Current management of treatment of injuries to the tarsometatarsal joint complex

Conduta atual no tratamento de lesões traumáticas do complexo tarsometatarsal

Mark S. Myerson, M.D

Abstract

In this study, the current management of injuries to tarsometatarsal complex are discussed. The treatment concepts are analised and a suggested reading list is proposed.

Keywords: Tarsal joints/injuries; Tarsal joints/radiography; Tarsal joints/surgery; Tarsal joints/therapy; Recovery of function; Treatment outcome

Resumo

Neste trabalho são discutidos os fatores que interferem na tipificação da lesão do complexo tarsometatarsal em pacientes atletas. Os conceitos terapêuticos são especificados para cada forma de apresentação. São revistos os princípios do método não-operatório e as táticas do tratamento cirúrgico são estabelecidas. A bibliografia sugerida é atualizada e pertinente ao manuseio desta lesão traumática, em atletas, proposto pelo autor.

Descritores: Articulações tarsianas/lesões; Articulações tarsianas/radiografia; Articulações tarsianas/cirurgia; Articulações tarsianas/terapia; Recuperação de função fisiológica; Resultado de tratamento

Correspondência
Mark S. Myerson
Institute for Foot and Ankle Reconstruction
Mercy Medical Center
301 St Paul Place, Baltimore,
Maryland, 21202, USA
Secretary: 1 (410) 6592867

Data de recebimento
20/05/2007
Data de aceite
25/06/2007

Director of the Institute for Foot and Ankle Reconstruction, Mercy Medical Center, Baltimore, Maryland

INTRODUCTION

Current management of injuries to the tarsometatarsal (TMT) complex depend on the type and mechanism of the injury, the forces involved, whether or not it is a high or low energy injury, and if it occurs in an athlete. Treatment concepts have evolved over the past decade to emphasize the wide spectrum of injuries to the tarsometatarsal joints, the use of more rigid forms of fixation, and most importantly in the athlete, an aggressive plan for rehabilitation

It is important to understand the mechanism of injury in these fractures and dislocations. Obviously, a high energy injury associated with either a motor vehicle accident, a fall from a height or a crushing injury, is vastly different from those from more minor twisting injuries. The older classification systems describing the various types of fractures and dislocations are not as important as an understanding of where the injury is located. These older classification schemes may have been thorough, but they did not help in any way with decision making with respect to treatment. In 1996, we presented a different classification system, which emphasized the motion segments of the midfoot. The foot is considered to have three columns: the medial column includes the first tarsometatarsal and medial cuneiform-navicular joints; the middle column includes the second and third tarsometatarsal joints, as well as the articulations between the middle and lateral cuneiforms and the navicular. The lateral column consists of the articulations between the fourth and fifth metatarsals and the cuboid. This simple classification system helps with planning treatment, since the metatarsals within a column often function as a functional unit. For example, if there is a dislocation of the second metatarsal, the other joint in the middle column, (the third) remains in an anatomic position. This system also highlights the importance of movement of various parts of the midfoot, which in turn is important with respect to the outcome. Interestingly, subtle incongruity is less well tolerated in the middle than the medial or lateral column, yet we have demonstrated previously that symptomatic posttraumatic arthritis is most common at the base of the second metatarsal. The lateral column, which has the greatest sagittal plane motion, is the least likely to be involved in post-traumatic arthritis. This is an interesting concept, since movement of these joints must somehow be correlated with functional outcome of treatment. It is also important to understand that injury to the tarsometatarsal joint(s) do not refer only to the specific metatarsal and its' corresponding cuneiform or cuboid.

Do not assume that injury to the tarsometatarsal joints include only the base of the metatarsals and the corresponding cuneiform and cuboid. Frequently, there is pathologic involvement of the intercuneiform space, or the naviculocuneiform joints (Figure 1). These injury patterns are treated differently and we should consider the broader term "tarsometatarsal joint complex" to refer to all types of injuries in this location.

Injuries of the tarsometatarsal joint complex are produced by either direct or indirect forces. The management of direct force and high energy type injuries is different, since there is frequently a crushing force which is associated with skin laceration or contusion, as well as fractures as well as metatarsal or cuneiform comminution. We have noted a tremendous increase in low energy twisting injuries, particularly those in athletes over the past decade. To a large extent, this is due to the changes in technology of the interface between the athletic shoe and the playing surface, particularly when playing on artificial turf. The forces on the foot that are created by this increased friction and torque has led to a marked increase in frequency of these injuries, for example in American football. These injuries occur when a force is applied along the longitudinal axis of the foot, which is in slight equinus with the metatarsals firmly planted on the ground distally, resulting in failure under tension dorsally. As the body moves forwards over the forefoot, which is fixed on the ground, twisting with rotation and abduction of the forefoot occurs causing the various patterns of dislocation described. As the abduction force increases, the recessed base of the second metatarsal dislocates and the remaining metatarsals displace laterally. This is of course an oversimplification, since there are many patterns of injury that can occur, either as fractures of the metatarsals or subluxation of tarsometatarsal and intercuneiform joints.

When we suspect an injury to the tarsometatarsal joint, radiographs of the foot should be sufficient to make a diag-

Figure 1 - Note in this radiograph that there is diastasis between the medial and middle cuneiform as well as subluxation of the second metatarsal laterally.

nosis. Our goal of diagnosis is to determine if there is any displacement or instability of the joints, since these form the basis for operative treatment. This is ideally documented with bilateral XR's with the patient bearing as much weight as tolerated on the injured foot. Because of the pain, bearing of weight on the injured foot may not be easy for the patient, but weight-bearing will often demonstrate subtle shifts of the midfoot which are otherwise not apparent. If a patient presents pain in the midfoot following injury and the radiographs are normal, the next sequence should be to determine whether or not instability of the midfoot is present.

One can of course obtain an magnetic resonance imaging (MRI) or a CAT scan to demonstrate that injury has occurred in these joints. This is, of course, not necessary if there is displacement present on a weight-bearing XR, but these imaging studies may be helpful only if to determine that an injury has taken place. The problem is not, however, whether an injury is actually present in the midfoot, but whether or not it is stable, since stability will determine the type of treatment provided. Further imaging studies are indicated if initial radiographs are normal or equivocal in the setting of a suspected tarsometatarsal injury, including stress radiographs, computed tomography and magnetic resonance imaging. Stress radiographs are very important if a diagnosis of midfoot injury has been made, tenderness over the tarsometatarsal joint is present, but the radiographic findings are either normal or equivocal.

Figure 2 - The manipulation of the midfoot with the passive pronation abduction stress maneuver is demonstrated here. This test is always positive in patients with a tarsometatarsal joint complex injury, and this is the same stress which is performed under anesthesia to demonstrate instability of the joints.

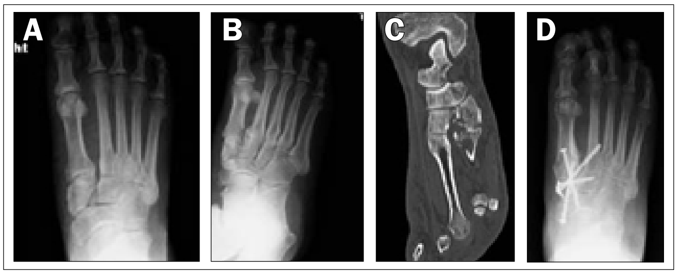

Figure 3 - (A,B) The AP and oblique radiographs in this patient demonstrated the medial column subluxation, but there was a concern for joint comminution and a CAT scan was obtained. (C) Note that on the CAT scan, the base of the second metatarsal appears to be normal without intra-articular joint fracture, but the base of the third metatarsal is markedly comminuted. (D) This was treated with an open reduction and internal fixation without an arthrodesis, and the third metatarsal cuneiform joint reduced once the second was re-aligned.

Stress radiographs should be obtained under anesthesia. If the diagnosis of midfoot injury is not certain, we manipulate the midfoot with passive pronation and simultaneous abduction (Figure 2). The pronation-abduction stress test is very sensitive and will clarify most injuries or subluxation of the medial or middle column. We have found this stress test to be particularly important to distinguish unstable third-degree sprains from stable first- and second-degree sprains in athletes. There is a different type of instability which occurs between the medial and the middle column and may extend between the cuneiforms and the naviculocuneiform joint. This pattern of injury is not easy to demonstrate on the standard passive pronation-abduction test, and we recommend a stress radiograph which squeezes between the medial and middle columns to determine instability. In practice, we obtain both of these stress radiographs for every patient. We used to obtain repeat radiographs while bearing weight at about two weeks following injury, but the stress radiographs are more reliable. Stress radiographs should be obtained even if it does appear to be a minimally displaced fracture of the tarsometatarsal joint complex. Computed tomography (CT) is a very useful diagnostic study for detecting subtle injuries of the tarsometatarsal joint complex. Even, however, with its sensitivity and impressive anatomic detail, CT has a limited role in planning treatment of injury to the tarsometatarsal joints. It is important that this imaging modality not be used to replace stress radiography, as it is a *static* test and is unable to assess stability. The problem that we have with CT is that it is *too* sensitive, and will demonstrate multiple fractures which do not require treatment, since the overall injury pattern is quite stable (Figure 3). MRI is another very sensitive study which can be used to diagnose subtle midfoot injury in the absence of subluxation or dislocation. We do not advocate the use of MR as a replacement for stress radiographs. Rather, we use MR to confirm the diagnosis and guide the treatment of a stable tarsometatarsal sprain as determined by stress radiographs (Figure 4).

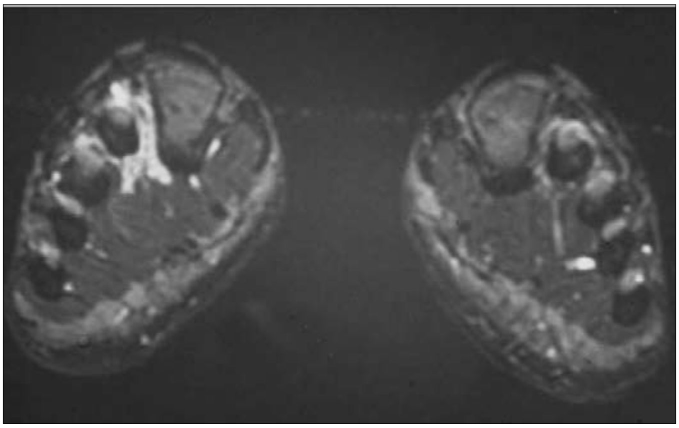

Figure 4 - The MRI was obtained in this patient who had a normal radiograph, but pain in the midfoot worsened with manipulation of the foot. The stress XR in this patient was normal.

Figure 5 - Note that bilateral XR's were obtained in this patient. Although the fracture-subluxation of the base of the second metatarsal is obvious, it is not as easy to diagnose the angulation and subluxation of the first metatarsal and the medial column. When comparing this, however, with the opposite foot, the subluxation of the medial column becomes more obvious.

In summary, then, we obtain weight-bearing radiographs of both feet (Figure 5). If there is clinical evidence of injury and the XR is normal, then an MRI will be obtained to determine the presence of edema around the joints. A CAT scan is useful to document the extent of comminution, which is not visible on radiographs. For all injuries, stress radiographs are then obtained to determine the extent of instability and the need to immobilization or operative treatment (Figure 6).

Figure 6 - A stress radiograph was performed in this foot which on a weight-bearing only demonstrated minor lateral subluxation of the second metatarsal. This demonstrates not only instability of the second, but also the medial and the lateral columns of the tarsometatarsal joints as well.

NONOPERATIVE TREATMENT

The role of nonoperative treatment in the management of *unstable* injuries of the tarsometatarsal joint is limited. Numerous studies have correlated the extent of displacement with outcome. It has also been shown that residual displacement of as little as 2 mm significantly decreases articular contact area, and surgery is probably indicated for even minimally displaced fracture-dislocations of the tarsometatarsal joints. It is certainly true that there are patients who present, for examination or treatment, one to two years following a minimally displaced injury of the tarsometatarsal joints who are not at all symptomatic. If one considers that subluxation of the tarsometatarsal joint complex is a type of mid foot sprain, should the treatment be based upon the presence of displacement as for any other type of sprain of the foot or ankle? We routinely treat a displaced syndesmosis injury operatively, but do not routinely do so for a Grade III ankle sprain. This has to do with the stability of the joint complex, and the residual instability, pain and dysfunction, even possibly the development of painful arthritis. We therefore need to assess the results of treatment (operative and nonoperative) in both high and low energy injuries in relation to the morbidity of the treatment itself. Left untreated, the majority of displaced mid foot sprains will lead to the development of painful arthritis, so it becomes an interesting question then as to the type of treatment initially provided. Certainly, for all obviously displaced injuries, operative treatment is recommended. However, the role of nonoperative treatment for stable and minimally displaced injuries, particularly in the athlete, has not been clarified. This is not intended to introduce doubt as to the ideal type of treatment for minimally displaced injuries, but only to emphasize that these treatments are not necessarily absolute. The recommendations for treatment have to be based on the potential development of arthritis which, as noted above, is more likely in an unstable or displaced injury.

If the midfoot is injured, but there is no instability noted on stress radiographs, then, by definition, this is a stable sprain, and is treated with immobilization in a boot or a cast. We permit weight-bearing as tolerated by the patient, provided no instability is demonstrated on repeat radiographs while bearing weight. The boot or cast is used until there is no midfoot pain on examination. At about 6-8 weeks, we examine the midfoot for tenderness, and use gentle stress of the midfoot to determine recovery of the sprain. Weight-bearing out of the boot may commence once there is no pain on stress, but return to activities must be closely monitored. The athlete is permitted to resume training and exercise, but may not engage in any activity which involves pronation, torque or twisting of the midfoot. We use a very stiff sole shoe and a rigid orthotic support in the shoe for six months. The athlete is allowed to return to exercise, but, initially, this is in a swimming pool and on stationary machines, including running on a treadmill. Running on an uneven ground surface and twisting or cutting activities are not permitted for four months. Most athletes will return to full activities including running, football and other ball sports after a non displaced sprain by 3-4 months, but it is not realistic to expect a full recovery before this time. Obviously, the timing of return to full athletic activities for these patients depends on the severity of the sprain and on the type of treatment used. We follow the same protocol for rehabilitation after operative treatment, but for these severe sprains, the return to full athletic activity is about 8-9 months.

Figure 7 - Note the tremendous swelling in this patient with a tarsometatarsal joint complex injury. Open reduction and internal fixation could not be performed with this degree of swelling and the swelling was reduced with an intermittent foot compression pump before operative correction.

OPERATIVE MANAGEMENT

Surgery is indicated for displaced fractures and dislocations. Once it is decided to proceed with surgery, we need to ask these following questions: when should surgery be performed? If there has been a delay in diagnosis, is it too late for surgery? Should the procedure be performed percutaneously or open? Which type of fixation is better, K-wires, screws or a ligament reconstruction? When should a primary arthrodesis be performed? How should the patient be managed postoperatively? When is the hardware removed? When can the athlete expect to return to function and sports?

- **Timing of surgery**. As a generalization, the sooner that we perform surgery, the quicker the rehabilitation. It is ideal, however, to perform the surgery when the swelling is decreased, unless a percutaneous approach to fixation is used. The most important factor influencing the decision as to the timing of surgery is determined by associated injury to the soft tissues, particularly when there is a direct crush type injury to the foot. If the swelling is severe, and provided a compartment syndrome is not present, then, we use an intermittent compression foot pump device, and once the swelling is decreased, surgery can be performed (Figure 7). If the diagnosis is missed or the treatment delayed, surgery without arthrodesis may still be performed successfully. The alternative to some type of reduction and internal fixation is an arthrodesis, so that the ultimate outcome always has to be compared with the latter procedure. For displaced fractures and dislocations, it becomes difficult to reduce after two months, and if deformity is present, then the outcome can never be as satisfactory as if the surgery is performed immediately. However, we have successfully reduced tarsometatarsal joint subluxation where there is neither fracture nor arthritis present with open reduction and internal fixation up to one year following injury (Figure 8). The success of such a late reduction will obviously depend upon the extent of articular incongruity present, and cannot be accomplished in the presence of a fracture. For these patients, it is preferable to perform an open reduction and internal fixation rather than the percutaneous method of treatment described below, since the thick scar in the first web space needs to be resected in order to reduce the joints.
- **Percutaneous *versus* open fixation**. An anatomic reduction is the most important goal in the treatment of injuries of the tarsometatarsal joint, and has been shown to correlate with outcome. Why does this re-

duction have to be performed open[2]? During the past decade, we have routinely used closed reduction, but *percutaneous* screw fixation for displaced tarsometatarsal injury. These dislocations are easy to reduce closed, and should initially be attempted for all patients regardless of the type of fixation to be used. We use gentle axial traction by pulling on the hallux and lesser toes distally, and pushing backwards on the ankle. Adduction of the midfoot with slight pressure will reduce the dislocation, which should be noted under fluoroscopic examination. Once the articulation is noted to be in reasonable alignment, the reduction is maintained with a large bone reduction clamp, applied between the base of the second metatarsal and the medial cuneiform. By gently squeezing the clamp, the base of the second metatarsal is gradually reduced into its' anatomic position. (Figure 9) Once the dislocation has been reduced, a decision is made for the type of internal fixation, which we generally perform with cannulated screws. For most types of subluxation and dislocations, this closed reduction and percutaneous form of fixation is successful (Figure 10). The sequence of fixation of the dislocated joints of the foot is also important. Although the middle column is the point around which the rest of the midfoot gains stability, the medial column needs to be fixed first. Assessment of instability of the first TMT joint is therefore very important and this is where stress evaluation of the joint is helpful. Although the subluxated second TMT joint is usually obvious, manipulation of the foot with passive pronation and abduction will clarify the subluxation of the first TMT joint. The fixation of the first TMT joint is performed by pulling the hallux into va-

Figure 8 - This patient presented at 13 months following a tarsometatarsal joint injury which was not diagnosed initially. Upon presentation, although subluxation of the joints was present, intraoperatively, the joint cartilage was quite normal and an open reduction was performed rather than an arthrodesis.

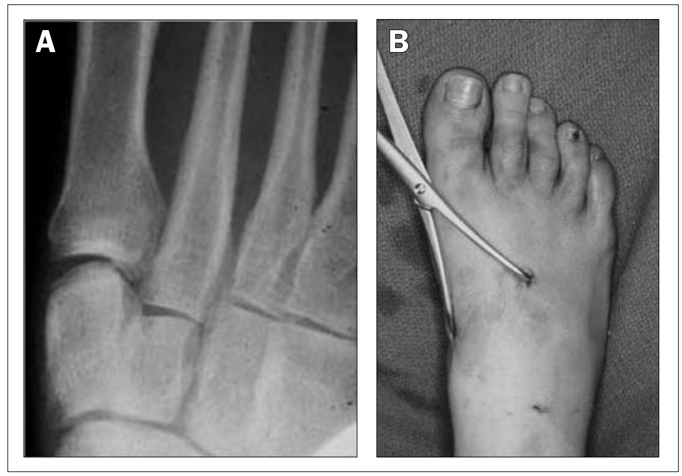

Figure 9 - (A) This patient presented with a typical medial and middle joint instability pattern, (B) which was reduced percutaneously and held temporarily with a bone reduction clamp.

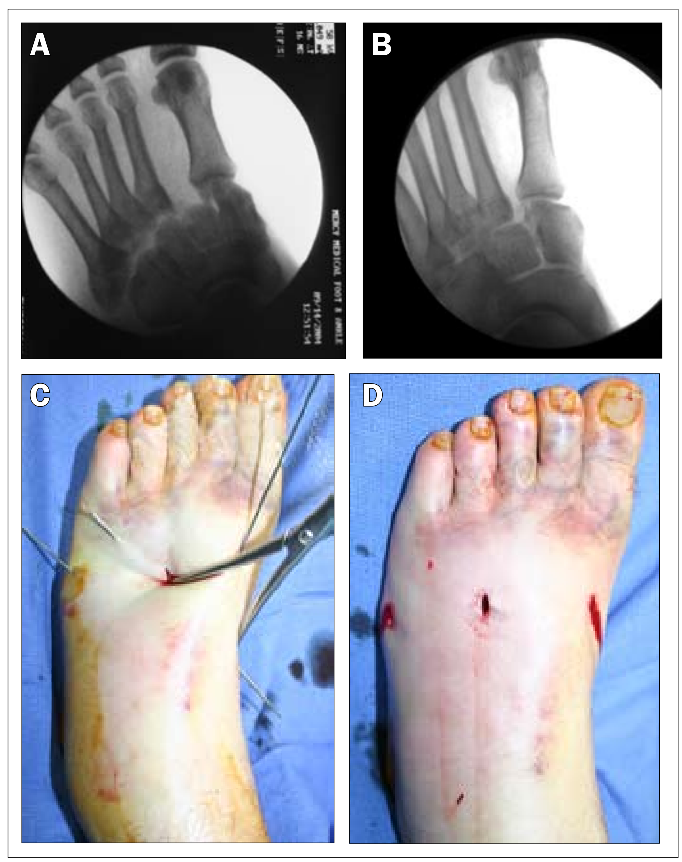

Figure 10 - (A) Closed reduction and percutaneous screw fixation was used for this patient. All three columns were involved in this severe dislocation which occurred in a football player. (B) Note that the medial column is reduced first, then held with a guide pin, (C) and this is followed by application of the bone reduction clamp. (D) The three skin punctures were all that were necessary to perform the closed reduction and percutaneous screw fixation for this patient.

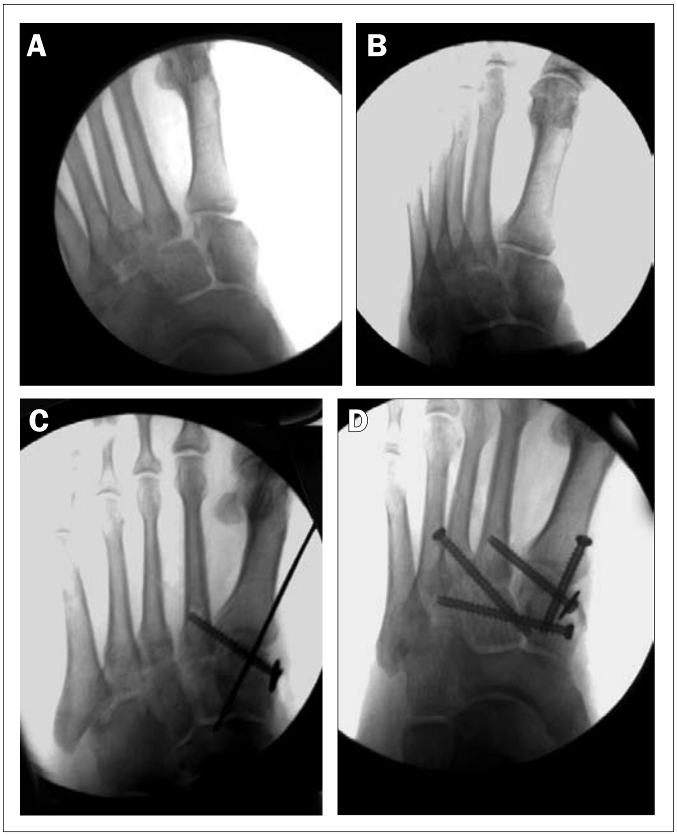

Figure 11 - (A) The medial and middle column was subluxated in this patient. (B) Note that the medial column is reduced first, (C) and this is followed by fixation of the second metatarsal into the mortise with an oblique screw introduced into the base of the second metatarsal from the medial cuneiform. (D) Finally, the oblique screw was inserted across the third metatarsal. It is easier to insert this screw from the metatarsal directed proximally and obliquely than from proximal to distal.

Figure 12 - The reduction could not be performed percutaneously in this patient since a large bone fragment was present blocking reduction. An incision was made, and a laminar spreader inserted between the first and second metatarsals to expose the bone fragment for excision followed by reduction and internal fixation.

rus and, simultaneously, pushing on the base of the first metatarsal with the thumb, which forces the first metatarsal into alignment with the medial cuneiform. Once the first metatarsal is fixed with a guide pin, the middle column is reduced with the bone reduction clamp, and a screw is inserted obliquely across from the medial cuneiform into the second metatarsal. This should be a partially threaded screw to create added compression of the base of the metatarsal into the mortise which locks the metatarsal into place (Figure 11).

If the closed reduction does not succeed, it is usually due to the presence of a bone fragment or soft tissue blocking reduction at the base of the second metatarsal (Figure 12). Soft tissue interposition (for example, a torn Lisfranc ligament) does not typically block reduction, since the ligament falls to the plantar surface of the foot. If, however, it is not possible to reduce the injury closed, then open reduction and internal fixation is indicated, with one longitudinal incisions placed over the dorsum of the involved tarsometatarsal joints (Figure 13). If more than one incision is used, then one must be careful to maintain as wide a skin bridge as possible. This is particularly important when there is an associated fracture of the cuboid, since this injury pattern usually mandates open reduction. The length of the cuboid and the lateral column of the foot must be restored to its normal length, in order to avoid a permanent abduction deformity of the forefoot. If the cuboid is fractured, it is important to start with the lateral reduction, in order to restore the length of the cuboid, which will help with the alignment and the reduction of the middle and medial columns. Although the cuboid can be reduced manually, we often use an indirect reduction technique with temporary external fixation to lengthen the lateral column of the foot, which then will help to reduce the midfoot. Pins are placed into the fifth metatarsal and calcaneus, and then a distractor is applied between the pins (Figure 14). The articular surfaces of the cuboid are inspected, and elevation of comminuted fragments are necessary to restore the articular surface. Fixation of the cuboid is always difficult, and one often needs to use an H-plate to maintain the length of this cancellous bone. The size and shape of the cuboid limits the type of fixation that can be used, and we will generally cross over from the calcaneus to the base of the fourth and fifth metatarsal or calcaneus and remove the plate at three months, once the cuboid has healed.

- **K-wire *versus* screw fixation**. There is a limited role for the use of K-wires for treating midfoot injuries, but they should be used sparingly as the sole form of fixation. Although K-wires are undoubtedly easy to insert, they are similarly easy to pull out and if K-wires are

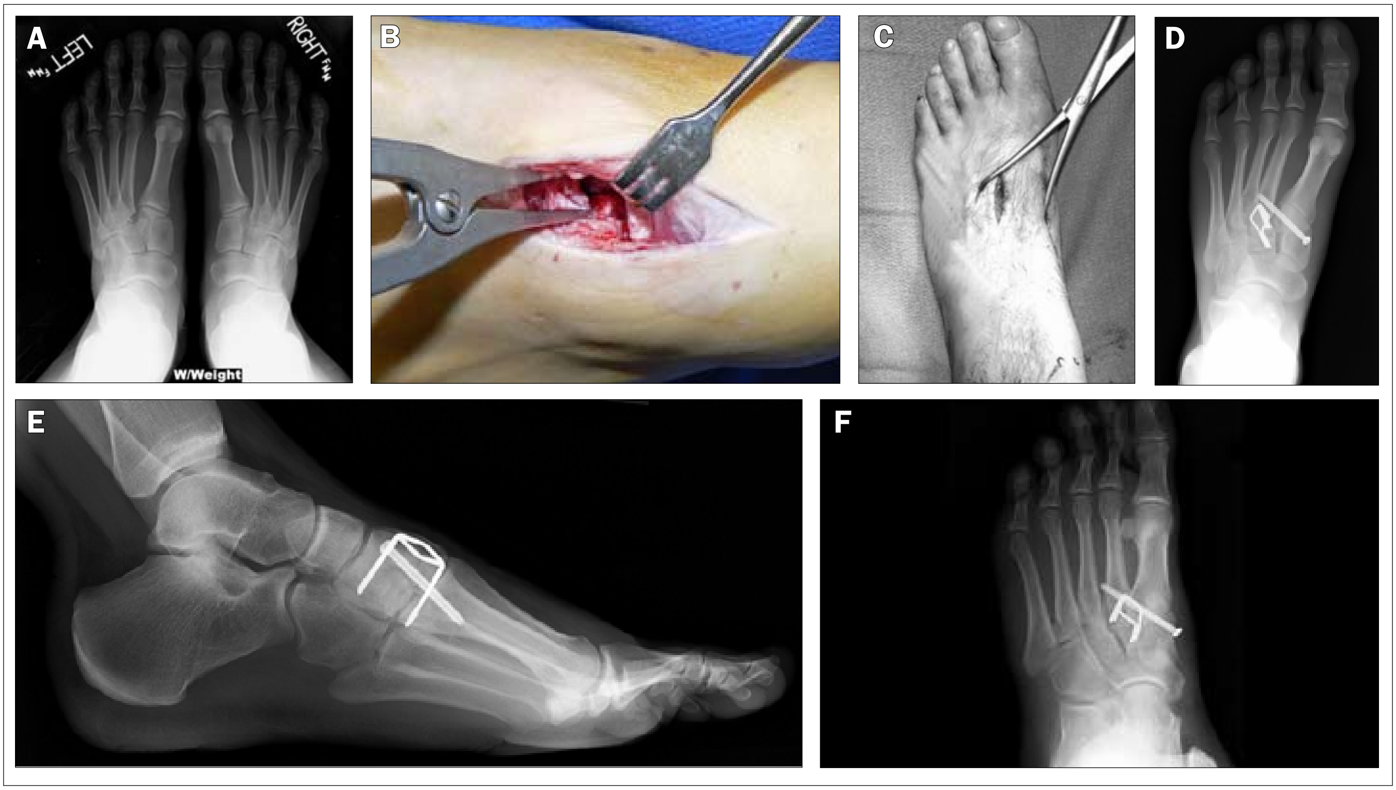

Figure 13 - (A) This patient sustained an injury to the middle column of the tarsometatarsal joint in an athletic injury. On the anteroposterior radiograph, there is a large fragment of bone at the base of the second metatarsal. (B) Intraoperatively, there was considerable comminution of the base of the second metatarsal noted, and the bone fragment was then excised using a rongeur, (C) the bone reduction clamp applied and (D,E,F) a primary arthrodesis of the second middle column performed. Note that in addition to the arthrodesis, a lag screw was introduced from the medial cuneiform into the base of the second metatarsal.

used, the reduction of the joints may be lost when loosening of the K-wire fixation occurs. These are injuries associated with joint subluxation and, in order to end up with stability, the dislocation must be reduced and held reduced for, at least, four months – a period during which K-wires are likely to fail (Figure 15). K-wires can, however, be used to stabilize the lateral column of the foot, and are inserted obliquely from the base of the fourth and fifth metatarsal into the cuboid or more medially into the cuneiforms. If there is marked fracture comminution and a primary arthrodesis is not performed, then, reduction with K-wire fixation may be necessary. When we do use a K-wire, it is buried subcutaneously to prevent complications of infection, if they are left protruding percutaneously. If skin contamination and infection occur, the K-wires may need to be removed prematurely, which then may be followed by loss of reduction.

- **Primary arthrodesis**. When do you choose a primary arthrodesis over open reduction and internal fixation? Certainly, in the setting of comminution, a reasonable alignment may be expected, and this may be preferable to a primary arthrodesis. There is minimal motion in the middle column joints and, therefore, if arthritis develops, could a subsequent arthrodesis be performed with the same outcome? Clearly, there are some comminuted fracture dislocations of the base of the middle column where the joint surfaces cannot be adequately reduced (Figure 16). Which is therefore more important, alignment, or joint congruity? If a primary arthrodesis is performed, then more dissection has to be done and more

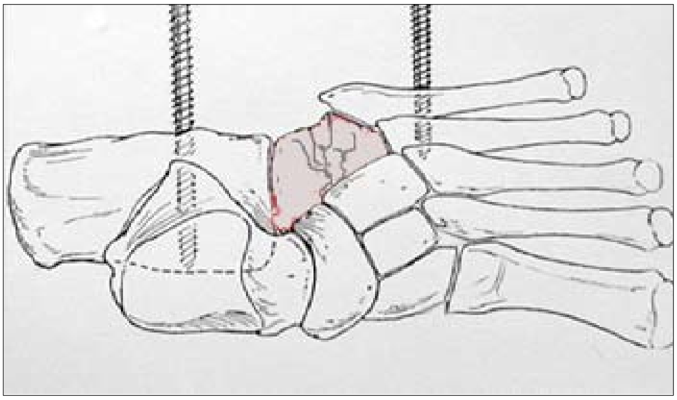

Figure 14 - A simple external fixator can be used to distract apart the lateral column of the foot, when the cuboid is fractured in conjunction with an injury to the tarsometatarsal joint complex. This facilitates exposure of the cuboid as well as reduction of the compressed bone.

viable bone removed. Once the small articular fragments are removed, then there are larger defects present, with a greater potential for joint instability, necessitating bone grafts and much more difficult fixation. This has not been the experience of other authors, who have recommended a primary arthrodesis over open reduction and internal fixation. In a randomized prospective study, Ly and Coetzee compared ORIF (Osteosynthesis Rigid Internal Fixation) with primary arthrodesis in 41 patients with isolated acute Lisfranc injuries, and found that the recovery time was quicker in the primary arthrodesis group, that the final AOFAS (American Orthopaedic Foot and Anckle Society) score was higher and that a return to function was better in the primary arthrodesis group. Furthermore, there were an additional five patients in the ORIF group who were ultimately treated with arthrodesis. In another study, Mulier et al. found that in a group of patients randomized to two surgeons, one performing the arthrodesis and the other an ORIF, that the patients who underwent and arthrodesis had far more complications and complaints of stiffness. We have identified, in our studies on post-traumatic arthritis of the midfoot treated with an arthrodesis, that these patients never have a normal foot. Certainly, the arthrodesis improved the symptoms of post-traumatic arthritis, but for the majority of these patients, there was deformity of the foot which required correction, and there were few who underwent an isolated single column arthrodesis. In summary, therefore, although primary arthrodesis has been advocated by a few authors, this is a difficult surgery to perform technically, and the resulting stiffness may not be desirable when compared to the patient who recovers from ORIF or percutaneous reduction and internal fixation. We would cer-

Figure 15 - (A) A very severe dislocation of all three columns was present in this patient following a motor vehicle accident. (B) This was treated with open reduction and k-wire fixation. The k-wires were removed at eight weeks and the patient allowed to commence weight-bearing. The patient ultimately was referred for treatment of painful post-traumatic arthritis of the entire midfoot. Note that the reduction of the midfoot, which had been obtained initially, was completely lost once the k-wires were removed.

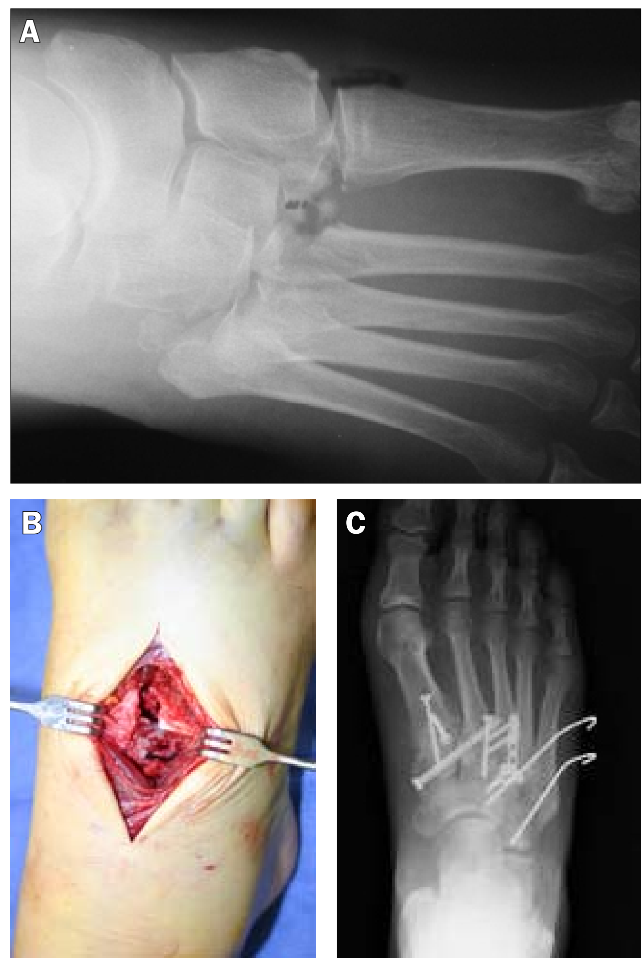

Figure 16 - (A) This injury was associated with comminution of the base of the second metatarsal which was easily visible on the XR. (B) The instability of the remaining columns was only diagnosed once the midfoot was correctly examined intraoperatively, and a primary arthrodesis was performed. (C) Note the use of a combination of methods of internal fixation. There was such comminution of the base of the third metatarsal that a mini fragment plate was used to perform the arthrodesis. The lateral column is never fused primarily, and this was fixed with k-wires which were removed at ten weeks.

tainly never consider a primary arthrodesis in the athletic individual, regardless of the potential for a rapid return to activity. Maintenance of motion in the medial column as well as the limited motion in the middle column is necessary to full function in these patients (Figure 17).

- **Ligament reconstruction**. There is some recent experience with ligament reconstruction in these acute midfoot subluxations. This is particularly applicable to the isolated injury, where subluxation is present associated with diastasis between the middle and medial column. Theoretically, all treatments which we provide are based on the restoration of the anatomy of the base of the second metatarsal and, therefore, if the Lisfranc ligament can be restored directly or indirectly, this would provide an ideal type of treatment. Obviously, it is not possible to directly repair the Lisfranc ligament. It is an oblique ligament which passes from the base of the second metatarsal obliquely into the distal lateral edge of the medial cuneiform. The ligament is extremely strong, and is situated more on the plantar than the dorsal surface of the joint, making direct repair impossible. However, indirect reconstruction of the ligament is possible. This is, after all, the principle of treatment whether it is done with ORIF or closed reduction and percutaneous fixation, since these treatments align the midfoot, and the oblique Lisfranc ligament heals by scar formation and ultimate stability. The ligament reconstruction can be performed as described by Nery using a tendon which is inserted obliquely across the joint surface and secured.
- **Postoperative management**. In the postoperative period, several issues must be addressed, including the duration of immobilization, protection of weight-bearing, initiation of activity and exercise, and most importantly, the duration for internal fixation. In the athlete, these parameters are more important. As noted above, it takes up to eight months before an athlete returns to full athletic function and may even take up to one year before these high performance athletes are asymptomatic. Since we use rigid screw fixation, early motion as well as protected weight-bearing is ideal. No weight-bearing is allowed for six weeks, but partial protected weight-bearing in a walking boot is permitted, once the incisions have healed. For the athletes, we initiate activity in a swimming pool three weeks postoperatively, followed by exercise on a stationary bicycle with high repetitions and little resistance by four weeks. Progressive increase in weight-bearing in a boot begins at six weeks and the boot is discontinued between eight and ten weeks, according to symptoms. When walking begins in a shoe, the shoe is stiffened as much as possible, and we add a very rigid orthotic arch support to the shoe. A carbon or graphite orthotic plate is also used inside the shoe as an alternative to an orthotic support. This rigid orthotic support is particularly important when returning to athletic activity, since the football shoe is typically quite flexible. The increase in athletic activity is monitored according to aching, soreness and swelling of the midfoot. Once the patient is able to run in a swimming pool, we then allow more activity on a bicycle, and an elliptical trainer, ultimately running on a treadmill. Running on a grass surface or the beach is not permitted for about six months due to the torsion on the midfoot.
- **Removal of hardware**. We maintain the internal fixation for a minimum of four months to allow for ligamentous healing. Unlike fracture of the forefoot, these dislocations take far longer to heal and reach joint stability. Generally, we plan to remove the hardware at four months, but preferably not sooner. There are even times when the hardware is left in permanently if the patient is asymptomatic. Motion does occur between the medial and the middle columns of the foot, and this will lead to ultimate fatigue failure of the fixation in some patients. There are some patients who start to develop aching and pain in the midfoot at about three months following surgery. If there is any concern about the stability of the midfoot and healing of the ligaments, then, they can go back into a boot and decrease rehabilitation until symptoms decrease. If there is any uncertainty regarding the stability of the foot, it is prudent to maintain fixation for as long as possible.

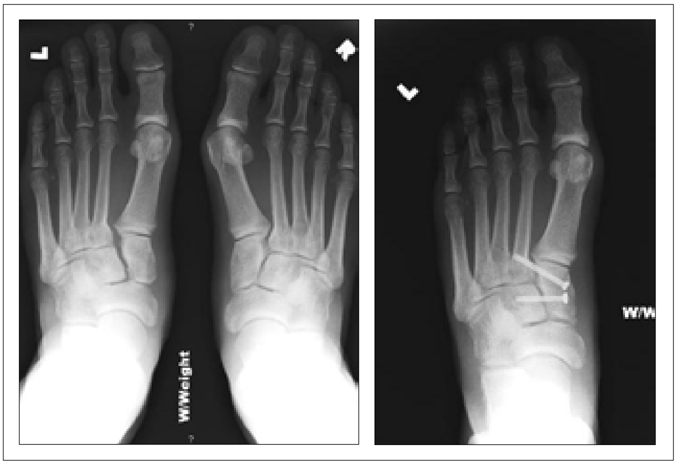

Figure 17 - A closed reduction and percutaneous screw fixation was performed in this high performance athlete. Note the instability present between the medial and the middle columns. It is important to stabilize this type of instability pattern with a transverse as well as an oblique screw inserted from the medial cuneiform.

REFERÊNCIAS

Arntz CT, Veith RG, Hansen ST Jr. Fractures and fracture-dislocations of the tarsometatarsal joint. J Bone Joint Surg Am. 1988;70(2):173-81.

Coss HS, Manos RE, Buoncristiani A, Mills WJ. Abduction stress and AP weightbearing radiography of purely ligamentous injury in the tarsometatarsal joint. Foot Ankle Int. 1998;19(8):537-41.

Curtis MJ, Myerson M, Szura B. Tarsometatarsal joint injuries in the athlete. Am J Sports Med. 1993;21(4):497-502.

Faciszewski T, Burks RT, Manaster BJ. Subtle injuries of the Lisfranc joint. J Bone Joint Surg Am. 1990;72(10):1519-22.

Komenda GA, Myerson MS, Biddinger KR. Results of arthrodesis of the tarsometatarsal joints after traumatic injury. J Bone Joint Surg Am. 1996;78(11):1665-76.

Kuo RS, Tejwani NC, Digiovanni CW, Holt SK, Benirschke SK, Hansen ST, Sangeorzan BJ. Outcome after open reduction and internal fixation of Lisfranc joint injuries. J Bone Joint Surg Am. 2000;82-A(11):1609-18.

Ly TV, Coetzee JC. Treatment of primarily ligamentous Lisfranc joint injuries: primary arthrodesis compared with open reduction and internal fixation. A prospective, randomized study. J Bone Joint Surg Am. 2006;88(3):514-20.

Meyer SA, Callaghan JJ, Albright JP, Crowley ET, Powell JW. Midfoot sprains in collegiate football players. Am J Sports Med. 1994;22(3):392-401.

Mulier T, Reynders P, Dereymaeker G, Broos P. Severe Lisfrancs injuries: primary arthrodesis or ORIF? Foot Ankle Int. 2002;23(10):902-5.

Myerson MS, Fisher RT, Burgess AR, Kenzora JE. Fracture dislocations of the tarsometatarsal joints: end results correlated with pathology and treatment. Foot Ankle. 1986;6(5):225-42.

Myerson MS. Tarsometatarsal arthrodesis: technique and results of treatment after injury. Foot Ankle Clin. 1996;1:73-83.

Myerson M. The diagnosis and treatment of injuries to the Lisfranc joint complex. Orthop Clin North Am. 1989;20(4):655-64.

Potter HG, Deland JT, Gusmer PB, Carson E, Warren RF. Magnetic resonance imaging of the Lisfranc ligament of the foot. Foot Ankle Int. 1998;19(7):438-46.

Resch S, Stenstrom A. The treatment of tarsometatarsal injuries. Foot Ankle. 1990;11(3):117-23.

Teng AL, Pinzur MS, Lomasney L, Mahoney L, Havey R. Functional outcome following anatomic restoration of tarsal-metatarsal fracture dislocation. Foot Ankle Int. 2002;23(10):922-6.

Trevino SG, Kodros S. Controversies in tarsometatarsal injuries. Orthop Clin North Am. 1995;26(2):229-38.