HUMAN FUNCTIONAL ANATOMY 213
THE ANKLE AND FOOT IN LOCOMOTION

THIS WEEKS LAB:
Forearm and hand

READINGS
The leg and sole of foot
1. Stern – Core concepts – sections 99, 100 and 101 (plus appendices)
2. Faiz and Moffat – Anatomy at a Glance – Sections 50 and 51
3. Grants Method:- The bones and sole of foot & Joints of the lower limb
   or any other regional textbook - similar sections

IN THIS LECTURE I WILL COVER:
Joints related to the talus
   Ankle
   Subtalar
   Talocalcaneonavicular
   Transverse tarsal
Other tarsal joints
   Toe joints
   Ligaments of the foot
   Arches of the foot
Movements of the foot & Compartments of the leg
   The ankle in Locomotion
   Ankle limps
      1. Flexor limp
      2. Extensor limp

JOINTS OF THE FOOT

THE HINDFOOT (JOINTS OF THE TALUS)

TROCHLEAR
The ankle, and distal tibiofibular joints
BODY
   Subtalar joint (Posterior talocalcaneal)
   HEAD
   Talocalcaneonavicular
   & Transverse tarsal joints

THE MID FOOT

THE FOREFOOT

METATARSAL AND PHALANGEAL
JOINTS (same as in the hand)
   Except 1st metatarsal and Hallux
   No saddle joint at base is 1st metatarsal
   Metatarsal head is bound by deep transverse metatarsal ligament
   Toes are like fingers
   Same joints, Lumbricals, Interossei, Extensor expansion
   Axis of foot (for abduction-adduction) is the 2nd toe.

JOINTS OF THE FOOT (2 joints that allow inversion and eversion)

SUBTALAR (Posterior talocalcaneal) JOINT
   Two (or three) talocalcaneal joints
   Posterior is subtalar
   Anterior (and middle) is part of the talocalcaneonavicular.
   With a strong interosseous ligament running between them (tarsal sinus)

THE TALOCALCANEONAVICULAR JOINT
   The head of the talus fits into a socket formed from the:
   The anterior talocalcaneal facets.
   The spring ligament.
   The socket of the navicular.

   Inversion and eversion below the talus (subtalar and talocalcaneonavicular)
   Axis of motion runs below the subtalar, and above the talocalcaneonavicular joints
   (upwards, forwards ,medially)
   Inversion (abduction & “supination”) – Eversion (adduction and “pronation”)
LIGAMENTS OF THE FOOT

Many ligaments are associated with more than one joint

SPRING LIGAMENT (Plantar calcaneonavicular ligament)
Stretches between the sustentaculum tali of the calcaneus to the navicula
It completes the socket of the talocalcaneonavicular ligament
It supports the head of the talus. (arches of the foot)

DELTOID LIGAMENT (from medial malleolus)
1. Tibiotalar (to posterior part of the talus)
2. Tibiocalcaneal (to sustentaculum tali of calcaneus)
3. “Tibio-spring ligament”
4. Tibionavicular

ARCHES OF THE FOOT

Arches are really springs - They absorb shock = Store energy
Kinetic energy of the foot is lost/stored in the support phase.
This springiness helps the foot conform with the substrate

MECHANISMS OF ARCH SUPPORT

COMPARTMENTS OF THE LEG AND MOVEMENTS OF THE FOOT

FLEX

Gastrocnemius
Soleus

Flexor Digitorum longus
Flexor hallucis longus

Tibialis posterior
Peroneus longus
Peroneus brevis

EXTEND

Tibialis anterior
Peroneus tertius

Extensor hallucis
Extensor digitorum longus

INVERT

EXTEND
**ANKLE IN LOCOMOTION - MOVEMENTS**

**STANCE PHASE**
1. **At Heel strike** (ankle in neutral position)
   - Ankle flexes (so the toes touch the ground)
2. **At Foot flat**
   - Ankle extends (Leg swings forwards over the ankle)
3. **After heal off**
   - Ankle flexes (Moving into the power stroke)

**SWING PHASE**
4. **After toe off (1st half of swing)**
   - Ankle extends
5. **2nd half of swing** - Ankle in neutral position

**ANKLE IN LOCOMOTION - MUSCLES**

**STANCE PHASE**
1. **At Heel strike** (ankle in neutral position)
   - Ankle flexes (Lowering the forefoot to the ground)
   - Ground reaction - Anterior tibial muscles active (eccentric)
2. **At Foot flat**
   - Ankle extends (trunk and leg move forwards over the foot)
   - Calf muscles are active slowing the leg down (eccentric)
   - (this is what causes the knee to extend)
3. **After heel off**
   - Ankle flexes (power stroke)
   - Calf muscles acting concentrically

**SWING PHASE**
4. **After toe off (1st half of swing)**
   - Ankle extends
   - Anterior tibial muscles are acting concentrically

**ANKLE LIMPS**

**Ankle extensor Limp**
- Loss of anterior tibial muscles - Common peroneal nerve lesion
  - Anterior tibial muscles do two things
    1. Control foot flexion after heel strike
       - This action is against considerable resistance
    2. Extend the foot so it will clear the ground in swing phase
       - This action is not resisted

**Ankle extensor limp**
1. Foot slap - Forefoot hits the ground hard
   - With weakness of the anterior tibial muscles
2. High stepping gait - to avoid toe drag
   - With complete paralysis of anterior tibial muscles

**Ankle flexor Limp**
- Loss of calf muscles - triceps surae - eg. damaged Achilles tendon
  - Calf muscles do two things
    1. Control foot extension after foot flat
    2. Provide the thrust at toe off

**Ankle flexor limp**
- Can’t control extension/dorsiflexion of foot
- CoG must not get in front of the ankle joint
- No push off with toes
- So the phase between foot flat and toe off is shortened and the foot is lifted off.
  - or the toes are pointed laterally so the everters do the work of the flexors

**SUBTALAR JOINT IN LOCOMOTION**

**Inversion - eversion**

**STANCE PHASE**
1. **After Heel off - Ankle Everts**
   - 1. Adding extra thrust
   - 2. Ensuring that the hallux is the last toe to leave the ground
   - Cause: Concentric action of the Peroneus longus and brevis

**SWING PHASE**
- Ankle Inverts
   - Cause: Concentric action of the Tibialis anterior
     - (Tibialis anterior is already active extending the foot)

**ARCHES OF THE FOOT IN LOCOMOTION**

**STANCE PHASE**
- The arches flatten out
  - Cause: Ground reaction
  - Resisted by:
    1. **The plantar ligaments**
       - The stretching of these ligaments stores energy which is released as the foot leaves the ground. (adds spring to your step)
    2. **The intrinsic muscles of the foot (eccentric)**

**SWING PHASE**
- Arches deepen
  - Cause: elastic recoil of the ligaments