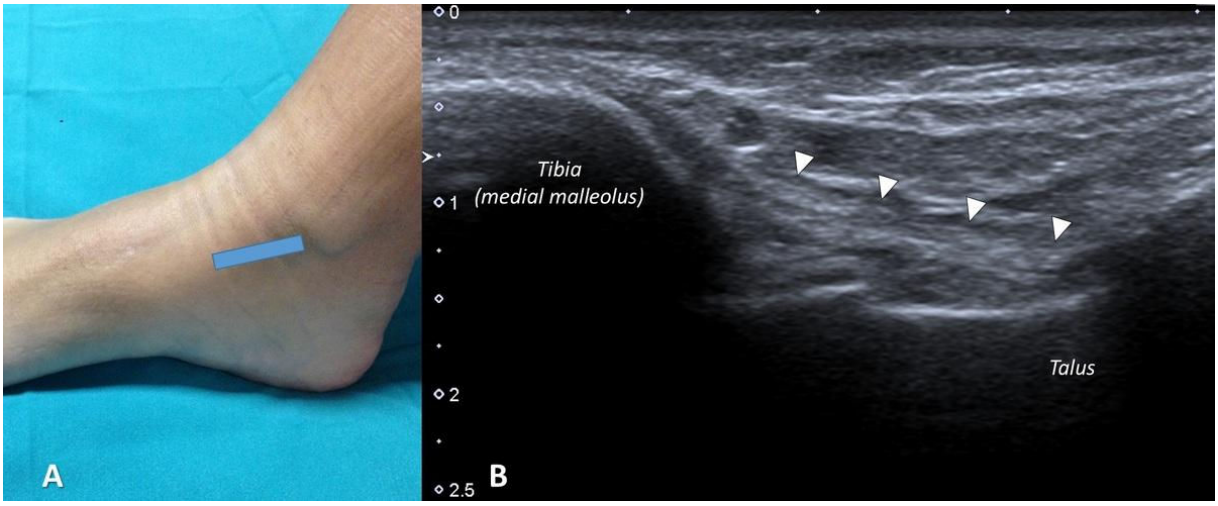

Fig. 18: A) Probe positioning for scanning the anterior tibiotalar ligament. B) Longitudinal ultrasound scan of the anterior tibiotalar ligament (arrowheads).

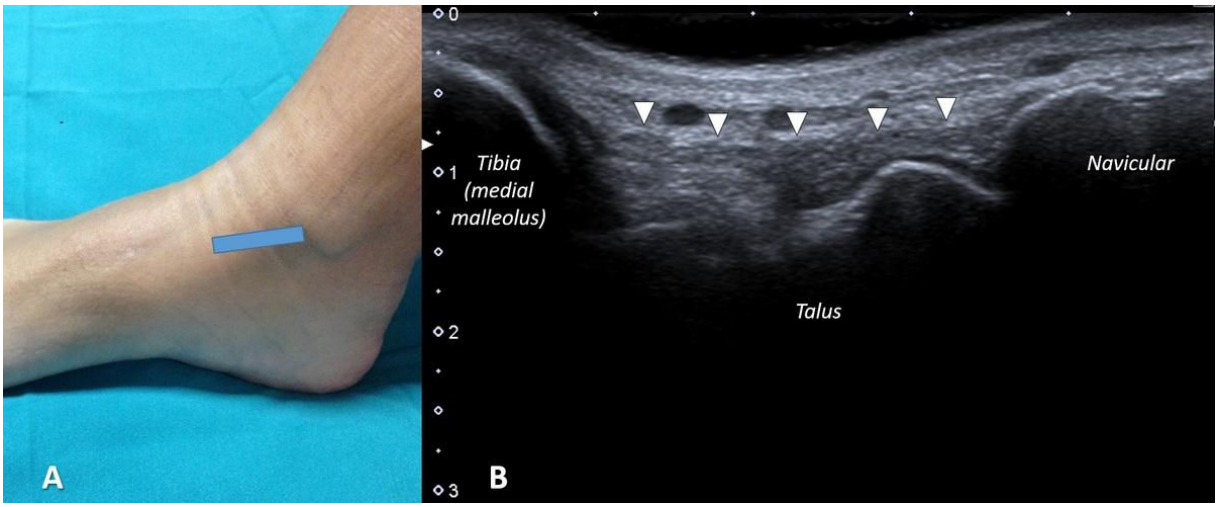

Fig. 19: A) Probe positioning for scanning the tibionavicular ligament. B) Longitudinal ultrasound scan of the tibionavicular ligament (arrowheads).

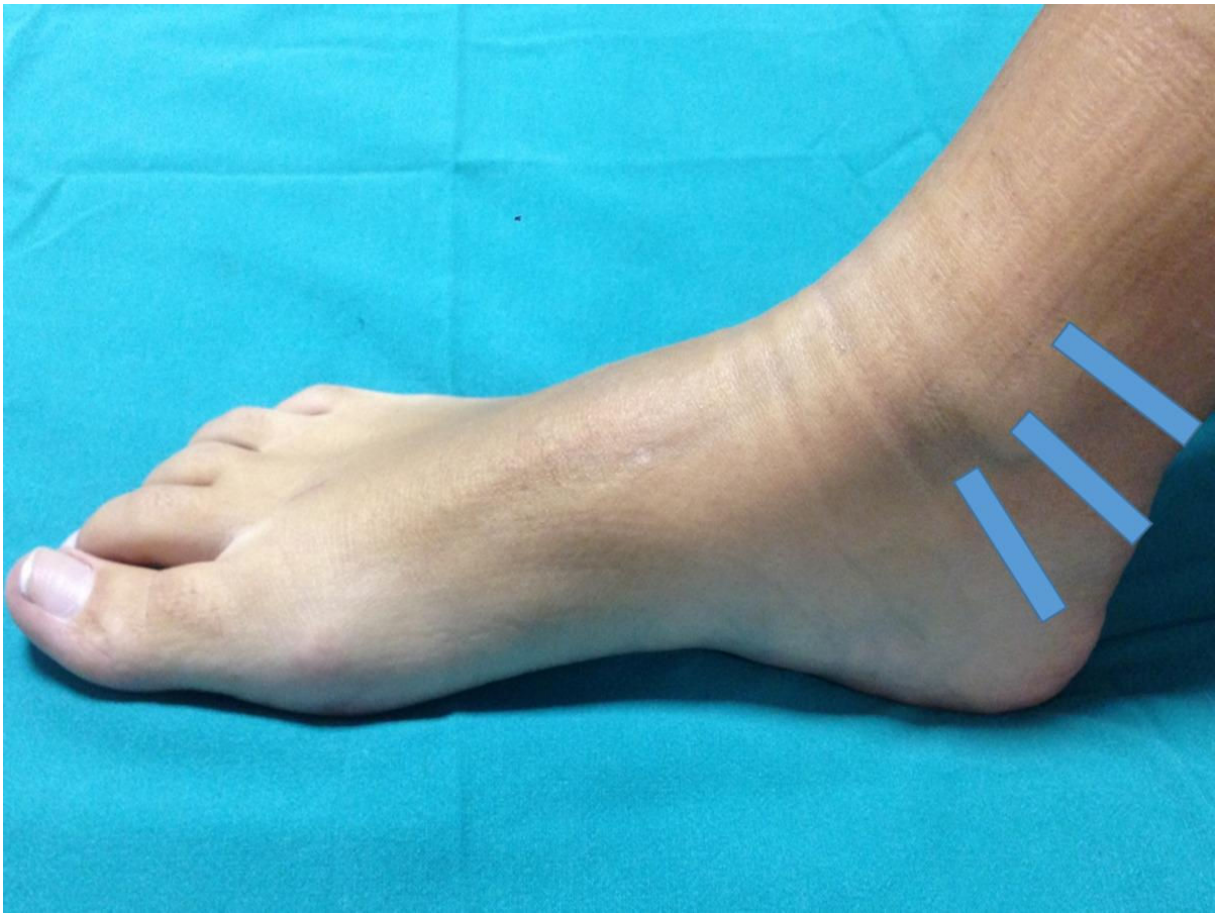

Fig. 20: Probe positions for assessing sequenced short-axis scans along the tarsal tunnel.

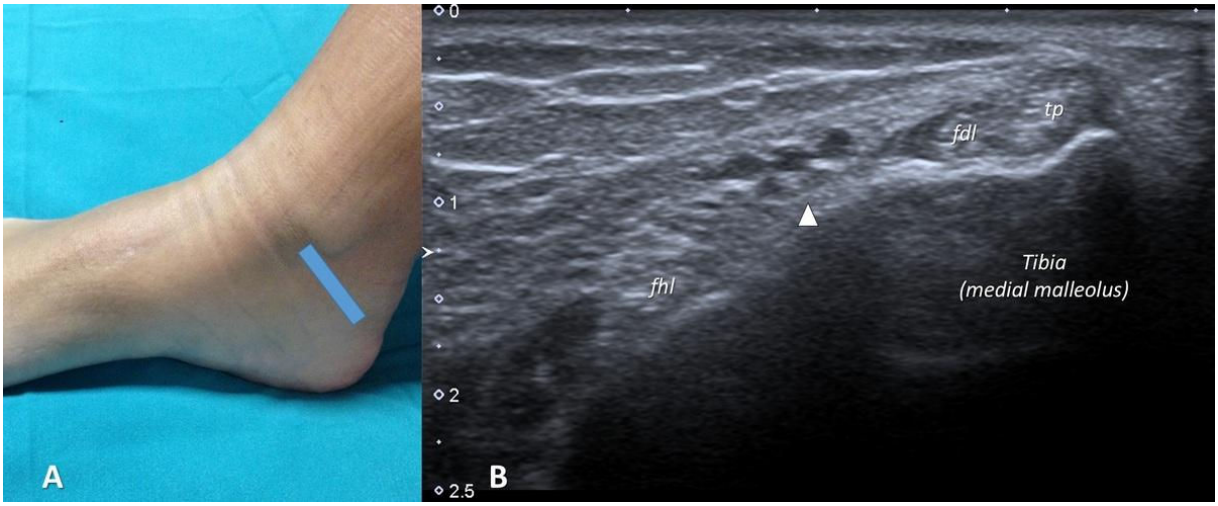

Fig. 21: A) Probe positioning for transverse scanning of the tarsal tunnel. B) Transverse ultrasound scan of tibialis posterior tendon (tp), flexor digitorum longus tendon (fdl), flexor hallucis longus tendon (fhl) and the neurovascular bundle which includes the tibial nerve and posterior tibial vessels (arrowhead).

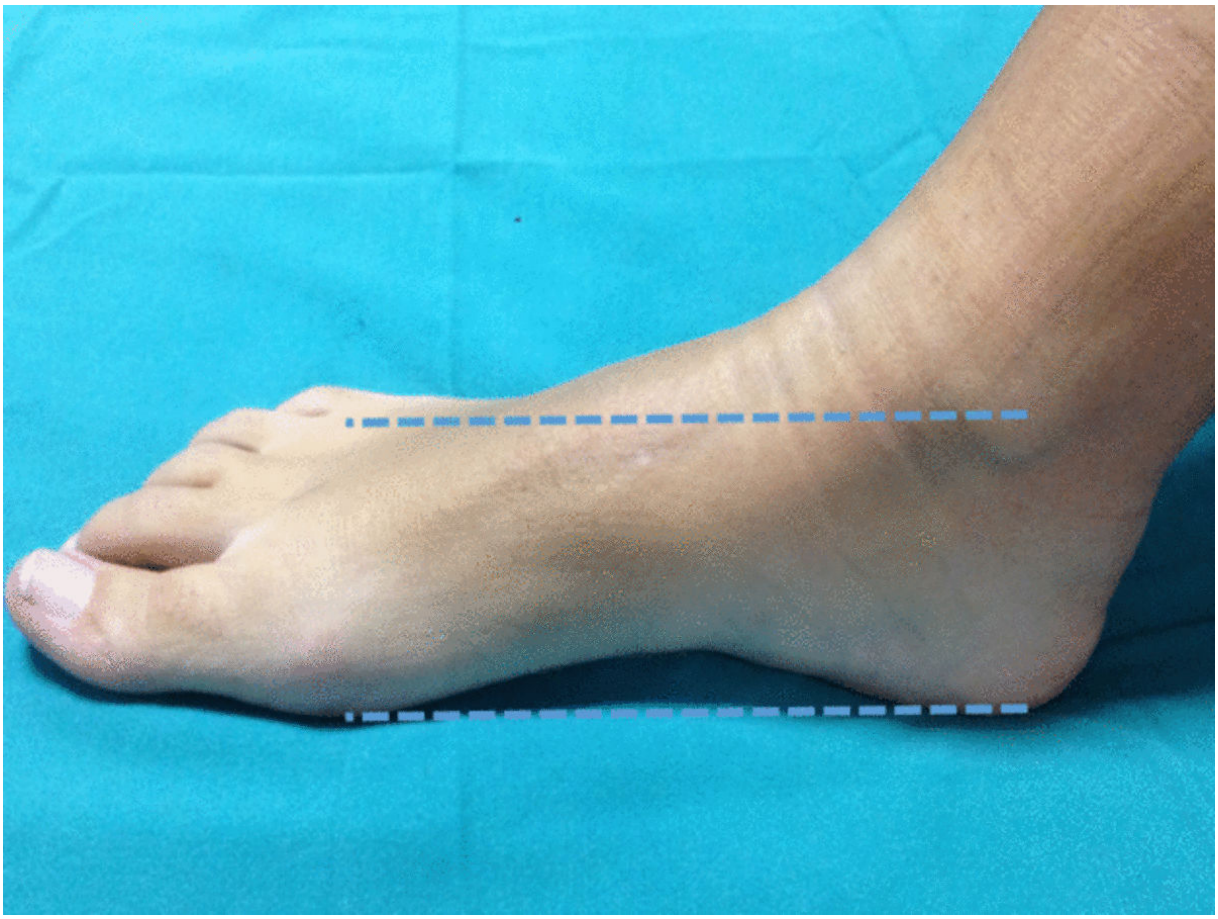

Fig. 22: Animated image showing probe positioning to evaluate the spring ligament.

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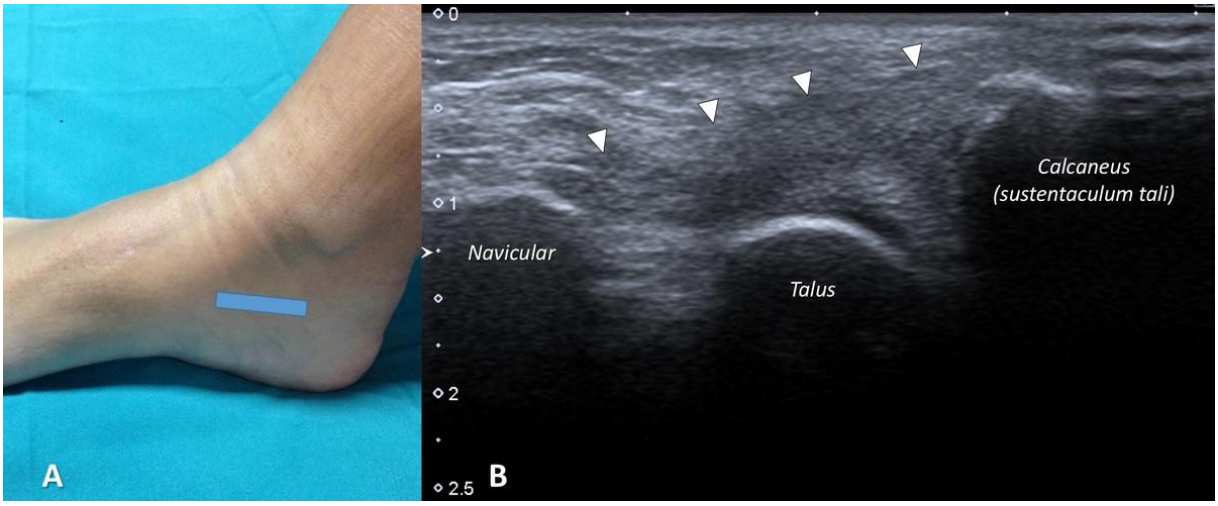

Fig. 23: A) Probe positioning for scanning the spring ligament. B) Longitudinal ultrasound scan of the superomedial calcaneonavicular ligament (arrowheads).

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Fig. 24: Starting position to evaluate the posterior ankle.

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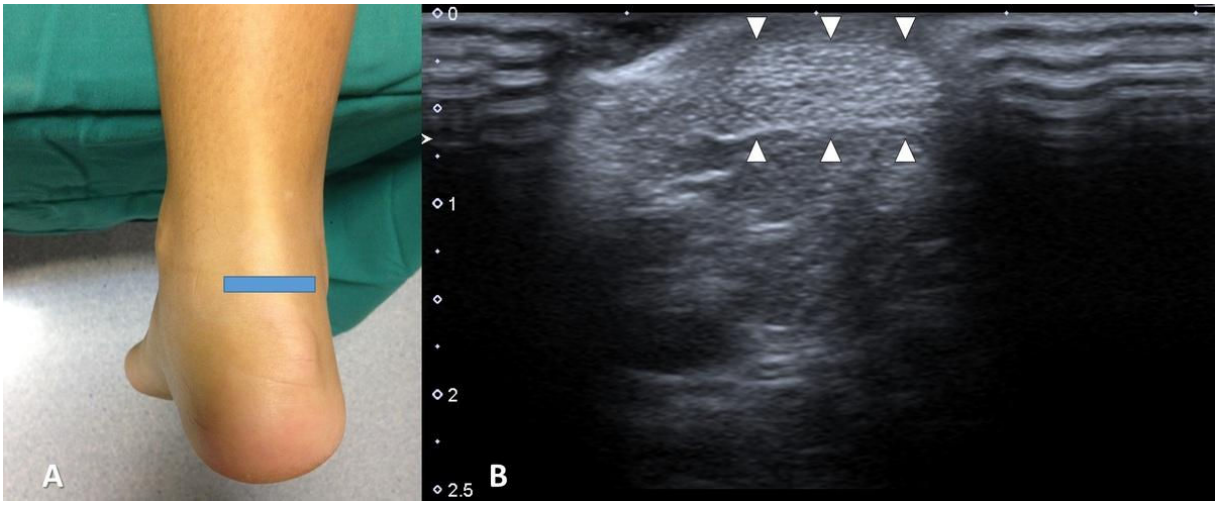

Fig. 25: A) Probe positioning for scanning the Achilles tendon. B) Transverse ultrasound scan of the Achilles tendon (arrowheads).

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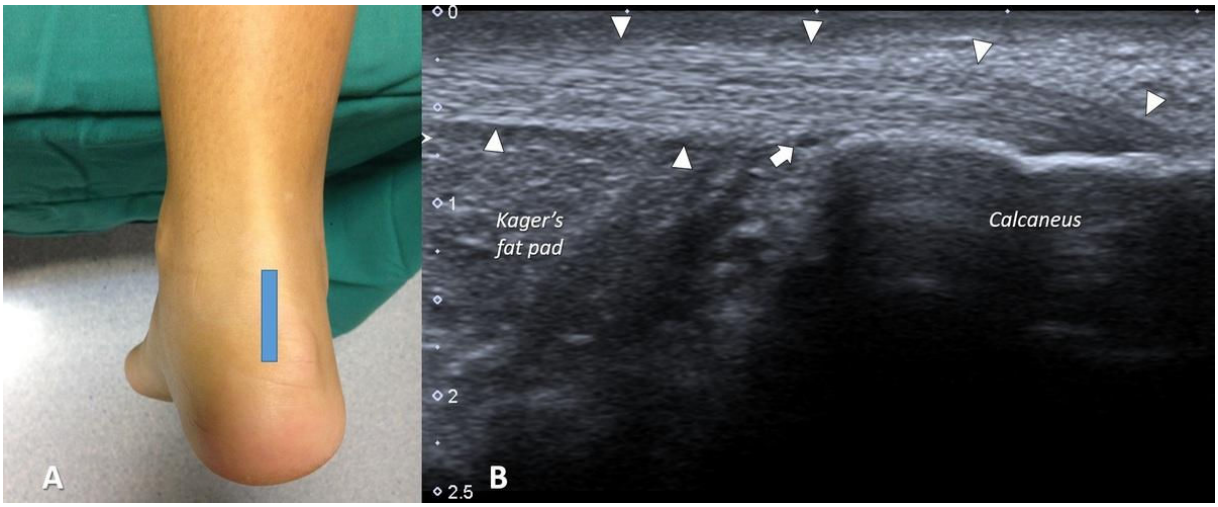

Fig. 26: A) Probe positioning for scanning the Achilles tendon. B) Longitudinal ultrasound scan of the Achilles tendon (arrowheads). Note the normal retrocalcaneal bursa (arrow).

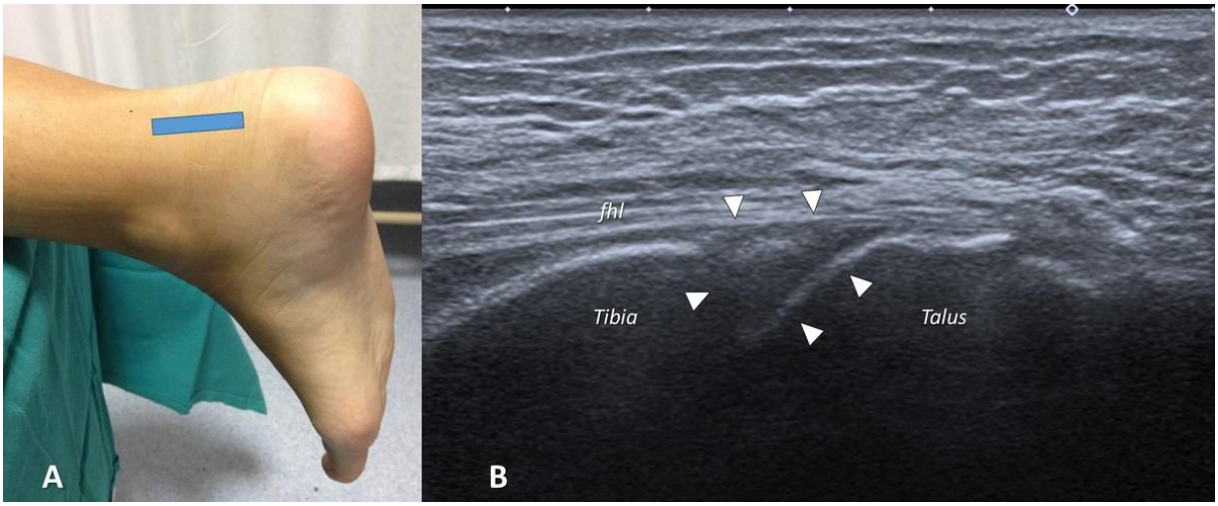

Fig. 27: A) Probe positioning for scanning the posterior joint recess. B) Longitudinal ultrasound scan of the posterior joint recess (arrowheads). Note the flexor hallucis longus tendon (fhl) which runs superficially.

Conclusion

High-resolution ultrasonography is a safe, fast, readily available and low cost technique that has become increasingly important when evaluating the ankle joint.

The awareness of the normal anatomy and the use of a standardized imaging technique are essential to improve diagnostic accuracy and reduce the intrinsic operator dependence of ultrasound.

Personal information

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