

# Sonography of the Normal Ankle: A Target Approach Using Skeletal Reference Points

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**OBJECTIVE.** Sonographic examination of the ankle depends on exact knowledge of the specific probe positions to acquire the best images.

**CONCLUSION.** In this article, we discuss these positions and illustrate them with drawings, anatomic slices or dissection, and sonograms. Positions studied include those for best imaging of the anterior tibiotalar joint, anterior tibiofibular ligament, anterior talofibular ligament, calcaneofibular ligament, peroneal tendons, Achilles tendon, flexor hallucis longus, posterior deltoid ligament, anterior deltoid ligament, and posterior medial tendons.

**Keywords:** anatomy, ankle, sonography, ultrasound

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**T**he ankle is commonly affected in trauma as well as overuse disorders and inflammatory conditions. Various imaging techniques may be used to assess the ankle, including CT, MRI, and sonography. The value of sonography of the ankle has been the subject of several articles [1–4]. However, a successful sonographic procedure depends on a thorough knowledge of normal anatomy and on specific probe positioning at various skeletal landmarks. Using these skeletal landmarks, specific structures can be analyzed in detail and the diagnosis of abnormal conditions is straightforward. In this article, we use drawings and anatomic images (Fig. 1) to illustrate a landmark approach for ankle sonography. We present normal ankle sonograms obtained at these landmarks and correlate them with anatomic slices or MR images.

## Methods

The normal and abnormal sonography images were obtained by imaging volunteers and a review of the interesting cases in logbooks of three institutions at which musculoskeletal sonography is routinely performed. Anatomic dissections and slices were obtained from the teaching database of the department of experimental anatomy at the Vrije Universiteit Brussel. Sonographic and anatomic images were reviewed by two investigators, and selected images are used in this article.

## Anterior Tibiotalar Joint

The probe is placed in the sagittal plane at the anterior aspect of the ankle (Fig. 2). The joint space is located superiorly to the clinically palpable lateral malleolus. The anterior tibial tendon is seen superficial to the joint [5]. A fat pad is present in the anterior tibiotalar joint and can be identified at sonography. Anatomic slices show the anterior fat pad. The tip of the fat pad is located in the tibiotalar joint. The joint capsule attaches distally over the talar neck. On sonograms, the fat pad is seen as a slightly hyperechoic triangular area anterior to the tibiotalar joint line. The cartilage covering the talus can be identified and has a hypoechoic appearance. In the case of tibiotalar effusion, the joint fluid can be depicted in the anterior joint recess and may be seen to displace the anterior fat pad. The cartilage covering the talus can be identified and is separated from the fluid by a “cartilage interface” sign.

## Anterior Tibiofibular Ligament

The probe is moved inferiorly in an oblique transverse plane to the position where the tibia and fibula are in closest contact (Fig. 3). The probe should be placed in a slightly oblique position for optimal visualization. In this location, the anterior tibiofibular ligament can be depicted. Tiny vascular structures are located deep in relation to the ligament. On anatomic dissection, several band-like structures can be seen extending from the tibia to the fibula. On sonography, the

ligament can be identified as a fibrillar structure exhibiting anisotropy artifact, depending on the angle of incidence [6, 7].

### Anterior Talofibular Ligament

The probe is placed in the transverse plane at the lateral ankle (Fig. 4). The lateral malleolus is clinically palpable, and the probe is placed at the most distal aspect of the lateral malleolus in the longitudinal axis of the foot. In this position, the anterior talofibular ligament can be seen. Deep in relation to the ligament, a small amount of joint fluid may be seen in the normal ankle. On anatomic slices, the ligament is seen as a bandlike structure extending from the distal fibula to the talar bone. At sonography, the ligament is identified as a fibrillar hyperechoic structure that may show anisotropy artifact [6, 7].

### Calcaneofibular Ligament

The probe is placed in an oblique coronal plane at the posterolateral ankle (Fig. 5). Oblique positioning is mandatory for exact localization of the ligament. The calcaneofibular ligament is then seen extending from the fibula to the calcaneus. The peroneal tendons are in close proximity to the ligament and may help in precisely localizing the ligament. On MRI, the ligament is seen originating on the fibula and extending to the calcaneus with a course deep in relation to the peroneal tendons. On sonography, the ligament may be seen as a hyperechoic fibrillar structure, again with anisotropy artifact [6, 7]. The peroneal tendons are located near the ligament.

### Peroneal Tendons

The probe is placed posterolaterally in the transverse plane slightly superior to the distal aspect of the lateral malleolus (Fig. 6). The peroneus brevis is adjacent to the bone and the peroneus longus is located more superficially (a mnemonic device is to think of “brevis against bone”). On anatomic slices, the peroneal tendons are seen located posteriorly to the lateral malleolus. At sonography, the tendons exhibit a hyperechoic aspect and variable anisotropy. The peroneus brevis is seen close to the bone and the peroneus longus is seen more superficially [8]. The peroneus brevis may appear relatively flat in the normal ankle. Some muscle fibers may be seen adjacent to the peroneus brevis tendon.

### Achilles Tendon

The probe is placed in the sagittal plane of the posterior ankle onto the palpable Achil-

les tendon (Fig. 7). The Achilles tendon and its insertion on the calcaneus can be seen. Deep in relation to the Achilles tendon, Kager's fat pad is evident, and adjacent to the tibia a part of the flexor hallucis longus muscle is seen. On anatomic slices, the Achilles tendon is seen to insert onto the posterior calcaneus. A small pre-Achilles bursa is located anterior to the tendon. On sonography, the Achilles tendon shows a fibrillar aspect [9]. Deep in relation to the tendon, the slightly hypoechoic Kager's fat pad is seen.

### Flexor Hallucis Longus

The flexor hallucis longus tendon is identified from a posterior approach (Fig. 8). From the midline position, the probe is slightly displaced medially from the Achilles tendon onto the flexor hallucis longus tendon, remaining in a strictly sagittal plane. The flexor hallucis longus tendon can be seen in the sagittal plane, as well as part of its muscle belly. On anatomic slices, the tendon is depicted in proximity to the posterior aspect of the tibiotalar and posterior talocalcaneal joints. At sonography, the hyperechoic fibrillar tendon is seen posterior to the talus [10]. A tibiotalar joint effusion also may extend in the synovial sheath of the flexor hallucis longus because in some patients a communication is present.

### Posterior Deltoid Ligament

The probe is placed in the coronal plane somewhat posteriorly at the medial aspect of the palpable tibia (Fig. 9). A short deep and a longer superficial tibiotalar portion of the deltoid ligament are seen. On anatomic slices, the thicker and deeper tibiotalar band is covered by the thinner and more superficial tibiotalar band. At sonography, both superficial and deep bands are nearly perpendicular to the probe and hence appear as relatively hypoechoic structures in the normal ankle [6, 7].

### Anterior Deltoid Ligament

The probe is placed at the medial ankle, somewhat more anteriorly than for visualization of the posterior deltoid ligament, and remaining in the coronal plane (Fig. 10). The longer tibio-calcaneal portion of the deltoid ligament is seen. On anatomic slices, the bandlike tibio-calcaneal portion of the deltoid ligament is seen. The medial tendons are located more superficially and include the tibialis posterior, flexor digitorum, and flexor hallucis tendons. At sonography, the long tibio-calcaneal part of the deltoid ligament is seen [6, 7]. However, it may not always be

possible to visualize this portion of the ligament in the normal ankle.

### Posterior Medial Tendons

The probe is placed posteromedially in the transverse plane slightly superior to the medial malleolus (Fig. 11). The tibialis posterior, flexor digitorum, artery and vein, posterior tibial nerve, and flexor hallucis tendon are shown (a mnemonic device is “Tom, Dick, and Very Nervous Harry”). The tibialis posterior is located in a small groove in the tibia that can serve as a reference point. On MRI, the tendons are visualized as hypointense rounded structures posterior to the tibia. The vascular structures and tibial nerve can also be depicted. At sonography, the tibialis posterior is larger than the other tendons and is located in a small groove in the posterior tibia, which is an excellent landmark for localization of the tendon. The tendons are depicted as rounded fibrillar structures [11]. Vascular structures can be identified as hypoechoic rounded structures; Doppler sonography may help in their localization. The veins also may be easily compressed with the ultrasound probe. The nerve is located adjacent to the vessels and shows a hyperechoic aspect. Usually the nerve is located superficially to the flexor hallucis longus; this tendon can be shown by slightly flexing and extending the great toe. However, this tendon is more easily depicted from a longitudinal posterior approach, with the probe adjacent to the midline.

### Plantar Fascia

The probe is placed inferiorly in the sagittal plane at the dorsal aspect of the foot. A slight displacement of the probe to the medial side gives the best depiction of the plantar fascia. On anatomic slices, the plantar fascia is seen as a white bandlike structure attaching to the inferior aspect of the calcaneus (Fig. 12). At sonography, the plantar fascia is depicted as a bandlike fibrillar structure attaching to the inferior aspect of the calcaneus. The plantar fascia typically has a thickness of 2–4 mm in asymptomatic persons [12].

### Conclusion

Sonography allows a detailed examination of the soft-tissue structures of the ankle. However, knowledge of normal anatomy and probe positioning is essential for an optimal examination.

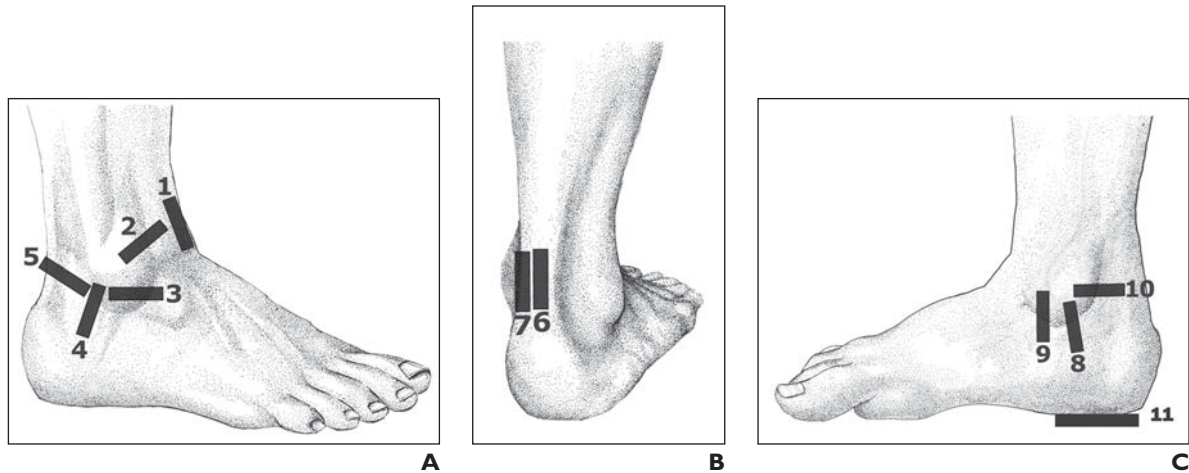
### Acknowledgment

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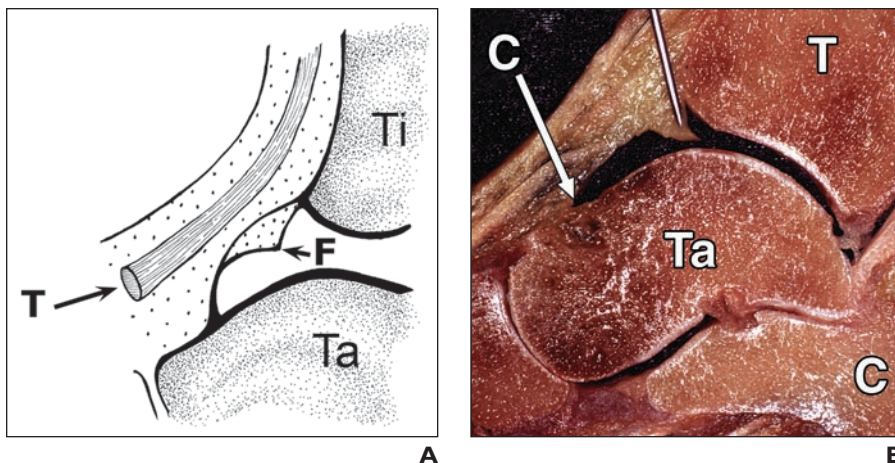


**Fig. 1**—Target positions for placement of ultrasound probe are shown on drawings.

**A**, Anterior tibiotalar joint (1), anterior tibiofibular ligament (2), anterior talofibular ligament (3), calcaneofibular ligament (4), and peroneal tendon group (5).

**B**, Achilles tendon (6) and flexor hallucis longus tendon (7).

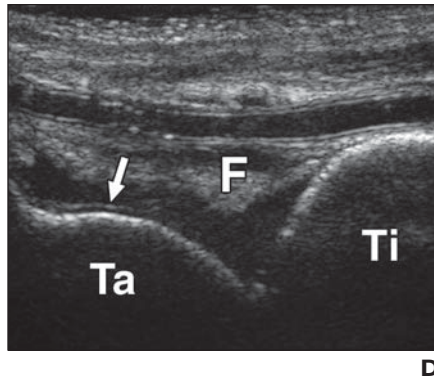
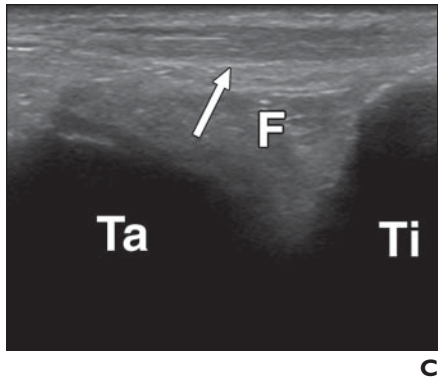
**C**, Posterior portion of deltoid (8), anterior portion of deltoid (9), posteromedial tendon group (10), and fascia plantaris (11).



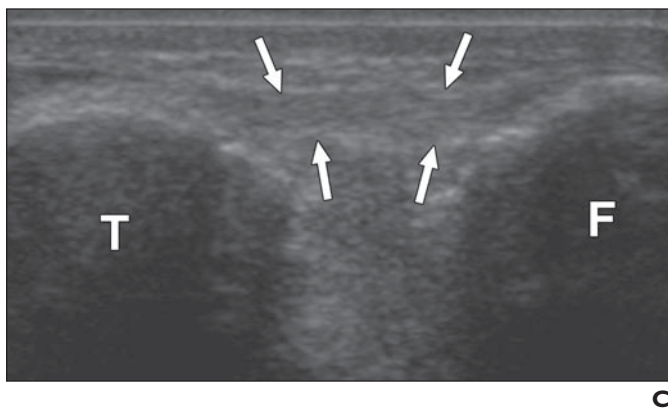
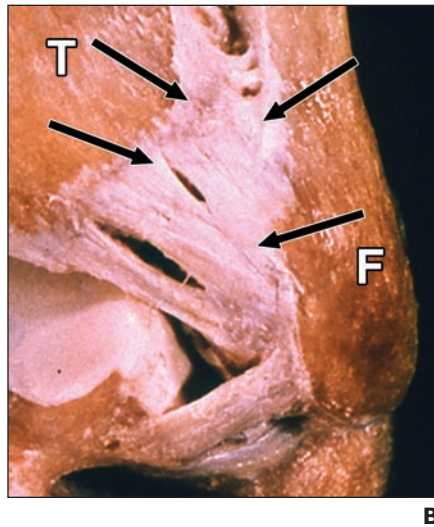
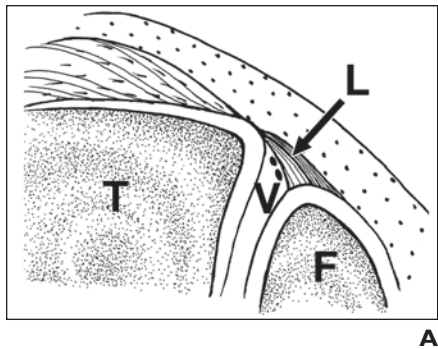
**Fig. 2**—Anterior tibiotalar joint. Ta = talus, Ti = tibia. **A**, Drawing illustrates anterior approach. Note anterior tibial tendon (T) that may sometimes be seen, and intraarticular fat pad (F).

**B**, Sagittal cadaveric slice. Metallic probe points to intraarticular fat pad. Capsular insertion (arrow, C) is seen over neck of talus. C = calcaneus.

(Fig. 2 continues on next page)

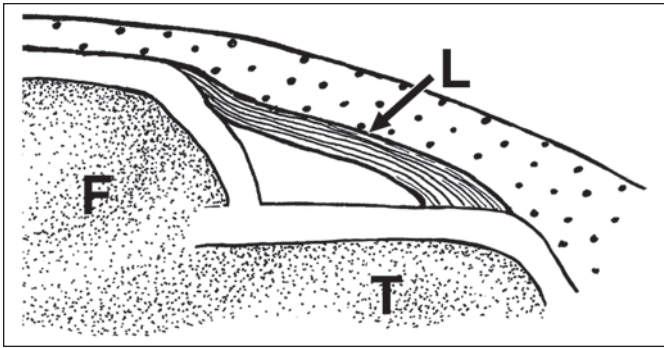


**Fig. 2 (continued)**—Anterior tibiotalar joint. Ta = talus, Ti = tibia.  
**C**, Sagittal sonogram shows fat pad (F) and anterior tibial tendon (*arrow*).  
**D**, Sagittal sonogram shows cartilage interface sign (*arrow*). F = fat pad.



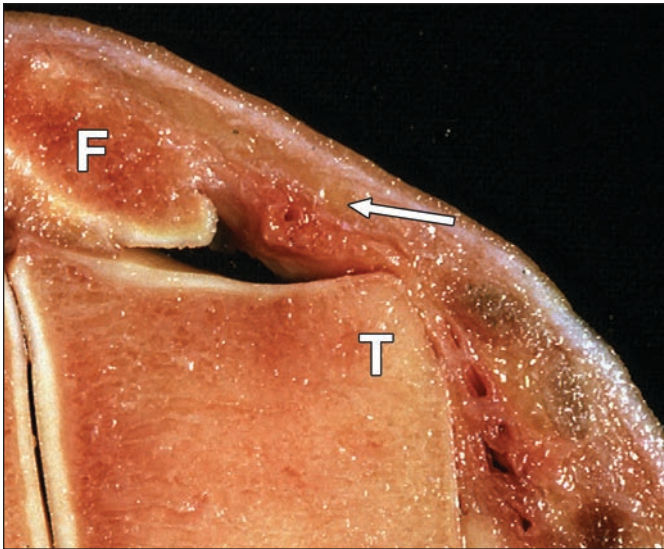
**Fig. 3**—Anterior tibiotalar joint. T = tibia, F = fibula.  
**A**, Drawing illustrates anterior tibiotalar ligament (*arrow*, L). Posteriorly, a few small vascular structures (V) can be seen.  
**B**, Anterior view of anatomic dissection shows anterior tibiotalar ligament (*arrows*).  
**C**, Transverse sonogram shows anterior tibiotalar ligament (*arrows*).

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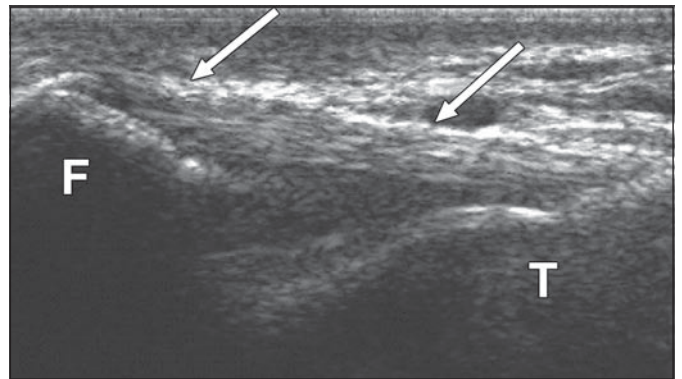


**A**

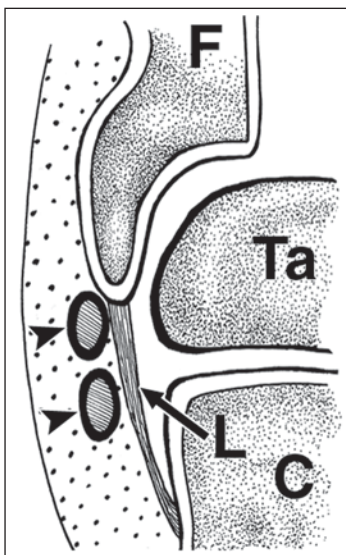
**Fig. 4—Anterior talofibular ligament.** F = fibula.  
**A,** Transverse sonogram shows anterior talofibular ligament (*arrow*, L). T = talus.  
**B,** Transverse anatomic slice shows talus (T), fibula (F), and talofibular ligament (*arrow*).  
**C,** Transverse sonogram shows anterior talofibular ligament (*arrows*). T = talus.



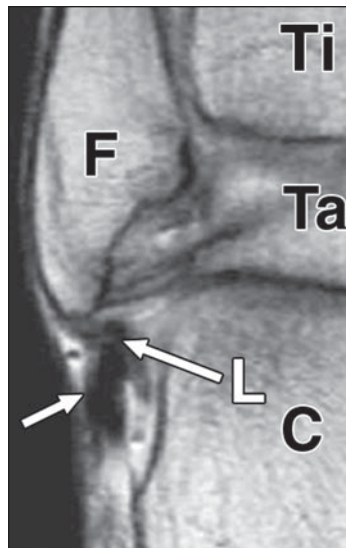
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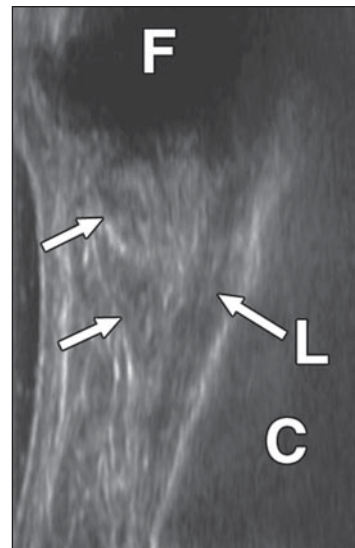
**C**



**A**

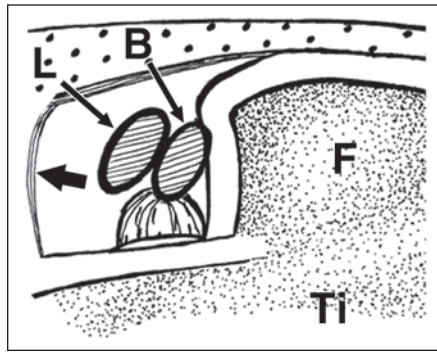


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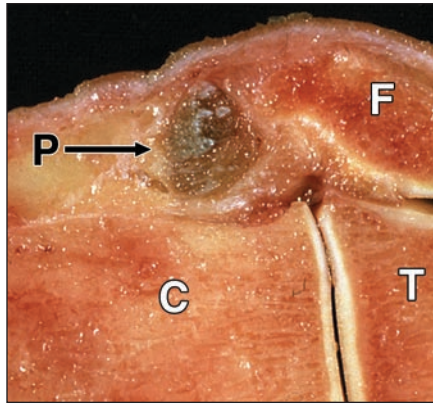


**C**

**Fig. 5—Calcaneofibular ligament.** F = fibula, C = calcaneus.  
**A,** Drawing in coronal plane shows calcaneofibular ligament (L). Also note peroneal tendons (*arrowheads*). Ta = talus.  
**B,** Coronal proton density-weighted MR image shows part of calcaneofibular ligament (*arrow*, L) and peroneal tendons (*arrow*). Ti = tibia, Ta = talus.  
**C,** Coronal sonogram shows calcaneofibular ligament (*arrow*, L) and peroneal tendons (*arrows*). Sonogram has been rotated for correlation with anatomic images.

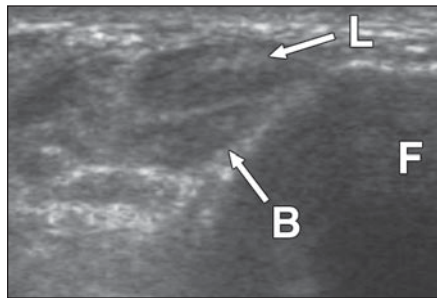


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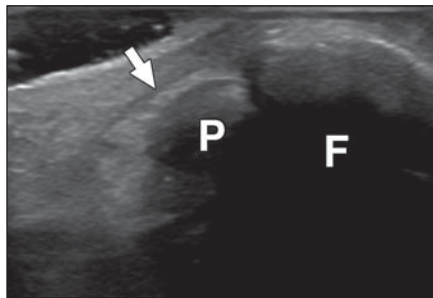


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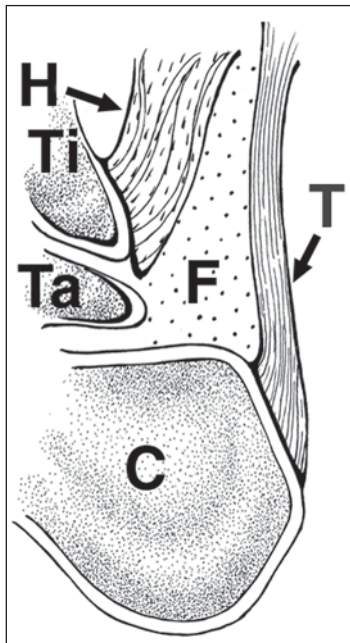
**Fig. 6**—Peroneal tendons. F = fibula.  
**A**, Drawing in transverse plane shows peroneus brevis (*arrow*, B) and peroneus longus (*arrow*, L) tendons. Thick arrow points to peroneal retinaculum. Ti = tibia.  
**B**, Transverse anatomic slice shows peroneal tendons (*arrow*, P). T = talus, C = calcaneus.  
**C**, Transverse sonogram shows peroneus brevis (*arrow*, B) and longus (*arrow*, L) tendons.  
**D**, Transverse sonogram shows fibula (F) and peroneal retinaculum (*arrow*). P = peroneal tendons.



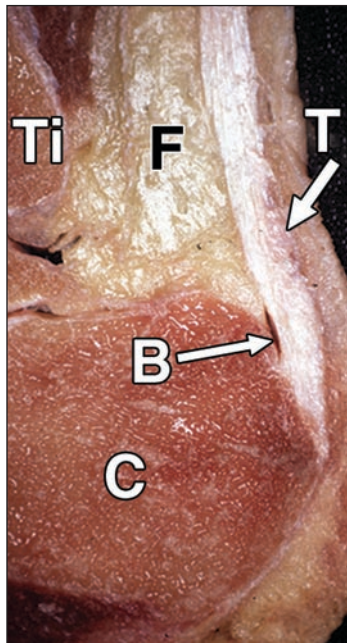
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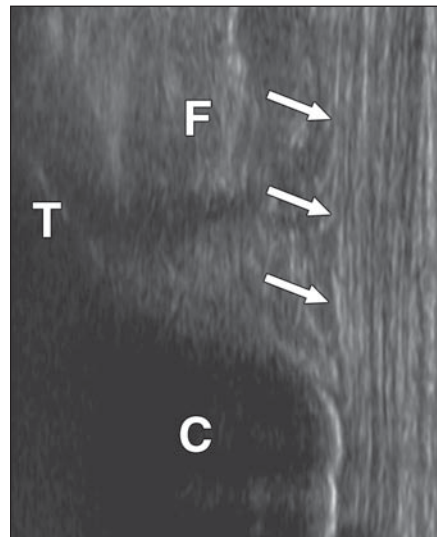
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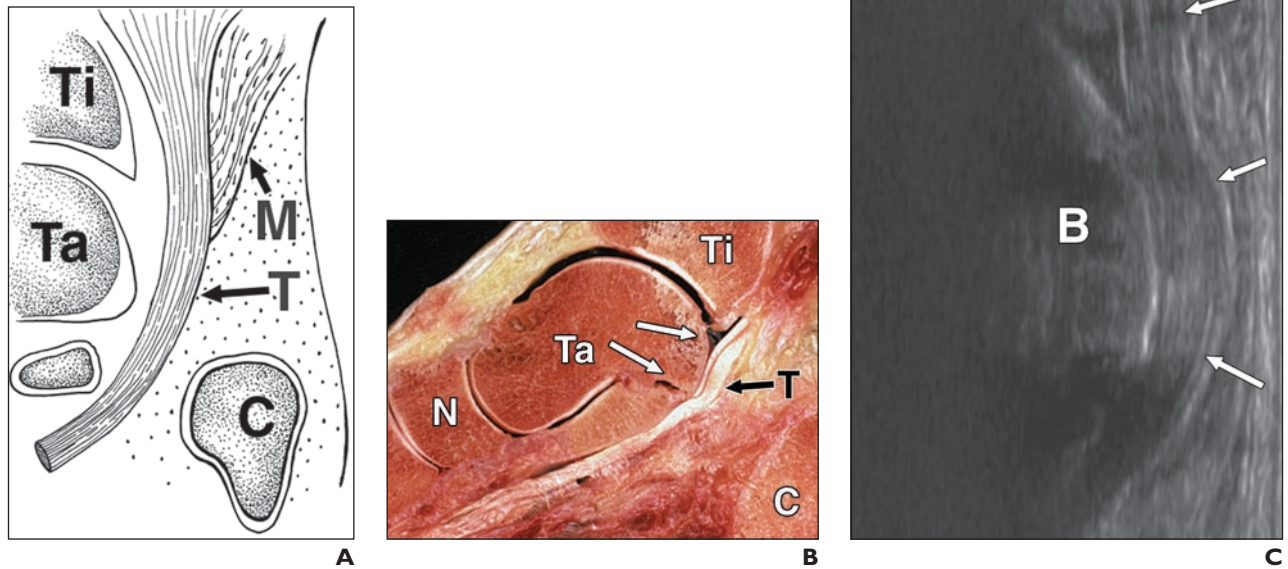
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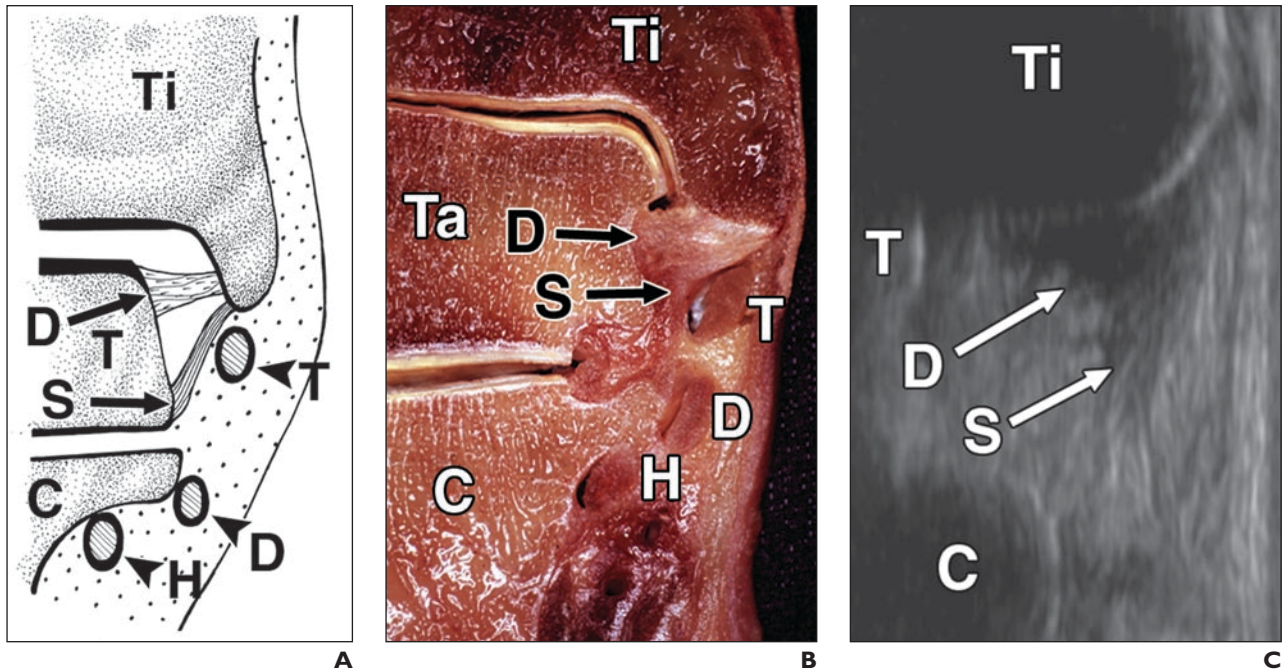
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**Fig. 7**—Achilles tendon. C = calcaneus.  
**A**, Drawing in sagittal plane shows Achilles tendon (T), Kager's fat pad (F), and flexor hallucis longus muscle belly (H). Ta = talus, Ti = tibia.  
**B**, Sagittal anatomic slice shows Achilles tendon (*arrow*, T). Also note small pre-Achilles bursa (*arrow*, B) and Kager's fat triangle (F). Ti = tibia.  
**C**, Sagittal sonogram shows fibrillar structure of normal Achilles tendon (*arrows*). Kager's fat triangle (F) is also seen. Sonogram has been rotated for correlation with anatomic images. T = tibia

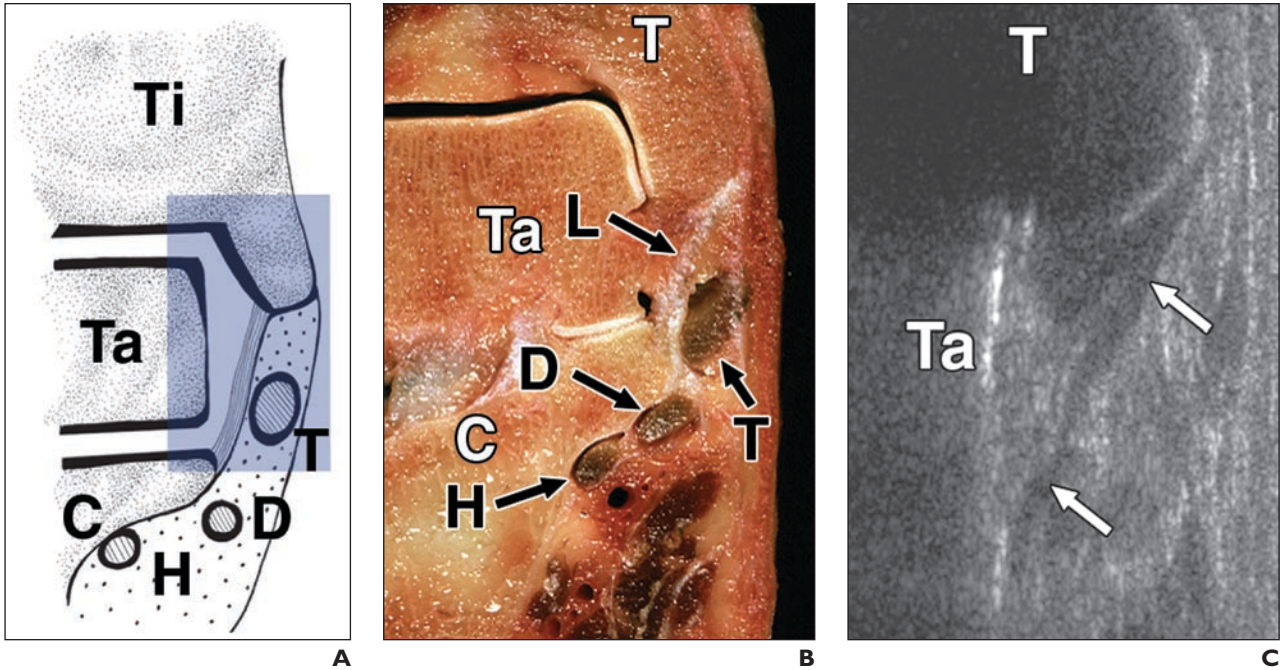
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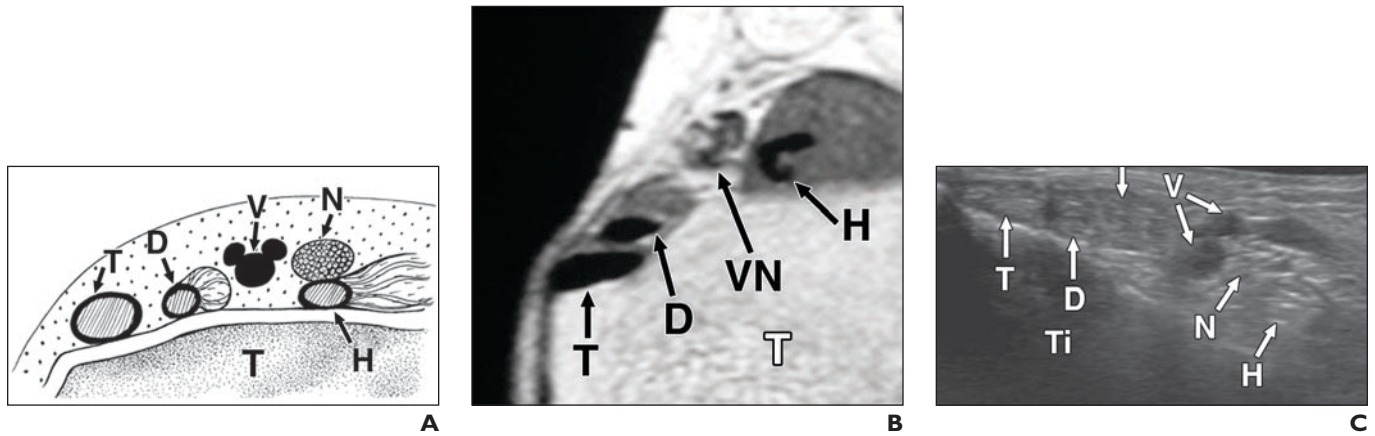
**Fig. 8**—Flexor hallucis longus tendon.  
**A**, Drawing in sagittal plane shows flexor hallucis longus tendon (arrow, T) and muscle (arrow, M). Ti = tibia, Ta = talus, C = calcaneus.  
**B**, Sagittal anatomic slice shows flexor hallucis longus tendon (arrow, T) in close proximity to talus (arrows, Ta). Ti = tibia, C = calcaneus, N = navicular bone.  
**C**, Sagittal sonogram shows flexor hallucis longus tendon (arrows) adjacent to talar bone (B). Sonogram has been rotated for correlation with anatomic images.



**Fig. 9**—Posterior deltoid ligament. Ti = tibia, C = calcaneus.  
**A**, Drawing in coronal plane of posterior deltoid ligament shows deep band (arrow, D), superficial band (arrow, S), and medial tendon group (arrowheads). T and arrowhead indicate tibialis posterior tendon; D and arrowhead, flexor digitorum tendon; H and arrowhead, flexor hallucis longus.  
**B**, Coronal anatomic slice shows deep (arrow, D), and superficial (arrow, S) bands of deltoid. T = tibialis posterior tendon, D = flexor digitorum tendon, H = flexor hallucis tendon, Ta = talus.  
**C**, Coronal sonogram shows part of deep component (arrow, D) of deltoid and more superficial component (arrow, S). Sonogram has been rotated for correlation with anatomic images. T = talus.

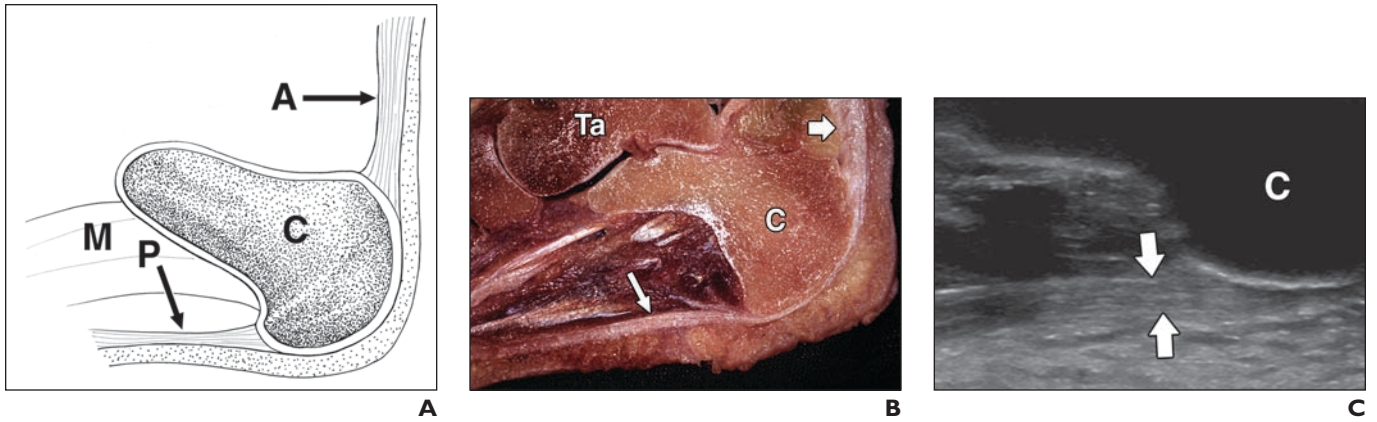


**Fig. 10**—Anterior deltoid ligament. Ta = talus.  
**A**, Drawing in coronal plane shows anterior component of deltoid inserting on calcaneus. C = calcaneus, T = tibialis posterior tendon, D = flexor digitorum tendon, H = flexor hallucis tendon, Ti = tibia.  
**B**, Coronal anatomic slice shows anterior component of deltoid (arrow, L). Also note tibialis posterior (arrow, T), flexor digitorum (arrow, D), and flexor hallucis longus (arrow, H) tendons. C = calcaneus, T = tibia.  
**C**, Coronal sonogram shows anterior band of deltoid (arrows). Sonogram has been rotated for correlation with anatomic images. T = tibia.



**Fig. 11**—Posterior medial tendons. T = tibia.  
**A**, Drawing in transverse plane illustrates tibialis posterior (arrow, T), flexor digitorum (arrow, D), artery and veins (arrow, V), posterior tibial nerve (arrow, N), and flexor hallucis tendon (arrow, H).  
**B**, Transverse proton density-weighted MR image shows tibialis posterior (arrow, T); flexor digitorum (arrow, D); artery, veins, and nerve (arrow, VN); and flexor hallucis tendon (arrow, H).  
**C**, Transverse sonogram of posteromedial tibia shows tibialis posterior (arrow, T), flexor digitorum (arrow, D) and its muscle belly (arrow), veins and artery (arrows, V), posterior tibial nerve (arrow, N), and flexor hallucis tendon (arrow, H). Ti = tibia.

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**Fig. 12**—Plantar fascia.

**A**, Drawing in sagittal plane shows calcaneus (C), plantar fascia (*arrow*, P), Achilles tendon (*arrow*, A), and muscles (M).

**B**, Sagittal anatomic slice shows plantar fascia (*thin arrow*), achilles tendon (*thick arrow*), calcaneus (C), and talus (Ta).

**C**, Sagittal sonogram shows calcaneus (C) and fibrillar plantar fascia (*arrows*). Sonogram has been rotated for correlation with anatomic images.