Metatarsal Fractures

Gabriel Khazen

1 Introduction

Fracture of the metatarsal bones is a frequent injury whose incidence has been reported between 35% and 88.5% of all fractures of the foot [1, 2]. Jeffers et al. [3] reported in their series that 49.1% of motorcycle accident foot fractures were metatarsal fractures. Despite the high incidence and inherent risk of complications from these fractures, there is very little literature reported on them [4], with the exception of the proximal fracture of the fifth metatarsal.

Metatarsal fractures can be caused by direct trauma, fall from height, overload, or inversion of the foot. Depending on the energy involved, they can be simple fractures involving a single metatarsal or complex fractures that affect several metatarsals, soft tissues and neighboring joints.

The incidence of fractures is diverse and may vary according to the age group and/or gender of the patient, with central metatarsal fractures, especially the third metatarsal, being the most frequent in elderly women [5] and the fifth metatarsal in young males [6]. In a demographic study, Cakir et al. [7] reported that the fifth MTT was fractured in 56% of the patients studied for metatarsal fractures, 15.6% presented multiple fractures, and 75% were injured after inversion of the foot or fall from height.

The inadequate treatment of metatarsal fractures can generate permanent sequelae to the patient, such as metatarsalgia, functional limitation and deformity of the forefoot (see Figs. 1 and 2); therefore, it is mandatory to preserve the forefoot anatomy [4, 5, 7].

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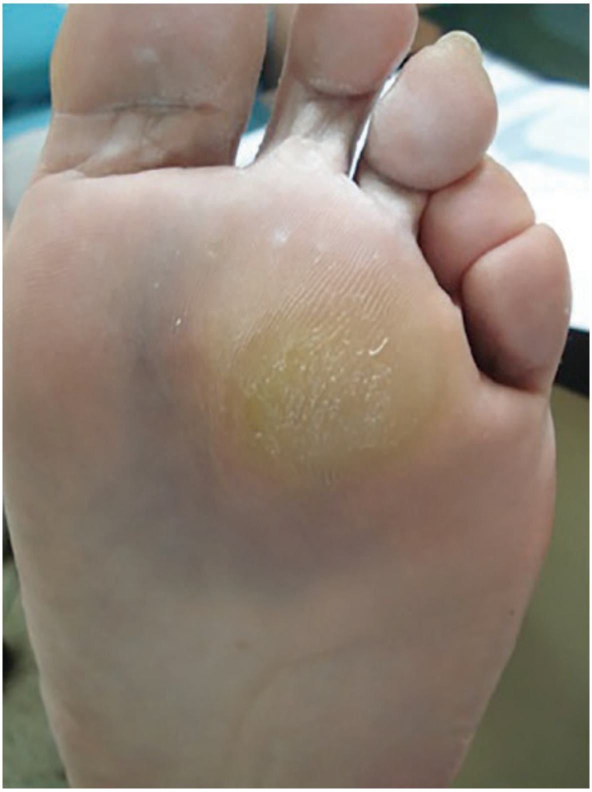

Fig. 1 Image of a foot with malunion of the third metatarsal in plantar flexion. The plantar overload is seen through a hyperkeratosis under the third metatarsal

Fig. 2 Clinical photo of a foot with malunion in the frontal plane of the second and third metatarsal that originated deformities of the lesser toes. In this case lateral deviation of the second toe and shortening of the third toe

2 Diagnosis

The clinical presentation of patients with metatarsal fractures will depend on the severity of the injury; it can range from mild pain to severe pain and/or signs of compartment syndrome, which we must be aware of in high-energy fractures, in fractures of multiple metatarsals and/or in forefoot/midfoot dislocations.

Imaging study is performed with anteroposterior, lateral, and oblique comparative feet X-rays. It is very important to know the radiological anatomy and the accessory bones to avoid confusion with an avulsion fracture [8].

In case of high energy injury or in an articular fracture, computed axial tomography should be requested. In certain special circumstances that will be discussed later, it may be necessary to indicate magnetic resonance imaging and/or other imaging studies.

3 Stress Fracture

The incidence of stress fracture of the metatarsals represents 38% of these fractures in the lower limb [9]; it can occur in any metatarsal, but more attention has been given to the fifth metatarsal due to its vascular anatomy.

Stress fractures of the second and/or third metatarsal are generated by repetitive loading of the area. Dixson et al. [10] determined that aspects of foot type such as low abduction and a low dynamic arch index, such as cavus and/or adductus, increased the risk of these fractures in the second metatarsal. Patients with third rocker metatarsalgia may increase the risk of third metatarsal fracture. Other risk factors are repetitive exercises such as jumping or running performed without adequate preparation [11]. Barrack et al. [12] report an increased risk of 30–50% incidence of these fractures in female patients with low bone mineral density.

Patients with stress fractures usually present nonspecific pain in the affected area and edema in the midfoot of sudden onset or preceded by a prodrome. The history and clinical evaluation are important to diagnose this injury, since in the initial radiological studies the fracture line may not be evident, if not weeks later when the periosteal reaction, bone resorption, and/or signs of fracture healing are evident, which can lead to doubt or misdiagnosis. In MRI, edema in periosteum and bone marrow, fracture lines, and edema in surrounding soft tissues can be seen [13].

In central metatarsals, stress fracture can be proximal or distal [14]. Proximal fractures are seen in patients with Achilles tendon contracture, significant difference in length between metatarsals and low bone mineral density, while distal fractures are more associated with training intensity.

4 Treatment

The treatment of the metatarsal fracture will depend on several factors but mainly it is related to the displacement of the fracture. Non-displaced fractures or those with slight displacement in the frontal or sagittal plane are treated nonsurgically. Shereff [15] recommends reduction and fixation in fractures with displacement greater than 2 mm and/or angulation greater than 10° (although no biomechanical study so far supports this criterion), to restore forefoot alignment.

Due to anatomical and biomechanical differences and different fracture mechanisms [16], fractures of the first metatarsal, lesser metatarsals and proximal fracture of the fifth metatarsal will be analyzed separately.

5 Fracture of the First Metatarsal

The incidence of this fracture depends on the age of the patient and the fracture mechanism; of all metatarsal fractures, this fracture has an estimated incidence of 1.5–5% [2, 7] in adults, and a 28% in children [17].

The head of the first metatarsal carries twice the weight of the lateral metatarsals during stance [18], so malunion can lead to significant biomechanic changes. Malunions in dorsiflexion can generate central metatarsalgia. Tranverse plane malunions (medial or lateral deviations), can generate angular deformities such as hallux valgus or varus; therefore, it is crucial to preserve the anatomy [19].

The fracture of the first metatarsal is usually generated by a high energy trauma and can be unstable due to the constant traction of intrinsic and extrinsic muscle groups. This fracture can present with some degree of comminution and/or proximal or distal joint compromise [20], which is better evaluated with a computerized axial tomography (see Figs. 3, 4, and 5).

Fig. 3 AP radiograph of a patient who suffered frontal trauma to his left foot. A fracture of the base of the first metatarsal is seen, with intra-articular involvement and displacement

Fig. 4 CT of the same patient presented in Fig. 3, with joint compromise

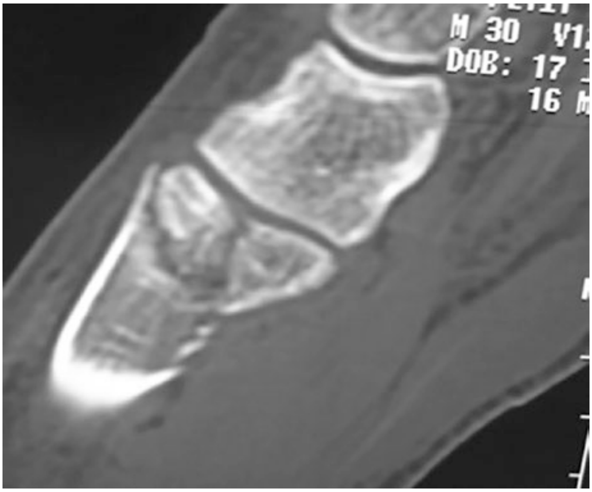

Fig. 5 Sagittal image of the same previous patient, showing the plantar fracture extension

5.1 Conservative Treatment

The treatment of this metatarsal fracture with a displacement of less than 2 mm and/or angulation of less than 10° in the sagittal or coronal plane consists of placing the patient in a postoperative rigid sole shoe or walking boot. X-rays should be performed at 2 weeks to verify that there has been no fracture displacement. The patient is kept in this immobilization for 4–6 weeks.

5.2 Surgical Treatment

Fractures with displacement greater than 2 mm and/or angulation greater than 10°, as well as the presence of proximal or distal articular fracture lines with displacement greater than 2 mm require surgical treatment [15]. This will depend on the type and anatomical location of the fracture. Fixation can be performed exclusively with Kirschner wires [21]; however, the risk of inadequate reduction or loss of reduction is very high with this technique and, therefore, the suggestion is to perform anatomic reduction and fixation with 2.7 or 2.0 mm low profile plates. For joint fractures, anatomical reduction with headless screws should be performed, stabilizing the metatarsal with anatomical T or L plates [21] (Figs. 6 and 7).

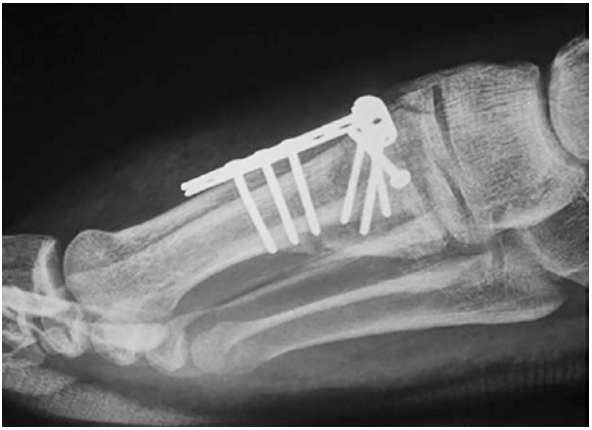

Fig. 6 Lateral radiograph of the same patient presented previously, stabilized with plate and screws

Fig. 7 AP X-ray of patient presented in previous image

Open fractures should be treated following the general recomendations, such as irrigation, debridement, fasciotomy (if necessary), external fixation and antibiotic therapy, between others.

6 Malunion of the First Metatarsal

The inadequate treatment of this fracture can lead to malunion. Malunions should be treated with an osteotomy correcting all deformity planes. A stable fixation should be perform using plate and screws (see Figs. 8, 9, 10, 11 and 12). If severe load transfer is present, with lesser metatarsal overload, plantar plate damage and/or stress fractures, additional lesser metatarsal elevation osteotomies could be performed.

Fig. 8 First metatarsal malunion, with shortening and elevation of the metatarsal head

7 Fracture of the Lesser Metatarsals

Lesser metatarsal fractures displacement and angulation can change the whole forefoot mechanics, generating pain and secondary fractures in adjacent bones. Medial or lateral displacements can generate secondary toe deviations as well.

Displacements greater than 2 mm or angulation in the sagittal plane greater than 10° may require reduction and fracture fixation [18], to restore the length and angulation of the metatarsal. Displaced transverse diaphyseal fractures may be more unstable due to traction of the intrinsic and extrinsic musculature, mainly the flexors. The isolated fracture of a central metatarsal will be more stable due to its intrinsic stability than multiple fractures.

Fig. 9 Clinical image of the patient shown in the previous image

Fig. 10 Long oblique osteotomy was performed in the fracture area to lower the metatarsal head and recover length

Fig. 11 Remote postoperative AP radiograph of previous patient. Consolidated remodeling osteotomy and metatarsal parabola recovered

Fig. 12 Lateral radiograph of previous patient. Recovery of the correct plantar angulation of the first metatarsal can be seen

The diaphyseal and distal fractures of the fifth metatarsal, known as the ballerina fracture [22], have been the subject of discussion and debate, and a special classification has even been described for this fracture [23]. The classification separates between no displacement, displacement equal or less than 3 mm and greater displacements with rotation and migration of the distal fragment. It is important to note that the fourth and fifth metatarsals have greater mobility in the sagittal plane than the other metatarsals. This may facilitate their adaptation to malunion of these bones.

Morgan et al. [24] reported good results for conservative treatment of diaphyseal fractures of the fifth metatarsal with rigid sole shoe and full weight bearing, regardless of fracture displacement. Although it is true that O'Malley et al. [22] reported in their study in 35 professional dancer patients similar results between the patients treated surgically and those treated nonsurgically, regardless of the magnitude of fracture displacement. The author has not had the same experience. Fifth metatarsal malunions can generate 4th metatarsal transfer pain. Therefore, the author uses same criteria for surgical indication as the fracture in other metatarsals, (Level V evidence), despite the previously referred studies [22, 24].

7.1 Conservative Treatment

Fractures with displacement equal to or less than 2 mm and/or angulation less than 10° are treated conservatively. We indicate a postoperative shoe to avoid full weight bearing [25]. X-rays are performed at 2 weeks to verify that no fracture displacement has occurred. The patient is kept in this immobilization for 4–6 weeks.

7.2 Surgical Treatment

Cakir [7] reported that metatarsal fracture displacement greater than 2 mm in any plane is associated with poor results. Surgical treatment is indicated to restore the length and/or angulation of the metatarsal.

Several reduction and fixation techniques have been described for diaphyseal and metatarsal neck fractures, consisting of retrograde medullary pinning, antegrade medullary pinning and plate fixation. The retrograde medullary pinning technique is the most commonly used [26].

7.3 Retrograde Medullary Pinning

This procedure can be performed percutaneously, but often due to the technical difficulty of achieving the anatomical reduction of the fracture, it is necessary to perform a longitudinal dorsal approach. A 1.4–1.8 mm Kirschner wire is introduced in an antegrade direction through the diaphysis of the distal fragment toward the metatarsal head, exiting plantar in the MTF joint or through the base of the first phalanx. This is followed by reduction of the fracture site and retrograde insertion of the wire into the proximal diaphysis (Fig. 13).

It is important to note that endomedullary fixation with Kirschner wires does not allow early mobilization of the joint. If the pin is passed through the base of the first phalanx, it can cause joint damage and stiffness. If the pin is placed plantar to the first phalanx, it will keep the metatarsophalangeal joint in dorsiflexion during the fixation time, which can generate a claw deformity.

Fig. 13 Reduction and synthesis of diaphyseal fractures of the metatarsal with retrograde intramedullary pinning

7.4 Antegrade Medullary Pinning

Techniques have been described to attempt intramedullary fixation while avoiding damage to the metatarsophalangeal joint. One option is to use wires perpendicular to the fracture, which proved to be very unstable [27]. The antegrade fixation described by Kim et al. [28], that inserts a pin with a double distal curvature that reduces the fracture, avoiding joint damage. However, they clarify in their report that it is a complex and demanding procedure, with a high rate of irradiation and a high risk of iatrogenic fracture of the proximal fragment where the pin is inserted; They reported a series of 30 patients followed for 5 years, where joint limitation was seen in 2 patients, and a global AOFAS score of 83 was achieved.

Potential complications found with wire fixation are: joint stiffnes, cartilage damagem infection, fracture displacemente, between others [29].

7.5 Fixation with Plates

Sánchez Alepuz et al. [4] did not show any difference when comparing 57 central metatarsal fractures treated with Kirschner pins in 21 patients and with nonsurgical treatment in 36 patients. They reported a 56.8% of metatarsalgia in cases of fracture malunion. Factors that contributed to poor outcome were malunion, open fractures and soft tissue injuries.

Bryant et al. [30] in their study of plate and screw fixation reported a 5% incidence of coronal or sagittal angulation, and no patient had residual metatarsalgia, nonunion, or discomfort.

Khazen et al. [31] compared the results with both fixation techniques in 47 patients. Eighteen patients were treated with open reduction and internal fixation with K-wire through the metatarsophalangeal joint or distal phalanx, with 44% showing some degree of loss of fracture reduction after implant removal, metatarsalgia in six patients, and residual claw deformity in 33% of patients. Open reduction and internal fixation with plate and screws were performed in 29 patients, with no evidence of loss of fracture reduction or metatarsalgia (Figs. 14 and 15).

Curtis et al. [32] biomechanically compared the resistance to failure between intramedullary pins, transverse pins, and non-locked plates, showing a greater resistance to failure and bending in fixation with plate and screws compared to intramedullary wires.

Due to the above arguments, our suggestion is to perform open reduction and internal fixation with 2.0 or 2.7 mm plates; this technique keeps an anatomical reduction and stable fixation, allowing early mobilization and weight bearing without distal joint damage.

Fig. 14 AP radiograph of patient with multiple metatarsal fractures, considering incomplete fracture of the first metatarsal, and complete fractures of the second, third, and fourth metatarsals

7.6 Special Considerations

In subcapital fractures with evident displacement or dislocation, fixation using 2.0 or 1.5 mm screws is recommended.

In proximal articular fractures or proximal metaphyseal comminuted fractures, a bridge plate (metatarsal-cuneiform) is the recommended option. In cases of moderate or severe cuneometatarsal joint damage, it may be necessary to perform primary arthrodesis, topic which will be discussed in another chapter.

Fig. 15 Open reduction and internal fixation of the fracture with plates, allowing early mobilization and support without distal joint damage, guaranteeing fracture reduction until consolidation is achieved

The concept of column stabilization in multiple or complex fractures with soft tissue involvement is interesting. If the fracture involves the medial (first metatarsal) and middle (second and third metatarsal) column with a stable lateral column (fourth and fifthh metatarsals), it is enough to stabilize the first and second (or third) metatarsals. If there is a fracture of the lateral and middle columns, it is enough to perform lateral column and second or third metatarsals fixation (Figs. 16, 17, and 18).

Fig. 16 Stabilization by columns in multiple or complex fractures with soft tissue involvement. AP radiograph of foot with multiple fractures of the second, third, and fourth metatarsals

In high energy trauma particular attention should be paid to the presence of compartment syndrome [33]. The respective fasciotomies should be performed together with fracture stabilization. This topic will be treated extensively in another chapter (Figs. 19, 20, and 21).

7.7 Malunion

Malunion can generate transfer metatarsalgia, plantar hyperkeratosis and toes deformities. Corrective osteotomies [34] should be performed if conservative treatment (insoles) failed.

Fig. 17 Oblique view of previous patient, showing comminution at the base of the third metatarsal

8 Proximal Fifth Metatarsal Fracture

The proximal fifth metatarsal fracture is the most common fracture of the foot (68% according to Petrisor [2]). The special characteristics of this area can generate a torpid evolution and a delay in return to physical activities, especially in athletes, [35, 36].

The fifth metatarsal is anatomically and biomechanically different from the other metatarsals. It has great motion to be able to adapt to irregularities during stance and gait [37]. Proximally it is stabilized by the plantar fascia, the insertion of the fifth toe

Fig. 18 AP radiograph of previous patient with reduction and stabilization of the second metatarsal, with additional fixation of the lateral column, achieving stability mainly stabilizing the second metatarsal

abductor tendon as well as the peroneus brevis, the tarsometatarsal ligaments, and the intermetatarsal ligaments that join it to the fourth metatarsal. These structures stabilize the proximal part.

Fujitaka et al. [38] reported in a study in soccer players that the group of patients with this fracture had a longer fifth metatarsal and its tuberosity was positioned more proximal; they also reported cavus feet were more prone to have this fractures.

The blood suply is a key factor to understand why fracture healing may fail in these fractures [39]. The main artery of the fifth metatarsal enters through the nutritional foramen, located approximately in the middle of the diaphysis. It divides into two branches, one proximal and one distal. In proximal fractures, the proximal branch gets interrupted, which may cause delayed-unions or non unions. In

Fig. 19 Open midfoot and forefoot fracture due to high energy trauma. Clinical image

contrast, the tuberosity receives blood supply from the metaphyseal arterioles, which favors the healing of fractures in this zone. Lawrence and Botte [40], after appreciating that the fractures distal to the tuberosity presented a higher incidence of delayed healing or nonunion for the reason described, classified the fractures of the proximal third of the fifth metatarsal in three zones; zone 1: tuberosity; zone 2: at the fourth-fifth metatarsal joint; zone 3: proximal diaphysis. The fracture of the tuberosity (zone 1) is an acute avulsion fracture generated by traction of the plantar fascia [41], following a midfoot inversion movement. Jones fracture (zone 2) by definition occurs at the level of the joint between the fourth and fifth metatarsals. This fracture bears the eponym since Sir Robert Jones presented a series of four cases of this metaphyseal fracture in 1902 [42], (including his own fracture, that occured while dancing). In this area, fractures may be generated by an acute mechanism after a forced inversion of the foot or by a chronic mechanism of axial load with the foot in plantar flexion. Stress fractures (zone 3) occur in the proximal diaphysis of the fifth metatarsal, distal to the joint between the fourth and fifth metatarsals. They are generated by chronic repetitive overload or a sudden increase in the level of activity. Carp [43] reported in 1927 that these metaphyseal fractures distal to the tuberosity of the fifth metatarsal (zones 2 and 3) presented some

Fig. 20 X-ray of previous patient, showing multiple metatarsal involvement, in addition to a Lisfranc fracture

difficulty to consolidate reporting 24% of nonunion. Subsequent anatomical studies confirmed the weak blood supply of this area, which can be interrupted by the fracture and compromise fracture healing.

Based on the healing problems of zones 2 and 3, Torg et al. [41] published a radiological classification, where they divide fractures into acute (type I), delayed consolidation with medullary sclerosis (type II), and nonunion (type III), recommending in their report surgical treatment only in the latter.

Clinically the patients with fracture in zones 2 or 3 refer pain in the fracture zone that is exacerbated with exercise; it can be preceded by a prodrome of discomfort in the same zone for several months, accompanied or not by edema and ecchymosis. In the physical examination some degree of varus in the rearfoot or lateral foot border overload can be appreciated.

The radiological study is mandatory with anterolateral, lateral, and oblique foot weight bearing X-ray [44]. MRI can help in decision making when there is any doubt about the treatment. Porter [45] described that an MRI with a weak signal in T1 in the area of a recent Jones fracture can be treated nonsurgically, but if there is

Fig. 21 X-ray of previous patient, showing reduction plus temporary osteosynthesis with Kirschner wires plus isolated intercuneiform screws

an increased signal in the same area, it should be treated surgically. Computed tomography may be helpful to evaluate sclerosis in Torg II and III fractures, as well as to evaluate fracture healing status.

9 Treatment

9.1 Zone 1

The tuberosity fracture (zone 1) is an acute avulsion fracture that should be treated conservatively (Fig. 22). It has been clearly demonstrated that prolonged immobilization leads to delayed recovery and worse outcomes [25]; therefore, functional rehabilitation is recommended. We recommend the use of a walking boot for 4–6 weeks with immediate full weight bearing as tolerated. As previously discussed, this is an

Fig. 22 Fracture of the fifth metatarsal tuberosity (zone 1), treated functionally with a walking boot

area with good irrigation by the metaphyseal arterioles, which aids in the healing of these fractures without the need for surgical treatment regardless of the degree of displacement or comminution.

The author has one exception for zone 1 fractures treatment: in fractures with metatarsal-cuboid joint compromise with more than 2 mm displacement, fracture reduction and fixation is performed using a screw (no evidence in the literature) (Figs. 23 and 24).

There are cases of non union in zone 1 fractures that are completely asymptomatic. If that is the case, the author does not recommend surgical treatment for this non union.

9.2 Zones 2 and 3

The treatment of zone 2 and zone 3 fractures remains controversial and a matter of debate. Reports of nonunion in these zones range from 7% to 67% [46], which led to discussion about the need to indicate surgical treatment, especially in athletic

Fig. 23 Long oblique fifth metatarsal fracture, with articular compromise with the cuboid and displacement greater than 2 mm

patients. Recent studies focus on improving fixation, biology and alignment corrections to reduce failures [45], mainly hindfoot varus.

In a systematic review, Rouche and Calder [47] reported healing in 96% of patients with Torg I fractures treated surgically, and 76% of those treated conservatively. In chronic Jones fractures, 97% of those operated and 44% of those not operated were healed which is why they recommend surgical treatment in these fractures. Baumbach et al. [48] recommend conservative treatment in zone 2 fractures with a walking boot and surgical treatment in zone 3 fractures. The literature is full of studies supporting both options, but most seem to coincide in indicating surgical treatment in zone 2 and zone 3 fractures in athletic patients, since it allows them to reintegrate more quickly to their sporting activity and has a lower risk of nonunion [35, 37, 40, 44–49].

Intramedullary screw fixation is the most accepted treatment for these fractures [37]. Although it is still controversial, several sizes and types of screws have been described. The ideal screw, is the one that completely fills the medullary canal (Fig. 25).

Fig. 24 Reduction and synthesis with screw in fracture of previous case

Most studies report a low failure rate of intramedullary screw fracture stabilization in the non-athlete population but a higher incidence of failure in athletes [50]. Larson also observed this tendency and reported nonunion in 40% of patients with this type of fracture, in his series only one elite athlete healed his fracture, highlighting that these patients start their high physical demand activity earlier, without radiological evidence of fracture consolidation.

Fig. 25 The screw should fill the intramedullary canal and the threads should pass the fracture site

Multiple clinical and biomechanical studies comparing sizes, materials, and fixation methods have been reported. Although biomechanically it has been proven that solid screws are more resistant [51], clinical studies have not been able to show better fracture healing rates with any specific type of screw.

Sides [52] compared solid with cannulated screws, finding no difference between them. Shah [53] compared 4.5 mm cannulated screws with 5.5 mm screws without showing significant difference in the bending of both screws, while Porter [45] compared them in athletic patients, reporting bent screw incidence in 12.5% of the 4.5 mm screws and none of the 5.5 mm screws.

Duplantier [54] compared fracture stabilization with lateroplantar locked plate versus screws, reporting that plates had more resistance to failure than screws. Huh [55] compared hooked plate and screws, reporting that screws showed more resistance to bending and plates more resistance to fracture site rotation. Ismat [56] described the fixation of this fracture with the Ulna hook plate reporting good results.

9.3 Author's Recommendation

In fractures of zone 1, we indicate conservative treatment with immediate weight bearing in postoperative shoe or walking boot for 6 weeks. Pituckanottai et al. [57] in a systematic review and meta-analysis reported that when immobilizing these fractures with plaster, the risk of nonunion is 1.5 times higher than with immobilization in a walking boot. In elderly patients we indicate vitamin D for 8 weeks [58].

In fractures of zones 2 and 3, Torg I, in non-athlete patients, we indicate conservative treatment in postoperative shoe or walking boot, non weight bearing for 2 weeks and then weight bearing as tolerated for another 4 weeks. After immobilization, if there is any degree of varus of the rearfoot or lateral overload, a corrective orthosis is indicated (with posterolateral elevation, low medial arch support and a depression for the first metatarsal head).

In athletes with fractures in zones 2 and 3, Torg I, and in patients with fractures in zones 2 and 3, Torg II type, surgical treatment is recommended.

9.4 Surgical Technique

Under sedation and regional ankle block, the surgical procedure is performed positioning the patient in lateral decubitus; the fracture is fixed using a cannulated partially threaded screw that fills the intramedullary canal with its threads pass the fracture focus, normally of 4.5 or 5.0 mm. The entry point should be "high and inside" at the metatarsal base, to correctly align it to the metatarsal diaphysis. Progressive weight bearing is allowed using a walker boot 4–6 weeks.

In cases of nonunion or refracture, screw exchange for a larger diameter is recommended. In addition bone graft and/or demineralized bone matrix should be added in the non union through a percutaneous lateral incision. If there is a hindfoot varus, a lateral sliding calcaneal osteotomy is added. A first metatarsal osteotomy is recommended depending on the flexibility of the varus deformity (evaluated with Coleman test) (Fig. 26).This topic will be discussed elsewhere in this book [44, 59].

In fractures Torg III (Fig. 27), surgical treatment is recommended including, extensive riming of the medullary canal, autologous bone graft (depending on the defect it can be taken from the calcaneus or tricortical from the iliac crest), demineralized bone matrix, and fixation with a lateral plate or intramedullary screw (Figs. 27, 28, 29, and 30). Non weight bearing for 2 weeks followed with weight bearing as tolerated in a boot for another 6 weeks.

Fig. 26 In cases of fifth metatarsal nonunion or refracture in patients with moderate to severe varus hindfoot deformity, a calcaneal valgus osteotomy is recommended

Fig. 27 In cases of Torg III fifth metatarsal stress fractures, surgical treatment is performed with an approach to the fracture site, extensive riming of the medullary canal, autologous bone grafting, demineralized bone matrix, and fixation with a lateral plate or intramedullary screw

Fig. 28 AP foot radiograph showing a fifth metatarsal stress fracture. Please note the lateral metatarsal cortex thickening and fracture line

Fig. 29 AP foot radiograph showing a fifth metatarsal stress fracture, magnified

Fig. 30 Oblique foot radiograph (same patient as Fig. 29) showing an endomedullary screw with a fully healed fifth metatarsal stress fracture

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