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MSK Ultrasound Bites: Tips and Tricks

Diagnostic Musculoskeletal Ultrasound in the Evaluation of the Deltoid Ligament of the Ankle

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The deltoid ligament of the ankle is a critical stabilizer of the medial aspect of the joint, often implicated in injuries ranging from sprains to complex fracture-dislocation scenarios. Injuries to the deltoid ligament are less common than lateral ankle sprains but can lead to chronic instability and dysfunction if not properly diagnosed and managed. Accurate diagnosis of deltoid ligament injuries is essential for appropriate treatment planning and optimizing patient outcomes. While magnetic resonance imaging (MRI) is considered the gold standard for ligament assessment, diagnostic musculoskeletal (MSK) ultrasound offers a portable, real-time, and cost-effective alternative that is gaining traction in rehabilitation and sports medicine settings. This article reviews the utility of MSK ultrasound in evaluating the deltoid ligament, including its anatomy, common injury patterns, sonographic techniques, and clinical implications for rehabilitation professionals. By integrating MSK ultrasound into clinical practice, providers can improve the accuracy of diagnosis, monitor healing progression, and guide rehabilitation strategies for optimal patient outcomes.

INTRODUCTION

Ankle injuries are among the most common musculoskeletal issues encountered in clinical practice, with the deltoid ligament involved in 10-15% of all ankle sprains. While deltoid ligament injuries are often associated with ankle fractures or high-energy trauma, isolated ligamentous damage can occur in sports and daily activities. Injuries to this ligament can significantly affect ankle stability, leading to chronic pain or dysfunction if not accurately diagnosed and managed. Traditional imaging modalities, such as MRI and radiography, provide valuable diagnostic information; however, constraints such as cost, accessibility, and time make it less practical in many rehabilitation settings. Diagnostic MSK ultrasound offers and readily accessible alternative for evaluating ligament integrity. This is important for those who need a time sensitive way to view the anatomy, for example when other diagnostic methods have a long waiting time to get in for assessment.[1] It also offers another great benefit of obtaining dynamic testing of ankle stability, as displacement of the medial structures during an eversion stress test is diagnostic of a deltoid ligament injury.[2,3] This article aims to provide a comprehensive guide for rehabilitation providers on the use of MSK ultrasound to evaluate the deltoid ligament, emphasizing its advantages, limitations, and clinical application. A recent narrative review of the use of ultrasound for ankle injuries suggests that systematic reviews and meta-analyses report that the pooled sensitivity and specificity of ultrasound are superior to those of the other imaging modalities such as MRI.[4] The high sensitivity of ultrasonography in detecting normal deltoid ligament from an injured is 0.90 indicating it is an excellent modality for the medial ankle ligaments.[5-7]

ANATOMY OF THE DELTOID LIGAMENT

The deltoid ligament, also known as the medial collateral ligament. It is a strong, bi-layered triangular structure on the medial side of the ankle, extending from the medial malleolus to the distal bones of the foot.[8] The ligament stabilizes the ankle joint against eversion forces and resists external rotation of the talus. The classic mechanism of injury to the deltoid ligament is forced eversion often in conjunction with lateral malleolar fractures. Another mechanism is due to inversion ankle sprains especially those with cases of chronic ligament ankle instability.[4]

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SUPERFICIAL LAYER – PROVIDES A BROAD SUPPORT AGAINST EVERSION FORCES

- Tibiocalcaneal ligament: Connects the tibia to the calcaneus.
- Tibionavicular ligament: Extends toward the navicular bone.
- Posterior superficial tibiotalar ligament: Stabilizes the posterior aspect of the talus.

DEEP LAYER – PRIMARILY STABILIZES THE TALUS AGAINST MEDIAL TRANSLATION AND EXTERNAL ROTATION

- Anterior tibiotalar ligament and posterior deep tibiotalar ligament form the deep component and are critical for resisting excessive rotational forces.

Understanding the layered structure and function of the deltoid ligament is essential for accurate MSK ultrasound assessment and differentiation of injury severity.

THE ROLE OF MSK ULTRASOUND IN LIGAMENT EVALUATION

ADVANTAGES

- Real-Time Imaging: Allows dynamic evaluation of ligament integrity while the ankle is moved through its range of motion.
- High-Resolution Visualization: Provides detailed images of soft tissue structures, including individual components of the deltoid ligament.
- Accessibility and Cost-Effectiveness: MSK ultrasound is portable, widely available, and less expensive than MRI.
- Dynamic Stress Testing: Enables direct visualization of ligament elongation or disruption during functional movements.

LIMITATIONS

- Operator Dependency: Requires skill and experience for accurate interpretation of findings.
- Depth Limitations: Visualization of deeper structures may be less effective compared to MRI.
- Artifacts and Shadows: Bone and calcifications may create image artifacts, requiring adjustments in probe positioning and frequency.

SONOGRAPHIC TECHNIQUE FOR EVALUATING THE DELTOID LIGAMENT

EQUIPMENT SETUP

- Probe Type: A high-frequency linear transducer (7–15 MHz) is recommended for optimal resolution. The probe should be placed along the medial malleolus with adjustments in angulation to capture both superficial and deep ligament components, which includes both anterior and posterior portions of the ligament.
- Patient Position: The patient is placed supine or lateral decubitus position with the ankle slightly plantarflexed to allow better visualization of medial structures.
- Dynamic Assessment: Stress maneuvers, such as valgus stress or dorsiflexion, can be applied during MSK ultrasound to reveal ligament instability or disruption.

EXAMINATION PROTOCOL

1. Superficial Layer Assessment
   - Begin imaging from the medial malleolus, moving caudally to visualize the tibiocalcaneal and tibionavicular ligaments.
   - Use power Doppler settings to detect hyperemia, indicating inflammation or acute injury.
2. Deep Layer Assessment
   - Deep ligaments are evaluated closer to the talus. A gradual examination shifting between static and dynamic imaging modes reveals partial tears or sprains.
   - Look for hypoechoic areas, indicative of edema, or disruptions in the ligament's fibrillar structure.
3. Comparison with Contralateral Ankle
   - Evaluate the healthy ankle for baseline comparison, particularly in suspected partial tears.

NORMAL SONOGRAPHIC APPEARANCE

The normal deltoid ligament appears as a hyperechoic, fibrillar structure with continuous and well-defined margins within the superficial layer, yet the deep fibers may appear hypoechoic due to their position.[9] Additionally, the posterior deltoid appears more hypoechoic with the deeper tibiotalar fibers less well defined than the more superficial anterior deltoid ligaments.[10] Dynamic assessment with stress maneuvers can confirm ligament integrity.

PATHOLOGIC FINDINGS IN DELTOID LIGAMENT INJURIES

Acute Sprains

- Hypoechoic thickening due to edema
- Disruption of fibrillar pattern
- Partial or complete ligament tears with discontinuity or retraction
- Associated joint effusion

Chronic Injury and Insufficiency

- Ligamentous thinning and hypoechogenicity
- Periligamentous fibrosis or calcification
- Dynamic instability with stress maneuvers

CLINICAL IMPLICATIONS FOR REHABILITATION PROVIDERS

MSK ultrasound provides real-time feedback for rehabilitation professionals, facilitating early diagnosis and intervention. Key applications include:

- Early Detection of Injury / Accurate Injury Grading: MSK ultrasound can quickly differentiate between a sprain and a more severe ligament tear to help guide treatment planning.
- Dynamic Functional Testing: Rehabilitation professionals can use MSK ultrasound during physical therapy sessions to monitor recovery and assess ligament function dynamically. Serial MSK ultrasound imaging aids in assessing ligament remodeling and readiness for rehabilitation progression.
- Guided Interventions: Ultrasound imaging assists in precision-guided injections, such as corticosteroids for inflammation or platelet-rich plasma (PRP) for ligament regeneration.
- Patient Education: Real-time imaging serves as a visual aid to explain the nature of the injury and set realistic expectations for recovery.

LIMITATIONS AND CHALLENGES

Despite its advantages, MSK ultrasound cannot entirely replace MRI for complex cases, such as when associated injuries to bony structures or deep intra-articular pathology are suspected. Additionally, the expertise required for optimal imaging technique limits its immediate adoption across all rehabilitation settings.

CONCLUSION

Diagnostic MSK ultrasound is a valuable tool for the evaluation of the deltoid ligament of the ankle, offering fast, accurate, and cost-efficient imaging for rehabilitation professionals. Its ability to provide real-time, dynamic assessments makes it particularly suited for rehabilitation providers who can integrate the MSK ultrasound findings into clinical decision-making, optimizing treatment strategies and improving patient outcomes. However, practitioners must be adequately trained to maximize it’s diagnostic potential. By integrating MSK ultrasound into practice, rehabilitation providers can enhance patient care, improve outcomes, and reduce the burden of false diagnoses or delayed treatment.

MEDIAL DELTOID LIGAMENT: ANTERIOR, MIDDLE, AND POSTERIOR FIBERS

LIGAMENTOUS PATHOLOGY

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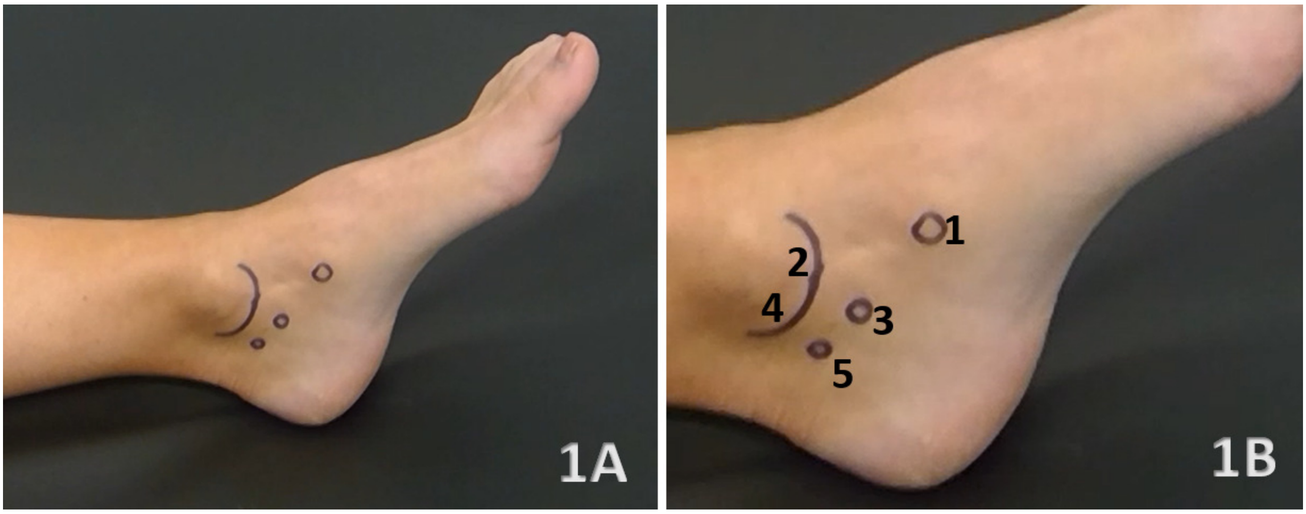

Figure 1A -- 1B. PATIENT POSITION AND REFERENCE MARKERS

The patient lies supine on the examination table with the hip and knee fully extended and the leg externally rotated as shown in Figure 1A. Figure 1B identifies the reference markers for the bony landmarks. (1) Tubercle of the navicular, (2) anterior colliculus of the medial malleolus, (3) sustentaculum tali of the calcaneus, (4) posterior colliculus of the medial malleolus, and (5) posteromedial talar tubercle.

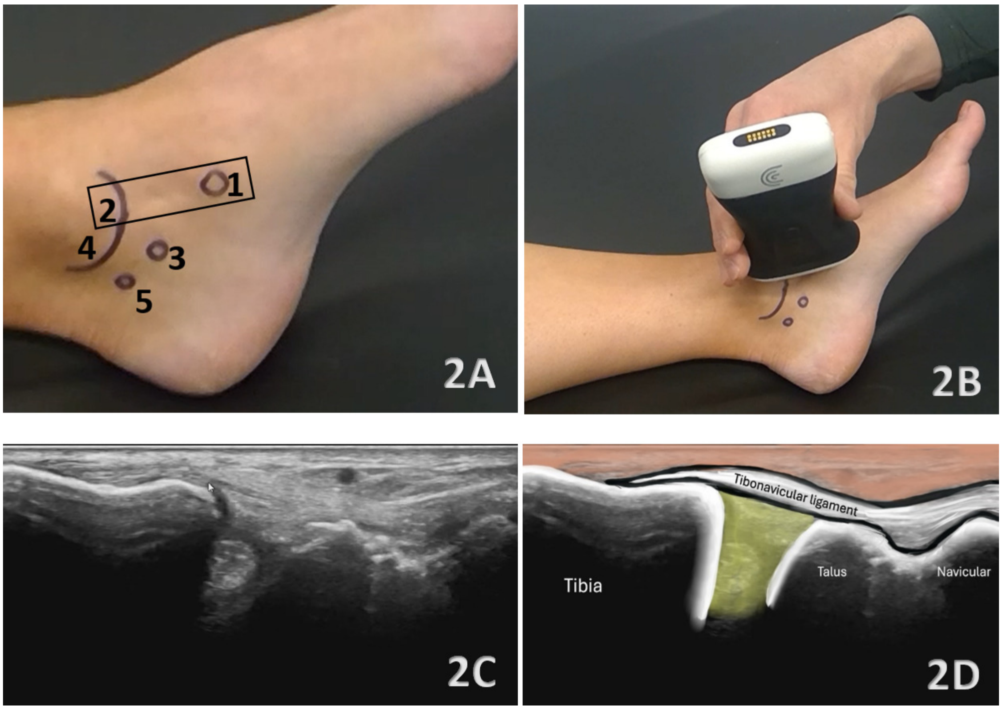

Figure 2A -- 2D. TRANSDUCER PLACEMENT AND NORMAL ANATOMY FOR THE TIBIONAVICULAR LIGAMENT (TNL)

The patient lies supine on the examination table with the hip and knee fully extended and the leg externally rotated. The transducer is placed in a straight line connecting the anterior colliculus of the medial malleolus to the dorsal aspect of the navicular tubercle allowing visualization of the anterior deltoid ligament fibers known as the tibionavicular ligament (TNL). As the transducer aligns, the fibers of the TNL become visible in a LAX view.

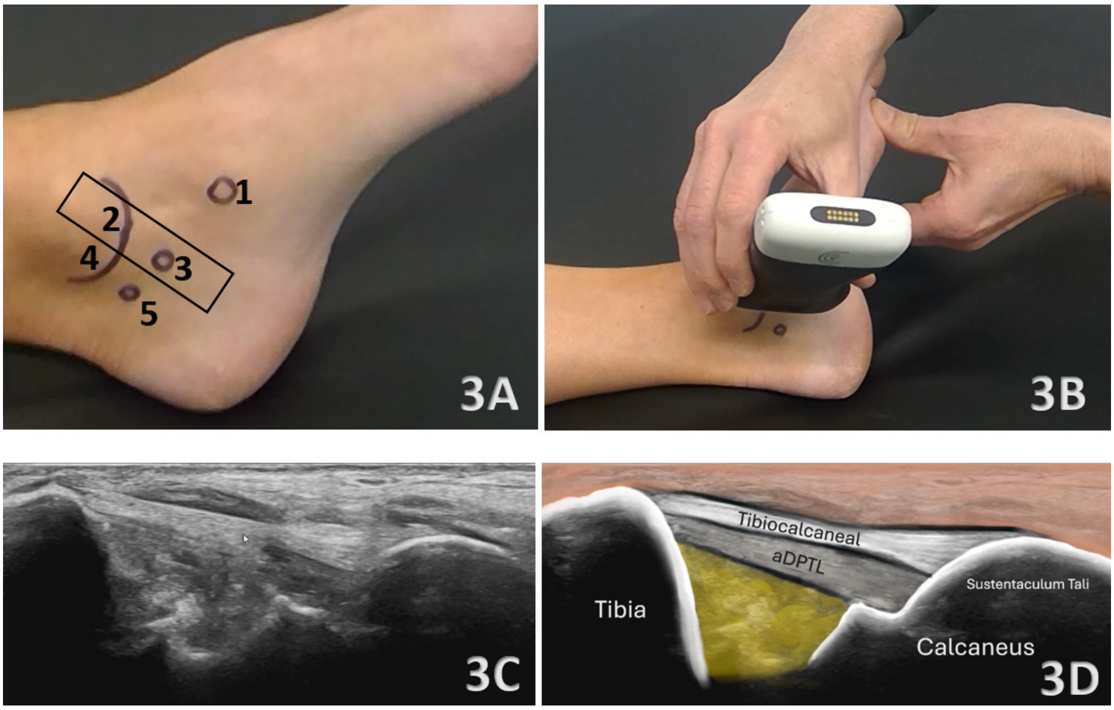

Figure 3A -- 3D. TRANSDUCER PLACEMENT AND NORMAL ANATOMY FOR THE TIBIOCALCANEAL LIGAMENT (TCL) AND THE ANTERIOR FIBERS OF THE DEEP POSTERIOR TIBIOTALAR LIGAMENT (aDPTL)

The patient lies supine on the examination table with the hip and knee fully extended and the leg externally rotated. The examiner positions the patient's foot and ankle into dorsiflexion, applying a static stretch to the middle fibers of the deltoid ligament, also known as the tibiocalcaneal ligament (TCL). The transducer is placed in a straight line connecting the anterior colliculus of the medial malleolus and the sustentaculum tali of the calcaneus. The anterior fibers of the deep posterior tibiotalar ligament (aDPTL) from the medial malleolus to the talus is visualized here. As the transducer aligns, the fibers of the TCL and the aDPTL become visible in a LAX view.

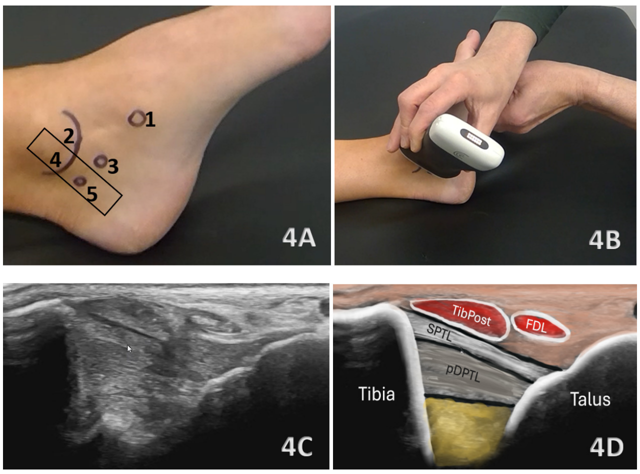

Figure 4A -- 4D. TRANSDUCER PLACEMENT AND NORMAL ANATOMY FOR THE SUPERFICIAL POSTERIOR TIBIOTALAR LIGAMENT (SPTL) AND THE POSTERIOR FIBERS OF THE DEEP POSTERIOR TIBIOTALAR LIGAMENT (pDPTL)

The patient lies supine on the examination table with the hip and knee fully extended and the leg externally rotated. The examiner positions the patient's foot and ankle into dorsiflexion, applying a static stretch to the deep posterior deltoid ligament, also known as the superficial posterior tibiotalar ligament (SPTL) and the deep posterior tibiotalar ligament (pDPTL). The transducer is aligned in a long-axis (LAX) view connecting the posterior colliculus of the medial malleolus and the posteromedial talar tubercle. A key reference point for visualization is the tibialis posterior tendon, seen in a short-axis (SAX) view. Directly beneath this tendon lies the deep capsular band of the deep posterior fibers of the deltoid ligament.

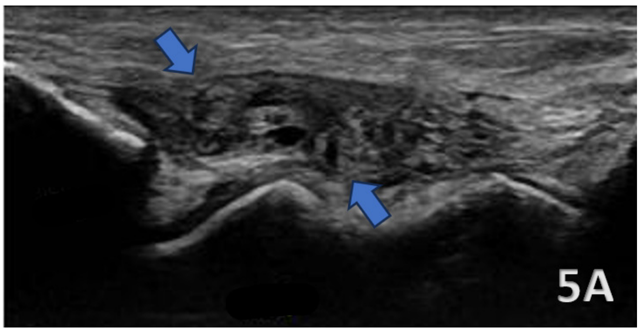

Figure 5A. RUPTURE OF THE TIBIONAVICULAR LIGAMENT (TNL)

Figure 5A shows a long axis view (LAX) of the TNL showing a hypoechoic discontinuity of the ligament, compatible with a complete tear (blue arrows). A stress image by placing the ankle into full plantar flexion provides more diagnostic confidence regarding the complete tear. See Figures 2A-2D for reference.

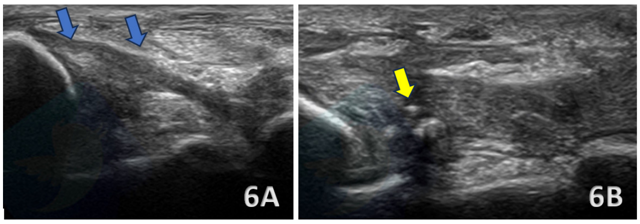

Figure 6A AND 6B. PARTIAL TEAR OF THE TIBIOCALCANEAL LIGAMENT (TCL) AND THE ANTERIOR FIBERS OF THE DEEP POSTERIOR TIBIOTALAR LIGAMENT (aDPTL)

In Figure 6A, a partial tear can be seen at the proximal attachment at the tibia. The TCL can be visualized as thickened and a hypoechogenicity appearance of both the TCL and the aDPTL (blue arrows). In Figure 7B, calcium deposits can be visualized inside the thickened ligament (yellow arrow). See Figures 3A-3D for reference.

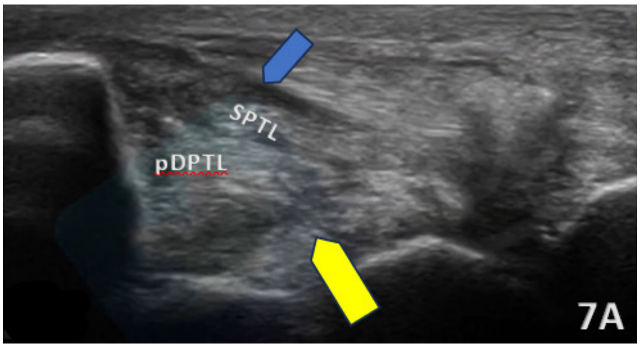

Figure 7A. PARTIAL TEAR OF SUPERFICIAL POSTERIOR TIBIOTALAR LIGAMENT (SPTL) AND THE POSTERIOR FIBERS OF THE DEEP POSTERIOR TIBIOTALAR LIGAMENT (pDPTL)

Figure 7A exhibits the heterogeneous hypoechogenicity of the pDPTL. This finding reveals a chronic thickening of the SPTL (blue arrow) and a partial tear of the pDPTL (yellow arrow). See Figures 4A-4D for reference.

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