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:
  1. **Hindfoot**: talus & calcaneus
  2. **Midfoot**: navicular, cuboid, & the 3 cuneiform bones
  3. **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

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.

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Joint Structure

- Superior Tibiofibular joint
- Inferior Tibiofibular joint
- Talocrural joint
- Subtalar 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

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Lippert, p303

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.

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.

Joint Structure

- **Transverse Tarsal Joint:**
  - (Midtarsal joint)
  - Anterior surfaces of the talus and calcaneus articulating with the posterior surfaces of the navicular and cuboid.
Joint Structure

- **Metatarsophalangeal (MTP) joints:**
  - Metatarsal heads articulate with the proximal phalanges
- **IP, PIP, DIP joints:**
  - Articulations between phalanges

Joint Movement

- **Sagittal Plane**
  - Dorsiflexion and Plantarflexion
- **Frontal Plane**
  - Inversion and Eversion
Joint Movement

- **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
    - Adduction
    - Plantarflexion

  http://www.youtube.com/watch?v=9-pB8kHq_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 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)

Lippert, p307

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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

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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

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:
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**

Lippert, p311

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

Mansfield, p310
**Myology of the Ankle & Foot**  
**Extrinsic Muscles**

### Tibialis Anterior

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>Proximal 2/3 of the lateral surface of the tibia and interosseous membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Medial and plantar aspects of the medial cuneiform and the base of the first 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, inversion</td>
</tr>
</tbody>
</table>

Lippert, p314

### Extensor Hallucis Longus

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>Middle section of the fibula and adjacent interosseous membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Dorsal base of the distal phalanx of the great toe</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 the great toe, dorsiflexion</td>
</tr>
<tr>
<td>“tidbit”</td>
<td>What’s in a name?</td>
</tr>
</tbody>
</table>

Lippert, p314

### Extensor Digitorum Longus

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>Lateral condyle of the tibia, proximal 2/3 of the medial surface of the fibula and adjacent interosseous membrane</th>
</tr>
</thead>
<tbody>
<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>“tidbit”</td>
<td>What’s in a name?</td>
</tr>
</tbody>
</table>

Lippert, 315
Myology of the Ankle & Foot
Extrinsic Muscles

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

Peroneus Longus

- **Origin**: Lateral condyle of the tibia, head and proximal 2/3 of the lateral surface of the fibula
- **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

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
**Myology of the Ankle & Foot**

**Extrinsic Muscles**

<table>
<thead>
<tr>
<th>Peroneus Brevis</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>
</tbody>
</table>

*Lippert, p316*

**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*

**Tibialis Posterior**

<table>
<thead>
<tr>
<th>Tibialis Posterior</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

### Flexor Digitorum Longus

**Origin**
Posterior surface of the middle 1/3 of the tibia

**Insertion**
By 4 separate tendons to the base of the distal phalanges of the 4 lesser toes

**Innervation**
Tibial n.

**Action**
Flexion of toes 2-5, plantar flexion, inversion

 fête

Lippert, 314

### Flexor Hallucis Longus

**Origin**
Distal 2/3 of the posterior fibula

**Insertion**
Plantar surface of the base of the distal phalanx of the great toe

**Innervation**
Tibial n.

**Action**
Flexion of the great toe, plantar flexion, inversion

Lippert, 313

### 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

Lippert, p311
### Myology of the Ankle & Foot

#### Extrinsic Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soleus</strong></td>
<td>Proximal 1/3 of the posterior fibula and fibular head and posterior aspect of the tibia</td>
<td>Calcaneal tuberosity via the Achilles tendon</td>
<td>Tibial n.</td>
<td>Plantar flexion</td>
</tr>
<tr>
<td><strong>Plantaris</strong></td>
<td>Lateral supracondylar line of the femur</td>
<td>Medial aspect of the Achilles tendon to insert on the calcaneal tuberosity</td>
<td>Tibial n.</td>
<td>Plantar flexion, initiates knee flexion</td>
</tr>
</tbody>
</table>

#### Intrinsic Muscles

- **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, p312
**Myology of the Ankle and Foot**

**Intrinsic Muscles**

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

**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>

**Common Ankle Pathology**

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