THE ANKLE AND FOOT
（足踝部）

LEARNING OBJECTIVES

- Understand the knowledge of anatomy, especially that which is on the surface or creates superficial bony landmarks in the ankle and foot
- Recognize the locations of muscles and their actions in the lower leg and foot

REFERENCES


BONY ANATOMY OF THE ANKLE AND FOOT (1)

- Osseous parts
  - Lower ends of the tibia and fibula
  - Calcaneus
  - Talus
  - Tarsal bones: navicular, cuboid, and three cuneiforms
  - Metatarsals and (proximal, middle & distal) phalanges
BONY ANATOMY OF THE ANKLE AND FOOT (2)

BONY ANATOMY OF THE ANKLE AND FOOT (3)

• Joints
  - Distal tibiofibular joint
  - **Talocrural (ankle) joint**: the distal ends of tibia and fibula articulate with the body of the talus
  - Subtalar (talocalcaneal) joint
  - Transverse tarsal (midtarsal) joint
  - Tarsometatarsal joints
  - Intermetatarsal joints
  - Metatarsophalangeal (MTP) joints
  - Interphalangeal (IP) joints

BONY PALPATION
LATERAL AND MEDIAL MALLEOLI

- Two large prominent knobs on either side of the ankle
- **Lateral malleolus**: the most distal end of the fibula
- **Medial malleolus**: situated at the distal end of the tibia
- Lateral malleolus extends further distally and is more posterior than the medial malleolus → lateral motion of the ankle is more limited than medial motion
- Palpation:
  - Sit or supine
  - Explore and compare the shapes, lengths and positions of the two malleoli

CALCANEUS (1)

- Forms the heel of the foot
- Situated beneath the talus and projects two inches posteriorly from the malleoli
- **Sustentaculum tali**
  - Located on the medial side of the calcaneus, roughly one inch (the distance of a finger width) distal to the medial malleolus
  - Like a plank to support the talus on the calcaneus
**Palpating the Sustentaculum Tali (1)**

- Place the ankle in a neutral position and locate the **medial malleolus**
- Slide about **1 inch** distal to the small tip of the sustentaculum
- *Passively inverting* the foot to make it easily accessible

**Calcaneus (2)**

- **Peroneal trochlea (fibular tubercle)**
  - Located on the lateral side of the foot
  - A small, superficial prominence to help stabilize the peroneal muscles
  - Roughly 1 inch distal to the lateral malleolus
  - Palpation:
    - With the ankle in a dorsiflexed position, locate the lateral malleolus
    - Slide roughly 1 inch inferiorly and explore for the small, superficial trochlea
    - Passively evert the foot to make it easily accessible
**CALCANEUS (3)**

- The tuberosity of the calcaneus
  - A rounded region located along its posterior surface
  - **Medial tubercle:**
    - Lies on the medial plantar surface of the calcaneus
    - A broad and large bony prominence (larger than lateral tubercle)
    - An attachment site for *abductor hallucis, flexor digitorum brevis* and *plantar aponeurosis* (fascia)
    - Clinical significances: a heel spur may become tender to palpation

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**PLANTAR FASCIA**

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**PALPATING THE CALCANEAL TUBEROSITY**

Calcaneal Tuberosity

Medial Tubercle

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**BONY ANATOMY OF THE MEDIAL FOOT**

Biel A. Trial guide to the body: how to locate muscles, bones, and more. 3E. P 349.
**First Metatarsal Bone and First Metatarsophalangeal (MTP) Joint**

- **First metatarsal**: situated at the medial foot
  - **The head** articulates with the first proximal phalange → First MTP joint
  - **The base** articulates with the first (medial) cuneiform
- **First MTP joint** is the joint most frequently involved in **gout and bunion**.
  - Palpation:
    - From the proximal phalanx of the big toe, moving proximally, the head of the first metatarsal bone and the joint are palpable at the ball of the foot
    - Palpate the crest between the base of 1st metatarsal and the first (medial) cuneiform

**First (Medial) Cuneiform**

- **The first cuneiform** serves as an attachment for the *tibialis anterior, peroneus (fibularis) longus and tibialis posterior* muscles.
  - Along its dorsal and medial surfaces, the other two cuneiforms can be located
  - The 1st cuneiform projects distally (about ½ inch) further than the other cuneiform bones
  - Palpation:
    - Just proximal to the base of the 1st metatarsal on the medial and dorsal sides to palpate the joint line
    - Move just proximal to the joint line to palpate the 1st cuneiform

**Palpating the Cuneiforms**

**Tuberosity of the Navicular Bone**

- Navicular articulates with five other bones: proximally with the talar head, distally with the three cuneiforms, and laterally with the cuboid bone
  - The superficial tuberosity bulges out of the medial side of the foot
  - An attachment site for the *tibialis posterior muscle* and the *spring ligament*
  - Palpation: *
    - Locate the base of the 1st metatarsal
    - Method 1: sliding along the medial foot, move proximally across the surface of the 1st cuneiform (about a finger width) to feel the bony prominence
**Bony Anatomy of the Foot**

[Image of bony anatomy of the foot]

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**Palpating the Navicular Tuberosity (1)**

[Image of the navicular tuberosity]

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**Palpating the Navicular Tuberosity (2)**

- Method 2: the tuberosity lies approximately 1-2 inches distal to the medial malleolus.

[Image of palpating the navicular tuberosity]


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**Anatomy of the Talus**

[Image of anatomy of the talus]

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**Head of the Talus**

- Anterior portion of the talus and articulation with the navicular bone
- Palpation:
  - Place the ankle in neutral position and locate the navicular tubercle
  - Method 1: slide proximally off the tubercle to the head of the talus
  - Method 2: draw a line between the medial malleolus and navicular tubercle → the head will be located around the mid position
  - Passively invert and evert the foot → when the foot is everted, the talar head will be more pronounced.

**Trochlea of the Talus**

- The large, superior prominence of the body of the talus
- Situated between the distal ends of the fibula and tibia
- The anterior part of the trochlea is located between the malleoli
- Palpation:
  - Passively invert and plantar flex the foot
  - Draw a horizontal line connecting the malleoli and drop inferiorly off the center of the line
  - A bony prominence will be more prominent near the lateral malleolus
BONY ANATOMY OF THE LATERAL FOOT

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TARSAL SINUS

- A depression located distally and anteromedially to the lateral malleolus of the fibula
- The space leads to the subtalar joint cavity between the talus and the calcaneus
- The extensor digitorum brevis muscle and fatty pad overlie the tarsal sinus
- Palpation:
  - Directly press into the depression just anteromedial to the lateral malleolus
  - Passively inverting the foot, the lateral side of the talar neck may be palpated by pushing your finger deeper into the sinus

PALPATING THE TARSAL SINUS


Houglum PA & Bertoti DB. Brunnstrom’s Clinical Kinesiology. 6 E. P 491.

PALPATING THE TALAR NECK

- The talar neck is located between the head and the trochlea
- The subject’s foot must be in plantarflexion in order to palpate the posterior aspect of the neck of the talus

FIFTH METATARSAL BONE AND FIFTH  METATARSOPHALANGEAL (MTP) JOINT

- **Fifth metatarsal:**
  - The head articulates with the fifth proximal phalange → Fifth MTP joint
  - Situated at the lateral side of the ball of the foot
  - The base flares out and is called the **styloid process of the fifth metatarsal**
    - The dorsal surface of the base of the fifth metatarsal: an attachment site of *peroneus (fibularis) brevis and tertius* muscles

- **Palpation:**
  - Probe proximally along the lateral shaft of the 5th metatarsal to its flared base

CUBOID BONE*

- This cube-shaped bone is surrounded by the 4th and 5th metatarsals, the 3rd cuneiform, the navicular and the calcaneus.
- Its dorsal surface is partially covered by the belly of *extensor digitorum brevis* → the cuboid is only partially accessible

- **Palpation:**
  - Draw an imaginary line from the styloid process of the 5th metatarsal to the lateral malleolus
  - Following this line, at roughly half an inch from the styloid process, is the cuboid → move slightly proximally from the styloid process of the 5th metatarsal

PALPATING THE 5TH METATARSAL BONE AND THE 5TH MTP JOINT

PALPATING THE CUBOID

*Biel A. Trial guide to the body: how to locate muscles, bones, and more. 3E. P 359.*
**SESAMOID BONES OF THE FIRST METATARSAL**

- Located along the plantar surface of the first metatarsal head and imbedded in the tendon of the flexor hallucis brevis
- Usually there are two, but sometimes more are present.
- Palpation:
  - Locate the head of the first metatarsal
  - Slide around to its plantar surface at the ball of the foot
  - Passively extend the first toe and use you thumbpad to explore the surface for the small sesamoid bones

**DELTOID LIGAMENT (MEDIAL COLLATERAL LIGAMENT)**

- Several ligaments originate at the medial malleolus and fan distally to attach at the medial tubercle of the talus, sustentaculum tali, and the navicular tuberosity
  → within this triangle, it may be palpated.
- The ligament is designed to prevent lateral motion of the ankle joint.
- Tenderness or pain elicited during palpation → a tear from eversion ankle sprain
- Palpation:
  - Locate the medial malleolus and sustentaculum tali
  - Slide distally from the medial malleolus at a 45° and palpate the anterior and posterior fibers
PALPATING THE DELTOID LIGAMENT

ANATOMY OF THE FLEXORS OF THE ANKLE AND FOOT (1)

- Buried deep to the gastrocnemius and soleus on the posterior leg
- The tendons curve around the medial malleolus and pass deep to the flexor retinaculum

- Tibialis posterior
  - Muscle actions: Invert the foot and plantar flex the ankle

- Flexor digitorum longus
  - Muscle actions: flex the 2nd-5th toes/ invert the foot/ weak plantar flexion the ankle

- Flexor hallucis longus
  - Muscle actions: flex the first toe/ invert the foot/ weak plantar flexion the ankle

ANATOMY OF THE FLEXORS OF THE ANKLE AND FOOT (2)
**Flexors of the Ankle and Foot (2)**

- **Palpation:**
  - Locate the medial malleolus
  - Have your partner invert and plantar flex his foot
  - Slide off the malleolus posteriorly and proximally into the space between the posterior shaft of the tibia and the calcaneal tendon
  - It is difficult to isolate specific tendons; however, tibialis posterior will be the most anterior.

**Posterior Tibial Artery**

- The main blood supply to the foot
- It extends from the popliteal artery.
- Its pulse is not always easy to find. However, it can be felt just inferior and posterior to the medial malleolus, the foot is relaxed in a non-weight-bearing position
- **Palpation:**
  - Locate the medial malleolus
  - Using two fingerpads, slide posterior to the malleolus and feel for the pulse of the artery.
ANATOMY OF THE TIBIALIS ANTERIOR

- A large and superficial muscle lies directly lateral to the tibial shaft
- The strongest dorsiflexor and inverter of the foot → its extreme weakness can result in a drop-foot
- Muscle actions: invert the foot and dorsiflex the ankle
- Palpation:
  - Ask the subject to dorsiflex and invert the foot
  - Palpate the muscle on the lateral side of the tibial shaft and track its distal attachment into the medial cuneiform
  - The tendon becomes quite prominent where it crosses the ankle joint

PALPATING THE TIBIALIS ANTERIOR
MUSCLE AND TENDON

ANATOMY OF THE EXTENSOR HALLUCIS
LONGUS

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**Extensor Hallucis Longus Tendon**

- Situated immediately lateral to the tibialis anterior tendon
- Muscle actions: extend the first toe/dorsiflex the ankle/invert the foot
- The tendon stands out immediately lateral to the tibialis anterior tendon at the level of the ankle joint
- Palpation:
  - Ask the subject to extend his first toe
  - Palpate the tendon from the first toes to the dorsal surface of the ankle

**Anatomy of the Extensor Digitorum Longus**

- Lies lateral to the extensor hallucis longus tendon
- Its four tendons are clearly palpable on the dorsal surface of the foot
- Muscle actions: extend the 2nd-5th toes/ dorsiflex the ankle/evert the foot
- Main dorsiflexors of the foot: tibialis anterior, extensor hallucis longus, and extensor digitorum longus muscles
- Palpation:
  - Ask the subject to extend his toes
  - Follow the tendons toward the ankle
  - Follow the tendon proximally as it merges into its muscle belly

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*Smith L.K. et al. Brunstrom’s clinical kinesiology. 5E. P 353.*

*Biel A. Trial guide to the body: how to locate muscles, bones, and more. 3E. PP 371 & 372.*
PALPATING THE EXTENSOR DIGITORUM LONGUS


DORSAL PEDAL ARTERY

- A branch of the anterior tibial artery → the secondary blood supply to the foot
- Located between the first and second metatarsal bones (or between the extensor hallucis longus and extensor digitorum longus tendons) on the dorsum of the foot
- Palpation:
  - Locate the first and second metatarsal bones or laterally to the hallucis longus tendon
  - Place two fingerpads between the two bones and use gentle pressure to explore the pulse

PALPATING THE DORSAL PEDAL ARTERY

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ANATOMY OF THE LATERAL COLLATERAL LIGAMENT

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**Lateral Collateral Ligament (1)**

- **Anterior talofibular ligament**: runs from the anterior portion of the lateral malleolus to the lateral aspect of the talar neck
  - A high incidence of ankle sprain → the first of the three lateral collateral ligament to undergo stress when the ankle is inverted and plant flexed
  - Palpation: easily palpated in the sinus tarsi (tarsal sinus)
- **Calcaneofibular ligament**: from lateral malleolus to the lateral wall of the calcaneus
  - In severe ankle sprains, after the anterior talofibular ligament has been torn, this ligament may be torn → Loss of function of both ligaments results in ankle instability.

**Lateral Collateral Ligament (2)**

- **Posterior talofibular ligament**: from the posterior edge of the lateral malleolus to the small lateral tubercle on the posterior aspect of the talus
  - Stronger than the two other collateral ligaments → involved only in the most severe injuries to the ankle (dislocations)
  - Its primary function is to *prevent forward slippage of the fibula onto the talus*

**Anatomy of the Peroneal Muscles**

- These tendons pass immediately behind the lateral malleolus as they cross the ankle joint.
- The brevis is closer to the malleolus, grooving the bone as it passes, while the longus lies just posterior to the brevis
- Muscle actions: evert the foot and assist to plantar flex the ankle
- Palpation:
  - Ask the subject to evert his foot
  - Follow the peroneus longus proximally toward the head of the fibula and then distally to their tendons around the back of the lateral malleolus
  - Follow the brevis tendon to the base of the fifth metatarsal
**Triceps Surae Muscles**

- Two large muscle masses of the posterior leg have a common distal attachment called **calcaneal (Achilles) tendon**
- **Gastrocnemius**: has two heads and crosses *two joints*
  - Muscle actions: flex the knee/ plantar flex the ankle
- **Soleus**: deep to the gastrocnemius, yet its medial and lateral fibers bulge from the sides of the leg extend further distal than the gastrocnemius
  - Muscle action: plantar flex the ankle
- **Palpation**:
  - Ask your partner to stand on his toes or plantar flex the ankle
  - Compare the difference in flexed knee and extended knee

**Palpating the Triceps Surae Muscles**

- When the knee is flexed, the gastrocnemius muscle is shortened and ineffectual as a plantar flexor. → isolated contraction of the soleus
  - Prone lying
  - Knee flexion and ankle plantarflexion
**Plantar Aponeurosis (Plantar Fascia)**

- A thick, superficial band of fascia originating from the medial tubercle of the calcaneal tuberosity to the metatarsal heads
- Function: support the longitudinal arch of the foot
- Palpation:
  - Crossing the ball of the foot, draw an imaginary triangle extending down to the heel
  - Passively flex and extend the toes, noting how this movement affects the tension of this fascia

**Muscles of the Foot (1) – Dorsal Aspect**

- **Extensor digitorum brevis**: situated on the dorsal surface of the foot
  - Its small belly lies deep to the extensor digitorum longus tendons and bulges out of the sinus tarsi
  - Muscle actions: extend the 2nd-4th toes
  - Palpation:
    - Locate the lateral malleolus. Slide two inches off the malleolus toward the fifth toe.
    - Ask your partner to extend her toes against your resistance to feel the muscles contract → Note how the belly forms a dense mound over the sinus tarsi

**Anatomy of the Muscles of the Foot**

**Palpating the Extensor Digitorum Brevis**

- Smith LK, et al. Brunnstrom’s clinical kinesiology. 5E. P 356.
**Muscles of the Foot (2) – Plantar Surface**

- Three superficial muscles located deep to the plantar aponeurosis form the first layer of the foot
  - *Flexor digitorum brevis*, *abductor digiti minimi*, *abductor hallucis*
    - Medial to the flexor digitorum brevis
    - Muscle action: abduct the first toe/assist to flex the first toe
    - Palpation:
      - Locate the medial surface of the foot
      - Ask the subject to flex or abduct his first toe against your resistance

**Summary**

- Find and recognize the shape and position of the bone in the ankle and foot
- Palpate the bony feature and recognize different structures around the bony landmark in the ankle and foot
- Recognize and palpate the muscle actions in the lower leg and the foot and trace their attachments