Clarification of Terms

- The **plantar** aspect of the foot refers to the sole or its bottom.
- The **dorsal** aspect refers to the top or its superior portion.
- The ankle and foot perform three main functions:
  1. Shock absorption as the heel strikes the ground.
  2. Adapting to the level (or uneven) ground.
  3. Providing a stable base of support from which to propel the body forward.

Mansfield, p306 & Lippert, p303

Osteology of the Ankle & Foot

- **The foot can be divided into 3 parts:**
  - **Hindfoot:** talus & calcaneus.
  - **Midfoot:** navicular, cuboid, & the 3 cuneiform bones.
  - **Forefoot:** the 5 metatarsals, & all phalanges.

Lippert, p303
Osteology of the Ankle & Foot

- **Tibia**
  - Medial condyle
  - Lateral condyle
  - Crest
  - Medial malleolus

- **Fibula**
  - Lateral malleolus
  - Head

The bones of the foot include the tarsals, metatarsals, and phalanges. The 7 tarsal bones are as follows:

- **Calcaneus**
- **Talus**
- **Navicular**
- **Cuboid**
- **3 cuneiforms**

The metatarsals are numbered 1, 2, 3, 4, 5 starting medially.

- Usually, the 1st and 5th are WBing bones, while the others are not
  - **Base** = proximal end of each metatarsal
  - **Head** = distal end of each metatarsal
  - 1st = thickest, shortest, articulates with 1st cuneiform
  - 2nd = longest, articulates with 2nd cuneiform
  - 3rd = articulates with 3rd cuneiform
  - 4th & 5th = articulates with the cuboid
Osteology of the Ankle & Foot

- **Phalanges:**
  - Same set up as the hand
  - The 1st digit (the hallux or great toe) has a proximal and distal phalanx, but no middle phalanx
  - Toes 2-5 (the lesser toes) each have a proximal, middle, and distal phalanx.

What can you palpate?
What can you NOT palpate?

Joint Structure

- Superior Tibiofibular joint
- Inferior Tibiofibular joint
- Talocrural joint
- Subtalair joint
- Transverse Tarsal joint
- Metatarsophalangeal (MTP) joint
- Interphalangeal (IP) joint
- Proximal interphalangeal (PIP) joint
- Distal interphalangeal (DIP) joint
Joint Structure

- **Superior Tibiofibular joint**
  - Articulation between head of fibula and the posterior lateral proximal tibia
  - Plane joint, synovial joint with capsule
- **Inferior Tibiofibular joint**
  - Syndesmosis (fibrous union) between concave distal tibia and convex distal fibula
  - No joint capsule

Lippert, p304

Joint Structure

- **Talocrural:**
  - The distal tibia and fibula sit on top of (and articulate with) the superior aspect of the talus, with the medial and lateral malleoli wrapping around the talus
  - Often described as a mortise joint
  - Uniaxial hinge joint
  - Considered triplanar because the axis of rotation is at an angle

Lippert, p305

Joint Structure

- **Subtalar Joint:**
  - The inferior surface of the talus articulates with the superior surface of the calcaneus
  - Plane synovial joint with 1 degree of freedom

Lippert, p306-307
Joint Structure

- **Transverse Tarsal Joint**: (midtarsal joint)
  - Anterior surfaces of the talus and calcaneus articulating with the posterior surfaces of the navicular and cuboid
  - ![Diagram](attachment://transverse_tarsal_joint_diagram.png)

- **Metatarsophalangeal (MTP) joints**:
  - Metatarsal heads articulate with the proximal phalanges

- **IP, PIP, DIP joints**:
  - Articulations between phalanges
  - ![Diagram](attachment://ip_pip_dip_joints_diagram.png)

Joint Structure

- **Sagittal Plane**
  - Dorsiflexion and Plantarflexion
  - ![Diagram](attachment://sagittal_plane_diagram.png)
Joint Movement

- **Frontal Plane**
  - Inversion and Eversion

- **Horizontal Plane**
  - Abduction and Adduction

- **Pronation**: (all 3 planes)
  - Specialized, applied motion based on a combination of:
    - Eversion
    - Abduction
    - Dorsiflexion

- **Supination**: (all 3 planes)
  - Specialized, applied motion based on a combination of:
    - Inversion
    - Abduction
    - Plantarflexion

http://www.youtube.com/watch?v=FGpl5sH1q-M&feature=channel&list=UL

Mansfield, p319
Joint Movement

- **Superior Tibiofibular Joint:**
  - Osteokinematics:
    - n/a
  - Arthrokinematics:
    - Small amount of gliding and rotation of the fibula on the tibia

- **Inferior Tibiofibular Joint:**
  - Much of the ankle joint’s strength relies on a strong union at this joint
  - Osteokinematics:
    - n/a
  - Arthrokinematics:
    - Slight movement allowed to accommodate motion of talus

Lippert, p304

Joint Movement

- **Talocrural Joint:**
  - Osteokinematics:
    - Plantarflexion and dorsiflexion
  - Arthrokinematics:
    - Convex talus glides posteriorly on the concave calcaneus during dorsiflexion and anteriorly during plantarflexion

Lippert, p306

Joint Movement

- **Subtalar Joint:**
  - Osteokinematics:
    - Inversion: turns a point anywhere on the plantar aspect of the foot toward midline
    - Eversion: turns a point on the plantar aspect of the foot laterally, or away from midline
  - Arthrokinematics:
    - Talus glides laterally on the calcaneus during inversion and medially during eversion

Lippert, p306 & Mansfield, p308-309
Joint Movement

- **Transverse Tarsal Joint:**
  - (aka midtarsal joint)
  - Functionally, the subtalar and transverse tarsal joints cannot be separated
  - For the sake of simplicity, inversion and eversion describe motions occurring at both the subtalar and transverse tarsal joints

Joint Movement

- **MTP joints:**
  - Just like the hand
  - **Osteokinematics:**
    - Flexion, extension, hyperextension, abduction, adduction
    - The point of reference for abd/add is the 2nd toe
    - Like the middle finger, the 2nd toe abducts in both directions
  - **Arthrokinematics:**
    - Concave moving on convex (glides in same direction as shaft of bone)

Joint Movement

- **IP, PIP, DIP joints:**
  - **Osteokinematics:**
    - Flexion and extension
  - **Arthrokinematics:**
    - Concave moving on convex, glides in same direction as shaft of bone
Supporting Structures of the Ankle and Foot

- **Capsule:**
  - Thin anteriorly and posteriorly and reinforced by ligaments on the sides

- **Deltoid ligament:**
  - Collateral ligament on the medial side of the ankle
  - Limits eversion
  - Triangle shaped ligament originating from medial malleolus, has 3 sets of fibers: tibionavicular, tibiocalcaneal, tibiotalar

- **Lateral collateral ligaments:**
  - Collateral ligament on the lateral side of the ankle
  - Limits inversion
  - Consists of 3 ligaments: anterior & posterior talofibular and calcaneofibular

Mansfield, p312

Supporting Structures of the Ankle and Foot...cont

- **Deltoid Ligament**
  - Image

- **Lateral Collateral Ligament**
  - Image

Supporting Structures of the Ankle and Foot...cont

- **Arches of the Foot:**
  - Like the hand, the foot has arches
  - The foot is the point of impact with the ground and must be able to absorb shock, adjust to changes in terrain and propel the body forward
  - Therefore, the foot is arranged in arches to distribute WB from the calcaneus to the 1st and 5th metatarsals
    - Medial longitudinal arch
    - Lateral longitudinal arch
    - Transverse arch

Lippert, p309
Supporting Structures of the Ankle and Foot... cont

- **Arches of the Foot:**

- **Ligaments:**
  - The 3 arches are supported by ligaments and fascia
  - **Spring Ligament:**
    - Calcaneus to navicular
  - **Long and short plantar ligaments:**
    - Spring ligament deep to short plantar ligament, which is deep to the long plantar ligament
    - Runs from calcaneus to cuboid & bases of 3, 4, 5 metatarsals
  - **Plantar fascia:**
    - Superficial fascia from calcaneus to proximal phalanges

Lippert, p309-310

Supporting Structures of the Ankle and Foot... cont

- **Ligaments:**
  - The 3 arches are supported by ligaments and fascia
  - **Spring Ligament:**
    - Calcaneus to navicular
  - **Long and short plantar ligaments:**
    - Spring ligament deep to short plantar ligament, which is deep to the long plantar ligament
    - Runs from calcaneus to cuboid & bases of 3, 4, 5 metatarsals
  - **Plantar fascia:**
    - Superficial fascia from calcaneus to proximal phalanges

Lippert, p309-310

Myology of the Ankle and Foot

- **Extrinsic Muscles**
  - **Anterior Compartment**
    - Tibialis anterior, extensor hallucis longus, extensor digitorum longus, peroneus tertius
  - **Lateral Compartment**
    - Peroneus longus, peroneus brevis
  - **Deep Posterior Compartment**
    - Tibialis posterior, flexor digitorum longus, flexor hallucis longus
  - **Superficial Posterior Compartment**
    - Gastrocnemius, soleus, plantaris

- **Intrinsic Muscles**

Lippert, p310
Myology of the Ankle and Foot
Extrinsic Muscles

- **Anterior Compartment:**
  - All 4 muscles are innervated by the Deep Peroneal Nerve
  - All 4 muscles perform dorsiflexion as one of their primary actions
    - Tibialis anterior
    - Extensor hallucis longus
    - Extensor digitorum longus
    - Peroneus tertius

**Tibialis Anterior**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Proximal 2/3 of the lateral surface of the tibia and interosseous membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Medial and plantar aspects of the medial cuneiform and the base of the first metatarsal</td>
</tr>
<tr>
<td>Innervation</td>
<td>Deep branch of the peroneal n.</td>
</tr>
<tr>
<td>Action</td>
<td>Dorsiflexion, inversion</td>
</tr>
</tbody>
</table>

Lippert, p314

**Extensor Hallucis Longus**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Middle section of the tibia and adjacent interosseous membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Dorsal base of the distal phalanx of the great toe</td>
</tr>
<tr>
<td>Innervation</td>
<td>Deep branch of the peroneal n.</td>
</tr>
<tr>
<td>Action</td>
<td>Extension of the great toe, dorsiflexion</td>
</tr>
</tbody>
</table>

“tidbit” What’s in a name?

Lippert, p314

Mansfield, p320
### Myology of the Ankle & Foot

#### Extrinsic Muscles

**Extensor Digitorum Longus**
- **Origin**: Lateral condyle of the tibia, proximal 2/3 of the medial surface of the fibula and adjacent interosseous membrane.
- **Insertion**: Splits into 4 tendons that attach to the proximal base of the dorsal surface of the middle and distal phalanges.
- **Innervation**: Deep branch of the peroneal n.
- **Action**: Extension of all joints of toes 2-5 (MTP, PIP and DIP joints).
- **“tidbit”**: What’s in a name?

**Peroneus Tertius**
- **Origin**: Distal 1/3 of the medial surface of the fibula and adjacent interosseous membrane.
- **Insertion**: Dorsal surface of the base of the 5th metatarsal.
- **Innervation**: Deep branch of the peroneal n.
- **Action**: Dorsiflexion, eversion.

---

**Myology of the Ankle & Foot**

Extrinsic Muscles

- **Lateral Compartment**:
  - 2 muscles are innervated by the Superficial Peroneal Nerve.
  - Both muscles perform evasion as one of their primary actions.
    - Peroneus longus
    - Peroneus brevis

---

Mansfield, p320
Myology of the Ankle & Foot

Extrinsic Muscles

Peroneus Longus
- **Origin**: Lateral fibular head and interosseous membrane
- **Insertion**: Lateral surface of the medial cuneiform and plantar base of the 1st metatarsal
- **Innervation**: Superficial branch of the peroneal n.
- **Action**: Eversion, plantar flexion

Peroneus Brevis
- **Origin**: Distal 2/3 of the lateral surface of the fibula
- **Insertion**: Styloid process of the 5th metatarsal
- **Innervation**: Superficial branch of the peroneal n.
- **Action**: Plantar flexion, eversion

Myology of the Ankle and Foot

Extrinsic Muscles

- **Posterior Compartment**: All muscles in the posterior compartment are innervated by the tibial nerve. All muscles in the posterior compartment perform plantarflexion as one of their primary actions.
- **Deep Posterior Compartment**: Tibialis posterior, Flexor digitorum longus, Flexor hallucis longus
- **Superficial Posterior Compartment**: Gastrocnemius, Soleus, Plantaris

Mansfield, p327
**Myology of the Ankle & Foot**

**Extrinsic Muscles**

---

**Tibialis Posterior**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Proximal 2/3 of the posterior aspect of the tibia, fibula, and interosseous membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Multiple attachments to every tarsal except the talus, also attaches to the bases of metatarsals 2-4, it’s the most prominent insertion on the navicular tuberosity</td>
</tr>
<tr>
<td>Innervation</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Action</td>
<td>Plantar flexion, inversion</td>
</tr>
</tbody>
</table>

---

**Flexor Digitorum Longus**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Posterior surface of the middle 1/3 of the tibia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>By 4 separate tendons to the base of the distal phalanx of the 4 lesser toes</td>
</tr>
<tr>
<td>Innervation</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Action</td>
<td>Flexion of toes 2-5, plantar flexion, inversion</td>
</tr>
</tbody>
</table>

“tidbit” What’s in a name?

---

**Flexor Hallucis Longus**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Distal 2/3 of the posterior fibula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Plantar surface of the base of the distal phalanx of the great toe</td>
</tr>
<tr>
<td>Innervation</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Action</td>
<td>Flexion of the great toe, plantar flexion, inversion</td>
</tr>
</tbody>
</table>
Myology of the Ankle & Foot
Extrinsic Muscles

**Gastrocnemius**

| Origin | Medial head: posterior aspect of the medial femoral condyle
|        | Lateral head: posterior aspect of the lateral femoral condyle |
| Insertion | Calcaneal tuberosity via the Achilles tendon |
| Innervation | Tibial n. |
| Action | Plantar flexion, flexion of the knee |

**Soleus**

| Origin | Proximal 1/3 of the posterior fibula and fibular head and posterior aspect of the tibia |
| Insertion | Calcaneal tuberosity via the Achilles tendon |
| Innervation | Tibial n. |
| Action | Plantar flexion |

**Plantaris**

| Origin | Posterior surface of the lateral epicondyle of the femur |
| Insertion | Medial aspect of the Achilles tendon to insert on the calcaneal tuberosity |
| Innervation | Tibial n. |
| Action | Plantar flexion, initiates knee flexion |
Myology of the Ankle and Foot

- **Intrinsic Muscles**
  - Originate and insert distal to the ankle joint
  - We do not use these muscles to perform intricate actions
  - All intrinsic muscles are located on the plantar surface
  - Their primary actions are to move the digits of the foot

Lippert, p317

---

<table>
<thead>
<tr>
<th>Prime Movers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action</strong></td>
</tr>
<tr>
<td>Plantarflexion</td>
</tr>
<tr>
<td>Dorsiflexion</td>
</tr>
<tr>
<td>Inversion</td>
</tr>
<tr>
<td>Eversion</td>
</tr>
<tr>
<td>Flexion of hallux</td>
</tr>
<tr>
<td>Flexion of toes 2-5</td>
</tr>
<tr>
<td>Extension of hallux</td>
</tr>
<tr>
<td>Extension of toes 2-5</td>
</tr>
</tbody>
</table>

Lippert, p317
Pin the Tail on the Donkey

- Point to the location of the...
  - Ankle dorsiflexors
  - Ankle plantarflexors
  - Ankle invertors
  - Ankle evertors

Common Ankle Pathology

- Shin Splits
- Pes Cavus and Planus
- Morton’s Neuroma
- Plantar Fasciitis

References