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**Goals:**

1. Discuss clinical applications of musculoskeletal ultrasound in the foot and ankle.
2. Demonstrate utility of diagnostic ultrasound in clinical decision-making.

Virtually all tendons and nerves about the ankle and foot region are amenable to diagnostic ultrasound examination. High frequency (>10 MHz) linear array and small footprint linear array transducers are typically utilized.

In patients presenting with posterior ankle pain, ultrasound can identify Achilles tendinopathy and differentiate between tendinosis and partial thickness tearing. Doppler examination may reveal tendon neovascularization, which is typically present in more severe and symptomatic cases. Associated paratenonitis, retrocalcaneal bursitis, and retro-Achilles (superficial Achilles) bursitis may be identified as primary or contributing conditions. Ultrasound guided bursa and paratenon injections may assist in diagnosis and management of these latter conditions, although caution must be exercised with respect to the use of corticosteroids in the vicinity of the Achilles or other ankle-foot tendons. Recent uncontrolled case series have reported symptomatic improvement in patients with chronic Achilles tendinopathy treated with ultrasound guided sclerosis of neovessels or intratendinous injection of dextrose (prolotherapy). Further research is warranted in this regard. Ultrasound can readily identify Achilles tendon rupture and assist in triage. In selected patients, tendon apposition during ankle plantar flexion has been associated with a favorable outcome following non-operative management. Deep posterior ankle pain may be due to flexor hallucis longus tendinopathy or tenosynovitis, posterior ankle joint effusion/synovitis or loose bodies, or os trigonum syndrome, all of which may be evaluated ultrasonographically on more sophisticated machines. Diagnostic tendon sheath injection or diagnostic/therapeutic os trigonum injection can be completed ultrasonographically as clinically indicated.

In the posteromedial ankle, ultrasound can readily depict the structures within the tarsal tunnel and adjacent region. Ultrasound can detect and characterize posterior tibial tendon disorders as accurately as MRI for clinical decision making. Although uncommonly performed, ultrasound guidance can be utilized to inject the posterior tibial tendon sheath for diagnostic or therapeutic purposes. The tibial nerve, medial and lateral plantar branches, and medial calcaneal branch can all be interrogated using high frequency transducers, facilitating identification of compression, inflammation, or neuroma. Ultrasound guided nerve block can be performed as indicated. Periarticular ganglion cysts arising from the medial tibotalar or subtalar joints may produce ankle pain or true tarsal tunnel syndrome. They appear as anechoic, multilobulated structures, and can be therapeutically aspirated using ultrasound guidance, although improvement is often temporary. It is important to recognize that ultrasound cannot adequately evaluate the joint structures from which such a cyst may arise and MRI would be recommended in such cases.
The peroneal tendons account for the majority of pain syndromes in the posterolateral ankle. Ultrasound accurately identifies and characterizes peroneal tendon disorders and is the test of choice for demonstrating tendon subluxation or dislocation. More recently, symptomatic peroneal tendon snapping within the retrofibular groove has been identified as a source of posterolateral ankle pain as demonstrated by ultrasound. Therapeutic and diagnostic peroneus longus or brevis tendon sheath injections may be performed as clinically indicated. Although uncommon, sural nerve disorders can manifest as posterolateral ankle pain. The nerve can be easily identified just anterior to the Achilles tendon and adjacent to the lesser saphenous vein. From this point, it can be traced distally in a transverse view to the level of its bifurcation at the base of the fifth metatarsal in most cases.

Tendon disorders are uncommon in the anterior ankle, although ultrasound can readily confirm a clinically suspected anterior tibialis tendon rupture. Ankle joint effusions are best visualized anteriorly in an anatomical sagittal plane with the ankle in slight plantarflexion. Effusions are usually simple, but may be complex and contain a variable amount of synovitis or loose bodies. Ultrasound guided aspiration and injection can be performed, taking care to avoid the dorsalis pedis artery and deep peroneal nerve. In the appropriate clinical setting, hyperchoic debris in the anterolateral gutter would support a clinical diagnosis of anterolateral impingement syndrome. Ultrasound guided injection may be helpful to accurately place the injectate into the meniscoid tissue. Examination of the anterior talofibular, calcaneofibular, and posterior talofibular ligaments can be performed, but is generally of no clinical utility because the ultrasonographic findings do not alter management.

Within the foot, ultrasound is most commonly utilized to confirm a clinical diagnosis of plantar fasciitis and characterize the structural severity. Similar to lateral epicondylitis in the elbow, soft tissue imaging is not indicated in most cases. In refractory or atypical cases, thickening (> 4-5 mm), hypoechogenicity, and heterogeneity of the plantar fascia would support a clinical diagnosis of plantar fasciitis. Absence of structural findings warrants a search for other causes. Ultrasound guided plantar fascia injections have been reported to provide greater therapeutic efficacy compared to non-guided injections in a single investigation, although firm conclusions in this regard await further study. Ultrasound can interrogate all the midfoot joints via a dorsal approach, identifying arthritis, synovitis, and periarticular ganglia. Dorsal osteophytic lipping resulting in neuritis or tendinopathy can be depicted with static ultrasound and confirmed with dynamic testing. Diagnostic or therapeutic ultrasound guided joint aspirations and injections may be performed for these conditions as clinically indicated. Interrogation of the plantar aspect of the midfoot remains challenging due to the complex anatomy and similar echogenicity of multiple layers of crossing tendons. The primary indication for ultrasound in this region is to confirm a clinically suspected plantar fibroma, appearing as a focal, hypoechogenic fusiform swelling located within the plantar fascia along its medial border. A mass lesion presenting with any other appearance warrants further evaluation with CT or MRI. Within the forefoot, ultrasound can detect effusions and/or synovitis in the metatarsophalangeal and interphalangeal joints, plantar plate disruptions, and Morton's neuromas, and intermetatarsal bursitis, facilitating identification of potential pain generators in patients presenting with forefoot pain or metatarsalgia. Morton's neuroma appears as a well defined, non-compressible, hypoechogenic mass lesion within the plantar aspect of the intermetatarsal space at the level of the metatarsal heads, as visualized from a plantar approach. Continuity with the interdigital nerve confirms the diagnosis, but is inconsistently visualized even using sophisticated machines. Morton's neuroma is often accompanied by intermetatarsal bursitis, appearing as an anechoic, compressible fluid collection dorsal to the Morton's neuroma as visualized from a plantar approach. Therapeutic joint aspiration and injection, as well as Morton's neuroma and intermetatarsal bursa injection, can be performed using ultrasound guidance.
Despite the broad range of clinical applications in the ankle and foot, ultrasound cannot adequately evaluate the intra-articular structures of the hindfoot or midfoot joints, and has limited capability to image many deeply located structures in the plantar midfoot region. Radiographs are recommended to supplement any ultrasound examination, and when clinically indicated, advanced diagnostic imaging should be pursued in the form of MRI, CT or bone scan.

