Techniques in Foot and Ankle Surgery 1(2):102–111, 2002

TECHNIQUE

Turf Toe Injuries of the Hallux Metatarsophalangeal Joint

ROBERT B. ANDERSON, M.D.
Miller Orthopaedic Clinic,
Charlotte, North Carolina, U.S.A.

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.

Address correspondence and reprint requests to Dr. Robert Anderson, Miller Orthopaedic Clinic, 1001 Blythe Boulevard, Suite 200, Charlotte, North Carolina, 28203; e-mail: drrba@carolina.rr.com

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.[4,5] A single survey of the NFL in 1990

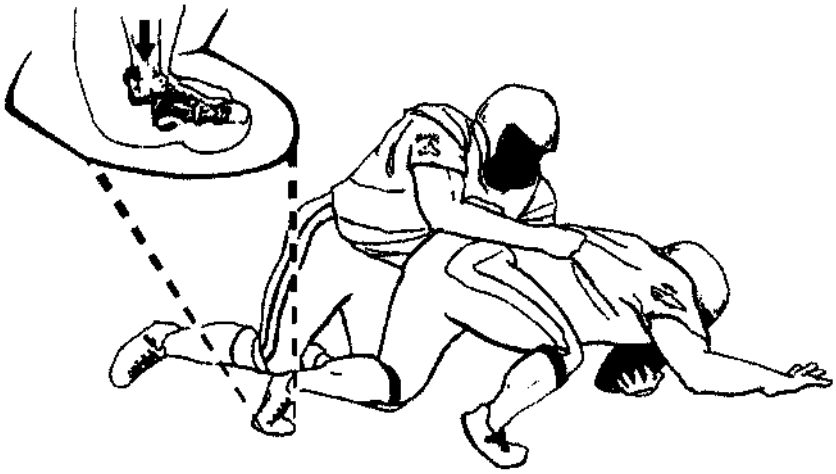

FIG. 1. Illustration of typical mechanism for the development of the turf toe injury. A foot fixed to the ground is subjected to an axial load and creates a hyperextension force at the hallux MP joint.

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

FIG. 2. Valgus force on the hallux MP joint may result in a variant of the classic turf toe injury and soft-tissue damage along the medial or plantarmedial aspect of the joint.

discussion of turf toe, as it possesses a different pathoanatomy 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 shoewear.[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 incorporated for attachment of cleats.[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 injury in 1986.[5] We have further developed this classification 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 examination may show small avulsion fractures of the plantar 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 position 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 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.[14]

Forced (stress) dorsiflexion lateral views have been quite helpful in eliciting plantar complex injury. The patient 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 interest 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 radiographic 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.[15] The

TABLE 1. *Classification of turf toe*

Type of injury	*Grade*	*Description*
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 with pain, (+) vertical Lachman's if pain allows 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
Hyperflexion (sand toe)		
Dislocation	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

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.

technique includes T2-weighted images in coronal, axial, and sagital 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.[1] 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. 4. Dorsiflexion stress lateral radiographs. Note the proximal position of the sesamoid in the injured foot **(B)** as compared with the uninjured side **(A)**.

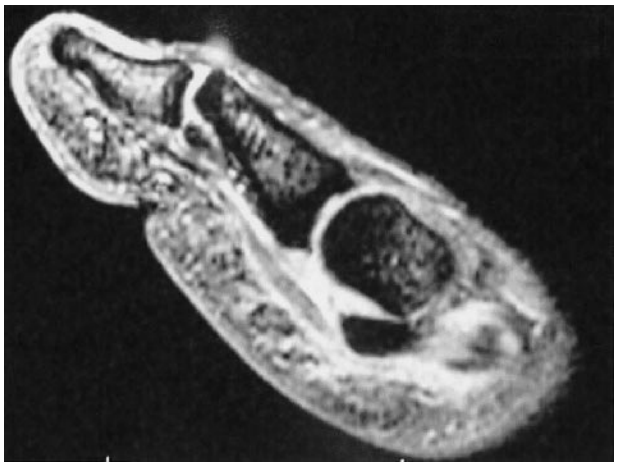

FIG. 5. MRI in sagital plane. Note the proximal position of the tibial hallux sesamoid, the distal soft tissue defect, and the edema within the FHL tendon.

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 plantarmedial, medial and plantarlateral, or a "J" configuration that extends plantarmedial 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 plantarmedial 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

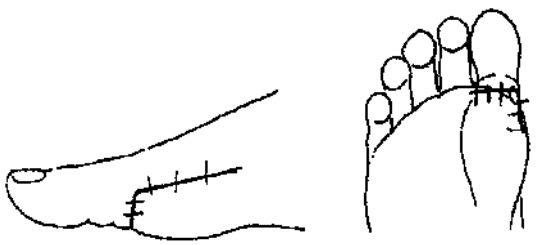

FIG. 6. Diagrams illustrating the placement of the incision on the hallux. This hockey stick or J-incision allows for full exposure of the medial and plantar aspect of the joint.

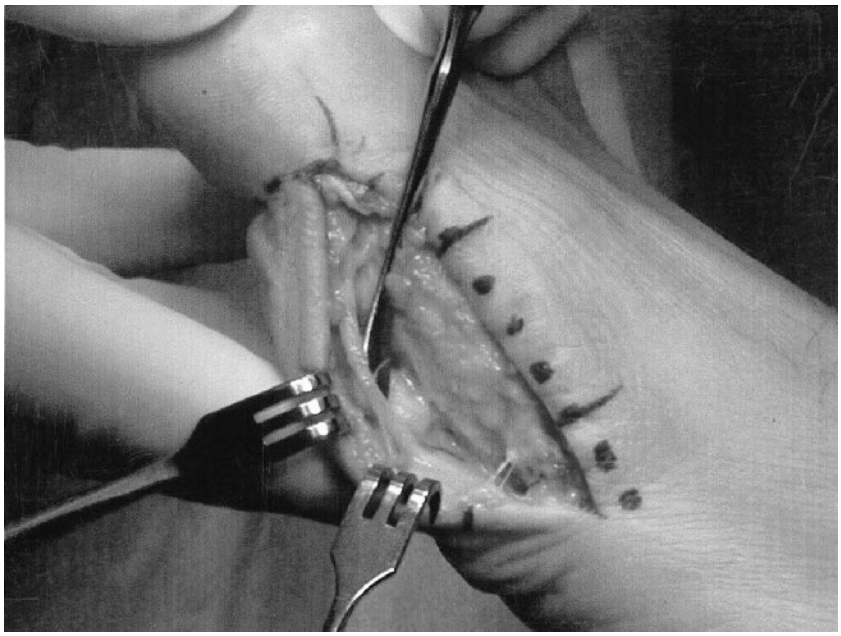

FIG. 7. Intraoperative photo noting identification and mobilization of the plantarmedial digital nerve.

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

FIG. 8. The defect has been fully delineated. Note the stump of healthy tissue that remains on the plantar base of the proximal phalanx and will be used for direct primary repair.

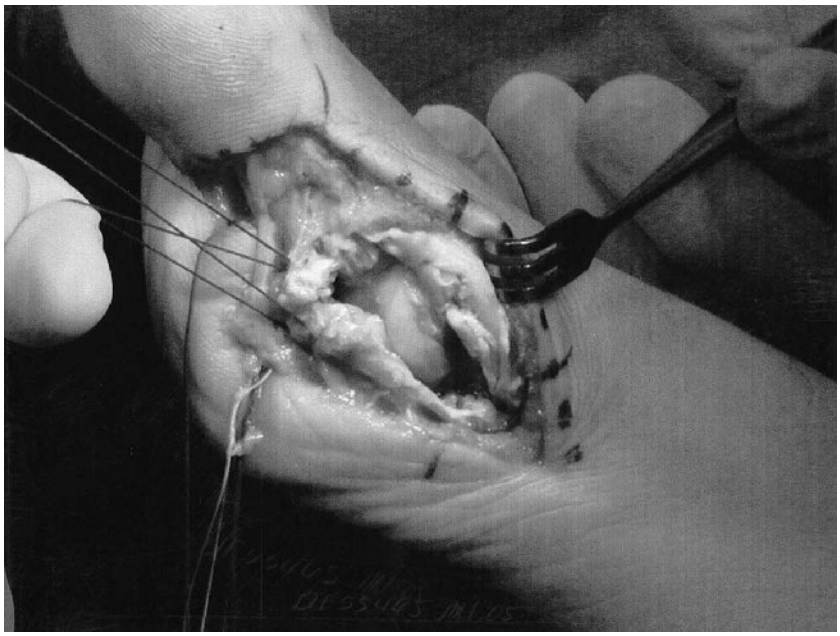

FIG. 9. Repair in progress from lateral to medial and working around the intact FHL tendon. In this case, nonabsorbable suture was used.

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. 10. In the absence of healthy tissue on the proximal phalanx, suture anchors can be used to advance the plantar complex.

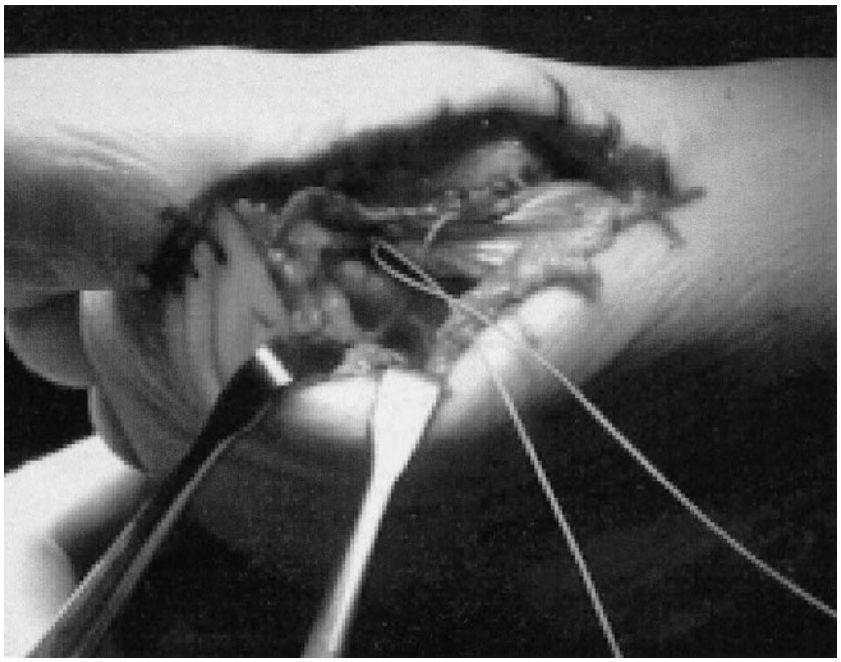

FIG. 11. Abductor hallucis tendon mobilized and rerouted to the plantar aspect of the joint to serve as a flexor tendon.

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 degenerative 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 plantarmedial 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 plantarmedial 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

1. Clanton TO, Ford JJ. Turf toe injury. Clin Sports Med 1994;13:731–741.
2. Ryan AJ, Behling F, Garrick JG, et al. Round table. Artificial turf: Pros and cons. Physician Sports Med 1975;3: 41–50.
3. Bowers KD Jr, Martin RB. Turf-toe: A shoe-surface related football injury. Med Sci Sports Exerc 1976;8:81–83.
4. Coker TP, Arnold JA, Weber DL, et al. Traumatic lesions of the metatarsophalangeal joint of the great toe in athletes. Am J Sports Med 1978;6:326–334.
5. Clanton TO, Butler JE, Eggert A. Injuries to the metatarsophalangeal joints in athletes. Foot Ankle 1986;7:162–176.
6. Rodeo SA, O'Brien S, Warren RF, et al. Turf-toe: An analysis of metatarsophalangeal joint sprains in professional football players. Am J Sports Med 1990;18:280–285.
7. Lieber J. Turf toe: The NFL's most pesky agony of da feet. Sports Illus 1988;69:401–402.
8. Underwood J. Just an awful toll. Sports Illus 1985;63: 48–62.
9. Mullis DL, Miller WE. A disabling sports injury of the great toe. Foot Ankle 1980;1:22–25.
10. Frey C, Andersen GD, Feder KS, et al. Plantarflexion injury to the metatarsophalangeal joint ("sand toe"). Foot Ankle 1996;17:576–581.
11. Jones DC, Reiner MR. Turf toe. Foot and Ankle Clinics 1999;4 (4):911–917.
12. Rodeo SA, Warren RF, O'Brien SJ, et al. Diastasis of bipartite sesamoids of the first metatarsophalangeal joint. Foot Ankle 1993;14:425–434.
13. Cooper DL, Fair J. Turf toe. Physician Sports Med 1978; 6(9):139.
14. Rodeo SA, Warren RF, O'Brien SJ, et al. Diastasis of bipartite sesamoids of the first metatarsophalangeal joint. Foot Ankle 1993;14:425–434.
15. Tewes DP, Fischer DA, Fritts HM, et al. MRI findings of acute turf toe. A case report and review of anatomy. Clin Orthop 1994;304:200–203.