

# Ultrasound-Guided Foot and Ankle Procedures



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## KEYWORDS

• Ankle • Foot • Injection • Ultrasound guidance

## KEY POINTS

- Ultrasound-guided injections about the foot and ankle can be used to assist in the alleviation of pain related to disorders of joints, bursae, tendons, and neurologic structures.
- Improved accuracy with ultrasound-guided injections about the foot and ankle allows these procedures to aid in the confirmation of a diagnosis as well as to improve safety, especially when performed adjacent to neurovascular structures.
- Clinicians should be familiar with alternative approaches for various ultrasound-guided procedures about the foot and ankle, because challenging individual patient anatomy or other factors may warrant modification of technique.

## TIBIOTALAR (ANKLE) JOINT INJECTION

### *Regional Anatomy*

The tibiotalar joint is a synovial hinge joint formed by the articulation of the tibia and fibula with the underlying talus. The joint recess extends proximally from the inferior tibial margin by a mean of 19.2 mm.<sup>1</sup> An intra-articular extrasynovial fat pad lies within the anterior recess. In addition, the ankle joint communicates with the posterior subtalar joint in 13.9% of cases.<sup>2</sup> From medial to lateral, the tibialis anterior tendon, extensor hallucis longus tendon, dorsalis pedis artery and adjacent deep peroneal nerve, extensor digitorum longus tendon, superficial peroneal nerve, and peroneus tertius tendon overlie the anterior ankle joint.

### *Patient and Ultrasound Machine Positioning*

- Patient: supine on table, injected side closest to provider
- Ultrasound machine: ipsilateral to involved side/provider

### *Transducer Type*

- High-frequency linear-array: small footprint preferred

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### **Needle Choice**

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- Injection only: needle 25 to 30 gauge, 25 to 38 mm
- Aspiration: at least 18-gauge, 38-mm needle

### **Injectate**

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Solution of local anesthetic plus corticosteroid (eg, 3 mL of 0.2% ropivacaine and 1 mL of 10 mg/mL triamcinolone).

### **Approaches**

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#### ***Long axis to joint in plane with transducer***

Transducer is aligned in a sagittal plane with the joint overlying the dome of talus (**Fig. 1**). The needle is advanced in an anterior-to-posterior direction deep to the fat pad and superficial to the articular cartilage on the dome of talus, preferably avoiding overlying tendons and neurovascular structures (**Figs. 2–4**).<sup>3</sup>

#### ***Short axis to the joint in plane with transducer (the author's preferred approach)***

The transducer is aligned in an axial plane with the joint overlying the dome of talus. The needle is advanced in a lateral-to-medial direction deep to the fat pad and superficial to the articular cartilage on the dome of talus, preferably avoiding overlying tendons and neurovascular structures (**Figs. 5–7**).



**Fig. 1.** Position of ultrasound transducer and machine for ankle joint injection in plane with joint. Left, proximal; right, distal.

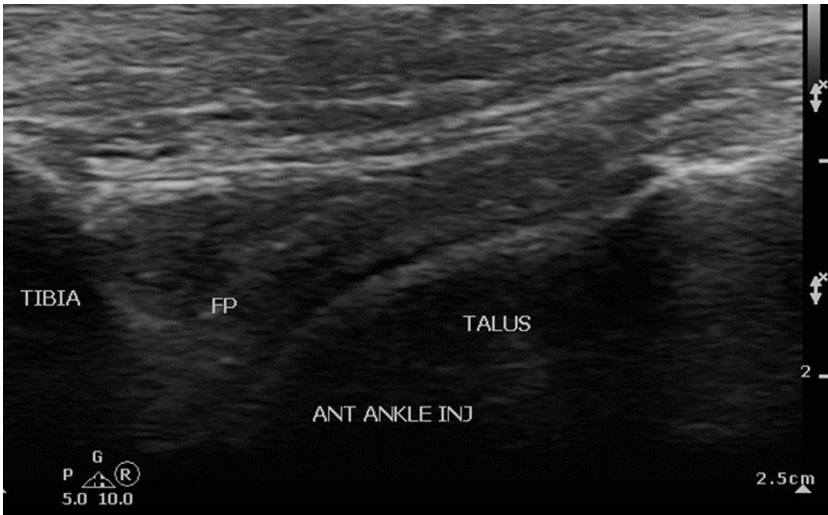
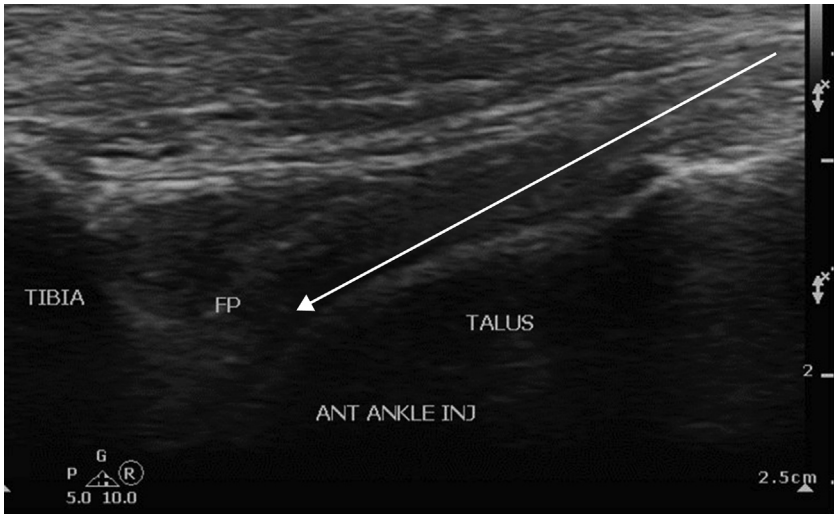


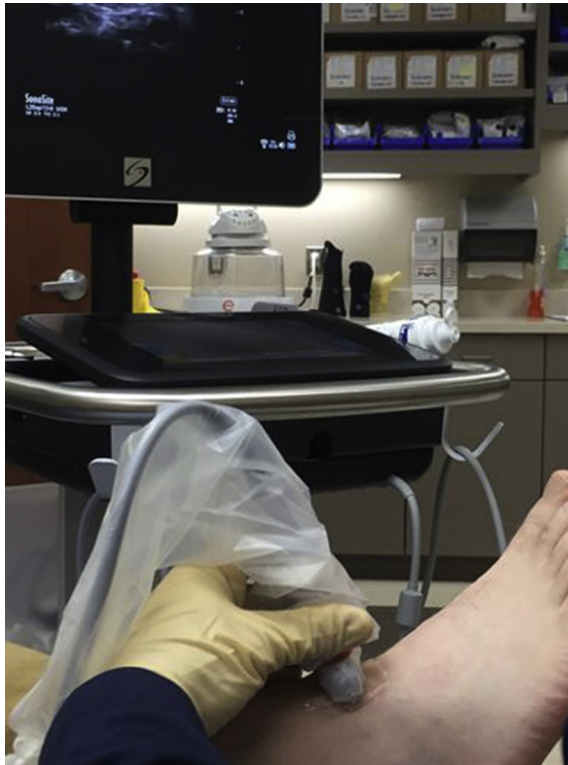
Fig. 2. Anterior ankle joint. Left, proximal; right, distal. Ant, anterior; FP, fat pad.



Fig. 3. Ultrasound transducer placement and needle approach for ankle joint injection, in plane with ankle, needle approaching in plane with transducer. Left, proximal; right, distal.



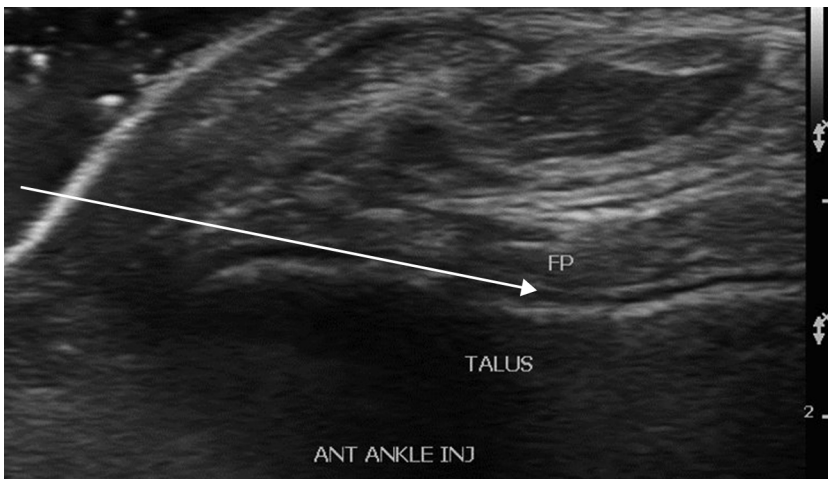
**Fig. 4.** Sonographically guided injection of the ankle joint, long axis to joint, needle in plane with transducer. Arrow delineates path of needle. Left, proximal; right, distal.



**Fig. 5.** Transducer position for ankle joint injection, short axis relative to joint. Left, proximal; right, distal.



**Fig. 6.** Ultrasound transducer placement and needle approach for ankle joint injection, short axis to joint, needle in plane with transducer. Left, lateral; right, medial.



**Fig. 7.** Sonographically guided injection of ankle joint, short axis to joint, needle in plane with transducer. Arrow delineates path of needle. Note gel standoff window to left of skin to improve placement of the needle. Left, lateral; right, medial.



***Long axis to the joint out of plane with transducer (technically more challenging)***

The transducer is aligned in a sagittal plane with the joint overlying the dome of talus. Using a walk-down technique from superficial to deep, the needle is advanced in either a lateral-to-medial or an anterior-to-posterior direction deep to the fat pad and superficial to the articular cartilage on the dome of talus, preferably avoiding overlying tendons and neurovascular structures (**Figs. 8 and 9**).

**POSTERIOR SUBTALAR JOINT INJECTION*****Regional Anatomy***

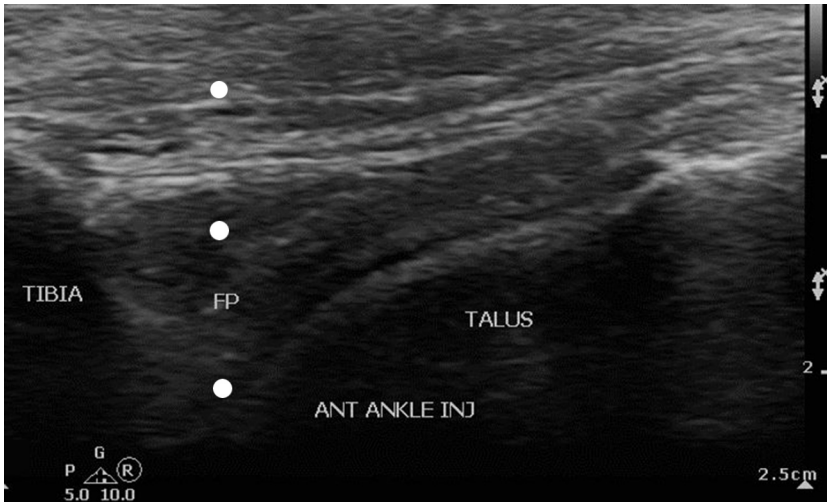
The subtalar joint is a synovial joint between the overlying talus and underlying calcaneus. This joint is divided into 3 facets: anterior, medial, and posterior. Of these, the posterior facet has the largest area and is the focus of this procedure. The flexor hallucis longus (FHL) tendon along with the tibial neurovascular structures overlie the medial aspect of the joint. Laterally, the calcaneofibular ligament and peroneal tendons overlie the joint with the sural nerve traversing just posterior and caudal to the joint. Posteriorly, the Achilles tendon and Kager fat pad are found superficial to the joint.

***Patient and Ultrasound Machine Position***

Positioning of the patient and ultrasound machine depends on the approach for the injection of this joint, and is discussed further later in this article.



**Fig. 8.** Ankle joint injection, with transducer long axis to joint, needle approach out of plane with transducer. Left, plantar; right, dorsal.



**Fig. 9.** Sonographically guided injection of ankle joint, long axis to joint, needle path out of plane with transducer. Dots represent path of needle. Each dot signifies a pass of the needle tip below the ultrasound beam. The needle is directed along a steeper trajectory with each pass until the tip is visualized deep to the FP. Left, proximal; right, distal.

### **Transducer Type**

- High-frequency linear-array: short footprint preferable

### **Needle**

- From 25 to 27 gauge, 32 to 51 mm
  - Longer needle (51 mm) likely needed for posterolateral approach

### **Injectate**

- Solution of local anesthetic plus corticosteroid (eg, 1 mL of 0.2% ropivacaine and 1 mL of 10 mg/mL triamcinolone)

### **Approaches**

#### **Posteromedial**

The patient position is lateral recumbent, affected side down with the lateral aspect of the ankle resting on a towel or pillow to slightly evert the ankle and open the joint space.<sup>4</sup>

The ultrasound machine is ideally placed posterior to the patient with the provider sitting on the anterior side facing the ultrasound machine and ankle.

The transducer is initially placed over the medial malleolus bridging to the sustentaculum tali. It is then swept posteriorly until the posterior subtalar joint opening is visualized (**Fig. 10**). Immediately overlying the joint, the FHL tendon and tibial neurovascular structures can typically be visualized. The needle is advanced in an anterior-to-posterior direction, out of plane relative to the transducer. A slightly caudal entry position relative to the joint may be needed to avoid the neurovascular structures (**Figs. 11** and **12**).



**Fig. 10.** Transducer position for posteromedial subtalar joint injection. Left, proximal; right, distal.

### ***Anterolateral***

The patient position is lateral recumbent, affected side up with the medial side of the ankle resting on a towel or pillow to induce slight inversion of the ankle to open the joint.<sup>4</sup>

The ultrasound machine is ideally placed posterior to the patient with the provider facing the screen and the anterior aspect of the ankle.

The transducer is initially placed overlying the distal fibula and calcaneofibular ligament (**Fig. 13**). Deep to the ligament, the opening of the posterior subtalar joint is easily visualized. The peroneal tendons overlie the ligament with the sural nerve being just caudal and posterior to the joint. The needle is advanced from anterior to posterior, out of plane relative to the transducer (**Figs. 14 and 15**).

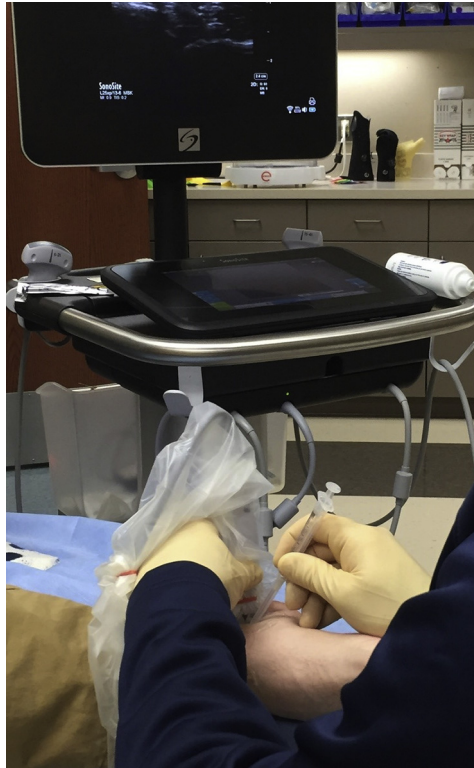
### ***Posterolateral***

The patient position is prone with the affected ankle dangling off the end of the examination table.<sup>4</sup> Slight passive dorsiflexion of the ankle may help with optimizing access to the joint recess.

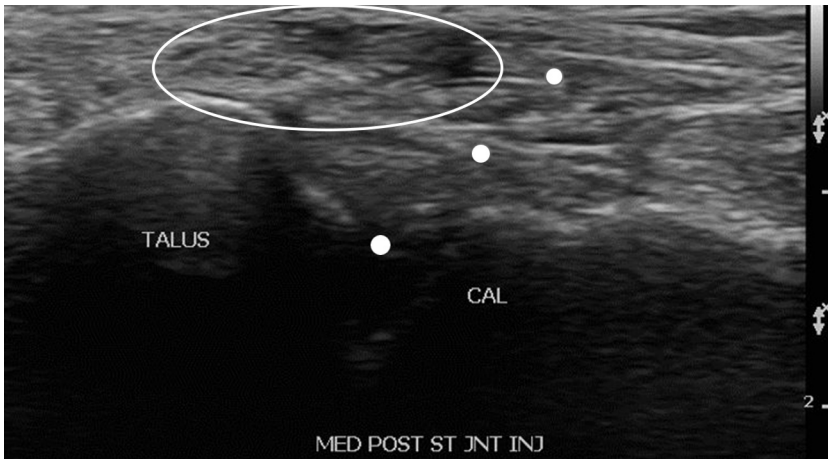
The ultrasound machine is ideally located contralateral to the involved ankle with the provider sitting ipsilateral to the involved ankle.

The transducer is placed in the sagittal plane just lateral to the Achilles tendon (**Fig. 16**). The transducer face is angled in a slight medial direction to allow for visualization of the posterior aspects of the tibia, talus, and calcaneus. The needle is





**Fig. 11.** Posteromedial subtalar joint injection. Transducer short axis to joint, needle approach out of plane with transducer.



**Fig. 12.** Posteromedial posterior subtalar joint injection, short axis to joint, needle path out of plane with transducer. Oval encircles the tibial neurovascular structures. Dots represent path of needle. Each dot signifies a pass of the needle tip below the ultrasound beam. The needle is directed along a steeper trajectory with each pass until the tip is visualized within the joint space. Left, superior; right, inferior. CAL, calcaneus.



**Fig. 13.** Transducer position for anterolateral subtalar joint injection. Right, distal and inferior; left, proximal.

inserted in a posterolateral direction, in plane with the transducer (**Fig. 17**). The posterior subtalar joint recess is visualized just deep to the Kager fat pad by visually following the posterior cortex of the calcaneus up to the joint space (**Fig. 18**).

## **MIDFOOT AND FOREFOOT JOINT INJECTIONS**

### ***Regional Anatomy***

The midfoot and forefoot joints are synovial joints that are subject to similar disease processes as the hindfoot. Most commonly, patients present with localized pain and swelling related to arthritis or a crystalline disease process. The joints are usually easier to view and access from a dorsal approach. Overlying structures can include the extensor tendons of the toes and branches of the superficial and deep peroneal nerves along with their vascular components.

### ***Patient Position***

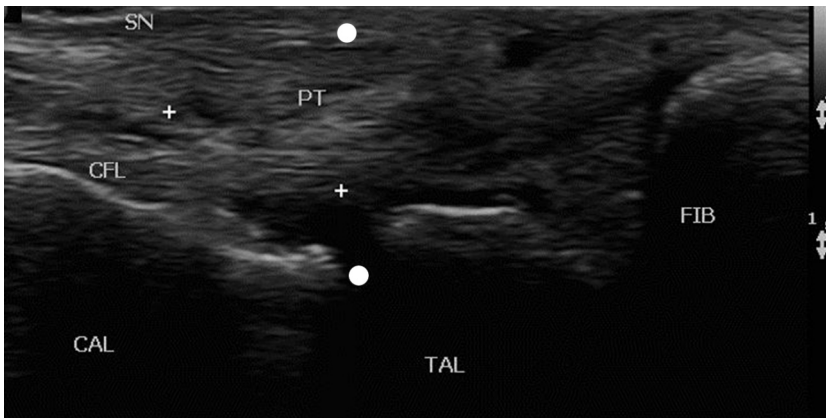
The patient position is supine on the examination table.

### ***Ultrasound Machine Position***

In general, the machine is placed ipsilateral to the involved side with the provider sitting facing the foot with the monitor easily viewed.



**Fig. 14.** Injection of anterolateral subtalar joint, transducer short axis to joint, needle out of plane with transducer. Left, proximal; right, distal.



**Fig. 15.** Anterolateral posterior subtalar joint injection, short axis to joint, needle path out of plane with transducer. Dots represent path of needle. Each dot signifies a pass of the needle tip below the ultrasound beam. The needle is directed along a steeper trajectory with each pass until the tip is visualized within the joint space. The crosses indicate the distance between sural nerve and joint space. Left, inferior; right, superior. CFL, calcaneofibular ligament; FIB, lateral malleolus of fibula; PT, posterior tibial tendon; SN, sural nerve; TAL, talus.



**Fig. 16.** Transducer position for posterolateral subtalar joint injection. Left, lateral; right, medial.

### ***Transducer Selection***

High-frequency linear-array, short-footprint devices are preferred.

### ***Needle***

- Injection only: needle 25 to 30-gauge, 25 to 38-mm
- Aspiration: 18-gauge, 38-mm needle

### ***Injectate***

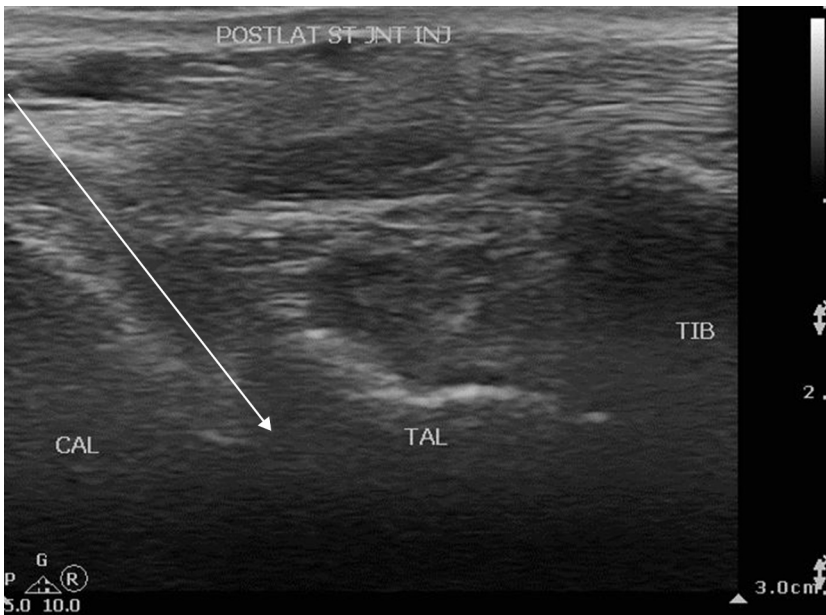
Anesthetic with or without corticosteroid; volume may depend on the size of the joint and amount of degenerative changes, where applicable.

### ***Approaches***

The joints can be approached from distal to proximal, lateral to medial, or medial to lateral.<sup>5</sup> The best approach depends on the target joint, patient size, and the regional anatomy overlying the joint. Careful preinjection ultrasound scanning allows providers to determine the safest, most efficient window for needle insertion. This author generally uses and recommends an in-plane approach relative to the transducer, but an out-of-plane approach is used if the needle path is limited by overlying structures. Regardless of the approach used, the ultimate goal is to place the needle tip within the joint space, and below the level of the joint capsule (**Figs. 19** and **20**).



**Fig. 17.** Posterolateral subtalar joint injection, transducer short axis to joint, needle in plane with transducer. Left, lateral; right, medial.



**Fig. 18.** Posterolateral posterior subtalar joint injection, long axis to joint, needle in plane with transducer. Arrow delineates path of needle. Left, inferior; right, superior. TIB, tibia.



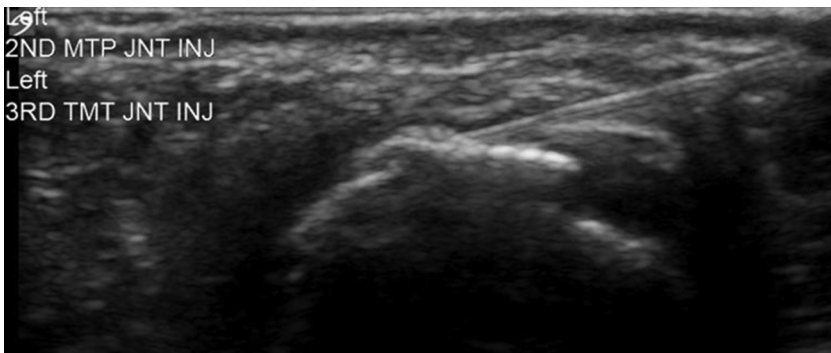


**Fig. 19.** Metatarsophalangeal joint injection, transducer long axis to joint, needle approaching in plane with transducer. Left, proximal; right, distal.

## TENDON SHEATH INJECTIONS

### *Regional Anatomy*

Typical tendon sheath targets include the peroneus longus and brevis; overlap of the FHL and flexor digitorum longus in the foot (master knot of Henry); tibialis anterior; and, in rare cases, the posterior tibial tendon. As a general rule, the author avoids injection of corticosteroid in the posterior tibial tendon sheath because of concerns regarding its propensity to rupture. Although, technically, the plantar fascia does not have a sheath, this structure is typically a target for corticosteroid injections or other related procedures.



**Fig. 20.** Sonographically guided second metatarsophalangeal joint injection, long axis to joint, needle in plane with transducer. Left, medial; right, lateral.

When present, a tendon sheath effusion can aid in placement of the needle tip. If no effusion is present, the sheath can gently be filled with careful placement of the needle tip adjacent to the target tendon. Along the lateral foot and ankle, clinicians should account for the sural nerve when approaching the peroneal tendon sheath. Medially, the tibial neurovascular structures need to be identified before the procedure.

### ***Patient Position***

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Positioning depends on the target; in general, the foot and ankle are placed in a manner that optimizes visualization of the target and allows easier placement of the injectate.

### ***Ultrasound Machine and Provider Position***

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The ultrasound machine is generally located ipsilateral to the involved side with the provider seated facing the foot and ankle and able to easily visualize the monitor and hands.

### ***Transducer***

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High-frequency linear-array, short-footprint transducers are preferred.

### ***Needle***

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A needle of 25 to 30 gauge and 25 to 38 mm is used.

### ***Injectate***

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Local anesthetic with corticosteroid; volumes may vary by tendon sheath injected and individual patient anatomy.

### ***Approaches***

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#### ***Flexor hallucis longus tendon sheath***

**Patient position** The patient position is prone with a foot hanging over the examination table.

**Transducer position** Transducer position is in the axial plane to the lower leg and medial to the Achilles tendon. Depth of field of view and focal zones are adjusted to allow visualization of the FHL tendon as it courses past the talus (**Fig. 21**).

**Needle approach** The needle enters the skin just lateral to the Achilles tendon and is directed through the Kager fat pad into the FHL tendon sheath (**Fig. 22**).

#### ***Peroneal tendon sheath***

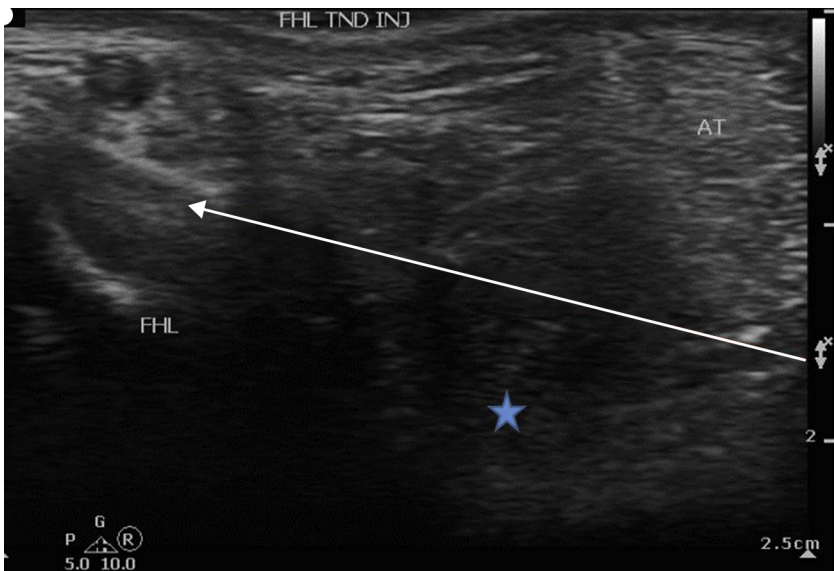
**Patient position** The patient position is lateral recumbent with the involved side up.

**Transducer position** The transducer position is axial to the tendons. The tendon sheaths can be injected anywhere along their course, from just proximal to the lateral malleolus to along the region of the foot.

**Needle approach** The needle can be directed in plane with the transducer in either an anterior or posterior direction depending on the location of the injection. In general, when injecting above the level of the lateral malleolus, it is easier to approach from posterior to anterior (**Figs. 23** and **24**). This direction is in contradistinction to that used when injecting below the level of the malleolus, where an anterior-to-posterior approach is recommended to help avoid the adjacent sural nerve (**Figs. 25** and **26**).



**Fig. 21.** FHL tendon sheath injection, short axis to the tendon, needle approach in plane with transducer. Left, medial; right, lateral.



**Fig. 22.** Sonographically guided flexor hallucis longus tendon sheath injection, short axis to the FHL tendon and Achilles tendon (AT), needle approach in plane with transducer. Arrow delineates path of needle. Star, Kager fat pad. Left, medial; right, lateral.

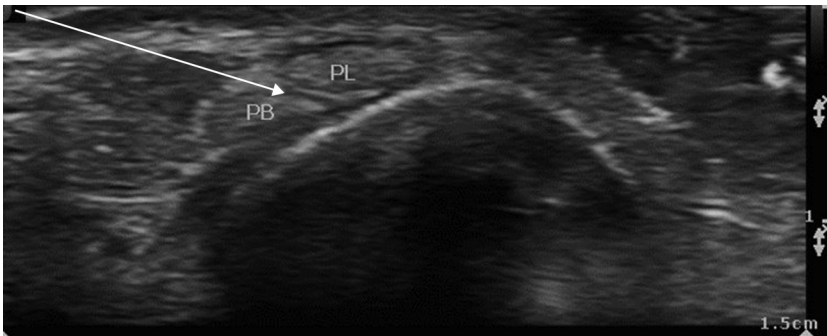


**Fig. 23.** Peroneal tendon sheath injection proximal to malleolus, short axis to the tendons, needle approach in plane with transducer. Left, proximal; right, distal.

***Plantar fascia injection***

**Patient position** The patient position is prone a with foot hanging off the examination table.

**Transducer position** The transducer can be placed long axis or short axis in reference to the plantar fascia (**Fig. 27**).



**Fig. 24.** Sonographically guided injection of peroneal tendon sheath at location proximal to lateral malleolus, short axis to peroneus longus (PL) and peroneus brevis (PB) tendons, needle approach in plane with transducer. Arrow delineates path of needle. Left, posterior; right, anterior.



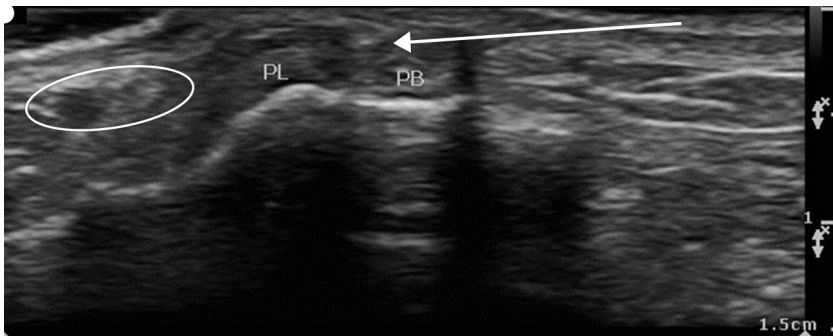
**Fig. 25.** Peroneal tendon sheath injection distal to lateral malleolus, short axis to the tendons, needle approach in plane with transducer. Left, proximal; right, distal.

**Needle approach** The approach depends on the desired outcome. It can be advanced in or out of plane with the transducer, from a medial/lateral or proximal/distal direction (**Fig. 28**). The needle and solution can be delivered superficial to, within, or deep to the plantar fascia.<sup>6</sup> Delivering an injection deep to the plantar fascia can also allow for treatment of Baxter neuropathy, which is a less common but clinically important cause of chronic heel pain.<sup>7</sup>

## BURSA INJECTION

### *Regional Anatomy*

The retrocalcaneal and retro-Achilles bursae are targets for injection about the hind-foot. On occasion, an adventitial bursa about the foot and ankle may be present, usually along the first metatarsophalangeal joint or plantar to the metatarsal heads.<sup>8</sup>



**Fig. 26.** Sonographically guided injection of peroneal tendon sheaths at location distal to lateral malleolus. Imaged short axis to PL and PB tendons, needle approach in plane with transducer. Arrow delineates path of needle. Oval encircles sural nerve and vein. Left, inferior and posterior; right, anterior and superior.





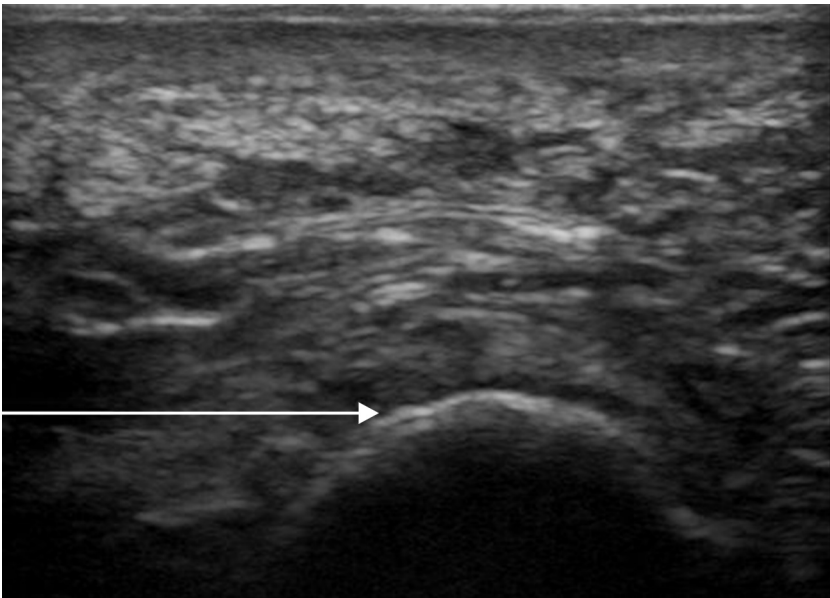
**Fig. 27.** Plantar fascia injection, short axis to plantar fascia origin, needle approach in plane with transducer. Left, proximal; right, distal.

#### ***Patient Position***

The patient position is prone or supine depending on the location of the target bursa.

#### ***Ultrasound Machine/Provider Location***

Ipsilateral to the involved bursa, the provider faces the foot, with the ability to visualize the monitor and hands.



**Fig. 28.** Sonographically guided plantar fascia injection. Arrow denotes needle path. Needle tip placed just deep to plantar fascia just distal to medial calcaneal tubercle. Left, medial; right, lateral.

**Transducer**

A high-frequency linear-array transducer is used.

**Needle**

- Injection only: a needle of 25 to 30 gauge, 25 to 38 mm.
- Aspiration: 18-gauge, 38-mm needle.

**Approach**

In or out of plane relative to the transducer. The needle can be advanced from either a medial or lateral direction into the desired bursa (**Figs. 29** and **30**).

**INTERDIGITAL NEUROMA OF FOOT****Regional Anatomy**

An interdigital neuroma of the foot involves the common plantar digital nerves, which are derived from the medial and lateral plantar nerves. Most frequently, neuromas are found at the third intermetatarsal space; a neuroma in this specific interdigital space is known as a Morton neuroma. This location is related to several factors: the common plantar nerve here forms from contributions of both the medial and lateral plantar nerves, the third metatarsal space is narrower than the other metatarsal spaces, and the third and fourth metatarsals tend to be more mobile relative to the other metatarsals.<sup>9</sup> Corticosteroid injections for symptomatic interdigital neuromas can potentially provide relief of pain for up to 3 months.<sup>10</sup>

**Patient and Ultrasound Machine Position**

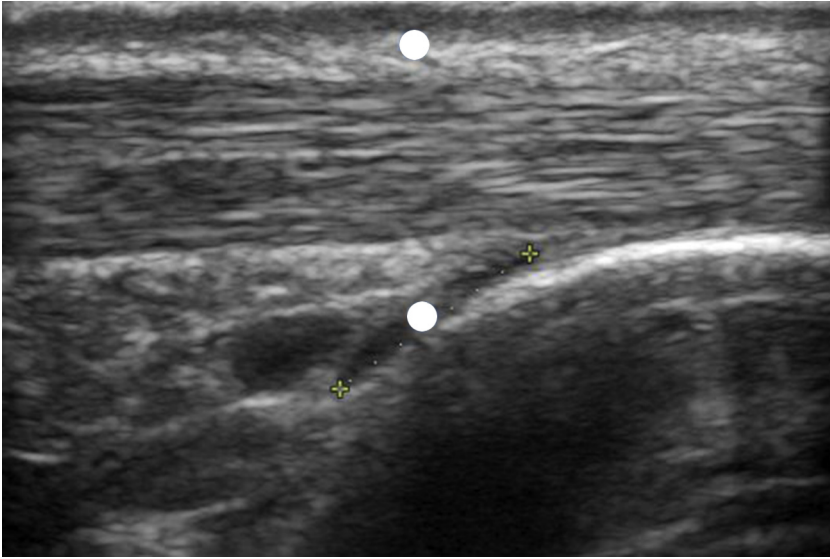
The patient is supine with the machine ipsilateral to the involved side, and the provider is facing the foot with the ability to visualize the monitor and hands.

**Transducer**

A high-frequency linear-array transducer is used.



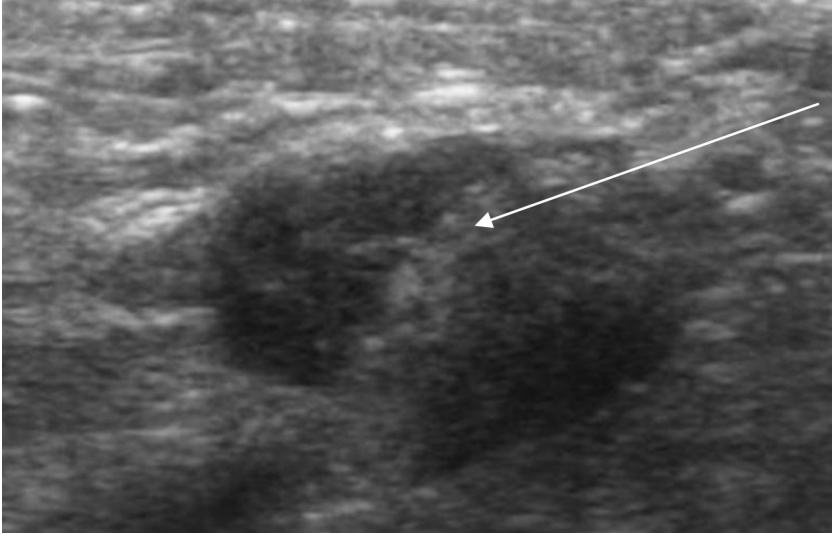
**Fig. 29.** Retro-Achilles or retrocalcaneal bursa injection, short axis to bursa, needle approach in plane with transducer. Right, lateral; left, medial.



**Fig. 30.** Sonographically guided retro-Achilles or retrocalcaneal bursa injection with out-of-plane approach depicted. The dots represent walk-down technique with needle to target bursa; in this example, the retrocalcaneal bursa is highlighted by crosses. Left, proximal; right, distal.



**Fig. 31.** Sonographically guided interdigital neuroma injection, long axis to neuroma, needle approach in plane with transducer. Left, lateral; right, medial.



**Fig. 32.** Sonographically guided interdigital neuroma injection, long axis to neuroma, needle approach in plane with transducer. Arrow delineates path of needle. Left, proximal; right, distal.

### ***Needle***

A needle of 25 to 30 gauge and 25 to 38 mm is used.

### ***Approach***

Distal to proximal in plane with the transducer, the needle enters between the toes along the plantar side of the interdigital space (**Figs. 31** and **32**). The transducer can be placed on the dorsal or plantar aspect of the foot.

### **SUMMARY**

Injections about the foot and ankle are commonly performed in musculoskeletal practice. Using sonographic guidance can improve the accuracy and potentially increase the safety of these procedures. Although this article is not exhaustive in describing ultrasound-guided injection techniques about the foot and ankle, it can serve as a good foundation from which to develop approaches when targeting other structures.

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