Turf Toe

Presentation, Diagnosis, and Management

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Abstract

» Turf toe is a common injury in athletes. The prevalence of this injury has increased since the implementation of artificial turf and has been reported to be as high as 45% in professional football players.

» The mechanism of injury, first described by Bowers and Martin in 1976, is hyperextension of the first metatarsophalangeal (MTP) joint, which causes disruption of the plantar structures. Turf toe can be classified as grade I, II, or III depending on the severity of the injury.

» Patients typically present with tenderness, swelling, and/or loss of motion at the MTP joint. Physical examination includes palpation of the key structures surrounding the joint, along with varus and valgus stress and drawer testing of the MTP joint. Weight-bearing radiographs and magnetic resonance imaging are the most commonly utilized imaging modalities.

» Turf toe typically is treated nonoperatively with rest, ice, nonsteroidal anti-inflammatory drugs, and compression. Operative treatment may be indicated when nonoperative measures are unsuccessful or in patients with severe disruptions of the plantar structures. Outcomes of turf toe are generally good, but in rare cases, the injury can be career-ending.

» The purpose of this review is to highlight the current literature on the epidemiology, risk factors, classifications, diagnosis, treatment, and clinical outcomes of turf toe.

Turf toe, a common foot injury in athletes, is broadly defined as an injury to the plantar surface of the first metatarsophalangeal (MTP) joint. It constitutes 0.83% of all injuries that are sustained by football players in the National Collegiate Athletic Association (NCAA)[1]. Turf toe was first described in 1976 by Bowers and Martin, who observed an increase in sprains of the first MTP joint following widespread installation of artificial turf[2]. Thus, the injury was termed *turf toe,* although it may occur with any surface. It is most common in football players, but it is also seen in athletes who participate in basketball, soccer, gymnastics, and dance[3,4]. The purpose of this review is to highlight the current literature on the anatomy, epidemiology, diagnosis, classification, treatment, and clinical outcomes of turf-toe injury.

Anatomy and Biomechanics

The first MTP joint, which is classified as a hinge and sliding joint, is a complex structure despite its small size. A key anatomic feature is the shallow groove of the first proximal phalangeal base, which introduces a degree of instability. The joint must therefore rely on static and dynamic stabilizers[5]. The capsule, the collateral capsular ligaments, and the plantar plate act as static stabilizers. The collateral capsular ligaments play an important role in resisting

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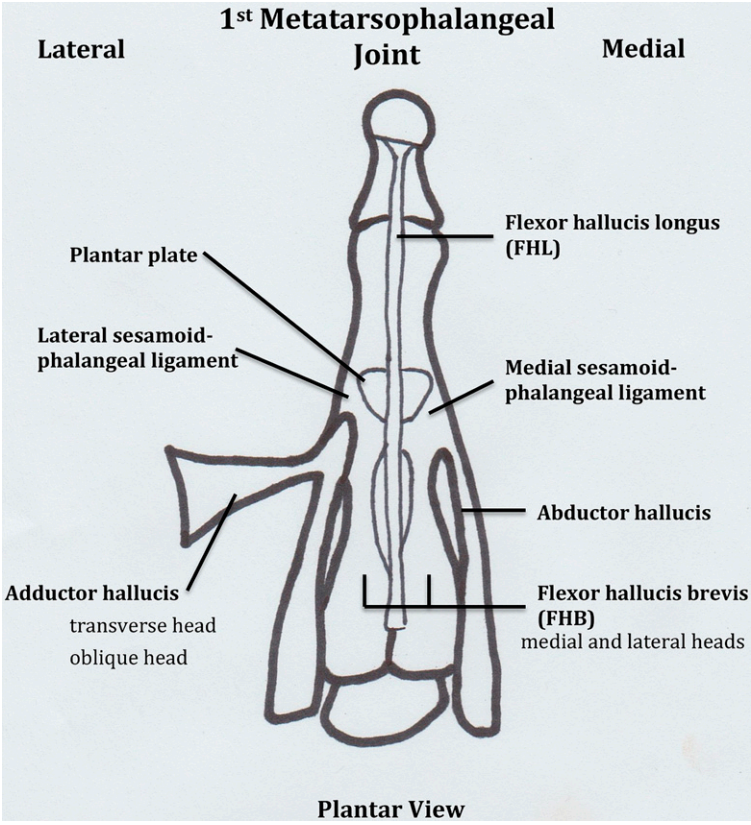

Fig. 1
Anatomy of the plantar surface of the first MTP joint.

varus and valgus forces[6] (Fig. 1). The plantar plate runs on the plantar surface from the first metatarsal neck to the base of the first proximal phalanx, enveloping the sesamoids[5]. Dynamic stabilizers include the flexor hallucis brevis (FHB), the sesamoids, and the tendons of the adductor hallucis and the abductor hallucis[7]. The FHB passes along the plantar aspect of the foot, where it divides into the medial and lateral tendons that encapsulate the sesamoids. This elevates the metatarsal head, providing a mechanical advantage to the joint[8]. Additionally, the medial and lateral sesamoids provide support to the first MTP joint by reducing the force applied to the joint and protecting the flexor hallucis longus (FHL) tendon[9]. The medial sesamoid is located more distally and is slightly larger in size, allowing it to absorb more force when weight-bearing[9]. The adductor hallucis is found on the lateral aspect of the MTP joint, providing stabilization and support. On the medial side of the first MTP joint, the abductor hallucis provides similar support.

Range of motion of the first MTP joint varies with passive and active motion. Active range of motion is restricted to 55° of dorsiflexion and 25° of plantar flexion, although the joint can withstand up to 75° of passive dorsiflexion[10]. Beyond this, the MTP joint is susceptible to sustaining a turf-toe injury. In a biomechanical study, Frimenko et al. developed an injury risk curve that predicts a 50% risk of sustaining a turf-toe injury when dorsiflexion exceeds 78°[11].

Epidemiology, Mechanism of Injury, and Prevention

Turf toe is one of the most common foot and ankle injuries in NCAA athletes and accounts for substantial time away from sport[12]. Clanton and Ford reported that foot injuries were the third most common time-loss injury for athletes at Rice University in Houston, Texas[13]. Football players, specifically running backs, tight ends, and linebackers, are the most susceptible[14]. In a recent National Football League (NFL) combine, 72% of players had a history of foot and ankle injuries, of which 10.9% were either turf toe or MTP joint dislocations[14]. The prevalence of turf toe has been reported to be as high as 45% over a career for high-level football players. However, a recent study showed a decline in the

Fig. 2
Plantar flexion of the foot and hyperdorsiflexion of the first MTP joint with an axial force (arrow).

Fig. 3

The dorsoplantar drawer, or Lachman, test examines the stability of the plantar structures. The joint is stressed vertically (arrow) to evaluate for laxity.

incidence of turf-toe injuries to 0.46 to 0.53 injuries per team per season[1], likely related to newer turf technology, preventative measures, and better shoe wear[15].

Turf toe classically occurs when the foot is in plantar flexion with hyperdorsiflexion of the first MTP joint while an axial force is applied to the foot (Fig. 2). Injury severity is dictated by force. In football, this injury usually results when a player falls onto the posterior aspect of another player's foot while the falling athlete's foot is in plantar flexion[16]. This causes the first MTP joint to be excessively dorsiflexed, placing strain on the plantar capsule. Alternatively, patients may sustain this injury when falling back onto their own heel while the toe is hyperextended and the foot is in plantar flexion[17].

Several factors are known to increase the risk of turf toe. Playing on artificial "fill" surfaces (artificial grass fibers with sand or rubber infill) increases the risk by 85% because these surfaces tend to be less forgiving and harder than natural grass[1]. Newer generations of "no-fill" turf have a risk of injury similar to natural grass[1]. Shoe wear is also an important factor because more flexibility is believed to increase the risk of turf toe[2]. Coughlin et al.[10] reported that wearing shoes with stiffer soles places the forefoot in a more protected position by limiting excessive dorsiflexion. Turf toe occurs more often during a game than during practice, likely due to increased intensity and competition[1].

Injury prevention is largely accomplished by limiting the risk factors. Foot orthotics, appropriate shoe wear, and taping prevent excessive dorsiflexion and are also useful after injury to provide support and protection[11,18]. Replacing older artificial turf fields with newer-generation turf or natural grass also can decrease the likelihood of injury.

Evaluation and Diagnosis

The diagnosis of turf toe requires a high index of suspicion. The injury is usually acute and often occurs during a football game. With a less-severe injury, patients may have localized tenderness to the first MTP joint, with minimal swelling and bruising. Players often are able to "play through" these minor injuries[10]. With severe injuries, patients are likely to present with diffuse tenderness, bruising, a decreased range of motion, an antalgic gait, and a hesitancy to push off during ambulation[19,20]. Severe injuries often lead to substantial time away from sport[20].

Physical examination begins with palpation of important anatomic structures surrounding the MTP joint, including the plantar capsule, the medial and lateral collateral ligaments, and the sesamoid complex. Plantar-surface tenderness is the most common finding.

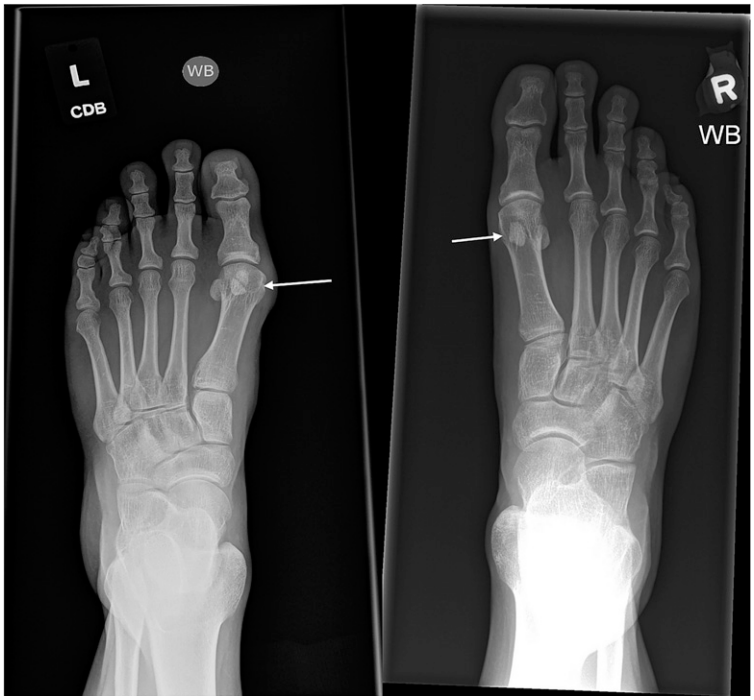

Fig. 4

Anteroposterior radiographs demonstrating a grade-III turf-toe injury of the right first MTP joint with proximal migration of the sesamoids compared with the contralateral foot. The arrows point to the sesamoids of each foot, and proximal migration is evident in the right foot.

Tenderness proximal to the sesamoids could suggest an FHB strain, which is a less severe injury[8]. Restriction of active and passive range of motion corresponds to injury severity. Reduced active plantar flexion, in particular, is common in more severe injuries[9]. Varus and valgus stress tests are used to evaluate the integrity of the medial and lateral collateral ligaments. The dorsoplantar drawer test, or Lachman test (Fig. 3), examines stability of the plantar structures. It is performed by applying dorsal stress on the proximal phalanx while stabilizing the first metatarsal. A positive Lachman test is defined as increased laxity or pain. Comparison with the contralateral hallux can assist in evaluating laxity. A comprehensive physical examination may be difficult to perform acutely secondary to pain.

Bilateral weight-bearing anteroposterior and lateral foot radiographs should be made when a turf-toe injury is suspected[19] (Fig. 4). On the lateral view, a comparison of the sesamoid location in the injured versus the uninjured great toe can predict injury severity because 3 mm of proximal migration is highly predictive of severe injury[21]. Obtaining 40° medial and lateral oblique views and a sesamoid view may allow better visualization of the sesamoids[17]. Avulsion fractures and dislocations may be present in severe turf-toe injuries, while minimal changes will be seen on radiographs in less severe injuries[22].

Magnetic resonance imaging (MRI) is not necessary for the diagnosis of acute turf-toe injuries, especially with recreational athletes. It is more likely to be utilized with collegiate and professional athletes when the severity of injury needs to be evaluated more urgently to better estimate time to return to sport. However, MRI may be useful with recreational athletes when the clinical examination is highly suggestive of a complete plantar capsule rupture because it allows visualization of the plantar plate, the collateral ligaments, and the sesamoid ligaments[23]. MRI can be used to grade turf-toe injuries based on the integrity of the plantar structures (Figs. 5-A and 5-B). The plantar

Fig. 5-A

Fig. 5-B

Figs. 5-A and 5-B T1-weighted spin-echo MRI indicating grade-II turf-toe injury. **Fig. 5-A** A partial tear of the plantar plate and capsule (arrow). **Fig. 5-B** Partial continuation of the plantar plate and capsule (arrow) demonstrates that it is not completely ruptured, which makes it a grade-II turf toe.

Table I Classification of Turf Toe[25]

Grade	Clinical	Radiographs	MRI
I	Mild effusion, tenderness, no bruising	Negative	Edema present but completely intact plantar capsule
II	Diffuse tenderness, moderate effusion, bruising, limited range of motion	Negative	Partial tear of the plantar capsule with effusion
III	Severe tenderness, effusion, bruising, pronounced loss of range of motion	Possible fracture, possible sesamoid migration	Complete tear of the plantar capsule with effusion; possible fracture and sesamoid migration

surface and the sesamoids are best visualized in the sagittal and coronal planes[23]. The presence of heterogeneity within the plantar plate suggests disruption, although MRI may overestimate the injury. Dietrich et al. found that cartilage defects, bone marrow edema, and subchondral cysts were present on MRI examinations in asymptomatic volunteers[24].

Classification

Anderson classified turf toe into 3 grades that are based on signs and symptoms[25] (Table I). Grade-I turf toe, a less-severe injury, involves stretching of the plantar complex. Patients present with localized tenderness, minimal swelling, and no bruising. Radiographic examination is negative, while MRI may show edema surrounding the joint. Grade-II turf toe consists of a partial tear of the plantar complex, and patients present with diffuse tenderness, moderate swelling, bruising, and restricted motion with associated pain. Radiographs are negative; however, MRI will show partial disruption with edema of the plantar capsuloligamentous complex. Grade-III injuries involve a complete tear of the plantar complex. Patients present with severe tenderness and swelling over the first MTP joint, a positive Lachman test, and, often, varus-valgus instability[25]. Radiographs may show a sesamoid fracture or proximal sesamoid migration, while MRI will demonstrate a full-thickness tear of the plantar capsule with associated edema.

Treatment and Outcomes

Turf-toe injuries (especially grades I and II) are often treated nonoperatively. George et al. found that only 1.74% of NCAA football players with turf toe required surgical intervention[1]. Treatment is initially focused on reducing pain and swelling while maintaining range of motion with the use of rest, ice, nonsteroidal anti-inflammatory drugs (NSAIDs), and compression[22]. Compression is accomplished via circumferential taping, which immobilizes the first MTP joint and provides stability[26]. Stiffness often results from the injury, and prolonged immobilization may lead to difficulty restoring preinjury range of motion, especially dorsiflexion[13]. Corticosteroid injections should be avoided because of their deleterious effects on soft tissues[23]. The average time away from sport is 10 days, although Clanton and Ford[13] reported that up to 50% of collegiate athletes can have persistent symptoms for at least 5 years following the injury. In more severe cases, surgical intervention may be necessary, and the injury can be career-ending.

Grade-I injuries do not require a period of non-weight-bearing. A carbon-fiber insert or a stiffer sole, which limits dorsiflexion and protects the plantar surface of the first MTP joint, is utilized for 6 to 8 weeks following injury[7,27]. Rehabilitation consists of low-impact activities including biking, exercising on an elliptical machine, and aquatic therapy. Athletes may slowly return to sport as tolerated and normally do not miss a substantial amount of time[8].

Grade-II injuries, on the other hand, often result in at least 2 weeks away from sport[8]. A period of non-weight-bearing in a walking boot with crutches may be needed for proper healing[8]. Range-of-motion exercises are utilized during this time to prevent joint stiffness. Gradual weight-bearing then is introduced. Impact activities and athletics are delayed until low-impact exercises are pain-free, at which point taping and orthotics are utilized[7].

Grade-III injuries result in complete rupture of the plantar capsule and generally require as long as 6 months for recovery. These are often still amenable to nonoperative treatment, although a longer period of immobilization is necessary[2,23]. Prolonged immobilization may lead to stiffness of the MTP joint, requiring an extended period of rehabilitation prior to returning to play. Before introducing explosive exercises (e.g., running or jumping), 50° to 60° of painless passive dorsiflexion is required[8]. If the injury is not recovering properly and is not amenable to nonoperative treatment, surgery may be performed.

Indications for surgery include a large capsular avulsion, a diastasis of a bipartite sesamoid, a diastasis of a sesamoid fracture, a retraction of a sesamoid, a traumatic hallux valgus deformity, vertical instability, a loose body, a chondral injury, and unsuccessful nonoperative treatment[16]. The goal of surgery is to restore function and stability to the first MTP joint. A medial J-shaped approach is utilized to expose the joint and to visualize any injured ligaments[17]. Identifying and protecting the medial digital sensory nerve is important to avoid any neurosensory loss or neuroma formation. Disruption of the sesamoid ligaments is repaired using nonabsorbable suture with the foot in 5° of plantar flexion[16]. The capsular rupture normally occurs distal to the sesamoid bones. If possible, direct end-to-end repair of soft tissue is performed. Alternatively, suture anchors or drill-holes can be used to fix soft tissue to bone. It is important to avoid injury to the FHL

tendon, which lies directly adjacent to the plantar complex[9].

Postoperatively, a spica splint is used to keep the toe in 10° to 20° of plantar flexion to protect the repair. Passive range of motion is initiated at 5 to 7 days to avoid arthrofibrosis, although excessive dorsiflexion should be avoided. Non-weight-bearing status is maintained for 4 weeks, at which time aquatic therapy may be initiated[8]. At 8 weeks, patients are transitioned from a walking boot to an accommodative shoe with a stiff insert that supports the first MTP joint. If symptoms permit, running is started at 12 weeks and return to play is allowed at 4 months postoperatively[22]. Full recovery may take up to 12 months.

Several studies have shown promising outcomes following surgery for turf-toe injuries. Anderson reported that 7 of 9 (8 male, 1 female) collegiate/professional athletes returned to full athletic activity with restoration of plantar stability following surgical repair or reconstruction of the first MTP joint[25]. Two patients were unable to return to sport because of pain and arthrosis. More recently, Smith and Waldrop reported good clinical outcomes in the operative management of 15 varsity-level high school football players who had sustained grade-III turf-toe injuries[16]. Eleven were able to return to football, 1 was lost to follow-up, and 3 quit the sport due to personal preference. Similarly, Drakos et al. described 3 cases (2 operative and 1 nonoperative) of turf-toe injuries in NCAA football players with good results[6]. The 2 surgical patients had complete plantar ruptures (grade III), while the nonoperative patient had a partial plantar rupture (grade II). All 3 of the patients successfully achieved full functional status and returned to sport by 6 months.

Overview

Turf toe can be difficult to diagnose and treat because of the numerous structures that make up the relatively small first MTP joint. However, early diagnosis based on history, physical examination, and appropriate imaging can lead to efficient and proper treatment. If initial nonoperative treatment is not successful, operative intervention may be necessary to restore function and stability of the first MTP joint. Advancements in artificial turf, shoe wear, and the treatment of turf toe have led to better outcomes.

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