APTA Maine
A Chapter of the American Physical Therapy Association

Chronic Mortise Instability - Part 1

Functional Anatomy of the Ankle Mortise

Introduction

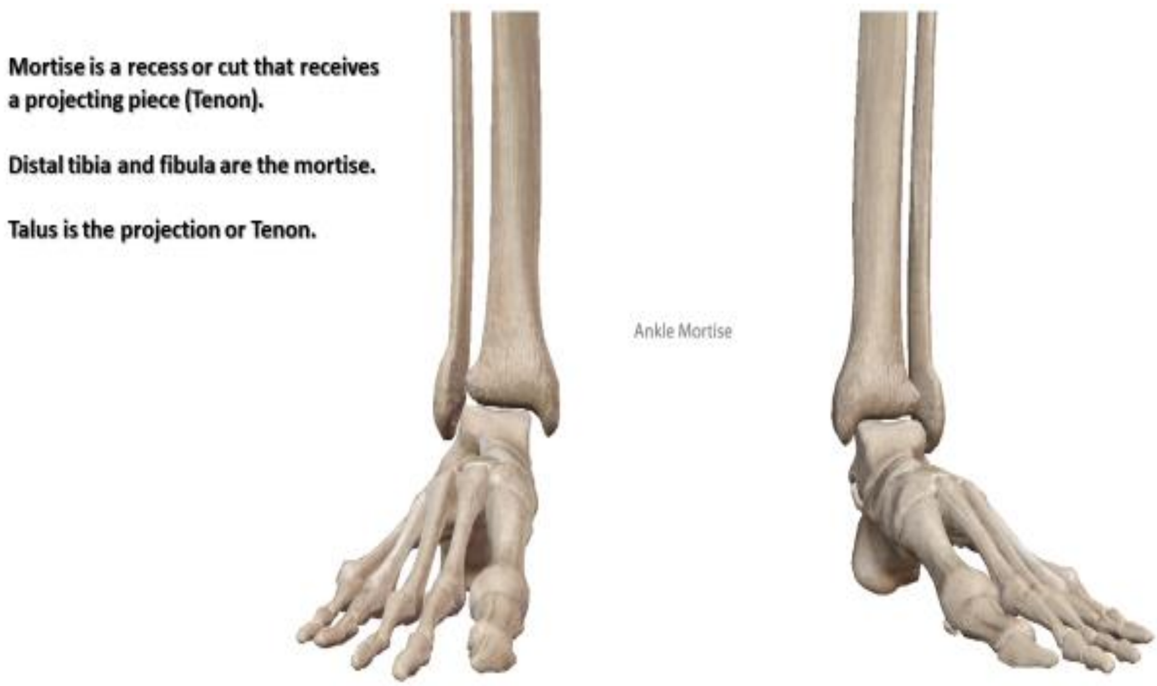
An underlooked cause of chronic ankle instability (CAI) is an unstable mortise. An unstable ankle mortise arises from ankle sprains of moderate-to-severe trauma. This type of lower limb instability alters the rear foot and midfoot biomechanics, resulting in premature loading of the medial foot (i.e., sudden foot flattening), and impaired absorption and propulsion during gait. The sequela of an unstable mortise produces concomitant clinical conditions ranging from an acquired flat foot, posterior tibialis tendon dysfunction, hallux valgus, and metatarsalgia[1]. Extrinsic to the foot and ankle, the unstable mortise can produce altered motor control, evidenced by muscle inhibition and facilitation patterns of the lower limb, pelvic girdle, and spine. Altered activation within specific neuromuscular sets can produce hip internal rotation mal-tracking (credit to Gail Molloy (https://denverptis.com/our-team/gail-molloy/)[2], SI-joint dysfunctions (innominate rotations and sacral torsions), and lumbar spine disorders (disc injury and functional instability)[1,2].

The purpose of this initial commentary is to describe the functional anatomy of the ankle mortise. Subsequent posts aim to answer the following questions.

1. How does ankle mortise instability occur?
2. How do we identify ankle mortise instability?
3. How do we restore ankle mortise stability?

Functional Anatomy

The ankle mortise consists of the crus (i.e., leg) formed by the tibia and fibula bones. These two bones accept the boney tenon (i.e., talus). Thus, the ankle mortise contains the distal tibiofibular syndesmosis and talocrural joint. The latter is a diarthrodial, sellar-type joint.



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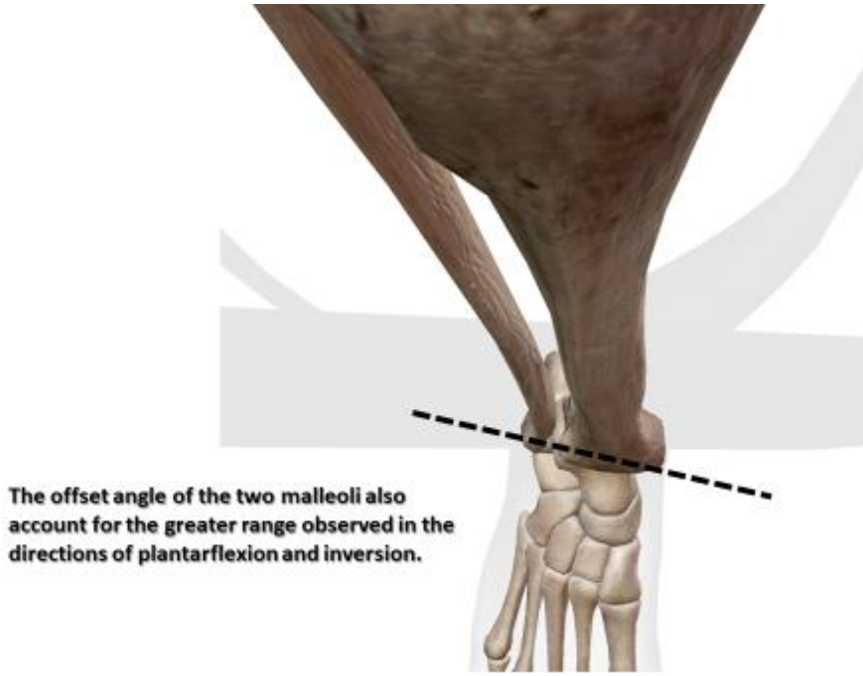
Due to the relative positions of the distal tibia and fibula bones, one can appreciate how the lateral malleolus overlaps the talus. When accounting for the angle formed between the two malleoli, the most significant proportion of talar mobility occurs in the parasagittal plane versus the transverse plane. The offset axis between the medial and lateral malleoli influences the ratio of eversion and inversion occurring at the talocrural joint. This unique structural anatomy reduces movement of the talus bone in the directions of eversion, external rotation, and lateral translation. When accounting for the amount of ligamentous tissue on the medial side of the talocrural joint, it should become clear why dorsiflexion-eversion ankle sprains occur less frequently than plantarflexion-inversion sprains. However, dorsiflexion-eversion injuries account for malleolar fracture patterns (i.e., Pott's fracture) and syndesmosis injuries (i.e., high ankle sprains). These injuries compromise mortise stability considerably.



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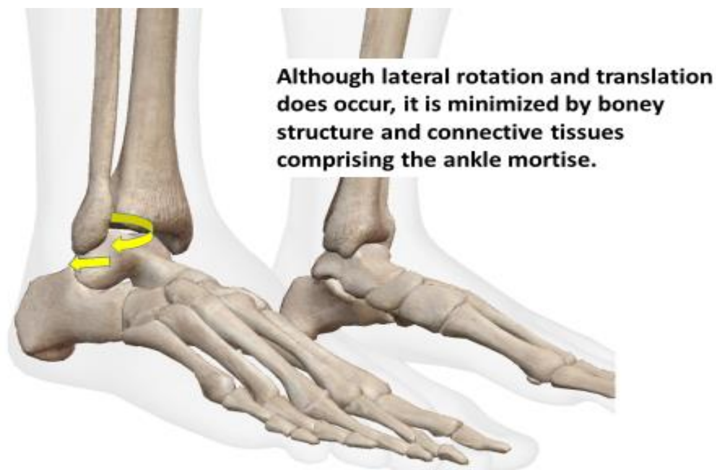

Under normal functioning conditions, rotation through the crus produces torsional loads that transmit to the talus. Due to the talus bone's limited degree of freedom in the transverse plane, the bone distributes load to adjacent structures in the foot to produce a rotational coupling[3]. James Earls states in his book Understanding the Human Foot, *"The large amount of cartilaginous surface - the area of interface with other bones-is indicative of its (talus) role as a negotiator of forces between adjacent bones"* (Chapter 4 - The Bones of the Foot)[3]. The critical point is that an unstable ankle mortise compromises the talus bone's ability to negotiate and distribute torsional forces to the connective tissues of the rear foot and midfoot. A simple clinical assessment to perform is the multi-segmental rotation test outlined below. In subsequent posts, we plan to discuss specific findings relating to foot and ankle instability with this assessment.

Multi-segmental rotation to the right side produces twisting of the right foot due to the externally rotating thigh and leg above it. The talus follows the externally rotating tibia bone.

Multi-segmental rotation to the left side produces flattening of the right foot due to the internally rotating thigh and leg above it. The talus follows the internally rotating tibia bone.

Multi-segmental rotation appraises the passive response (absence of motor activation) of the foot to torsion. Image courtesy of Husson University School of Physical Therapy.

The fibula bone articulates to the tibia at the distal and proximal tibiofibular joints. Within the crus, an interosseous membrane bridges the two bones and serves as a conduit for body weight and ground reaction forces transmitted through the lower limb.

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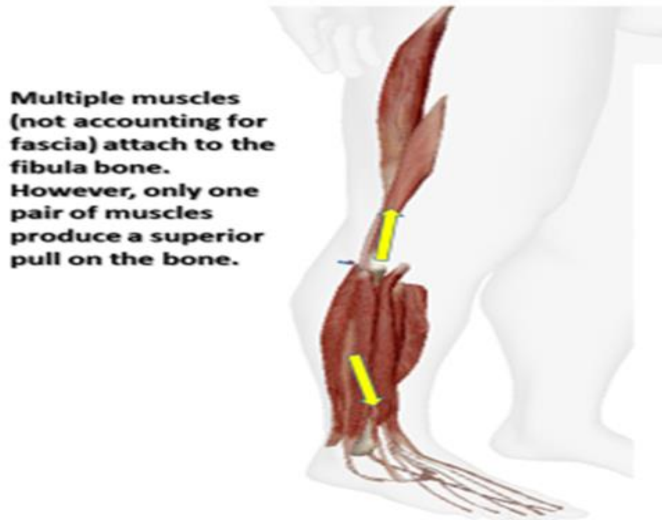
The interosseous membrane provides an attachment point for multiple muscles originating in the anterior and posterior muscle compartments. Although nine muscles attach to the fibula bone alone, only one (paired together) can produce a superior force vector that acts upon it - the biceps femoris muscle. The remaining eight muscles create an inferiorly directed force vector on the fibula. These factors are essential to ankle stability during bipedal gait. For instance, in the late swing phase, the anterior leg muscles are active just before initial contact to position the ankle in dorsiflexion. At the same time, the eccentric load of their functional antagonists controls and finely tunes the ankle's position in preparation for initial contact. The net effect is an inferiorly directed pull on the fibula bone to achieve sufficient extension of the lateral malleolus over the talus.



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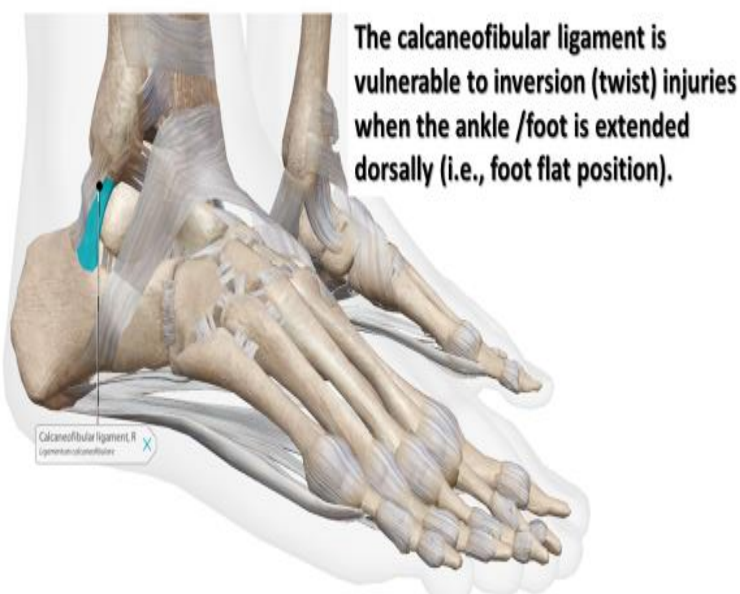
This critical point in the gait cycle prevents excessive eversion during the transition into initial contact and loading response. As indicated in the prior paragraph, this helps explain why an eversion ankle sprain is less frequent than inversion ankle sprains when positioned in ankle dorsiflexion and accounts for the higher frequency of calcaneofibular ligament injuries (inversion injury in a foot flat position).



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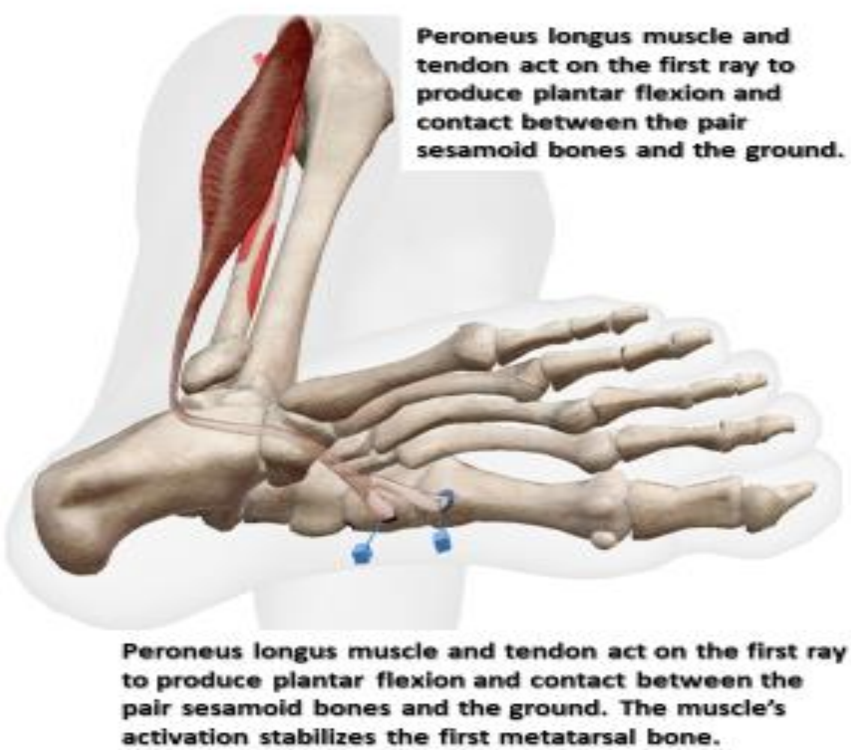
The loading response phase of gait (flattening of the lateral foot) and the subsequent transition into midstance also require adequate ankle mortise stability. The eccentric activation of multiple extrinsic foot muscles that incorporate to the interosseous membrane, fibula, and tibia produce the necessary force closure to enhance mortise stability during gait. However, the distal fibula must splay enough to accommodate the head of the talus. Forward advancement of the crus over the dome of the talus results in a relative translation of the talus posteriorly, which produces angular movement into talocrural joint dorsiflexion. The head of the talus wedges in the mortise and sufficiently splays the distal fibula -albeit very slightly. This slight splay creates a bowing effect on the fibula bone in combination with its superior translation, which tensions the interosseous membrane and capsuloligamentous structures of the proximal tibiofibular joint. Mechanoreceptors in these tissues send encoded signals back to the CNS, which forward to alpha motors that facilitate motor unit recruitment of the peroneus longus and brevis muscles. The activation of the peroneus longus muscle produces plantar flexion of the foot's 1st ray to achieve medial foot contact with the ground - specifically, the pair of sesamoid bones.



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Ankle mortise instability leads to the acquired flat foot and altered contact forces between the first metatarsal head and the ground. The sequela related to chronic ankle mortise instability leads to impaired load transfer and inefficiency due to altered motor control. Upcoming posts cover pathoanatomy, clinical presentation (illness script), examination techniques, and treatment considerations. As a preview to the upcoming posts, we have provided an example of the anterior (reverse anterolateral) draw test and posterior drawer tests.

Anterior drawer

Posterior drawer

Relative glide of the talus to the crus performed in the two drawer tests. The posterior drawer assesses mortise stability in the closed-packed position of the talocrural joint. Image courtesy of Husson University School of Physical Therapy.

Disclaimer

Individuals experiencing foot pain should consult with a healthcare provider. Physical therapists can be instrumental in the patient care management of ankle/foot pain with mobility and strength deficits. Only a licensed physical therapist should perform the assessment technique upon receiving the appropriate education, training, and practice.

Video: Anterior and Posterior Drawer Tests

Courtesy of Husson University School of Physical Therapy with permission from Brianna Villanova, B.S., SPT, class of 2025 (as instructed by the author of this commentary).

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Acknowledgements

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2. Molloy G. https://denverptis.com/our-team/gail-molloy/

3. James E. Understanding the Human Foot: An Illustrated Guide to Form and Function for Practitioners. North Atlantic Books. November; 2021.