The Ankle and Foot
Clarification of Terms

- The **plantar** aspect of the foot refers to the role 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
  - Head

- **Fibula**
  - Lateral malleolus
Osteology of the Ankle & Foot

- The bones of the foot include the tarsals, metatarsals, and phalanges. The 7 tarsal bones are as follows:
  - Calcaneus
  - Talus
  - Navicular
  - Cuboid
  - 3 cuneiforms

Lippert, p302
Osteology of the Ankle & Foot

- 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.

Lippert, p302
Osteology of the Ankle & Foot

- **Phalanges:**
  - Same set up as the hand
  - The 1\textsuperscript{st} 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.
Joint Structure

- Superior Tibiofibular joint
- Inferior Tibiofibular joint
- Talocrural joint
- Subtalar joint
- Transverse Tarsal joint
- Metatarsaophalangeal (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
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

Lippert, p307
Joint Structure

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

- **IP, PIP, DIP joints:**
  - Articulations between phalanges

Lippert, p307
Joint Movement

- **Sagittal Plane**
  - Dorsiflexion and Plantarflexion
Joint Movement

- **Frontal Plane**
  - Inversion and Eversion
Joint Movement

- **Horizontal Plane**
  - Abduction and Adduction
Joint Movement

- **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
    - Adduction
    - Plantarflexion

http://www.youtube.com/watch?v=-F9pBsHq--M&feature=channel&list=UL

Mansfield, p309
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

Lippert, p307
Joint Movement

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

Lippert, p307
Joint Movement

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

Lippert, p307
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
- Lateral Collateral Ligament
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:**

![Diagram of the foot with labeled arches](image)
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:**
    - Short plantar ligament deep to long plantar ligament and spring ligament deep to short 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**
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
Myology of the Ankle & Foot
Extrinsic Muscles

<table>
<thead>
<tr>
<th>Tibialis Anterior</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
</tr>
<tr>
<td><strong>Action</strong></td>
</tr>
</tbody>
</table>

Lippert, 314
### Extensor Hallucis Longus

<table>
<thead>
<tr>
<th>Origin</th>
<th>Middle section of the fibula 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>
<tr>
<td>“tidbit”</td>
<td>What’s in a name?</td>
</tr>
</tbody>
</table>

*Lippert, p314*
## Myology of the Ankle & Foot: Extrinsic Muscles

### Extensor Digitorum Longus

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Lateral condyle of the tibia, proximal 2/3 of the medial surface of the fibula and adjacent interosseous membrane</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Splits into 4 tendons that attach to the proximal base of the dorsal surface of the middle and distal phalanges</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Deep branch of the peroneal n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Extension of all joints of toes 2-5 (MTP, PIP and DIP joints)</td>
</tr>
<tr>
<td><strong>“tidbit”</strong></td>
<td>What’s in a name?</td>
</tr>
</tbody>
</table>

Lippert, 315
### Myology of the Ankle & Foot

#### Extrinsic Muscles

<table>
<thead>
<tr>
<th><strong>Peroneus Tertius</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Distal 1/3 of the medial surface of the fibula and adjacent interosseous membrane</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Dorsal surface of the base of the 5th metatarsal</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Deep branch of the peroneal n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Dorsiflexion, eversion</td>
</tr>
</tbody>
</table>

Lippert, p317
Myology of the Ankle and Foot
Extrinsic Muscles

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

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

#### Extrinsic Muscles

<table>
<thead>
<tr>
<th>Peroneus Longus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
</tr>
<tr>
<td>Lateral condyle of the tibia, head and proximal 2/3 of the lateral surface of the fibula</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
</tr>
<tr>
<td>Lateral surface of the medial cuneiform and plantar base of the 1st metatarsal</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
</tr>
<tr>
<td>Superficial branch of the peroneal n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
</tr>
</tbody>
</table>

Lippert, 316
### Peroneus Brevis

<table>
<thead>
<tr>
<th>Origin</th>
<th>Distal 2/3 of the lateral surface of the fibula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion</td>
<td>Styloid process of the 5&lt;sup&gt;th&lt;/sup&gt; metatarsal</td>
</tr>
<tr>
<td>Innervation</td>
<td>Superficial branch of the peroneal n.</td>
</tr>
<tr>
<td>Action</td>
<td>Plantar flexion, eversion</td>
</tr>
</tbody>
</table>

Lippert, p316
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

<table>
<thead>
<tr>
<th><strong>Tibialis Posterior</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
</tr>
<tr>
<td><strong>Action</strong></td>
</tr>
</tbody>
</table>

Lippert, 313
## Myology of the Ankle & Foot
### Extrinsic Muscles

<table>
<thead>
<tr>
<th>Flexor Digitorum Longus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
</tr>
<tr>
<td><strong>Action</strong></td>
</tr>
<tr>
<td><strong>“tidbit”</strong></td>
</tr>
</tbody>
</table>

Lippert, 314
**Myology of the Ankle & Foot**

**Extrinsic Muscles**

<table>
<thead>
<tr>
<th></th>
<th>Flexor Hallucis Longus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Distal 2/3 of the posterior fibula</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Plantar surface of the base of the distal phalanx of the great toe</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Tibial n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Flexion of the great toe, plantar flexion, inversion</td>
</tr>
</tbody>
</table>

Lippert, 313
### Myology of the Ankle & Foot

#### Extrinsic Muscles

<table>
<thead>
<tr>
<th>Gastrocnemius</th>
<th>Action</th>
</tr>
</thead>
</table>
| **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. |

Lippert, p311
### Soleus

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>Proximal 1/3 of the posterior fibula and fibular head and posterior aspect of the tibia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Calcaneal tuberosity via the Achilles tendon</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Tibial n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Plantar flexion</td>
</tr>
</tbody>
</table>

Lippert, p312
### Myology of the Ankle & Foot

#### Extrinsic Muscles

| **Plantaris** | 
|---|---|
| **Origin** | Lateral supracondylar line 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 |

Lippert, p312
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
Intrinsic muscles of the foot

- Flexor digitorum brevis
- ABDuctor Hallucis
- ABDuctor digiti minimi
- Dorsal interossei (ABDuctors)
- Plantar interossei (ADDuctors)
- Lumbricals
- Flexor Hallucis Brevis
- ADDuctor Hallucis
- Extensor Digiti Minimi

Lippert, p318
# Myology of the Ankle and Foot

## Prime Movers

<table>
<thead>
<tr>
<th>Action</th>
<th>Muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantarflexion</td>
<td>Gastrocnemius, soleus</td>
</tr>
<tr>
<td>Dorsiflexion</td>
<td>Tibialis anterior</td>
</tr>
<tr>
<td>Inversion</td>
<td>Tibialis anterior, tibialis posterior</td>
</tr>
<tr>
<td>Eversion</td>
<td>Peroneus longus, peroneus brevis</td>
</tr>
<tr>
<td>Flexion of hallux</td>
<td>Flexor hallucis longus</td>
</tr>
<tr>
<td>Flexion of toes 2-5</td>
<td>Flexor digitorum longus</td>
</tr>
<tr>
<td>Extension of hallux</td>
<td>Extensor hallucis longus</td>
</tr>
<tr>
<td>Extension of toes 2-5</td>
<td>Extensor digitorum longus</td>
</tr>
</tbody>
</table>

Lippert, p317
Common Ankle Pathology

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