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Review

Ankle and midfoot ligaments: Ultrasound with anatomical correlation: A review

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ABSTRACT

We present a detailed overview of anatomical and US features of ankle and midfoot ligaments based on our own dissections and cadaver studies as well as US imaging in cadavers and volunteers. The ligament anatomy about the ankle and midfoot is complex. Most ligaments are superficial and hence very well accessible for US. US technique to obtain optimal visualization however is difficult and requires a learning curve. We discuss US technique in detail for each individual ligament. We divided the ligaments in different groups: tibiofibular ligaments, Bassett's ligament, lateral collateral ligament complex (anterior talofibular ligament, calcaneofibular ligament, lateral talocalcaneal ligament, posterior talofibular ligament), medial collateral ligament complex, spring ligament, Chopart joint ligaments (bifurcate ligament, dorsal talonavicular ligament, lateral calcaneocuboid ligament, long and short plantar ligaments), Lisfranc ligaments, sinus tarsi ligaments.

1. Introduction

Ankle and foot ligaments play an important role in providing stability to the joints they cross. Ankle and mid-foot injuries are common [1] and can disrupt these ligaments leading to acute and chronic joint instability, as well as pain.

The anatomy of the ligaments around the ankle and foot is quite complex. In this overview in the form of a pictorial essay, we present a detailed depiction of normal anatomy of these ligaments and their imaging appearance on ultrasound (US), which can be very useful in the correct diagnosis [2] and treatment planning [3] of traumatic and non-traumatic ligamentous abnormalities [4]. Ultrasound can additionally be useful in needle guidance for interventions more accurately and efficiently compared to blind procedures, especially in ankle and foot where the anatomy is complex, different structures need to be identified and precise technique is a requisite [5].

We divide the ligaments in different groups. At the level of the ankle, we address the tibiofibular ligaments, Bassett's ligament, lateral collateral ligament complex (anterior talofibular ligament, calcaneofibular ligament, lateral talocalcaneal ligament, posterior talofibular ligament), and medial collateral ligament complex (also known as 'deltoid' ligament complex).

We discuss the spring ligament together with the tibiospring component of the deltoid ligament. Ligaments at the Chopart joint include the bifurcate ligament, dorsal talonavicular ligament, lateral calcaneocuboid ligament as well as long and short plantar ligaments. The emphasis of our work is less on Lisfranc ligaments: The several tarsometatarsal ligaments can be assessed, in particular along the dorsum of the foot [6] but the interosseous Lisfranc ligament is beyond the reach of US [7]. Also the sinus tarsi ligaments are largely beyond the reach of ultrasound [8].

2. Discussion

After an initial description of general ultrasound features of ligaments, we describe the ligaments systematically on the basis of the joints they stabilize. Special anatomic and US features of the ligaments will be emphasized and illustrated.

Ankle ligaments are essentially bundles of collagen fibers [9,10]. In general, on US images, they appear as echogenic fibrillary structures similar to any other ligaments [10].

The US beam should be as perpendicular as possible to the ligament to avoid anisotropy artifact [9]. If this is not the case, the ligament may artifactually lose its fibrillary structure and misdiagnosis may occur.

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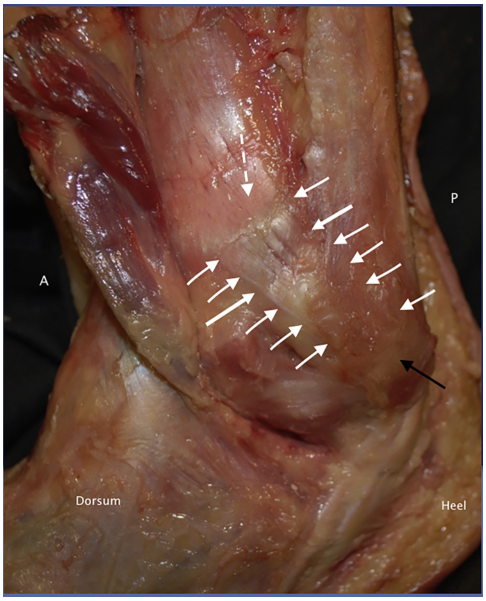

Fig. 1. Anatomical specimen of ankle viewed from lateral side showing anterior tibiofibular ligament (arrows). The ligament extends between the anterior tubercle of the tibia on one side (dashed arrow) and the anterior border of the fibular shaft and lateral malleolus on the other side (black arrow). Note its multifibered appearance. (A = anterior, P = posterior).

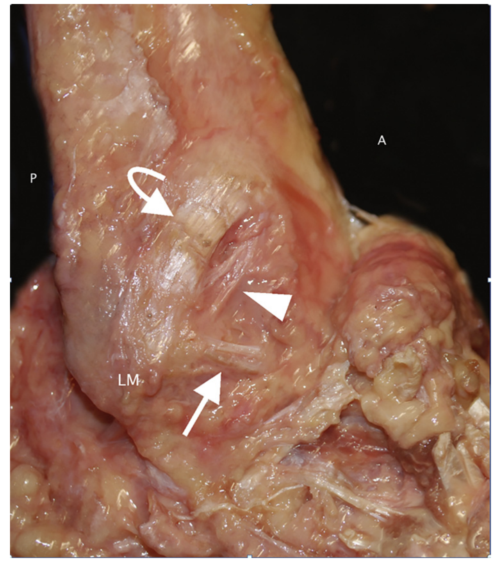

Fig. 3. Anatomy specimen of ankle viewed from anterolateral aspect: The Bassett's ligament (arrowhead) is seen in relation to the anterior tibiofibular ligament (curved arrow) which lies superior to it and the anterior talofibular ligament (straight arrow) which lies inferior to it. Bassett's ligament is the most distal fascicle of the anterior tibiofibular ligament. (A = anterior, P = posterior, LM = lateral malleolus).

On US, ankle ligaments are usually scanned along their long axis. Short-axis US, however can provide important additional information [10] and we recommend always assessing the ligaments in both axes.

Dynamic stress maneuvers may provide additional information about ligament integrity [10,11]. However, these techniques are not standardized and reference values are largely absent in the literature.

3. Tibiofibular (syndesmotic) ligaments

The distal tibiofibular joint (syndesmosis) is reinforced by an anterior tibiofibular ligament and posterior tibiofibular ligament [1,12,13].

The anterior tibiofibular ligament courses obliquely downward and laterally from the anterior tubercle of the tibia and inserts on the anterior border of distal fibular shaft and lateral malleolus (Fig. 1).

To visualize the ligament with US, the ankle should be placed in dorsiflexion. Our approach consists of placing the probe in an oblique transverse plane above the level of the ligament where a clear gap can be seen between the tibia and fibula. When the probe is moved inferiorly both bones join up closely, and just distal to this level the ligament is best depicted (Fig. 2). It should be emphasized that the ligament courses very obliquely and when the probe is not placed along this oblique axis, the ligament will not be well shown.

Bassett's ligament is considered to represent the most distal fascicle of the anterior tibiofibular ligament [14,15]. In reality, it is clearly separated from the rest of the ligament by fibro-fatty tissue and lies deeper to the rest of the ligament (Fig. 3). To visualize the ligament with US, the exact same approach as for the anterior tibiofibular ligament can be used. Once the level of the latter ligament is reached, the probe is displaced slightly more inferiorly, still in an oblique plane, and Bassett's ligament becomes evident. At this level, the bony contour of the talus can be visualized, providing another US clue that the probe is actually positioned at Bassett's ligament rather than at the anterior tibiofibular ligament (Fig. 4).

Bassett's ligament has been implicated in anterolateral impingement, although this is not entirely agreed upon. Correlation of abnormal imaging findings with clinical impingement tests is a prerequisite to consider such a diagnosis. Excision of Bassett's ligament (arthroscopically or by open surgery) could relieve the pain without compromising ankle stability [1,16,17].

The posterior tibiofibular ligament (Fig. 5) is stronger than the anterior tibiofibular ligament [10]. It has two components, superficial and deep. The superficial and superior component originates at the

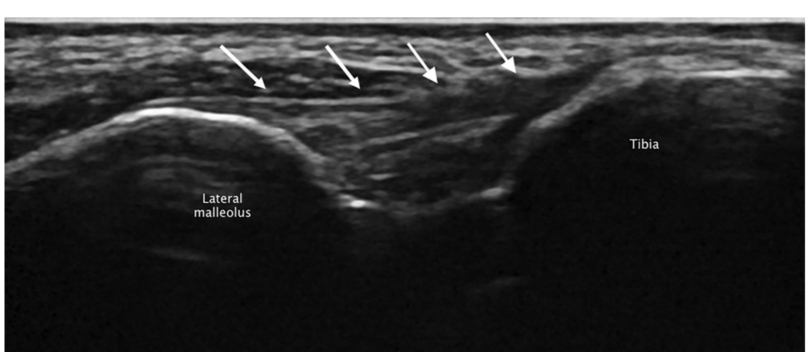

Fig. 2. US image of distal anterior tibiofibular ligament (arrows). An excellent view of the anterior tibiofibular ligament can be obtained by holding the probe obliquely with the foot in dorsiflexion.