

## THE LEG, ANKLE & FOOT

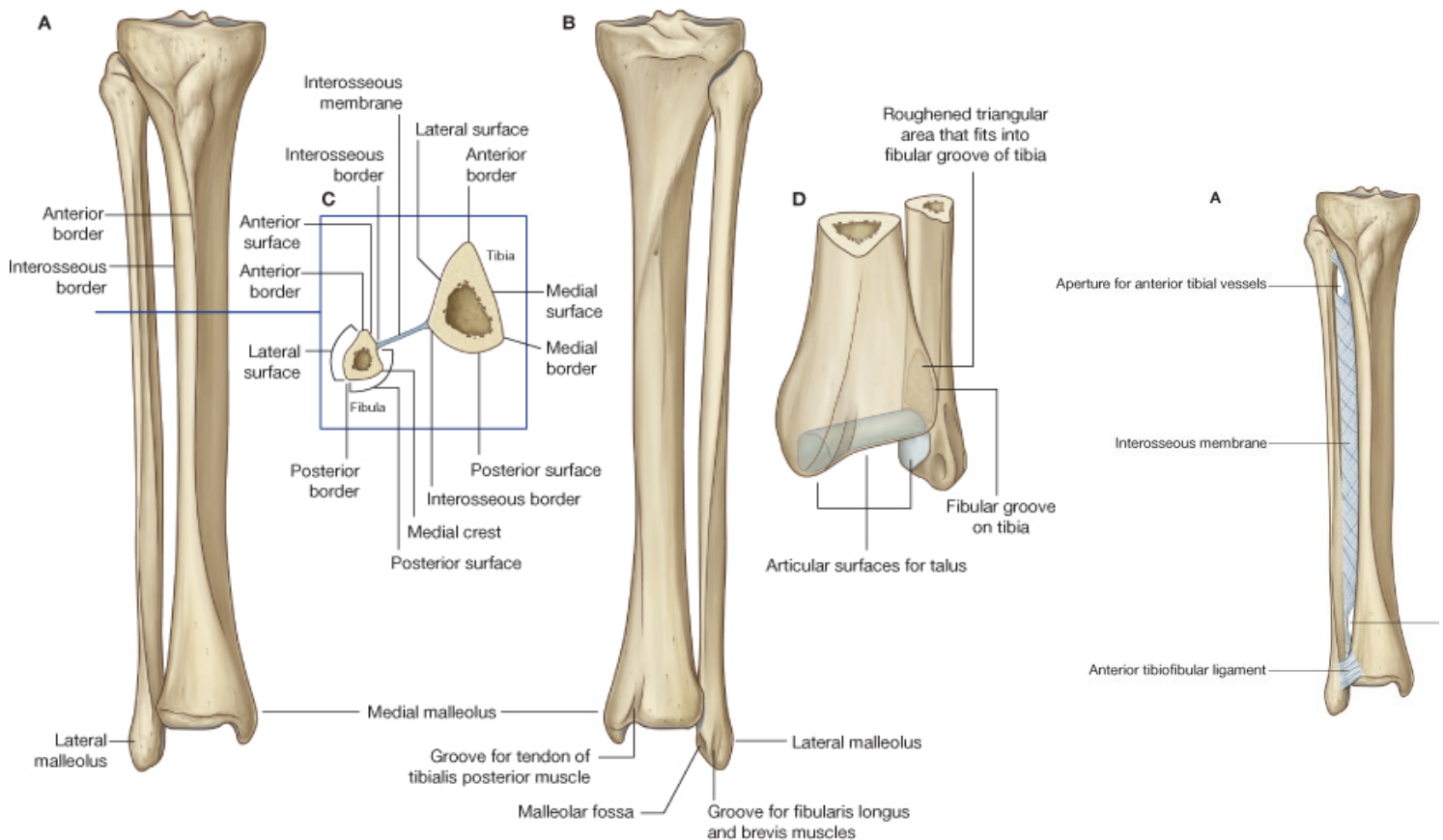
- Distal ends of tibia & fibula articulate with the bones of the ankle.

### **Shaft of the tibia:**

- Shaft of the tibia has a very **sharp anterior border** – subcutaneous so easy to palpate
- Laterally, facing the fibula, there is another sharp border – **interosseous border**.
- Δ transverse section of tibia is triangular in shape

### **Fibula:**

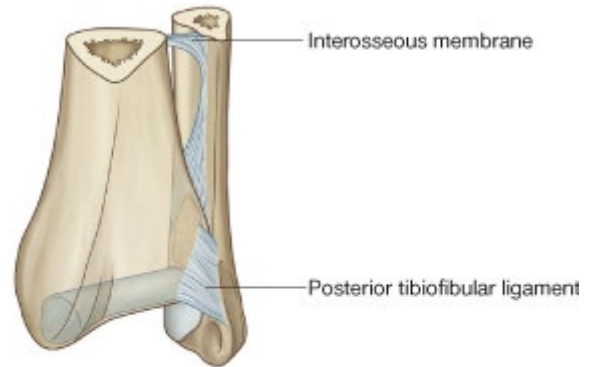
- Has a **head** at proximal end
- Head articulates with the lateral tibial condyle at the **proximal tibiofibular joint**.
- Below head of fibula is a narrow neck
- Thin shaft
- Shaft has an **interosseous border** which faces that of the tibia
- The interosseous borders of the tibia and fibula are united by **interosseous membrane**
  - Provides site for muscle attachment (as in the forearm)
  - Fibres slope obliquely downwards: tibia → fibula
  - Hole in upper membrane, which transmits **anterior tibial artery** from popliteal fossa → front of leg.



- **Soleal line** is only notable landmark on back of tibia

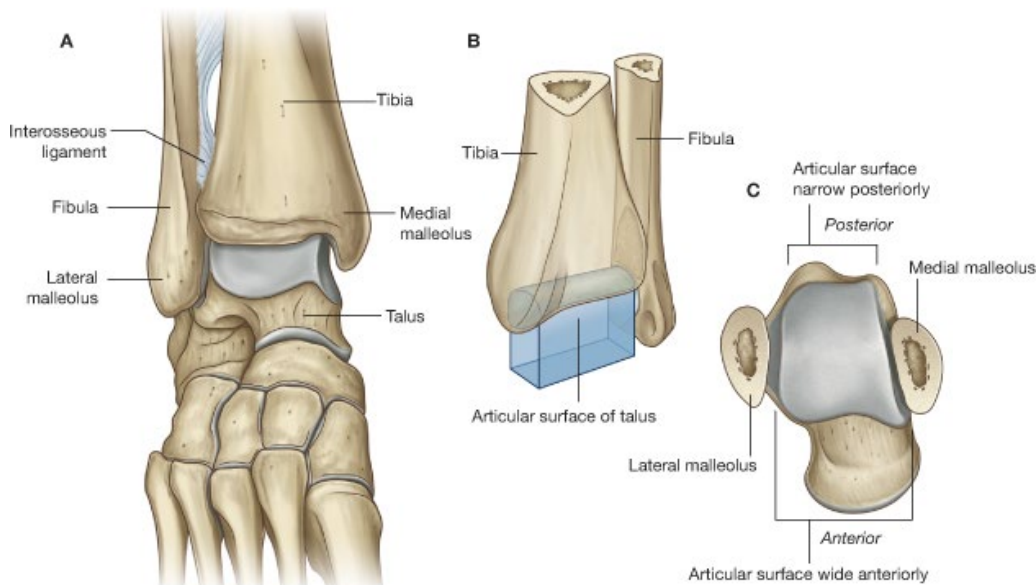
### ***Distal ends of the tibia & fibula:***

- Distal ends of the tibia & fibula are joined by the **distal tibiofibular joint**
- This is a **strong fibrous joint**
- The bones are linked further by the:
  - **Anterior tibiofibular ligament**
  - **Posterior tibiofibular ligament**
- Posterior tibiofibular ligament is particularly strong – projects low over back of ankle joint.
- Lower surface of tibia = quadrilateral articular surface
- Medially, tibia projects downwards as **medial malleolus**
- Laterally, the fibula projects downwards as the **lateral malleolus**:
  - Projects lower than the medial malleolus
  - Posterior to the medial malleolus
- Both medial and lateral malleoli can be palpated easily.



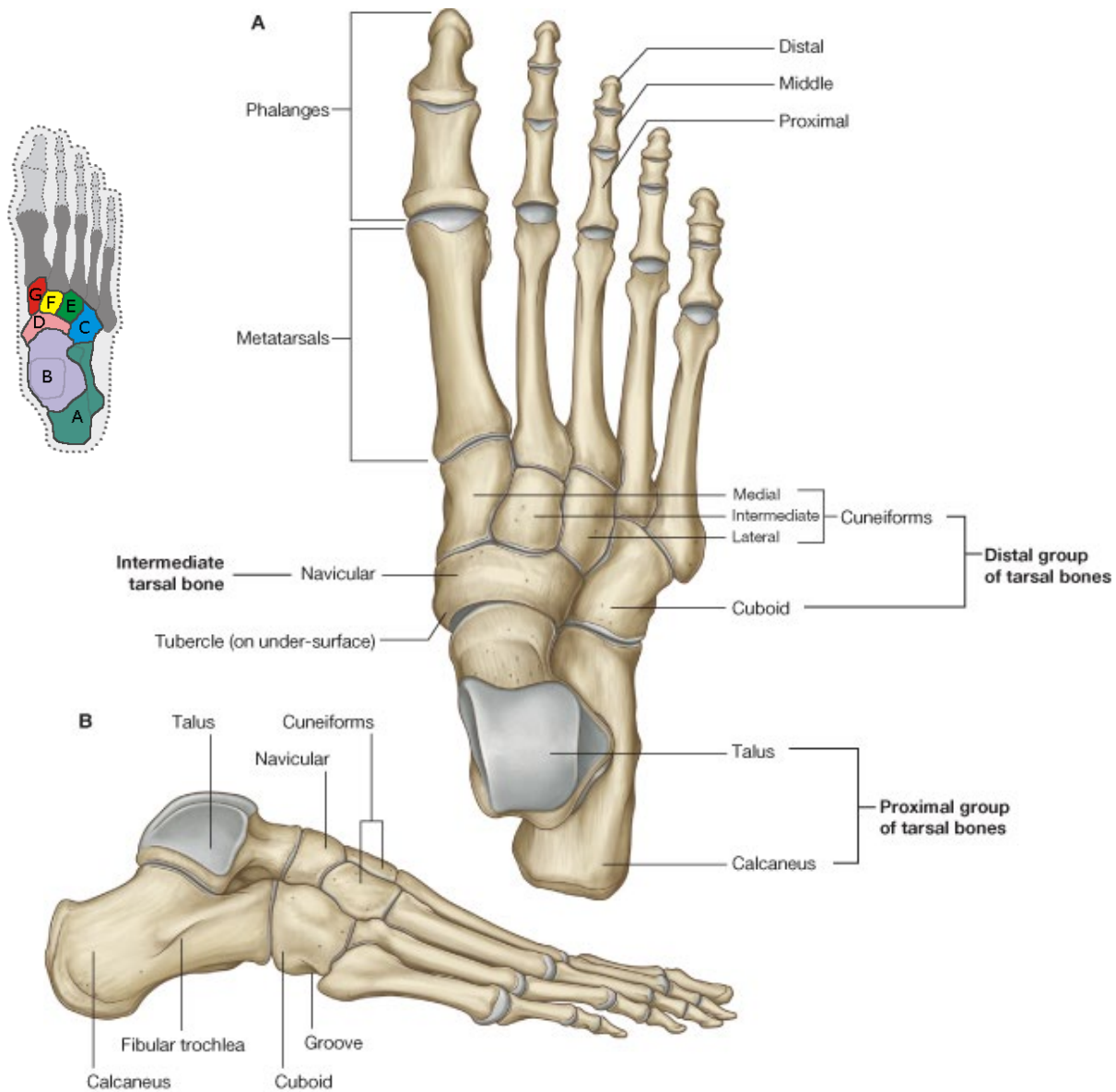
### ***Mortise:***

- The **mortise** is the articular surface formed by the:
  - Lateral & medial malleoli
  - Inferior surface of tibia
  - Posterior tibiofibular ligament
- The mortise articulates with the ankle bone.
- The distal tibiofibular joint must be v. strong to maintain integrity of mortise – or else ankle bone would ride up between tibia & fibula during running etc.



### ***BONES OF THE FOOT:***

- The **tarsal** bones are more irregularly arranged than the mobile carpal bones of the wrist.
- **Tarsus** refers to bones between the tibia/fibula and the metatarsals
- Arrangement allows for stability – essential for upright bipedal locomotion.



- **Nav Cubed Turnips Cautiously**

- **Talus** sits at summit of the foot – fits into the ankle mortise to form the **ankle joint**
- Talus is mounted on the **calcaneus** – the heel bone.
- **Joint between talus & calcaneus = subtalar joint**
- Along **lateral edge** of foot, the calcaneus articulates with the **cuboid** via the **calcaneocuboid joint**
- **Medial edge** of foot is raised off of the floor by 4 bones:
  - Talus → **navicular: talonavicular joint**
  - Navicular → **cuneiforms (medial, intermediate, lateral)**
- This arrangement of bones has primitive mammalian origins

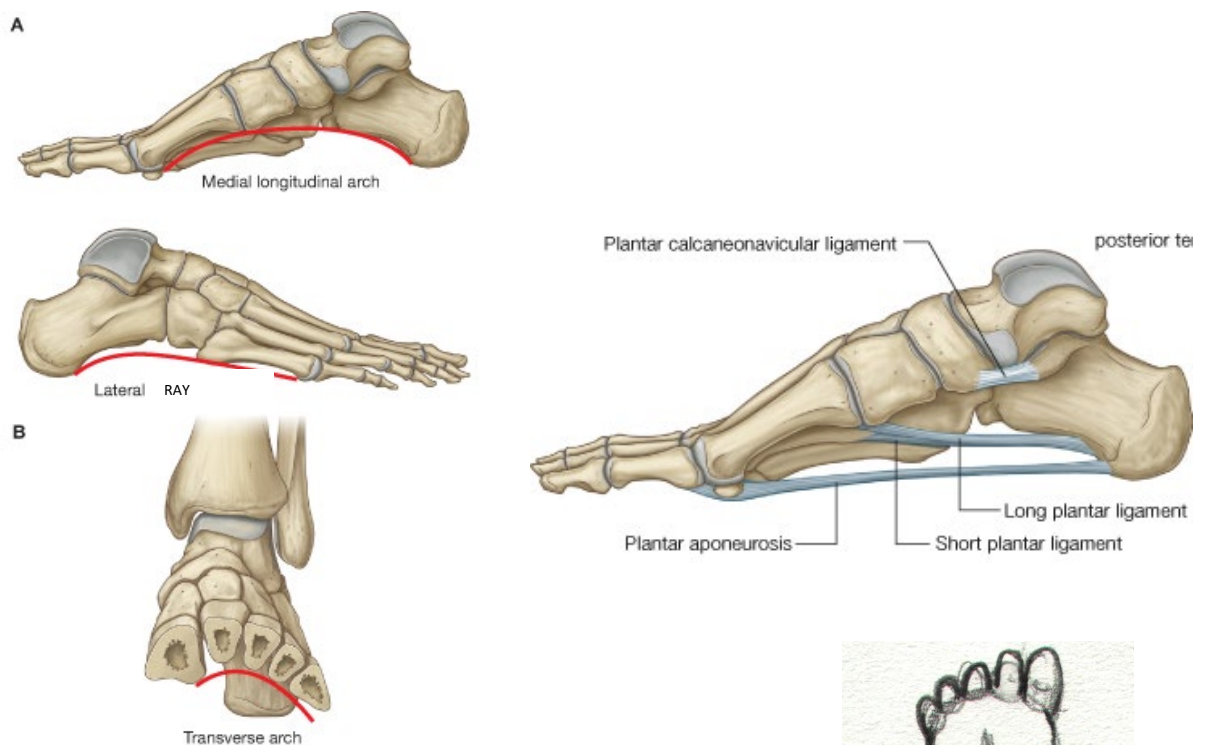
**THE ARCH OF THE FOOT:**

- The arrangement of the tarsal bones ensures that body weight is transmitted in an even manner

- Talus transmits weight through itself to two boney pillars – **rays** - which rest on the ground; thus it acts like the **keystone** of a roman arch:
- *Posterior ray*: **calcaneus**
- *Anterior ray*: **navicular + 3 cuneiforms**
- The arch formed is the **medial longitudinal arch of the foot**
- Arch is maintained by:
  - Shape of bones
  - Small muscles
  - Ligaments & tendons
- During running, arch is compressed 1cm ↓ downwards ground
- This stretches the ligaments spanning the arch:
  - **Long plantar ligament**
  - **Short plantar ligament**
- These ligaments store elastic potential energy, and release 70% of it when foot leaves the ground.

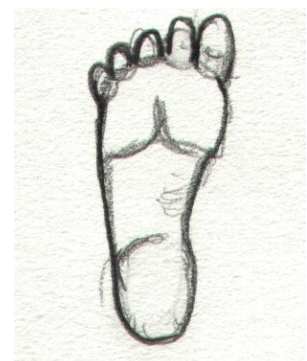
**LATERAL RAY:**

- The lateral ray of the foot is composed of:
  - **Cuboid**
  - **4<sup>th</sup> + 5<sup>th</sup> metacarpal**
- Lies in gentle contact with ground on standing (as no arch here)
- Lateral ray doesn't bear much weight – only briefly when walking
- More important for balance.



**DISTRIBUTION OF WEIGHT OVER FOOT WHILST WALKING:**

1. **Heel strike** – weight of body passes through heel
2. Weight spreads along lateral aspect of foot → head of metatarsals
3. Weight rolls across ball of foot → 1<sup>st</sup> metatarsal



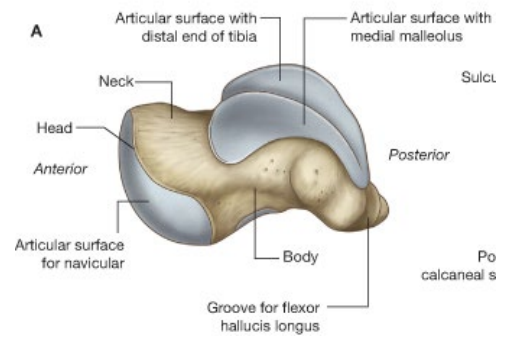
- 4. **Toe off** – powerful big toe, the **hallux**, propels the body forwards.

### JOINTS OF THE TARSAL REGION:

- 4 important joints to consider

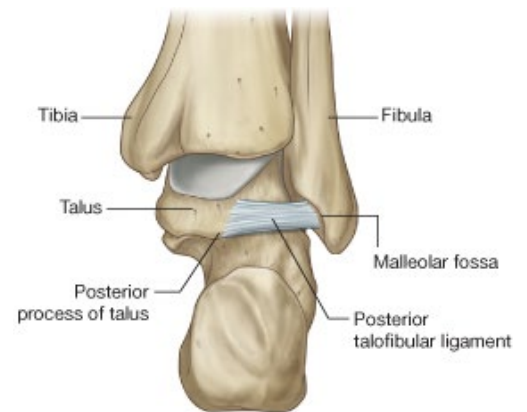
### Ankle joint

- Synovial
- Hinge joint
- Articulation:
  - **Mortise** of tib & fib
  - **Trochlea** (the upper articular surface of talus)
  - Trochlea articulates with:
    - Lower tibial surface
    - Medial & lateral malleoli
- The malleoli clamp either side of the trochlea – holding it in place.
- In some, the trochlea of the talus narrows towards the back.
- **Neutral position of ankle joint:** foot right angles to the leg.
- **Plantar flexed:** toes point downwards
- **Dorsiflexed:** toes pointed upwards
- People with a trochlea which narrows towards the back – plantarflexion brings the narrow bit of the trochlea between the malleoli.
- **BUT** the joint is not loose: the inferior tibiofibular ligaments can stretch & the fibula can bend, such that the narrow part is held firm, and then as the foot is returned to the neutral position, the malleoli separate a few mm to accommodate the larger part of the trochlea.
- **Nonetheless, the foot is more prone to injury in the plantarflexed position.**



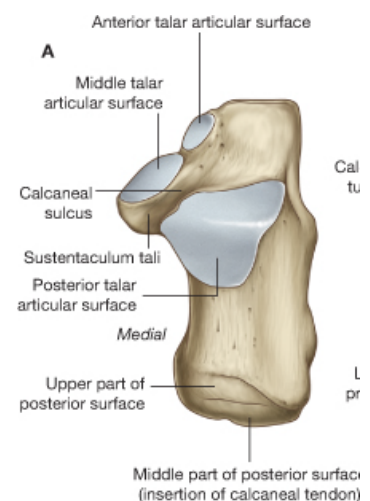
### The fibrous capsule of ankle joint:

- Strong
- Attached to the articular margins
- Strengthened at the back by the posterior tibiofibular ligament
- Also strengthened by ligaments on either side.
- SM covers all non-articular surfaces.



### Subtalar joint

- Joint between **talus & calcaneus**
- Synovial
- Articular surface of the calcaneus is dome shaped & curved – ensure particular movement of the calcaneus under the talus:
- **Abduction** of foot away from midline → lateral edge of foot raised off ground; **eversion**
- **Adduction** of foot towards midline → medial edge of foot raised off ground; **inversion**
- **Abduction-eversion**
- **Adduction-inversion**
- Due to shape of articular surfaces of subtalar joint.

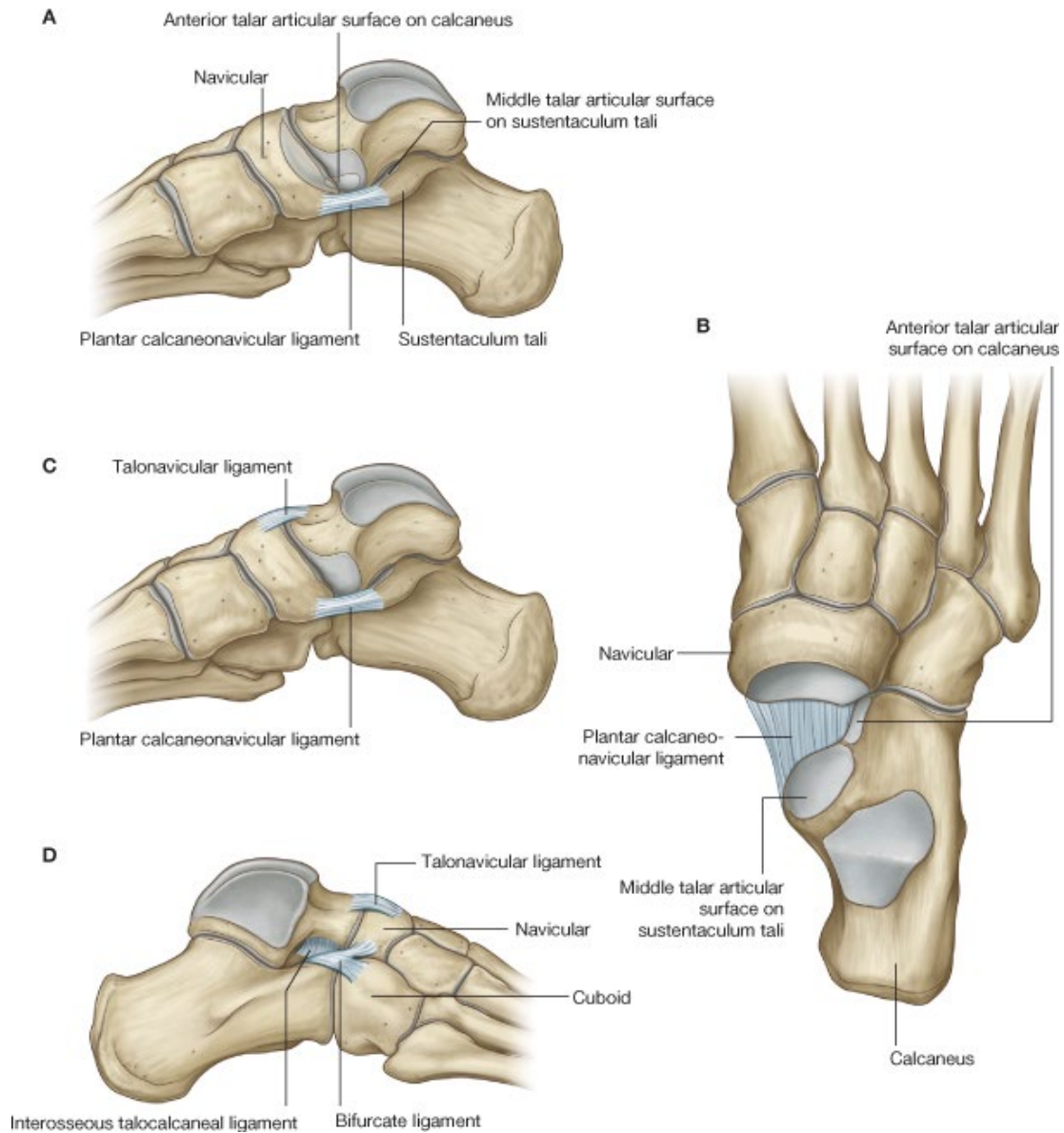


- In these movements, the talus is stationary and the calcaneus swings beneath it.
- There are 3 articular surfaces on the calcaneus for articulation with the talus: **posterior + middle + anterior**

### **Talonavicular joint**

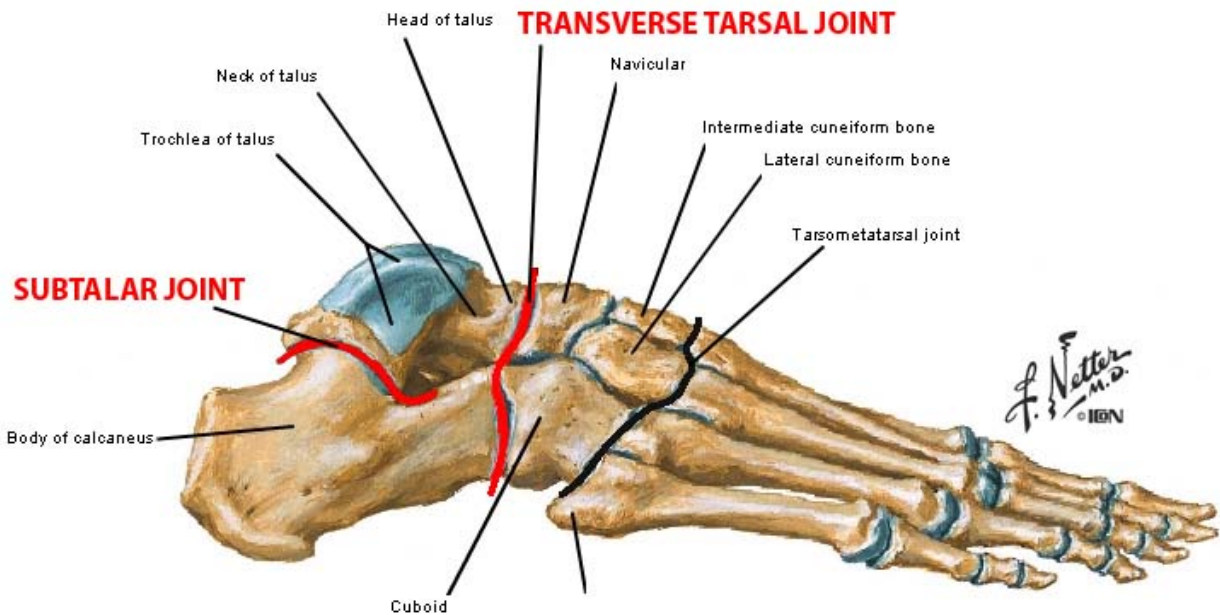
- Between talus and navicular
- Synovial
- Ball & socket
- **Connection of talus to the medial ray**
- Ball: **head of talus**
- Socket:
  - **Navicular**
  - **Sustentaculum tali** (bony platform on medial side of calcaneus)
- Between the navicular and the calcaneus is the **spring ligament** (called plantar calcaneonavicular ligament in grays)
- Although this is a ball and socket joint, it doesn't show much mobility.
- Movement is restricted to the tarsus swinging beneath the talus
  - Abduction-eversion
  - Adduction-inversion





**Calacenocuboid joint:**

- Between **calcaneus & cuboid**
- Synovial
- Articular surfaces are flat – movements are sliding.
- **TRANSVERSE TARSAL JOINT:** talonavicular joint + calcaneocuboid joint

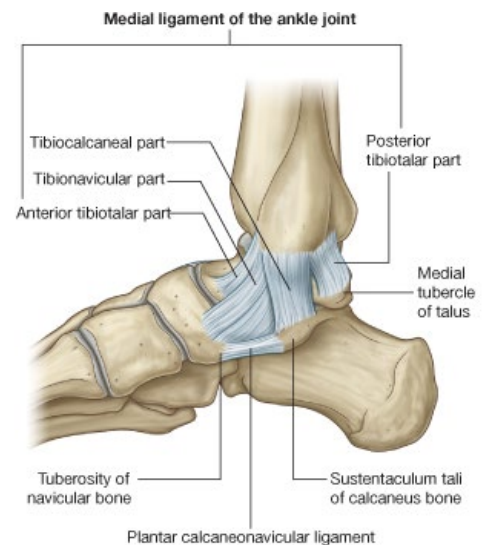


**Subtalar joint**  
**Transverse tarsal joint**  
**Tarsometatarsal joint**

#### LIGAMENTS AROUND THE TARSAL JOINTS:

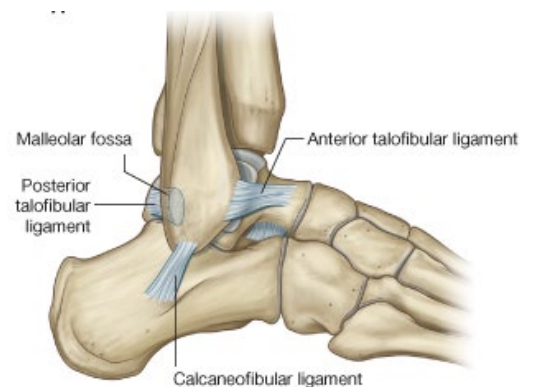
##### Medial ligament (aka deltoid ligament)

- Triangular shaped (hence 'deltoid')
- Apex: medial malleolus
- Base: talus
- **Δ spans the ankle joint**, supporting it.
- Part of the base also inserts into the calcaneus bone at the sustentaculum tali.
- **Δ spans the subtalar joint** as well.
- Part of the base also inserts into the spring ligament & navicular.
- **Δ spans the talonavicular joint** as well – giving it support



##### Lateral ligament

- Strong, but often strained in ankle injuries
- Has 3 fibrous bands
- Anterior band:
  - Lateral malleolus → anterior talus
- Posterior band:
  - Lateral malleolus → posterior talus
- Δ anterior & posterior bands both strengthen the ankle joint
- Middle band:

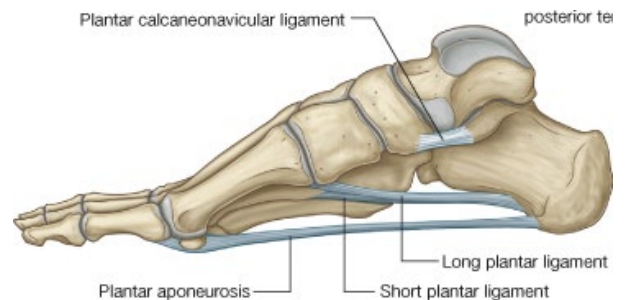




- Lateral malleolus → calcaneus
- Orientation is downwards & backwards.
- Δ middle band strengthens both the ankle and subtalar joints

### Long plantar ligament:

- Sole of foot
- Origin: inferior surface of calcaneus
- → extends under surface of cuboid
- Inserts: base of metatarsals
- Δ supports the calcaneocuboid joint



- The other tarsal bones are united by synovial joints as well as the 4 described above, but these are less important.
- The other joints of the foot are also synovial:
  - **Tarsometatarsal**
  - **Metatarsophalangeal**
  - **Interphalangeal**
- The metatarsophalangeal joint (MTP) of the **big toe** is clinically important.
- Often the site of:
  - **Arthritis**
  - **Gout**
- NOTE, unlike the finger MCP joint, the MTP joint of the toe can only actively perform flexion & extension.
- The other movements of adduction, abduction & circumduction can be produced in the metatarsophalangeal joints, but only **passively**.

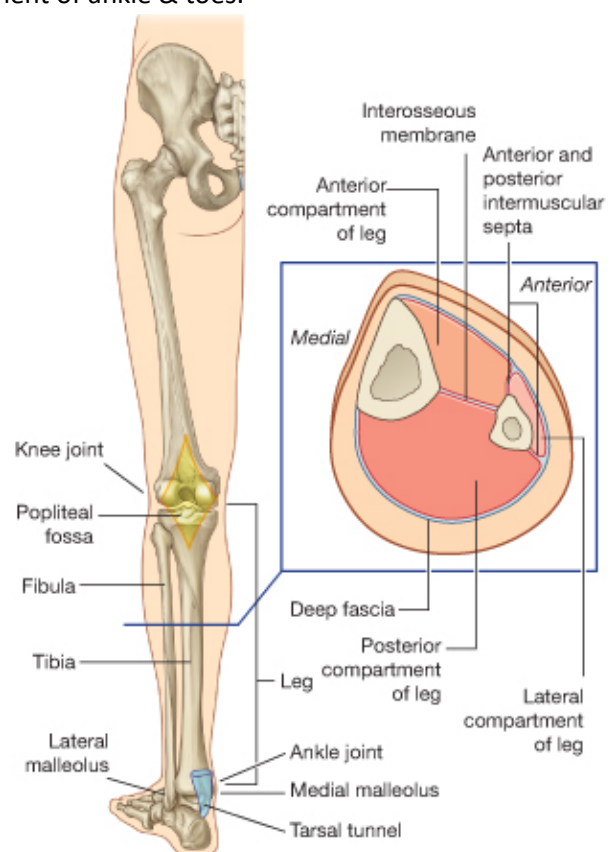
### MUSCLES OF THE LEG & FOOT

- Below knee joint – muscles of the leg are for movement of ankle & toes.
- Lower leg is divided into an anterior & posterior compartment by **osseofascial septum**:

- **Tibia** →
- **Interosseous membrane** →
- **Fibula** →
- **Posterior intermuscular septum**

- Osseofascial septum divides the lower leg into:
  - Anterior compartment
  - Posterior compartment

- **Anterior compartment:**
  - Dorsiflexion of ankle



- Extend toes
- **Medial group of anterior compartment:**
  - Adduction-inversion
- **Lateral group of anterior compartment:**
  - Abduction-eversion
- All muscles of anterior compartment: innervated by **common peroneal nerve** (of sciatic)
- **Posterior compartment:**
  - Plantar flexion of ankle
  - Flexion of toes
- Tendons of these muscles pass to heel and into sole of foot
- One muscle also performs adductor-inversion
- All muscles of posterior compartment: innervated by **tibial nerve** (of sciatic)

## MUSCLES OF THE ANTERIOR COMPARTMENT OF LOWER LEG

- **Central muscles of this group:**
  - Primarily: **extension of the toes**
  - Secondarily: **dorsiflexion of ankle**

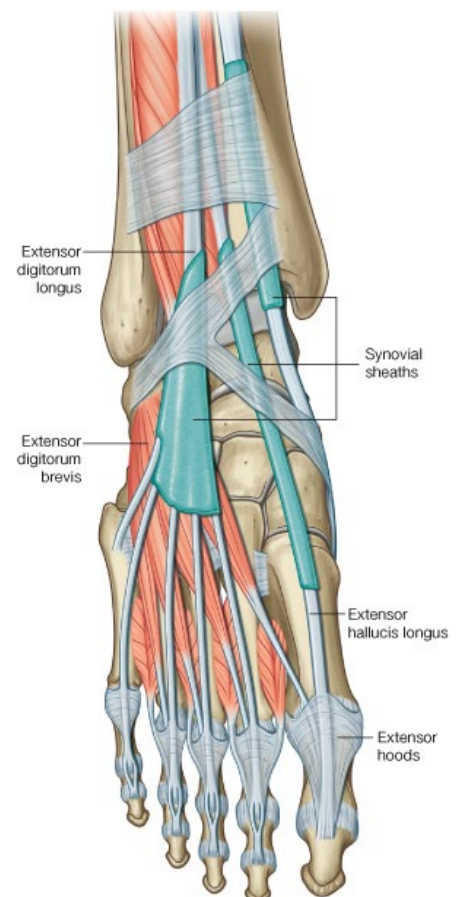
- **Extensor digitorum longus**
- **Extensor hallucis longus**

- As both muscles pass over the front of the ankle, they are held down by thickenings in the deep fascia – **extensor retinacula**
- The extensor retinacula is composed of **superior retinacula** and **inferior retinacula**.

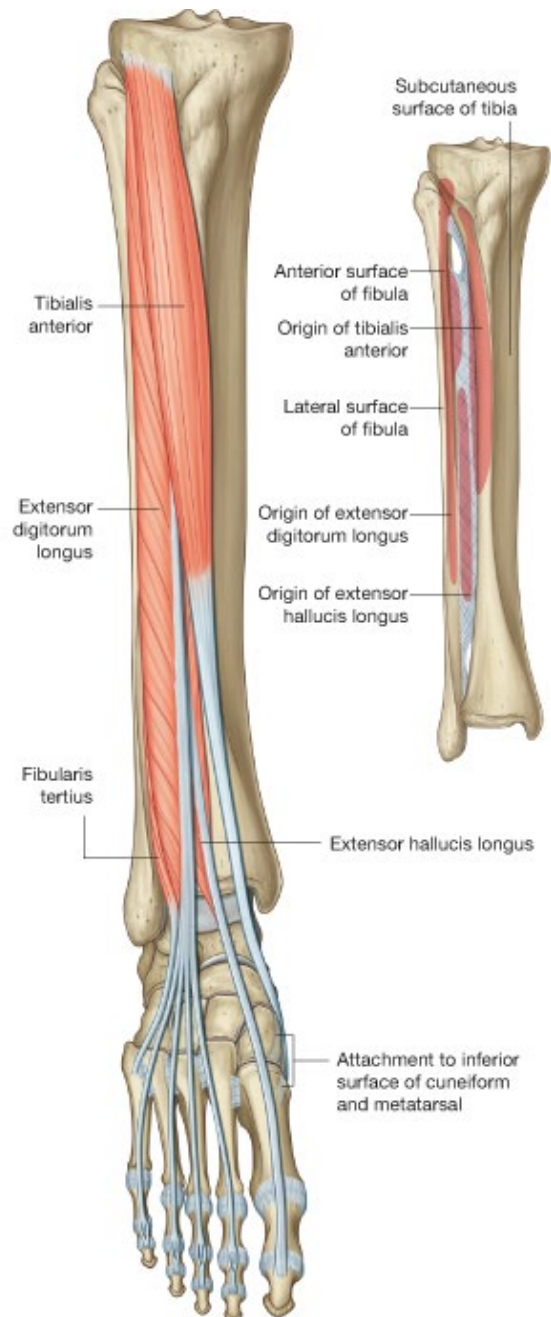
- **Superior extensor retinacula:**
  - Extends between tibia & fibula
- **Inferior extensor retinacula:**
  - 'Y'-shaped
  - Stem attached to lateral calcaneus
  - Upper limb attached to medial malleolus
  - Lower limb attached to medial border of foot, blending with deep fascia of the sole.

### Extensor digitorum longus:

- **Origin: fibula**
- Passes down leg towards ankle
- Becomes a tendon which passes beneath the extensor retinacula.
- Covered by synovial sheath as it passes beneath the extensor retinacula.
- Divides in 4 tendons, which pass to the 4 lateral toes.
- Over the proximal phalanges the tendons form **extensor expansion** (similar to those in the fingers).



- **Central slip** then gains insertion into middle phalynx
- **2 collateral slips** insert into base of distal phalynx.
- Action of extensor digitorum longus:
  - **Extension of lateral 4 toes:**
    - Metatarsophalangeal joints
    - Interphalangeal joints
- Nerves supply is from the **deep peroneal nerve**



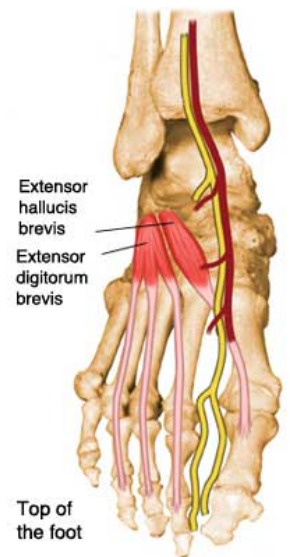
**Note, no muscular origin from the flat subcutaneous surface of the tibia**

### Extensor hallucis longus:

- Origin: **mid-fibular shaft + interosseous membrane**
- Passes under extensor retinacula – surrounded by its own synovial sheath
- Strong tendon
- Inserts into distal phalanx of big toe
  
- Action: **extend the big toe joints:**
  - Metatarsophalangeal
  - Interphalangeal
  
- Supplied by **deep peroneal nerve**
  
- Tendon of extensor hallucis longus can be ruptured in injury → impossible to extend big toe – it stays in a flexed position.
- → difficult to walk without shoes – flexed big toe trips patient up.

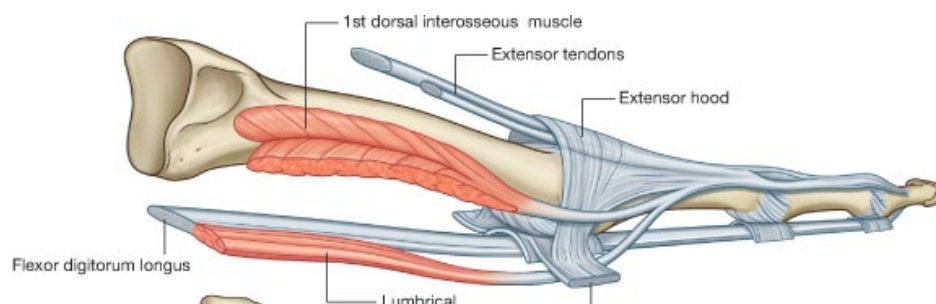
### Extensor digitorum brevis & extensor hallucis brevis

- The extensor digitorum and hallucis longus are assisted in extension by a short muscle on the dorsum of the foot:
  - **Extensor digitorum brevis / hallucis brevis**
- The muscle arises from the upper surface of the calcaneus
- **Divides into 4 tendons:**
  - Most medial tendon: **extensor hallucis brevis**
    - Passes to the proximal phalanx of big toe
  - Lateral 2<sup>nd</sup>, 3<sup>rd</sup> & 4<sup>th</sup> tendons: **extensor digitorum brevis**
  - Insert into the extensor expansions of the toes
  
- The muscle is supplied by the **deep peroneal nerve**



### LUMBRICAL & INTEROSSEOUS MUSCLES:

- As in the hand
- But play a much less important role than those in the hand
  
- Lumbricals:
  - Arise: long flexor tendons in the sole of the foot
- Interossei:
  - Arise: metatarsal bones
- The tendons of both insert into the extensor expansions of 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> & 5<sup>th</sup> toes.
  
- Action:
  - **Flex metatarsophalangeal joint**
  - **Weakly extend interphalangeal joint**



➤ **Most medial (& superficial) muscle of anterior compartment:**

**Tibialis anterior:**

- Large
- Origin:
  - **Tibia** (this is a medial muscle)
  - **Interosseous membrane**
- Passes deep to extensor retinacula – covered with its own synovial sheath
- Insertion: medial side of foot:
  - **Medial cuneiform**
  - **First metatarsal**
- Action:
  - **Dorsiflexion of the foot**
  - **Adductor-inversion** (points toes towards midline and raises medial foot)
- Tibialis anterior is supplied by the **deep peroneal nerve**

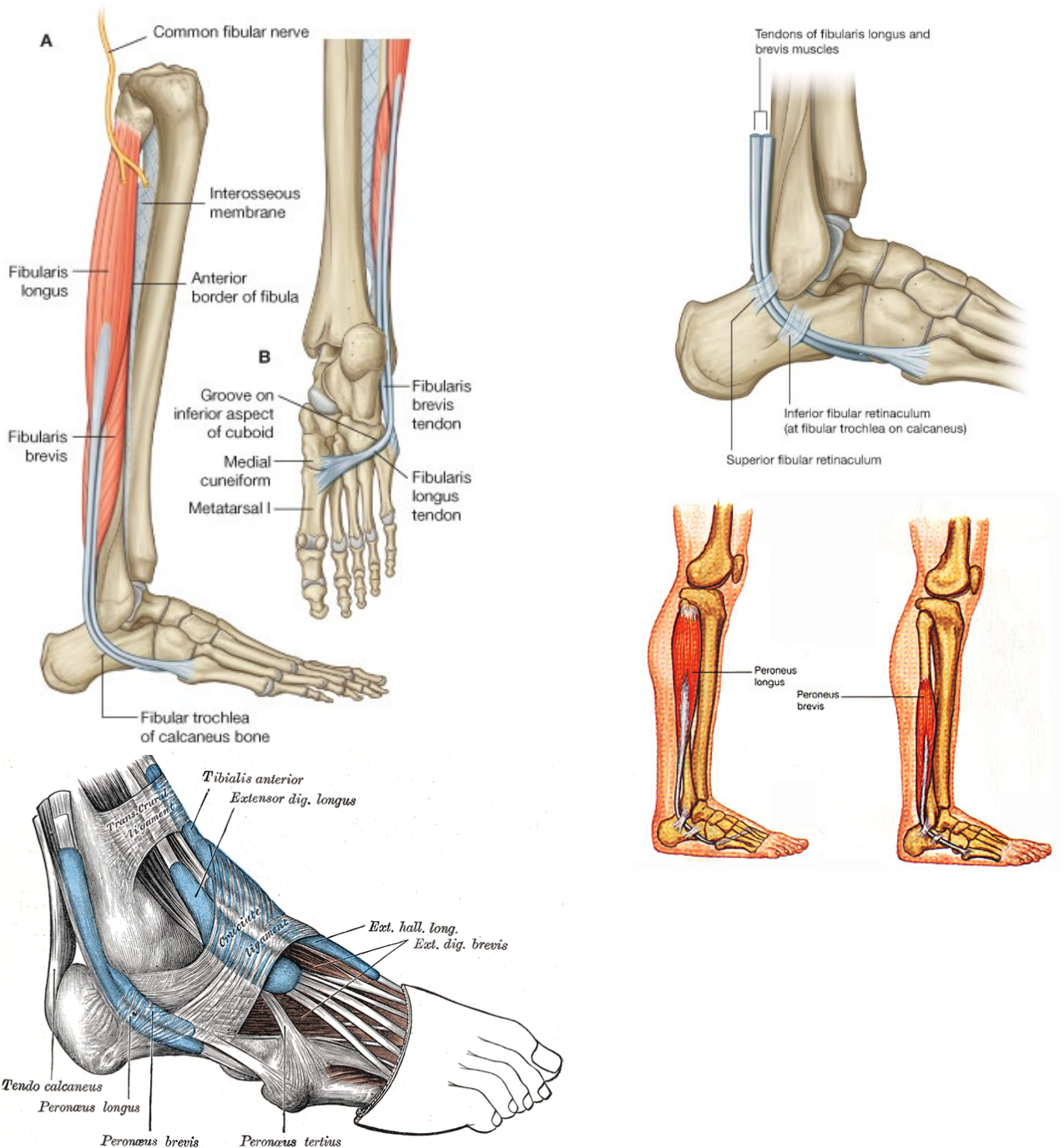
➤ **Most lateral muscle of the anterior compartment:**

**Peroneal muscles:**

- **Peroneus longus**
  - Origin: upper part of fibula
- **Peroneus brevis**
  - Origin: lower part of fibula
- Both curl around the lateral malleolus → lateral aspect of ankle
- Held in place by 2 retinacula:
  - **Superior peroneal retinacula**
    - Lateral malleolus ←→ calcaneus
  - **Inferior peroneal retinacula**
    - Attached to lateral calcaneus at both ends
- The 2 peroneus tendons pass beneath the peroneal retinacula:
  - Surrounded by **common sheath** beneath the superior retinacula
  - Surrounded by **separate individual sheaths** beneath inferior retinacula
- **Peroneus brevis:** inserts into peroneal tubercle at base of 5<sup>th</sup> metatarsal
- **Peroneus longus:**
  - Sweeps around to sole of foot – held in groove on cuboid by long plantar ligament – surrounded by synovial sheath.
  - Inserts into same bones as tibialis anterior on the medial side of the foot:
    - **Medial cuneiform**
    - **1<sup>st</sup> metatarsal**
- The tendons of peroneus longus (lateral origin) and tibialis anterior (medial origin) thus pull in opposite directions:
  - Tibialis anterior: adduction-inversion
  - Peroneus longus: abduction-eversion

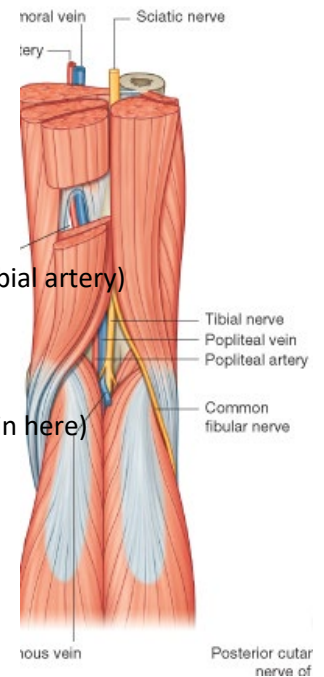


- Both peroneal muscles are supplied by **superficial peroneal nerve**.
- Blood supply from **peroneal branch** of **posterior tibial artery** (all the rest of the anterior compartment is supplied by the anterior tibial artery).
- **Peroneus tertius** is a small muscular slip
- Actually slip of extensor digitorum longus, arising from lower fibula
- Tendon is delicate and doesn't pass through the peroneal retinacula – instead passes deep to the **extensor retinaculum**.
- Should be considered with the muscles which pass beneath the extensor retinaculum
- Inserts into **base of 5<sup>th</sup> metatarsal** (like peroneus brevis)
- Supplied by: **deep peroneal nerve**
- Action: **weak dorsiflexion**.



## NEUROVASCULAR SUPPLY TO THE FRONT OF THE LEG:

- Muscles of the front of the leg are supplied by:
  - **Common peroneal branch** of the sciatic nerve (grays calls it fibular nerve)
  - **Anterior tibial artery** (from the **popliteal artery**)  
(*Except peroneal muscles – supplied by peroneal branch of the posterior tibial artery*)
- **Common peroneal branch** was identified leaving the popliteal fossa
- Runs beneath the head of the fibula
- Comes to **lie on neck of fibula** on lateral side of knee (can be rolled beneath the skin here)
- Divides into:
  - **Deep peroneal branch**
  - **Superficial peroneal branch**
- Mixed nerves – supply all muscles and skin on the front of the leg

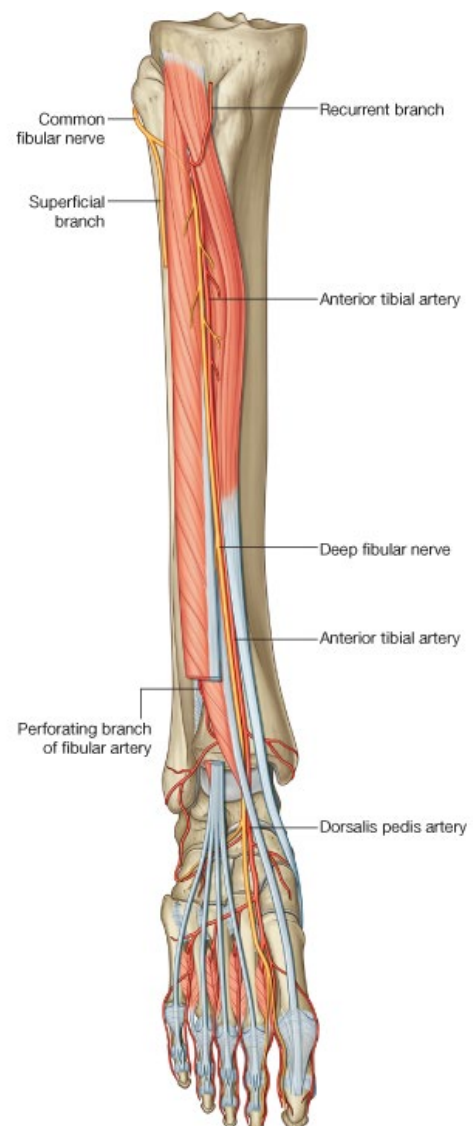


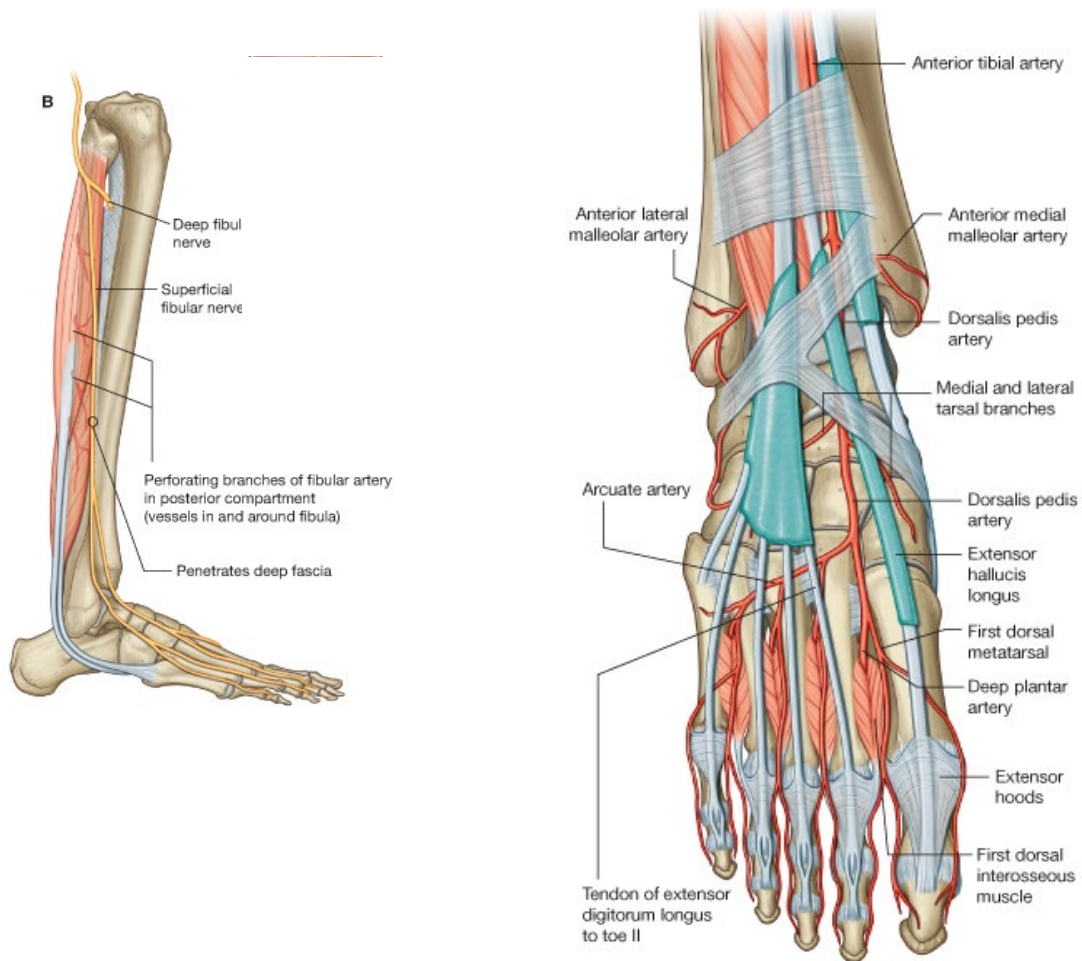
### Deep peroneal branch:

- Passes onto the front of the interosseous membrane
  - Can be seen here by separating the tibialis anterior from the extensor digitorum longus & extensor hallucis longus.
- At ankle it is crossed by tendon of extensor hallucis longus (as the tendon passes to big toe)
- On dorsum of foot it lies between the tendons of extensor digitorum longus & extensor hallucis longus.
- It passes **beneath the extensor retinacula**
- Then divides into lateral and medial branches.
- **Lateral division:** supplies **extensor digitorum brevis**
- **Medial division:** **cutaneous** – supplies 1<sup>st</sup> cleft skin.
- Whilst in the front of the leg, the **deep peroneal branch supplies all the muscles of the anterior compartment** except the peroneal muscles:
  - Extensor digitorum longus
  - Extensor digitorum brevis
  - Extensor hallucis longus
  - Extensor hallucis brevis
  - Tibialis anterior
  - Peroneus tertius

### Superficial peroneal branch:

- From the posterior aspect of the neck of the fibula, the superficial branch passes immediately **into the substance of the peroneus longus & peroneus brevis**
- The superficial branch supplies only these 2 peroneal muscles.
- The superficial nerve then divides into lateral & medial branches.
- These branches pass **superficial to the extensor retinacula** (unlike the deep branch)
- Supplies skin of dorsum of foot and toes.



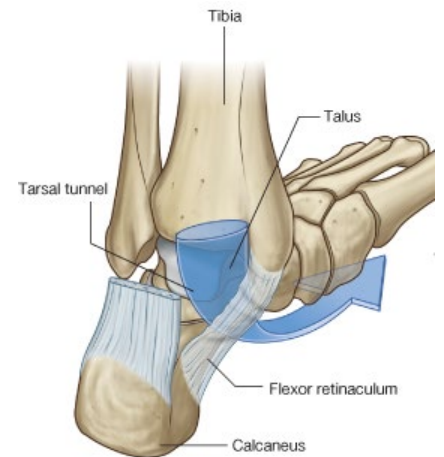


### Anterior tibial artery

- Branch of popliteal artery
- Pierces interosseous membrane to enter front of leg
- Accompanies the deep peroneal nerve down the leg.
- Supplies blood to muscles on front of leg (except peroneus longus & brevis)
- Passes **deep to the extensor retinacula**
- Like the deep peroneal nerve, it lies between the tendons of the extensor digitorum longus & extensor hallucis longus.
- Can be easily palpated in this region
- (The tendon of extensor hallucis longus is particularly visible if the toe is bent).
- As the anterior tibial artery passes onto the dorsum of the foot it is renamed the **dorsalis pedis**
- On the dorsum of the foot the dorsalis pedis runs to the 1<sup>st</sup> web space with the medial branch of deep peroneal nerve
- Passes into sole of foot
- On the dorsum of the foot the dorsalis pedis also gives off an **arcuate branch** which supplies the metatarsals and toes by means of:
  - **Dorsal metatarsal branches**
  - **Digital branches**
- Note it is the **peroneal branch** of the **posterior tibial artery** which supplies the **peroneal muscles**.

## MUSCLES OF THE BACK OF THE LOWER LEG

- **Plantar flexion** of ankle
- **Flexion** of toes
  
- All muscles on the back of the leg are supplied by the **tibial nerve**
  
- The muscles are arranged in **3 layers**:
  - **Deepest** layer: **tibialis posterior**
    - Origin: tibia + fibia + interosseous membrane
    - Insertion: sole of foot
  - **Middle** layer: **long flexors of the toes**
    - Insertion: toes
  - **Superficial** layer: **plantar flexors of ankle**
    - Insertion: heel
  
- The **deep and middle layers** reach the sole of foot and toes by curling beneath the **medial malleolus** (tibia malleolus).
- The outermost layer (plantarflexors) insert into the **calcaneus tendon**.
- **Flexor retinaculum** is thickening of deep fascia here, holding these tendons in place.
- Flexor retinaculum: **medial malleolus** ↔ **calcaneus**



### **DEEPEST LAYER OF MUSCLES ON BACK OF LEG:**

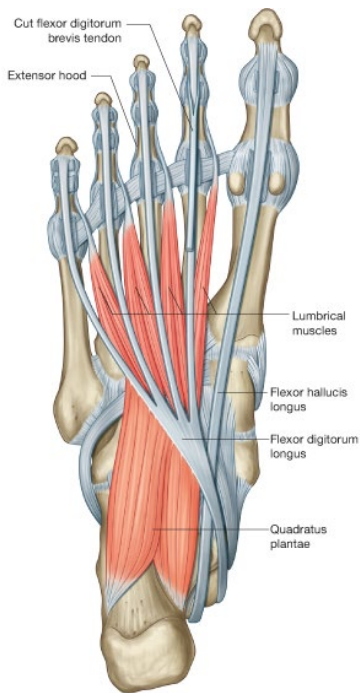
- **Tibialis posterior**
- Origin:
  - **Tibia**
  - **Fibula**
  - **Interosseous membrane**
- Tendon passes **deep to the flexor retinaculum** – surrounded by synovial sheath
- In sole, sends fibrous insertions to nearly all bones of sole
- **Main insertion: navicular**
  
- Action:
  - **Plantar flexion**
  - **Adduction-inversion** (as it pulls on medially placed navicular)
  
- Innervation: **tibial nerve**

### **MIDDLE LAYER OF MUSCLES ON BACK OF LEG:**

- **Flexor digitorum longus**
- **Flexor hallucis longus**
- Next layer of “onion” out from the tibialis posterior – so must have an origin further out.
  
- **Flexor digitorum longus**
  - Origin: **tibia**
  - Inserts: divides into 4 tendons which insert into **terminal phalanges** of lateral 4 toes.
  
- **Flexor hallucis longus**



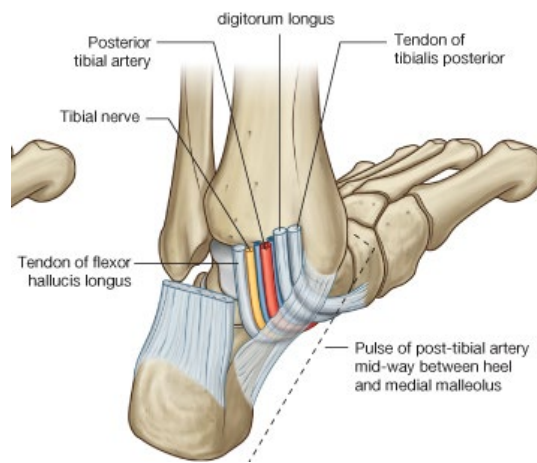
- Origin: fibula
- Inserts: single tendon which inserts into terminal phalanx of big toe.
- Both pass deep to the flexor retinaculum – are **covered with separate synovial sheaths**.
- Action: **flexion of metatarsophalangeal joint & interphalangeal joint.**
- Innervation: **tibial nerve**



**NOTE** the order of the tendons of the deep and middle layers as they pass beneath the flexor retinaculum:

**Tom Dick ANd Harry**

**Tibialis posterior, flexor Digitorum longus, Artery, Nerve, flexor Hallucis longus**



- As the tendons of flexor digitorum longus & flexor hallucis longus travel along the plantar surface of the toes, they are held in place by **fibrous flexor sheaths**.
- $\Delta$  are also surrounded by synovial sheaths
- **NOTE** the tendons of the flexor digitorum longus would exert a v. oblique pull on toes – as they travel from medial malleolus and spread to the toes.
- To correct this, a small muscle – **flexor accessorius** – arises from calcaneus to insert into the tendon of flexor digitorum longus (note in grays diagrams, called quadratus plantae)
- A **lumbrical muscle** arises from medial side of each tendon of the flexor digitorum longus.
- The muscle winds around to front of metatarsal & insert into extensor expansion
- Assist in flexion of metatarsophalangeal joint – but not as important as in the hand.

**SUPERFICIAL LAYER OF MUSCLES ON BACK OF LEG:**

- Plantar flexion of ankle
- **Soleus**
- **Gastrocnemius**
- **Plantaris**



- All 3 muscles insert as a common tendon into calcaneus

### Soleus

- Is the deepest of the 3 muscles
- Origin:
  - Tibia: soleal line
  - Fibula
- Forms a fibrous arch between these 2 origins.
- Ends in a tendon at the ankle which inserts into common tendon into calcaneus.

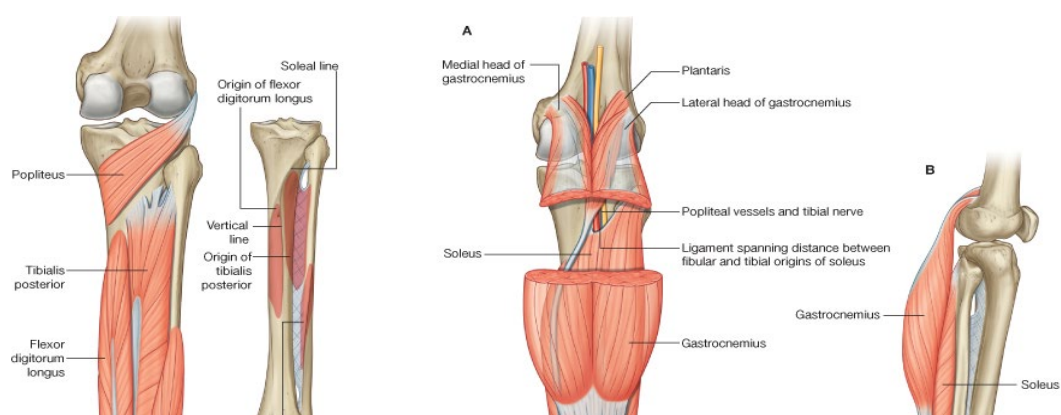
### Gastrocnemius

- Arises as 2 heads:
  - One from lateral femoral condyle
  - One from medial femoral condyle
- Makes up most of the muscle mass of the calf
- Inserts into common tendon into calcaneus

### Plantaris

- Delicate muscle – mainly exists as tendon
- Arises from femur on medial side of lateral gastrocnemius head
- Plantaris tendon is stretched during running / walking like elastic
- Can return 90% of the elastic potential energy stored
- (important in animals like kangeroos for locomotion)

- Near the ankle, the tendons of gastrocnemius & plantaris fuse with the soleal tendon
- The 3 tendons combined make up the tendo calcaneus – aka **achilles tendon**.
- Tendo calcaneus inserts into the calcaneus
- Easily palpated on back of ankle.
- Tendo calcaneus is separated from underlying bone by a small bursa.
- All 3 muscles of the superficial layer are:
  - **Plantar flexors**
  - Innervated by the **tibial nerve**

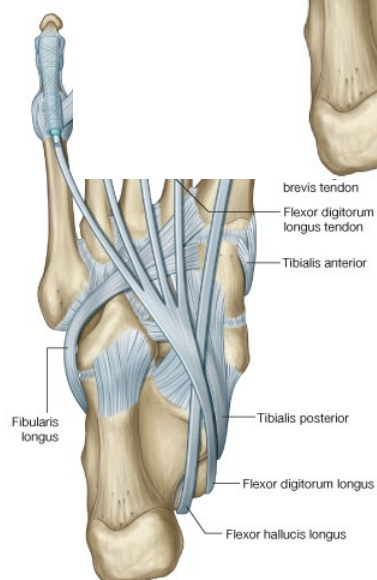
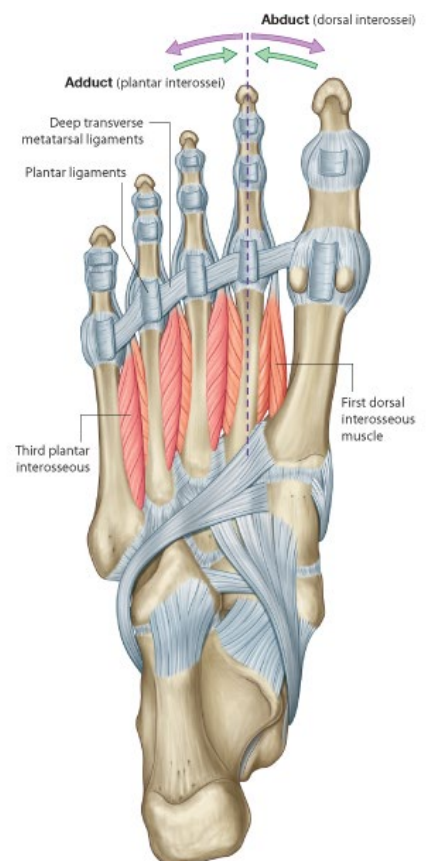


**TENDONS ON THE SOLE OF THE FOOT:**

- Deepest layer:
  - **Tibialis posterior**
    - → navicular (+other bones of sole)
  - **Peroneus longus** (aka fibularis longus)
    - → medial border of foot: medial cuneiform + base of big toe metatarsal
    - Same insertion as tibialis anterior
  
- Peroneus longus passes obliquely beneath the **long plantar ligament**
  
- **Interossei**
  - Arise as 2 groups (like those in the hand)
  - Insert into the extensor expansions
  - Flex the metatarsophalangeal joints
  - Much less precise & important than those in the hand

**Summary of *deepest layer of sole*:**

- Metatarsals + their interossei
- Tibialis posterior
- Peroneus longus
- Long plantar ligament



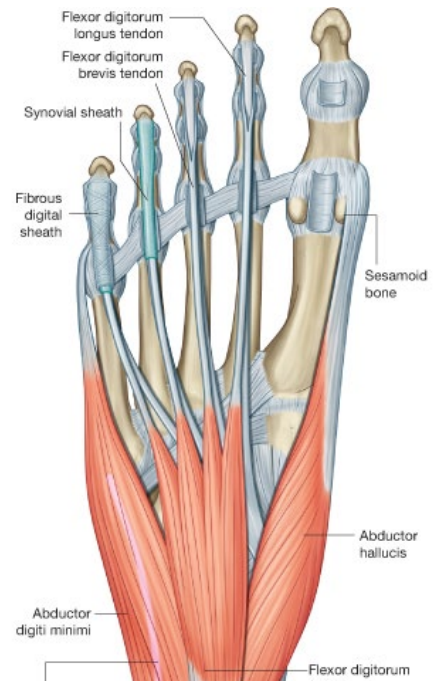


- **Superficial** to this deep layer on the sole of the foot is:
  - Flexor digitorum longus (+ flexor accessorius muscle)
  - Flexor hallucis longus

**Small muscles form 2 further layers:**

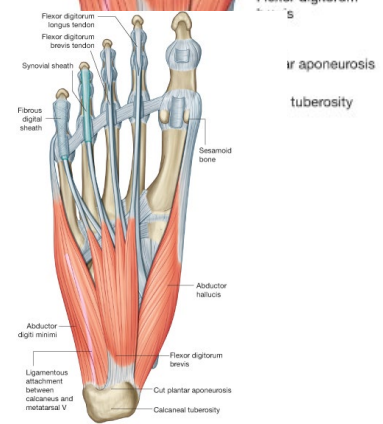
Most superficial

- **Abductor hallucis**
- **Abductor digiti minimi**
  - Arise from the calcaneus
  - Insert into the **proximal phalanx** of the big and little toe
- **Flexor digitorum brevis:**
  - Between the 2 short abductors
  - Arises from calcaneus
  - Splits into 4 tendons
  - Insert into fibrous flexor sheaths of **middle phalanges** of lateral 4 toes
  - Split on the middle phalanges to allow the tendon of the flexor digitorum longus to reach the terminal phalanges.



Deeper layer of small muscles:

- Short flexors of big toe & toe 5:
  - **Flexor hallucis brevis**
  - **Flexor digiti minimi**
  - Insert into the proximal phalanges of big toe & toe 5



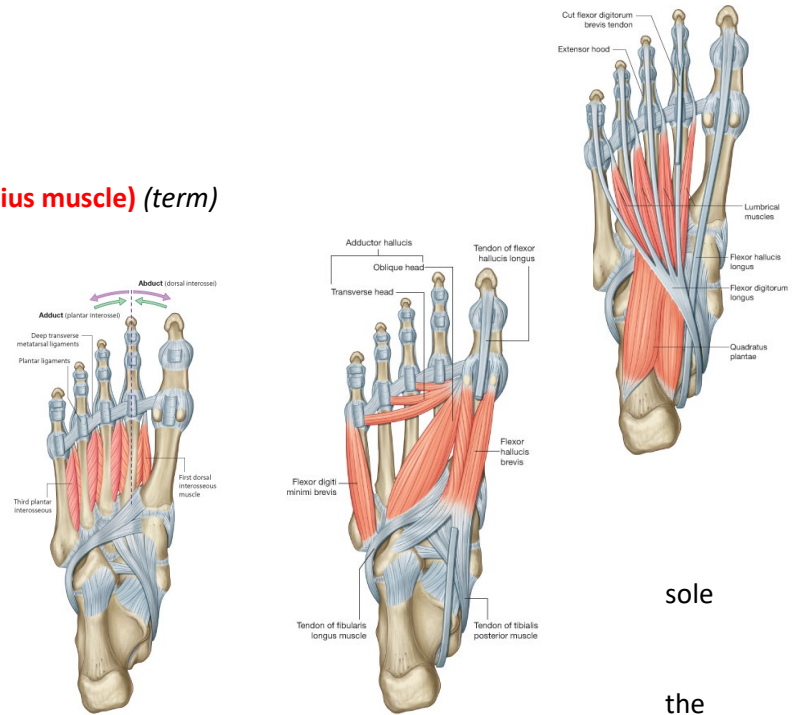
- **Adductor hallucis:**
  - Akin to adductor pollicis of hand
  - Origin: **metatarsals**
  - Insertion: **proximal phalanx** of big toe

**SUMMARY OF LAYERS OF MUSCLES & TENDONS ON SOLE**  
**Superficial → deep**

1. **Abductor hallucis** (*prox*)  
**Abductor digiti minimi** (*prox*)  
**Flexor digitorum brevis** (*middle*)
2. **Flexor digitorum longus (+ accessorius muscle)** (*term*)  
**Flexor hallucis longus** (*term*)
3. **Flexor hallucis brevis** (*prox*)  
**Flexor digiti minimi** (*prox*)  
**Adductor hallucis** (*prox*)

4. **Long plantar ligament**  
**Tibialis posterior**  
**Peroneus longus**  
**Metatarsals + interossei**

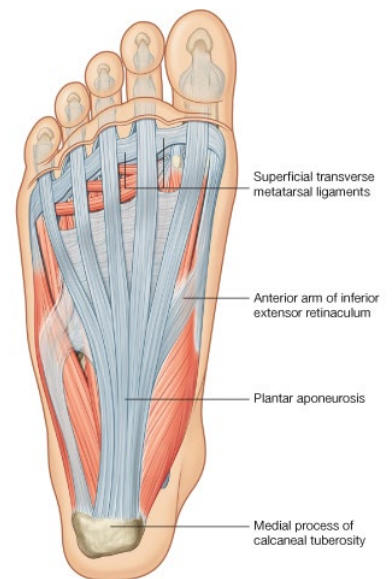
- **Skin + subcutaneous fat** of of foot is thick
- Esp. in weight bearing areas
- Deep fascia is thickened as **plantar aponeurosis**
- Plantar aponeurosis acts in the same way as the palmar aponeurosis – covering the intermediate compartment of the foot.
- **NOTE v. strong similarities between sole of foot & palm of hand.**



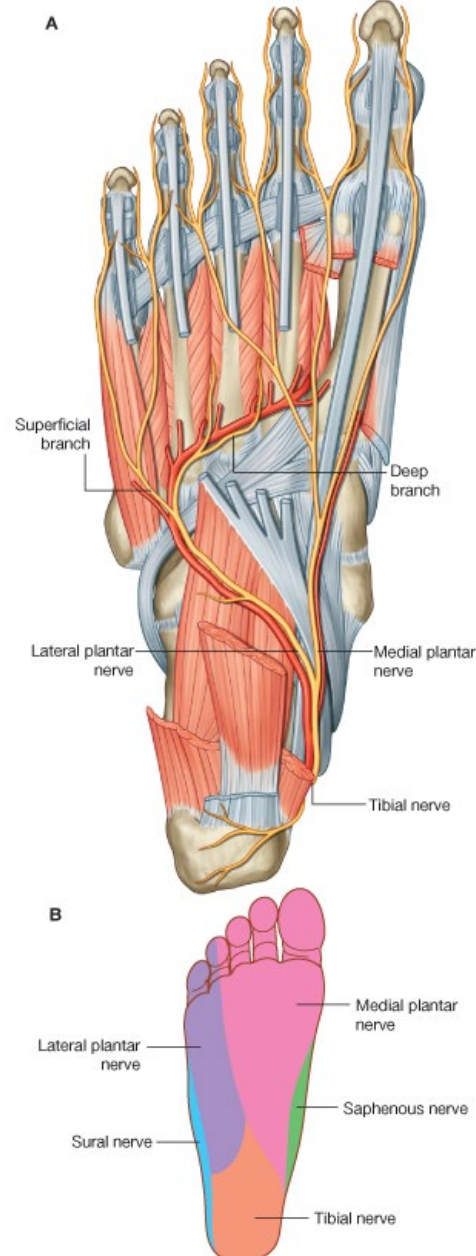
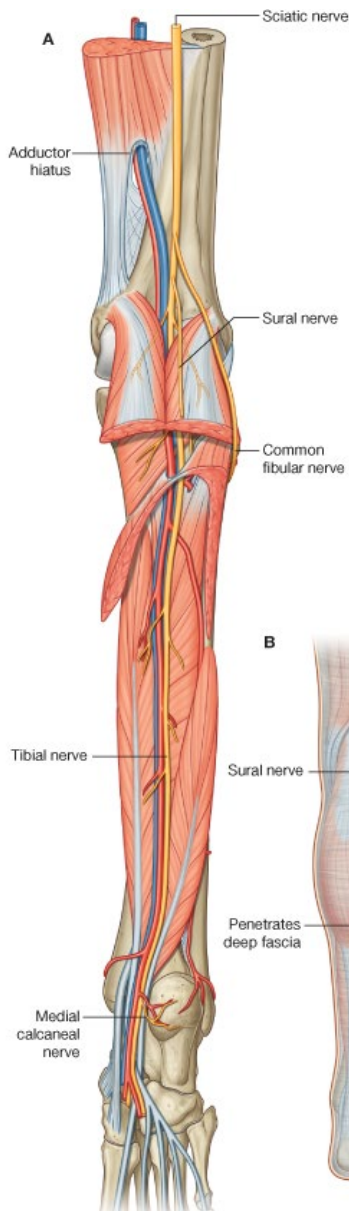
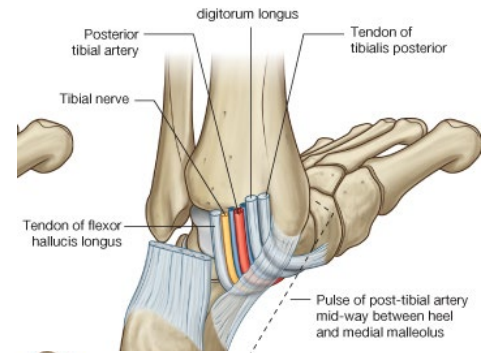
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**NEUROVASCULAR STRUCTURES OF LEG & SOLE OF FOOT**

- Sciatic nerve divides in the popliteal fossa
  - Common peroneal nerve
  - Tibial nerve
- **Tibial nerve** is responsible for the nerve supply to muscles on back of leg & sole of foot.
- Tibial nerve leaves lower angle of popliteal fossa
- Immediately passes deep to the fibrous arch formed by origin of soleus (superficial layer muscle)
- Δ lies beneath the superficial layer of muscles on the back of the leg
- Passes down the leg between the muscles of the middle stratum:
  - (*tibia*) **Flexor digitorum longus** – **tibial nerve** – **flexor hallucis longus** (*fibia*)
- Curled around medial malleolus at ankle, along with the tendons of these muscles (T, D, AND H)



- Passes beneath the flexor retinaculum
- Under the flexor retinaculum, it divides into 2 terminal branches:
  - **Medial plantar nerve**
  - **Lateral plantar nerve**



- Make comparisons with the nerves of palm of hand:
  - **Medial plantar nerve** (median nerve of hand)



- **Lateral plantar nerve** (ulnar nerve of hand)

<b>Medial plantar nerve</b>	<b>Median nerve</b>
Short muscles of big toe	Short muscles of thumb
Most medial lumbrical	Lateral 2 lumbricals
Flexor digitorum brevis	Counterpart is 'flexor digitorum superficialis' which originates in forearm, & is supplied here.

- The **lateral plantar nerve** is counterpart of ulnar nerve in hand
- Both divide into superficial & deep branches
- The superficial branches supply similar cutaneous segments
- The deep lateral plantar nerve supplies all the short muscles of the foot not supplied by the medial plantar nerve.

### BLOOD SUPPLY TO BACK OF LEG & SOLE OF FOOT

- **Popliteal artery**
- At lower border of popliteus muscle, popliteal artery divides into 2 terminal branches:
  - **Anterior tibial artery**
  - **Posterior tibial artery**

#### **Anterior tibial artery:**

- Immediately pierces interosseous membrane
- **Supplies musculature on front of leg**

#### **Posterior tibial artery:**

- Larger – as has a greater muscle mass to supply
- Gives off **peroneal branch**
  - Passes deep to soleal bridge → lateral side of leg
  - Supplies peroneal muscles

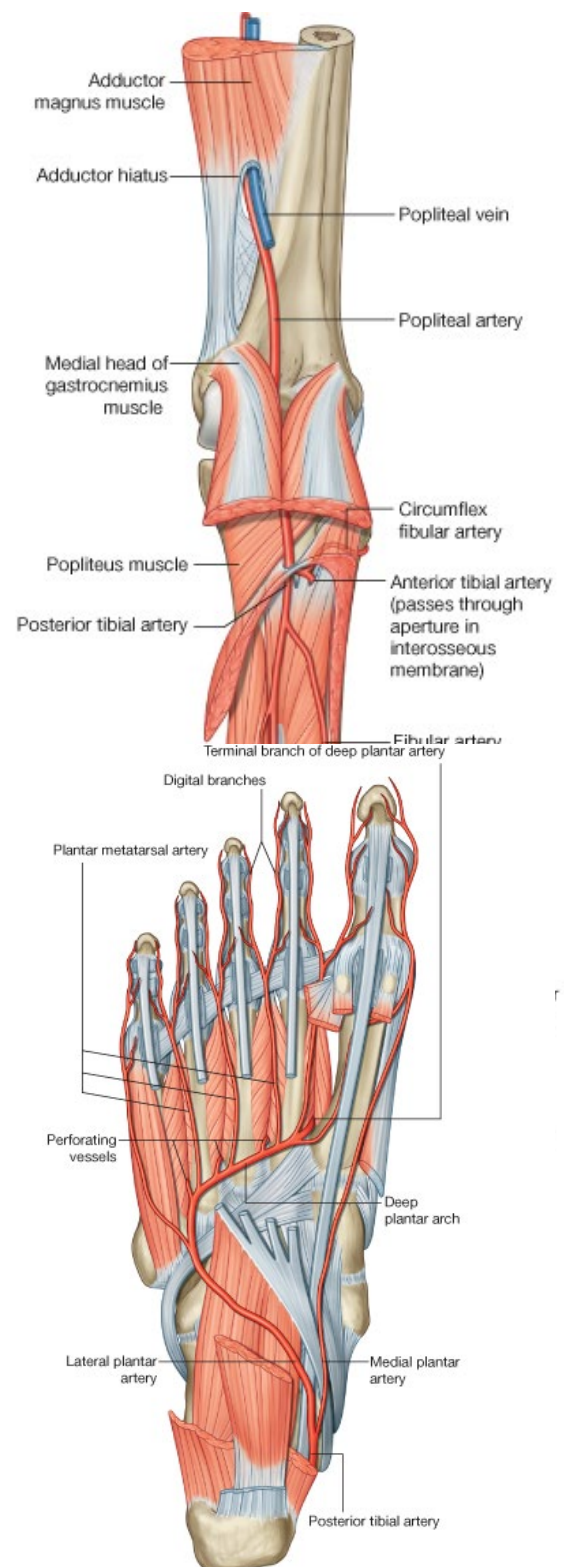
- **Posterior tibial artery** then continues with the tibial nerve
- Deep to the flexor retinaculum it divides into:
  - **Medial plantar artery**
  - **Lateral plantar artery**

- Accompany nerves of the same name (derived from tibial nerve)

- **Lateral plantar artery**
  - Follows deep branch of lateral plantar nerve into depths of sole – the **plantar arch**.
- Both medial plantar arteries & lateral plantar arteries then give of metatarsal & digital vessels.

### VENOUS DRAINAGE OF LOWER LIMB:

- Upright position → considerable hydrostatic pressure for venous blood to overcome.



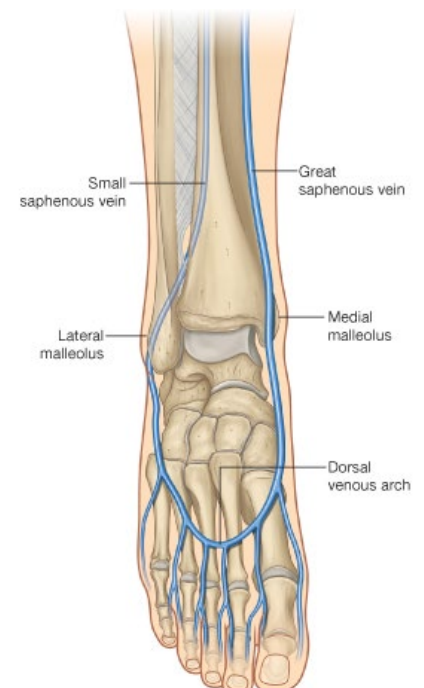
- Venous return aided by:
  - Skeletal muscle pump
  - Valves
  - Proximity of veins to arteries – pulsation of arteries massages blood up the veins. Especially true for **venae comitantes**.

- In leg blood is drained from superficial & deep tissues.
- **Superficial veins: outside deep fascia**
- **Deep veins: inside sheath of deep fascia**

avi

- **Deep veins:**
- Accompany (below + their branches)
  - Tibial artery
  - Popliteal artery
  - Femoral arteries
- Blood flows → **external iliac vein**
- Blood flows efficiently in the deep veins as are surrounded by muscle & pulsating arteries, & have valves.
- **Superficial veins:**
- Have no muscular surround
- Travel in subcutaneous fat, and often have no surrounding arteries.
- They *do* have valves
- Superficial veins pierce deep fascia → drain into deep veins.
- Valves at the point of perforation ensure that blood drains from superficial → deep (and not other way round).
- Superficial veins are not good at dealing with engorgement as surrounded by fat: excess blood extends them and stagnates.

- 2 important superficial veins:
  - **Great saphenous vein**
  - **Small saphenous vein**
- Blood of the foot drains through veins between the metatarsals into **venous arch** on dorsum of foot (similar to hand).
- Why this venous arch structure?
  - Pressure on dorsum of foot when walking (& palm when gripping).
  - Venous arch between the bony struts of the foot allows pressure-free escape-route for blood.
- The venous arch runs into:
  - Medially: **great saphenous vein**
  - Laterally: **small saphenous vein**



#### **Great saphenous vein:**

- Runs up over anterior surface of medial malleolus
- Runs through subcutaneous tissue of medial side of leg
- Several important perforations to the deep veins at the level of the ankle and lower leg.
- Reers posteriorly to negotiate the knee

- → front of the thigh
- Receives several tributaries in upper part of thigh
- Terminates just below medial end of the inguinal ligament by perforating the deep fascia through the saphenous opening.
- Surrounded by cribriform fascia as it passes through the saphenous opening.
- As with all superficial venous perforations, there is a valve as the great saphenous vein passes through the deep fascia.

#### **Small saphenous vein:**

- Lateral side of foot → lateral side of ankle → midline of back of lower leg
- Perforates deep fascia (popliteal fascia) in popliteal fossa
- Enters the popliteal vein.

### **LYMPHATIC DRAINAGE OF THE LOWER LIMB**

General rule:

- Superficial lymphatics follow veins
- Deep lymphatics follow arteries

#### **Superficial lymphatics**

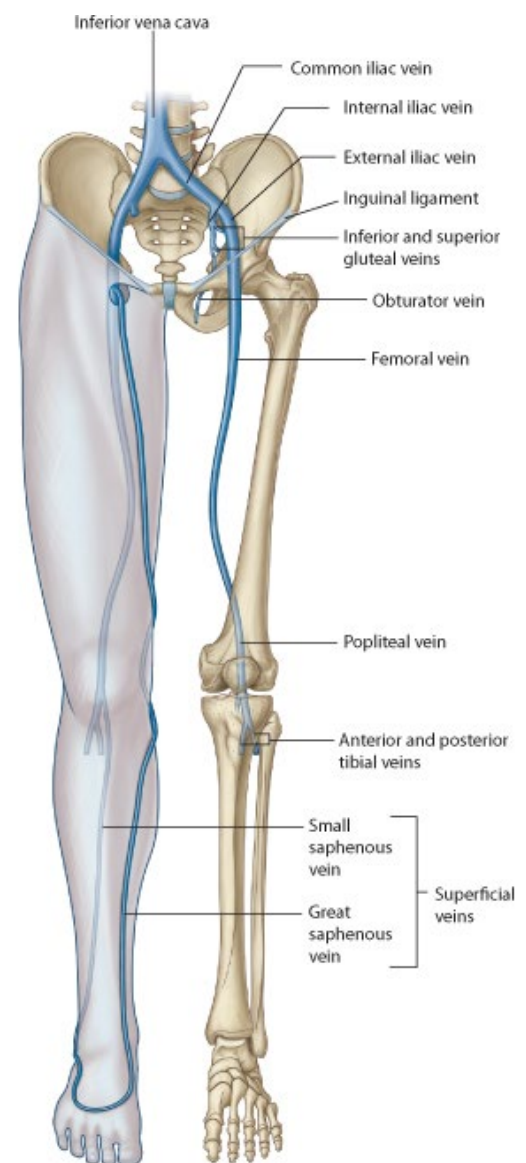
- Most lymphatics drain along great saphenous vein → vertical inguinal lymph nodes of groin
- Not much lymph drains along the small saphenous vein.
- Since lymph drains from the foot & leg → inguinal nodes, infections of the foot or lower leg lead to enlarged inguinal lymph nodes.

#### **Deep lymphatics of lower limb:**

- Follow arteries & drain into deep inguinal LNs
- Drain through lymph vessels in the **femoral canal** → abdominal cavity.
- → lymph vessels surrounding external iliac artery → surrounding aorta → thoracic duct

### **LYMPH NODES IN FEMORAL TRIANGLE**

- LNs in femoral triangle are important in filtering lymph from lower limb.
- Arranged in **superficial and deep groups**.
- **Superficial inguinal LNs:**
- Arranged like letter 'T'
- **Horizontal:** subcutaneous fat below inguinal ligament – receives lymph from lower abdominal wall, back and perineum.
- **Vertical:** around great saphenous vein – receives lymph from the lower leg & foot which travels up superficial lymphatics with the great saphenous vein.



- **Deep inguinal LNs:**
- Efferents from superficial inguinal LNs pass through the cribriform fascia into the deep inguinal LNs.
- Deep LNs surround the upper end of the femoral vein
- One node is consistently found in the femoral canal (medial to femoral vein in the femoral sheath).

## APPLIED ANATOMY OF THE ANKLE & FOOT

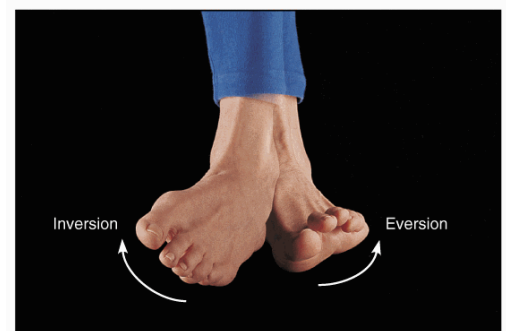
### FRACTURE OF TIBIA & FIBULA

- Extremely common
- Pattern of fracture depends on force applied:
  - Car bumper hitting leg: both tib & fib fracture @ same point
  - Skiing accident (a twisting force): tib & fib fracture @ different levels.
- **Pott's fracture:** both bones are broken at the level of the malleoli



### SPRAINED ANKLE

- V. common
- Usually forced inversion
- Lateral ligament of ankle joint is partially/completely torn.
- Lateral ligament consists of 3 bands
- The bands usually damaged are the:
  - Anterior band: talofibular
  - Middle band: calcaneofibular
- The posterior band of the ligament ruptures only in severe injury.



### MUSCLE / TENDON DAMAGE:

- **Plantaris tendon** can rupture spontaneously:
  - → severe pain in the calf.
- **Tendo calcaneus (achilles tendon)** can also partially/completely rupture
- **Poliomyelitis:** often affects the dorsiflexors & evertors of the leg.
  - Less common nowadays due to polio vaccine

### **PROBLEMS WITH NERVES:**

- **Pressure on common peroneal nerve** → **paralysis of muscles** supplied by this nerve.
- Problem spot is where common peroneal nerve lies superficially on neck of ulnar.
  - Bad positioning of patient on operating table
  - Tight plaster of paris / tourniquet

### **Foot drop:**

- Permanent damage to common peroneal nerve as it winds around head of the fibula → **foot drop**; inability to evert or dorsiflex the foot.
- Patient must walk with high step, so toes don't hit floor first & trip patient up.

### **VASCULAR SUPPLY TO THE FOOT:**

- **Impaired blood supply** to lower limb →
  - Changes in skin
  - Pain in muscles on walking
  - Gangrene (death of tissue)
- Should therefore be able to palpate normal pulses in:
  - Femoral artery
  - Popliteal artery
  - Dorsalis pedis
  - Posterior tibial artery
- Blockage is often high in aorta / iliacs
- But sometimes localised to leg arteries; these blockages can be removed / bypassed.

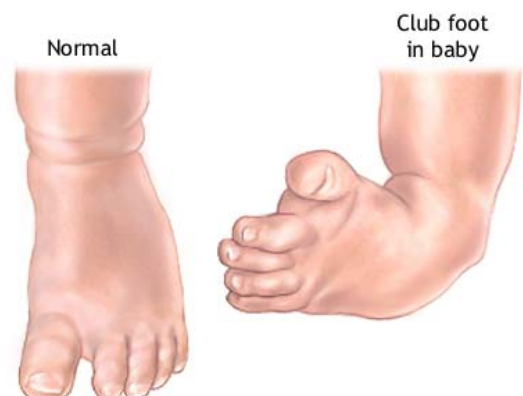
### **Varicose veins**

- Abnormally dilated veins in the leg
- Due to loss of function of valves in the perforators (superficial veins → deep veins through deep fascia):
  - At level of ankle
  - At perforating terminations of great & small saphenous veins
- → accumulation of blood in the superficial veins
- → dilation of superficial veins
- Blood supply to skin & subcutaneous tissues suffers.
  
- Varicose veins of perforators on medial side of ankle →
  - Skin discolouration
  - Ulcers

### **CONGENITAL ABNORMALITIES**

#### **Club foot (talipes equinovarus):**

- Baby's foot is:
  - **Plantarflexed** (toes point downwards)
  - **Adducted**
  - **Inverted**
- Special names for congenital deformities:
  - Abnormal plantarflexion: **equinus**
  - Abnormal adduction towards midline: **varus**





- Generic name for an abnormal ankle position: **talipes**
- Δ 'club foot' = **talipes equinovarus**
- Many congenital abnormalities at the time of birth lie in the soft tissues and so can be corrected by manipulation.
- BUT if they are neglected, the bones ossify in the abnormal shape & ligaments & capsules contract further → more drastic surgery needed.
- The same is true for **congenital dislocation of the hip**.