

Imaging of Turf Toe



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KEYWORDS

- Turf toe • First metatarsophalangeal joint • Plantar plate • Plantar capsuloligamentous complex
- Sesamoid • MR imaging

KEY POINTS

- During the advent of artificial turf and flexible footwear in football, turf toe was initially coined and described as a 1st metatarsophalangeal (MTP) joint sprain injury. In the classic setting of hyperextension of the 1st MTP joint, turf toe is an injury to its plantar capsuloligamentous complex.
- The plantar capsuloligamentous complex consists of the plantar plate, collateral ligaments, overlying tendinous confluences, and nondesignated capsular tissue.
- Advances in MR imaging and knowledge of the complex 1st MTP joint help to pinpoint the injured plantar structures as well as assess severity and chronicity of the injury. Detailed analysis of turf toe should highlight the best conservative and surgical options for the injured athlete to reach optimal recovery.

INTRODUCTION

Turf toe was given its now well described and well known moniker in 1976 by Bowers and Martin at the University of West Virginia.¹ They attributed the football injury of the 1st MTP joint to the combination of the hard artificial playing surface and the use of flexible shoes. That same year, across the Atlantic Ocean, the first in vivo MR imaging study was performed by Sir Mansfield.² Forty years later, turf toe remains a significant issue in the athletic community. In that same time span, advances in MR imaging have enabled an earlier, more accurate, and more detailed diagnosis of turf toe.

Although most prevalent in football, turf toe also occurs in many other athletic disciplines including wrestling, basketball, baseball, soccer, lacrosse, dancing, and gymnastics.³ The common themes of turf toe injury are hard playing surfaces, light flexible footwear, and axial loading. It is up for debate whether the use of artificial surface versus natural grass plays a contributing factor in turf toe.⁴ Ultimately, the injury is multifactorial in nature.⁵

Turf toe is classically recognized as a plantar hyperextension injury of the 1st MTP joint.

MECHANISM OF INJURY

In the acute setting, turf toe typically occurs with axial loading on the dorsiflexed, planted 1st MTP joint on a raised heel (**Fig. 1**). Forcible dorsiflexion (plantar hyperextension) beyond the normal range of motion results in injury to 1 or more portions of the plantar capsuloligamentous complex of the 1st MTP joint. This is the most common mechanism of injury and is estimated to occur in more than 80% of turf toe instances.⁶ Injury can occur proximal to, at the level of, or distal to the sesamoids. Subsequently, excessive hyperextension of the 1st MTP joint may cause plantar capsuloligamentous complex, chondral, and osseous injuries.

Directional and rotational components of force (eg, axial, varus, and valgus) as well as hallux position determine the structures involved in turf toe injury.

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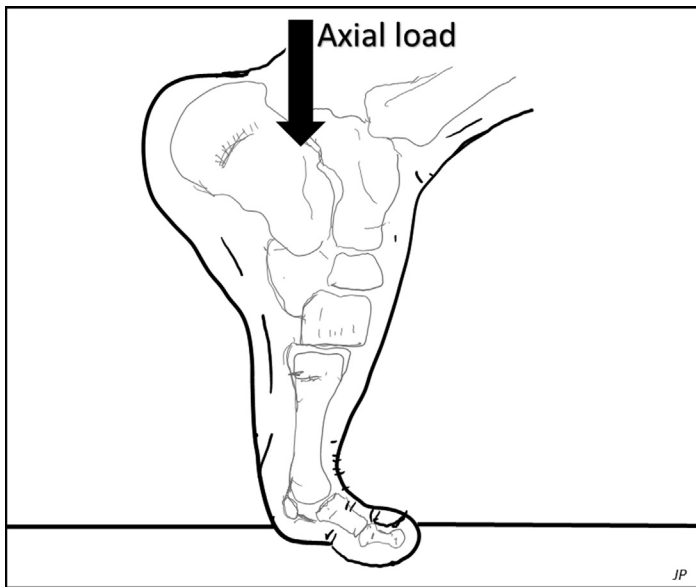


Fig. 1. Mechanism of turf toe injury. The planted forefoot with the heel raised is subjected to an axial load (arrow) forcing the 1st MTP joint into extreme dorsiflexion.

NORMAL ANATOMY

The 1st MTP joint is a modified hinge joint. The shallow groove of the 1st proximal phalangeal base contributes to the joint's inherent instability. The 1st MTP joint derives stability from the hallux sesamoids and its surrounding, supporting capsuloligamentous structures. The medial and lateral sesamoids add a layer of complexity to the 1st MTP joint relative to the lesser MTP joints. The sesamoids serve as a fulcrum for push-off power during gait and athletic endeavors. The 1st MTP joint bears up to 60% of body weight during normal gait and up to 3 to 8 times body weight during push-off activities.^{5,7,8}

The 1st MTP joint range of motion is greatest in the sagittal plane, approximately 15° of plantar flexion and approximately 80° of dorsiflexion when standing.⁹

The 1st MTP joint anatomy can be challenging. It is important that referring teams and radiologists are familiar with and share the same anatomic nomenclature because variations in terminology exist.

To approach the 1st MTP joint anatomy, it helps to focus on its central structures and then extend to its periphery. At its core, the 1st MTP joint consists of the articulation of the 1st metatarsal head and 1st proximal phalangeal base as well as the paired articulations of the 1st metatarsal head-medial sesamoid and 1st metatarsal head-lateral sesamoid.

The plantar plate of the 1st MTP joint is used as a broad encompassing term of the plantar

capsule. It may be visualized as a hammock extending from the 1st metatarsal neck, encasing the sesamoids and inserting onto the base of the 1st proximal phalanx. The proximal thinner portion of the hammock, the paired confluent metatarsal-sesamoid (MT-S) ligaments, originates from the metatarsal neck and inserts on the respective sesamoid (Fig. 2A). The distal thicker aspect of the hammock, the paired sesamoid phalangeal (SP) ligaments, originates from the respective sesamoid and inserts on the proximal phalangeal base (see Fig. 2A; Fig. 3A). There is thinner plantar plate capsular tissue between these 2 ligaments. The SP ligament has a taut appearance on MR imaging in neutral position. The SP ligaments are key stabilizers of the 1st MTP joint.

The intersesamoid (IS) ligament is an additional thick structure bridging the medial and lateral sesamoids (Fig. 4A). The literature varies in terms of the histologic nature of the IS ligament and other portions of the plantar plate reporting both fibrous and fibrocartilaginous tissue at this location.^{5,10,11} The IS ligament is designated as the plantar plate by Netter¹² in his illustrations.

The plantar capsuloligamentous complex is composed of all the aforementioned structures of the plantar plate in addition to the collateral ligaments, the overlying tendinous confluences, and remaining nondesignated capsular tissue.

At the periphery of the 1st MTP joint lie the medial and lateral collateral ligaments. Medial

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