Foot and Ankle Injuries in Soccer

Publish date: October 19, 2018
Authors:
Enrique Feria-Arias, MD Karim Boukhemis, MD Christopher Kreulen, MD, MS Eric Giza, MD

Author Affiliation | Disclosures

Authors’ Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

Dr. Feria-Arias and Dr. Boukhemis are foot & ankle orthopaedic surgery fellows at UC Davis Medical Center, Sacramento, CA. Dr. Kreulen is Assistant Professor of Orthopaedics, Foot and Ankle Service, at University of California Davis, Sacramento, CA. Dr. Giza is Professor and Chief of the Orthopaedic Foot & Ankle Service, at University of California Davis, Sacramento, CA; Sacramento Republic FC Head Team Physician; and Major League Soccer Medical Research Chair.

Address correspondence to: Eric Giza, MD, University of California, Davis, Department of Orthopaedics, 3301 C Street, Suite 1700, Sacramento, CA  95816 (tel, 916-734-6805; email, ericgiza@gmail.com).

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Take-Home Points

- Soccer injuries of the foot and ankle are becoming more prevalent due to the ever-growing popularity of the sport.
- Low ankle sprains represent the majority of foot and ankle-related injuries due to soccer and most can be treated non-operatively, with an early mobilization protocol followed by a phased rehabilitation.
- High ankle sprains are less common than low ankle sprains; however, they require a lengthier rehabilitation and most of the time are treated surgically.
- Impingement-like syndromes are common among soccer players and can be due to repetitive microtrauma from recurrent ball impact. Most of these syndromes respond favorably to non-operative modalities.
- Stress fractures of the foot, although less common, often require surgical stabilization in soccer players.

Epidemiology

With roughly 200,000 professional and around 240 million amateur soccer players, soccer has been recognized as the most popular sport worldwide. Nevertheless, given its rising popularity in society, one must also consider the increasing incidence of injuries as a result. Elite soccer players sustain between 10 and 35 injuries per 1000 competitive playing hours.\(^1\) Approximately 80% are traumatic, and 20% are overuse injuries.\(^2\) Soccer injuries are more frequent with increasing age of the participants, whereas the incidence of injuries in preadolescent players is low. The incidence of injuries has been found to be higher during competition when compared with practice/training sessions, with some studies showing that 59% of injuries occurred during games.\(^2\) Amateur or
recreational soccer players sustain fewer injuries than professional soccer players, as one would expect, given both the higher intensity of training and match schedule in professionals.

The ankle is one of the most commonly injured joints in soccer, with some studies suggesting it comprises one-fifth of all injuries sustained during soccer, which is only second to those of the knee.² Ankle sprains specifically are quite a common occurrence in soccer.³-⁹ A recent study of an English premier league club showed that over a 4-season period, 20% of injuries were of the foot and ankle with a mean return to sport time of 54 days.¹⁰ Of all foot and ankle related injuries, ankle sprains are the most common, followed by bruises/contusions, and tendon lesions. Fractures are very rare (1%) in soccer, but when they do occur they impart a much more extended recovery. During the 2010 Fédération Internationale de Football Association (FIFA) World Cup, ankle sprains were among the most common injuries and approximately half lead to players missing training or competitive matches.⁵

Anatomy

Knowledge of the biomechanics of both the foot and ankle joints is essential to understand soccer injuries. The ankle joint (talocrural articulation) consists of the distal ends of the tibia and fibula, which form the mortise, and the superior aspect of the talar dome.¹¹ As a hinge joint, the ankle provides 20° of dorsiflexion and 50° of plantar flexion,¹² with stability provided by the lateral, medial, and superior ligamentous complexes. The superior articular surface of the talus is narrower posteriorly, which creates a looser fit within the mortise during plantar flexion.¹¹ This decreased stability could help explain why the most common injury in soccer involves a plantar flexion mechanism.¹³,¹⁴ Inferiorly, the talus articulates with the calcaneus to form the subtalar joint. It is at this site that the majority of both foot inversion and eversion occurs. The transverse tarsal joints (Chopart’s joints) separate the hindfoot from the midfoot. Movement of this joint depends on the relative alignment of its 2 articulations: the talonavicular and calcaneocuboid joints. During foot eversion, these 2 joints are parallel to each other allowing supple motion and aiding in shock absorption during the heel strike phase of the gait cycle. With foot inversion, the joints become nonparallel and thus lock the transverse tarsal joints providing a rigid lever needed for push-off.¹¹,¹²

Lateral Ligaments

The ankle joint is stabilized laterally by a ligament complex consisting of 3 individual ligaments, all originating from the lateral malleolus: the anterior talofibular ligament (ATFL), the posterior talofibular ligament (PTFL), and the calcaneofibular ligament (CFL) (Figure 1).¹¹,¹²,¹⁵ The ATFL is the primary restraint to inversion in plantar flexion, and it helps resist anterolateral translation of the talus in the mortise. However, it is the weakest and therefore the most frequently injured of the lateral ligaments. The PTFL plays only a supplementary role in ankle stability when the lateral ligament complex is intact. It is under the greatest strain in ankle dorsiflexion and acts to limit posterior talar displacement within the mortise as well as talar external rotation.¹³,¹⁶ The CFL is the primary restraint to inversion in the neutral or dorsiflexed position. It restrains subtalar inversion, thereby limiting talar tilt within the mortise.

Deltoid Ligament

The deltoid ligament complex consists of 6 continuous adjacent superficial and deep ligaments that function synergistically to resist valgus and pronation forces, as well as external rotation of the talus in the mortise.¹¹-¹³ The superficial layer crosses both ankle and subtalar joints. It originates from the anterior colliculus and fans out to insert into the navicular, neck of the talus, sustentaculum tali, and posteromedial talar tubercle. The
tibiocalcaneal (sustentaculum tali) portion is the strongest component in the superficial layer and resists calcaneal eversion. The deep layer crosses the ankle joint only. It functions as the primary stabilizer of the medial ankle and prevents both lateral displacement and external rotation of the talus. It originates from the inferior and posterior aspects of the medial malleolus and inserts on the medial and posteromedial aspects of the talus.\textsuperscript{12,17,18}

**Syndesmosis**

The ankle syndesmosis, or inferior tibiofibular joint, is the distal articulation between the tibia and fibula. The syndesmosis contributes to ankle mortise integrity through its firm fixation of the lateral malleolus against the lateral surface of the talus. Ligaments comprising the ankle syndesmosis include the anterior inferior tibiofibular ligament (AITFL), the posterior inferior tibiofibular ligament (PITFL), the inferior transverse ligament, and the interosseous ligament (IOL).\textsuperscript{12}

**Ankle Sprains**

Ankle sprains are the most common pathology encountered amongst soccer players, representing from one-half to two-thirds of all ankle related injuries. Most sprains occur outside of player contact.

**Lateral Ankle Sprains and Instability**

Injury to the lateral ligaments of the ankle represents 77\% to 91\% of all ankle sprains in soccer.\textsuperscript{6,19} The greatest risk factor for an ankle sprain in a soccer player is a history of prior sprain.\textsuperscript{20} Other risk factors include increasing age, player-to-player contact, condition of the pitch, weight-bearing status of the injured limb at the time of injury, and joint instability or laxity.\textsuperscript{21,22}

The evaluation of an ankle sprain to determine its severity is best done after the acute phase, approximately 4 to 7 days after the initial injury when both pain and swelling have subsided.\textsuperscript{23} The anterior drawer (ATFL instability) and talar tilt (CFL instability) tests are useful in evaluating ankle instability in the delayed or chronic setting; however, both have been shown to have limited sensitivity and significant variability amongst different examiners.\textsuperscript{24}

Clinical examination will direct further diagnostic tests including X-rays, magnetic resonance imaging (MRI), and computed tomography (CT). The Ottawa ankle rules are generally helpful in determining whether plain X-rays are indicated in the acute setting.\textsuperscript{25,26} (Figure 2) According to these rules, ankle radiographs should be obtained if ankle pain is reported near the malleoli and 1 or more of the following is seen during examination: inability to bear weight immediately after injury and for 4 steps in the emergency department, and bony tenderness at the posterior edge or tip of the malleolus. Stress X-rays are generally not indicated in acute injuries but may be useful in chronic ankle instability cases.\textsuperscript{23}

Ankle sprains cover a broad spectrum of injuries; therefore, a grading system was devised to aid in guiding treatment. Grade I (mild) sprains are those with minimal swelling and tenderness but have the ligaments still intact. Grade II (moderate) sprains occur when there are partial ligament tears associated with moderate pain, swelling, and tenderness. Finally, Grade III (severe) sprains are complete ligament tears with marked swelling, hemorrhage, tenderness, loss of function, and abnormal joint motion and instability.\textsuperscript{23,24}

Initial treatment for all ankle sprains is nonoperative and involves the RICE (rest, ice, compression, elevation)
protocol with the use of nonsteroidal anti-inflammatory drugs (NSAIDs) during the acute phase (first 4-5 days) with a short period (no >2 weeks) of immobilization. Most authors agree that early mobilization followed by phased rehabilitation is warranted to minimize time away from sports. Prolonged immobilization (>2 weeks) has detrimental effects and may lead to a longer return to play. The rehabilitation protocol is divided into stages: (1) pain and edema control, (2) range of motion (ROM) and strengthening exercises, (3) soccer specific functional training, and (4) prophylactic intervention with balance and proprioception exercises. Surgical intervention is rarely indicated for acute ankle sprains. There are exceptions, however, such as when ankle sprains are associated with other injuries that require acute intervention (eg, fracture, osteochondral lesion). Surgery is indicated in the setting of chronic, recurrent mechanical instability. Anatomical repairs (modified Brostrom) seem to produce better outcomes than non-anatomical reconstructions (eg, Chrisman-Snook). Surgical outcomes are good, and most athletes are able to return to their pre-injury level of function.

In athletes, prevention of recurrent sprains is key. Braces may help prevent ankle sprains and bracing has been shown to be superior to taping, as tape loses its restrictive properties within 20 to 30 minutes of initiating activity. Application of an orthosis (lace-up ankle orthosis) has been shown to reduce the incidence of ankle re-injury in soccer players with previous ankle sprains. Several studies have found minimal, if any, effect of orthoses on athletic performance. Low-profile braces for soccer have been developed which allow for minimal disruption of the player’s boot and space proximally to insert the shin guard. Another essential component of prevention is prophylactic intervention with balance and proprioceptive exercises. A study looking at first division men’s league football (soccer) players in Iran showed a significant decrease in re-injury rates with proprioceptive training. In 2003, FIFA introduced a comprehensive warm-up program (FIFA 11+), which has since been shown in several studies to decrease the risk of injury in amateur soccer players.

**Medial Ankle Sprains and Instability**

Soccer places an unusually high demand on both the medial foot and ankle structures when compared with other sports. For instance, striking the ball requires the player to abduct and externally rotate the foot, which preloads medial structures. Hintermann looked at 54 cases of medial ankle instability and found that injury commonly occurred during landing on an uneven surface, which applies to soccer players when landing after heading the ball or jumping over a tackle. Pronation with eversion and extreme rotational injuries are well known to cause deltoid ligament injury. However, complete rupture of the deltoid ligament is rare and is more often associated with ankle fractures. Due to its close proximity and similarly shared function in medial plantar arch stabilization with the tibiospring and spring ligaments, posterior tibialis tendon dysfunction is also frequently seen in medial ankle instability. After an acute injury, patients can present with a medial ankle hematoma and pain along the deltoid ligament. Although chronic insufficiency is diagnosed based on the feeling of “giving way,” pain in the medial gutter of the ankle and a valgus and pronation deformity of the foot can be corrected by activating the peroneus tertius muscle. Arthroscopy is the most specific way to confirm clinically suspected instability of the medial ankle; however, MRI can demonstrate loss of organized medial fibers (Figures 3A, 3B). Primary surgical repair of deltoid ligament tears yield good to excellent results and should be considered in the soccer player to prevent problems associated with chronic non-repaired tears such as instability, osteoarthritis, and impingement syndromes. After surgical repair, players will undergo extensive physical therapy that progresses to sport-specific exercises with the ultimate goal of returning to competitive play around 4-6 months post-operatively.

**High Ankle Sprains (Syndesmosis)**

High ankle sprains are much less common than low ankle sprains; however, when they do occur they portend a lengthier rehabilitation and a poorer prognosis, especially if undiagnosed. Lubberts and colleagues studied the
epidemiology of isolated syndesmotic injuries in professional football players. They pooled data from 15 consecutive seasons of European professional football between 2001 and 2016. They examined a total of 3677 players from 61 teams across 17 countries. There were 1320 ankle ligament injuries registered during 15 seasons, of which 94 (7%) were isolated syndesmotic injuries. The incidence of these injuries increased annually between 2001 and 2016. Injuries were 74% contact-related, and isolated syndesmotic injuries were followed by a mean of a 39-day absence. Moreover, football players may have an increased risk of syndesmotic sprains due to foot planting and cutting action.

These injuries are typically identified with pain over the AITFL and interosseous membrane. Physical examination tests that help identify syndesmotic injuries include the squeeze test, external rotation test, and crossed-leg test. The diagnosis can be made on plain X-ray when there is clear diastasis between the distal tibia and fibula. Two critical measurements on plain films are made 1 cm above the tibial plafond and are used to evaluate the integrity of the syndesmosis: tibiofibular clear space >6 mm, and tibiofibular overlap <1 mm, which indicate disruption of the syndesmosis. More subtle injuries can be diagnosed with better sensitivity and specificity using MRI, which can also reveal secondary findings such as bone bruises, ATFL injury, osteochondral lesions, and tibiofibular incongruity. Arthroscopy is an invaluable diagnostic tool for syndesmotic injuries with a characteristic triad finding of PITFL scarring, disrupted interosseous ligament, and posterolateral tibial plafond chondral damage.

Classification of the ligaments involved can aid in the selection of appropriate treatment. Grade I injuries involve AITFL tears. Grade IIa injuries involve AITFL and IOL tears. Grade IIb injuries include AITFL, PITFL, and IOL tears. Grade III injuries involve injury to all 3 ligaments, as well as a fibular fracture. Conservative treatment is recommended for Grades I and IIa, while surgical intervention is necessary for Grades IIb and III (Figures 4A, 4B). Compared with other ankle sprains, syndesmotic injuries typically require a more prolonged recovery/rehabilitation. Some studies suggest that these injuries require twice as long to heal. Hopkinson and colleagues reported a mean recovery time of 55 days following syndesmotic injuries in cadets at the United States Military Academy at West Point. Some surgeons advocate surgical intervention in professional athletes with mild sprains to expedite return to play.

Surgery has been well established as necessary in more severe injuries where there is clear diastasis or instability of the syndesmosis. Traditionally, screws were used for surgical fixation; however, they often required a second surgery for subsequent removal. There is no general consensus on the optimal screw size, level of placement, or timing of removal. More recently, non-absorbable suture button fixation (eg, TightRope; Arthrex) has become more popular and provides certain advantages over screw fixation, such as avoiding the need for hardware removal. TightRope has been shown to provide more accurate stabilization of the syndesmosis as compared with screw fixation. Since malreduction is the most important indicator of poor long-term functional outcome, suture button fixation should be considered in the treatment of the football player. Finally, Coluc and colleagues reported a lower complication rate and earlier return to sports in patients treated with knotless suture button devices compared with screw fixation.

Osteochondral Lesions

Osteochondral lesions (OCLs) are cartilage-bone defects that are usually located in the talus. They can be caused by an acute traumatic event or repetitive microtrauma with no apparent history of trauma (eg, ankle instability). Acute OCLs can occur in soccer secondary to an ankle sprain or ankle fracture. Symptoms of OCLs include pain, swelling, and mechanical symptoms such as catching or locking, and on physical examination, one might see an effusion. The initial imaging modality of choice is radiographing; however, in ankle sprains with continued pain and swelling MRI may be indicated to rule out an underlying OCL. Missed acute lesions have a tendency not to
heal and become chronic lesions, which can cause pain and playing disability. It is well established that chronic ankle instability is an important etiologic factor for OCLs. With the normal hydrostatic pressure within the ankle joint, synovial fluid gets pushed into cartilage/bone fissures, which can then lead to cystic degeneration of the subchondral bone. 

Surgical repair of an OCL is dependent on both the size and location of the lesion. Acute lesions can be managed by arthroscopic débridement, microfracture, or fixation of the lesion if enough bone remains attached to the chondral lesion. Return to play is based on development and maturation of fibrocartilage over the lesion (débridement/microfracture) or healing and incorporation of the new graft (chondral repair procedures). Meanwhile, chronic lesions can be managed in 1-stage (microfracture, osteochondral autograft transfer or 2-stage (autologous chondrocyte implantation [ACI]) procedures. Additional biologic healing augmentation with platelet-rich plasma has been described as well. Newer techniques in treating chronic talus OCLs, including ones that have failed to respond to bone marrow stimulation techniques, have been developed more recently such as the use of particulated juvenile articular cartilage allograft (DeNovo NT Natural Tissue Graft®; Zimmer Biomet). These newer techniques avoid the need for a 2-stage procedure, as is the case with ACI.

Further studies are needed to both investigate long-term outcomes and determine the superiority of the arthroscopic juvenile cartilage procedure compared with microfracture and other cartilage resurfacing procedures. When surgically treating OCLs, one must also restore normal ankle joint biomechanics for the lesion to heal. For instance, in the presence of ankle instability, ligament reconstruction must be performed. Also, one should also consider addressing any hindfoot malalignment with an osteotomy (calcaneus, supramalleolar). In a recent retrospective study, van Eekeren and colleagues showed that approximately 76% of patients were able to return to sports at long-term follow-up after arthroscopic débridement and bone marrow stimulation of talar OCLs. However, the activity level decreased at long-term follow-up and never attained the pre-injury level. 

**Ankle Impingement**

**Anterior Ankle Impingement (Footballer’s Ankle)**

Anterior ankle impingement is caused by anterior osteophytes on both the distal tibia and talar neck. It is thought to be related to repetitive microtrauma to the anteromedial aspect of the ankle from recurrent ball impact. It is very common amongst soccer players with some studies suggesting that 60% of soccer players have this syndrome. Ankle impingement is characterized by anterior pain with ankle dorsiflexion, decreased dorsiflexion, and swelling. It is primarily diagnosed with lateral ankle X-rays, which will show the osteophytes. An oblique anteromedial X-ray may increase detection of osteophytes (Figure 5). The early stages of anterior impingement can be treated successfully with injections and heel lifts. Treatment of lesions that fail to respond to conservative management involves arthroscopic or open excision of osteophytes. Most patients with no preexisting osteoarthritis treated arthroscopically will experience pain relief and return to full activity, though recurrent osteophyte formation has been noted at long-term follow-up.

Anterior ankle impingement is most often caused by acute ankle sprains with an inversion type of mechanism. The subsequent reactive inflammation can cause fibrosis leading to distal fascicle enlargement of the AITFL. Impingement in the anterolateral gutter of this enlarged fascicle can also cause both chronic reactive synovitis and chondromalacia of the lateral talar dome. MRI can identify abnormal areas of pathology; however, 50% of cases are diagnosed based on clinical examination alone. Patients generally present with a history of anterolateral ankle pain and swelling with an occasional popping or snapping sensation.
Soccer players commonly develop anterior bony impingement due to repetitive loading of the anterior ankle from striking the ball. This repetition can lead to osteophyte formation of the anterior distal tibia and talar neck. After the osteophytes form, decreased dorsiflexion can occur due to a mechanical stop and inflammation of the interposed capsule.

The patient will exhibit tenderness to palpation along the anterolateral aspect of the ankle, with pain elicited at extreme passive dorsiflexion. Initially, an injection with local anesthetic and corticosteroid can serve both a diagnostic and therapeutic purpose; however, patients who fail conservative treatment can be treated with arthroscopy and resection of the involved scar tissue and osteophytes. The best results are seen in those patients with no concurrent intra-articular lesions or ankle osteoarthritis (Figure 5). When treated non-operatively, a player may return to play when pain resolves; however, if treated surgically with arthroscopic debridement/resection, a player must wait until his surgical scars have healed prior to attempting return to play.

**Anteromedial Ankle Impingement**

Anteromedial ankle impingement is a less common ankle impingement syndrome. It is associated with eversion injuries or following medial malleolar or talar fractures. Previous injury to the anterior tibiotalar fascicle of the deltoid complex leads to ligament thickening and subsequent impingement in the anteromedial corner of the talus. Adjacent fibrosis and synovitis are common consequences of impingement; however, osteophyte formation and chondral stripping along the anteromedial talus can also be seen. Patients typically complain of pain along the anteromedial joint line that is worse with activity, clicking or popping sensations, and painful, limited dorsiflexion. On examination, impingement can be detected through palpation over the anterior tibiotalar fascicle of the deltoid ligament and eversion or extreme passive dorsiflexion of the foot, all of which will elicit medial ankle tenderness. Initial treatment consists of rest, physical therapy, and NSAIDs. Refractory cases may be amenable to arthroscopic or open resection of the anterior tibiotalar fascicle with débridement of any adjacent synovitis and scar tissue.

**Posterior Ankle Impingement**

Posterior ankle impingement is often referred to as “os trigonum syndrome” since the posterior impingement is frequently associated with a prominent os trigonum. An os trigonum is an accessory ossicle representing the separated posterolateral tubercle of the talus. It is usually asymptomatic. However, in soccer players, pain can occur from impaction between the posterior tibial plafond and the os trigonum, or because of soft tissue compression between the 2 opposing osseous structures. The pain is due to repetitive microtrauma (ankle plantarflexion) or acute forced plantarflexion, which can present as an acute fracture of the os trigonum. Because soccer is a sport requiring both repetitive and extreme plantarflexion, it may predispose players to posterior ankle impingement (Figures 6A, 6B).

Clinically, it can be very difficult to detect and diagnose because the affected structures lie deep and it can coexist with other disease processes (eg, peroneal tendinopathy, Achilles tendinopathy). Patients will complain of chronic deep posterior ankle pain that is worse with push-off activities (eg, jumping). On examination, patients will exhibit pain with palpation over the posterolateral process and with the crunch test. Lateral radiograph with the foot in plantar flexion will show the os trigonum impinged between the posterior tibial malleolus and the calcaneal tuberosity. An MRI will demonstrate the os trigonum as well as any associated inflammation and edema, while it can also demonstrate coexisting pathologies.

Initial treatment consists of rest, NSAIDs, and taping to prevent plantar flexion. Ultrasound-guided cortisone
injection of the capsule and posterior bursa can be both therapeutic and diagnostic. A posterior injection can be used to temporize the symptoms so that the soccer player can make it through the season.

Surgical excision is saved for refractory cases, and this can be done either through an open posterolateral approach or arthroscopic techniques. Recently, Georgiannos and Bisbinas\textsuperscript{67} showed in an athletic population that endoscopic excision had both a lower complication rate and a quicker return to sports compared with the traditional open approach. Carreira and colleagues\textsuperscript{68} conducted a retrospective case series of 20 patients (mostly competitive athletes). They found that posterior ankle arthroscopy to address posterior impingement allowed for the maintenance or restoration of anatomic ROM of the ankle and hindfoot, ability to return to at least the previous level of activity, and improvement in objective assessment of pain relief and a higher level of function parameters.\textsuperscript{68}

\textbf{Tendon Pathology}

\textbf{Superior Peroneal Retinaculum Injury}

The superior peroneal retinaculum (SPR) forms the roof of the superior peroneal tunnel. The tunnel contains the peroneus brevis and longus tendons and is bordered by the retromalleolar groove of the fibula and the lower aspect of the posterior intramuscular septum of the leg.\textsuperscript{69,70} The SPR originates from the posterolateral ridge of the fibula and inserts onto the lateral calcaneus, and it is the primary restraint of the peroneal tendons within the retromalleolar sulcus.

Injury to the retinaculum results from both ankle dorsiflexion and inversion, and forceful reflex contraction of the peroneal muscles, which causes subluxation or dislocation of the contained tendons.\textsuperscript{69} A high level of suspicion is required regarding these injuries since the mechanism of injury is similar to that of a simple lateral ankle sprain. In the setting of retrofibular pain, snapping or popping sensations around the lateral malleolus, or chronic ankle instability that worsens on uneven surfaces, one must consider an injury to the SPR.\textsuperscript{69} Radiographs are not always diagnostic; however, occasionally on an internal rotation view, one may see a cortical avulsion off the distal tip of the lateral malleolus (“fleck sign”) indicating a rim fracture from an SPR injury (\textbf{Figure 7}). MRI is the best imaging modality to assess the peroneal tendons, as well as an SPR injury. Recently, ultrasound has grown in popularity and may be more useful, since it allows for dynamic evaluation of subluxating/dislocating tendons.\textsuperscript{69}

Conservative management is often associated with poor outcomes, and surgery is indicated for all acute and chronic dislocations in athletes.\textsuperscript{71} Anatomic reconstruction of the SPR is the preferred surgical method.\textsuperscript{72} Peroneus brevis debulking and fibular groove deepening may also augment the retinaculum repair.\textsuperscript{73} van Dijk and colleagues in their systematic review showed that patients treated with both groove deepening and SPR repair have higher rates of return to the sport than patients treated with SPR repair alone.\textsuperscript{74}

\textbf{Stress Fractures}

\textbf{Fifth Metatarsal}

Fifth metatarsal stress fractures usually occur secondary to lateral overload or avulsion of the peroneus brevis. The fifth metatarsal base can be susceptible to injury in a cavovarus foot. Non-operative treatment typically requires a longer period of immobilization (boot or cast) and necessitates a longer period of non-weight-bearing
(anywhere between 6-12 weeks). Therefore, surgery is typically recommended in athletes or in the setting of a recurrent base of the fifth metatarsal fracture to expedite healing and return to play. Return to play is still not recommended until there is evidence of radiographic healing of the fracture. There are certain distinctions with fifth metatarsal stress fractures regarding location and healing rates that need to be taken into account.\textsuperscript{75,76} In particular, zone 2 injuries (Jones fractures) represent a vascular watershed area, making these fractures prone to nonunion with nonunion rates as high as 15% to 30%. Occasionally, the cavovarus deformity will require correction as well as a reduction in the risk of recurrence or nonunion. Surgical fixation most commonly consists of a single screw placed in an antegrade fashion.\textsuperscript{77} One must pay attention to screw size since smaller diameter screws (<4.5 mm) are associated with delayed union or nonunion. Moreover, screws that are too long will straighten the curved metatarsal shaft and can lead to fracture distraction or malreduction (Figures 8A, 8B).\textsuperscript{77}

Patients have returned to competitive sports within 6 weeks; however, it should be noted that causes of failure were linked to early return and return to sports before a radiographic union can lead to failure of fixation. Ekstrand and van Dijk\textsuperscript{78} studied a large group of professional soccer players and found that out of 13,754 injuries, 0.5% (67) were fifth metatarsal fractures. Of note, they found that 45% of players had prodromal symptoms. Furthermore, after surgical treatment the fractures healed faster, compared with conservative treatment (75% vs 33%); however, there was no significant difference in lay-off days between both groups (80 vs 74 days).\textsuperscript{78} Matsuda and colleagues\textsuperscript{79} looked at 335 male collegiate soccer players, 29 of whom had a history of a fifth metatarsal stress fracture. They found that playing the midfield position and having an everted rearfoot and inverted forefoot alignment were associated with fifth metatarsal stress fractures.\textsuperscript{79} Saita and colleagues\textsuperscript{80} found that restricted hip internal rotation was associated with an increased risk of developing a Jones fracture in 162 professional football players. Finally, Fujitaka and colleagues\textsuperscript{81} looked at 273 male soccer players between 2005 and 2013. They found an association between weak toe-grip strength and fifth metatarsal fractures, suggesting that weak toe-grip may lead to an increase in the load applied onto the lateral side of the foot, resulting in a stress fracture.\textsuperscript{81}

**Navicular**

Another common tarsal bone that sustains stress fractures is the navicular. It is not as common as calcaneal stress fractures in military recruits but can occur in the same type of population, as well as explosive athletics such as sprinters and soccer players. It commonly presents with an indistinct vague achy pain with activity that improves with rest, and pain at the dorsum of the midfoot or along the medial longitudinal arch with activity. It can easily go undiagnosed for quite some time given the difficulty in visualizing the navicular with plain radiographs. Clinically, it is difficult to make the diagnosis, and therefore advanced imaging is necessary when the injury is suspected. Both MRI and CT scans can be used to understand the extent of the injury (Figures 9A-9C). In non-displaced stress fractures, conservative non-operative treatment is the appropriate treatment modality with a brief period of immobilization and non-weight-bearing;\textsuperscript{82} however, operative treatment is also considered in elite athletes. In either case, return to play is discouraged until there is evidence of radiographic healing. When a displacement is noted, or there is a delay in diagnosis, then operative treatment is recommended.

**Conclusion**

Ankle injuries are very common in soccer and can result in decreased performance or significant loss of playing time. Treatment of acute injury generally follows a conservative route, with surgical intervention reserved for severe ruptures or osteochondral fracture of the ankle joint. Chronic ankle pathology resulting in mechanical or functional instability generally requires surgery to repair ligamentous damage and restore normal ankle kinematics. It is critical for the soccer player to receive appropriate rehabilitation prior to returning to play in
order to reduce the risk for reinjury and further chronic instability. Prevention and early intervention of ankle injuries is key in preventing the long-term sequelae of ankle injuries, such as arthritis, in former soccer players.

Key Info

Figures/Tables

Figures / Tables:

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![Figure 1. Anatomy of the lateral ligament complex showing the anterior talofibular ligament (small arrow) and the calcaneofibular ligament (large arrow).](giza_soccer_issue_f1.jpg)

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Figure 2. Ankle stress radiograph demonstrating lateral ligamentous laxity.
Figure 3. (A) Preoperative coronal T2 magnetic resonance imaging (MRI) showing a chronic deltoid tear. (B) Postoperative MRI demonstrates reconstitution of the deltoid fibers.

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Figure 4. (A) Axial magnetic resonance imaging demonstrating injury to the anterior inferior tibiofibular ligament (small arrow) and posterior inferior tibiofibular ligament (large arrow). (B) Intraoperative arthroscopy picture demonstrating a tear of the syndesmosis complex.

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Figure 5. Lateral ankle radiograph demonstrating anterior osteophytes (arrow) in a 22-year-old professional soccer player.
Figure 8. (A) Lateral radiograph of an os trigonum (arrow) and multiple soft tissue calcifications. (B) Corresponding magnetic resonance imaging demonstrating soft tissue inflammation (arrow) around the os trigonum.
Figure 7. Anteroposterior radiograph showing a “fleck sign” (arrow), which represents a type 3 peroneal dislocation.

Figure 7: Anteroposterior radiograph showing a “fleck sign” (arrow), which represents a type 3 peroneal dislocation.
Figure 8. (A) Preoperative computed tomography scan of a 23-year-old professional soccer player with an acute on chronic fifth metatarsal fracture. (B) Healed fracture at 6 weeks after fixation with a solid percutaneous screw.
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References


*Figure 9.* (A) Axial and (B) coronal computed tomography scans showing a navicular stress fracture with cortical disruption. (C) Postoperative radiograph after percutaneous fixation.


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**Multimedia**

**Product Guide**

- STRATAFIX™ Symmetric PDS™ Plus Knotless Tissue Control Device
- STRATAFIX™ Spiral Knotless Tissue Control Device
- BioComposite SwiveLock Anchor
- BioComposite SwiveLock C, with White/Black TigerTape™ Loop

**Citation**

Enrique Feria-Arias, MD Karim Boukhemis, MD Christopher Kreulen, MD, MS Eric Giza, MD. Foot and Ankle Injuries in Soccer. *Am J Orthop.*

Publish date: October 19, 2018