PROTOCOLS FOR INJURIES TO THE FOOT AND ANKLE

I. DIGITAL FRACTURES

A. Background

Digital fractures commonly occur in the workplace and are usually the result of a crush injury from a falling object, or from striking one's foot against an immobile object (stubbing one's toe).

There is a wide range of digital fractures, from simple non-displaced fractures requiring stiff soled shoe wear, to comminuted compound intra-articular fractures requiring emergent surgical debridement and stabilization.

Minimizing digital fracture occurrence should be the primary goal in the workplace, and the steel toe "safety shoes" has significantly reduced the incidence of these injuries.

B. Diagnostic Criteria

1. History and Physical Examination:

i. Typically, the patient presents with a painful, swollen toe. The patient often complains of difficulty with shoe wear and ambulation.

ii. Physical exam reveals swelling, erythema and ecchymosis at the injured digit, which can often extend into the forefoot. Palpating the injured digit reproduces the pain.

2. Diagnostic Imaging:

i. Plain Radiography: Standard antero-posterior (AP), oblique, and lateral radiographs of the entire foot should be obtained to not only include the toe, but the entire foot as injuries more proximal are common.

ii. Bone Scan: Not indicated.

iii. CT Scan: Not indicated.

iv. MRI: Not indicated.

C. Treatment based on Fracture Type

1. Lesser Digit Fractures — 2^{nd} -5^{th} toe fractures:

i. Extra-articular fractures

1. Non-displaced: Buddy splint with post op shoe or short CAM walker depending on patient comfort level for 2-4 weeks.

2. Displaced: Closed reduction under digital anesthetic block followed by buddy splint, post-op shoe, or short CAM walker boot for 4-6 weeks require evaluation by orthopedic surgeon or podiatrist in cases of severe displacement or painful non-union.

ii. Intra-articular fractures

1. Non-displaced: Buddy splint with post op shoe or short CAM walker depending on patient comfort level for 2-4 weeks.

2. Displaced: Closed reduction under digital anesthetic block followed by buddy splint, post-op shoe, or short CAM walker boot for 4-6 weeks. Require evaluation by orthopedic surgeon or podiatrist in cases of severe displacement or painful non-union that may require surgical intervention.

iii. Open Fractures

1.Tetanus prophylaxis should be administered as soon as possible, with appropriate antibiotics.

2. Simple wounds can be irrigated and closed in the Emergency Department.

3. More complex wounds and crush injuries should be evaluated by an available orthopedic Surgeon or Podiatrist and often require operative intervention.

iv. Return to Work

1. With all types, patient may return to modified duty when comfortable, with appropriate foot orthosis (buddy splint, post-op shoe, or CAM walker). This clinical decision is determined by their treating healthcare provider. Physical therapy can be used to expedite return to function when appropriate.

2. Great Toe Fractures:

i. Extra-articular fractures

1.Non-displaced proximal or distal phalanx fracture

a. Subungal hematoma should be decompressed if present via nail puncture or nail avulsion.

b. Post-op shoe or Short Cam walker for 2-4 weeks

1. Comminuted distal tuft fracture

a. Subungal hematoma should be decompressed if present via nail puncture or nail avulsion.

b. Post-op shoe or Short Cam walker for 2-4 weeks

ii. Intra-articular fractures

1. Distal phalanx dorsal avulsion fracture (Great toe mallet)

a. Displaced: Open reduction and internal fixation followed by immobilization with post-op shoe, short leg cast, or Short CAM walker for 4-6 weeks.

b. Non-displaced**:** Fracture shoe, or Short CAM walker for 4-6 weeks.

2. Intra-articular distal or proximal phalanx fractures

a. Non-displaced**:** Fracture shoe or Short CAM walker for 4-6 weeks.

b. Displaced**:** Attempt closed reduction, but often unsuccessful, under digital anesthetic block. If necessary open reduction and internal fixation (ORIF) followed by short leg cast immobilization or short CAM walker for 4-6 weeks.

iii. Open Fractures

1. Tetanus prophylaxis should be administered as soon as possible, with appropriate antibiotics.

2. Simple wounds can be irrigated and closed in the Emergency Department.

3. More complex wounds and crush injuries should be evaluated by an available Orthopedic Surgeon or Podiatrist and often require operative intervention.

iv. Return to Work

1. With non-operative fractures, patient may return to modified duty when comfortable, with appropriate foot orthosis (buddy splint, postop shoe, or CAM walker). This clinical decision is determined by their treating healthcare provider.

2. Operative injuries typically require two weeks of treatment at home followed by return to modified duty when comfortable, with appropriate foot orthosis (buddy splint, post-op shoe, or CAM walker).

3. Physical therapy can be used to expedite return to function when appropriate.

D. Summary

Digital fractures are common in the workplace and often result from blunt trauma caused by a falling object or stubbing of the toe. Injuries range from simple non-displaced fractures to open intraarticular injuries which require surgical treatment.

The nature of the worker's occupation will often dictate when return to function will occur. It is to be determined by the treating physician when return to work will either delay healing or put the worker at risk for re-injury.

Digital fractures usually do not preclude a worker returning to modified duty or sedentary desk work when soft tissue swelling and patient's comfort level allows.

II. METATARSAL FRACTURES AND DISLOCATIONS

A. Background

Metatarsal fractures are typically the result of blunt trauma or a crush injury to the foot from a falling object, a fall from height or misstep, or from a worker striking their foot against an immobile structure. Metatarsal stress fractures can occur from repetitive overuse of the foot (such as frequent pedal use, excessive walking, or jack-hammer use) and are of insidious onset.

Metatarsal fractures are typically separated into three areas, 1st metatarsal fractures, central metatarsal fractures (2-4 metatarsal), and 5th metatarsal fractures. They can be open or closed, intraarticular or extra-articular, and follow fracture classification patterns of long bones where fractures can occur at the base, midshaft, neck, or head of the metatarsal. Metatarsal dislocations can often occur in work related injuries and represent another subcategory of metatarsal injuries

Occurrence is common and not related to gender or age. Protective industrial work boots and varied terrain floor surfaces offer protection from these injuries.

B. Diagnostic Criteria

1. History and Physical Examination:

i. The patient typically presents acutely after an accident or fall with immediate pain and swelling at the fracture site, often with the inability to ambulate. The exception to this is with stress fractures where the onset is insidious, but the patient often points directly to the level of the stress fracture. Obtaining an accurate history is important, in particular the mechanism of injury.

ii. Physical examination reveals progressive edema in the forefoot with tenderness to palpation at the fracture site and surrounding radial tissue. Patients will often be highly guarded, particularly in comminuted, displaced, and intra-articular fractures. Careful neurovascular exam is critical, particularly in crush injuries where foot compartment syndromes can occur and are surgical emergencies. In cases where compartment syndrome is suspected, frequent neurovascular exams and elevation at or just above the level of the heart is important. The orthopedic surgeon should have a low threshold to perform foot fasciotomies if excessive swelling and pain out of proportion to the injury suggests a compartment syndrome. Open injuries are

not common, but the foot should be carefully examined in its entirety for open wounds, and these should be addressed in the operating room.

2. Diagnostic Imaging:

i. Plain Radiography: Three view x-rays (AP, Oblique, and lateral) should be obtained of the entire foot to evaluate for injury. Contralateral films are not necessary, but stress views and weight bearing views can often be helpful to evaluate for ligamentous injuries (Lisfranc Injuries). Repeat x-rays at 2-3 weeks after onset of pain can be helpful in identifying stress fractures

ii. Bone Scan: Not routine. Can be helpful in cases of suspected stress fractures but often require 7- 10 days after stress fracture occurrence to be positive.

iii. CT Scan: Not routine. Can be helpful and necessary when intra-articular extension exists and is used to aid operative decision making and planning. Also, important tool in diagnosing metatarsal base dislocations (Lisfranc injuries) which often require surgical management.

iv. MRI: Not routine. Can be helpful when history suggests a stress fracture, can detect a stress fracture within days of its occurrence. Can also be a helpful tool when patient fails to improve 4-6 weeks post conservative management. Useful tool in diagnosing Lisfranc injuries which are non-placed and give the orthopedic surgeon necessary information to plan definitive care.

C. Treatment Based on Fracture Type

1. 1st Metatarsal Fractures:

i. Non-Displaced: These can be treated in a non-weight bearing cast or CAM walker for 4-6 weeks, followed by progressive weight bearing for another 46 weeks. Close radiographic follow-up is required at 1-2 week intervals in fractures at risk of displacing.

ii. Displaced: Since the 1st metatarsal bears most of the weight during the gait cycle, reduction of the displaced 1st metatarsal is important to minimize the long-term complication of lesser metatarsal overload secondary to a , shortened or elevated 1st metatarsal head. ORIF is usually required to stabilize the fracture. The foot is typically immobilized in a short leg cast or CAM walker for 4-6 weeks, followed by another 4-6 weeks of progressive weight bearing and physical therapy.

iii. Intra-articular: Anatomic reduction of intra-articular fractures is essential to prevent long-term post-traumatic arthritis of the 1st metatarsal-phalangeal-joint, or 1st tarsal-metatarsal-joint. ORIF is usually required to stabilize the fracture. The foot is typically immobilized in a short leg cast or CAM walker for 4-6 weeks, followed by another 4-6 weeks of progressive weight bearing and physical therapy.

2. Central Metatarsal Fractures:

i. Non-Displaced: These can be treated in a non-weight bearing cast or CAM walker for 4-6 weeks, followed by progressive weight bearing for another 4-6 weeks. Close radiographic follow up is required at 1 to 2 week intervals in those fractures at risk for displacing.

ii. Displaced: When evaluating displaced central metatarsal fractures, it is important to evaluate the relationship of the metatarsal heads with respect to the 1st

metatarsal. Displaced fractures with a normal metatarsal head relationship with respect to the surrounding metatarsal heads can be treated non-operatively in a short leg cast or CAM walker for 4-6 weeks. These are relatively stable injuries as the distal intermetatarsal ligaments are usually intact. In displaced fractures where there is significant shortening of the metatarsal head, or where neurovascular or skin compromise is present, reduction is necessary. Those fractures that cannot be maintained by closed means are treated with ORIF. The foot is typically immobilized in a short leg cast or CAM walker for 4-6 weeks, followed by another 4-6 weeks of progressive weight beating and physical therapy.

iii. Intra-articular: Fortunately, these injuries are rare. When they occur they usually occur along with associated dislocations of the metatarsal bases and represent Lisfranc joint fracture dislocations. These are usually treated with ORIF. Postoperatively, the patient is immobilized for 4-6 weeks in a short leg splint or short leg cast, and then requires another 4-6 weeks of progressive weight bearing and physical therapy until full weight bearing with a regular shoe is possible.

3. 5^{th} Metatarsal Fractures:

i. Non-displaced: These can be treated in a post-operative shoe or CAM walker, for 4-6 weeks, and the patient is allowed to weight bear as tolerated.

ii. Displaced: Follow the guidelines for displaced central metatarsal fractures above. (C-2-ii)

iii. Jones Fractures: These represent fractures at the metaphyseal-diaphyseal junction and have the propensity to become non-unions. The blood supply in this area of the 5^{th} metatarsal is tenuous and represents a watershed area. As such, non-unions of Jones fractures can occur. There are some proponents that suggest immediate ORIF, which is often advocated in high performance athletes. In certain working populations, ORIF allows earlier return to work. Jones fractures, however, can be managed by closed means with a short leg non-weight bearing cast for 6 weeks followed by another 4-6 weeks of progressive weight bearing. If during serial radiographic follow up there are no visible signs of bony healing by about 6 weeks, AND the patient has persistent pain at the fracture site, then ORIF is recommended.

Postoperatively, the patient is immobilized for 4-6 weeks in a short leg splint or short leg cast, and then requires another 4-6 weeks of progressive weight bearing and physical therapy until full weight bearing with a regular shoe is possible

iv. Base of the 5^{th} Avulsion Fractures: These represent an avulsion fracture from the lateral tarsal metatarsal ligament pulling on the base of the 5^{th} metatarsal. Most often these are stable injuries and can be treated in a weight bearing short leg cast, CAM walker, or postoperative shoe for 4-6 weeks with return to modified duty once the patient's comfort allows. Significantly displaced and rotated fractures represent significant intraarticular injuries and should be reduced. If the reduction is not stable via closed means, then OR-IF should be performed. Postoperatively, the patient is immobilized for 4-6 weeks in a short leg splint or short leg cast, and then requires another 4-6 weeks of progressive

weight bearing and physical therapy until full weight bearing with a regular shoe is possible.

v. Stress Fractures: Stress fractures are typically non-displaced and treated with a CAM walker, short leg cast, or post op shoe for a period of 4-6 weeks, with return to modified duty once the patient is comfortable. Fractures that do not heal by 3 months often require surgical repair. As an adjunct to treatment, the treating healthcare provider may opt for the use of Bone Stimulators to expedite healing and return to function. Return to full activity is possible after fracture healing.

4. Metatarsal Dislocations (Lisfranc Joint Injuries):

i. Metatarsal dislocations often require surgical treatment, as closed management typically does not allow for anatomic reduction.

ii. Lisfranc dislocations represent dislocations at the bases of the metatarsals with respect to the tarsal bones. Missed Lisfranc injuries go on to develop often debilitating midfoot arthritis.

The standard of care is to treat them with ORIF. Postoperatively, the patient is immobilized for 4-6 weeks in a short leg splint or short leg cast, and then requires another 4-6 weeks of progressive weight bearing and physical therapy until full weight bearing with a regular shoe is possible.

5. Open Fractures and Crush injuries:

i. Crush injuries should be monitored in the hospital with frequent neuro-vascular checks to rule out compartment syndrome of the foot.

ii. When open fractures are identified, tetanus prophylaxis should be administered as soon as possible, with appropriate antibiotics

iii. Patient is taken emergently to the operating room by an orthopedic surgeon for surgical debridement, open reduction, and internal fixation.

iv. Severe crush injuries with concomitant compartment syndrome are treated with foot fasciotomies, and delayed closure, either primarily or with skin grafts.

v. Post-operatively, the foot is immobilized for approximately 4-6 weeks, and the patient is then started in a physical therapy program with progressive weight bearing for another 4-6 weeks

vi. Prognosis is poor long term as patient is often left with chronic pain that precludes his/her ability to return to significant labor-intensive jobs.

D. Summary

Metatarsal fractures represent a higher level of injury to the foot and ankle, and as such, proper identification, treatment, and rehabilitation is paramount to the successful outcome and expedient return to function of the injured worker. These injuries can occur as the result of direct blunt trauma, such as an object falling on a foot or a worker striking his/her foot against another object, via indirect means, such as twisting mechanism or misstep, or from repetitive microtrauma leading to a stress fracture.

Most often these injuries can be treated non-operatively, however when the mechanics of the foot are significantly affected because of displaced fractures, reduction is necessary, and this is usually via ORIF.

The nature of the worker's occupation will often dictate when return to function will occur. The treating physician determines when return to work will no longer interfere with healing or put the worker at risk for re-injury. This occurs typically 2-3 weeks after surgery, or 1-2 weeks with closed management of minimally displaced fractures.

III. PLANTAR FASCIITIS

A. Background

Plantar fasciitis is a very common problem causing pain at the base of the plantar heel often brought on by overuse, trauma or impact in the heel as in a fall, or poorly fitting shoes. The pathophysiology of plantar fasciitis reveals disorganized tissue at the origin of the bands of the plantar fascia at the base of the calcaneus or within its mid substance. This thickened tissue in turn puts a stretch on the surrounding nerves, and as such, can cause significant pain. Plantar fasciitis often causes severe pain that can limit the injured workers ability to stand and walk for prolonged periods of time.

B. Diagnostic Criteria

1. History and Physical Examination:

i. The patient typically presents with gradual onset of pain or after an accident or fall with immediate pain and swelling at the injury site, often with difficulty ambulating. Obtaining an accurate history is important, particularly the mechanism of injury to rule out other types of concomitant injuries.

ii. Physical examination often reveals tenderness to palpating at the base of the heel at the plantar fascia origin or in the mid substance of the plantar fascia. In cases of gradual onset or overuse, there will be no swelling and the skin is intact. In post-traumatic injuries swelling will be seen at the plantar aspect of the foot (sole). Acute calcaneal fractures and calcaneal stress fractures can often masquerade as plantar fasciitis, close attention must be paid by the health care provider to rule this out by compressing the heel. Heel pain with compression should prompt the clinician to further work up.

2. Diagnostic Imaging:

i. Plain Radiography: Three view x-rays (AP, Oblique, and lateral) should be obtained of the entire foot to evaluate for injury. Repeat x-rays 2-3 weeks after injury can be helpful in identifying stress fractures of the calcaneus if pain persists at follow up.

ii. Bone Scan: Not routine. Indicated to rule out stress fractures for persistent pain 3 weeks from injury.

iii. CT scan: Not routine.

iv. MRI: Not routine. Indicated for persistent pain beyond 2-3 weeks to rule out associated stress fractures of the calcaneus.

C. Treatment Based on Injury Type

1. Plantar Fasciitis and traumatic plantar fascia rupture:

i. Often treated with night splinting, strapping or taping and physical therapy. Custom orthotics are not indicated, but over the counter gel heel cups can afford some pain relief. Eight-five percent of cases will resolve within 6 weeks. Patients with pain that persists beyond 6 weeks often require corticosteroid injection. Time out of work is rarely indicated unless in instances of severe traumatic rupture.

ii. Surgical management of plantar fasciitis is rare but indicated in recalcitrant cases that persist beyond 6-9 months of active non-operative management. Return to full

duty is dictated by the job description but can often be upwards of 3-6 months. More recently stem cell injections hold promise in alleviating the pain from plantar fasciitis and allow for return to work and function within 6 weeks. A dramatic improvement from traditional surgical release.

D. Summary

Plantar fasciitis is most often the result of overuse, poor fitting shoes, and sometimes trauma. It is typically a self-limiting process that responds well to a short period of rest, bracing and physical therapy. Typically, minimal down time is associated with it and rarely is any long-term disability associated with it.

IV. MIDFOOT AND HINDFOOT INJURIES

A. Background

The midfoot is comprised of five tarsal bones (navicular, cuboid, medial cuneiform, middle cuneiform, and lateral cuneiform), and the hindfoot of comprised of two bones (calcaneus and talus). The intricate relationship of the tarsal bones with the hindfoot make up the apex of both the longitudinal and transverse arches of the foot, and their stability is important to the normal function of the foot.

Variations in normal anatomy of the foot can lead to a wide variety of foot shapes which range from the high arched cavo-varus foot shape, to the adult acquired or flexible flat foot. Having an underlying high arched or flat foot does not preclude a worker from performing the normal duties of most jobs as evidenced by the Royal Canadian Army study in the 1940's which showed no demonstrable functional difference between asymptomatic flat feet and normal feet of army recruits.

Injuries to the mid and hind foot typically represent a higher level of injury often a result from a fall from height or a crush injury. Emergent evaluation of the foot in an emergency room by experienced 01thopedic surgeons is often necessary to evaluate for serious soft tissue injuries, compartment syndromes, and fractures which often need surgical stabilization.

B. Diagnostic Criteria

1. History and Physical Examination:

i. The patient typically presents acutely after an accident or fall with immediate pain and swelling at the injury site, often with the inability to ambulate. Obtaining an accurate history is important, particularly the mechanism of injury. Sprains of the midfoot present much more innocuously, and the worker is usually able to ambulate but complains of a pain and a limp.

ii. Physical examination reveals progressive edema in the mid and hindfoot with tenderness to palpation at the fracture site and surrounding radial tissue.

Patients will often be highly guarded, particularly in comminuted, displaced, and intra-articular fractures. Careful neurovascular exam is critical, particularly in crush injuries where foot compartment syndromes can occur and are surgical emergencies. In cases where compartment syndrome is suspected frequent neurovascular exams and elevation at or just above the level of the heart is important. The orthopedic surgeon should have a low threshold to perform foot fasciotomies if excessive swelling and pain out of proportion to the injury suggests compartment syndrome. Open injuries are not common, but the foot should be carefully examined in its entirety for open wounds, and these should be addressed in the operating room.

2. Diagnostic Imaging:

i. Plain Radiography: Three view x-rays (AP, Oblique, and lateral) should be obtained of the entire foot to evaluate for injury. Contralateral films are not necessary, but stress views and weight bearing views can often be helpful to evaluate for ligamentous injuries (Lisfranc Injuries). Repeat x-rays 2-3 weeks after injury can be helpful in identifying stress fractures or unstable midfoot ligamentous injuries.

ii. Bone Scan: Not routine. Can be helpful in cases of suspected stress fractures, but often require 7-10 days after stress fracture occurrence to be positive.

iii. CT scan: Not routine. Can be helpful and necessary when intra-articular extension exists and is used to aid operative decision making and planning. Also, important tool in diagnosing tarsal-metatarsal injuries (Lisfranc injuries) as well as talus and Calcaneus fractures. Useful tool also to delineate osteochondral injuries of the talus.

iv. MRI: Not routine. Can be helpful when history suggests a stress fracture and can detect a stress fracture within days of their occurrence. Can also be helpful tools when patient fails to improve post 4-6 weeks of conservative management and can pick up avulsion fractures that are easily missed with plain radiography. Useful tool to delineate osteochondral injuries of the talus.

C. Treatment Based on Injury Type

1. Midfoot Sprains:

i. Midfoot sprains represent a continuum of injury to the midfoot and can often be debilitating injuries. If the plain weight bearing x-rays are initially normal, treatment begins with activity modification in a stiff sneaker, post-op shoe or CAM walker for 1-2 weeks while the swelling and pain resolves, with gradual return to activity. Referral to orthopedic surgeon is indicated when patients fail to improve after 2-3 weeks. This often suggests a more significant injury and repeat weight bearing x-rays should be obtained to evaluate for unstable midfoot injuries and/or fractures not recognized at initial work up; MRI and CT scan may be indicated at this point if the history, physical exam, and plain films warrant. Physical therapy is often initialized to maximize functional recovery.

2. Tarsal Fractures (Not talus, calcaneus, or navicular):

i. Non-displaced: treatment often consists of short leg cast or CAM walker for 4-6 weeks with a progressive weight bearing program with physical therapy.

ii. Displaced: treatment often consists ORIF, short leg cast or CAM walker for 4-6 weeks, followed by progressive weight bearing with physical therapy for another 4-6 weeks. Return to normal function can occur as early as 3-4 months, but in significant injuries can be upwards of 12 months for full recovery.

3. Talus, Calcaneus, and Navicular Fractures:

i. Non-displaced: treatment often consists of short leg cast or CAM walker for 4-6 weeks with a progressive weight bearing program with physical therapy.

ii. Displaced: treatment often consists of ORIF, short leg cast or CAM walker for 4-6 weeks, followed by a non-weight bearing physical therapy program for another 4-6 weeks. Return to normal function can occur as early as 3-4 months, but in significant injuries can be upwards of 12-24 months for full recovery.

4. Open Fractures and Crush injuries:

i. Crush injuries should be monitored in the hospital with frequent neurovascular checks to rule out compartment syndrome of the foot.

ii. When open fractures are identified, tetanus prophylaxis should be administered as soon as possible, with appropriate antibiotics

iii. Patient is taken emergently to the operating room by an orthopedic surgeon for surgical debridement, open or closed reduction, and internal or external fixation.

iv. Severe crush injuries with concomitant compartment syndrome are treated with foot fasciotomies, and delayed closure, either directly or with skin grafts.

v. Post-operatively, the foot is immobilized for approximately 4-6 weeks, and the patient is then started in a physical therapy program with progressive weight bearing for another 4-6 weeks.

D. Summary

Mid and Hind foot injuries are typically the result of higher energy mechanisms, and fortunately do not occur frequently. Prompt involvement by orthopedic surgeons is essential to both maximize functional outcome of patients, as well as expedite return to work.

Sprains of the midfoot often resolve within 2-3 weeks and symptoms persisting beyond this should prompt referral to orthopedic surgeon for further work up, Physical therapy early on can maximize return to function and expedite return to work.

Severe injuries to the mid and hindfoot can be significantly debilitating and often are the result of falls from heights or crush injuries. Open reduction and internal fixation of indicated fractures can maximize overall long-term function. Despite prompt evaluation, treatment, and fixation the long-term functional outcome of these injuries is typically poor and is usually related to the development of significant post-traumatic arthritis.

V. ANKLE INJURIES

A. Background

Ankle injuries are amongst one of the most common injuries sustained at work. They represent approximately 30% of all complaints of patients reporting to the emergency department. More common reasons to sustain an ankle injury include poor shoe wear choice, uneven or irregular surfaces, missteps, and falls from heights.

There is a wide spectrum of injuries comprising ankle injuries. They range from the common grade 1 ankle sprain which typically resolves within 1-3 days, to the severe open ankle fracture dislocation which can take upwards of 1-2 years to obtain maximal medical improvement.

Preventing ankle injuries is the primary goal in protecting workers. Appropriate shoe wear, textured surfaces to prevent slippage, and awareness of surroundings when operating machinery and when working at heights are important measures which workers should be aware of to minimize the risk of ankle injuries.

B. Diagnostic Criteria

1. History and Physical Examination:

i. The patient typically presents acutely after an accident or fall with immediate pain and swelling at the injury site, often with the inability to ambulate. Obtaining an accurate history is important, particularly the mechanism of injury. Ankle sprains typically occur after an inversion of the foot ("rolling in," "rolled over"). The patient complains of pain and inability to ambulate.

ii. Physical examination reveals progressive edema at the level of the ankle with tenderness to palpation usually over the lateral side of the ankle (area of anterior talo-fibular ligament rupture and fibular fractures). Patients often will be highly guarded, particularly in comminuted, displaced, and intra-articular fractures. Careful neurovascular exam is critical, particularly in crush injuries where leg and foot compartment syndromes can occur and are surgical emergencies. In cases where compartment syndrome is suspected frequent neurovascular exams and elevation at or just above the level of the heart is important. The orthopedic surgeon should have a low threshold to perform foot and leg fasciotomies if excessive swelling and pain out of proportion to the injury suggests a compartment syndrome. Open injuries are not common, but the foot and ankle should be carefully examined in its entirety for open wounds, and these should be addressed emergently in the operating room.

2. Diagnostic Imaging:

i. Plain Radiography: Three view x-rays (AP, Mortise, and lateral) should be obtained of the ankle to evaluate for injury. Contralateral films are not necessary, but stress views and weight bearing views can often be helpful to evaluate for gross ligamentous instability. Repeat x-rays 2-3 weeks after injury can be helpful in identifying stress fractures or unstable ligamentous injuries in those patients who fail to improve after a period of activity modification.

ii. Bone Scan: Not routine. Can be helpful in cases of suspected stress fractures, but often require 7-10 days after stress fracture occurrence to be positive.

iii. CT Scan: Not routine. Can be helpful and necessary when intra-articular fracture extension exists or if an osteochondral defect or intra-articular loose body is suspected.

iv. MRI: Not routine. Can be helpful when history suggests a stress fracture and can detect a stress fracture within days of its occurrence. Can also be a helpful tool when patient fails to improve post 4-6 weeks of physical therapy and can pick up a multitude of foot and ankle injuries masquerading as an ankle sprain (See "Persistent Pain After an Ankle Sprain" below).

If a neurologic disorder such as tarsal tunnel syndrome or peripheral neuropathy is suspected as a cause of chronic ankle pain, EMG/NCV testing may be appropriate.

C. Treatment Based on Injury Type

1. Anatomy:

i. Stability of the ankle is made possible by both bony congruence (the fit of the talus within the distal tibia and fibula) as well as by the integrity of the ligaments, muscles and tendons which surround the ankle. The ligaments and bones represent the static stabilizers (as they are fixed) and the muscles and tendons represent the dynamic stabilizers (as they move). The lateral side of the ankle is stabilized by the lateral collateral ligament (LCL) complex, the fibula and syndesmosis, and the peroneal tendons. The LCL complex consists of the anterior talo-fibular ligament,

the calcaneo-fibular ligament, and the posterior talo-fibular ligament. The medial side of the ankle is stabilized by the deltoid ligament, the medial malleolus, the posterior tibial tendon, flexor digitorum longus tendon, and the flexor hallucis longus tendon. The deltoid ligament consists of superficial and deep layers which work in concert to stabilize the medial side of the ankle.

2. Ankle Sprains:

i. The most common ligament injured in the typical inversion ankle sprain is the anterior talo-fibular ligament, followed by the calcaneo-fibular ligament, the posterior talo-fibular ligament, and finally the deltoid ligament. Ankle sprains are graded 1-3. Acute surgical repair is **NOT** indicated, even with MRI confirmed complete ligament rupture, as upwards of 75% of these patients recover without any functional limitation. Patients with clinical ankle instability after months of rehabilitation **MAY** warrant surgical reconstruction.

1. **Grade 1 Sprain:** Micro-tearing of the collateral ligaments about the ankle, without any appreciable ankle joint laxity on exam. Treated with RICE protocol (Rest, Ice, Compressive Dressing (splint), Elevation). Typically resolves within 1-2 weeks.
2. **Grade 2 Sprain:** Complete tearing of some of the collateral ligaments of the ankle, with some laxity noted on physical exam. Treated with RICE protocol, immobilization with an ankle brace or CAM walker boot, and early mobilization with Physical Therapy. Typically resolves in 2-4 weeks.
3. **Grade 3 Sprain:** Complete rupture of the collateral ligaments of the ankle (usually medial or lateral side), with gross instability on examination. Acute surgical repair is NOT indicated. Treatment requires immobilization in a short leg cast or CAM walker boot for 2-3 weeks, followed by 3-6 weeks of Physical Therapy. Grade 3 sprains can potentially go on to gross instability that requires long-term bracing, rehabilitation, or surgical reconstruction.
4. **Chronic Ankle instability:** Ankles which are chronically unstable after 2-3 months of rehabilitation and bracing warrant further workup with stress x-rays and/or MRI to evaluate for intra-articular osteochondral defects. Based on functional complaints, physical exam, and diagnostic tests, reconstructive surgery may be required for functional recovery. Post-operatively, patients are typically immobilized with a cast or CAM walker for 4-6 weeks, followed by a functional rehabilitation and proprioceptive training program for another 4-6 weeks.

3. Ankle Dislocations:

i. Ankle dislocations are the result of a higher mechanism of injury and represent complete rupture of the lateral and medial collateral ligaments. They are usually associated with a fracture, but not always. Treatment is emergent closed reduction under conscious sedation or anesthetic ankle block. The patient is typically immobilized in a short leg cast or splint for 2-3 weeks followed by progressive weight bearing in a CAM walker or weight bearing short leg cast over 4-6 weeks. Patient is then initiated in a functional rehabilitation and proprioceptive training program for approximately 4-6 weeks, and then allowed to return to full function.

Surgery is rarely indicated, unless chronic instability develops after several months of rehabilitation.

4. Ankle Fractures:

i. Stable fractures: fractures involving the tips of the medial or lateral malleolus, and do not involve the ankle mortise represent stable ankle fractures. These injuries typically represent an indirect avulsion fracture from the collateral ligament origins on the medial and/or lateral malleolus. Oblique fractures involving the lateral malleolus (typical supination-external rotation pattern of injury), without any widening of the medial ankle clear space (space must be less than 4mm), are also considered stable. Rarely, minimally displaced fractures of the posterior malleolus can occur, and typically represent extraarticular injuries and have no evidence of displacement of the tibio-talar joint on AP, lateral or mortise x-rays. Stable ankle fractures are treated with an air splint, ankle brace, CAM walker, or short leg cast for a period of 2-4 weeks, followed by rehabilitation program for another 4-6 weeks. Surgical treatment is rarely indicated, unless the fracture goes on to a painful non-union, in which case surgery is indicated.

ii. Unstable fractures: these fractures indicate the loss of bony stability to the ankle joint and represent intra-articular fractures. Displacement of the medial clear space (space between the medial malleolus and the medial side of the talus) greater than 4 mm indicates an unstable ankle fracture. Initial treatment begins in the emergency department with a closed reduction under conscious sedation or ankle block followed by splinting or short leg casting. Depending on the condition of the soft tissues, surgery can be delayed as long as 2-3 weeks to minimize the risk of wound healing problems. Fractures involving the weight bearing portion of the distal tibia (pilon fractures) represent high energy injuries of the ankle, and usually require 1-3 weeks for soft tissue swelling to resolve prior to surgery. Pilon fractures are typically treated in an external fixator initially, as splint and casts are inadequate, and surgical ORIF is delayed. Post-operative course for most ankle fractures requires immobilization for 24 weeks in a splint or short leg cast, followed by 4-8 weeks of progressive weight bearing in a CAM walker, short leg cast, or ankle brace with physical therapy. Pilon fractures are typically immobilized longer, and kept non-weight bearing for 3 months prior to the initialization of weight bearing. Maximal medical improvement after surgical repair of an unstable ankle fracture typically occurs 6-9 months after surgery but can be upwards of 1-2 years in more severe injuries.

5. Open Fractures and Crush injuries:

i. Crush injuries should be monitored in the hospital with frequent neurovascular checks to rule out compartment syndrome of the foot and leg.

ii. When open fractures are identified, tetanus prophylaxis should be administered as soon as possible, with appropriate antibiotics.

iii. Patient is taken emergently to the operating room by an orthopedic surgeon for surgical debridement, open or closed reduction, and internal or external fixation.

iv. Severe crush injuries with concomitant compartment syndrome are treated with leg fasciotomies, and delayed closure. Often the application of vacuum assisted

closure devices (VAC dressings) and implanted antibiotic cement beads are utilized to minimize wound infections. In severe injuries, involvement with a plastic surgeon and/or vascular surgeon is necessary to reestablish neurovascular supply to the foot, as well as closure of the soft tissue envelope.

v. Post-operatively, the foot is immobilized for approximately 6-8 weeks. Physical therapy is delayed until the soft tissue envelope of the ankle is restored and the patient's neurovascular status has stabilized. This can take several months, and typically takes 1-2 years for patient to be at maximal medical improvement.

6. Persistent Pain after an Ankle Sprain:

i. Persistent pain 2-3 months after an ankle sprain is **NOT** typical so when it exists usually indicates a concomitant ankle disability. Careful history and physical examination usually direct the physician to the reason for persistent pain. If this is not easily apparent further workup with an MRI and/or stress ankle radiographs is indicated to evaluate the ankle further. The differential diagnosis is long and includes:

1. Anterolateral impingement syndrome
2. Anteromedial impingement syndrome
3. Anterior joint line impingement
4. Osteochondral defects of the tibial plafond
5. Osteochondral defects of the talus
6. Loose bodies within the ankle
7. Peroneal tendonitis
8. Peroneal tendon tear
9. Peroneal tendon dislocation
10. Symptomatic os sub-fibulare
11. Nonunion medial malleolar avulsion fracture
12. Nonunion lateral malleolar avulsion fracture
13. Anterior process fracture of the calcaneus
14. Lateral process fracture of the talus
15. Chronic ankle instability
16. Sinus tarsi syndrome
17. Posterior tibial tendonitis
18. Posterior tibial tendon tear
19. Posterior process of the talus fracture
20. Symptomatic os trigonum of the talus
21. Posterior ankle impingement syndrome
22. Flexor hallucis longus tendonitis
23. Avascular necrosis of the talus
24. Tarsal tunnel syndrome
25. Peripheral neuropathy

ii. Treatment: treatment is dictated by the pathology, but usually begins with a period of rest, immobilization, physical therapy guided specifically towards the

pathology, and possibly diagnostic and therapeutic injections of cortisone with a local anesthetic. Failure to improve after non-surgical treatment for about 4-6 weeks warrants surgical treatment. Recovery is dictated by the surgical intervention, but the patient is typically at maximal medical improvement by 6-12 months after surgical reconstruction.

D. Summary

Ankle injuries are amongst the most commonly sustained injuries in the workplace. Approximately 25,000 ankle injuries occur every day in the United States. There is a wide range of ankle injuries but fortunately most only require a short period of treatment before return to full functional.

Acute surgical repair of ankle sprains or dislocations is not indicated, and only rarely after completing a functional rehabilitation and proprioceptive training program is surgery warranted.

Physical therapy is a useful adjunct in treating patients with ankle injuries as often their proprioception and static ankle stabilizers are disrupted. Physical therapy focusing on functional rehabilitation and proprioceptive training can expedite return to function and minimize the development of chronic ankle instability.

As with all foot and ankle injuries, prevention is the key to worker safety. Efforts should be made by employers to provide employees with education regarding proper shoe wear and fall prevention, as well as providing a work environment free of hazards which could cause serious injury.

PROTOCOL HISTORY
Passed: 12/15/1992
Amended: 5/5/2009
Amended: 1/12/2021