



**SCS Continuing Education
presents:**

Basic Structure and Function of the Ankle and Foot

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Introduction:

Hello and welcome to this program from **SCS Continuing Education!** Knowledge is the key to success for ourselves and our patients. This easy-to-use point and click program allows you to navigate through text and visual aides designed to provide a comprehensive view of the material covered. Please feel free to contact **Shane Smith** at ceuarmy@yahoo.com if you have any questions.

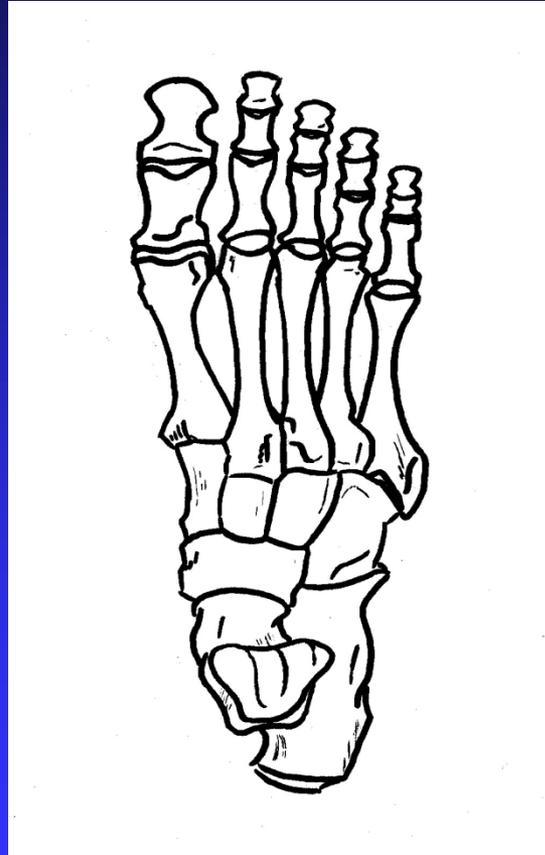
Course Abstract and Objectives:

The objective of this home study course is to provide the learner with a computer based tutorial that will give them the means to learn the basic anatomy and function of the ankle and foot. A mastery test will be administered at the end of this home study course in order to ensure that competency of the material has been achieved.

Accreditation of this course does not necessarily imply the FPTA supports the views of the presenter or the sponsors.

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Basic Structure and Function of the Ankle and Foot



by Shane Smith PTA, RT(R)
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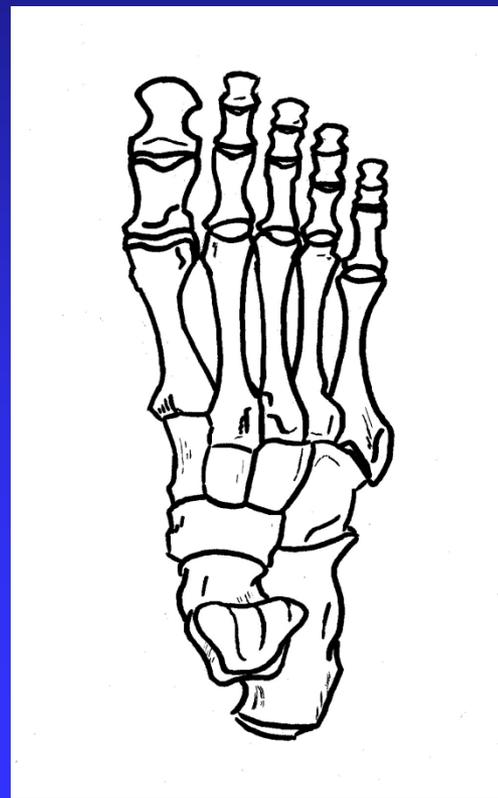
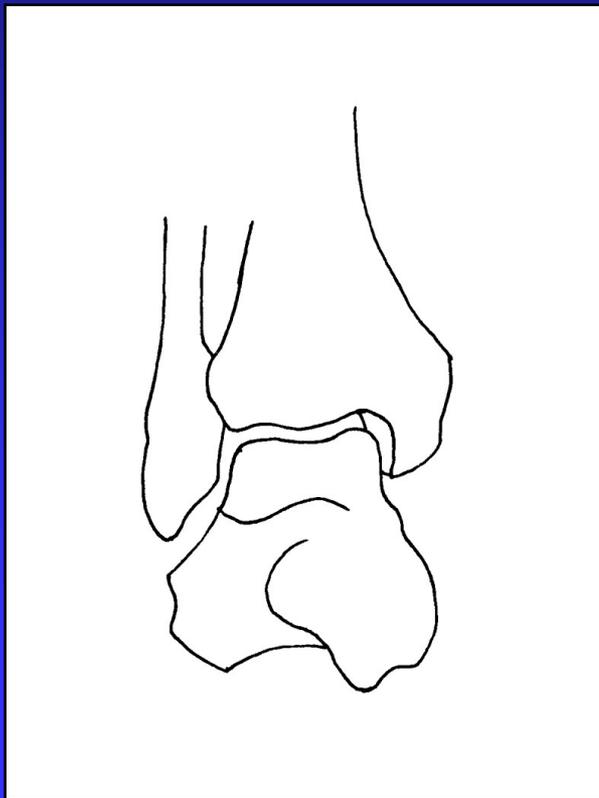
CHAPTERS:

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Bony Anatomy

The Foot and Ankle

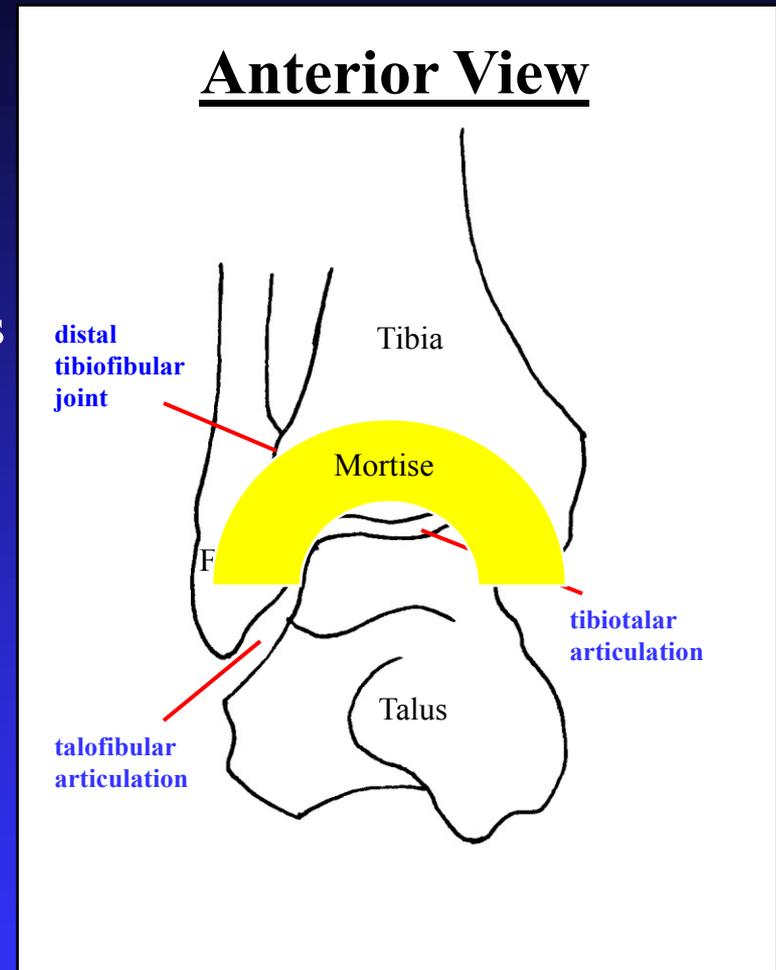
There are 28 bones and 25 joints in the foot and ankle complex. These structures are configured to accommodate the stability and mobility responsibilities of the foot and ankle on various surfaces during varying degrees of weight bearing.



The Ankle

The ankle joint or “talocrural joint” is a synovial hinge joint that is made up of the articulation of 3 bones. The 3 bones are the tibia, the fibula and the talus. The articulations are between the talus and the tibia and the talus and the fibula.

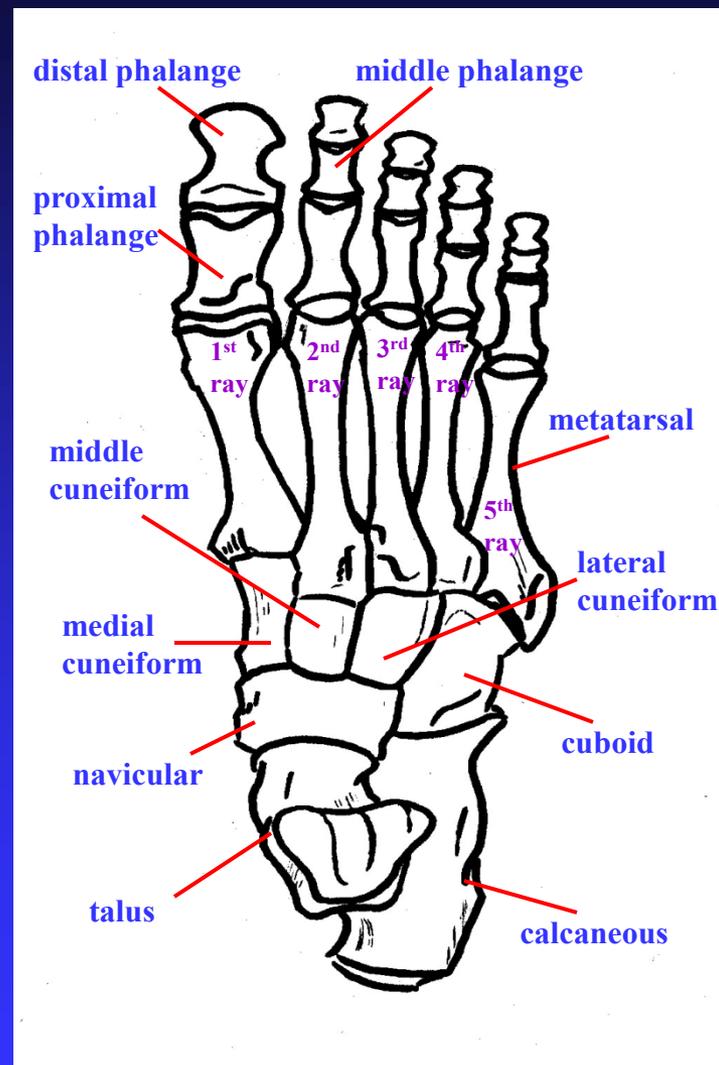
The “mortise” is the concaved surface formed by the tibia and fibula. The mortise is adjustable and is controlled by the proximal and distal tibiofibular joints. The talus articulates with this surface and allows dorsiflexion and plantar flexion.



The Foot

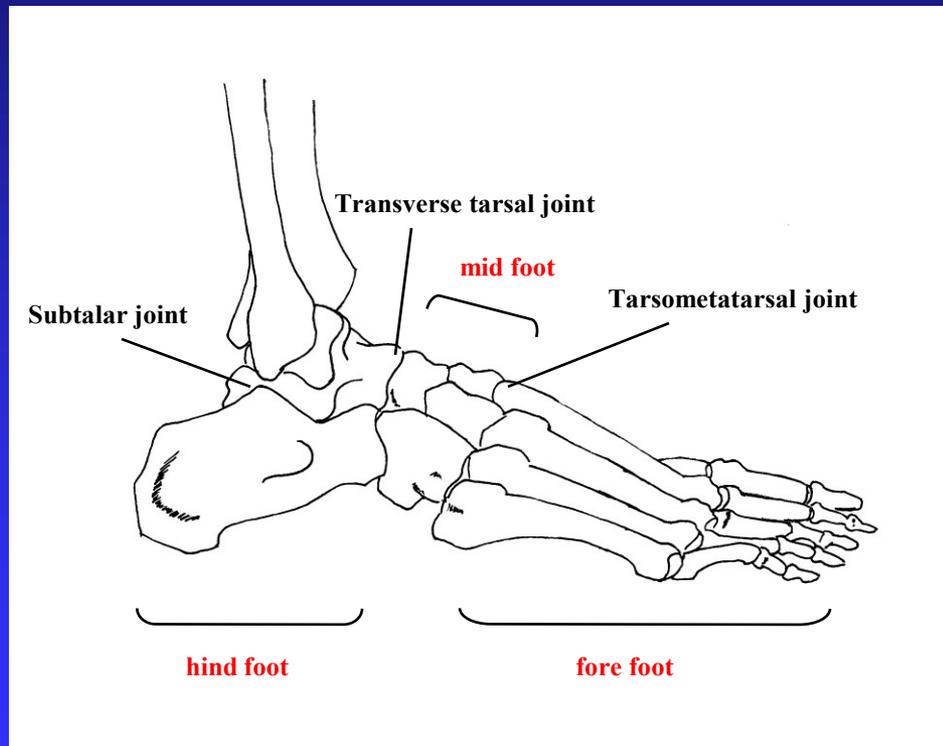
Let's identify the bones of the foot. Notice that the great toe only has a proximal and distal phalange. There are also 2 sesamoid bones (not shown) located under the 1st MTP joint.

The toes are also known as “rays.” The great toe is the 1st ray, the next toe is the 2nd ray, the middle toe is the 3rd ray, the next lateral toe is the 4th ray and the “little” toe is the 5th ray.

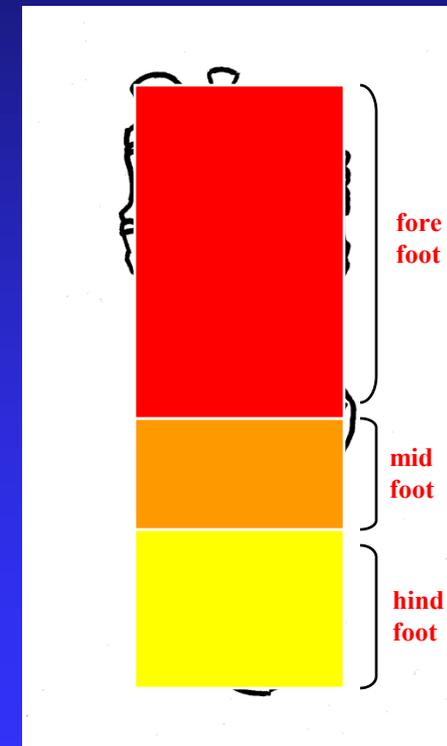


The Foot

The foot is divided into 3 categories; the fore foot (metatarsals and phalanges), mid foot (cuboid, navicular and 3 cuneiforms) and hind foot (talus and calcaneous).



Lateral foot



AP foot

Note: The joints will be discussed later in the tutorial.

Origins and Insertions of Muscles

In this chapter, we will review the origins and insertions of the muscles of the foot and ankle. Note that all of these muscles cross and act upon more than one joint.

For the purpose of this presentation, the muscles of the foot and ankle have been divided into anterior and posterior categories as well as anterior and plantar views of the foot.

Anterior

peroneus longus

peroneus brevis

extensor hallucis
longus

tibialis anterior

extensor digitorum
longus

extensor digitorum
brevis

Posterior

soleus

gastrocnemius

plantaris

tibialis posterior

flexor digitorum
longus

flexor hallucis
longus

Plantar View of Foot

lumbricales

flexor hallucis brevis

flexor digitorum brevis

Extensor Digitorum Longus

O: lateral condyle of tibia and $\frac{3}{4}$ shaft of fibula

I: proximal and distal phalanges 2-5

A: metatarsal (MP) and IP extension

Extensor Hallicus Longus

O: 1/2 shaft of fibula

I: base of distal phalanx of great toe

A: interphalangeal (IP) extension

Tibialis Anterior

O: lateral condyle and proximal $\frac{2}{3}$ shaft of tibia

I: 1st cuneiform and metatarsal

A: dorsiflexion and inversion

Peroneus Brevis

O: distal $\frac{2}{3}$ of fibula

I: 5th metatarsal

A: eversion

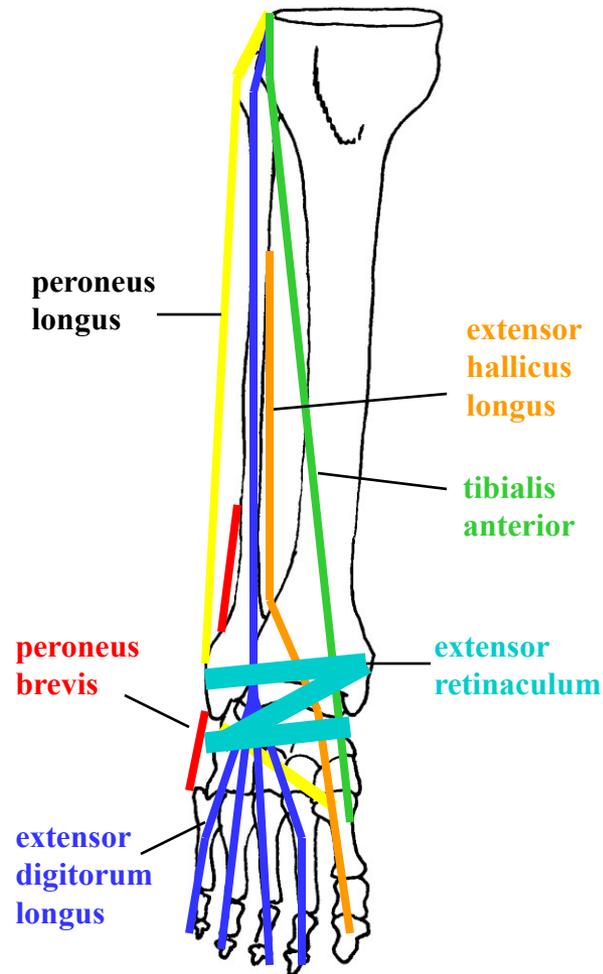
Peroneus Longus

O: head and $\frac{2}{3}$ shaft of fibula; lateral condyle of tibia

I: 1st cuneiform and metatarsal

A: eversion

Anterior View



The **extensor retinaculum** holds the anterior musculature to the ankle.

Soleus

O: fibula head and proximal 1/3 shaft and tibia

I: tendo calcaneus (Achille's tendon)

A: plantar flexion

Gastrocnemius

O: medial and lateral condyle of femur

I: tendo calcaneus (Achille's tendon)

A: plantar flexion

Tibialis Posterior

O: proximal 2/3 shaft of tibia and fibula

I: navicular, 3 cuneiforms and calcaneus

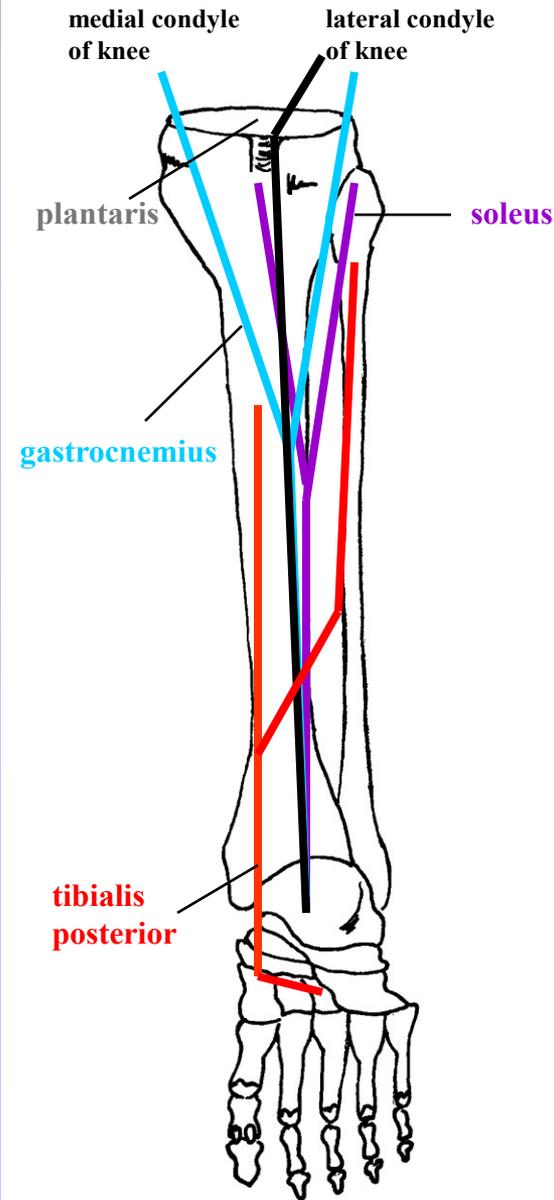
A: foot inversion

Plantaris

O: above lateral condyle of knee

I: calcaneal tendon and calcaneus

A: plantar flexion



Posterior View

Note: The gastrocnemius and the soleus are collectively known as the **triceps surae**.

Flexor Hallicis Longus

O: distal 2/3 shaft of fibula

I: base of distal phalanx of great toe

A: interphalangeal (IP) flexion

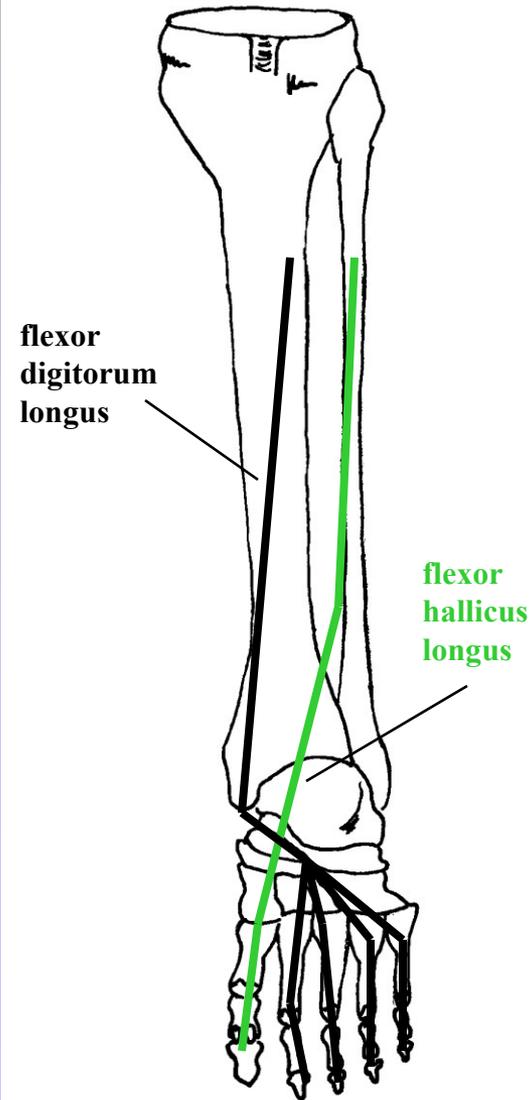
Flexor Digitorum Longus

O: middle 2/3 shaft of tibia

I: base of distal phalanges of four toes

A: PIP and DIP flexion

Posterior View



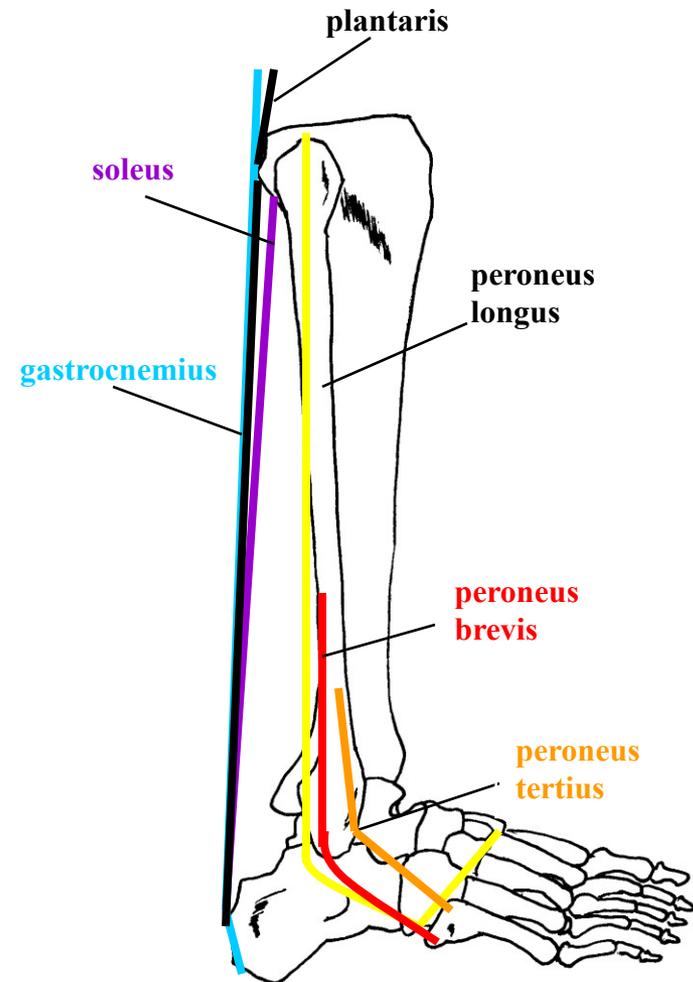
To the right is an illustration of some of the muscles reviewed in the previous slides as seen from a lateral view.

Peroneus Tertius

O: distal 2/3 of fibula

I: base of 5th metatarsal

A: dorsiflexion and eversion



Lateral View

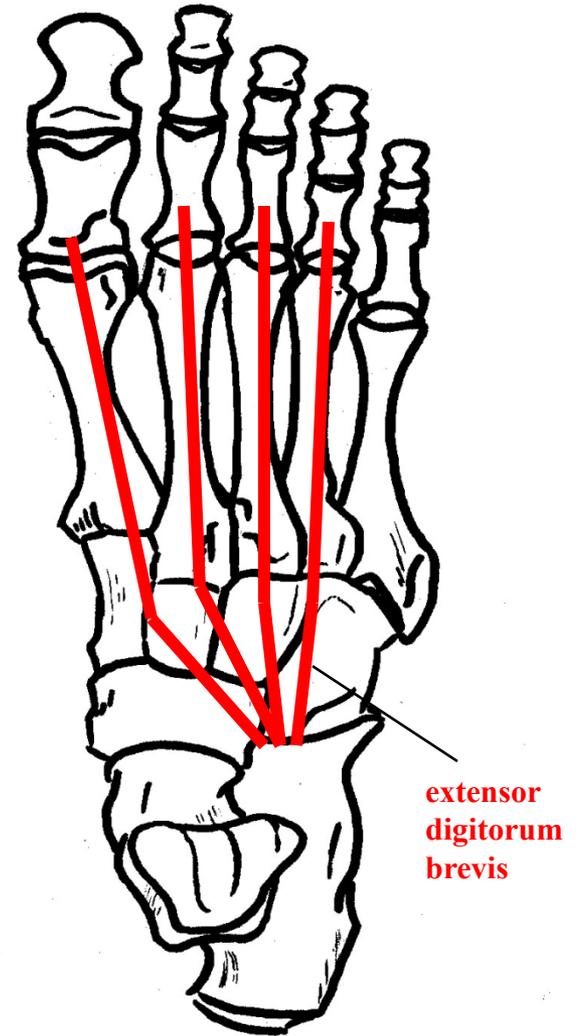
Extensor Digitorum Brevis

O: calcaneus

I: proximal phalanges of great toe and
toes 2-4

A: MP and IP extension

Anterior View of Foot



Lumbricales

O: tendons of Flexor Digitorum Longus

I: tendons of Extensor digitorum Longus
on toes 2-5

A: MP flexion

Flexor Hallicus Brevis

O: cuboid and lateral cuneiform

I: proximal phalanx of great toe

A: MP flexion

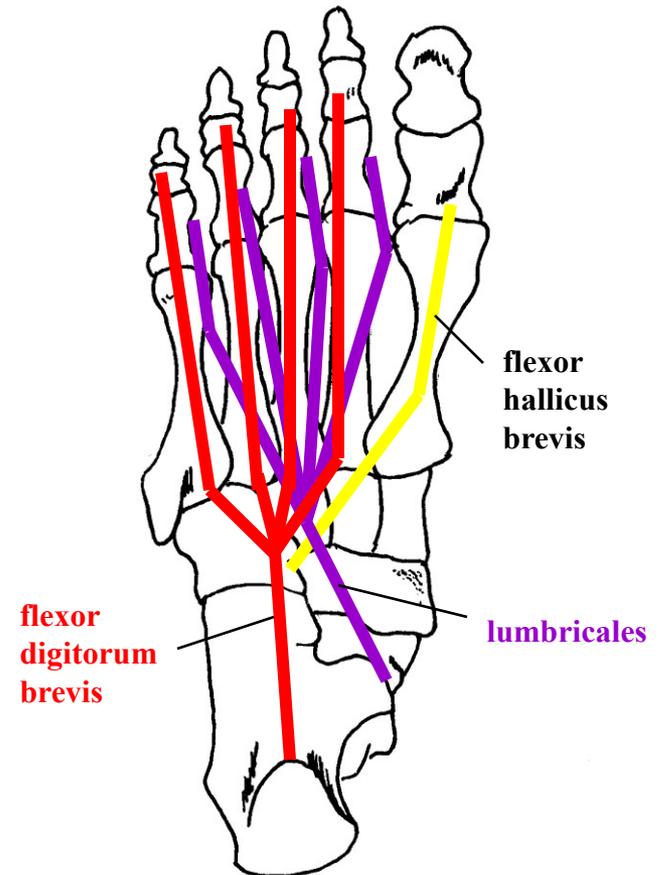
Flexor Digitorum Brevis

O: calcaneus

I: middle phalanges of toes 2-5

A: PIP flexion

Plantar View of Foot



Nerve Innervations

Nerve Innervations:

There are six nerves associated with the motor and sensory functions of the foot and ankle. They are:

Superficial peroneal nerve (L4-S1)

Deep peroneal nerve (L4-S1)

Lateral plantar nerve (S2-S3)

Medial plantar nerve (L5-S3)

Tibial nerve (L5-S2)

Tibial (medial popliteal) nerve (L5-S1)

Nerve Innervations:

Superficial peroneal nerve (L4-S1)

- Peroneus longus
- Peroneus brevis

Nerve Innervations:

Deep peroneal nerve (L4-S1)

- Tibialis Anterior
- Extensor hallucis longus
- Extensor digitorum longus
- Peroneous tertius

Nerve Innervations:

Lateral plantar nerve (S2-S3)

- 2nd, 3rd and 4th Lumbricales

Nerve Innervations:

Medial plantar nerve (L5-S3)

- Flexor Hallicus Brevis
- Flexor Digitorum Brevis
- 1st Lumbricale

Nerve Innervations:

Tibial nerve (L5-S2)

- Flexor Digitorum Longus
- Flexor Hallicus Longus
- Soleus
- Gastrocnemius
- Plantaris

Nerve Innervations:

Tibial (medial popliteal) nerve (L5-S1)

➤ Tibialis Posterior

Ligaments

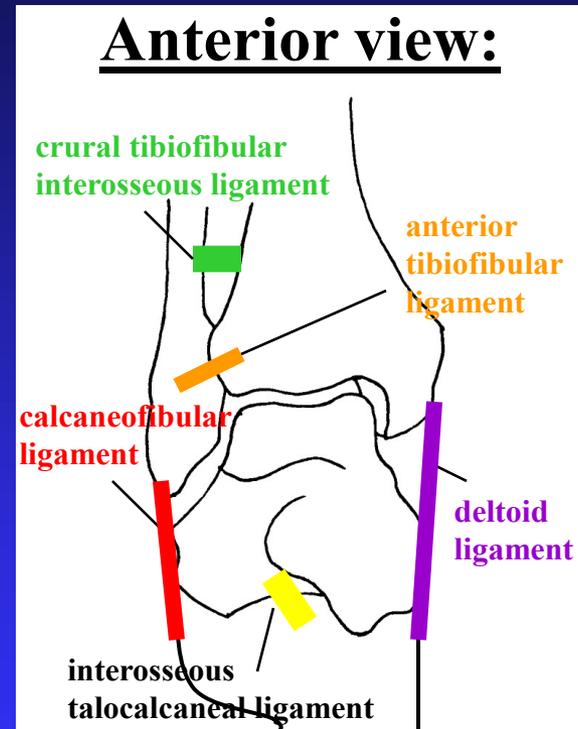
Ligaments:

The **crural tibiofibular interosseous ligament** attaches between the distal fibular and distal tibia and helps maintain the integrity of the mortise.

The **anterior tibiofibular ligament** and the **posterior tibiofibular ligament** (not shown) attaches to the lateral malleolus and the distal tibia and helps maintain the integrity of the of the distal tibiofibular joint.

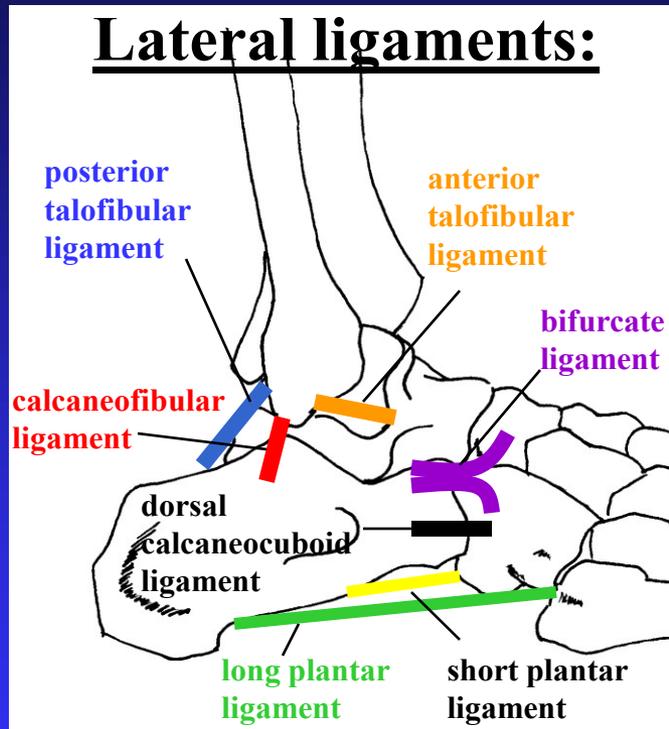
The **interosseous talocalcaneal ligament** is located within the tarsal canal and limits pronation.

The **ligamentum cervicis** (not shown) is also located within the tarsal canal but limits supination.



The calcaneofibular and deltoid ligaments will be discussed in the upcoming slides so they will not be defined here.

Ligaments:



The **LCL** (lateral collateral ligaments) is made up of the **anterior talofibular ligament**, the **posterior talofibular ligament** and the **calcaneofibular ligament**. This group of ligaments limits varus stresses on the ankle. The weakest and most commonly torn of this group is the anterior talofibular ligament.

The function of the **long plantar** and **short plantar** (or **plantar calcaneocuboid**) ligaments is to maintain the arch of the foot.

The **bifurcate ligament** attaches from the calcaneus to the navicular and the cuboid.

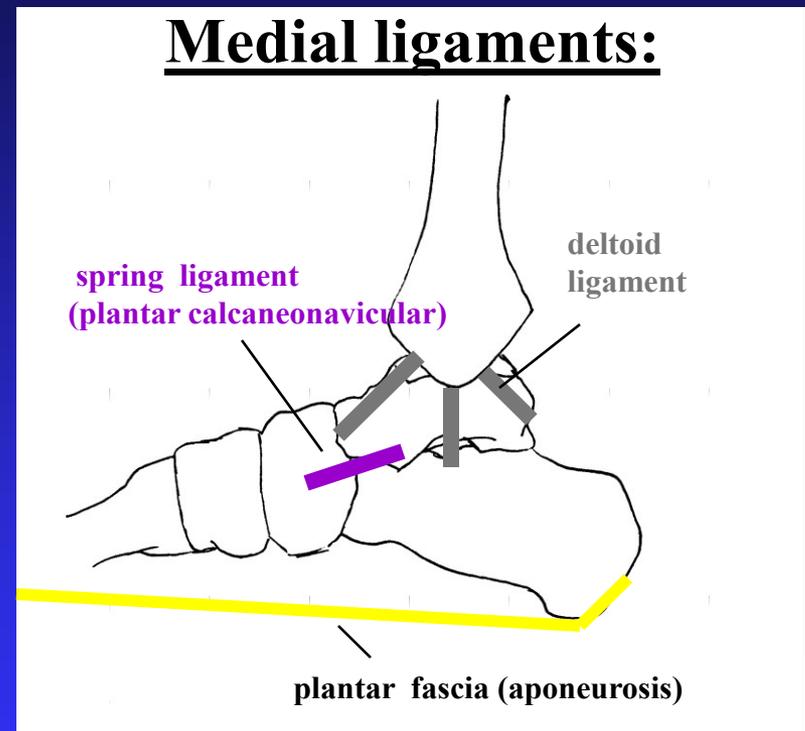
The **dorsal calcaneocuboid ligament** is found lateral and distal to the bifurcate ligament and also attaches from the calcaneus to the cuboid.

Ligaments:

The **MCL** (**medial collateral ligaments**) is made up of the three fan-shaped ligaments attached to the distal tibia, also known as the **deltoid ligament**. This group of ligaments limits valgus stresses on the ankle. This is a fairly strong group and not commonly torn.

The function of the **spring** (or **plantar calcaneonavicular**) ligament is to maintain the arch of the foot.

The **plantar fascia** (**aponeurosis**) is a sheet of connective tissue that runs from the calcaneous to the proximal phalanges.



Arthrokinematics

Arthrokinematics:

Now that we have been reoriented to the structure of the foot and ankle, let's review the key concepts related to motion. This section is split into three sections: **joint classification**, **range of motion** and the **arch**.

Let's begin by reviewing some terminology that will be used in the forthcoming slides.

- **synovial joint:** diarthrotic; allows one or more types of free movement; contain articular cartilage, synovial fluid, synovial membrane and a fibrous capsule.
- **inversion:** combination of supination, adduction and plantar flexion..
- **eversion:** combination of pronation, abduction and dorsiflexion.
- **compound joint:** made up of two or more bones and/or joints.
- **uniaxial joint:** 1 degree of freedom.
- **hinge joint:** monaxial; flexion/extension.
- **syndesmosis:** fibrous connection between a concave and convex surface.
- **condyloid joint:** allows all forms of angular movement except axial rotation.

Joint Classification:

Joint	Bones involved	Type
➤ talocrural (ankle)	talus, tibia and fibula	synovial; hinge
➤ proximal tibiofibular	proximal tibia and fibula	synovial
➤ distal tibiofibular	distal tibia and fibula	syndesmosis
➤ subtalar	talus and calcaneous	uniaxial
➤ transverse tarsal	talus, navicular, calcaneous and cuboid	compound
➤ tarsometatarsal	metatarsals, cuneiforms and cuboid	synovial
➤ metatarsophalangeal	metacarpal and proximal phalanx	condyloid; synovial
➤ interphalangeal	adjacent phalanges	synovial; hinge

Range of Motion:

Talocrural joint:

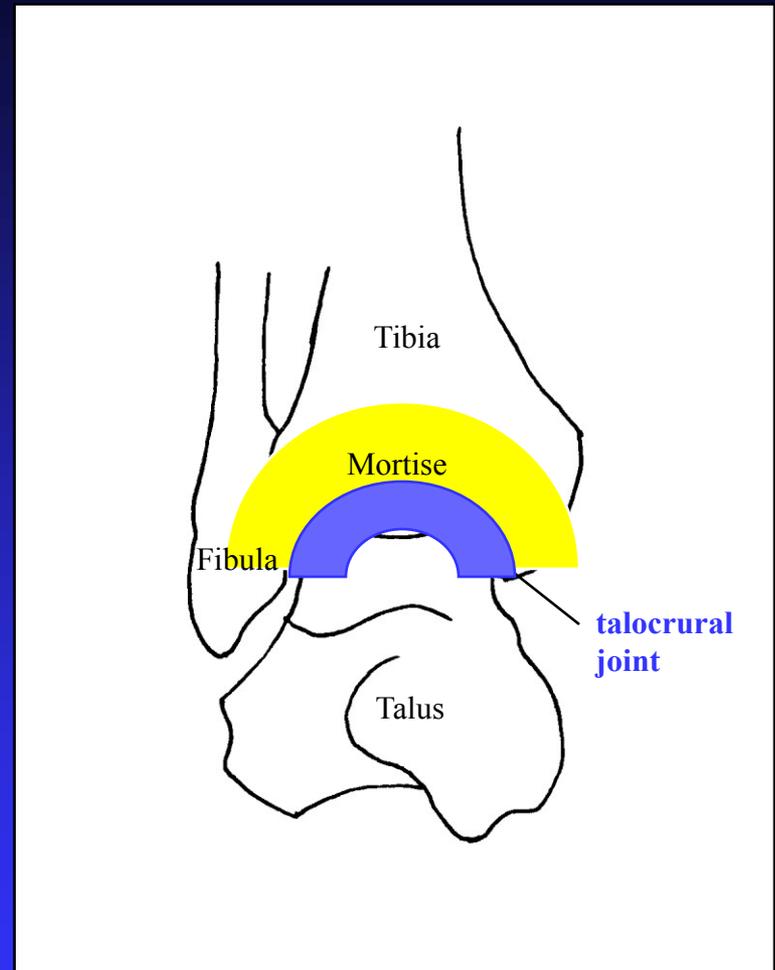
Most congruent joint in the body. It allows 1° of freedom: **dorsiflexion** and **plantar flexion**.

In open chain activity (non-weight bearing), the convex talus slides posteriorly during dorsiflexion and anteriorly during plantar flexion on the concave tibia and fibula.

In closed chain activity (weight bearing), the tibia and fibula move on the talus.

Total talocrural joint motion is approximately:

- **plantar flexion: 30°-50°**
- **dorsiflexion: 20°**



Range of Motion:

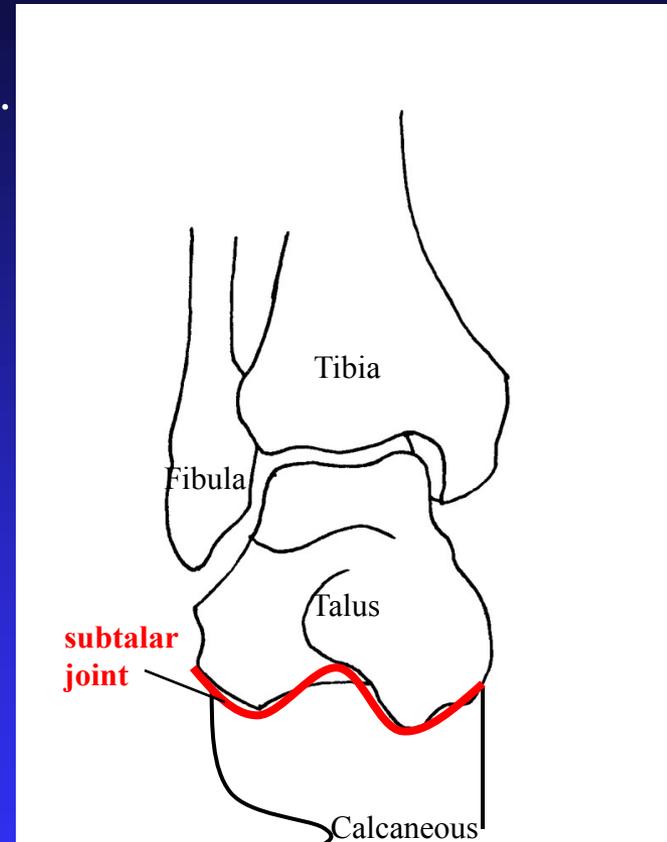
Subtalar joint:

Also known as the **talocalcaneal** joint. It is a triplanar, uniaxial joint which allows 1° of freedom: **supination** (closed packed position) and **pronation** (open).

Supination is accompanied by calcaneal inversion (**calcaneovarus**) and pronation is accompanied by calcaneal eversion (**calcaneovalgus**).

Total subtalar joint motion is approximately:

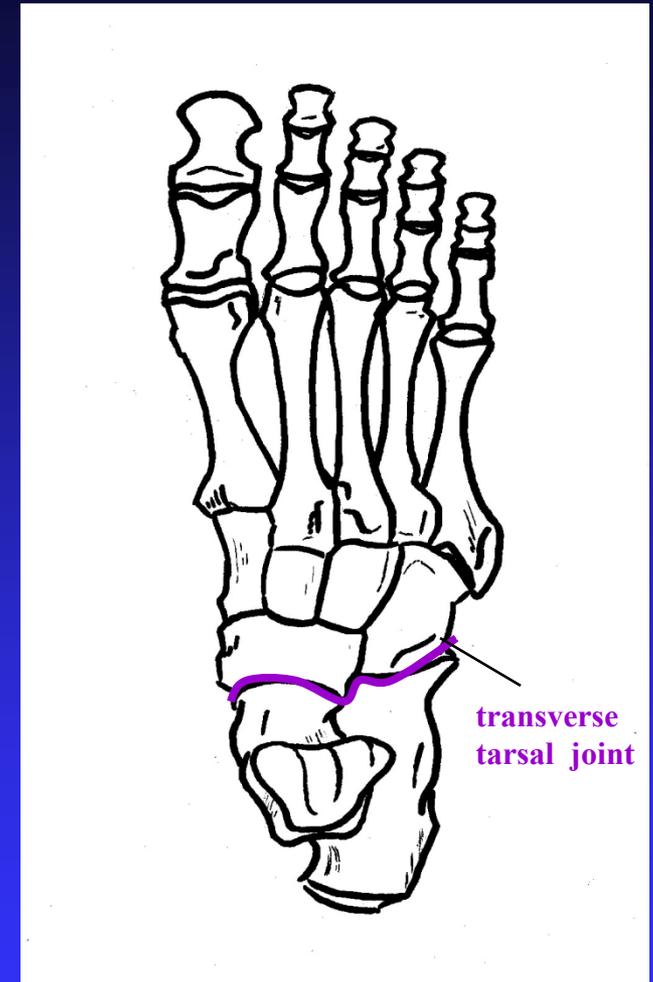
- **inversion: 20°**
- **eversion: 10°**



Range of Motion:

Transverse tarsal joint:

Also known as the **midtarsal** joint. It is a compound joint which allows compensation between the hind foot and fore foot on uneven terrain. It is made up of four bones (talus, calcaneus, cuboid and navicular) and two joints (talonavicular and calcaneocuboid).



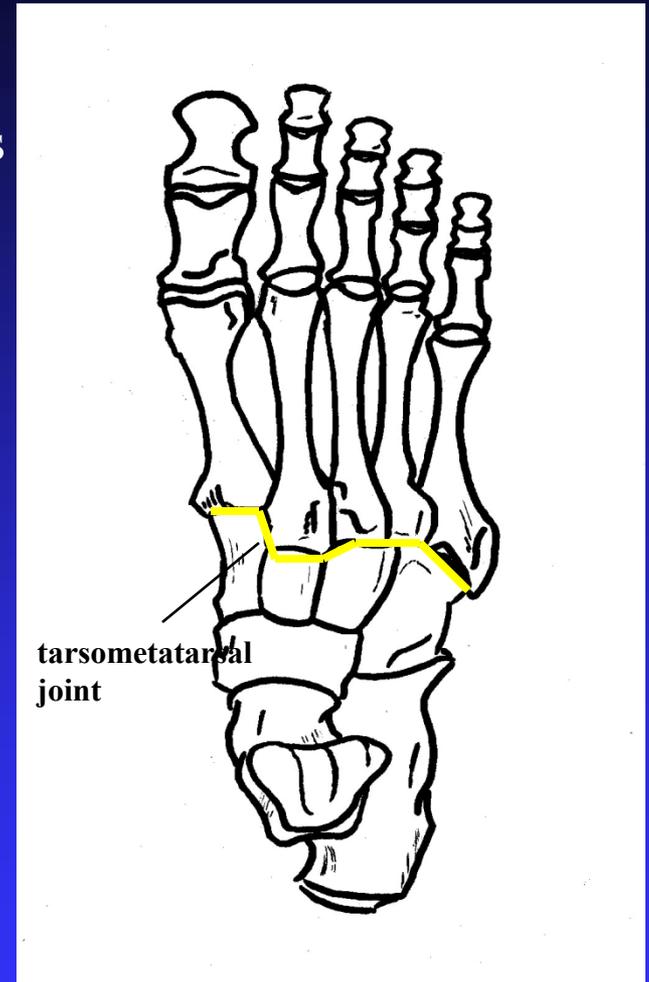
Range of Motion:

Tarsometatarsal joint:

Plane synovial joint formed by articulations with:

- 1st metatarsal and medial cuneiform
- 2nd metatarsal and middle cuneiform
- 3rd metatarsal and lateral cuneiform
- 4th and 5th metatarsals and cuboid

Continues the compensating movement available at the transverse tarsal joint once the maximum range of motion of that joint has been reached.



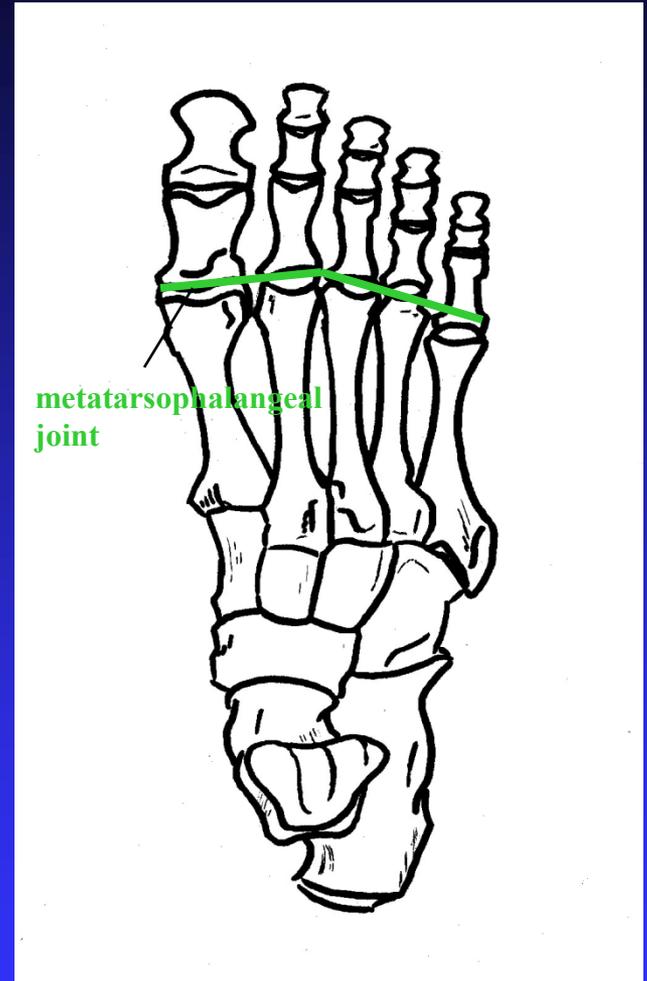
Range of Motion:

Metatarsophalangeal joint:

Also known as the “**ball of the foot.**” It is a condyloid synovial joint with 2° of freedom: flexion/extension and abduction/adduction.

Total MTP joint motion is approximately:

- **great toe flexion: 0°-45°**
- **toe flexion: 0°-40°**
- **great toe and toe extension: 0°-80°**



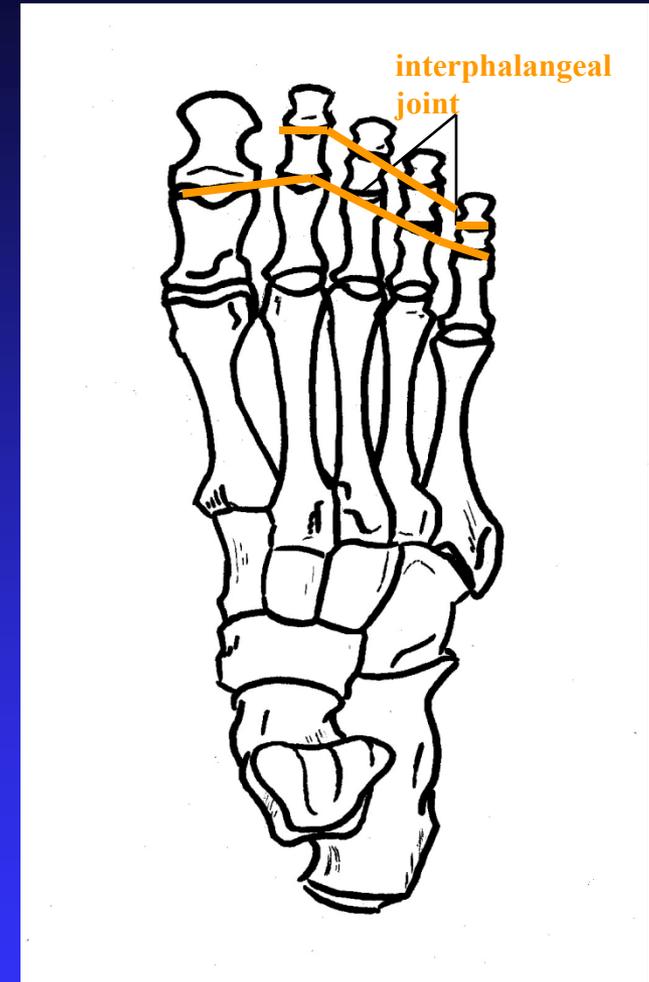
Range of Motion:

Interphalangeal joint:

IP joints are synovial hinge joints with 1° of freedom: flexion/extension.

Total IP joint motion is approximately:

- IP flexion of great toe: **0°-90°**
- PIP flexion: **0°-35°**
- DIP flexion: **0°-60°**
- great toe and toe extension: **0°-80°**

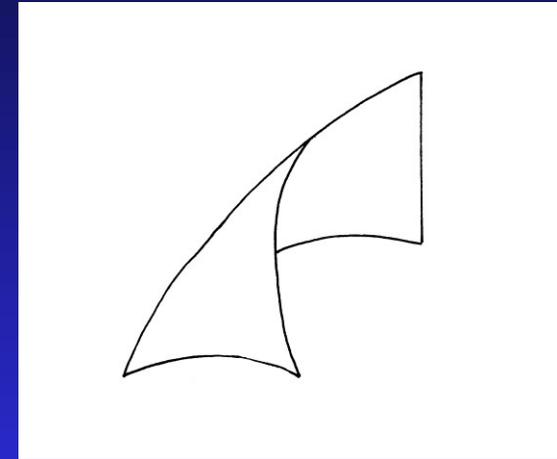


The Arch:

The arch, also referred to as a twisted osteoligamentous plate, is formed by the configuration of bones and ligaments in the foot. The arch plays a role in both mobility and stability.

In mobility, the arch acts as a shock absorber and allows the foot to adapt to changes in terrain.

In stability, it allows for weight distribution through the foot during weight bearing and converts foot to a rigid lever when pushing off during gait. The **plantar fascia** tightens during extension at the metatarsophalangeal joint. This tightening results in a shortening of the plantar fascia that keeps the midfoot and hind foot locked in an supinated position as the heel lifts off the ground. This is known as the **windlass mechanism**.



Common Clinical Findings

Now that we've reviewed and understand the basic structure and function of the foot and ankle, let's review some of the common clinical findings.

1. Achilles Tendinitis:

- inflammation caused by repetitive motions involving the Achilles tendon.
- RX: rest/immobilization, ice, ultrasound, NSAIDs, massage, stretching, exercise.

2. Achilles Tendinosis:

- progression of the inflammation of the Achilles tendon to degeneration of the tendon.
- RX: rest/immobilization, ice, ultrasound, NSAIDs, massage, stretching, exercise, surgery.

3. **Ankle Sprain:**

- injury involving one or more ligaments in the ankle.
- severity dependent upon number of ligaments involved, stretched vs torn and to the degree the ligament is torn.
- RX: rest/immobilization, ice, NSAIDs, compression wrap, elevation, surgery.

4. **Ankle Fracture:**

- injury involving one or more bones of the ankle.
- severity dependent upon number of bones involved, displaced vs non-displaced, protruding through skin.
- RX: rest/immobilization, ice, NSAIDs, compression wrap, elevation, surgery.

5. **Plantar Fascitis:**

- inflammation to the plantar fascia resulting in heel pain due to prolonged non-weight bearing (sitting) in some cases and prolonged weight bearing (standing) in others.
- RX: stretching exercises, ice, rest, NSAIDs, orthotics and/or shoe modification.

6. **Pes Planus:**

- also known as “flat foot”; partial or complete loss of arch.
- RX: weight loss, rest, NSAIDs, orthotics and/or shoe modification, surgery.

7. **Chronic Instability :**

- usually caused by a lateral ankle sprain that has not healed properly and/or repeated ankle sprains resulting in laxity in the LCL.
- RX: strengthening exercises, bracing, NSAIDs.

8. **Osteoarthritis :**

- breakdown and loss of cartilage in one or more joints.
- could be caused by flatfoot, jamming toe(s), fracture, severe sprain.
- RX: strengthening exercises, rest, NSAIDs, orthotics and/or shoe modification, bracing, steroid injections, surgery.

9. **Pes cavus:**

- excessively supinated foot as a result of a high arch
- loss of shock absorption ability or adaptation to uneven terrain
- RX: questionable results with conservative intervention.

Conclusion:

- Therapists, and their patients, are constantly challenged with how to compensate for loss of function of the foot and ankle in order to accomplish activities of daily living.
- The ankle joint is the most congruent joint in the body.
- The Achilles (calcaneal) tendon is the strongest tendon in the body.
- The structure and condition of the plantar arch can significantly effect how the foot and ankle function together.
- The 1st and 5th rays are the most mobile. The 2nd and 3rd rays are the most stable.
- Functional aspects of the foot:
 - provide base of support
 - accommodate supporting surface during gait
 - shock sbsorption
 - provide a rigid lever for push off during gait

Test:

There are **50** questions on this test. All answers can be found within the context of this program. The “hint” button located next to each question will provide you the information needed to answer the question. At any time during the test you may skip a question and return to it later. You must successfully answer 70% of the questions in order to receive credit for the course. To access the test, please close out of this course by clicking the “x” in the top right corner.

Good luck!!!

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