Chapter 11
The Foot

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Functional Anatomy

Anatomy

Anatomically, the foot can be divided into forefoot, midfoot, and hindfoot (Fig. 11.1). The forefoot is distal to the tarsometatarsal joints, the midfoot is distal to the transverse tarsal joint excluding the forefoot, and the hindfoot is the talus and calcaneus. There are static and dynamic components that maintain the foot shape in both the longitudinal and transverse planes. Static stabilizers include the plantar fascia, joint capsules, and interosseous ligaments. The posterior tibial tendon is a dynamic stabilizer of the longitudinal arch and it serves to invert the hindfoot to make it a more rigid structure for toe off during gait.

Red Flags

1. *Inflammatory Arthritis*. About 90 % of people with rheumatoid arthritis eventually develop symptoms related to the foot or ankle. Symptoms may occur in any segment of the foot. Other inflammatory types of arthritis that affect the foot and ankle include gout, ankylosing spondylitis, psoriatic arthritis, and Reiter's syndrome.

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Fig. 11.1 Foot – plantar aspect

Symptoms can be vague with these problems and include warmth, swelling, and pain in the joints. Rheumatoid arthritis has a hallmark symptom of stiffness in the morning that usually improves after a few hours.

2. *Neuropathy*. Most common cause is diabetic related but many etiologies have been described. An insensate foot can be prone to neurotrophic ulcers, foreign bodies, infections, etc. Charcot neuroarthropathy is a potentially severe destruction of the bony anatomy. In the acute phase, it presents similar to infection with erythema, swelling, warmth, and pain. As opposed to infection, the erythema

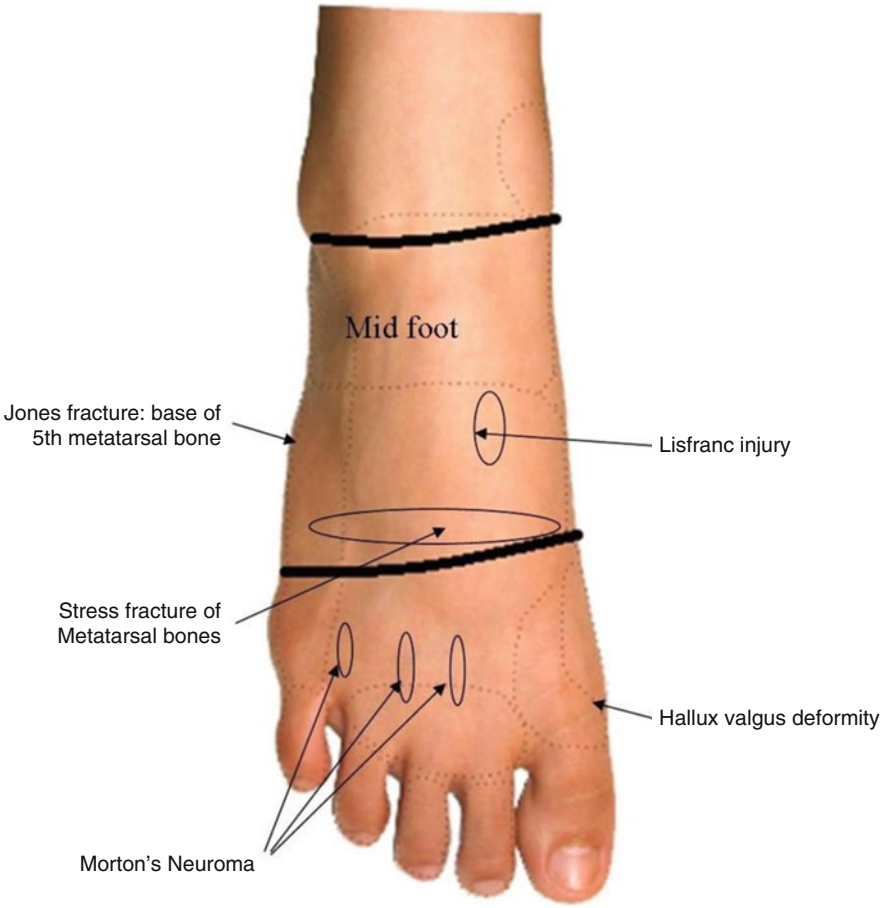

Fig. 11.2 Foot – dorsal aspect

associated with Charcot arthropathy will typically resolve with elevation. Suspicion of Charcot arthropathy should trigger specialist referral.

3. *Trauma*. Pain in the midfoot after trauma can indicate a Lisfranc injury. This is a serious problem that occurs at the midfoot tarsometatarsal joint (Fig. 11.2). A sprain of this joint occurs as a result of a low energy type of injury like rolling over of the foot or dropping objects on the foot. A fracture dislocation of this joint occurs as a result of a high energy type of injury like a car accident or fall from a high position. Symptoms can include pain over the Lisfranc joint complex (Fig 11.1), bruising over the bottom of the foot (plantar ecchymosis sign), inability to bear weight, and pain with stress exam. Weight-bearing AP X-ray of bilateral feet might show instability of the midfoot and will allow detection of subtle asymmetry. This is a commonly missed injury, but when identified, it needs orthopedic referral.

Talus and calcaneal fractures are serious injuries that require orthopedic referral. Talus fractures are higher-energy injuries, whereas calcaneal fractures usually occur after fall from height.

Exam

Evaluation of the foot should always involve examination of the ankle joint as described in the previous chapter. Foot examination can be divided into forefoot, midfoot, and hindfoot exams. Observe the foot in weight-bearing position, walking, and on heel rise. Inspect and palpate for hindfoot and forefoot alignment, arch height, deformities of the toes or foot, callus formation, tenderness, and changes in neurological examination both sensory and motor. If any deformity is observed, it is useful to see if it is passively correctable with the patient in a seated position. Inspection of the shoe inside and out along with the sole for abnormal wear can also be helpful.

Forefoot

Metatarsalgia (Forefoot Pain)

Claw toes and hammer toes are the common causes of metatarsalgia due to subluxation of the MCP joints of the toes, and the metatarsal heads become prominent on the sole causing the callosities and tender spots. Treating the causes will help treat metatarsalgia. Patients with a cavus (high-arched) foot commonly have metatarsalgia because of increased pressure over the metatarsal-phalangeal joint (MPJ). Equinus contracture also contributes to forefoot overload. Metatarsalgia is common in elderly patients due to loss of the plantar fat pad with aging. Offloading with orthotics or metatarsal pads should be the first-line treatment.

Hammer Toe and Claw Toe

Typically these develop due to flexor/extensor imbalance. This imbalance leads to flexion at the proximal interphalangeal joint and extension at the metatarsal phalangeal joint, creating the clawing effect. It usually affects the lesser 4 toes. These deformities may be flexible or fixed. Conservative treatment while the deformity is still correctable passively can be effective. Treatment options include wearing shoes with wide toe box, padding the dorsal aspect of the toes involved, taping, and over-the-counter orthotics. Resistant and rigid deformities of claw or hammer toes which are symptomatic may need surgical correction.

Hallux Valgus (Bunion) Deformity

Valgus deformities of the first metatarsal phalangeal joint with prominent bump (medial eminence) on the medial forefoot. Hallux valgus may have a genetic predisposition, so they "usually run in the family." Women are affected more than men; this can often be related to shoewear choices. The degree of the deformity does not always correlate well with the severity of the symptoms. It is important to obtain full weight-bearing X-rays in order to adequately assess the alignment in the hallux valgus deformity. This will help in determining the treatment options. Most bunions are treatable without surgery. Properly fitting comfortable shoes with a wide nonconstrictive toe box is important in all cases. Medial bunion pads may also be helpful in decreasing the symptoms associated with the bunion, and a toe spacer placed between the great toe and the second toe can help reduce the bunion deformity. Surgery is indicated when pain and discomfort are not getting better with conservative management and not for cosmetic reasons. Always treat according to the severity of patient's symptoms.

A deformity similar to a bunion on the lateral forefoot is called a bunionette (tailor's bunion). This can lead to a hard corn and occasionally painful bursitis. This is largely caused by poorly fitting tight shoes. Bunionette deformities can be treated conservatively with a change in shoes to those with a large toe box. This allows plenty of toe space decreasing constriction and relieving symptoms. In the rare case of persistent pain, surgical correction may be necessary.

Morton's Neuroma

Morton's neuroma is a thickening of the tissue that surrounds the digital nerve leading to the toes. Morton's neuroma most frequently develops between the third and fourth toes, usually in response to irritation, trauma, or excessive pressure between the metatarsal heads. The incidence of Morton's neuroma is eight to 10 times greater in women than in men. The common symptoms include the feeling of "walking on a marble" or burning pain in the ball of the foot that may radiate into the toes. The patient can also experience tingling or numbness in the toes. High-heeled and tight narrow shoes aggravate this condition. Treatment can include offloading, NSAIDs, and occasional steroid injections. Neuroma resistant to conservative treatment may be surgically excised.

Stress Fracture

A stress fracture develops due to repeated stress reaction applied to the weight-bearing bones of the feet, generally the metatarsals and calcaneus. These fractures are often a result of overuse and can be seen in those with a sudden increase in

activity like long-distance runners or in jumping sports. The pain develops gradually, becoming more intense with physical activity. Pain can be relieved by rest but as the conditions worsens will persist during rest, and a person may complain of night pain. An individual will likely have tenderness localized to a specific area and may have swelling. The patient will rarely have bruising or discoloration in the area. These most commonly are treated conservatively. Modifying activity and boot immobilization to decrease stress on the area over a period of 6–8 weeks will generally lead to uneventful healing.

Stress fracture of the navicular bone is a more complicated injury. Symptoms primarily will be vague activity-related pain over the dorsal midfoot. When suspected the patient should be promptly given crutches and be non-weight bearing until a workup (MRI, radiographs) or orthopedic referral is completed.

Midfoot

Midfoot Arthritis

Common cause of midfoot pain in adult patients. Causes can include previous trauma, inflammatory arthritis, and osteoarthritis. On exam one may see swelling and tenderness to palpation of the dorsal midfoot. Radiographs will show joint space loss and occasionally collapse of the longitudinal arch. Conservative treatment can include rigid orthoses or shoes, NSAIDs, and selective image-guided injections. Arthrodesis (fusion) of the involved joints is the surgical option.

Tarsal Coalition

Tarsal coalition represents abnormal fusion between two or more tarsal bones of the foot. The two most common sites of tarsal coalition are talocalcaneal or calcaneonavicular joints; bridging can be either fibrous, cartilaginous, or osseous and commonly becomes symptomatic in the 2nd decade of life, corresponding to approaching skeletal maturity. Tarsal coalitions can be completely asymptomatic, but when symptoms do occur, they may include pain in the midfoot or hindfoot and loss of subtalar joint motion. Clinical examination may show a rigid flatfoot and pain in the sinus tarsi or hindfoot. Recurrent ankle sprains can occur due to lack of motion in the tarsal joints. Foot X-rays and/or CT scan are needed to make the diagnosis. Conservative treatment can include rest, immobilization, and NSAIDs. Surgical referral is indicated for those who fail conservative treatment.

Hindfoot

Adult-Acquired Flatfoot Deformity

Adult-acquired flatfoot deformity (AAFD) is a progressive flattening of the arch of the foot that occurs as the posterior tibialis tendon becomes insufficient. When the posterior tibialis tendon does not work properly, a number of changes can occur to the foot and ankle. Symptoms often start with pain and tenderness along the posterior tibialis tendon behind the medial malleolus. As the tendon progressively fails, deformity of the foot and ankle occurs. This may include progressive flattening of the arch, shifting of the heel laterally into valgus, rotation and deformity of the forefoot, and/or tightening of the Achilles tendon. At certain stages of this disorder, pain may shift from medial to lateral as subtalar or subfibular impingement occurs. In late stages it might lead to development of arthritis and deformity of the ankle joint.

Posterior tibialis tendon dysfunction may occur in patients who already have a flatfoot for other reasons. As the arch flattens with weight-bearing activities, more stress is placed on the posterior tibialis tendon, which results in progressive disorder. The peroneus muscle and tendons on the lateral aspect of the ankle act to counterbalance the action of the posterior tibialis tendon. When the posterior tibialis tendon fails, the counteracting muscles and tendons become a relatively unopposed deforming force. Table 11.1 describes the diagnosis and management of this condition.

Table 11.1 Adult-acquired flatfoot deformity

Signs and symptoms	Pain and swelling on the inside of the ankle Loss of the arch and the development of a flatfoot Gradually developing pain on the outer side of the ankle or foot Tenderness over the midfoot, especially when under stress during activity On asking patient to do a single limb heel rise, they may be unable or normal heel inversion does not occur
Risk factors	Obesity, diabetes, hypertension, previous surgery or trauma such as an ankle fracture, local steroid injections and rarely Inflammatory diseases such as Reiter's syndrome, rheumatoid arthritis, spondylosing arthropathy, and psoriasis
Conservative management	NSAIDs, rest and immobilization in case or CAM boot during acute painful period followed by orthotics (arch support), braces (lace up or hinged), and physical therapy
Surgical management	Considered only after completely exploring all aspects of conservative management Tenosynovectomy: debridement of inflamed tissue surrounding the tendon Osteotomy: calcaneal osteotomy to improve alignment of the heel Tendon transfer: the flexor digitorum longus is used to replace the function of the damaged posterior tibialis tendon Arthrodesis: fusion of the tarsal joints at late stage of the disease with severe arthritis

Pes Cavus

Pes cavus (high-arched foot) can be seen during the evaluation of other ankle or foot conditions. Typically there is marked elevation of the longitudinal arch, and the hindfoot will be in a varus position when viewed from behind. This position leads to stress on the lateral foot and hindfoot. It can be associated with ankle instability, peroneal tendinopathy, chronic lateral foot pain, and stress fractures (especially 5th metatarsal). Orthotics crafted with lateral hindfoot and midfoot posting can help with management. Surgical reconstruction is not uncommon in those that fail conservative management. Most cases are idiopathic, but pes cavus is a hallmark of Charcot-Marie-Tooth disease. Classic "champagne flute" appearance of the lower leg due to muscle wasting, neurological abnormality, or family history may indicate need for neurology referral for definitive diagnosis.

Plantar Fasciitis

The plantar fascia is a tough layer of connective tissue that supports the arch of the foot; it originates at the plantar calcaneus and extends to the base of the toes. Plantar fasciitis is caused by overloading of the fascia due to prolonged standing, walking, and occasionally a tight heel cord or calf muscle. These stressors cause overloading repetitive "microtraumas" to the fascia. Clinically, it usually presents as painful spot in the heel at the medial calcaneal tuberosity. Pain during weight bearing, especially with the first few steps in the morning or after sitting for a time, occurs. Management includes rest, NSAIDs, orthotics or heel pads, physical therapy, and even night splints. Cortisone or PRP injections can mitigate symptoms but should not be overutilized.

Mechanical Heel Pain

The heel pad is made up of elastic adipose tissue that can be injured or can degenerate gradually over time. Mechanical heel pain most often occurs after the age of 40 but can be injured any time with repeated stresses or trauma. Obesity and footwear with poor cushion can contribute to it as well. Pain is generally localized to a small area in the heel pad. Management includes use of ice (immersion of heel), NSAIDs, heel cup or cushion, and avoiding walking barefoot at all times.

Please refer to Fig. 11.3 for the Foot Meaningful Use form.

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset : _____
Mechanism of Injury : _____
Relieving Factors : _____
Exacerbating Factors : _____

PMH: Chronic Medical Conditions: _____

Occupation/Sport /Position: _____

Red Flags:

1. Deep puncture wound; rule out foreign body
2. Ruptured Achilles tendon
3. Midfoot Pathology
   - Lis Franc
   - Navicular
   - Tendon rupture
4. Persistent symptoms (90 days) with no specific diagnosis
5. Systemic symptoms, neuropathy

Q1. Rear foot pathology?
a) Differential diagnosis for heel pain (See Figure 11.1)
b) Posterior impingement
c) Achilles tendinopathy
d) Reactive arthritis

Q2. Midfoot pathology?
See Red Flags

Q3. How to treat?
a) Splint
b) Boot
c) Radiographs

Common and Don't Miss Conditions:

- Red Flags
- Heel pain differential diagnosis
- Retained foreign body
- Neuropathy
- Morton's Neuroma
- Metatarsalgia
- Tendinopathy

Fig. 11.3 The Foot Meaningful Use form

TREAT APPROPRIATELY	Ankle/Foot Pain .....719.47 Achilles tendonitis.....726.71 Tendonitis .....726.79 Foot Sprain/Strain.....845.10
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Unable to bear weight with negative X-ray findings Cellulitis of Foot/Ankle
CALL CONSULTANT THAT DAY	Uncertain X-ray findings Fracture Cold/Avascular Foot Diagnosis uncertain/perplexing
CONSULT OR REFER	Septic joint Nerve entrapment Fractures, if not comfortable treating Torn Achilles Vascular disease needing surgical treatment

Plan:
- ☐ Xray / Imaging What: _____
- ☐ Laboratory Eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 11.3 (continued)

Suggested Readings

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