Arşiv Kaynak Tarama Dergisi
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Evaluation of Patients with Foot and Ankle Trauma in Emergency Medicine

Birinci Basamakta Ayak ve Ayak Bileği Travmalı Hastaların Değerlendirilmesi

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ABSTRACT
Foot and ankle injuries may be due to ligament strain or complicated and unstable distant bone fractures depending on the direction and shape of the trauma. Early diagnosis and treatment prevent complications and long-term morbidity. The specialist should take the patient's history and determine the mechanism and nature of the trauma (recurrent or not) and post-trauma mobilization predictions to evaluate an injured foot and ankle. The trauma mechanism generally points to the possible location of the damage. Trauma size critical for determining the time it takes the injury to recover and the patient to return to work, which can be shortened by the right immobilization. Foot and ankle injuries are more common in indoor court athletes and people with reduced proprioceptive senses and restricted foot dorsiflexion. The specialist should identify preventable and modifiable risk factors and take necessary measures.
Keywords: Ankle ınjury, foot ınjury, low extremity fractures

ÖZET
Ayak ve ayak bileği yaralanmaları bu anatomik lokalizasyondaki bağların gerilmesinden kaynaklanabileceği gibi travmanın yönünne, şekline göre uzak kemik kırıklarına neden olabilecek komplike unstabil kırık şeklinde de olabilir. Yaralanmanın erken tanınıp uygun tedavinin uygulanması komplikasyonları ve uzun dönem morbiditeyi önlemek anlamında önemlidir. Travmatik ayak ve ayak bileği değerlendirilirken dikkatlice öykü alınmalıdır. Travmanın mekanizması, hastanın travma sonrası mobilizasyonun öngörüleri ve tekrarlayan bir travma olup olmadığı belirlenmelidir. Yaralanmanın mekanizması hasarın oluşacağı yeri genelde gösterir. Yaralanmanın boyutu, iyileşme için gereken süre ve işe dönme yeteneğini belirlemede önemlidir. Uygun immobilizasyon bu süreyi kısaltabilir. Propriyoseptif duyularında azalma, ayağı dorsifleksiyonda kısıtlılığı olanlarda, kapalı kort sporu yapanlarda ayakve ayak bileği yaralanma riski artmaktadır. Önlenebilir ve değiştirilebilir risk faktörleri belirlenmeli ve tedbir alınmalıdır.
Anahtar kelimeler: Ayak travması, ayak bileği travması, alt ekstremite kırıkları

Introduction

Foot and ankle injuries may be due to ligament strain or complicated and unstable distant bone fractures depending on the direction and shape of the trauma. Early diagnosis and treatment prevent complications and long term morbidity. The specialist should take the patient's history and determine the mechanism and nature of the trauma (recurrent or not) and post-trauma mobilization predictions to evaluate an injured foot and ankle. The trauma mechanism generally points to the possible location of the damage. Trauma severity is critical for determining the time it takes the injury to recover and the patient to return to work, which can be shortened by the right immobilization. Foot and ankle injuries are more common in indoor court athletes and people with reduced proprioceptive senses and restricted foot dorsiflexion[1]. In the light of this article, we aim for physicians to identify preventable and modifiable risk factors and take necessary precautions.

Ankle Anatomy

The ankle is formed by three bones; tibia, fibula, and talus (Figure 1). The tibia forms the upper portion of the joint and the medial and posterior malleolus, while the fibula forms its lateral malleolus. The lateral malleolus prevents the ankle and foot from turning outward excessively, while the medial malleolus talus articulates medially with the body. The posterior malleolus is the posterior aspect of the distal tibia to which the syndesmotic ligament complex is attached[2].

Figure 1. Ankle anatomy

The ligaments attached to those bones also play a role in joint stability and injury type (Figure 2).

- The deltoid ligament (DL) connects the tibia medially to the talus and calcaneus. It is the strongest ankle ligament that is rarely injured.
- The anterior/posterior talofibular ligament (ATFL/PTFL) connects the fibula to the talus. Ankle injuries are most common in the ATFL.
- The calcaneofibular ligament (CFL) connects the fibula laterally to the calcaneus. Isolated injury is rare in the CFL. With the lateral ligament complex, the CFL may rupture as a result of severe trauma.
- The anterior/posterior tibiofibular ligament (ATiFL/PTiFL) connects the tibia and fibula distally at the tibiotalar joint level. It forms the syndesmosis of the ankle and provides syndesmosis support together with the interosseous membrane extending to the proximal of the ankle. These structures prevent separation of the distal tibia and fibula[2]

Figure 2 Ligaments of ankle and bones forming to joint

Ankle Trauma

Ankle injuries are common, mostly due to sports activities[1]. The ankle has complex movements. Inversion and eversion are technically subtalar joint movements, which, however, turn into supination and pronation movements combined with ankle and midfoot joint movements. Supination (inversion) injuries cause tension in the lateral ankle components and compression in the medial structures, while pronation (eversion) injuries cause medial tension and lateral compression. The tense structures usually fracture or tear before compressing the structures on the opposite side.

Supination injuries: The most common ankle injuries are supination injuries, which cause tension on the lateral components. In acute ankle injuries, the ratio of sprain to fracture is 8:1[3]. Most ankle fractures are malleolar fractures. 60-70% of these fractures are unimalleolar, 15-20% bimalleolar, and 7-12% trimalleolar malleolar fractures[4]. Fractures affecting both medial and lateral malleoli are called bimalleolar fractures, while those involving the posterior malleolus are called trimalleolar fractures.

Isolated malleolar fractures are considered stable fractures because there are no accompanying contralateral and syndesmotic ligament injuries if there is no dislocation. However, bimalleolar and trimalleolar fractures are unstable fractures that require surgical stabilization for treatment.

Lateral ankle injuries: The lateral ankle components are the ATFL, CFL, PTFL and fibula lateral malleolus. The ATFL is the most commonly injured. Isolated injuries are rare in the calcaneofibular ligament. Tears may occur in all three ligaments depending on the severity of the trauma. It is not common but may cause nerve damage.

Medial ankle injuries: The deep and superficial fibers of the deltoid ligament and the medial ankle components of the tibia form the medial malleolus. The deltoid ligament is the strongest ankle ligament, which causes medial malleolus avulsion fractures prior to tears. Those fractures initially look like isolated fractures but deteriorate the lateral and posterior structures.

The posterior tibial artery and the tibial nerve are posterior to the medial malleolus. The specialist should take into account the possibility of neurovascular damage in injuries on that site[5].

Syndesmotic injuries: They result from the dorsiflexion of the ankle with the internal rotation of the tibia. They are anterior/posterior tibiofibular ligament and interosseous membrane injuries. They may also cause proximal fibular fractures and recurrent ankle sprains, requiring utmost attention[6].

Imaging

The Ottawa ankle rules help the specialist determine whether radiological imaging of the foot and ankle is necessary for acute ankle injuries. Radiography is not required for patients who do not meet the Ottawa criteria because fracture probability is low. Patients who do not meet the Ottawa criteria have a negative prediction of 96.4% - 99.6%[7]. The Ottawa ankle rules help reduce the number of unnecessary radiotherapy in emergency services by 30-40%. Imaging is performed for ankle injuries in patients with diabetes and reduced peripheral senses and under the influence of alcohol, regardless of the Ottawa criteria.

Ottawa Ankle Rules

Radiographic imaging is required for ankle injuries in the presence of pain in the malleolar zone and any of the following (see Figure 3):

Tenderness on palpation at the posterior edge of the lateral malleolus

or

Tenderness on palpation at the posterior edge of the medial malleolus

or

Inability to bear weight on both feet twice (four steps)

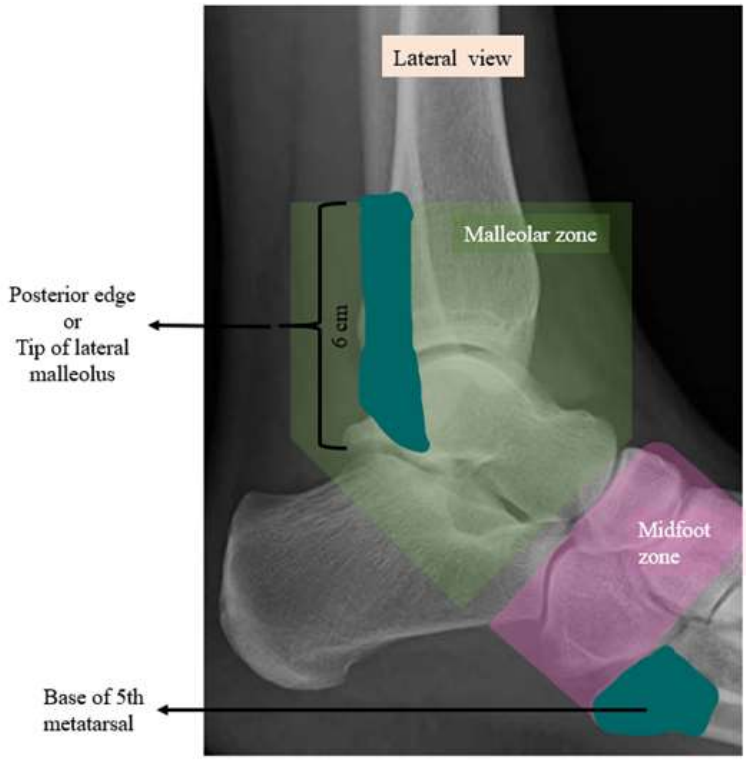

Figure 3 The Ottawa ankle rules

The severity of ankle injuries is evaluated using physical examination and plain radiographs. Anterior-posterior (AP), oblique, and lateral views are standard. The anterior-posterior radiograph is the best option for isolated lateral and medial malleolar fractures. Lateral radiography is the best option for posterior malleolar fractures. Oblique (mortise) radiography is performed using AP projection with a lateral angle of 10-20° to visualize talus and syndesmotic injuries. Oblique (mortise) radiography imaging allows the specialist to evaluate the relationship between the talus and the medial and lateral malleolus, as well as inconsistencies in distances (Figure 4).

Figure 4 View option of ankle in X-Ray

The medial and lateral malleoli and the tibia are equidistant from the talus. An isolated fracture is a stable fracture if (1) <2mm displacement, (2) no dislocation in the tibiotalar joint, (3) <25% joint surface involvement, and (4) no damage on the related soft tissue[8].

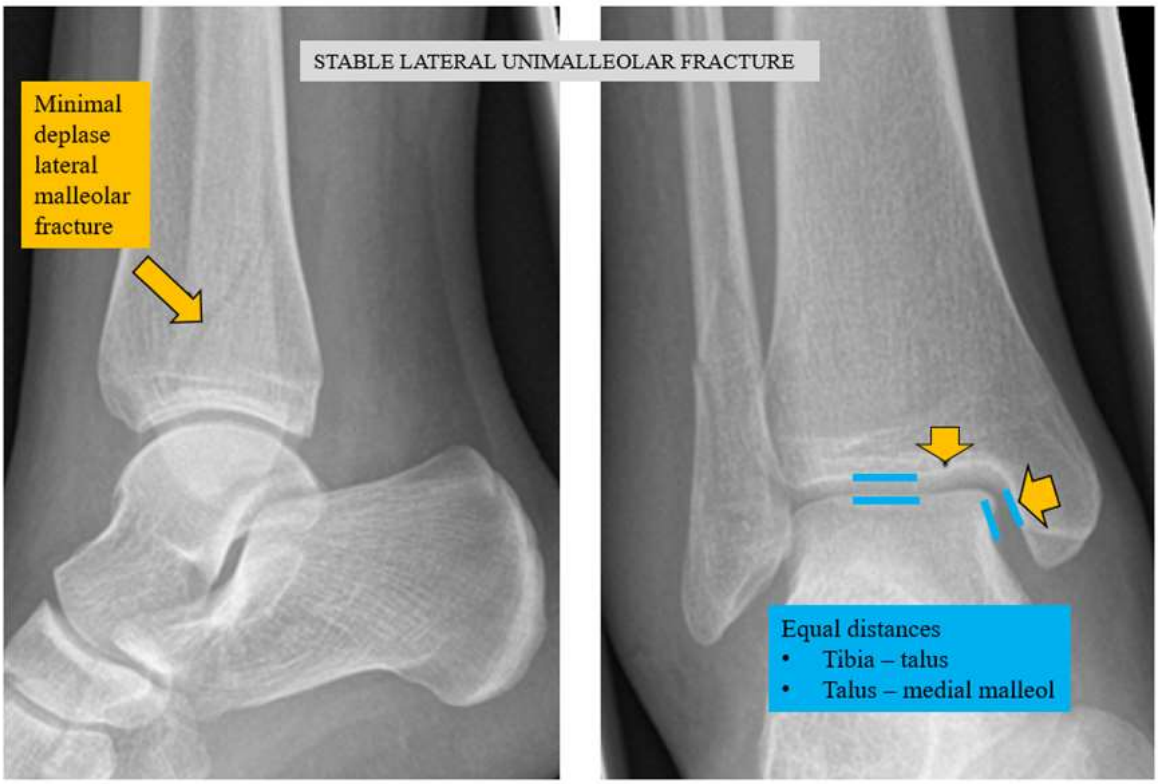

Figure 5 Stable fracture; <2 mm displacement, no dislocation, <%25 joint surface involvement

Figure 6 Bimalleolar and trimalleoler fractures are unstable

A distance of greater than 4 mm between the talus and medial malleolus in a mortise image is a sign of deltoid ligament damage (Figure 7)[9].

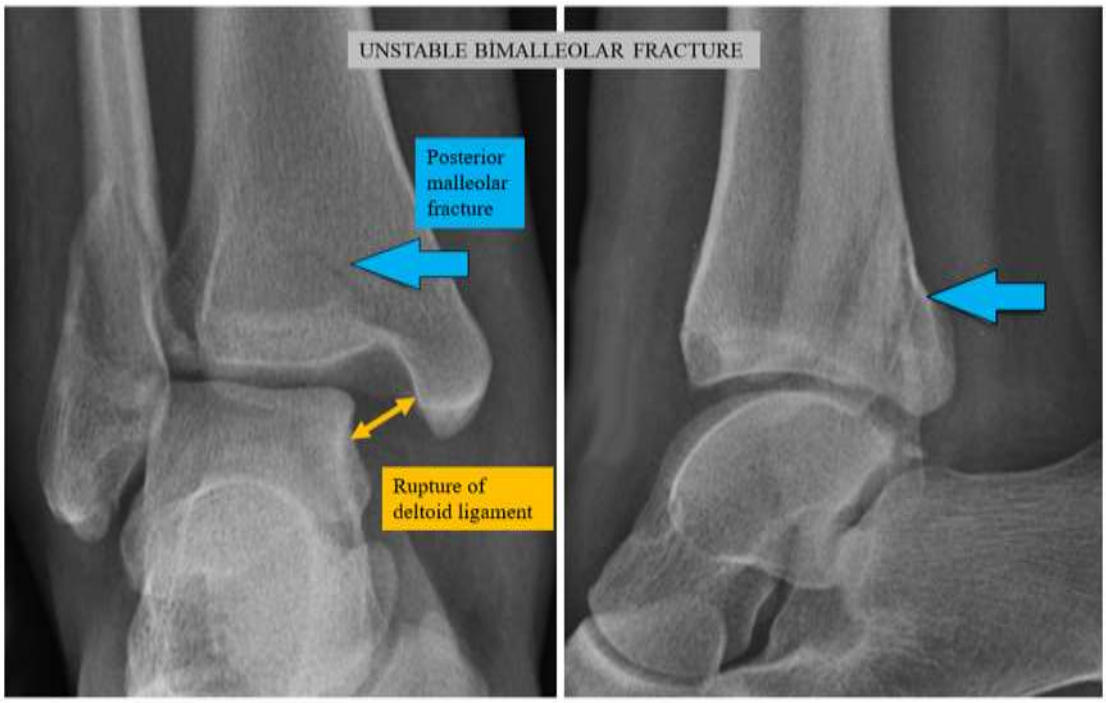

Figure 7. Deltoid ligament damage, unstable fracture

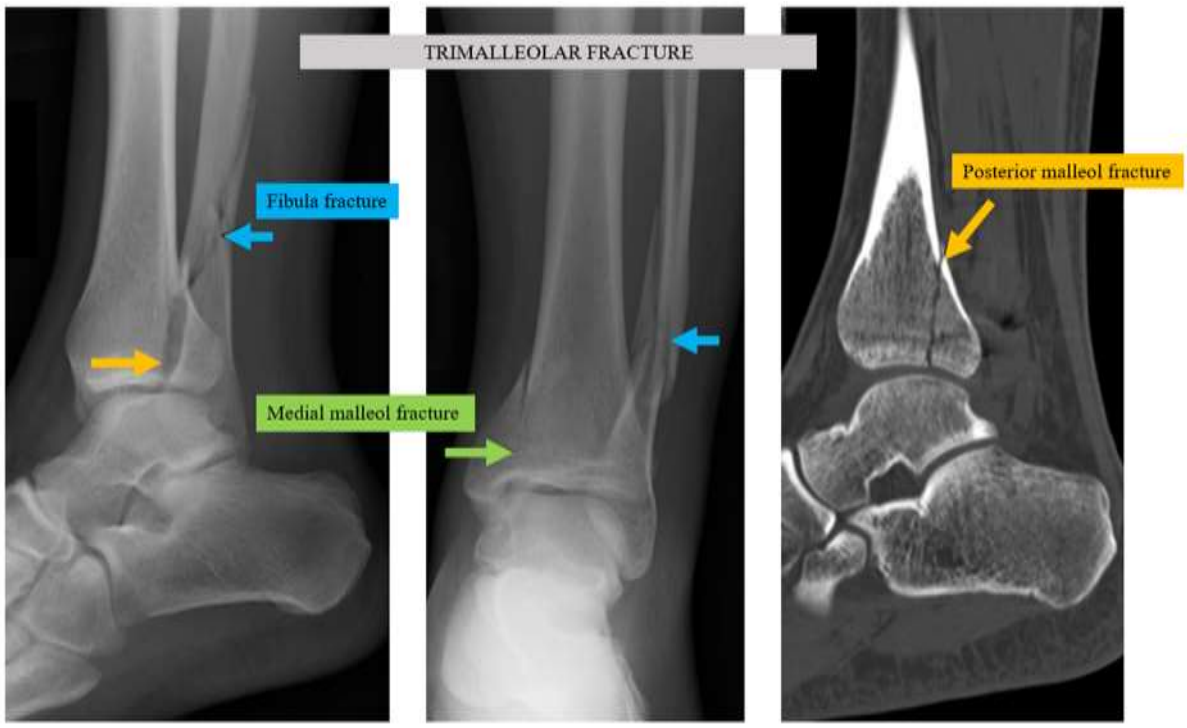

Figure 8. Trimalleolar (lateral, medial,posterior) unstable fracture

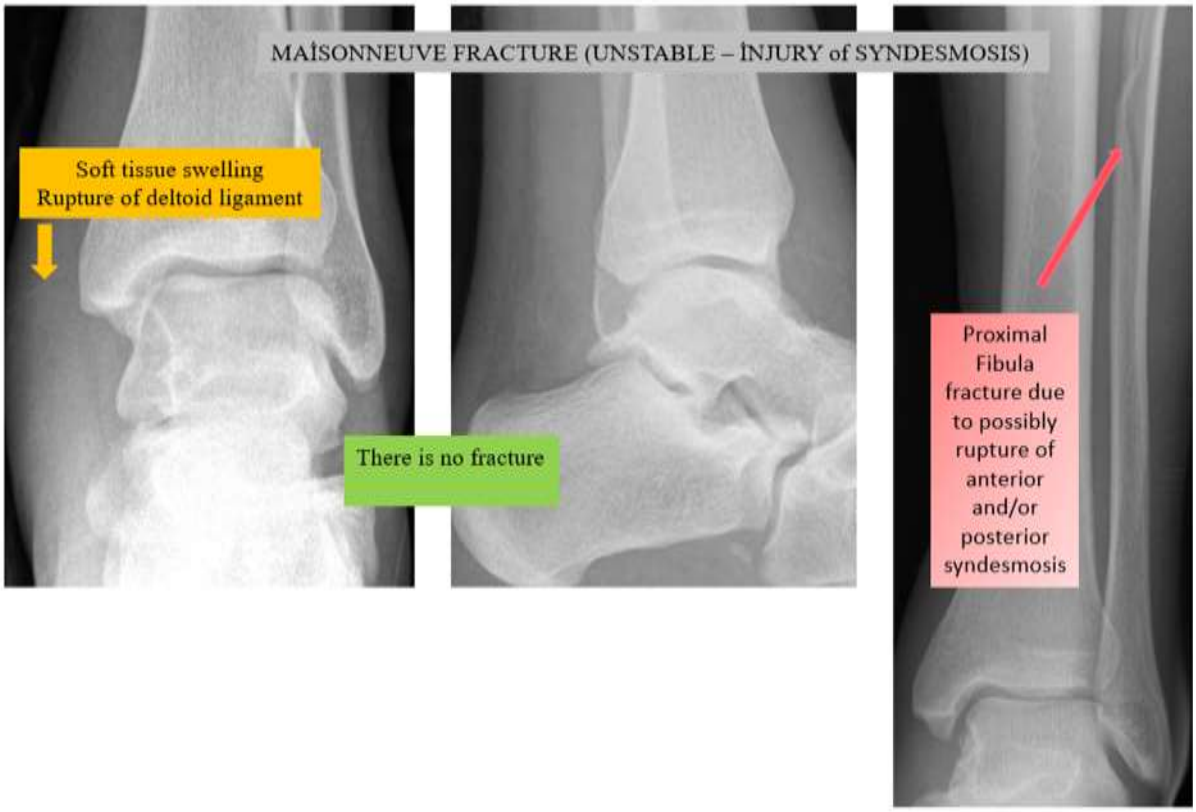

Figure 9 Maisonneuve fracture; combination of the proximal fibulae fracture with ligamentous injury (often deltoid ligament and/or tibiofibular syndesmosis)

Magnetic resonance imaging (MRI) is not better than plain radiography at detecting acute injury[10]. If the pain persists after 6-8 weeks of treatment, the specialist should consider the possibility of soft tissue damage, silent fractures, and syndesmosis damage.

Treatment

Specialists and orthopedists should examine patients with open fractures and neurovascular damage together because such patients require immediate surgery. Fractured dislocations should be reduced as soon as possible to prevent them from causing severe complications, such as avascular necrosis and compartment syndrome. After ruling out an emergency intervention, the specialist should determine whether the fracture is stable, and if the fracture is non-stable, she should consider nonoperative options.

The goal is to limit pain and swelling and maintain range of motion (ROM) before ambulation. The type of treatment depends on how stable the fracture or sprain is. RICE (rest, ice, compression, elevation) is recommended for sprains and stable malleolar fractures during the first two to three days[11].

REST: Using crutches to constrain weight bearing

ICE: Applying ice compressing on the injured area for 15-20 minutes, every 2-3 hours in the first 48 hours, or soak the injured area in cold water until the swelling is gone[11].

COMPRESSION: Wrapping the injured area with an elastic bandage to help decrease swelling on the soft tissue.

ELEVATION: Keeping the injured area at or above the level of the heart to help increase the lymphatic and venous drainage and to minimize swelling

Patients with open fractures and neurovascular damage require urgent orthopedic consultation and treatment. Fractured dislocations should be reduced as soon as possible to prevent them from causing severe

complications, such as avascular necrosis and compartment syndrome[12]. There is no time to wait for the orthopedist for wound cleansing with normal saline, prophylactic antibiotherapy, and tetanus prophylaxis in open fractures.

- The injured part should be splinted posteriorly in a neutral position (ankle at 90°) to provide support and reduce pain. A tampon should be placed in the splint in the presence of severe edema or deformity.
- Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) can be used for pain management[13].
- If the specialist is considering surgery, she should inform the patient and his family members about the procedure and obtain their consent, and avoid using narcotic analgesic in the meantime.
- Isolated lateral malleolar fractures below the tibiotalar joint level are stable fractures that require nonoperative treatment. Follow-up for 3-6 weeks with a short leg posterior splint is sufficient.
- A deltoid ligament disruption and/or medial fracture due to > 4mm of displacement in the lateral malleolus is an unstable fracture that requires orthopedic consultation[9].
- A splint is sufficient for isolated medial or posterior malleolar nondisplaced fractures without additional ligament damage.
- Bimalleolar and trimalleolar fractures are nonstable fractures that require surgical fixation.
- In the presence of pain, numbness, and tingling, and skin discoloration distal to the splint during or after treatment, the specialist should immediately re-examine the patient for the possibility of compartment syndrome and refer him to an orthopedist[14].

Complications

The right treatment for patients without comorbidities have a low risk of complications, but it is higher in smokers and patients with diabetes and peripheral vascular diseases[12].

Acute complications are recognized immediately and require immediate surgery.

Compartment syndrome usually occurs gradually and progresses rapidly within a few hours. It is common in young males under 35 years old. The earliest and most acute symptom is pain disproportionate to injury. If left untreated, it causes muscle contracture, sensory deficit, paralysis, infection, nonunion, and amputation. Both open and closed fractures and excessively rigid casts can cause compartment syndrome[14].

Open fractures and peripheral vascular and nerve injuries: Fractured parts or casts or splints can cause vascular nerve compression and injury.

Chronic complications

Instability and osteoarthritis: Undetected syndesmosis injuries (Maisonneuve fracture) can cause unstable joints and early osteoarthritis. Undetected deltoid ligament damage in a lateral malleolus fracture causes joint pain and degeneration.

Pain: Complex regional pain syndrome may develop 4-6 weeks after the fracture. It is characterized by swelling, reduced ROM, vasomotor instability, skin changes, and patchy bone demineralization. Its etiology and pathophysiology are unknown. Classical inflammation, neurogenic inflammation, and maladaptive changes in the perception of pain in the central nervous system may be responsible for it. It is more common in women than in men[15]. It requires a differential diagnosis from soft tissue and bone infection, compartment syndrome, peripheral vascular disease, deep vein thrombosis, peripheral neuropathy, rheumatoid arthritis, Raynaud's phenomenon, and erythromelalgia.

Foot Anatomy

Normal foot anatomy varies from person to person. The shape of the foot varies from long to short and wide to narrow, depending on any difference in the curvature of an axis from the rearfoot to the forefoot. The shape of the foot also depends on the accessory and sesamoid bones and the difference in their location. Foot structure and shape play a vital role in the injury.

In the sagittal plane, the foot is categorized into three regions: the forefoot (metatarsal bones, phalanges, and sesamoid bones), mid-foot (all other tarsal bones), and rearfoot (talus and calcaneus). The forefoot is categorized into two in the mediolateral plane: medial column and lateral column. The medial column is formed by the first, second, and third phalanges and their metatarsals. The lateral column is formed by the fourth and fifth phalanges and their metatarsals. Both columns articulate with the tarsal bones for stability.

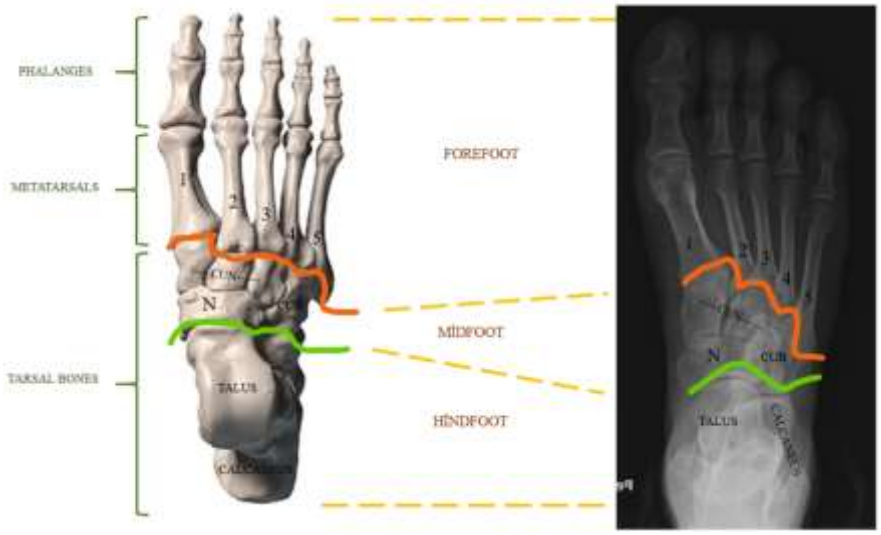

Figure 10 Talar bones anatomy[3]

Foot Trauma

Hindfoot Trauma

Calcaneus and talus fractures are caused by high-energy accidents, such as falls from height and motor vehicle accidents. When the specialist detects fractures in the tarsal bones, she should perform an examination for possible accompanying injury. Calcaneus fractures are more common than talus fractures, but the latter have a higher risk of morbidity because they progress to avascular necrosis due to low blood flow. The specialist should check for pelvis and spine fractures in such fractures caused by axial weight-bearing[16].

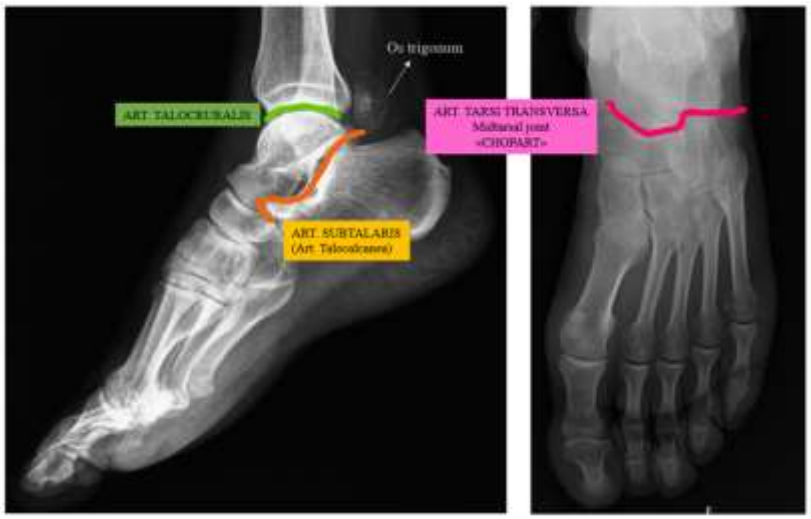

Figure 11. Joints form by talus; art. Talocruralis with tibia, art. Subtalaris with calcaneus, Chopart joint with other tarsal bones)

Talus Fractures

Talus fractures are 0.1 - 0.85 percent of all fractures[17]. Snowboarders are 17 times more likely to suffer a talus fracture due to incorrect axial force transmission in jumps[18]. The talus bone is divided into three sections, neck, body, and head. Talus fractures are most common in the neck. Talus fractures in the neck, even nondisplaced ones, are highly likely to result in avascular necrosis because the neck is the entry point of the vessels that supply blood to the body. Articular surfaces composed of cartilage are more than 60 percent of the bone, and most fractures are intra-articular[19]. The abundant articular cartilage in the talus allows the arteries to reach only certain areas of the bone. Therefore, the blood supply to the talus is relatively low, increasing the risk for avascular necrosis. The talar body forms the calcaneus and the subtalar joint, which is where supination and pronation occur. The specialist takes anterior-posterior, lateral, and mortis radiographs if she suspects a talus fracture. If she has difficulty in diagnosis, she should take computed tomography as well.

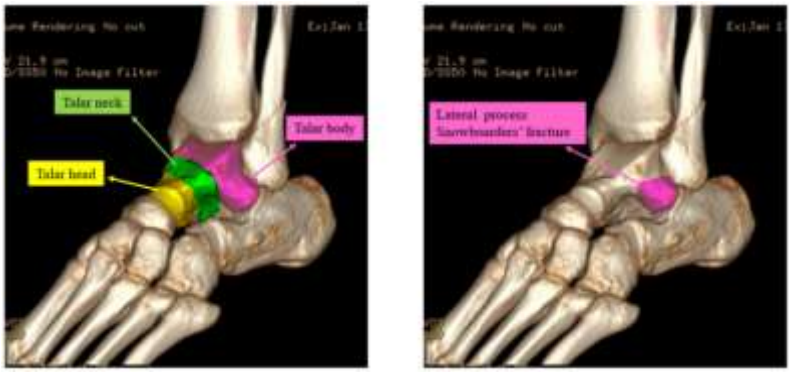

Figure 12. Talar fractures zones; head, neck and body

An open fracture requires urgent surgery in the presence of neurovascular damage and/or dislocation.

- *Talar head fractures* are caused by axial weight-bearing on the foot in plantar flexion. The navicular bone and associated ligaments may also be damaged. Talar head fractures are usually intraarticular fractures, which may impair the stability of the talonavicular joint and dislocate the talus. Conservative treatment is the option if a talar head fracture is a nondisplaced fracture that does not extend to the subtalar joint and concerns only a surface of <5mm[17]. An orthopedist should be consulted for surgery in all other fractures.
- *Talar neck fractures;* Half of all talus fractures are talar neck fractures caused by excessive dorsiflexion. Talar neck fractures are extraarticular fractures[20]. Maximum pain is palpated 1-3 cm distal to the anteromedial ankle joint. All cases require surgery.

Figure 13. Talar neck fracture; X-ray lateral and MRI sagittal images

Figure 14. Same patient, postoperative fixation view

- *Talar body fractures* are high-risk injuries involving the subtalar joint. They often disrupt talar vascularization and cause avascular necrosis. Avascular necrosis is observed in 25 percent of fractures, but it may be observed in half of all open, fragmented, or displaced fractures[21]. All cases require surgery.

1. *Lateral process fractures* are caused by axial weight-bearing in snowboarders when the foot is in dorsiflexion and flexion. Snowboarders are 17 times more likely to suffer a lateral process fracture. Lateral process fractures may be mistaken for ankle sprains. If left undiagnosed, they may result in osteoarthritis. Surgery is the only option for fractures displaced more than 1-2 mm[18].
2. *Posterior process fractures* may be caused by the compression of the posterior process with strong plantar flexion or stress due to strong dorsiflexion[22]. A short leg splint for 4 to 6 weeks is the treatment of choice for a fracture that does not extend to the talar body.
   A posterior process fracture should be differentiated from the Os Trigonum Syndrome. The edges of an acute fracture tend to be jagged and rough, while the Os Trigonum Syndrome is characterized by the bone with a round and smooth surface.

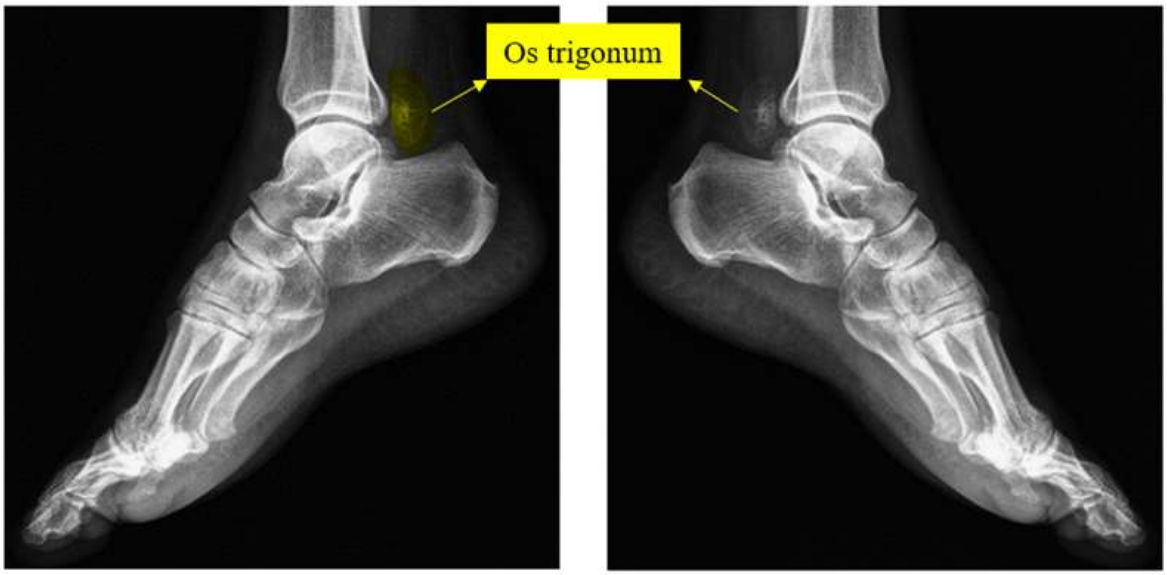

Figure 15. Os trigonum; a round and smooth surface different from posterior process fracture

Calcaneus Fractures

Calcaneus fractures are only 1-2 percent of all fractures. The largest and most frequently fractured bone is the tarsal bone. Calcaneus fractures, which are 60 percent of all tarsal fractures, are caused by axial weight-bearing due to falls from heights. They are characterized by severe pain, prominent swelling, and sometimes deformed heel. Abrasion and incision, and blisters due to excessive and rapidly developing edema, may be observed on the skin[23]. The more the blisters, the more severe the trauma. The blisters may contain clear or bloody fluid. Incision and discharge depend on the risk of infection. The specialist should also consider the possibility of contralateral calcaneus and lumbar and/or pelvic injuries accompanying calcaneus fractures[21].

Figure 16. Lover's fracture; extraarticular fracture with burst fractures of the lumbar spine

Bohler's and Gissane angles are used in plain radiographs in case of suspected fracture.

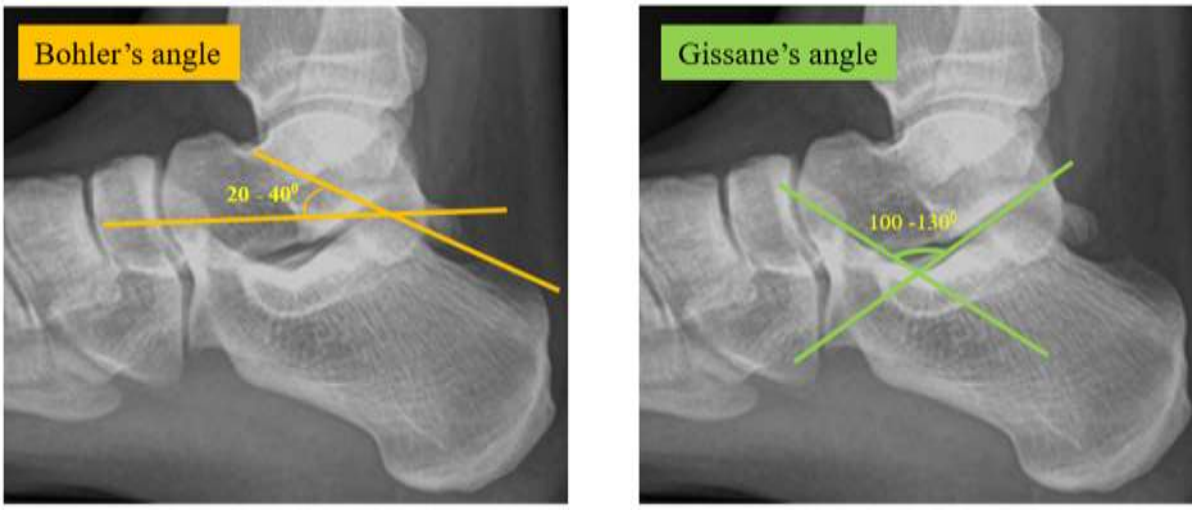

Figure 17. Bohler's and Gissane's angle are drawn in lateral view

Bohler's angle is the intersection of a line drawn from the highest point of the calcaneal tuberosity to the highest point of the posterior facet and a line between the anterior and posterior articulating facets. A Bohler's angle of 20° or less is a sign of a calcaneal fracture[24]. Gissane angle is the intersection of two lines drawn parallel to the anterior and posterior facets of the subtalar joint. A normal angle of Gissane is 100 to

130°. A Bohler's angle > 130° is a sign of a calcaneal fracture. However, Bohler's and Gissane angles within normal ranges cannot rule out the possibility of a fracture[25]. If the specialist is unsure whether both angles are within normal ranges, she should perform the same measurements on the other foot for comparison.

Calcaneus fractures are classified as intraarticular and extraarticular. Clinic and treatment depend on the type of fracture.

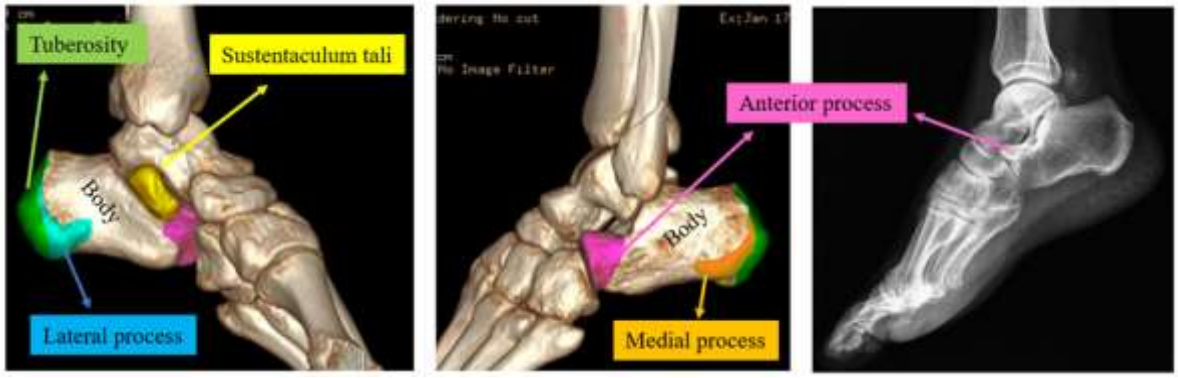

Figure 18. Calcaneal fractures areas

- *Extraarticular Fractures:* Most extraarticular fractures are in the form of avulsion fractures. They usually have a good prognosis and a good response to conservative treatment if they are not significantly displaced. Both the RICE protocol and expert opinion are required for diagnosis[26]:

- Anterior process fractures
- Medial/lateral process fractures
- Tubercle avulsion fractures
- Sustentaculum tali fractures
- Body fractures not extending to the subtalar joint

Figure 19. Extraarticular calcaneus fractures

- *Intraarticular fractures* are characterized by more pronounced heel deformity and greater swelling (Figure 20). Increased swelling also brings about an increased risk of compartment syndrome (up to 10%). The risk of complications increases, especially with displacement towards the posterior[27]. Computed tomography (CT) should be performed to fully characterize a fracture in the presence of high clinical suspicion but negative plain radiographs. All intra-articular calcaneus fractures should be referred to an orthopedist as soon as possible. Treatment includes RICE and analgesic therapy, and perhaps fasciotomy. Intraarticular fractures have a poor prognosis and are hard to manage.

Figure 20 Intraarticular calcaneus fracture; lateral X-Ray view, CT sagittal and 3D views

An orthopedist should be consulted as soon as possible for open fractures, neurovascular damage, fractures associated with dislocations, and trauma with a high risk of compartment syndrome.

Mıd-Foot Trauma

Mid-foot injuries are rare injuries caused by high-energy trauma, such as motor vehicle accidents and falls from heights. The Ottawa foot rules are used for assessing acute post-traumatic pain, swelling, and tenderness to palpation in a mid-foot injury.

Foot radiography is required for ankle injuries in the presence of pain in the midfoot zone and any of the following (see Figure 21):

Tenderness in the fifth metatarsal bone

or

Tenderness in the navicular bone

or

Inability to bear weight on both feet twice (four steps)[7]

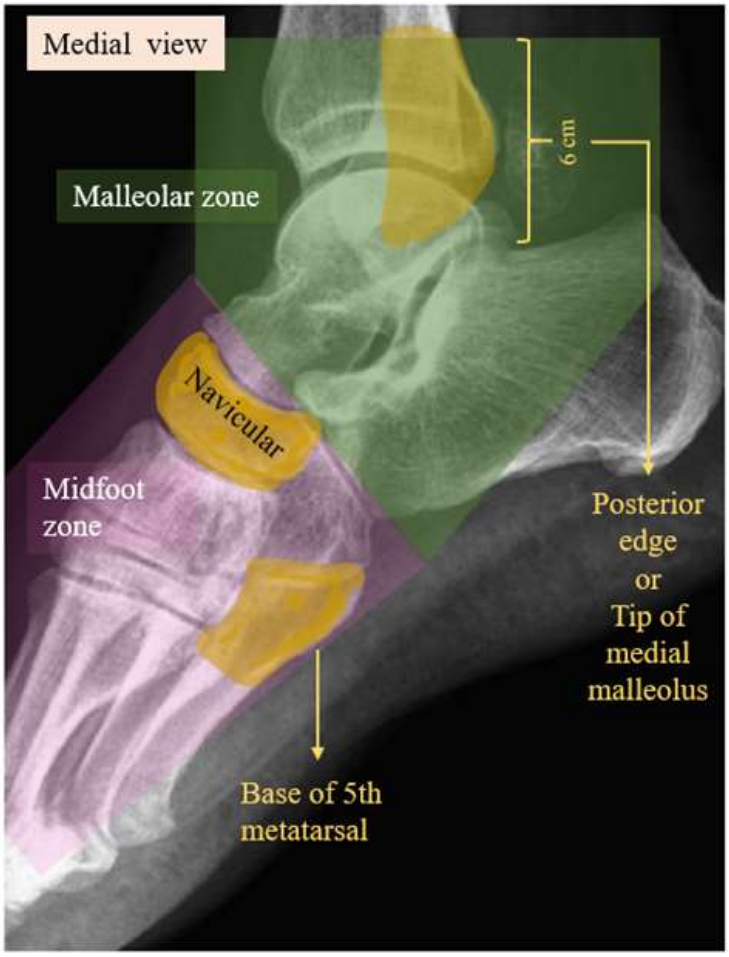

Figure 21 The Ottowa foot rules

Cuboid and Cuneiform Fractures

Cuboid and cuneiform fractures are extremely rare[28]. They are seen together with adjacent bone and ligament injuries, especially in high-energy traumas. The anterior-posterior radiograph is the best option for cuboid and cuneiform fractures. However, they are easy to overlook on plain radiographs. Computed tomography should be performed in the presence of post-traumatic mid-foot pain and inadequate plain radiography.

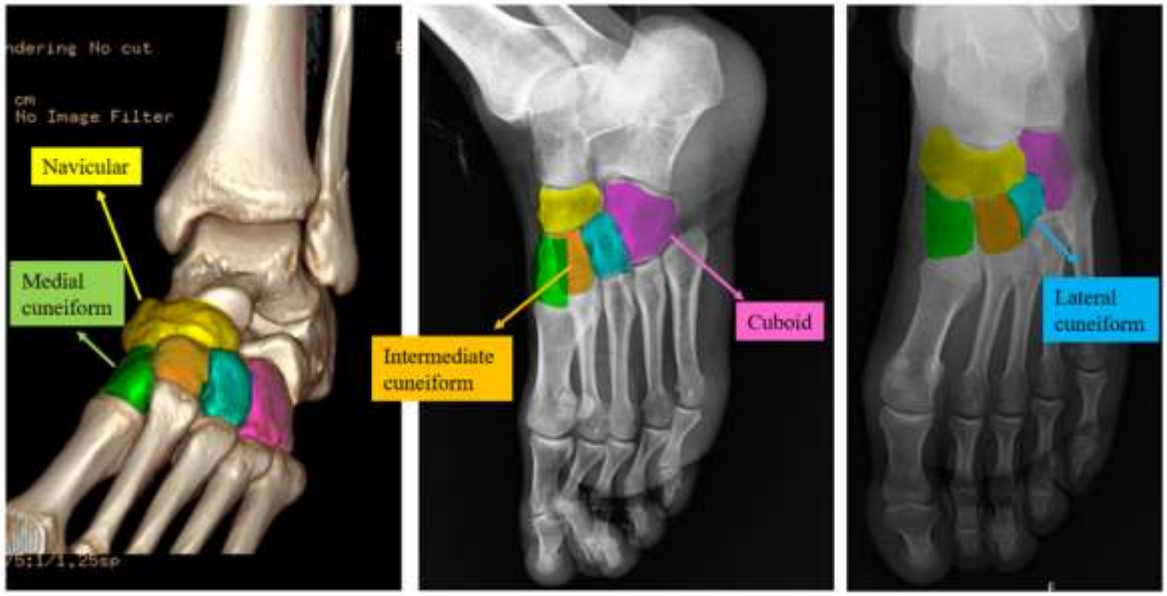

Figure 22. Mid-foot (navicular, cuneiforms and cuboid) anatomy

The cuboid bone is squeezed between the calcaneus and the fourth and fifth metatarsals and fractured due to axial weight-bearing to the heel of the foot in plantar flexion (Figure 23). They are also known as "nutcracker" fractures because they are common in ballerinas and riders[29, 30]. Nutcracker fractures have the same mechanism as Lisfranc fractures, and therefore, cuboid fractures accompanied by Lisfranc fractures are more common than isolated cuboid fractures.

Treatment consists of standard RICE protocol and posterior splinting. Isolated fractures uncomplicated with neighboring structures have a good prognosis, and therefore, do not require surgery. Complicated mid-foot fractures accompanied by fifth metatarsal, calcaneus, and/or Lisfranc injuries require surgery[31]. Isolated injuries of the cuneiform bone are also infrequent.

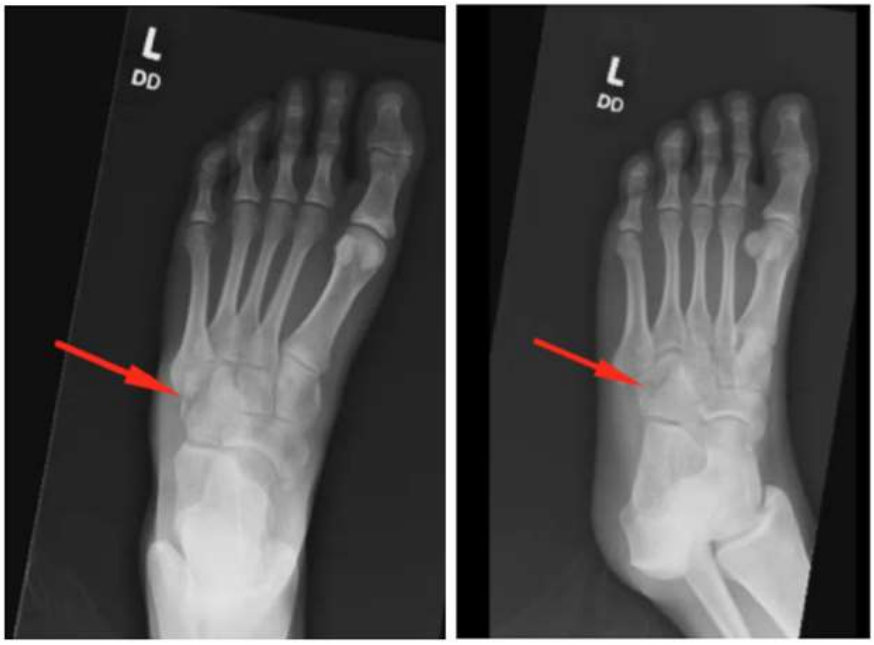

Figure 23. Nutcracker (cuboid) fracture; lateral and oblique views[32]

Navicular Fractures

Acute navicular fractures are rare fractures mostly in the form of dorsal avulsion, tuberosity, and body fractures. In addition to standard foot radiographs, weight-bearing radiographs should be taken to evaluate the Chopart joint. Computed tomography should be performed in the presence of negative plain radiographs but clinical suspicion[28].

All fractures due to high-energy trauma should be referred to an orthopedist.

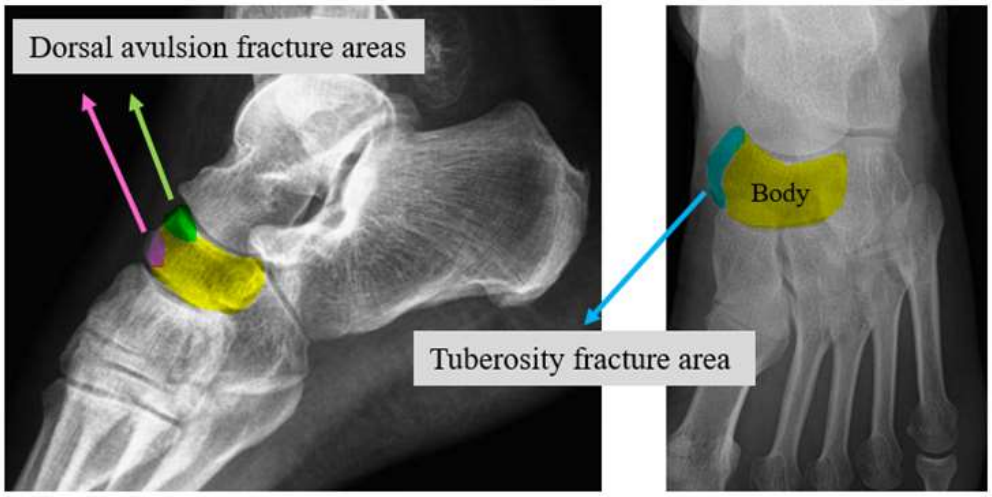

Figure 24. Navicular fractures areas

Lisfranc Injuries

Tarsometatarsal (TMT) joint (Chopart joint) and Lisfranc injuries characterized by sprains in the ligaments associated with the joint and/or bone fractures. Mild injuries that do not displace the tarsometatarsal joints are stable injuries. However, even they are painful and require a lengthy recovery period. Unstable injuries displace a part or all of the TMT joint and cause ligaments injuries and/or fractures in the proximal portion of the metatarsal. A reduced dorsalis pedis pulse indicates severe dislocation. Post-traumatic mid-foot swelling and pain are accepted as signs of a Lisfranc injury until proven otherwise.

Being stomped on the knee (e.g., football players) or skipping one step while descending the stairs and falling on the next step when the foot in plantar flexion, or falling from a horse with the foot stuck in the stirrup are common causes of Lisfranc injuries[33].

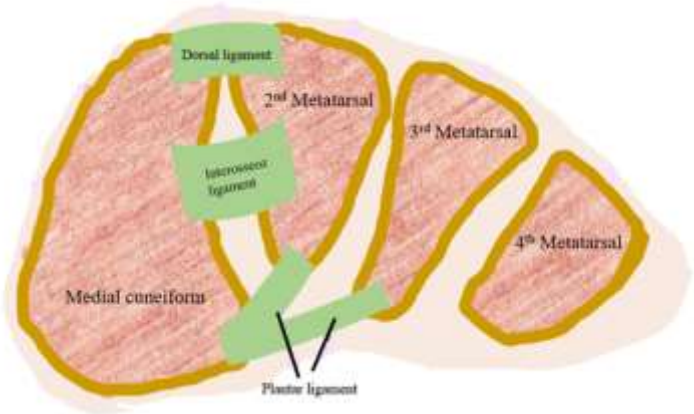

Figure 25. Lisfranc ligaments; coronal cross section view

Of the three ligaments, the dorsal ligament is the weakest and most frequently injured[34]. The interosseous ligament can bear twice the weight as the dorsal ligament[35].

The presence of plantar ecchymosis is pathognomonic for a TMT joint complex injury[36].

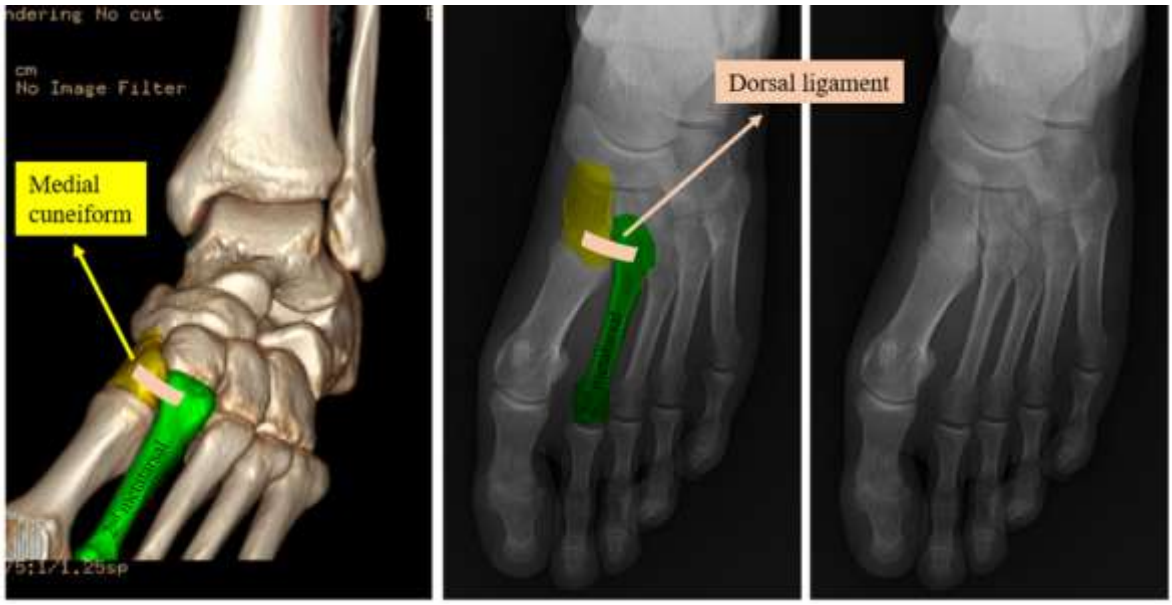

Figure 26. Dorsal ligament, between medial cuneiform and second metatarsal bone

Anterior-posterior, lateral, and oblique radiographs are taken. In an AP image, the medial border of the second metatarsal and the medial edge of the middle cuneiform should be linear. In an oblique image, the medial border of the fourth metatarsal and the medial edge of the cuboid should be linear. A displacement of > 1 mm is considered pathological[37].

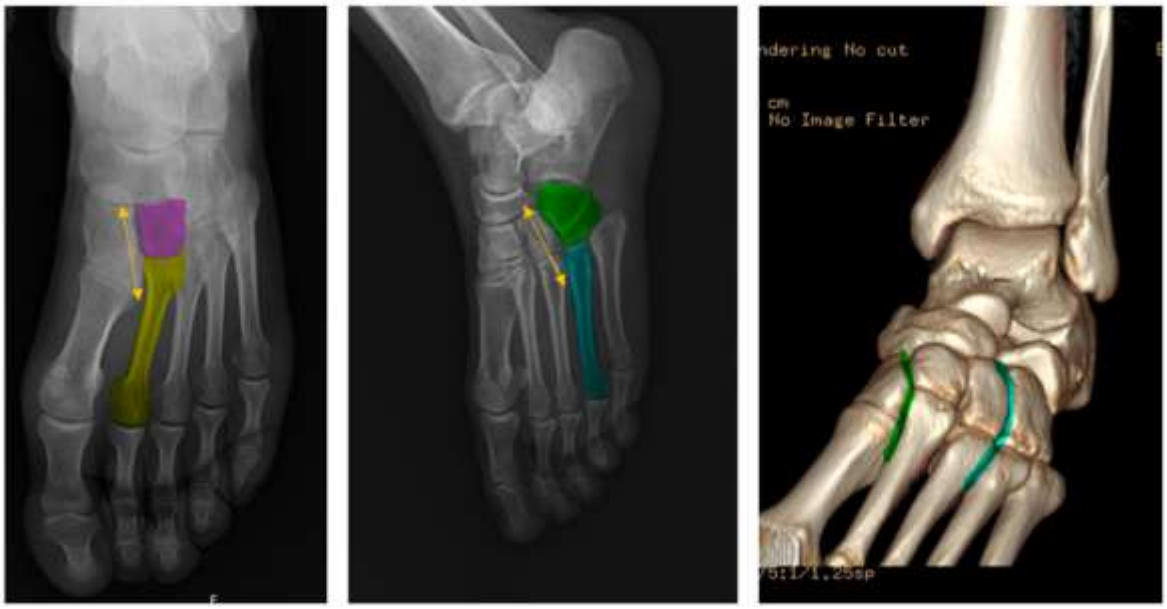

Figure 27. A normal (stable) anatomy of Lisfranc joint in AP and oblique views

An avulsion fracture may be present at the origin or insertion of the Lisfranc ligament in anterior-posterior and oblique images. A small bony fragment seen in the Lisfranc space is the fleck sign, which is also pathognomonic for an injury[38].

Figure 28. Fleck sign, pathognomonic for avulsion fracture; small bony fragment in the Lisfranc space

The acute treatment of the TMT joint complex after diagnosis is the standard RICE + drug therapy.

- A proximal fracture in any of the first four metatarsals
- 1 mm divergence between the first and second metatarsals in comparative evaluation and
- In the presence of the fleck sign, experienced specialists should evaluate all TMT joint injuries, including injuries believed to have only soft tissue damage. The patient can return to physical activity after 9-12 months.

Forefoot Trauma

Metatarsal Fractures

Metatarsal fractures are the most common foot fractures, except for finger fractures[39]. A shaft fracture in one metatarsal is displaced minimally by adjacent metatarsals and splints. Displacement is more in multiple shaft and proximal fractures. The proximal end is usually displaced planarly.

RICE is the acute treatment of choice. Laterally or medially displaced metatarsal fractures do not need to be reduced to achieve good treatment outcomes. Dorsally or planarly displaced (3-4 mm) or angulated (> 10°) fractures should be reduced and splinted[40].

Figure 29. Multiple shaft fractures that are displaced dorsally require open reduction

Open fractures are referred to surgeons in the presence of neurovascular damage[23]. Surgical consultation is also needed for:

- Multiple shaft fractures,
- Proximal tibia fractures,
- Intraarticular fractures,
- Unstable fractures of the first metatarsal, and
- Lisfranc injuries

Figure 30. Unstable trimalleolar fracture and first and second metatarsal displaced fractures

Proximal Fifth Metatarsal Fractures

The head and proximal of the fifth metatarsal articulate with the fourth metatarsal, while its tuberosity articulates with the cuboid. Variations in bone vascularization are critical in the pathophysiology of recovery. The tuberosity is vascularized by the branches of the nutrient artery and many metaphyseal vessels, while the proximal diaphysis is vascularized only by the nutrient artery. Vascular deterioration increases the risk of nonunion and osteonecrosis in proximal diaphysis fractures[41].

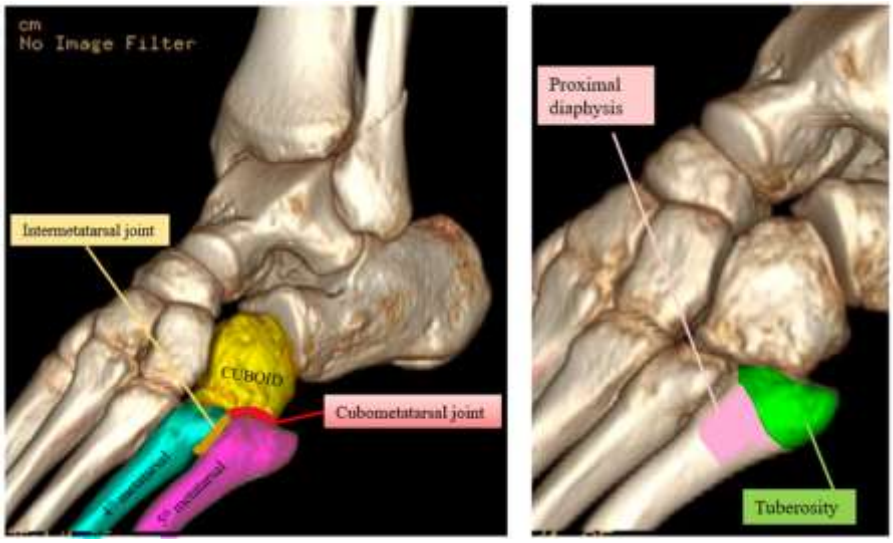

Figure 31. Jones(proximal diaphyseal) and pseudo-jones(tuberosity) fracture areas

- *Tuberosity fractures (pseudo-jones)* occur proximally to the intermetatarsal joint due to forced inversion of the foot and ankle in plantar flexion. If a tuberosity fracture is displaced more than 3 mm and covers the cuboid joint surface by 1-2 mm, it may require orthopedic intervention. RICE is the standard treatment of choice[42].
- *Proximal diaphyseal fractures (Jones)* extend towards the intermetatarsal joint and may even involve the joint. Lifting the heel off the ground and suddenly changing the direction of the foot in plantar flexion (e.g., football, basketball, tennis, etc.) is the common cause of proximal diaphyseal fractures. Displaced fractures generally require internal fixation. A fracture displaced more than 2 mm is referred to an orthopedist. RICE is the acute treatment of choice[42].

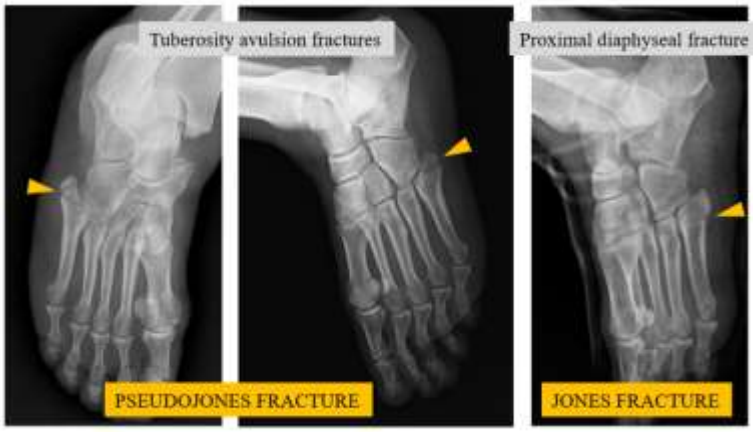

Figure 32. RICE is the acute treatment of choice in Jones and pseudo-jones fractures

Toe Fractures

Toe fractures are common fractures, mostly treated by emergency physicians. If ignored, they can cause severe pain and disability. They are caused by axial loading and deflection mechanisms. They have a good prognosis and are easy to treat[43].

The first toe has two phalanges, and the other four have three phalanges. Tendons and ligaments attach to the head of those phalanges. The tendons get between the ends of the fracture and make reduction difficult, even call for open reduction.

Neurovascular damage is unusual unless it is an open fracture and a severe burst injury.

Subungual hematoma is, most of the time, a sign of a phalanx fracture, which may cause severe pain and should be drained in the first 24 hours[40]. The specialist should pull the nail out if it has significant deformation and large subungual hematoma. However, if it is a minor injury, the specialist can suture it with absorbable sutures within eight hours following irrigation[44].

Figure 33. Traumatic metatarso-phalangeal dislocation without fracture

Transverse fractures tend to be stable, while segmented and spiral fractures are most likely unstable.

RICE is the standard treatment of choice. The specialist can buddy tape an injured toe (except the first toe) to an uninjured one to treat a stable fracture, and meanwhile, she should continue to reduce the injured toe.

Figure 34. Transverse fractures tend to be stable, segmented and spiral fractures are most likely unstable

Orthopedic consultation is required for[45]:

- Impaired circulation
- Fractures with dislocation
- Unstable fractures (reduction fails when stopped pulling)
- Large contaminated injuries
- Fractures where buddy taping does not work
- Open fractures of the proximal phalanges

Results

Foot and ankle injuries are a common cause for a visit to the emergency department. Determining the degree of injury, consulting an expert when necessary, and applying the right treatment to reduce morbidity. Early and true treatment in patients without comorbidity reduces the risk of complications. However, patients with diabetes and peripheral vascular diseases and smokers are at higher risk of developing complications, the most common of which are instability, osteoarthritis, and chronic pain. Treatment involves rest, cold compression, and elastic bandage and elevation to reduce edema. Analgesics are also an option. There are no significant differences in effectiveness among NSAIDs. In one animal study, administration of NSAIDs after fracture surgery reduced the biomechanical properties of healing bones compared to the control group[46]. Opiates should not be first-line treatment and should be titrated to each patient prior to hospitalization. The specialist should consider the possibility of neurovascular damage and compartment syndrome in the presence of increased pain, numbness, and tingling, and skin discoloration distal to the splint during or after treatment. Patients with diabetes should be followed up more frequently for skin damage, malunion, and infection because they are at a higher risk for post-fracture complications.

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