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1. Introduction
The foot serves two main functions. It acts as a mobile adaptor to adjust to varying terrain, and as a rigid lever for forward propulsion in locomotion. The two functions are time specific in that when the foot spends too much time being a mobile adaptor it is not spending enough time being a rigid lever and vice versa.

Problems with the feet and ankles can arise from mechanical, vascular, neurological or metabolic (for example inflammation) problems. The foot is affected not only by local problems or stresses but also from systemic diseases. Approximately 40% of people have foot and/or ankles problems.

For those who are not familiar with the typical osteopathic terminology, we refer to chapter 10 at the end of this e-book.
2. Biomechanics and Important Anatomical Features


2.1. General

Biomechanics of the ankle and foot analyses how the various structures of ankle and foot work together to perform specific functions.

The foot meets the diverse requirements through the integrated movements of its 28 bones that form 25 joints.

The foot has the characteristics of a triple axial joint, which allows it to assume any position. The three main axes of movement converge in the talus.

![Figure 1 - Triple axial joint](image1)

According to Kapandji, the foot can be compared architectonically to a vault, which is supported by three arches.

![Figure 2 - Vault presentation of the foot](image2)
This vault presentation is interesting when we look at the static foot.

Tendons and ligaments hold the three arches. They allow the foot to support the weight of the body and they are leverage for walking.

The arches are fully developed by the age of 13.

**Different joints in the foot:**

- Proximal and distal tibiofibular joints.
- Talocrural joint (ankle).
- Talocalcaneal or subtalar joint.
- Transverse tarsal joint:
  - Talonavicular joint.
  - Calcaneocuboid joint.
  - Talocalcaneonavicular joint.
- Five tarsometatarsal joints.
- Five metatarsophalangeal joints.
- Nine interphalangeal joints.

To facilitate description, the bones of the foot are traditionally divided into three functional segments:

- The hindfoot (talus and calcaneus).
- The midfoot (navicular, cuboid and three cuneiform bones).
- The forefoot (metatarsals and phalanges).

---

**Figure 3 - Hindfoot, midfoot, forefoot – dorsal view**
3. Lesional Mechanics

3.1. General

The foot is a mechanically complex structure that carries weight and acts as an adaptor to the soil when walking and running. The foot is therefore vulnerable for mechanical lesions.

Foot lesions have to be considered in relation to eventual dysfunctions in the knee, hip, pelvis and lumbar spine.

Treating the foot doesn’t only concern mobility of the different foot joints. Stability of knee, hip, pelvis and lumbar area (core stability) is here of the outmost importance. More details on the lumbopelvic, hip and knee stability can be found in the e-book on the hip.

A good local stability of the foot means correct alignment of the calcaneus and correct formation of the arches.

Core stability means the ability of the lumbo-pelvic-hip complex to prevent buckling of the vertebral column and to return it to equilibrium following perturbation.

Coordination and co-contraction of muscles provide spine stiffness. In other words ‘it is the ability to control the position and motion of the trunk over the pelvis to allow optimal production, transfer and control of force and motion to the terminal segment in integrated kinetic chain activities’. (Kibler et al 2006)

Core stability can also be described as the possibility to continually and instantaneous adapt to changing postures and loading conditions. It ensures the integrity of the spine and provides a stable base for the movements of the extremities. The core also absorbs forces transmitted through the lower extremities during activity.

The feet and the lower extremities in general can be seen as mobile structures but the mobility of extremity movements depends on the core activity. Core muscles are active before the initiation of extremity movements. “Proximal stability before distal mobility”.

‘Core stability may provide several benefits to the musculoskeletal system, from maintaining low back health to preventing foot injury’ (Willson et al 2005).
3.2. The Talocrural Joint

3.2.1. Compression Lesion
A compression lesion is a lesion where the talus has migrated cranially between tibia and fibula. The distance between tibia and fibula increases.

**The lesion is produced by:**

- Direct trauma: jumping.
- Micro-trauma: overweight or long-time standing.
- Weakness of the capsuloligamentary structures between tibia and fibula.

The lesion is mostly associated with an adduction of the talus and a caudal translation and fixation of the fibula.

**Local Mechanics**

- The patient jumps in the air with the foot in inversion.
- He comes down to the floor with the foot still in inversion.
- This trauma causes a compression/impaction lesion of the tibiotalar joint with external rotation of the talus within the fork tibia-fibula.
- The impaction lesion with external rotation of the talus keeps the fibula mechanically in an inferior position.
- The malleoli are spread by the compression/impaction of the talus as it ascends.

*Figure 71 - Compression lesion tibiotalar joint*
An ascending chain appears with an ilium posterior lesion.

Figure 72 - Ascending chain

Local findings:

- Distance between malleoli is increased.
- Band like swelling around the ankle (sometimes).
- Pail on palpation of the anterior tibiofibular ligament.
- Reduced ROM in flexion and in extension.
- Reduced ROM of the fibula.
- Diffuse pain when walking, running.
4. Foot Pain

4.1. General
The complaints in the lower extremity and foot will be divided in the following possible problems:

- Mechanical.
- Vascular.
- Neurologic.
- Metabolic.
- Degenerative.
- Rheumatic.
- Infectious.

4.2. Mechanical Problems

4.2.1. Strains and Fractures

4.2.1.1. March Fracture
The base of the 2\textsuperscript{nd} metatarsal bone is firmly fixed between the ventral ends of the medial and lateral cuneiform.

The 2\textsuperscript{nd} metatarsal and toe form the axis of the foot.

The immobility of the 2\textsuperscript{nd} metatarsal and the slenderness of its shaft contribute to its spontaneous fracture following mild repetitive trauma (stress fracture). In these overuse injuries, damage to bone exceeds the rate of repair.

Stress fractures of the foot most commonly affect the 2\textsuperscript{nd} and 3\textsuperscript{rd} metatarsals, classically in runners. Other foot stress fractures include the navicular and calcaneus frequently in basketball players, and the 5\textsuperscript{th} metatarsal in football players.

This type of fracture is generally seen in young, otherwise healthy individuals. They also occur in other locations, such as the tibia and femur. Metatarsal stress fractures have been referred to as march fractures, named after similar injuries in soldiers.
The osteopath must think of a march (stress) fracture when there is pain directly over a metatarsal, usually more proximal than the metatarsal head. X-rays give a definite diagnosis and a bone scan is positive early in the process.

The treatment is rest with a stiff soled shoe, boot or cast.

4.2.1.2. Calcaneal Fracture
This type of fracture mostly occurs with fall from a height.

This fracture may present as posterior tibialis tendinitis.

Symptoms:
- Immediate swelling, pain and inability to bear weight, minimal deformity unless comminute fracture occurs.

The calcaneus can occasionally have a stress fracture. It occurs due to repetitive trauma and is characterized by sudden onset in the plantar-calcaneal area.
Symptoms:

• Weight bearing (particularly at heel strike) causes pain.

The treatment is conservative: 2 to 3 weeks of rest (non weight bearing).

4.2.1.3. Talus Fracture
This fracture occurs either laterally from severe inversion/dorsiflexion force or medially from inversion/plantarflexion force with tibial external rotation.

Symptoms:

• History of repeated ankle trauma, pain with weight bearing, intermittent swelling, catching/snapping, talar dome tenderness upon palpation.

The treatment is conservative: 2 to 3 weeks of rest (non weight bearing).

4.2.1.4. Jones Fracture
This is a fracture of the 5th metatarsal proximal metaphyseal diaphyseal junction.

It is caused by inversion and plantar flexion, direct force (stepped on) or repetitive trauma.

Symptoms:

• Immediate swelling and pain over 5th metatarsal.

• High non-union rate and course of healing is unpredictable.

Treatment: short leg cast for 6 to 8 weeks followed by protective weight bearing for another 6 weeks.

Competitive athletes: surgery.

Figure 85 - Jones fracture
5. Examination

Lesion means that there is a loss of mobility.

Dysfunction of the foot joints can cause complaints. Dysfunctions can be hyper- as well as hypomobilities.

5.1. Case History
In the case history, the osteopath tries to identify the nature of the pain:

- **Aching pain** can be from a ligament, especially when occurring in the morning with morning stiffness. Also when it occurs after a longer period of immobilization (sitting or standing). Ligament complaints are also often associated with osteoarthrosis. Transient morning pain that subsides after the patient has taken a few steps, but which reappears with exercise such as walking longer distances or climbing stairs (exercise pain), is typical of degenerative foot disorders.
- **Sharp pain** on specific movements can be caused by muscle strain or inflammation, tendinitis or bursitis.
- **Fatigue** can be caused by bad posture and poor muscular balance. It can also be associated with arteriosclerosis, rheumatoid arthritis or cancer.
- **Radiating pain** indicates a neurogenic factor and can be radicular or pseudo radicular.
- **Numbness or muscle weakness** indicates compression or damage of a nerve.
- **Vague, sometimes irradiating pain in the legs during exercise** can indicate an ischemic neuralgia. The differential diagnosis should consider neurogenic claudication (in the presence of stenosis of the spinal canal) and vascular claudication (in the presence of peripheral vascular disease). With neurogenic claudication, the patient feels no pain when beginning exercise, and bending forward in a sitting position lessens the pain. Generally, the pain radiates symmetrically into both legs. With vascular claudication, the patient reports more rapid onset with exercise, and distal rather than proximal pain. This will be accompanied by alterations in perfusion, and occasionally by murmurs detectable by auscultation over the femoral arteries.
- **Bilateral pain** in the feet can be associated with lumbar canal stenosis or rheumatic disease.
- **Unstable walking** can be associated with osteoarthrosis (Trendelenburg) but also with central neurological problems such as cervical myelopathy.
• **Nocturnal pain** often indicates cancer, inflammation/infection or rheumatic disease.

The type of patient (child, adult, elderly, pregnant, peri-menopausal woman) can give information to the osteopath.

The onset of foot pain is important. Was there a trauma? Was the onset sudden or progressively worsening?

Where there recent infections?

Is there symptom magnification and psychological distress? (superficial or non-anatomical pain distribution, non-anatomic sensory or motor disturbance, inconsistent neurological signs, inappropriate or excessive verbalization of the pain).

**5.2. Observation**

**5.2.1. General**

*The general observation tries to identify:*

- Muscular contours (asymmetry).
- Muscular atrophy.
- Swelling and/or erythema.
- Other deformities.
- Observational comparison bilateral.
- Where are the somatic dysfunctions (more details in the e-book “Integration and Applied Principles in Osteopathy” of the same authors).
- Observation of other joints such as the hips and knees (position and eventual deformations).

**5.2.2. Observation of the Shortened Structures**

The osteopath observes the position of the feet in space with the patient standing. It is important is that he or she observes the location of the shortened structures.

*For example:*

- When the osteopath observes a foot position standing in valgus, the shortened structures are on the lateral side, the overstretched structures on the medial side.
- When the osteopath observes a foot position standing in varus, the shortened structures are on the medial side, the overstretched structures on the lateral side.
The aim of this observation (of the shortened structures) is to see where locally can be treated. Local treatment can only be done on the shortened side (mobilization of manipulation).

The complaints of the patient can be on the shortened side as well as the overstretched side.

**Figure 128 - Pelvic shift to the left**

**Figure 129 - Shortened structures or false joint axis**
6. Techniques

6.1. Mobilizations


6.1.1. General

The aim of a mobilization is:

- Correction of the false axis in the joint by stretching retractions in the capsule and surrounding ligaments. This is done with enough specificity so that it is appropriate even in a joint that is hypermobile in other directions. In this way the biomechanical quality of the joint can be repaired and the overstretched soft tissues can be relaxed.
- Via rhythmical mobilizations and use of long lever techniques a drainage (improved circulation) of all soft tissues around the joint will occur. Near to the false axis (shortened structures) congestion of all tissues will still occur.
- The mobilization is done in a pain free and rhythmical manner. The aim is to normalize any hyperactivity of the sympathetic system in the surrounding tissues. Pain will increase this sympathetic activity further.
- Via rhythmical compression/traction the synovial production is stimulated which is a desirable reaction when treating arthrotic joints. This is also the reason why mobilizations of an arthritic joint (inflammation) are not suggested.
- Range of motion increase is not necessarily the primary aim of mobilization. It can even be relatively contraindicated so as not to cause instability (especially of concern in arthritic joints).

The mobilization must be pain free so as to avoid increasing sympathetic activity further, which is contrary to the treatment goal.

The mobilization must occur at the end of range so that a light tension is maintained in the tissues (capsules and ligaments) being treated.

The mobilization is rhythmical and with circumduction where possible. If the aim is to stimulate synovial production, a light push/pull (compression/traction) technique is indicated.

The mobilization is always done in the direction of the false axis (shortened structures) and according to the normal biomechanics of the joint. Hypermobile directions are avoided.
Contraindications

- Inflammation or infection.
- A joint with intra-articular swelling. Mobilization will only increase and worsen the swelling.
- Painful end of range.
- In the direction of a structurally damaged capsule.
- Directly following recent trauma.

6.1.2. Mobilization of the Tibiotarsal Joint in Plantar and Dorsiflexion

The patient is supine and the osteopath fixes the tibia and fibula.

He mobilises the talus in plantar flexion and adds an anterior translation.

He mobilises the talus in dorsiflexion and adds a posterior translation.

The technique is done rhythmically and without provoking pain.

Video 33 - Mobilization of the tibiotarsal joint in plantar and dorsiflexion
6.1.3. Mobilization of the Tibia in Anterior and Posterior Translation against the Talus

The patient is supine with the knee at 90°.

The osteopath fixes the foot of the patient with his knee and the talus with one hand.

The other hand translates the tibia in anterior and posterior translation.

![Image](image1.png)

Video 34 - Mobilization of the tibia in anterior and posterior translation against the talus

6.1.4. Posterior Mobilization of the Tibia

The osteopath contacts the talus between thumb and index finger. He rolls the talus towards anterior and adds traction and plantar flexion. This way he finds the barrier of motion.

The calcaneus is on the table and the leg is kept straight. The osteopath mobilises the tibia towards posteriorly against the talus.

The effect of the technique can be observed at the level of the medial malleolus.

![Image](image2.png)

Video 35 - Mobilization of the tibia in anterior and posterior translation against the talus
8. About the Authors

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Both authors are holders of university degrees, namely the Master of Science in Osteopathy (MSc.Ost. – University of Applied Sciences), and are very active with the promotion and academic structuring of osteopathy in Europe. In 1987 they began The International Academy of Osteopathy (IAO) and are, to this day, the joint-principals of this academy. The IAO is since several years the largest teaching institute for osteopathy in Europe. Both osteopaths are members of diverse professional organizations, including the American Academy of Osteopathy (AAO), the International Osteopathic Alliance (IOA) and the World Osteopathic Health Organization (WOHO), as part of their mission to improve osteopathic development.

This osteopathic encyclopaedia aims to demonstrate the concept that a proper osteopathic examination and treatment is based upon the integration of three systems: the musculoskeletal, visceral and craniosacral systems.