Current Ultrasound Application in the Foot and Ankle

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KEYWORDS

• Musculoskeletal ultrasound • Image-guided injection • Ultrasound of the foot/ankle
• Plantar fascia • Tendinosis • Tendonitis • Hydrodissection

KEY POINTS

- Ultrasound has been used in the foot and ankle for nearly 2 decades and is being used with increasing frequency and indication.
- Utilization in diagnosis demonstrates unique advantages that are complementary to other imaging modalities.
- High-resolution ultrasound is the modality of choice for needle placement, including joint injection.
- Increasing collaboration between foot and ankle surgery and skilled ultrasonographers is leading to innovation in minimally invasive treatment of common diagnoses.

INTRODUCTION

Ultrasound of the lower extremity was one of the first utilizations of Ultrasound in Musculoskeletal Medicine and continues to grow in practice and publication with diagnostic and interventional applications.[1–3] Before the 1990s, it was primarily used for the evaluation of mass and soft tissue lesions. There were early uses in joint imaging, especially with regard to characterization of the Baker cyst and in characterizing tendon abnormality.[2,3] In the last 15 years, more and more applications are being documented in the literature, further supporting the diagnostic and interventional use of ultrasound. Lower-extremity applications have been popular, likely because of the inherent strengths of ultrasound as they relate to the foot and ankle. Sufficient clarity and detail necessary for diagnosis or interventions under ultrasound are best when the structures are superficial, are discreet, and have clear landmarks; all accurate descriptors of foot and ankle anatomy. Musculoskeletal ultrasound's cost-effectiveness and absence of radiation is welcomed by providers and patients alike.[4] To date, the published literature abounds with applications of musculoskeletal ultrasound in foot and ankle diagnostics from mass lesions to nerve entrapment syndromes. Interventional applications continue to develop as well, ranging from accurate needle placement to emerging therapies for common diagnoses while also offering the foot and ankle surgeon alternative methods of performing traditional surgeries.

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PLANTAR FASCIOSIS

Plantar fasciosis is a commonly encountered condition that often requires imaging for proper diagnosis.[5] Ultrasound provides an accurate and cost-effective modality to evaluating the bands of the plantar fascia and its attachments on the calcaneus. Biomechanics of the lower extremity create tensile forces that result in disruption of the fascia, producing heel pain.[4,6] The cause of plantar fascial pain is not fully understood; however, inflammation is noted on histologic evaluation of acute disease, whereas degeneration is noted in chronic plantar fasciosis.[4] The condition is noted to affect 10% to 20% of injured athletes and 10% of the general population, with 5% to 10% going onto surgical intervention.[6,7] Sonography can be effectively used to diagnose plantar fasciosis and assess response to interventions based on a 2016 systematic review of clinical trials.[7]

On ultrasound, the plantar fascia displays the classic compact fibrillar pattern (Fig. 1). This pattern is seen when the fascicles of a ligament or tendon are visualized in the long axis and directly perpendicular to the sound beam of a high-frequency ultrasound probe. The image typically demonstrates a dense grouping of transverse hyperechoic lines with minimal spacing and close parallel arrangement.[5] When evaluating patients, multiple characteristics have been described to identify diseased tissue. Thickness greater than 4 mm, increased Doppler signal, calcific disease, and loss of both echogenicity and fibrillar pattern were correlated with painful heels.[5,8] Not only is ultrasound a preferred tool for diagnosis of plantar fasciosis, but also it has been shown to be effective at monitoring a patient's response to treatment[8,9] Moustafa and colleagues[8] compared patients with painful plantar fasciosis against asymptomatic heels and monitored their response to dexamethasone injections. Each patient had a repeat ultrasound evaluation at their 3-week follow-up appointment to assess their plantar fascia. They noted a decrease in plantar fascia thickness and an associated reduction in symptoms, giving an objective finding to the patient's improvement during treatment. Multiple studies have found a correlation between plantar fascia thickness and pain. These changes have been described following various treatment modalities, such as nonsteroidal anti-inflammatory drug therapy, Botox type A injections, shockwave therapy, and laser therapy.[10] The use of ultrasound allows for instant and dynamic visualization of other structures in the foot that can cause heel pain. Ultrasound-guided Tinel of Baxter nerve can aid in accurate diagnosing and treatment plans. Baxter neuropathy along with medial calcaneal neuropathy can occur with or without plantar fasciopathy. Other differential diagnoses that can be visualized via ultrasound include plantar fibromatosis, foreign bodies, calcaneal stress fractures, rheumatoid nodules, plantar vein thrombosis, and rupture (Fig. 2).[4]

Measurement of the plantar fascia is an important aspect of diagnosis. In one study, men had an average thickness of 2.4 mm on the right foot and 2.5 mm on the left foot. Women had thinner fascia, with 1.8 mm bilaterally. The same study found that thickness increased with age, height, body mass index, and weight.[11] Decreases in thickness are associated with decreased pain and can be used to evaluate different treatment modalities.[10] It is

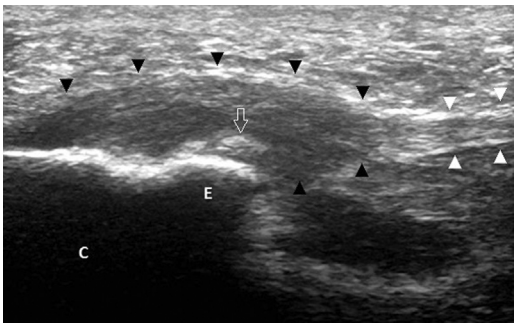

Fig. 1. Severe plantar fasciosis. Plantar long-axis view of the medial band. Normal thickness and compact fibrillar pattern is seen just distal to the origin (*white arrowheads*). The origin at the calcaneus (C) is grossly thickened with hypoechoic loss of layered architecture (*black arrowheads*) and calcific change (*white arrow*) at the enthesophyte (E).

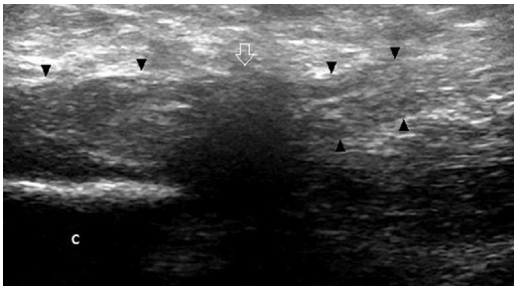

Fig. 2. Subacute high-grade partial tear of the plantar fascia. Long-axis view of the plantar fascia demonstrates complete loss of echotexture with a spheroid hypoechoic lesion (*arrow*). The surrounding fascia is edematous and thickened (*arrowheads*). C, calcaneus.