Ankle Joint and Nerves

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Introduction

Foot and ankle pain is a common reason for patients to present to their primary care doctor. It is clinically challenging to identify the etiology of foot and ankle pain because the region is anatomically complex. Two of the most common musculoskeletal causes of foot and ankle pain include tibiotalar and subtalar joint pathology such as osteoarthritis. In addition foot pain may be neuropathic in nature. The peripheral nerves of the foot may be injured or entrapped, which can cause pain in specific nerve distributions.

The ankle joint is formed from three primary articulations: the tibiotalar joint, the subtalar joint, and the distal tibiofibular joint (Fig. 24.1). The tibiotalar joint is formed by the articulation between the tibia and fibula with the talus. It is a hinged synovial joint, which allows for flexion and extension. The subtalar joint is formed by the articulation of the talus and the calcaneous. The subtalar joint has an anterior and posterior component. The tibiotalar and subtalar joints communicate in approximately 10–20% of people.

There are five peripheral nerves which innervate the foot: the superficial peroneal nerve (SPN), deep peroneal nerve (DPN), saphenous nerve (SaN), tibial nerve (TB), and sural nerve (SuN).

The SPN and DPN are branches of the common peroneal nerve . The SPN provides sensation to the majority of dorsum of the foot, apart from the webspace of the first and second toe, which is supplied by the DPN (Fig. 24.2). The SPN usually emerges below

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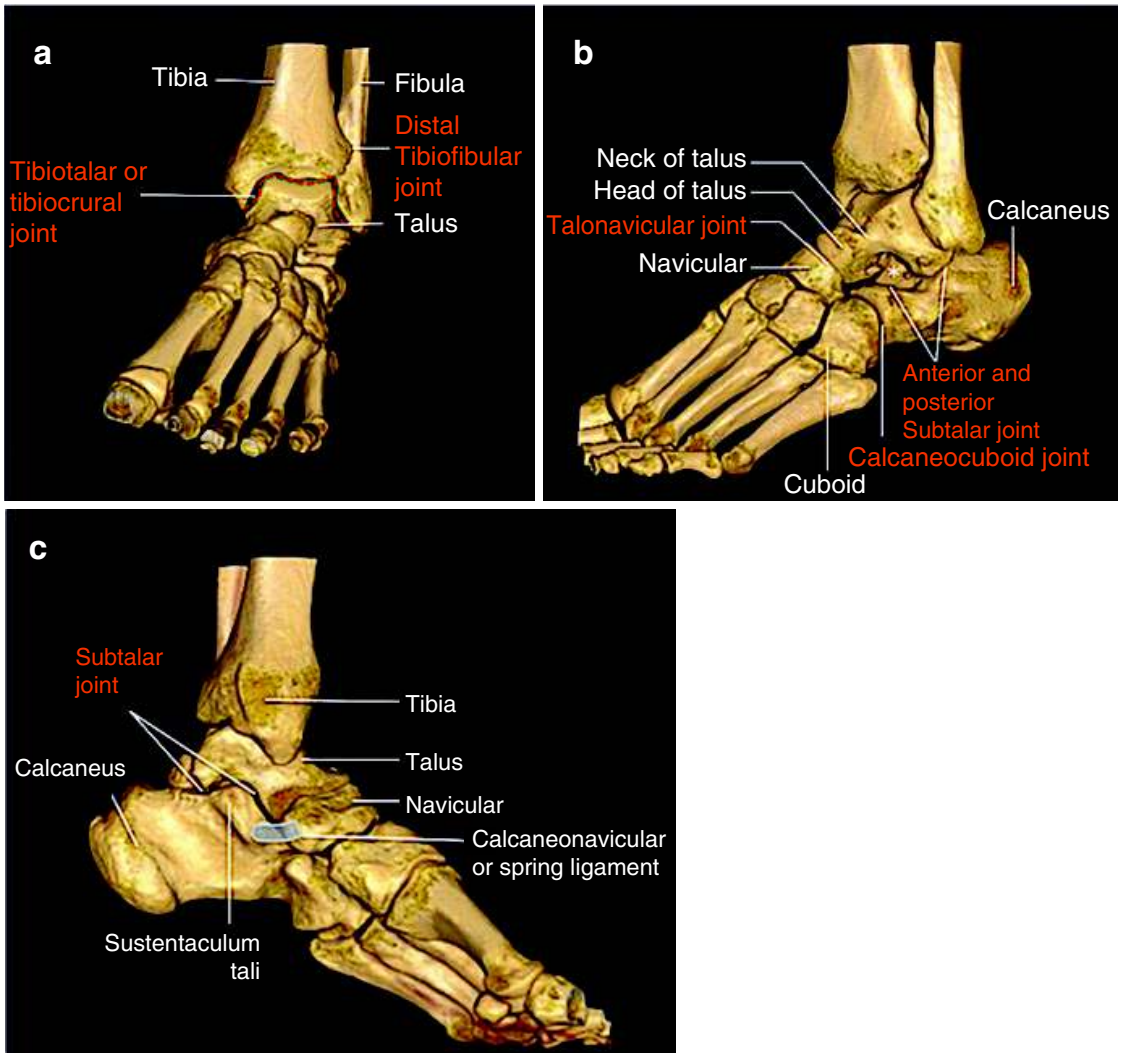

Fig. 24.1 Ankle anatomy. (**a**) Anterior view. (**b**) Lateral view. (**c**) Medial view. (Reprinted with permission from the Philip Peng Educational Series)

the knee in the middle third of the leg in the fascial plane between the peroneus muscles and the extensor digitorum longus muscle (Fig. 24.3). The terminal branches are sensory. Above the level of the ankle joint the DPN lies lateral to the anterior tibial artery between the extensor digitorum longus and extensor hallucis longus tendons.

On the medial aspect of the ankle, the SaN provides sensation to the region around the medial malleolus and the medial aspect of the foot (Fig. 24.4). The SaN runs adjacent to the greater saphenous vein in the distal lower extremity. It commonly bifurcates 3 cm above the medial malleolus into an anterior and posterior division.

The TN provides sensation to the plantar aspect of the foot. The TN runs in the tarsal tunnel adjacent to the posterior tibial artery (Fig. 24.5). The TN gives off a calcaneal branch proximal to the medial malleolus and then continues to terminate in the medial and lateral branches.

The SuN provides sensation to the lateral aspect of the distal leg and the lateral aspect of the foot. In the distal leg, the SuN runs adjacent to the lesser saphenous vein between the Achilles tendon and the peroneus tendons (Fig. 24.6).

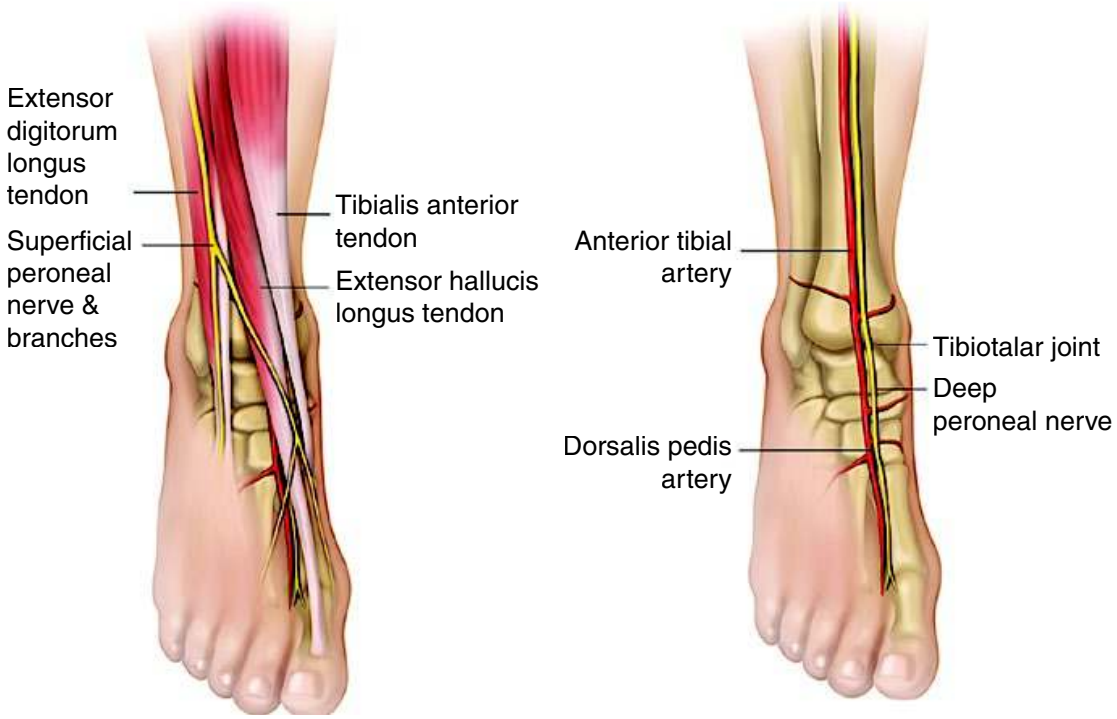

Fig. 24.2 Anterior view of the ankle. (**a**) Superficial peroneal nerve. (**b**) Deep peroneal nerve and tibiotalar joint. (Reprinted with permission from the Philip Peng Educational Series)

Patient Selection

Injection of the tibiotalar and subtalar joints can be valuable for diagnostic and therapeutic purposes. Joint injections with local anesthetic can help to clarify the articular contribution of pain and may be used for surgical planning for arthrodesis. Joint injections can also provide symptomatic relief for osteoarthritis, rheumatoid arthritis, and ankle impingement. Perineural injections around the foot and ankle nerves may be offered for patients with neuropathic pain, particularly in the context of peripheral nerve injury or entrapment.

Ultrasound Scan for Ankle Nerves

Sural and Superficial Peroneal Nerve

- Position: Supine, tilted contralateral side, affected leg nondependent position
- Probe: Linear 6–15 MHz

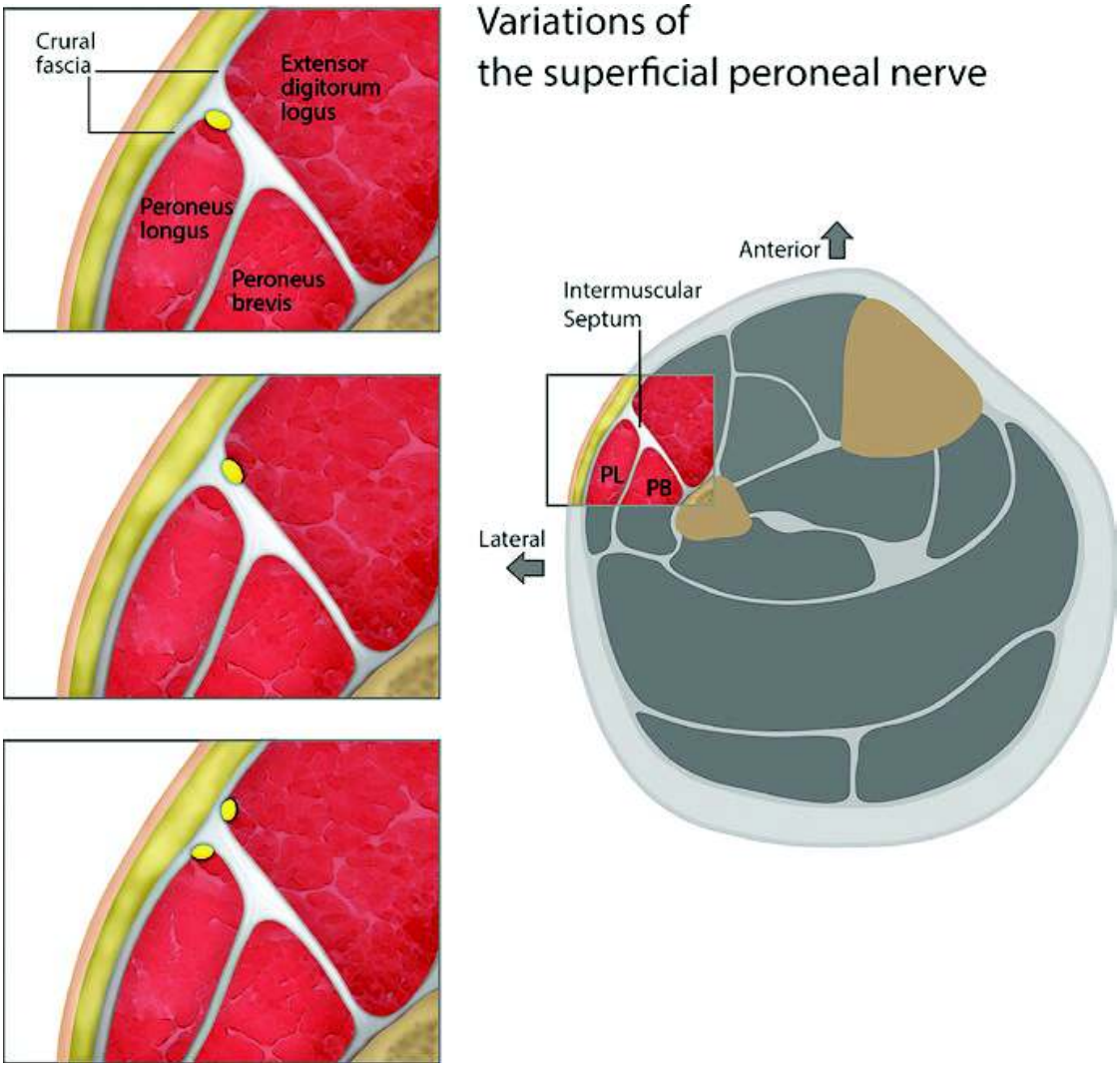

Fig. 24.3 Superficial peroneal nerve in middle third of leg. (Reprinted with permission from the Philip Peng Educational Series)

Scan 1

The author suggests to place the probe initially at the lower one-third of the leg over the fibula (F) and extensor digitorum longus (EDL) (Fig. 24.7 upper panel). SPN is deep to the crural fascial (bold arrow). The SPN (arrow) can be located at the junction of the intermuscular septum (between the peroneus muscle and EDL as indicated by the arrow heads) and the crural fascia.

Scan 2

By moving the probe in the caudal direction, the SPN (arrow) can be seen within the crural fascia (bold arrows) in the middle figure (Fig. 24.7 middle panel).

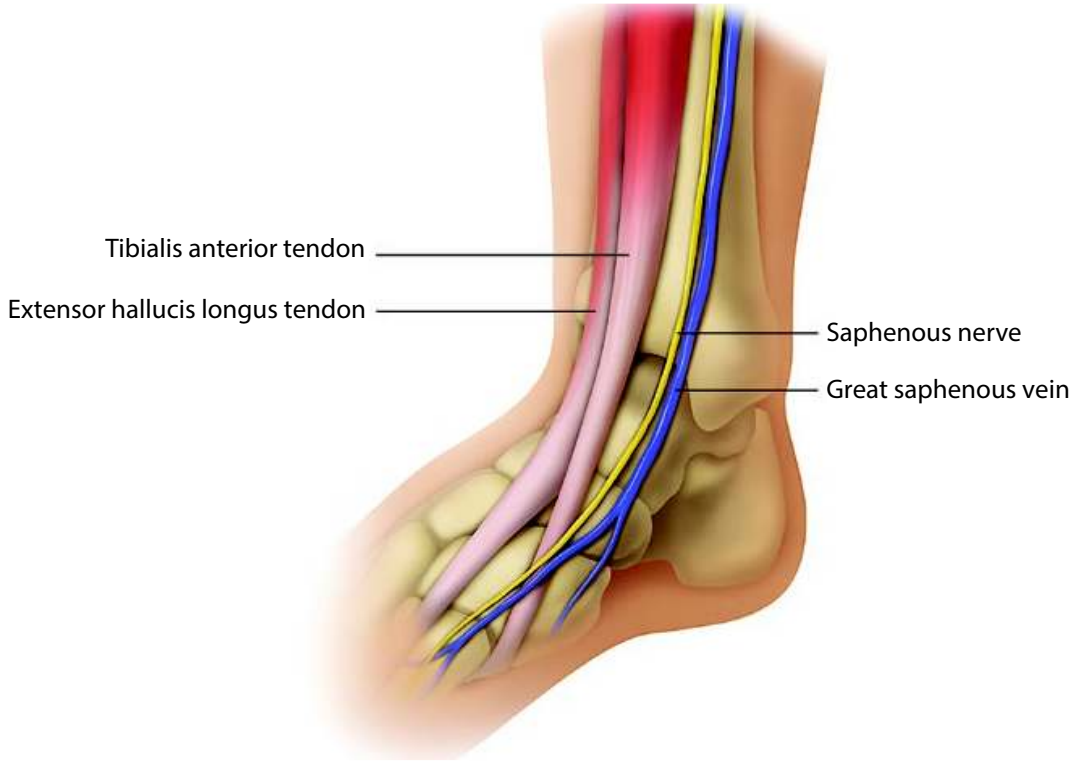

Fig. 24.4 Anteromedial view of the ankle. Saphenous nerve. (Reprinted with permission from the Philip Peng Educational Series)

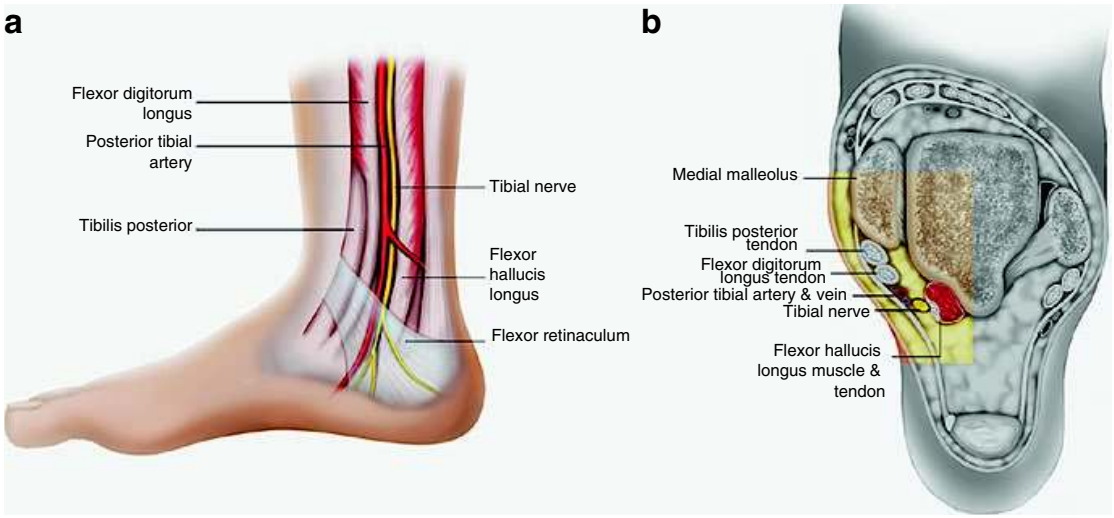

Fig. 24.5 Medial view of the ankle. (**a**) Medial view tibial nerve. (**b**) Cross-sectional view of the ankle. (Reprinted with permission from the Philip Peng Educational Series)

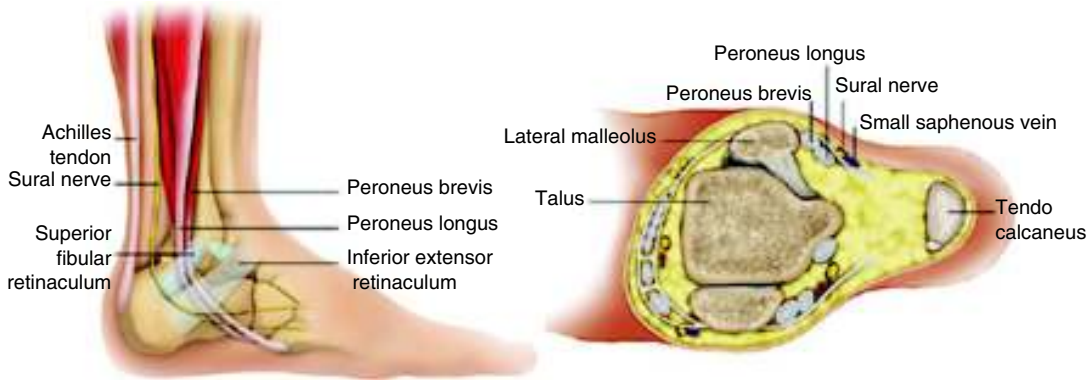

Fig. 24.6 Lateral view of the ankle. (**a**) Lateral view of sural nerve. (**b**) Cross-sectional view of the ankle. (Reprinted with permission from the Philip Peng Educational Series)

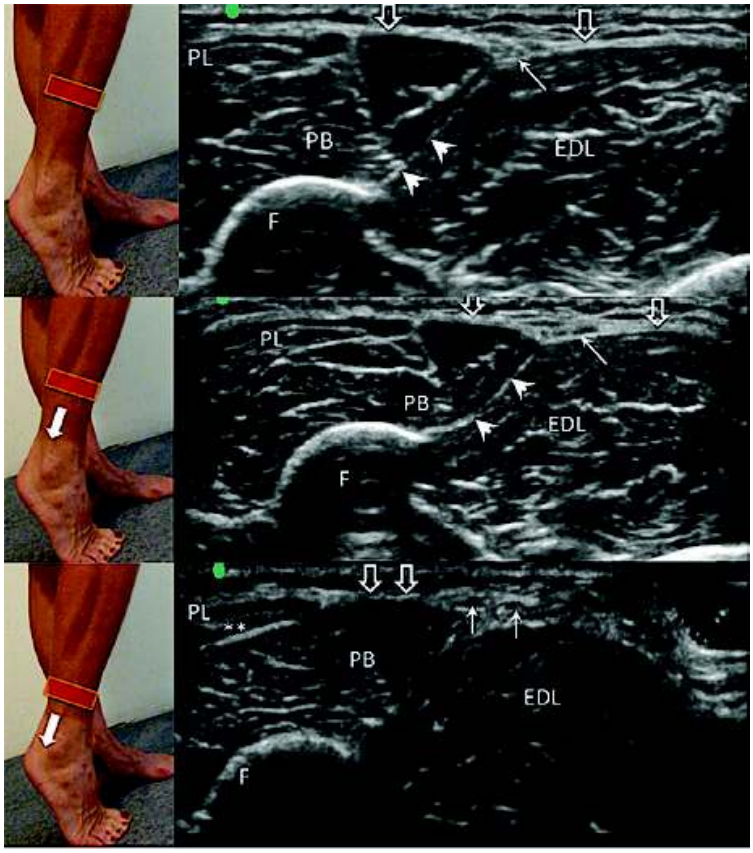

Fig. 24.7 Sonoanatomy of the superficial peroneal nerve at different locations in the lower extremity. (Reprinted with permission from the Philip Peng Educational Series)

Scan 3

Further caudal movement of the probe, the SPN (arrows) is now superficial to the crural fascia (bold arrows) (Fig. 24.7 lower panel). PB and PL, peroneus brevis and longus; **, PB tendon; F, fibula.

Placing the probe between the lateral malleolus and Achilles tendon (TA), a fascia plane (bold arrows) can be appreciated (Fig. 24.8). Sural nerve (arrow) can be seen adjacent to the lesser saphenous vein (V) in this fascia plane.

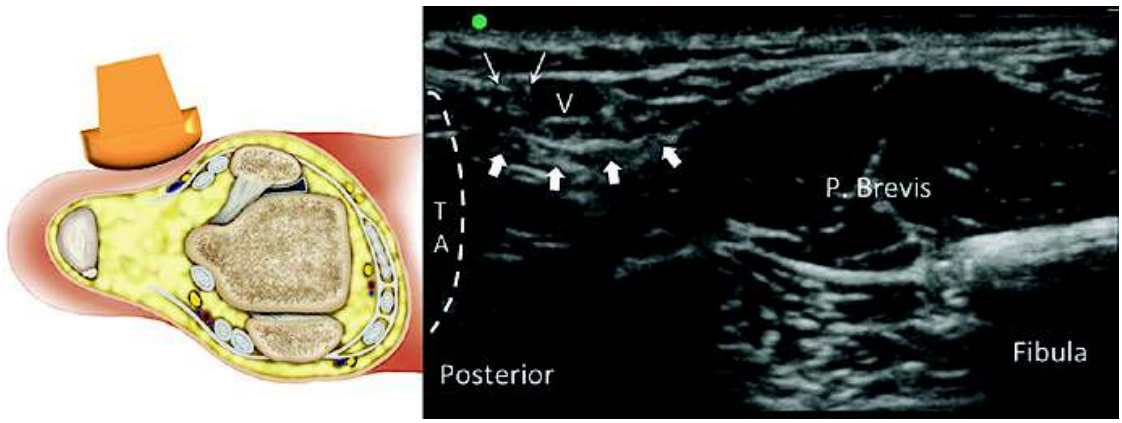

Fig. 24.8 Sonoanatomy of sural nerve. Line arrow, SuN. P. brevis, peroneus brevis. (Reprinted with permission from the Philip Peng Educational Series)

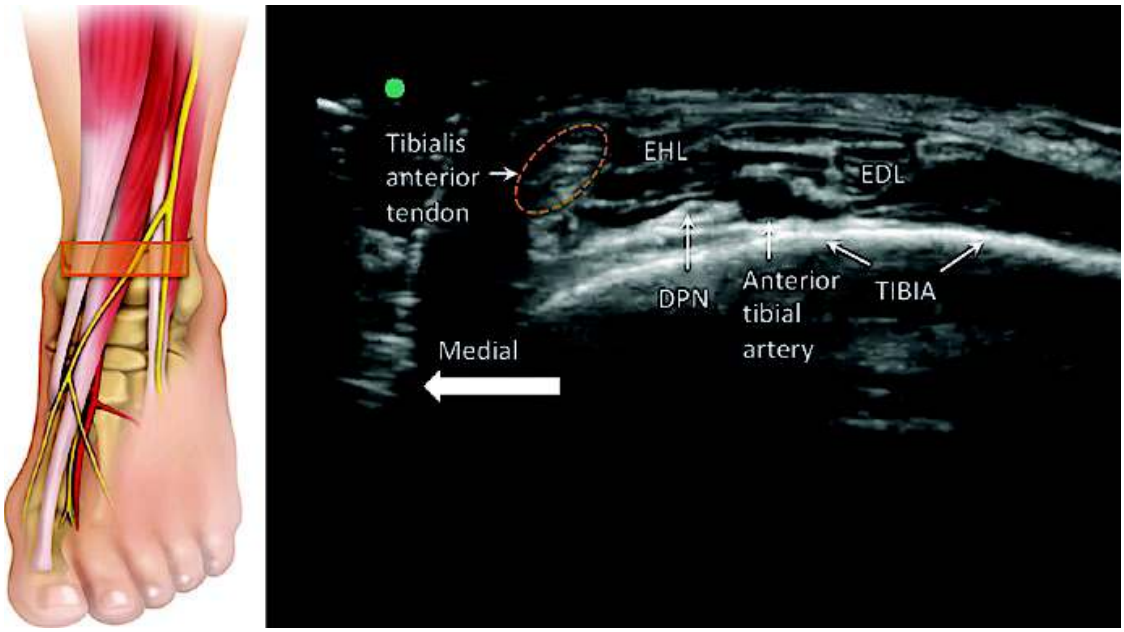

Fig. 24.9 Sonoanatomy of DPN. (Reprinted with permission from the Philip Peng Educational Series)

Deep Peroneal Nerve

- Position: Supine, knee flexed, foot on the examination table
- Probe: Linear 6–15 MHz

By placing the probe in short axis to the tendons just above the ankle joint, the most prominent tendon will be the tibialis anterior tendon (orange circle) (Fig. 24.9). Deep to the extensor hallucis longus (EHL) and extensor digitorum longus (EDL) tendon, the anterior tibial artery is seen. The DPN is in the fascia plane with the vessel.

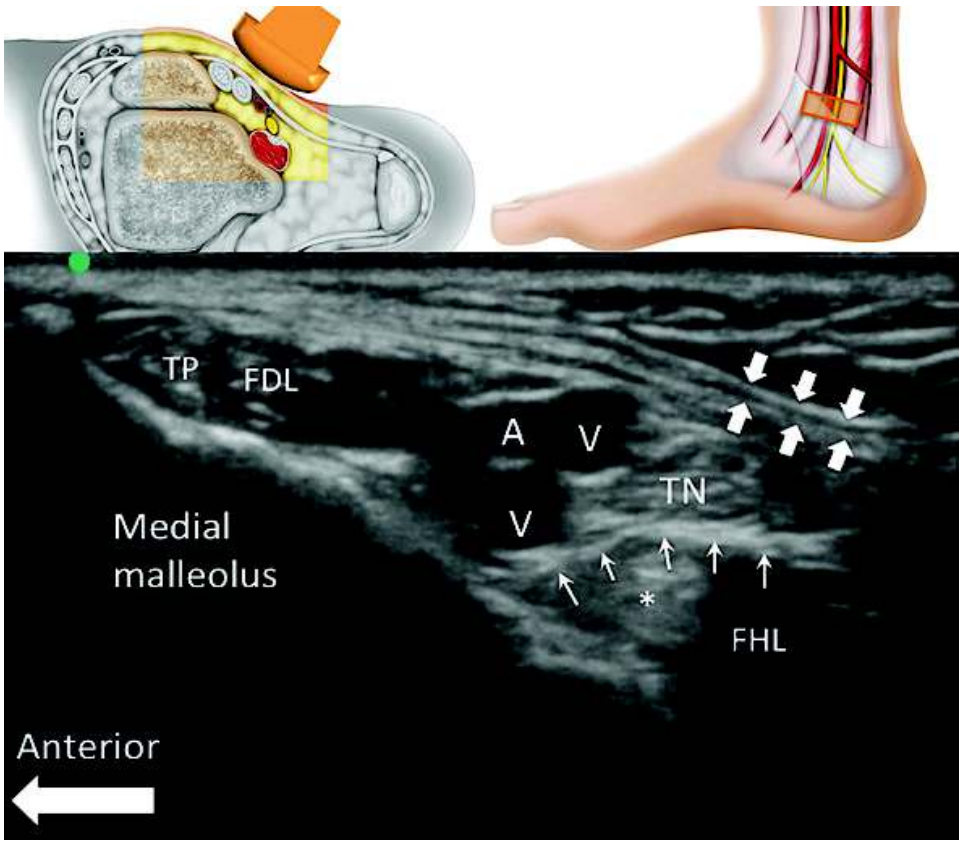

Fig. 24.10 Sonoanatomy of tibial nerve. TP, tibialis posterior tendon; FDL, flexor digitorum longus tendon; bold arrows, flexor retinaculum. (Reprinted with permission from the Philip Peng Educational Series)

Tibial and Saphenous Nerve

- Position: Supine, tilted ipsilateral side, knee flexed
- Probe: Linear 6–15 MHz

By placing the probe between the medial malleolus and Achilles tendon, the tarsal tunnel and its content are revealed (Fig. 24.10). The tibial nerve (TN) is visualized posterolateral to the posterior tibial artery over the flexor hallucis longus (FHL). By moving the big toe, the TN is seen resting on the fascia over the FHL (line arrows), and the tendon of FHL (∗) is seen as well.

Place the probe over the medial malleolus and apply very slight pressure (Fig. 24.11). The saphenous nerve (arrow) is seen beside the saphenous vein (SV). Quite often the nerve is small or is already divided into small branches and cannot be visualized at this level.

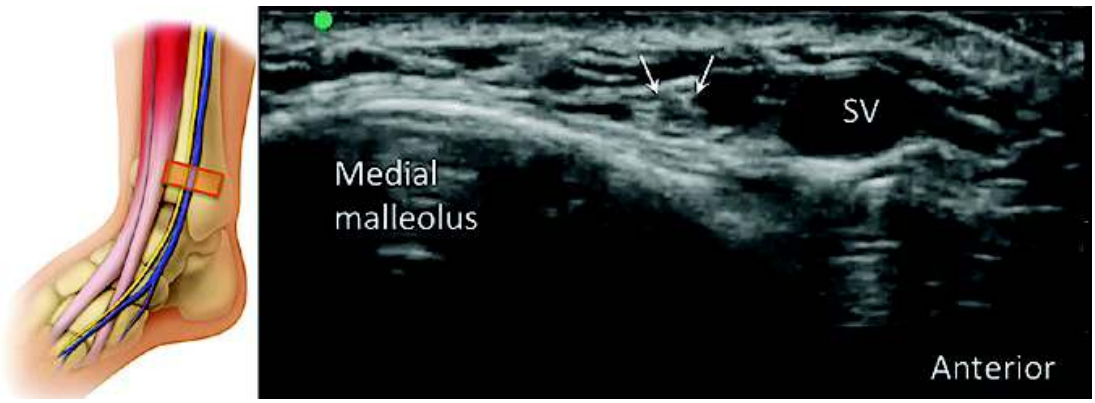

Fig. 24.11 Sonoanatomy of sural nerve. (Reprinted with permission from the Philip Peng Educational Series)

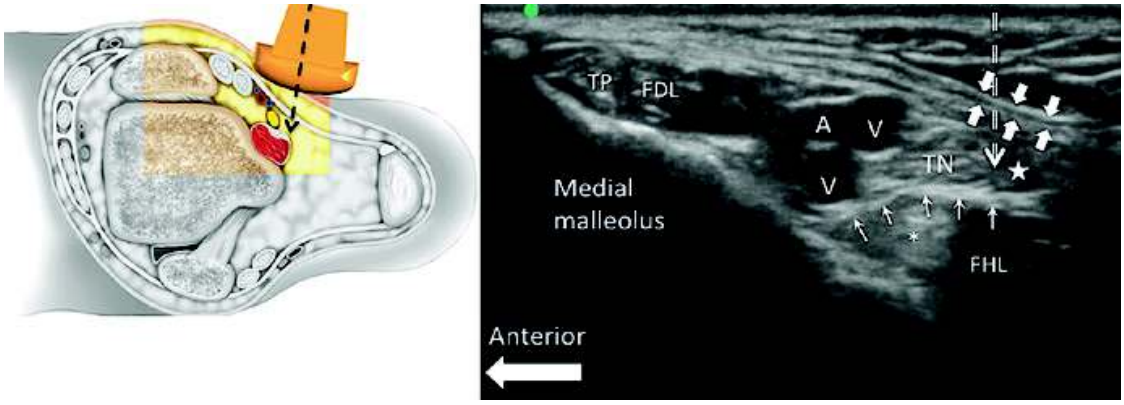

Fig. 24.12 Out-of-plane needle insertion to the space behind tibial nerve. (Reprinted with permission from the Philip Peng Educational Series)

Procedure for Ankle Nerves

- Drugs: Bupivacaine 0.25% 10 mL mixed with depo steroid (Depo-Medrol) 40 mg
- Needle: 25G 1.5-inch needle

For each site, 3–5 mL is sufficient, larger volume for TN. For TN, we prefer to direct the needle out-of-plane (dotted arrow) to target the space (★) posterior to TN formed by the retinaculum (bold arrow) and the fascia overlying the FHL (arrows) (Fig. 24.12). For SPN, SaN, and DPN, we suggest in-plane and SN out-of-plane.

Ultrasound Scan for Ankle Joints

Tibiotalar Joint

- Position: Supine, knee flexed, foot on the examination table
- Probe: Linear 6–15 MHz

Scan 1

Similar to Fig. 24.9, place the probe at distal tibia. Identify the tibialis anterior tendon.

Scan 2

Rotate the probe so as to view the long axis of tibialis anterior (TA) tendon (Fig. 24.13). The space between the TA tendon (arrow) and the medial malleolus is the entry where the anterior recess of the tibiotalar joint is visualized. It is covered by fat pad (∗).

Subtalar Joint (Lateral Approach)

There are three approaches to the subtalar joint and the author prefer lateral approach.

- Position: Lateral position, affected leg nondependent position, rolled towel on the medial ankle to allow inversion of the ankle
- Probe: Linear 6–15 MHz

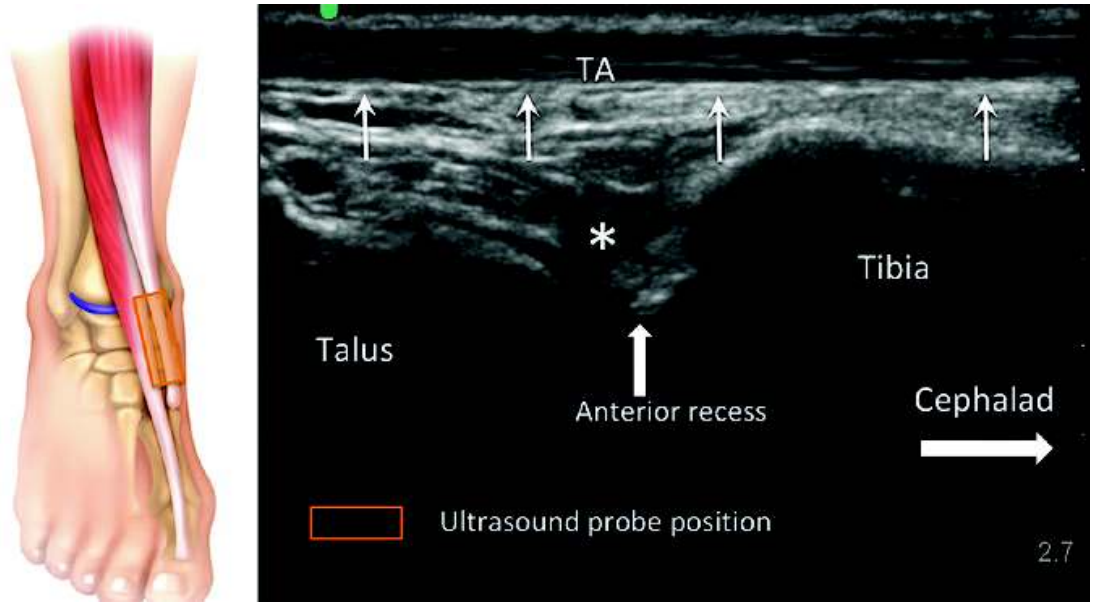

Fig. 24.13 Sonoanatomy of anterior to the tibiotalar joint. (Reprinted with permission from the Philip Peng Educational Series)

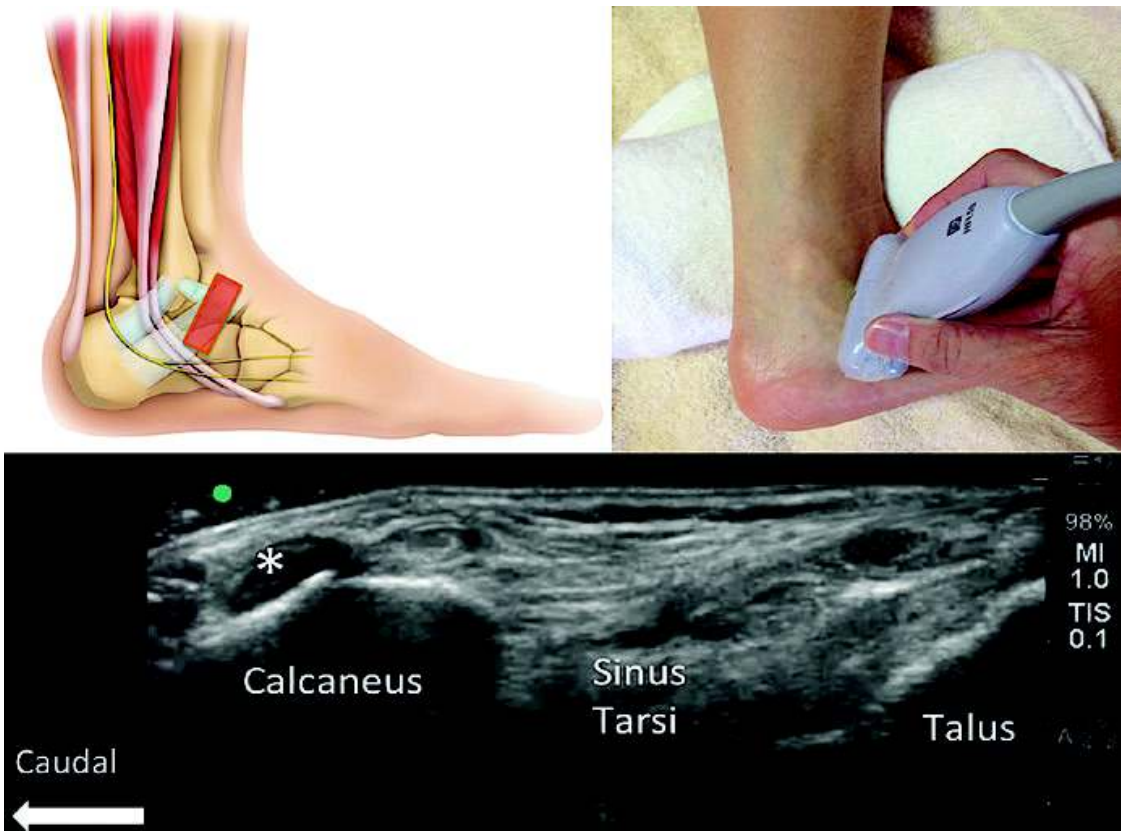

Fig. 24.14 Sonoanatomy of sinus tarsi. (Reprinted with permission from the Philip Peng Educational Series)

Scan 1

Palpate the sinus tarsi (a big "hollow" in the lateral ankle) and place the probe over it (Fig. 24.14). On the calcaneal side, the peroneus tendon (∗) can be seen.

Scan 1

Rotate the probe toward the lateral malleolus as much as possible, and the hyperechoic shadow of both calcaneus and talus will become superficial with a gap in between (bold arrow) (Fig. 24.15). This is the entrance to the subtalar joint. The peroneus tendon (∗) is on the calcaneus side.

Procedure

Tibiotalar Joint Injection—Anterior Joint Recess

- Needles: 22G 3.5-inch needle.
- Drugs: 3 mL of local anesthetic (2% plain bupivacaine)
- 1 mL steroid (40 mg Depo-Medrol)

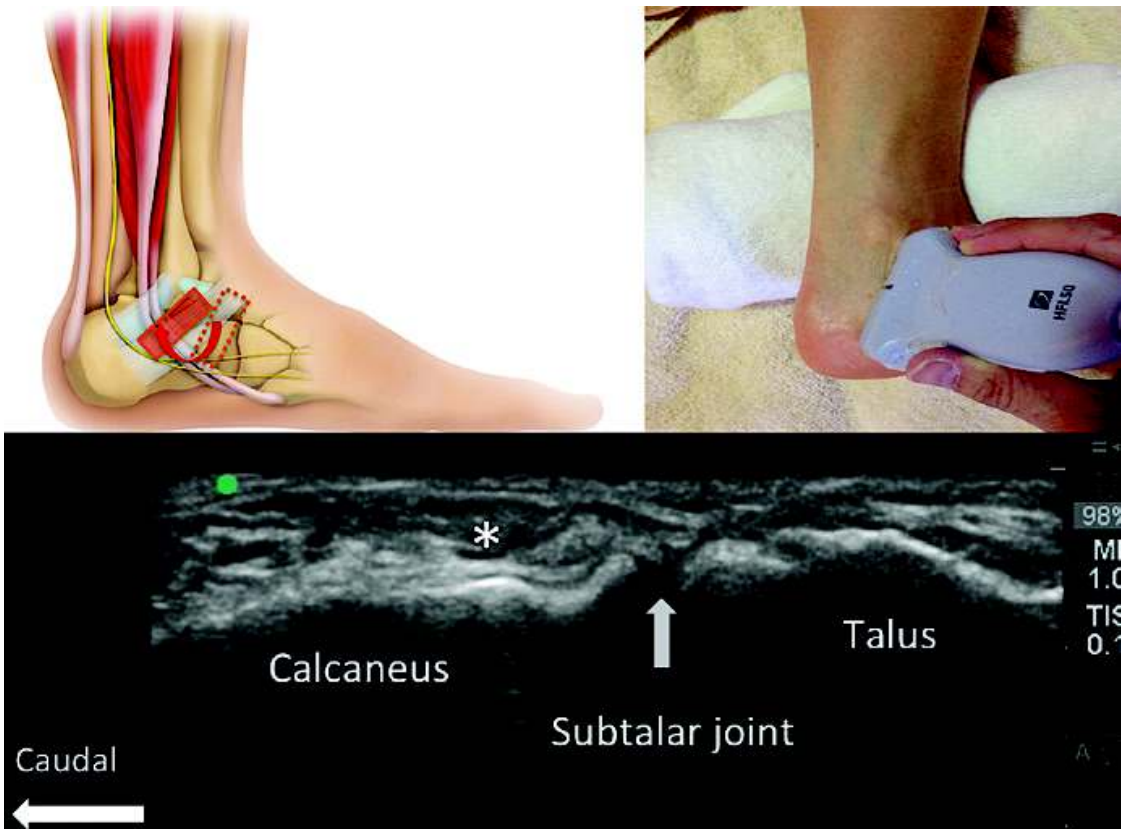

Fig. 24.15 Sonoanatomy of posterior subtalar joint. (Reprinted with permission from the Philip Peng Educational Series)

Both out-of-plane (Fig. 24.16a) and in-plane (Fig. 24.16b) approaches have been described. The authors prefer out-of-plane because of the ease and short distance to the target. Once the needle passes the anterior fat pad, hydrolocation with normal saline is used to ensure the spread of the injectate into the joint. A successful injection will result in rising of the fat pad.

Subtalar Joint Injection—Lateral Approach

Needles: 25G 1.5-inch needle.
Drugs: 2 mL of local anesthetic (2% plain lidocaine)
1 mL steroid (40 mg Depo-Medrol)

An out-of-plane technique is used. The linear probe is rotated posteriorly to visualize the subtalar joint (Fig. 24.17). The needle tip is passed between the calcaneous and talus using hydrolocation with saline. Thin arrows, needle direction with out of plane technique. Thick arrow, subtalar joint. Reprinted with permission from the Philip Peng Educational Series.

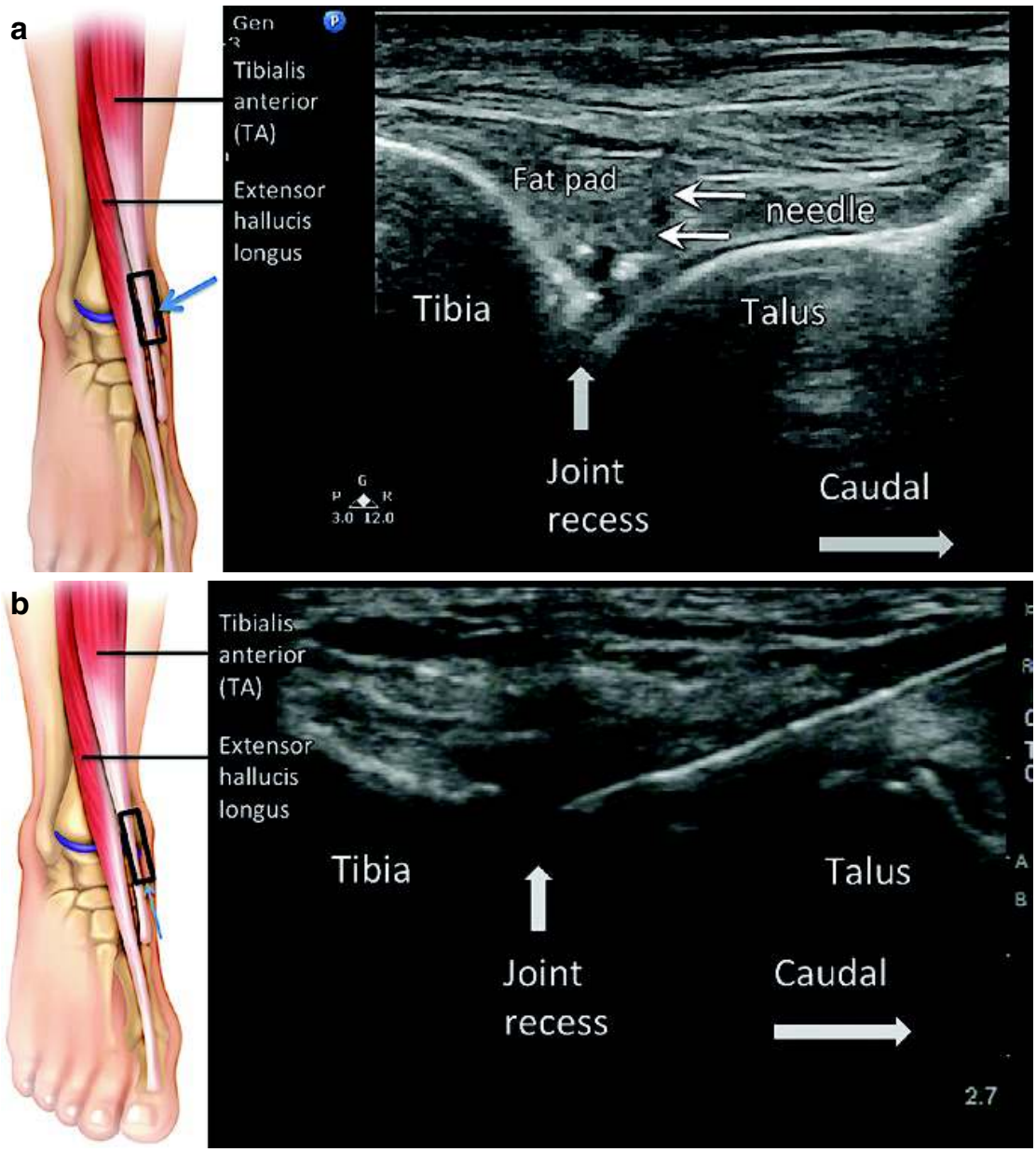

Fig. 24.16 (**a**) Out-of-plane needle insertion to tibiotalar joint. (**b**) In-plane approach to tibiotalar joint. (Reprinted with permission from the Philip Peng Educational Series)

Clinical Pearls

1. When scanning the anterior tibiotalar joint, ensure the patient's foot is flat on the examination table with the knee flexed. This opens the anterior joint recess.
2. When scanning the tibiotalar joint, start by scanning over the tibialis anterior tendon. The probe should then be shifted medially. Needle insertion medial to the tibialis anterior tendon will prevent injury to the deep peroneal nerve or dorsalis pedis artery.

3. When injecting the anterior tibiotalar joint, ensure the medication is not accumulating within the anterior fat pad.
4. The subtalar joint can be injected from the medial side, lateral side, or posterolateral side. The lateral approach is the preferred approach by the author as there is less risk to neurovascular structures in this region.
5. When scanning the lateral subtalar joint, start by scanning the sinus tarsi which can be palpated in most patients. Then rotate the distal aspect of the probe posteriorly and look for the peroneal tendons. The subtalar joint will be visualized adjacent to the peroneal tendons.

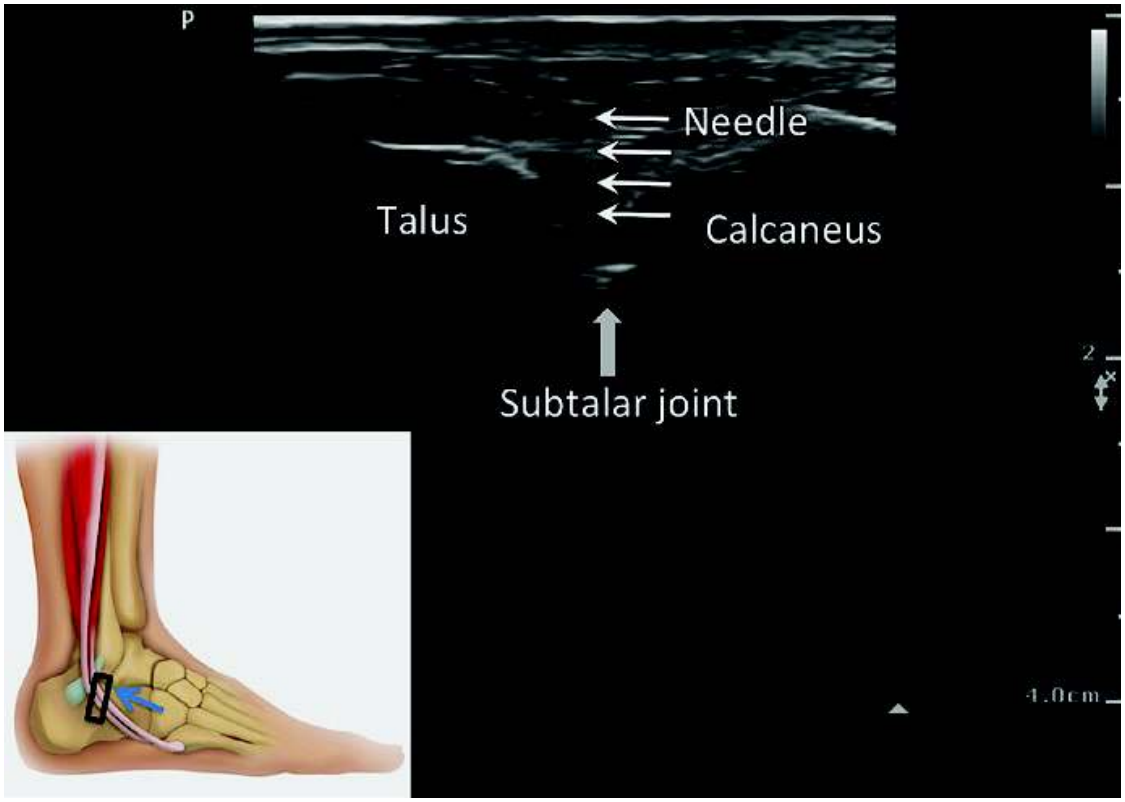

Fig. 24.17 Needle insertion to subtalar joint. (Reprinted with permission from the Philip Peng Educational Series)

Literature Review

Ultrasound guidance is a validated technique for tibiotalar and subtalar joint injections. Studies have shown 100% accuracy rates when ultrasound guidance is used for tibiotalar joint injections. Accuracy rates for subtalar joint injections also approach 100%. Due to the anatomy of the subtalar joint, extravasation of the injectate to surrounding structures occurs in approximately 20% of injections. Rates

of extravasation to areas such as the subtalar joint and peroneal tendons are similar between ultrasound and other injection techniques such as fluoroscopy and anatomic guidance. Foot and ankle joint injections with local anesthetic and steroid can be valuable for diagnostic purposes. Literature generally supports the correlation between response to local anesthetic and steroid and good surgical outcome. From a therapeutic standpoint, a limited number of studies demonstrate short-term benefit with foot and ankle injections with local anesthetic and steroid. Viscosupplementation is another viable option for ankle joint injections. A recent meta-analysis concluded that viscosupplementation for ankle arthritis can significantly reduce pain and is likely superior to reference therapy; however, the number of studies is limited. Larger good quality randomized studies are required to assess longer-term efficacy of foot and ankle injections.

Suggested Readings

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