Turf toe injuries and traumatic hallux valgus in the athlete

Lesões do tipo "turf toe" e hálux valgo traumático no atleta

Jeremy J. McCormick[1], Robert B. Anderson[2]

ABSTRACT

Injuries of the great toe are often underappreciated and can lead to significant functional disability. Among university athletes, Clanton and Ford[1] found that foot injuries were the third leading cause of missed time, and a large portion of these injuries involved the hallux metatarsophalangeal (MTP) joint. A sprain or tear of the capsular ligamentous structures of the first MTP joint is known as a turf toe injury. If unrecognized or mistreated, these injuries can lead to chronic problems, such as loss of push-off strength, persistent pain, progressive deformity and, eventually, joint degeneration. The focus of this article is to review the anatomy and function of the hallux MTP joint, describe the turf toe injury, and present our experience in diagnosing and treating a variant of turf toe injuries known as traumatic hallux valgus.

Keywords: Athletic injuries/diagnosis; Hallux/anatomy & physiology; Hallux/injuries; Metatarsophalangeal joint/injuries; Sprains and strains/etiology; Sprains and strains/therapy

Resumo

Lesões do hálux são subestimadas e podem levar à significativa disfunção. Entre os atletas universitários, é citada por Clanton e Ford[1] como a terceira causa mais frequente de ausência nos treinamentos, além de envolver a articulação metatarsofalângica. O estiramento ou a rotura das estruturas ligamentares e capsulares da primeira articulação metatarsofalângica é conhecida como lesão do tipo "turf toe". Se não diagnosticada ou negligenciada, esta lesão resulta em afecção crônica, tais como perda de desprendimento do hálux, dor persistente, deformidade progressiva e, eventualmente, degeneração articular. O objetivo deste artigo foi revisar a anatomia funcional da articulação metatarsofalângica, descrever a lesão do tipo "turf toe" e apresentar nossa experiência no diagnóstico e tratamento das diferentes variações das lesões tipo "turf toe" conhecidas como hálux valgo traumático.

Descritores: Traumatismos em atletas/diagnóstico; Hallux/anatomia & fisiologia; Hallux/lesões; Articulação metatarsofalângica/lesões; Entorses e distensões/etiologia; Entorses e distensões/tratamento

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INTRODUCTION

Turf toe was originally described by Bowers and Martin[2], in 1976, as a hyperextension injury to the hallux MTP joint. They found an average of 5.4 turf toe injuries per season in football players at the University of West Virginia. Similar numbers were found by Coker et al[3] at the University of Arkansas, and by Clanton et al.[4] at Rice University, who found 6.0 and 4.5 turf toe injuries per football season, respectively. In 1990, Rodeo et al.[5] published a survey of 80 active NFL players. Their findings were that 45% of the players had experienced a turf toe injury, with 83% of these occurring on artificial turf. While the injury classically occurs in football players participating on artificial surfaces, turf toe injuries can occur in any field sport, and on any surface. There has been an apparent increase in the occurrence of turf toe injuries, possibly due to the evolution to more flexible and lighter shoes, to an increase in number of sports venues with artificial turf, or to changes in surface-cleat interaction.

The typical mechanism of most turf toe injuries is delivery of an axial load to a foot that is in fixed equinus. As the foot progresses into dorsiflexion, the load drives the hallux MTP joint into hyperextension, leading to attenuation or disruption of the plantar joint complex (Figure 1). A spectrum of injuries can occur, ranging from strain or sprain of the plantar structures to frank dorsal dislocation of the toe.

Variations of the typical hyperextension mechanism for turf toe injury are based on the position of the hallux and the force of injury. The most common variant, described by Watson et al.[6], involves a valgus directed force which results in greater injury to the medial/plantar-medial ligamentous structures and tibial sesamoid complex (Figure 2). This mechanism can lead to a traumatic hallux valgus deformity as result of unbalanced force from the adductor hallucis tendon and resultant lateral contracture of the hallux MTP joint. Douglas et al.[7] reported a similar case in which a soccer player was slide-tackled from the side. After failing conservative treatment for this hallux MTP injury, the player obtained an MRI which showed a medial collateral ligament injury of the great toe requiring repair. The traumatic hallux valgus entity and surgical repair has been previously outlined by Anderson[8].

ANATOMY

The hallux MTP joint does not have inherent stability, for the proximal phalanx has a shallow cavity in which the metatarsal head articulates. Most of the stability comes from the capsular ligamentous sesamoid complex (Figure 3). Fan

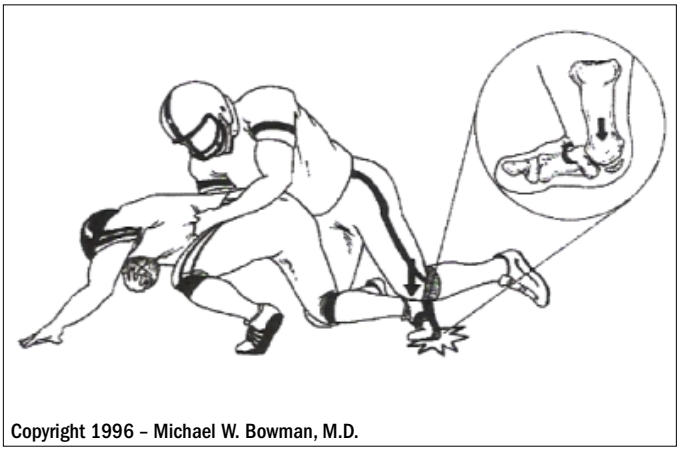

Figure 1 - Foot in fixed equinus with axially directed load leading to turf toe injury.

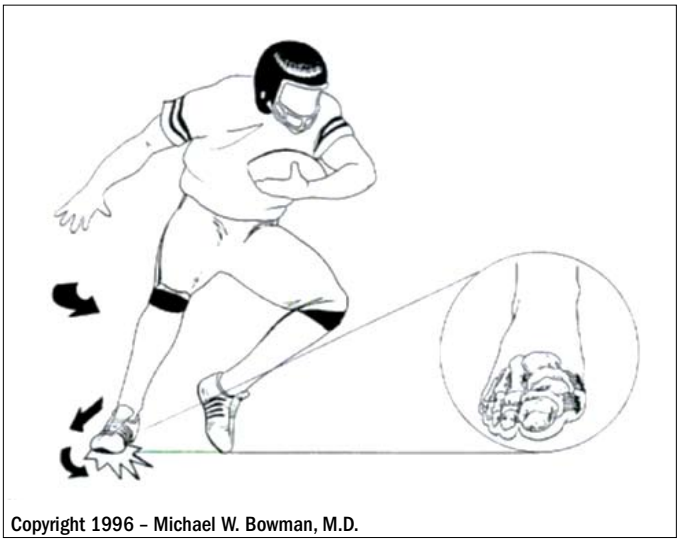

Figure 2 - Valgus directed moment causing medially based injury to hallux MTP joint.

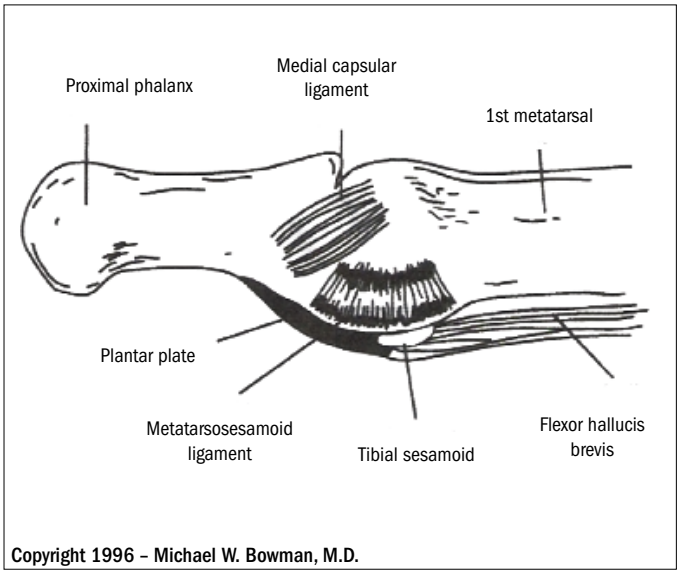

Figure 3 - Medial aspect of the first MTP joint.

shaped medial and lateral collateral ligaments, composed of an MTP ligament and a metatarsosesamoid ligament, course between the proximal phalanx and the metatarsal. These collateral ligaments are important for MTP joint stability during cutting activities. The plantar plate is a separate fibrous structure that courses through the joint capsule from a firm attachment on the proximal phalanx to a weaker attachment on the metatarsal head. In fact, the capsular ligamentous complex of the MTP joint is a confluence of structures, including the collateral ligaments and plantar plate, the abductor hallucis, adductor hallucis, and flexor hallucis brevis (FHB).

The FHB originates from the plantar aspect of the cuboid and lateral cuneiform, as well as from the posterior tibialis insertion over the medial and middle cuneiforms. As it courses distally, the FHB divides into a medial and lateral tendon which envelops the medial (tibial) and lateral (fibular) sesamoid, respectively (Figure 4). The sesamoids help protect the flexor hallucis longus (FHL) and maintain its course along the plantar aspect of the great toe. They also provide a mechanical advantage for the FHB by elevating the metatarsal head. At the level of the sesamoids, the abductor hallucis tendon conjoins with the medial head of the FHB tendon, and the adductor hallucis tendon conjoins with the lateral head of the FHB tendon. The FHB tendons then insert at the base of the proximal phalanx with the thick volar (plantar) plate.

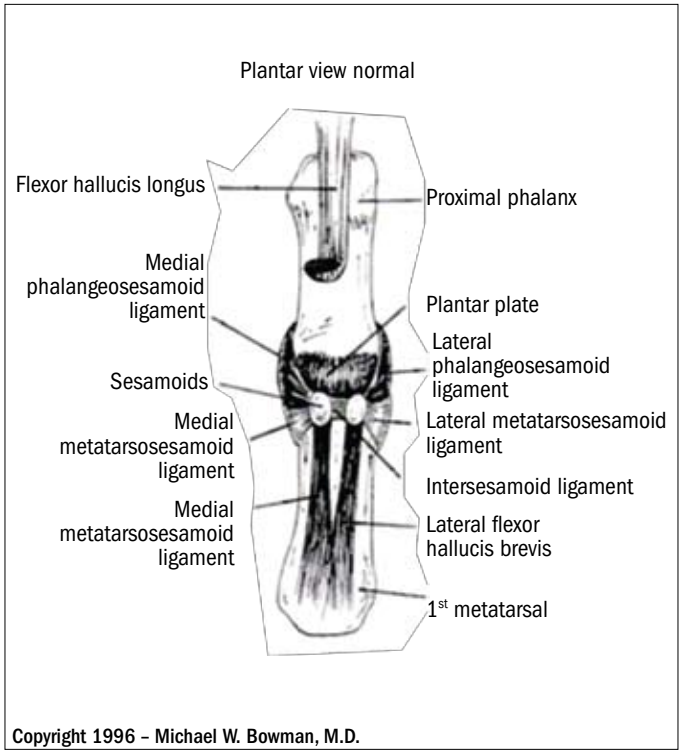

Figure 4 - Plantar view of the normal hallux MTP joint.

The capsular ligamentous sesamoid complex of the hallux MTP must withstand 40 to 60% of body weight during normal gait[9]. During athletic activity, this value increases to two to three times the body weight, and, with a running jump, the forces at the MTP joint complex can reach eight times the body weight[10]. With this in mind, it becomes clear that the capsular ligamentous sesamoid complex is critical to the function of an athlete and directs importance to careful consideration in their care.

EVALUATION

Turf toe injury can range from ligament strain to frank dislocation of the MTP joint. The category of turf toe has been grouped into hyperextension, hyperflexion, and dislocation type injuries, which can usually be distinguished by the history and physical exam (Table 1). Additionally, to guide treatment and return to play, a clinical classification has been devised (Table 2). Because of the variability in degree and type of injury, it is important to carefully evaluate any turf toe and to understand the mechanism and timing surrounding the occurrence. Also, it is important to evaluate

Table 1 - Classification of turf toe injury

Type of injury	Grade	Description
Hyperextension (turf toe)	I	Stretching of plantar capsular ligamentous complex
		Localized tenderness, minimal swelling, minimal ecchymosis
	II	Partial tear of plantar capsular ligamentous complex
		Diffuse tenderness, moderate swelling, ecchymosis
		Restricted movement with pain
	III	Frank tear of plantar capsular ligamentous complex
		Severe tenderness, marked swelling and ecchymosis
		Limited movement with pain + vertical Lachman's test
		Possible associated injuries: Medial/lateral injury Sesamoid fracture/bipartite diastasis Articular cartilage/subchondral bone bruise
Hyperflexion (sand toe)		Hyperflexion injury to hallux MTP or IP joint
		May involve injury to lesser MTP joints as well
Dislocation	I	Dislocation of the hallux with the sesamoids
		No disruption of the intersesamoid ligament
		Frequently irreducible
	IIA	Associated disruption of the intersesamoid ligament
		Usually reducible
	IIB	Associated transverse fracture of one or both sesamoids
		Usually reducible
	IIC	Complete disruption of intersesamoid ligament with fracture of one of the sesamoids
		Usually reducible

Adapted from Anderson RB, Shawen SB. Great-toe disorders. In: Porter DA, Schon LC, editors. Baxter's The Foot and Ankle in Sport, 2nd ed. Philadelphia: Elsevier Health Sciences; 2007. p. 411-33. Adapted with permission from Adelaar RS, editor. Disorders of the Great Toe. Rosemont, IL, American Academy of Orthopaedic Surgeons, 1997.

Table 2 - Clinical classification system for turf toe injury

Grade	Objective findings	Activity level	Treatment
1	Localized planter or medial tenderness	Continued athletic participation	Symptomatic
	Minimal swelling		
	No ecchymosis		
2	More diffuse and intense tenderness	Loss of playing time for 3 to 14 days	Walking boot and crutches as needed
	Mild to moderate swelling		
	Mild to moderate ecchymosis		
3	Severe and diffuse tenderness	Loss of playing time for at least 4 to 6 weeks	Long-term immobilization in boot or cast *versus* surgical repair
	Marked swelling		
	Moderate to severe ecchymosis		
	Painful and limited range of motion		

Fonte: Douglas et al.[7]

Adapted from Anderson RB, Shawen SB. Great-toe disorders. In: Porter DA, Schon LC, editors. Baxter's The Foot and Ankle in Sport, 2nd ed. Philadelphia: Elsevier Health Sciences; 2007. p. 411-33. Adapted with permission from Adelaar RS, editor. Disorders of the Great Toe. Rosemont, IL, American Academy of Orthopaedic Surgeons, 1997.

a turf toe injury acutely, as the examination can be more accurate in localizing injured structures.

The assessment should begin with observation of the hallux MTP joint for ecchymosis or swelling. The position of the hallux should be noted and compared to the contralateral, uninjured foot. A more valgus position at the MTP joint would suggest a medial based injury or traumatic hallux valgus deformity (Figure 5). Observation should be followed by a careful systematic palpation of the capsular ligamentous structures, namely the collateral ligaments, dorsal capsule, and plantar sesamoid complex. The MTP joint should then be trialed through a series of range of motion maneuvers to determine instability. Varus and valgus stress can be placed on the joint to determine the integrity of the collateral ligaments. With a traumatic hallux valgus, one should not mistake a neutral realignment of the hallux MTP joint with varus stress for varus laxity. Decreased resistance to dorsiflexion suggests a plantar plate injury. A dorso-plantar drawer test, similar to a Lachman test at the knee, is another maneuver that contributes with important information about the integrity of the joint capsule. Serial examinations are necessary due to the potential for progressive valgus of the hallux over time, particularly if the individual remains athletically active.

Next, active flexion and extension of the MTP joint should be evaluated to determine the integrity of the flexor and extensor tendons. Grading the strength of active flexion can be helpful in deciding the extent of injury, as normal strength would suggest less severe structural damage. One should remember that the assessment of an acutely injured athlete may be difficult due to the discomfort and pain of trauma.

Once the physical exam is completed, radiographic evaluation is mandatory. One should obtain weight-bearing AP and lateral views of the foot as well as a sesamoid axial view. Most often, the x-rays will be negative; however, one may find a small avulsion fracture from the plantar aspect of the proximal phalanx or the distal aspect of the sesamoid, suggesting a capsular avulsion. Comparison of radiography of

Figure 5 - Clinical photograph of a traumatic hallux valgus deformity (L) as compared to normal hallux alignment (R).

Figure 6 - Radiographic images of sesamoid retraction (L) as compared to normal sesamoid position (R).

the contralateral, uninjured foot are highly recommended, as Prieskorn et al.[11] described that patients with complete rupture of the plantar plate would have proximal migration of the sesamoids (Figure 6). In addition to comparing sesamoid position, one should also pay close attention to the alignment of the hallux, noting any asymmetry of the hallux valgus angle.

If there is clinical suspicion for plantar plate injury, one can obtain a forced dorsiflexion lateral radiograph[5]. With passive hyperextension of the hallux MTP joint, the sesamoids should migrate distally, implying continuity of the plantar complex. The forced dorsiflexion lateral view not only helps to assess this sesamoid movement, but also to assess diastasis of a fractured or bipartite sesamoid, joint subluxation, or proximal sesamoid migration in the case of a more serious plantar plate injury. Whenever possible, fluoroscopic imaging is utilized to produce a real-time view of the MTP joint and sesamoid complex. The injured toe is examined for integrity of the plantar plate through dynamic motion and compared to the contralateral side. Much as with the forced dorsiflexion lateral, lack of distal sesamoid excursion with toe extension suggests a plantar soft tissue disruption. Live fluoroscopy is both diagnostic and educational to the patient in demonstrating turf toe injury. In our practice, use of fluoroscopy has become a standard part of our diagnostic algorithm.

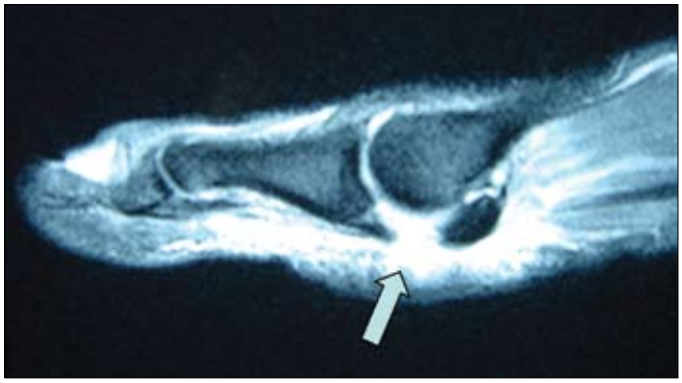

Figure 7 - Spectral Presaturation Inversion Recovery (SPIR) sagittal MRI of the great toe. The arrow shows rupture of the capsular ligamentous complex just distal to the medial sesamoid bone.

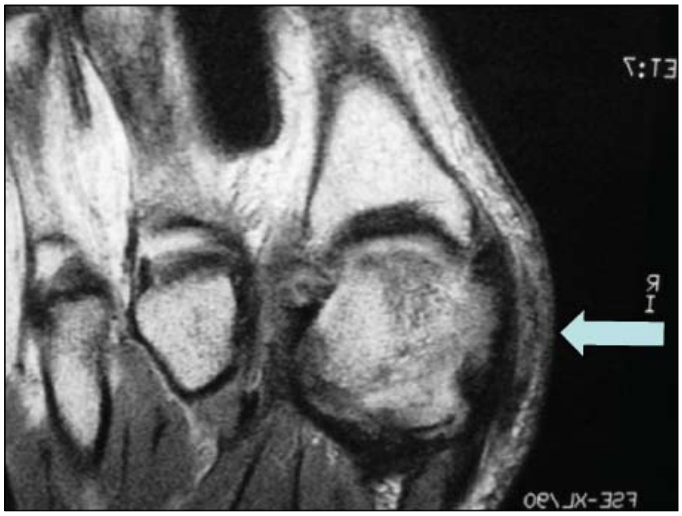

Figure 8 - T1 coronal MRI of the great toe. The arrow demonstrates attenuation of medial capsular ligamentous structure.

In addition to plain radiographs and fluoroscopy, arthrography was historically used as an adjunctive study. With improved imaging, MRI has replaced arthrography in most circumstances. MRI can be used to identify soft tissue injury as well as osseous or articular damage. T2 weighted images obtained in coronal, axial and sagittal planes provide an optimum level of anatomic detail and will identify subtle injury[12]. An MRI should be obtained in all Grade 2 or 3 injury, as it provides critical information for the formulation of a treatment plan and prognosis, particularly regarding return to activity or play. Figure 7 shows a sagittal SPIR (Spectral Presaturation Inversion Recovery) image of the hallux MTP joint with clear disruption of the plantar capsular ligamentous structures just distal to the sesamoid bone. Figure 8 demonstrates a T1 coronal image of the hallux MTP joint with attenuation of the medial capsular structures.

TREATMENT

Non-operative treatment

Once the turf toe is recognized, the treatment for early stages of all grades of injury is very similar. The basic principles of rest, ice, compression, and elevation (RICE) can be applied to help in the reduction of initial swelling. Additionally, an anti-inflammatory medication can be used to help relieve symptoms. Taping is not advised in the acute setting as it may compromise circulation. In addition to RICE, athletes may benefit from the use of a walking boot or short leg cast with a toe spica extension in slight plantarflexion. For medial based injuries, adding a slight varus moment to the spica extension is advised. The position of splinting helps protect the hallux from extension at the MTP joint while theoretically bringing the rupture into close apposition. With this protection in place, the patient may weight bear as tolerated. If symptoms permit, gentle range of motion can begin at 3 to 5 days from the injury. As early treatment continues, it is important to complete the diagnostic process and grade the injury for helping to direct continued treatment and prognosis for return to physical activities. It is also important to follow the patient with serial examinations as the deformity can progress with athletic activity, particularly in traumatic hallux valgus injuries. Cortisone or anesthetic injections are not advised.

A grade 1 injury, or plantar structure attenuation, allows athletes to return to competition with little or no loss of playing time. The toe may benefit from taping in slight plantarflexion to provide compression and limit movement. In addition, the athlete should modify their shoe wear to a stiff sole shoe that includes a turf-toe plate to limit hallux MTP

extension. Another option is a custom orthotic with a Morton's extension. A grade 2 injury, or partial plantar capsular ligamentous rupture, will generally result in loss of playing time of at least two weeks. The same treatment regimen that is used for grade 1 injuries should be applied to grade 2 injuries. Return to play will be dictated by the athlete's symptoms as well as the ability to reach near pre-injury level of performance.

A grade 3 injury, or complete plantar capsular ligamentous rupture, may require up to eight weeks of recovery. With these injuries, a longer period of immobilization is appropriate before returning to play. Again, return will be dictated by symptoms. Ideally, the hallux MTP will have 50 to 60 degrees of painless passive dorsiflexion. Additionally, the requirements of an athlete's sport or position will play a role in determining ability to return to activity. It should be made clear to the athlete that a recovery period of up to six months can be expected before complete resolution of symptoms, where shoe wear modifications and taping are not necessary.

The more medial based injury can also occur in various grades. Even in the more mild degrees, the athlete may find difficulty performing "cutting" maneuvers or simply pushing off the medial aspect of the forefoot. The use of medial based taping techniques or a toe separator between the hallux and second toe in addition to shoe modifications may be helpful.

Surgical treatment

Fortunately, operative treatment of turf toe injuries is seldom necessary. The decision to treat a patient surgically is difficult. Indications for surgery include: progressive hallux valgus deformity, a large capsular avulsion with an unstable joint (particularly medially), diastasis of a bipartite sesamoid or sesamoid fracture, retraction or migration of the sesamoids (single or both), gross instability, or progressive clawing of the hallux. Additionally, one must consider surgical intervention if a patient fails conservative measures and remains dysfunctional, such as with loss of push-off strength. The goal of surgery is to restore the anatomy necessary to regain stability and function of the plantar capsular ligamentous complex of the hallux MTP joint.

Acute repair or reconstruction of a medially based soft tissue disruption that has led to a traumatic hallux valgus deformity consists of a technique similar to that of a modified McBride bunionectomy. First, a dorsal first web space incision is used to release the adductor hallucis tendon from the sesamoid complex in an effort to minimize potential valgus deforming forces (Figure 9). Next, a classic medial approach is used to expose the injured medial structures at the hallux MTP joint. Typically, a "J" incision is made, and extended horizontally across the hallux MTP flexion crease (Figure 10). With this approach, care must be taken to identify and protect the plantarmedial digital nerve as it courses near the tibial sesamoid (Figure 11). The soft tissues are carefully freed to identify the defect in the plantar plate, typically distal to the sesamoids. Plantarflexion of the joint can assist the visualization of the defect.

Once the soft tissues are dissected and exposed, the medial eminence of the metatarsal head should be resected (Figure 12). Next, the gap in the ruptured capsular ligamentous complex is primarily repaired with non-absorbable sutures. Most often, one finds adequate tissue on the base of the proximal phalanx for reattachment. If this tissue is inadequate, then suture anchors or drill holes can be used to

Figure 9 - Surgical approach for traumatic hallux valgus repair.

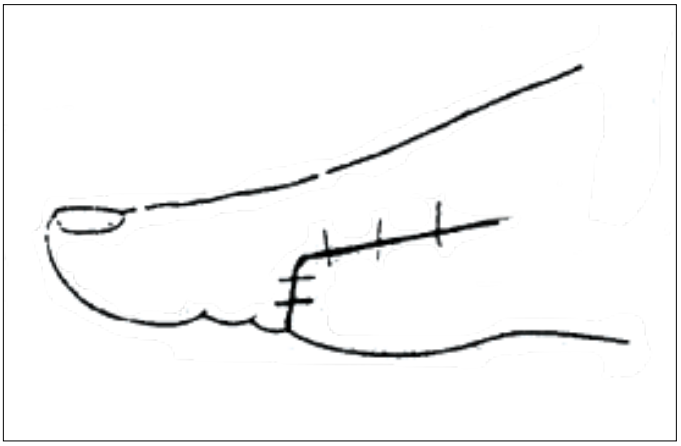

Figure 10 - Classic "J" approach to turf toe repair.

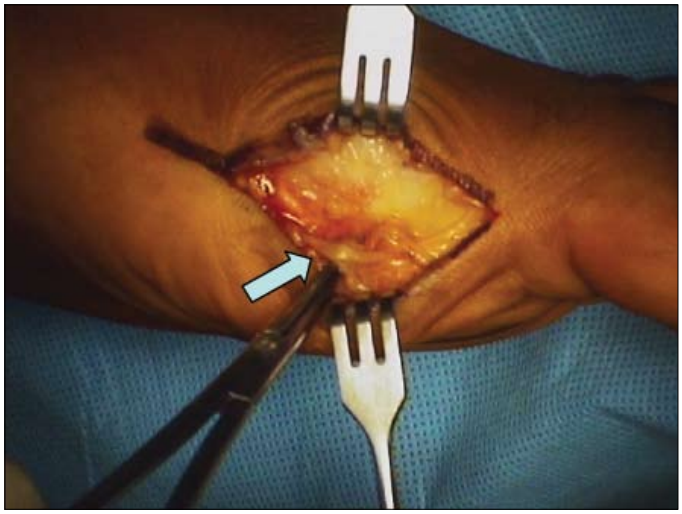

Figure 11 - Medial exposure of the hallux MTP joint with arrow identifying the plantarmedial digital nerve.

assure firm fixation of the soft tissues to the proximal phalanx. One must be sure to avoid suturing the FHL tendon as it is intimately involved with the plantar complex of the MTP joint (Figure 13). Lastly, the medial capsular dissection is closed, completing the reconstruction of the traumatic hallux valgus deformity (Figure 14).

At this point, intra-operative fluoroscopy is helpful to verify an improved, advanced position of the sesamoids as well as fluid excursion of the sesamoids with hallux MTP dorsiflexion. Additionally, the hallux valgus alignment, that resulted from the medial based injury, will be corrected to a more normal and neutral alignment after repair (Figure 15).

Situations in which there is a sesamoid fracture or diastasis of a bipartite sesamoid as part of the medially based

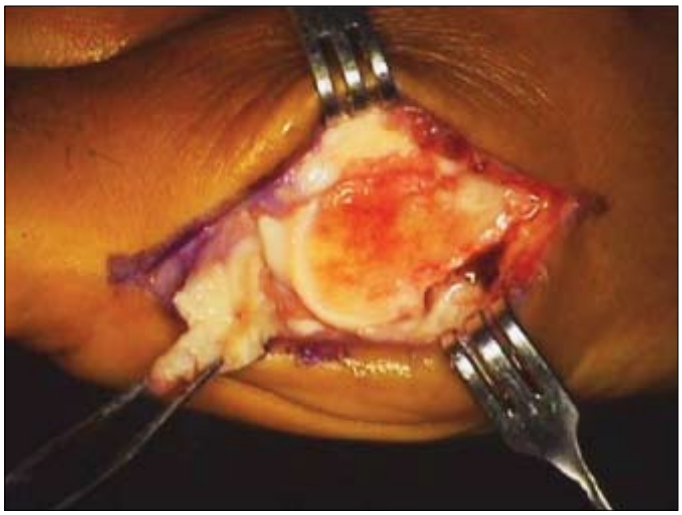

Figure 12 - Medial eminence resection in traumatic hallux valgus repair.

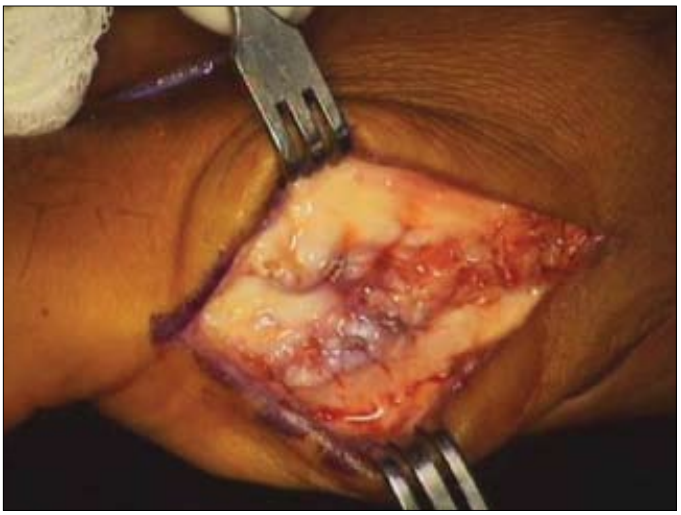

Figure 14 - Medial view of capsular ligamentous repair after resection of medial eminence.

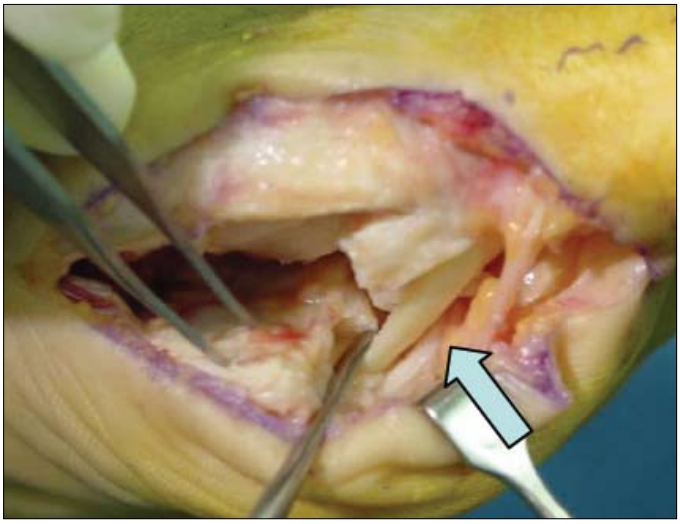

Figure 13 - Medial exposure of hallux MTP joint showing disruption in medial capsular ligamentous complex: the arrow demonstrates FHL tendon.

Figure 15 - (A) Preoperative radiographic view of traumatic hallux valgus deformity and (B) postoperative radiographic view of traumatic hallux valgus deformity after repair.

injury, preserving one pole of the sesamoid is recommended, if possible. Ideally, there is a smaller distal pole fragment that is amenable to excision. Once the bone is excised, the soft tissues are repaired using drill holes through the remaining proximal sesamoid as an adjunct. If complete sesamoidectomy is necessary, a large soft tissue defect may remain within the plantar complex, compromising flexor power or resulting in fixed deformity. In this situation, the abductor hallucis tendon can be detached from its distal insertion, mobilized, and transferred plantarly into the defect. This transfer will serve to provide collagen for structural stability, thereby improving plantar restraint to dorsiflexion forces and augmenting the flexion power of the hallux MTP joint.

Late reconstruction of a turf toe injury may be necessary in an athlete who is inadequately diagnosed or treated, or in the athlete who continues to perform despite injury. In these situations, surgical repair can be difficult due to retraction and scarring of the soft tissues. Advancement of the capsule and sesamoids may require fasciotomies or fractional lengthening of the proximal FHB and/or abductor hallucis muscle-tendon unit. If a cock-up deformity that is passively correctable has developed, a Girdlestone-Taylor type procedure can be performed; splitting the flexor tendon and re-approximating it into the dorsal extensor complex or directly transferring the flexor tendon through a drill hole in the proximal phalanx and securing it with a biotenodesis screw.

Postoperative management

Postoperative management of surgical reconstruction is challenging due to the need of finding balance between soft tissue protection and early range of motion. Immediately after surgery, a toe spica splint should be used to keep the toe in 5 to 10 degrees of plantarflexion. In the case of traumatic hallux valgus repairs, the toe should also be maintained in slight varus. With careful supervision to avoid excessive dorsiflexion, gentle passive range of motion can begin at five to seven days to decrease the development of arthrofibrosis at the sesamoid-metatarsal articulation. The patient should remain non-weightbearing for four weeks, with a removable splint or protective boot. Slight varus overcorrection of the hallux is maintained with taping or with the use of a toe separator. At night, the patient should wear a removable bunion splint with plantar restraint. At four weeks, the patient may begin protected weight-bearing in a boot, and, at this point, can initiate active motion with progression over time. By eight weeks, the patient can discontinue use of the boot and transition to shoes modified with a plantar plate or insert to prevent hallux MTP hyperextension. The athlete is allowed to continue increasing activities as tolerated with protective taping and shoe wear, and will be able to return to contact activity at approximately four months. Despite a return to full activity, it should be clear that it will take at least six months, and often as long as 12 months, to obtain full recovery.

Various authors have reported on their experience with turf toe injuries. Anderson[8] reported on 19 high level athletes who underwent evaluation for disabling turf toe injuries, nine of which were operatively repaired. All but two patients returned to full athletic activity with documented restoration of plantar stability. There were no operative complications. Coker et al. reported on nine athletes with hyperextension injury to the first MTP joint, finding that the most common long term complaints were joint stiffness and pain with athletic activity[13]. Clanton et al. had a larger group of 20 patients at a five-year follow-up from a turf toe injury[4]. Fifty per cent of these athletes reported the persistence of symptoms of pain and stiffness.

Specifically examining traumatic hallux valgus injuries, we have experience with 13 patients requiring surgical correction: 12 males and 1 female who were all professional athletes, average of 25.4 years. All patients had an adductor release with medial reconstruction. Two of them required tibial sesamoidectomy with an abductor tendon transfer into the remaining defect. When combined, the 13 patients had an average preoperative hallux valgus angle of 39 degrees, and an average postoperative hallux valgus angle of 18 degrees. All patients were able to return to their professional sport and, thus far, none of them have documented instability patterns, joint degeneration, or hallux varus.

CONCLUSIONS

The evaluation and diagnosis of turf toe injuries is improving as it becomes a more recognized pattern of hallux MTP injury. When diagnosed, assessed and treated accurately, with surgical repair when necessary, athletes can successfully return to play and efficiently reach their pre-injury level of participation.

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