Turf Toe Injuries of the Hallux Metatarsophalangeal Joint

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ABSTRACT
Injuries to the hallux metatarsophalangeal joint are not uncommon, particularly in the running athlete. One of the more common causes of hallux injuries is the product of a hyperextension force on a foot fixed to the ground. When the resultant injury is ligamentous, it has been termed “turf toe.” Unfortunately, nearly any sprain of this joint, regardless of mechanism or severity has been given this label. Furthermore, trainers and physicians may fail to recognize the potential dysfunction of this injury, thus providing inadequate care and protection from further injury. Long-term sequelae include FHL tendon tear, hallux valgus or varus, cock-up deformity with IP joint contracture, and degenerative joint disease.

While the majority of these injuries can be treated nonoperatively, those with significant instability need to be recognized and surgically managed to allow for restoration of the anatomy and the opportunity for return to full function.

Keywords: turf toe, hallux metatarsophalangeal joint, traumatic bunion, sesamoid, hallux rigidus, hyperextension

Since the term “turf toe” was first used in the literature by Bowers and Martin in 1976, soft tissue hyperextension injuries to the first or hallux metatarsophalangeal (MP) joint have received increasing attention from physicians, trainers, and athletes. Clanton found that foot injuries rank third behind ankle and knee injuries as the most common time-loss injury among university athletes.1 Of these foot injuries, a large proportion were sprains of the forefoot and, more specifically, the hallux MP joint. In our practice, we have seen a number of collegiate and professional athletes with a broad range of injuries to the hallux MP joint. In the past, these injuries have been grouped under the general heading of turf toe, but actually represent a spectrum of injuries from the mild to the severe. In addition to the straight hyperextension injury of the hallux MP joint, we now recognize there are variations that account for injury to specific anatomic structures in the capsular-ligamentous-sesamoid complex.

These injuries can lead to significant functional disability, especially when not recognized early on. In the short-term, these injuries can result in difficulties with push-off and running. Long-term sequelae lead to difficulty in return to pre-injury performance due to pain and lack of push-off strength as well as hallux limitus or rigidus and fixed deformities. Physicians involved in the treatment of foot and ankle injuries, especially those tending to athletes, need to be familiar with the spectrum of injuries about the hallux MP joint, the conservative as well as operative treatments for these injuries, and the late sequelae encountered in this athletic population.

UNDERSTANDING TURF TOE
Turf toe, in its simplest form, is a sprain of the hallux metatarsophalangeal joint occurring in sports and related to the shoe-surface interface. It is most often seen in football players participating on artificial grass but also occurs in soccer, tennis, basketball, and wrestling (Fig. 1).

Historically, this was an inconsequential injury prior to the development artificial turf in 1966. It became a topic for round-table discussion on artificial turf by James Garrick in 1975.2 As mentioned previously, the term “turf toe” was coined by Bowers and Martin in 1976 and was described as a shoe-surface interface problem.3 Coker et al. subsequently recognized it as a significant and disabling injury in football players in 1978.4 The incidence and epidemiology of the turf toe injury has been reported infrequently. At the University of West Virginia, 5.4 such injuries were reported per football season.3 The University of Arkansas found an injury rate of 6.0 per football season, and at Rice University, 4.5 per football season.5 A single survey of the NFL in 1990...
noted that 45% of 80 active players had suffered a turf toe injury in their career, 83% on artificial turf.6

Our own experience with this injury has been on a college and professional level. We believe that the injury is probably under-reported and under-appreciated. While the gradual return to grass fields being observed across the country should decrease the risk, lighter, more flexible shoes increase the overall incidence for these injury patterns.

The overall effect that a turf toe injury has on a given individual is quite variable. The severity of injury alone may dictate the time for recovery. Mild injuries often result in no loss of game time while severe injuries can result in 6 to 8 weeks out of play. Chronic severe injuries may be career ending.7,8 However, the loss of playing time is also dependent upon position played; i.e. linemen tolerate the injury better than runners and sprinters. At any rate, the impact of these injuries on athletic function should not be underestimated. As illustrated in the Arkansas study, ankle sprains occurred four times more often but hallux MP injuries were responsible for a disproportionate number of missed practices and games.4

The basic mechanism of a turf toe injury is primary hyperextension of hallux MP joint with attenuation and disruption of plantar complex. Usually an axial load is applied to the heel of a foot fixed in equines and is quite similar to the Lisfranc injury mechanism of the midfoot. There is a wide spectrum of injury that includes partial tearing of plantar soft tissues to frank dislocation of the joint. As plantar rupture occurs, unrestricted dorsiflexion may result in impaction injury of proximal phalanx on the dorsal articular surface of the metatarsal head.

Numerous variations can occur, depending upon force of the injury and position of the hallux. The most common variation is that created by valgus-directed force, which results in injury to the plantar medial complex or tibial sesamoid. Such an injury may result in the development of a traumatic bunion and hallux valgus (Fig. 2).

While a varus force and subsequent deformity has rarely been reported, it has been observed in our practice.9 Hyperflexion injuries to the hallux MP joint can also occur and have been termed “sand toe” by Frey.10 While that series noted a propensity in beach volleyball players, 12% of Rodeo’s series claimed primarily plantarflexion mechanism as well.6 The injury pattern may also occur in classic and modern dancers. However, this hyperflexion mechanism should not be considered in the...
discussion of turf toe, as it possesses a different patho-
anatomy and treatment philosophy.

As stated earlier, numerous etiological factors for turf
toe injuries have been postulated. The shoe-surface
interface association has been substantiated and includes a
hard artificial playing surface and flexible shoe-
wear.\textsuperscript{3,11,12} Increased friction between the shoe and the
turf, as occurs with artificial surfaces, places the foot at
risk. The lighter, soccer-style shoes also place the hallux
MP joint at risk for hyperextension in contrast to the
traditional football shoe which has a steel plate incorpo-
rated for attachment of cleats.\textsuperscript{11,13}

Pre-existing restriction in hallux MP motion has not
been documented in the etiology of this injury but is
frequently observed in the athletic population. Lack of
ankle dorsiflexion also places the hallux MP joint at
greater risk and may serve as a predisposition of this
injury. Player position, at least in football, may hold
some risk as running backs and receivers are more often
affected than offensive or defensive linemen.

Clanton described a classification of the turf toe in-
jury in 1986.\textsuperscript{5} We have further developed this classifi-
cation to include a gradation of injury based on signs and
symptoms. Table 1 is based on the idea that there is a
spectrum of injury that may extend to frank dislocation
of the hallux MP joint.

A thorough radiologic evaluation of the hallux MP
joint is mandatory in diagnosing and treating the turf toe
injury. Routine radiographs of the foot are often negative
other than for soft tissue swelling. However, close ex-
amination may show small avulsion fractures of the plan-
tar aspect of proximal phalanx or at the distal pole of
sesamoid. Capsular avulsions may also be noted along
the periphery of the joint. Assessment of sesamoid po-

tion on standing AP radiographs is critical. It is our
recommendation that one should obtain bilateral AP
standing foot views for comparison. (Fig. 3) We believe
that proximal migration of the sesamoid(s) signifies
plantar complex disruption. An attempt has been made to
quantify this migration and relationship to plantar soft
tissue disruption. Absolute measurements are being de-

defined: >10.4mm from tip of tibial sesamoid to phalanx or
>13.3mm for fibular sesamoid equates to a 99.7% chance
of plantar complex rupture.\textsuperscript{14}

Forced (stress) dorsiflexion lateral views have been
quite helpful in eliciting plantar complex injury. The pa-
tient passively hyperextends both hallux MP joints,
which is followed by an assessment and comparison of
distal migration of tibial sesamoid as should normally
occur with dorsiflexion. This view may also delineate
diastasis of a bipartite or fractured sesamoid (Fig. 4).

Sesamoid views include axial and oblique images
that further assist in evaluating for diastasis or fracture.
Arthrography of the hallux MP joint is of historical in-

terest only, being displaced by MRI, although it may be
considered as an adjuvant to MRI. It likely remains the
best method for identifying the presence and extent of
capsular disruption, but must be done fairly early.

MRI is recommended for any patient with radio-

diographic abnormalities, as well as in all grade II and III
injuries. This study best defines the degree of soft tissue
injury, as well as osseous and articular damage.\textsuperscript{15}

\begin{table}
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\begin{tabular}{|l|l|l|}
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Type of injury & Grade & Description \\
\hline
\parbox{2.5cm}{Hyperextension (turf toe)} & I & 1. stretching of plantar complex \\
& & 2. localized tenderness, minimal swelling, no ecchymosis \\
& II & 1. partial tear \\
& & 2. diffuse tenderness, moderate swelling, ecchymosis, restricted movement with pain \\
& III & 1. frank tear \\
& & 2. severe tenderness to palpation, marked swelling and ecchymosis, limited movement \\
& & 3. possible associated injuries \\
& & a. medial/lateral injury \\
& & b. sesamoid fracture/bipartite diastasis \\
& & c. articular cartilage/subchondral bone bruise \\
& & 4. these may represent spontaneously reduced dislocations \\
\parbox{2.5cm}{Hyperflexion (sand toe)} & I & 1. dislocation of the hallux with the sesamoids \\
& & 2. no disruption of the intersesamoid ligament \\
& & 3. usually irreducible \\
& II A & 1. associated disruption of intersesamoid ligament \\
& & 2. usually reducible \\
& II B & 1. associated transverse fracture of one of the sesamoids \\
& & 2. usually reducible \\
& II C & 1. complete disruption of intersesamoid ligament fracture of one of the sesamoids \\
& & 2. usually reducible \\
\hline
\end{tabular}
\caption{Classification of turf toe}
\end{table}
technique includes T2-weighted images in coronal, axial, and sagittal planes. We have found that the MRI can assist in grading, identifies subtle injuries, and helps to formulate a treatment plan and prognosis. We therefore have a very low threshold in performing this study in the elite or professional athlete (Fig. 5).

**HISTORICAL PERSPECTIVE ON TREATMENT**

Little has been written or formalized in the treatment of turf toe injuries. Nonoperative treatment of all grades of turf toe injuries includes the RICE principle of: rest, ice, compression, and elevation. Analgesics and anti-inflammatory medication are used. A boot or cast can be applied and is recommended for the first week after injury in more severe injuries. A toe spica extension with the hallux and MP joint in mild plantarflexion removes tension from the injured plantar complex. Weightbearing is instituted as tolerated.

Taping regimens provide compression while limiting movement at the MP joint. This is most helpful in milder injuries, as are orthoses and shoe wear modifications. Off-the-shelf rigid insole devices can be placed in an accommodative shoe (e.g., Scott turf toe plate, full-length or forefoot only) as a cost-minded alternative to a custom-made device made with a Morton’s extension to limit hallux MP motion. The shoe itself can be stiffened with a plate incorporated into sole of shoe, but tends to be heavy.11

Corticosteroid and/or anesthetic injections are not advised in any injury, particularly when attempting to keep an athlete on the playing field. However, an anesthetic

FIG. 3. Standing AP radiograph of the feet. Note the proximal position of the tibial and fibular sesamoids on the right, indicative of a distal rupture of the plantar joint complex.

FIG. 4. Dorsiflexion stress lateral radiographs. Note the proximal position of the sesamoid in the injured foot (B) as compared with the uninjured side (A).
injection alone may be used for localized pain in single nerve distribution, but with care not to completely anesthetize the toe.

There are no studies to date that discuss the surgical indications or technique for turf toe injuries. The material that follows has been derived from personal experience in treating these injuries over the past 10 years.

**INDICATIONS/CONTRAINDICATIONS OF SURGERY**

Fortunately, operative treatment is seldom necessary but should be considered for large capsular avulsion with unstable joint (especially medial), diastasis of bipartite sesamoid or sesamoid fracture, retraction of sesamoids (single or both), traumatic bunion/progressive hallux valgus, a positive vertical Lachman’s test, and the presence of a loose body or chondral injury.

Diastasis of bipartite sesamoids and proximal migration of these structures can be progressive and serial examinations with radiographs are necessary. Surgery is indicated for progressive changes, as they are likely followed by the development of a cock-up toe deformity. Late sequelae to undiagnosed and neglected or under treated turf toe injuries may also require surgery. This not only includes the cock-up deformity alluded to but hallux rigidus as well.

The contraindications to surgery in the athlete with a turf toe injury are quite basic. Most obvious is the lack of symptoms or dysfunction. This situation will arise more in a non-sprinter in which toe push-off is not necessary for performance. However, that same individual needs to understand that late sequelae, including fixed deformity, may occur.

**TECHNIQUE**

The surgical technique includes a decision regarding the type of incision to use. Options include plantar medial, medial and plantar lateral, or a “J” configuration that extends plantar medial and then crosses plantarly along the flexor crease at base of hallux (Fig. 6).

Regardless of the incision used, the surgeon must identify and protect the plantar medial digital nerve (Fig. 7). Thereafter the surgical technique employs the identification and assessment of the degree and extent of soft tissue injury, followed by an anatomic repair. A longitudinal incision at the level of the abductor hallucis tendon will afford both intra- and extra-articular visualization of the plantar complex. The defect is fairly obvious in acute injuries, but when surgery is delayed, scar and granuloma formation can be extensive, making the delineation of the soft-tissue injury difficult. In this instance, the fibrous tissue is removed while protecting the flexor hallucis longus (FHL) tendon and surrounding nerves. A stump of healthy tendon is typically preserved at the distal pole of the sesamoids and base of the proximal phalanx (Fig. 8). In patients with late presentation, the FHL tendon must be thoroughly examined for longitudinal tearing. These tears will occur secondary to repetitive and excessive stretching of the tendon due to the lack of plantar restraint at the joint level.

Once the defect has been fully defined, it needs to be mobilized distally. In complete plantar ruptures, both sesamoids will be proximally retracted but will slide distally around the FHL tendon. In the event of a late presentation, mobilization of the plantar complex can be difficult due to fibrosis and scarring. However, adequate length can be obtained to complete a primary repair while performing a fasciotomy and/or fractional lengthening of the flexor hallucis brevis (FHB) and abductor hallucis muscles proximal to the sesamoids.

Distal ruptures require primary repair of remnants from lateral to medial, working around the FHL tendon (Fig. 9). A nonabsorbable suture has been replaced recently with slow-resorbing materials (Panacryl [Ethicon, Inc., Somerville, NJ]). If soft tissues are inadequate, one

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**FIG. 5.** MRI in sagital plane. Note the proximal position of the tibial hallux sesamoid, the distal soft tissue defect, and the edema within the FHL tendon.

**FIG. 6.** Diagrams illustrating the placement of the incision on the hallux. This hockey stick or J-incision allows for full exposure of the medial and plantar aspect of the joint.
may use suture anchors or drill holes to the plantar aspect of the base of proximal phalanx (Fig. 10).

Diastasis or fracture of the tibial hallux sesamoid usually requires excision of both poles and repair of the resulting soft-tissue defect. We have had little success with partial excision of the sesamoid and find that reattachment in this situation is difficult. When a tibial hallux sesamoidectomy is performed, we routinely transfer the abductor hallucis tendon to the resulting plantar defect. The transfer will serve as a new flexor tendon while assisting in closing the defect itself, thus providing additional plantar restraint to dorsiflexion forces (Fig. 11).

When there is diastasis of both the tibial and fibular sesamoids, a decision can be made to preserve both sesamoids by advancing the plantar complex and then using nonabsorbable suture to cerclage around the proximal and distal poles, repairing the adjacent soft tissues. Should the articular surface of the sesamoid be damaged, or if there is significant cystic change or fragmentation
within the sesamoid body, it is excised and the defect is managed with an abductor tendon transfer as above.

A traumatic bunion may result from injuries in which a valgus force is directed to the hallux. In this instance, the medial capsule, medial collateral ligament, and the medial head of the FHB tendon may rupture or attenuate and lead to an unbalanced joint. In this case, progressive hallux valgus with proximal migration of the tibial hallux sesamoid may occur. This condition is managed with a modified McBride bunionectomy-type procedure. The adductor hallucis tendon is released via a longitudinal incision on the dorsum of the first web space. The medial defects are identified, advanced and repaired primarily. A conservative excision of the bunion exostosis is performed which is felt to assist in the postoperative scarring of these medial structures (Fig. 12).

Occasionally turf toe injuries will be associated with intra-articular symptoms. A thorough examination of the joint is possible via the initial longitudinal capsulotomy and debridement is performed as necessary. In chronic situations, the lack of a plantar joint restraint may have created cartilage loss or frank eburnation at the dorsal one-third of the metatarsal head. Changes consistent with hallux rigidus may also result. In these situations, a dorsal cheilectomy is performed.

## POSTOPERATIVE MANAGEMENT

Postoperative management is dictated by the delicate balance between soft-tissue protection and early range of motion of the hallux MP joint. It is important to use athletic trainers and physical therapists for careful moni-

![FIG. 9. Repair in progress from lateral to medial and working around the intact FHL tendon. In this case, nonabsorbable suture was used.](image)

![FIG. 10. In the absence of healthy tissue on the proximal phalanx, suture anchors can be used to advance the plantar complex.](image)
FIG. 11. Abductor hallucis tendon mobilized and rerouted to the plantar aspect of the joint to serve as a flexor tendon.

FIG. 12. (A) Preoperative AP radiograph of athlete with progressive hallux valgus and painful push-off secondary to a turf toe variant injury. (B) Postoperative radiograph of same individual having undergone modified McBride type of procedure. Note improved sesamoid position and correction of the hallux valgus.
toring and hands-on passive motion exercise. General guidelines for this postoperative regimen include the initiation of gentle passive motion under supervision at 7–10 days. The patient remains nonweightbearing in a removable splint or boot with hallux protected for 4 weeks. At 4 weeks the patient is allowed to increase active motion of the joint and ambulate in boot. Modified shoe wear is instituted at 2 months and return to contact activity, with protection from excessive dorsiflexion, at 3 to 4 months. One must expect 6 to 12 months for full recovery.

The most difficult part of the treatment regimen is determining when an individual will be able to return to play. We have found this to be dependent upon the player’s position, level of discomfort, and healing potential. In general, this correlates to 50–60 degrees of painless passive dorsiflexion of the hallux MP joint. The return is facilitated by the use of taping and shoe modifications as described above. The athlete may require these shoe modifications for at least 6 months after return to play.

RESULTS

There is little written on the success of operative, or nonoperative management of the turf toe injury. Clanton and Seifert reported on 20 athletes with a 5-year follow up and found 50% with persistent symptoms that included stiffness and pain.5

Our review of patients treated at the Miller Clinic confirms the benefits of early recognition and surgical repair of complete ruptures. Over a period of 10 years, over 19 collegiate and professional athletes were evaluated in our Foot and Ankle Center with a disabling turf toe injury. Each displayed a degree of sesamoid migration and discontinuity of the hallux MP plantar soft tissue complex. Evaluation included stress lateral radiographs and MRI. Nine surgeries (nine feet) were subsequently performed under our direction; eight men and one woman, ages 18 to 33 years. The time from injury to surgery ranged from 1 week to 7 months. Surgical repair or reconstruction restored continuity of the plantar complex in each patient. As a result of fragmentation or degeneration, four sesamoidectomies were performed (three tibial, one fibular). The three patients undergoing a tibial hallux sesamoidectomy required an abductor hallucis tendon transfer to restore plantar plate continuity. Follow up ranged from 1–10 years, with questionnaires completed by each patient. All but two patients, both professional football players, returned to full athletic activity and documented restoration of plantar stability with minimal residual discomfort. Despite good joint stability, one patient had persistent pain upon toe-off and a second patient developed severe progressive degenera-

tive joint disease. There were no complications identified that were directly related to the surgery itself.

COMPLICATIONS

As with any surgery, the typical complications of wound healing problems and infection are present. Athletes may be at a slightly greater risk for these complications as they initiate rehabilitation very early in the postoperative course.

Transient neuritis of the plantar medial digital nerve at the level of the hallux MP joint is to be expected, as retraction of this structure is necessary to perform surgical repair. However, a transection and secondary neuroma is a complication that may result in significant discomfort and difficulty with shoe wear and push-off, and should be preventable with meticulous dissection and intraoperative protection.

Unmonitored or excessive range of motion of the hallux MP joint early in the postoperative course may result in a loss of continuity of the soft-tissue repair and a recurrence of the same instability pattern experienced by the athlete preoperatively. This will be evident on postoperative radiographs as a proximal migration of the sesamoids or gradual cock-up of the hallux itself.

Lastly, inadequate rehabilitation and prolonged immobilization of the repair may result in hallux MP joint stiffness, possibly in slight plantarflexion. This toe posture would significantly limit the athlete’s ability to run and sprint.

FUTURE CONCERNS

Despite the gradual trend for discontinuation of artificial playing surfaces, it is our belief that turf toe injuries will persist or increase in incidence as players develop into larger and quicker individuals, creating high-energy contact situations. Furthermore, the lighter shoes being worn provide less protection to forefoot forces sustained. It is imperative that physicians and trainers involved in the care of athletic teams understand the anatomy and biomechanics of the hallux MP joint and the implications that the turf toe injury has to the running athlete.

Numerous sequelae of untreated injuries have been observed. In the short term there may be a difficulty with push-off. In addition, the unrestrained dorsiflexion leads to secondary damage in the form of repetitive joint impaction and eventual hallux rigidus-like findings, longitudinal tears, or even rupture of the FHL tendon. Progressive hallux valgus and a bunion deformity may follow a primarily medial or plantar medial injury. Late surgical reconstruction is more difficult due to retraction of soft tissues. In these instances it is necessary to explore and debride the joint, often performing a cheilec-
tomy as well. The advancement of soft tissues may require fasciotomies and fractional lengthening of FHB and the abductor hallucis tendon. A modified McBride bunionectomy can be used for correction of hallux valgus, as this procedure allows for the release of the unbalanced adductor hallucis tendon and joint realignment.

Long-term problems include chronic pain and fixed deformity. Specifically, untreated hyperextension injuries may result in clawing of the hallux, IP joint contracture (cock-up deformity), and frank degeneration of the joint. Late surgical treatment of these particular problems is difficult. Flexor-to-extensor tendon transfer with IP fusion can be considered for these cock-up deformities, providing that the hallux MP joint is free of advanced degeneration.

**REFERENCES**