



University of Baghdad

College of Medicine

2022-2023



Title: The Sole of the Foot

Grade: One

Module: HSF-I

Speaker: Prof. Dr. Malak A. Taha

Date: 10-11/3/2024



Objectives



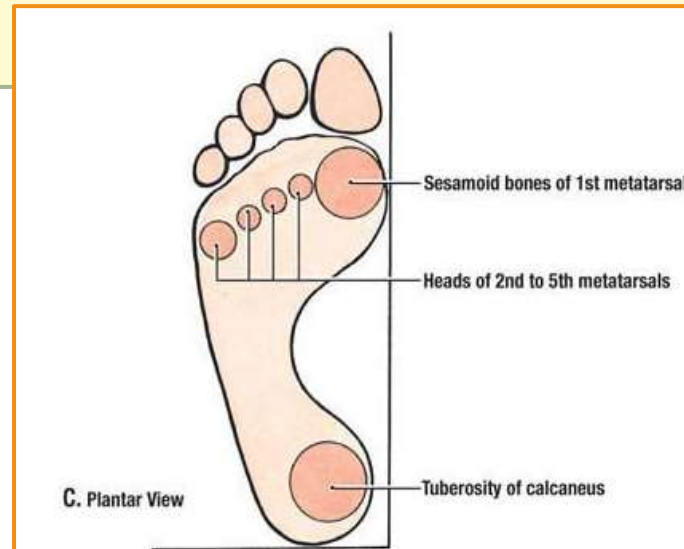
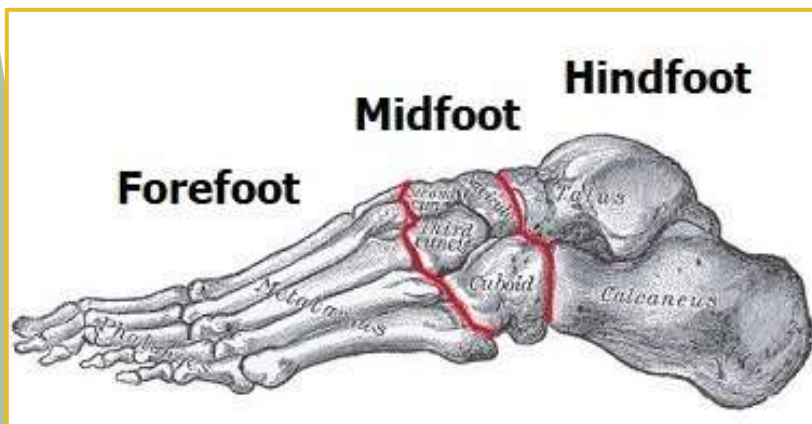
- **Describe** the layers of the sole
- **Define** the main nerves & vessels in the sole
- **List** some important ligaments & tendons in the region
- **Define** foot arches
- **State** some clinical correlates

SKIN AND SUBCUTANEOUS TISSUE OF SOLE

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- ▶ **Skin** over the major **weight-bearing areas** of the sole—the **heel, lateral margin, and ball of the foot**—is thick. The skin is **hairless, sensitive** and **sweat glands** are numerous
- ▶ **Subcutaneous tissue** is **more fibrous** than in other areas of the foot.
- ▶ Fibrous septa divide this tissue into **fat-filled areas**, making it a **shock-absorbing pad**, especially over the heel



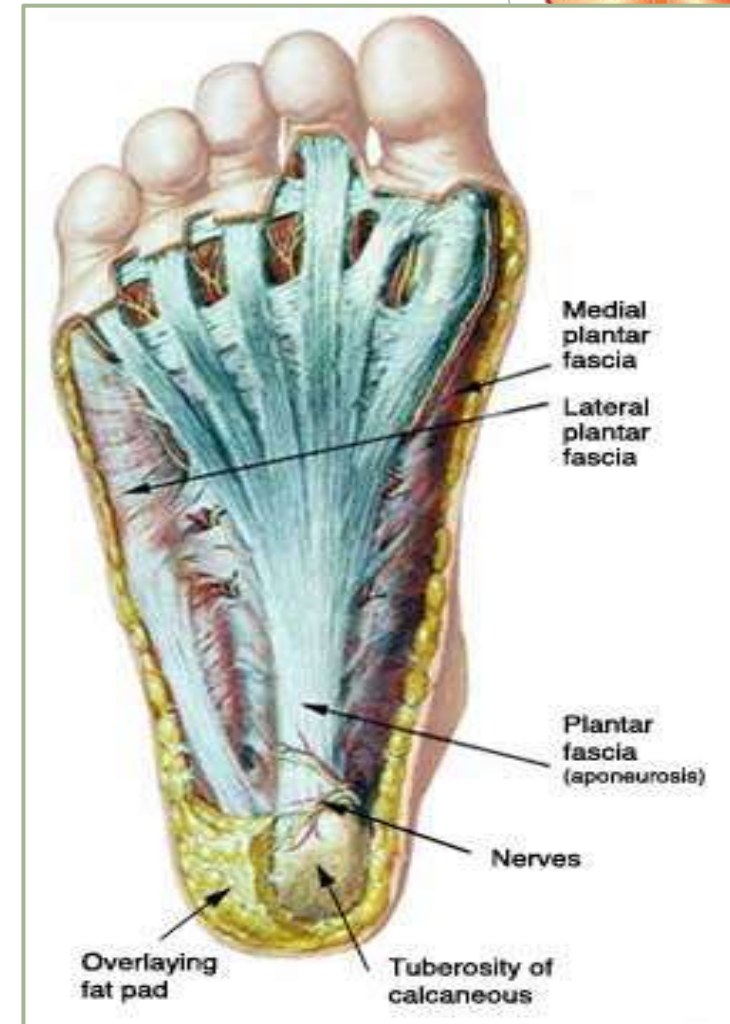


DEEP FASCIA OF FOOT OF SOLE

- ▶ The **plantar fascia** (the deep fascia of the sole)has
- ✓ a **thick central part** (plantar aponeurosis)
- ✓ **weaker medial and lateral parts.**

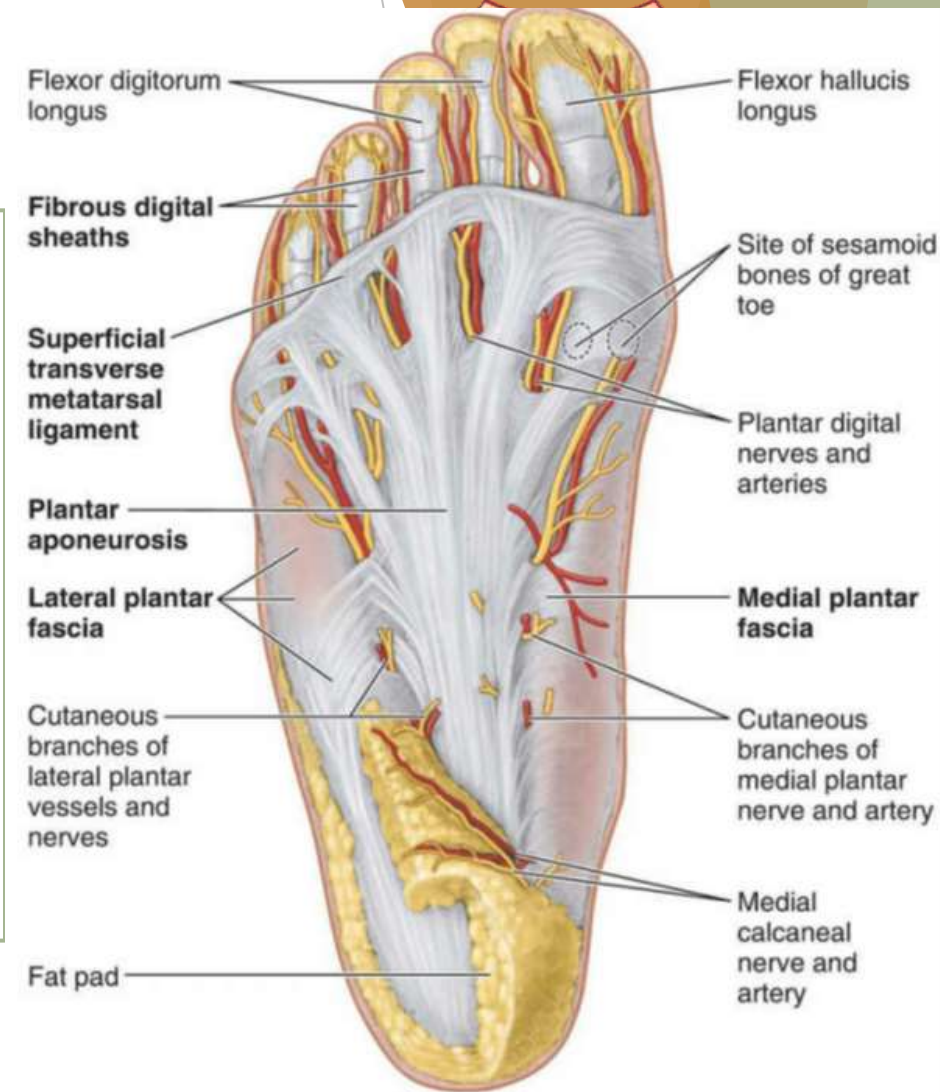
➤ **Functions:**

- Anchoring skin.
- Enhancing the grip.
- Promoting foot arches.
- Protection.



Plantar aponeurosis

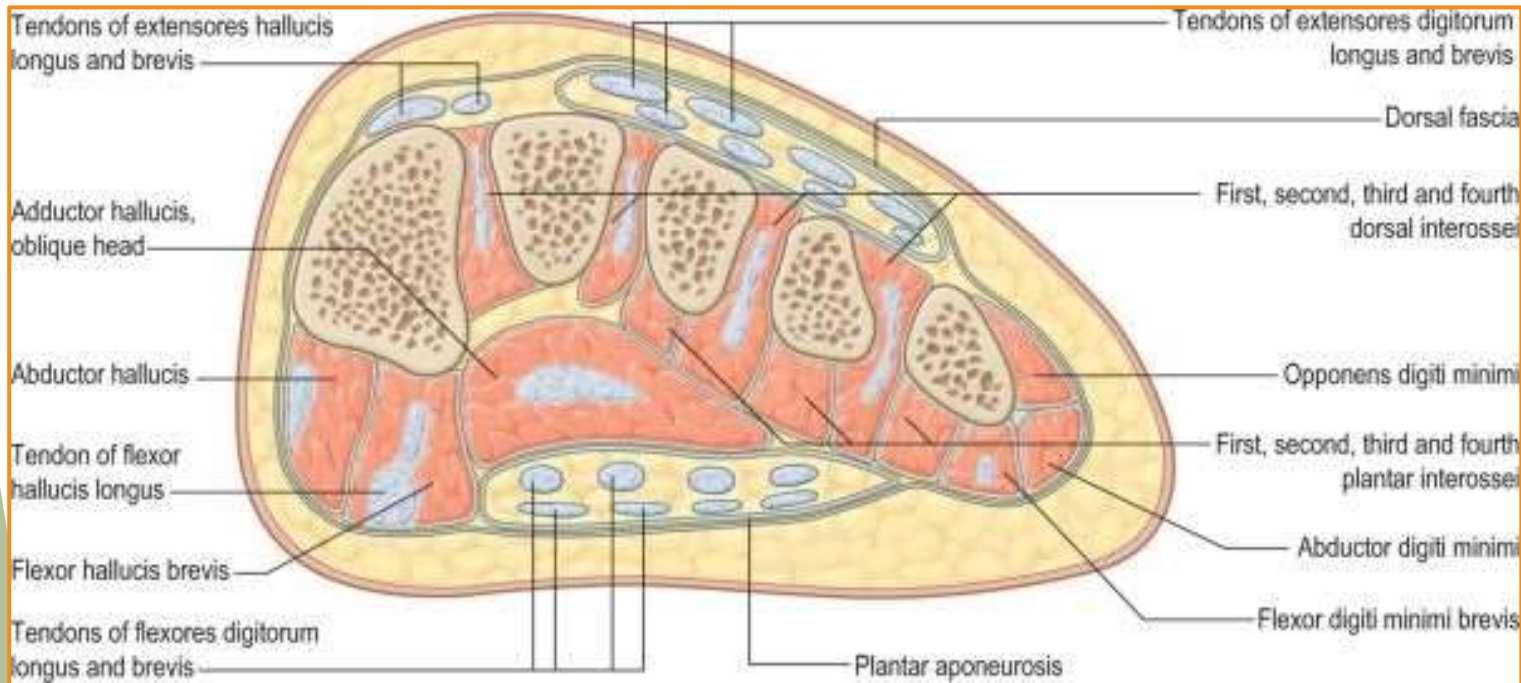
- A fibrous sheet that arises from the **medial process of calcaneal tuberosity**. It divides into five bands, one for each toe. The **middle 3 bands of digital slips** are the **broadest**
- Slips are connected to each other by the **superficial transverse metatarsal ligaments** at the level of metatarsal heads
- The digital slips bifurcate for the passage of the flexor tendons and are inserted around the edges of the **fibrous flexor sheaths** and into the **deep transverse metatarsal ligaments**



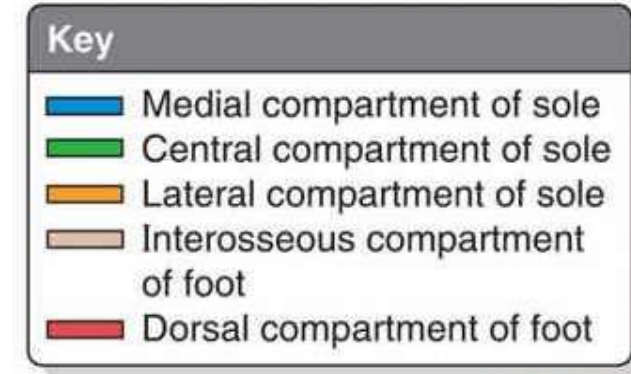
(B) Sole of foot (plantar aspect, inferior view)

Compartment of the foot

- In the midfoot and forefoot, **vertical intermuscular septa** extend deeply (superiorly) from the margins of the plantar aponeurosis toward the **1st and 5th metatarsals**, forming the three (**Medial, central & lateral**) compartments of the sole

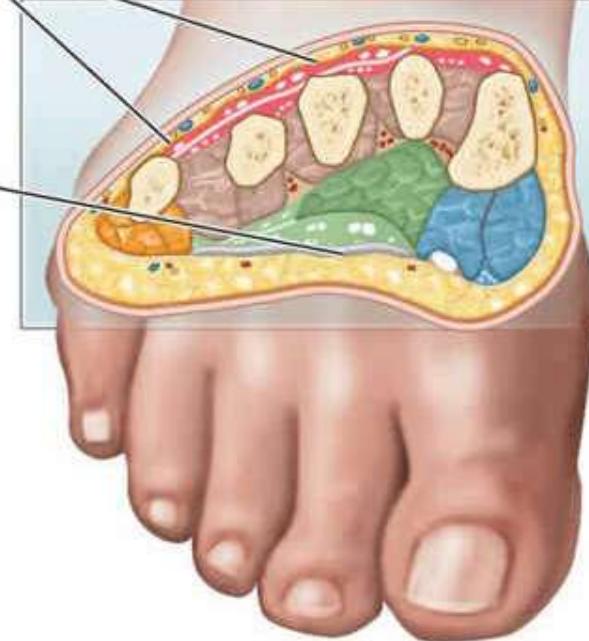


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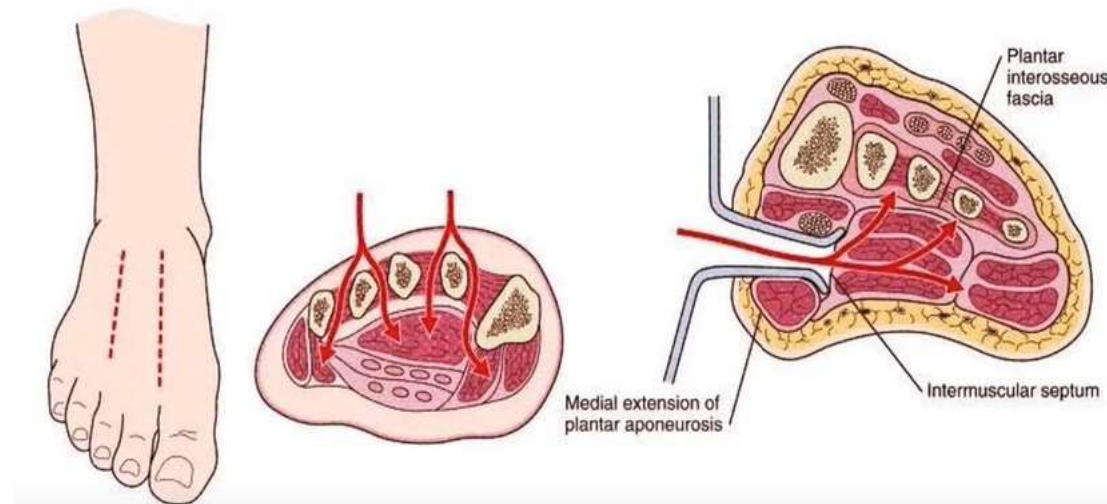
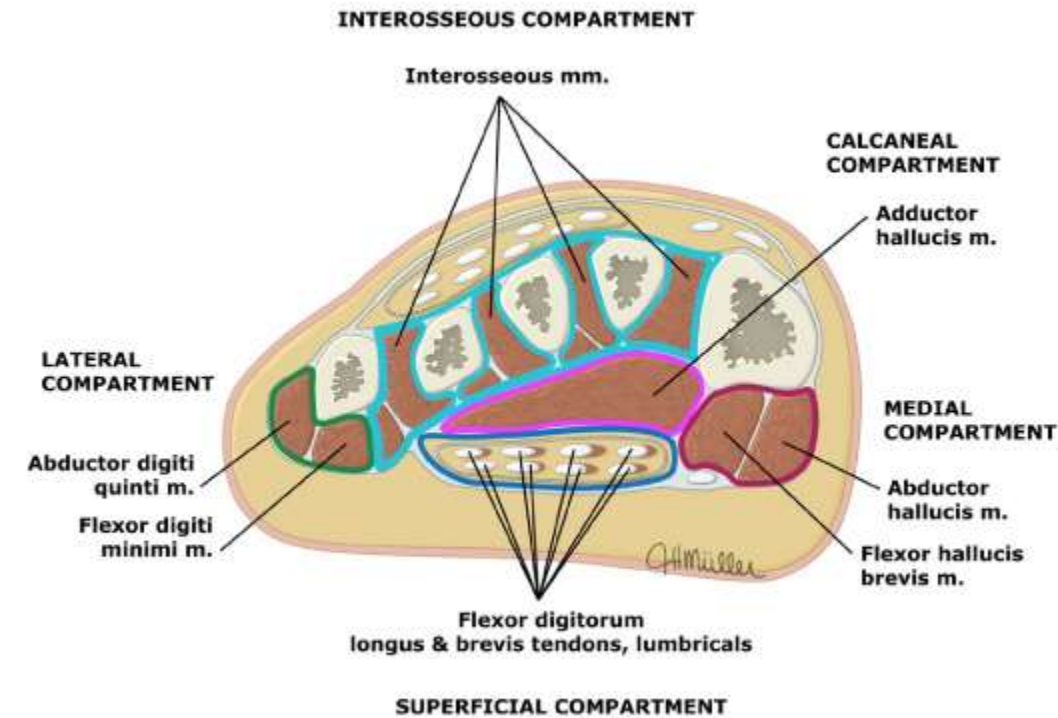
Dorsal fascia

Plantar fascia



(C) Transverse section of foot compartments (anterior view)

- In the **forefoot** only, a fourth compartment, the **interosseous compartment of the foot**
 - ✓ Metatarsals
 - ✓ dorsal interosseous muscles,
 - ✓ plantar interosseous muscles
 - ✓ deep plantar and metatarsal vessels.
- A fifth compartment, the **dorsal compartment of the foot**,
 - ✓ extensors hallucis brevis & extensor digitorum brevis
 - ✓ neurovascular structures of the dorsum of the foot



Plantar Fasciitis

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- Inflammation of the **plantar fascia** is often caused by an **overuse mechanism**. It may result from **running** especially when **inappropriate footwear is worn**.
- If a **calcaneal spur** (abnormal bony process) protrudes from the medial tubercle, **plantar fasciitis** is likely to cause pain on the medial side of the foot when walking
- Usually a **bursa** develops at the end of the spur that may also become inflamed and tender.

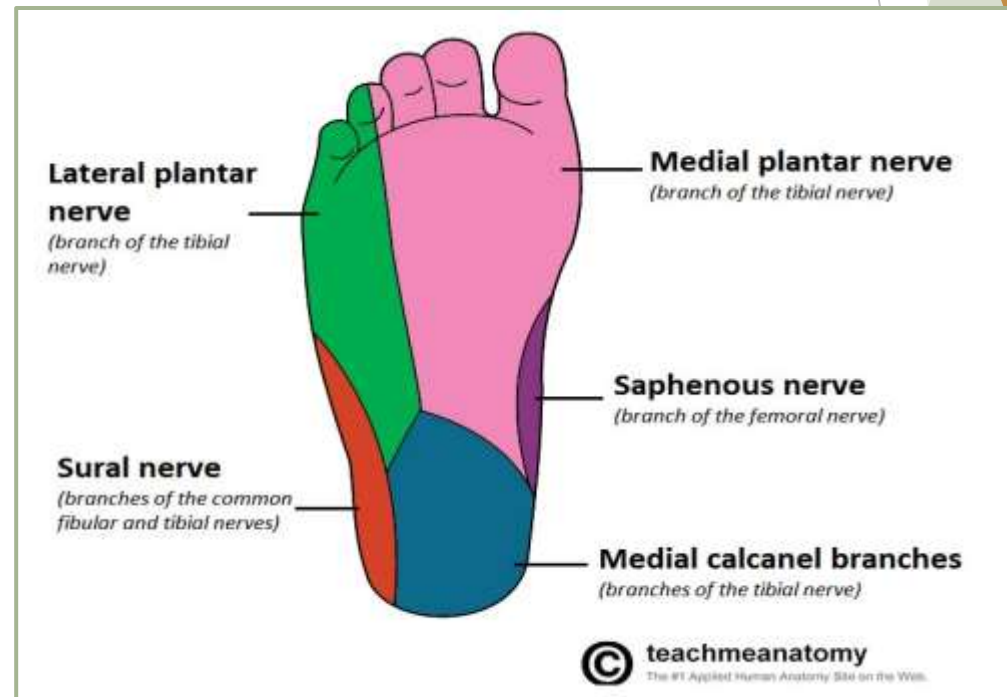
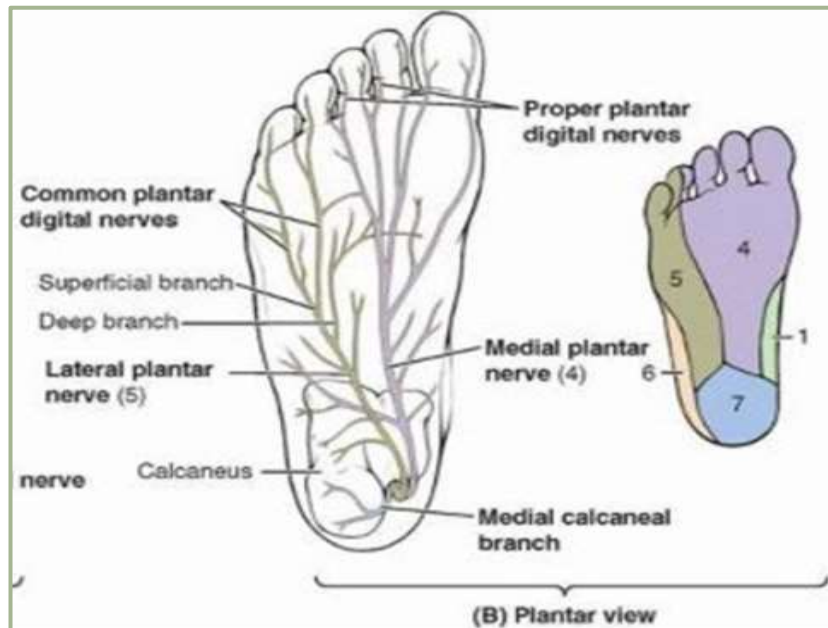


Cutaneous nerves

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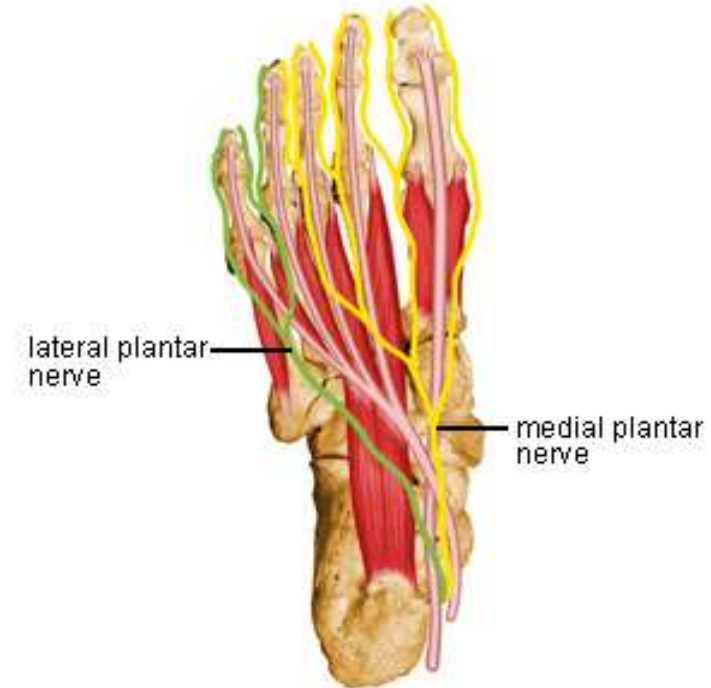
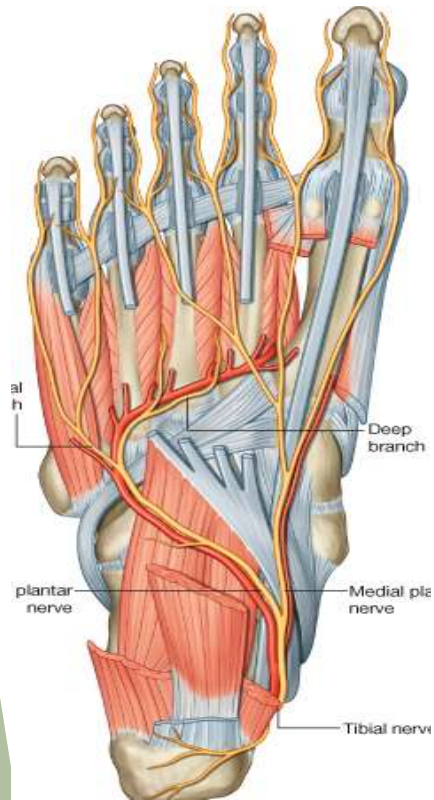


- ❖ **Medial calcaneal branch of tibial nerve** supplies the heel
- ❖ Medial aspect of the foot skin is supplied by the **saphenous nerve**
- ❖ **The sural nerve** supplies the foot skin laterally
- ❖ The major area is supplied by the **medial & lateral plantar nerves**





- ❖ **Medial plantar n. gives 1 proper & 3 common digital nerves for the medial 3.5 toes**
- ❖ **Lateral plantar n. gives 1 common & 1 proper digital nerves for the lateral 1.5 toes**

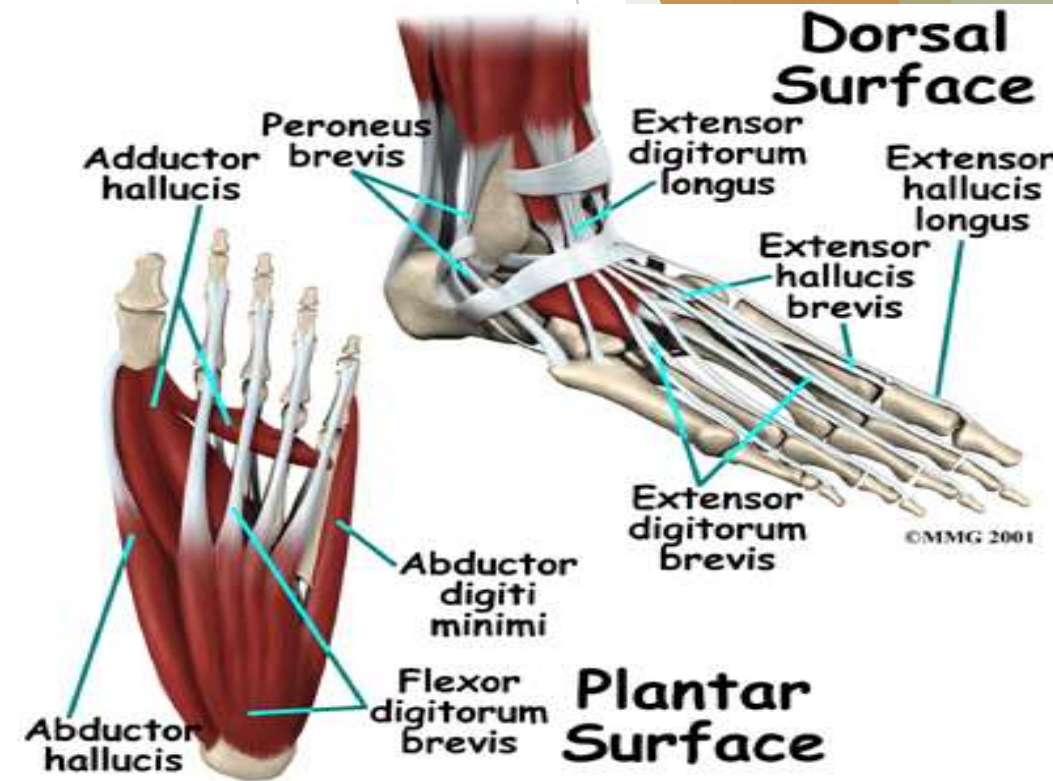


Muscles of Foot

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- Of the **20 individual muscles** of the foot,
 - ✓ **14** are located on the **plantar aspect**,
 - ✓ **2** are on the **dorsal aspect**,
 - ✓ **4** are **intermediate** in position.
- ❑ Despite their compartmental and layered arrangement, the **plantar muscles** function primarily as a group during the **support phase of stance**, **maintaining the arches of the foot**
- ❑ They basically **resist forces** that tend to **reduce the longitudinal arch** as **weight** is received at the **heel** and is then transferred to the **ball of the foot** and **great toe** (anterior end of the arch).



Layers of the sole

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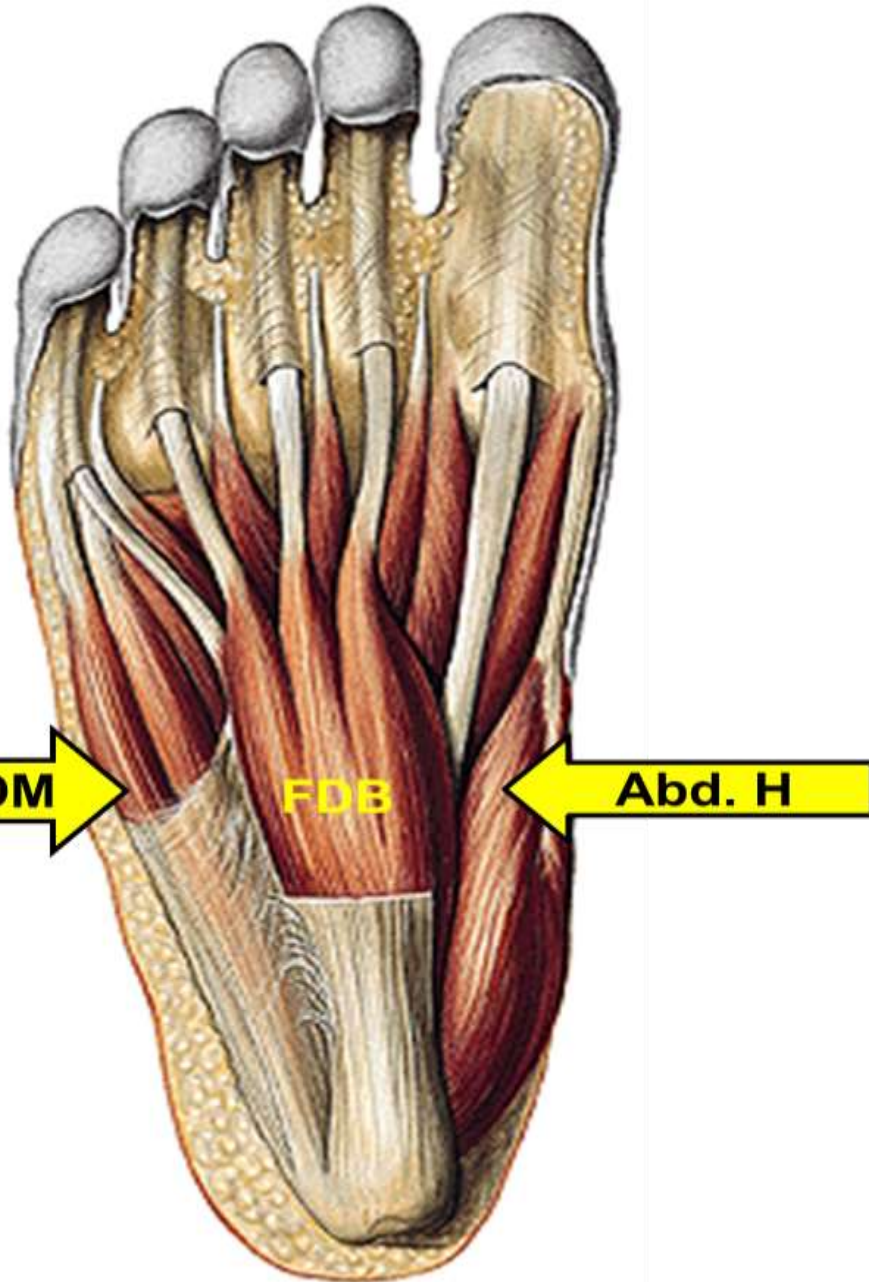
Layer No.	Structures
First	FDB, abductor H & abductor DM
Second	Long flexor tendons, lumbricals & Q plantae
Third	FHB, FDMB & adductor hallucis
Fourth	Interossei , Tendons of peroneus longus & tibialis posterior fibularis longus

There are **two neurovascular planes** between the muscle layers of the sole of the foot:

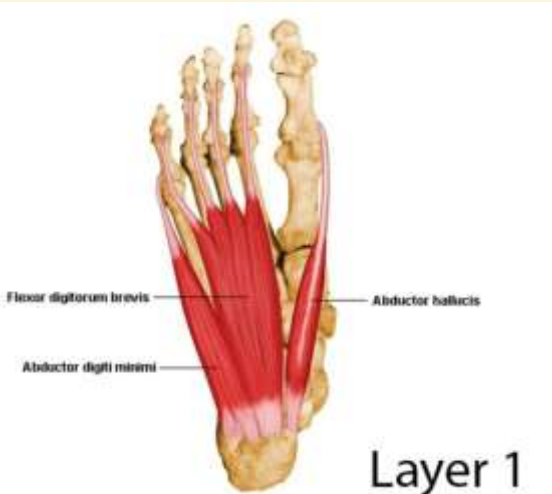
- (1) a **superficial one** between the 1st and the 2nd muscular layers
- (2) a **deep one** between the 3rd and the 4th muscular layers.

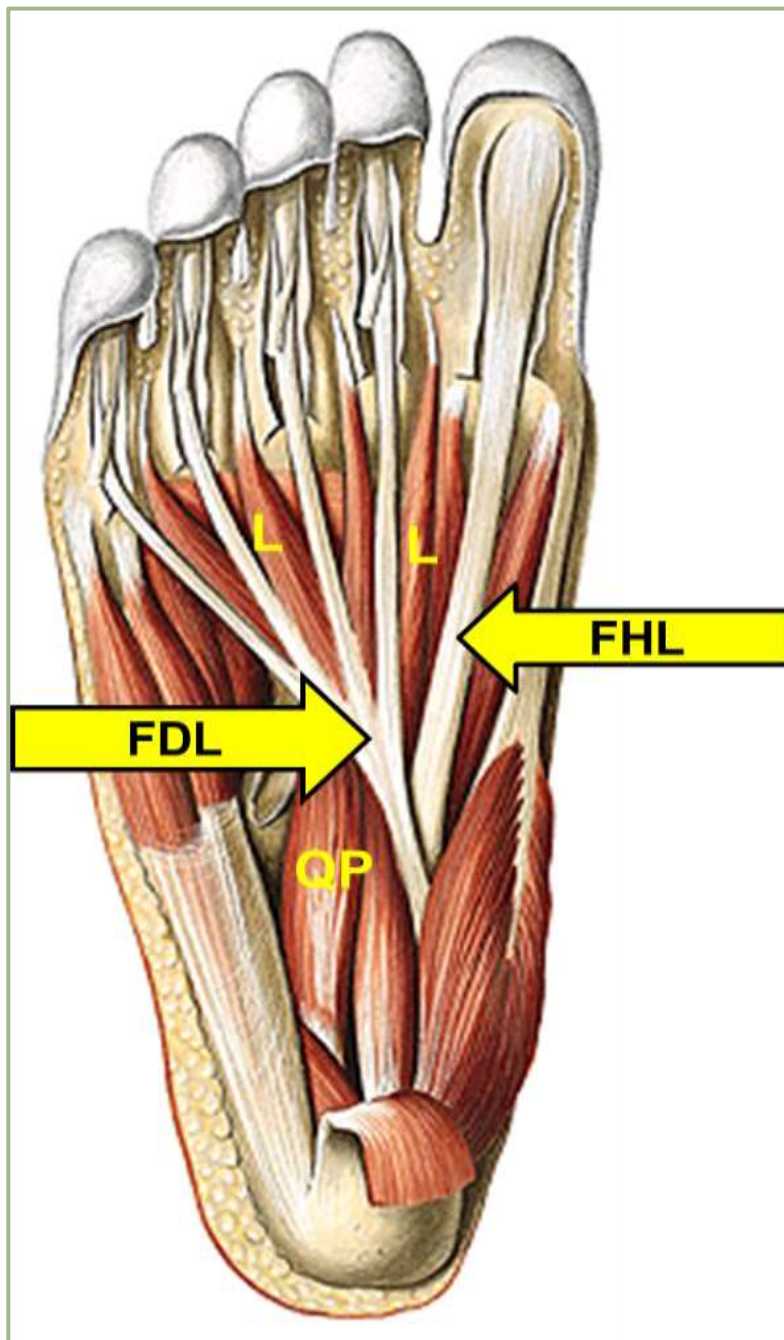


First Layer



MUSCLES OF FOOT: 1ST LAYERS OF SOLE

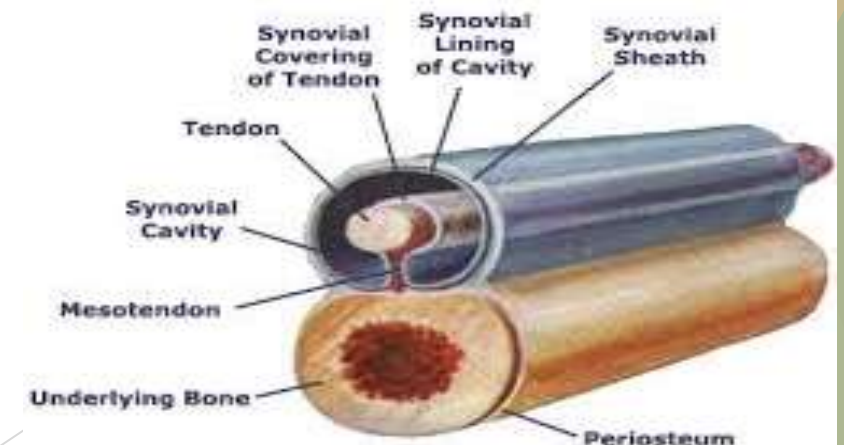
Muscle	Proximal attachment	Distal Attachment	N Supply	Main Action
Abductor hallucis	Tuberosity of calcaneus; plantar aponeurosis 	Medial side of base of proximal phalanx of 1st digit	Medial plantar nerve (S2, S3)	Abducts and flexes 1st digit
Flexor digitorum brevis		Both sides of middle phalanges of lateral four digits		Flexes lateral four digits
Abductor digiti minimi		Lateral side of base of proximal phalanx of 5th digit	Lateral plantar nerve (S2, S3)	Abducts and flexes 5th digit



Second Layer

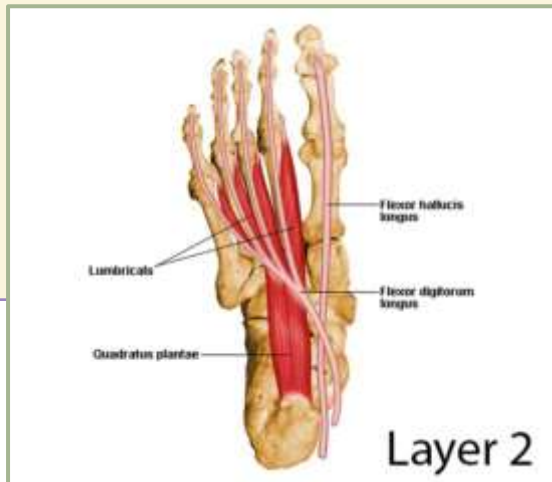
Long flexor tendons

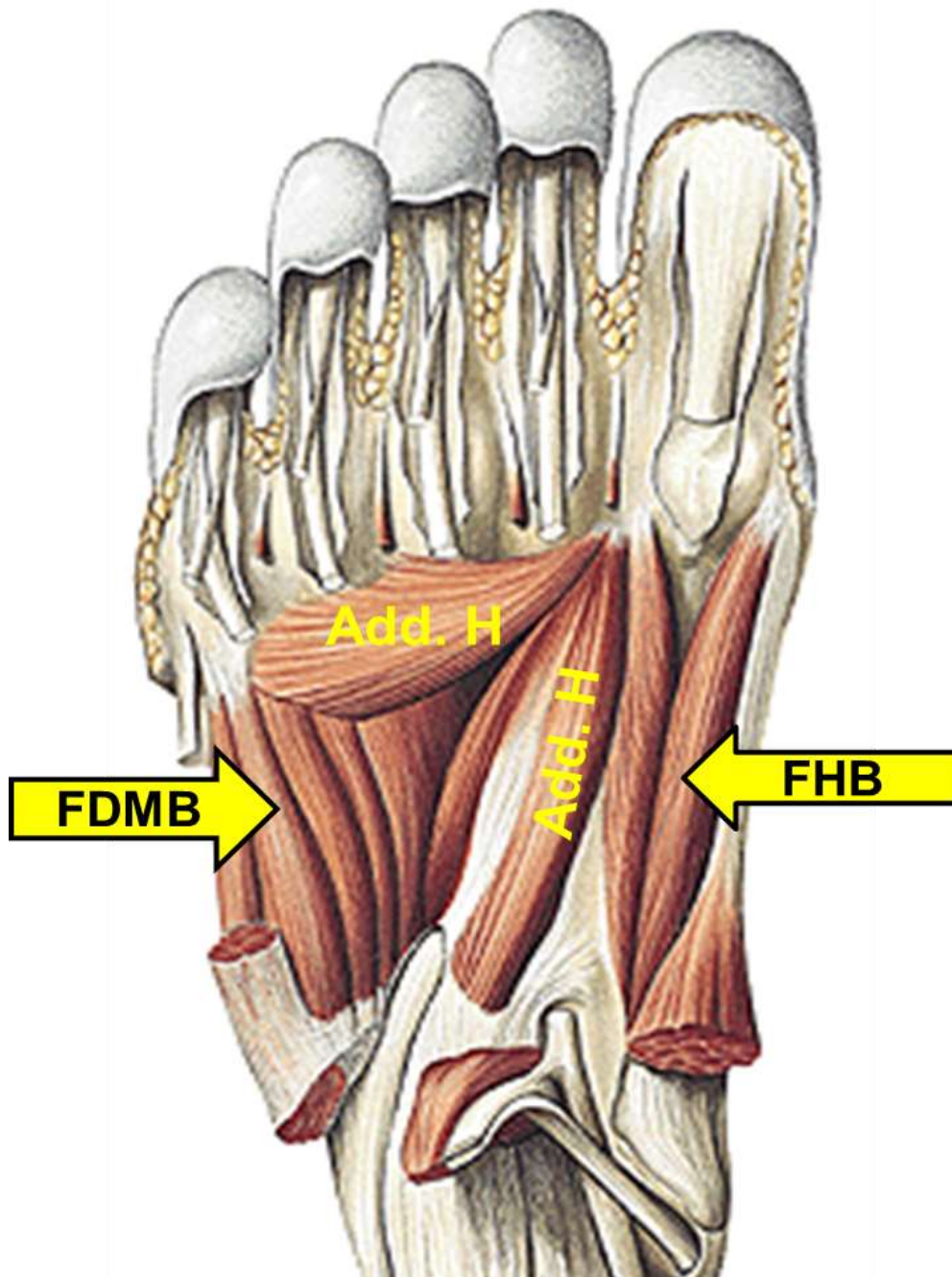
- Crossing takes place between the tendons of FDL & FHL, the latter being deeper
- **Fibrous flexor sheaths** extend on the **undersurface** of each toe from the **metatarsal head** to the **base of the distal phalanx**.
- **Synovial sheaths** start proximal to the fibrous ones & enclosed inside them



MUSCLES OF FOOT: 2nd LAYERS OF SOLE


Muscle	Proximal attachment	Distal Attachment	N Supply	Main Action
Quadratus plantae	Calcaneal tuberosity	Posterolateral margin of tendon of flexor digitorum longus	Lateral plantar nerve (S2, S3)	Assists flexor digitorum longus in flexing lateral four digits
Lumbricals	Medial sides of Tendons of flexor digitorum longus	Medial aspect of expansion over lateral four digits	Medial one: medial plantar nerve (S2, S3) Lateral three: lateral plantar nerve (S2, S3)	Flexion of - MTPJ Extension of - IPJ





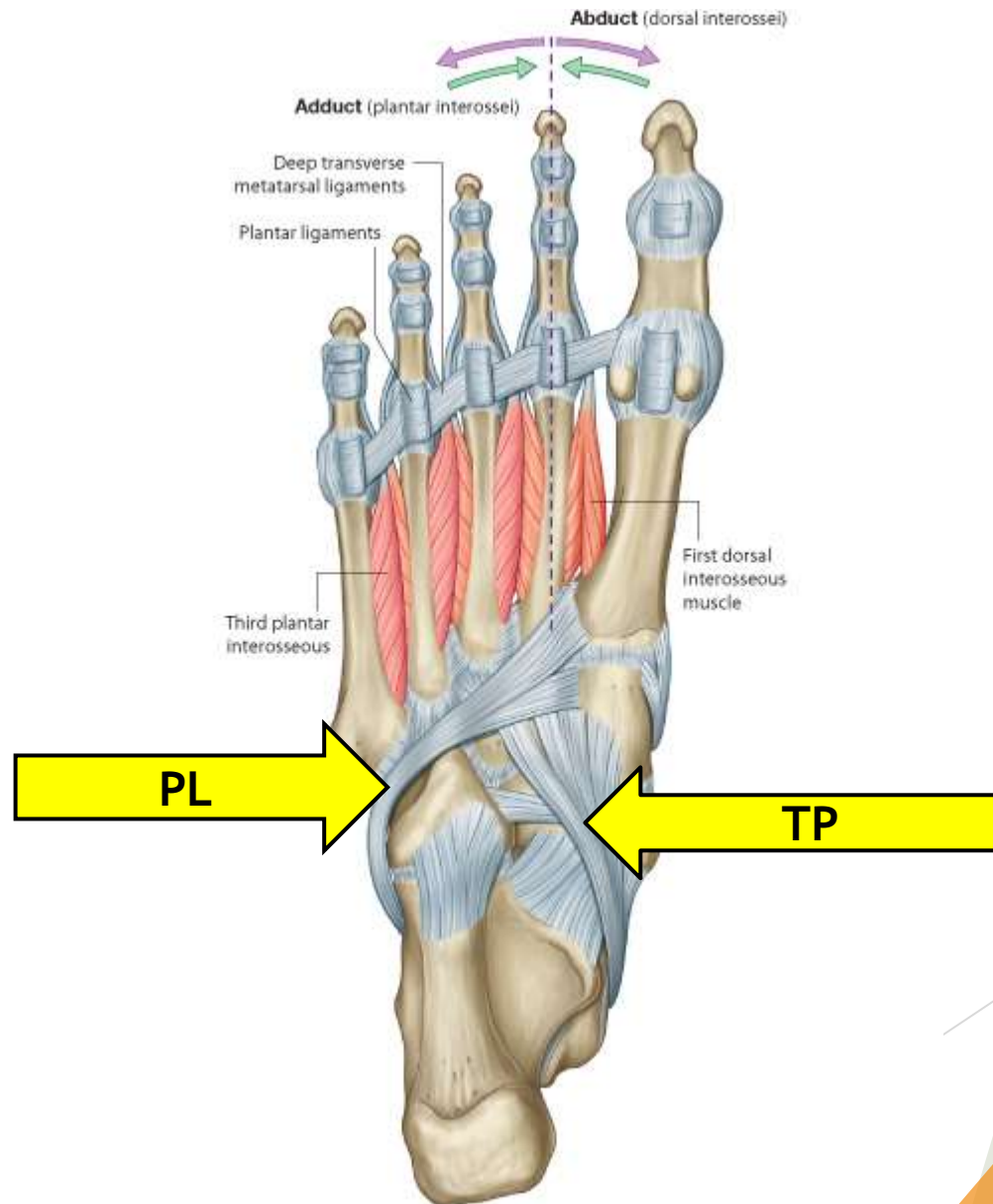
Third Layer

MUSCLES OF FOOT: 3rd LAYER OF SOLE

Muscle	Proximal attachment	Distal Attachment	N Supply	Main Action
Flexor hallucis brevis	Plantar surfaces of cuboid and lateral cuneiform	Both sides of base of proximal phalanx of 1st digit	Medial plantar N. (S2, S3)	Flexes 1 st digit at MTPJ
Adductor hallucis	Oblique head: bases of metatarsals 2-4 Transverse head: deep transverse metatarsal ligament and plantar ligaments of metatarsophalangeal (MTP) joints	Tendons of both heads attach to lateral side of base of proximal phalanx of 1st digit	Deep branch of lateral plantar N. (S2, S3)	Adducts great toe at MTPJ
Flexor digiti minimi brevis	Base of 5th metatarsal 	Base of proximal phalanx of 5th digit	Superficial branch of lateral plantar N. (S2, S3)	Flexes little toe at the MTPJ

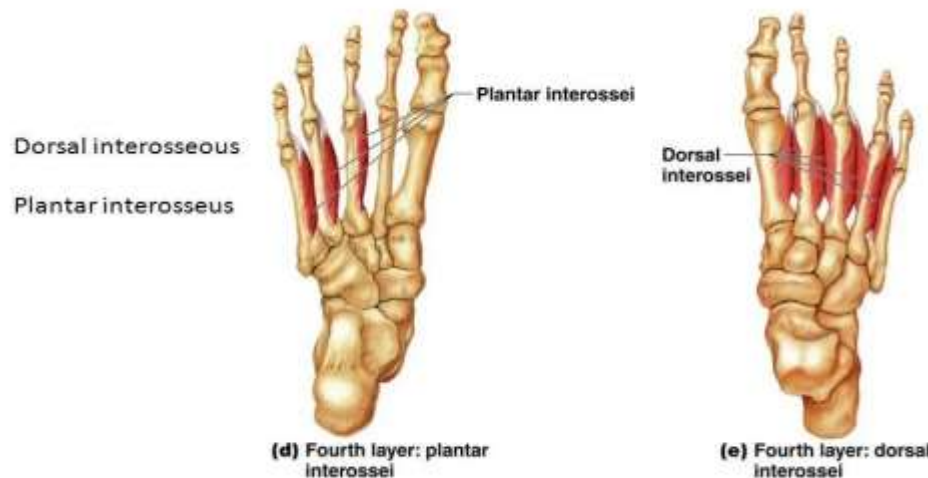


Fourth layer



MUSCLES OF FOOT: 4th LAYER OF SOLE

Muscle	Proximal attachment	Distal Attachment	N Supply	Main Action
Plantar interossei (three muscles)	medial sides of metatarsals 3-5	Dorsal expansions Bases of proximal phalanges of toes 3-5	Lateral plantar nerve (S2, S3)	Adduct digits (3-5) and flex metatarsophalangeal joints
Dorsal interossei (four muscles)	Adjacent sides of metatarsals 1-5	Dorsal expansions Bases of proximal phalanges of toes 2-4	Lateral plantar nerve (S2, S3)	Abduct digits (2-4) and flex metatarsophalangeal joints



Metatarsal 2:

- Considered as **the foot axis** because of its relative immobility

Relative immobility

+

slenderness



Marsh fracture (spontaneous fracture with repetitive minor trauma)



Plantar Reflex

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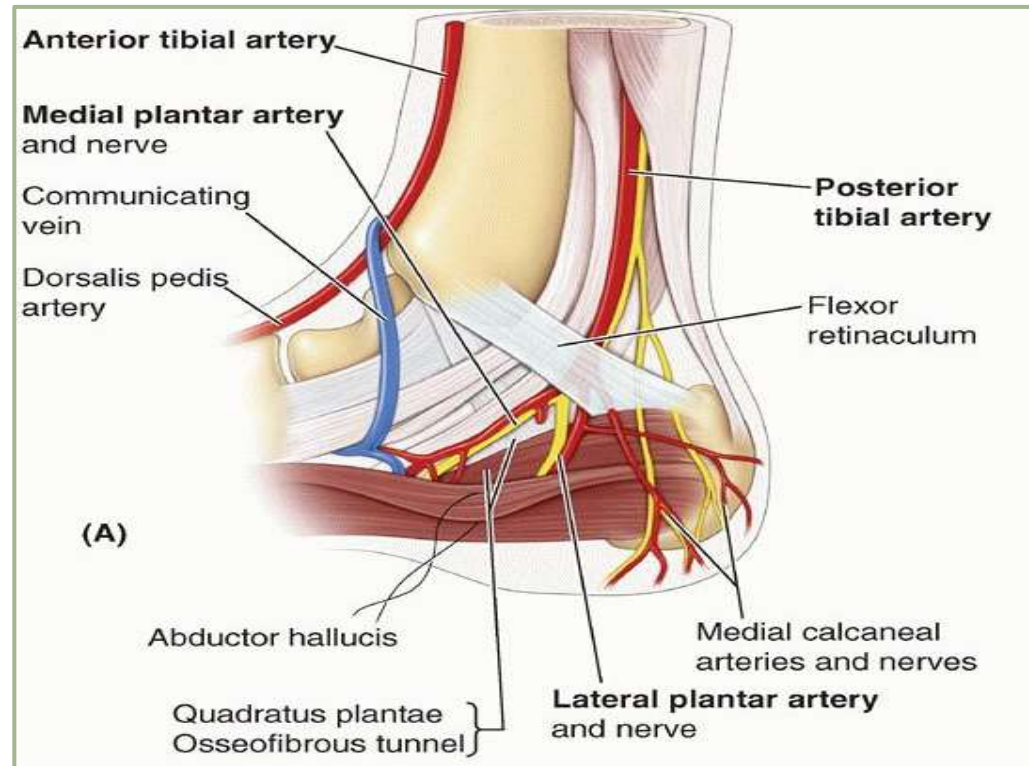
- L4, L5, S1, and S2 nerve roots
- Is routinely tested during neurologic examinations.
- The lateral aspect of the sole of the foot is stroked with a blunt object, such as a tongue depressor, beginning at the heel and crossing to the base of the great toe.
- Flexion of the toes is a normal response.
- Dorsiflexion of the great toe is an abnormal response (Babinski sign), indicating brain injury or cerebral disease, except in infants.

ARTERIES OF SOLE OF FOOT

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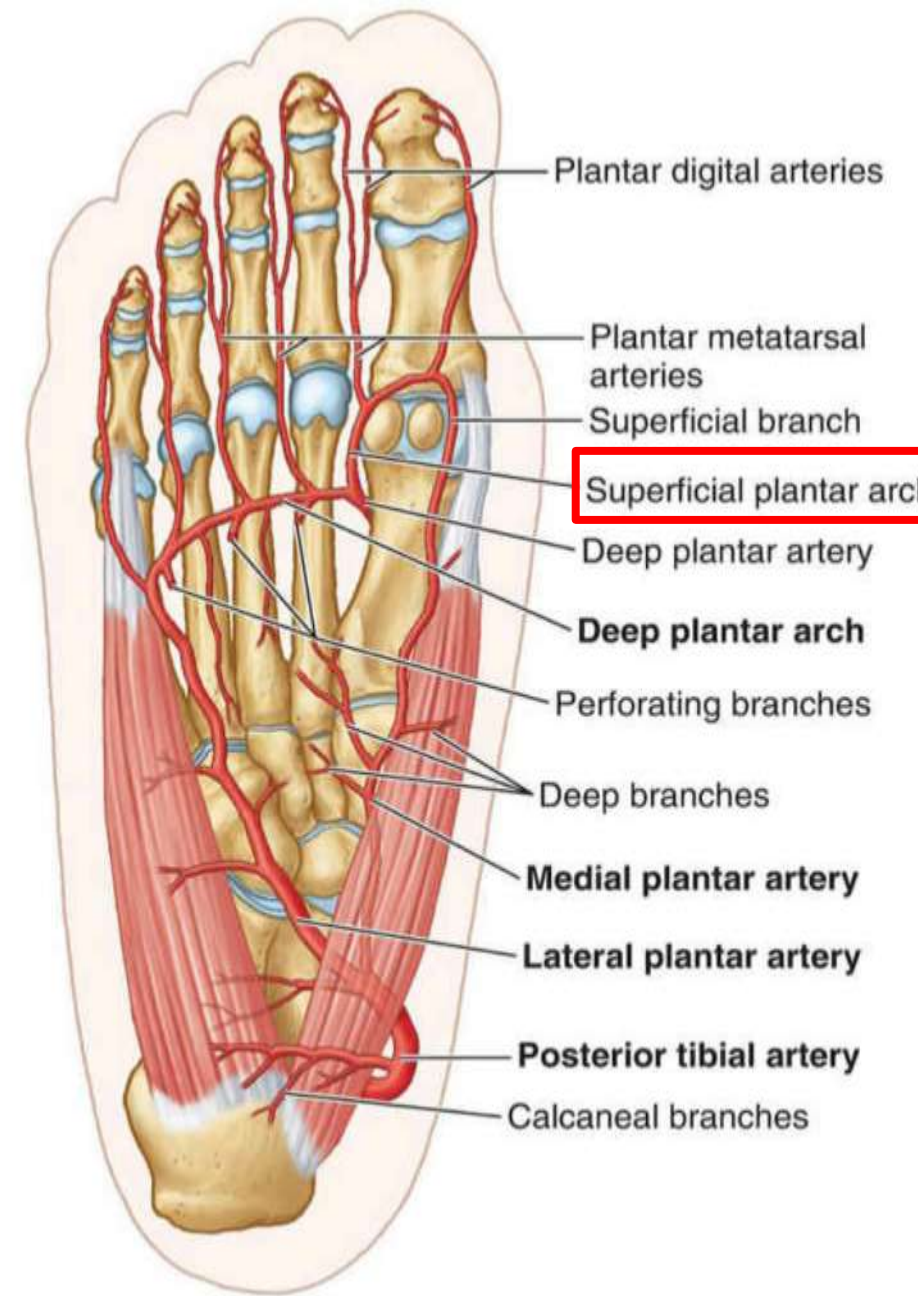
- is derived from the **posterior tibial artery**, which divides deep to the flexor retinaculum
- The terminal branches pass deep to the **abductor hallucis** (AH) as the **medial** and **lateral plantar arteries**, which accompany the similarly named nerves.



Medial Plantar Artery

- is the smaller terminal branch of the posterior tibial artery
- At first deep to abductor hallucis, it runs distally between abductor hallucis and flexor digitorum brevis, supplying both.
- It gives rise to
 - a **deep branch** (or branches) that supplies mainly muscles of the great toe.
 - a larger **superficial branch** that
 - ✓ supplies the skin on the medial side of the sole
 - ✓ Has digital branches that accompany digital branches of the medial plantar nerve
 - ✓ anastomose with medial plantar metatarsal arteries

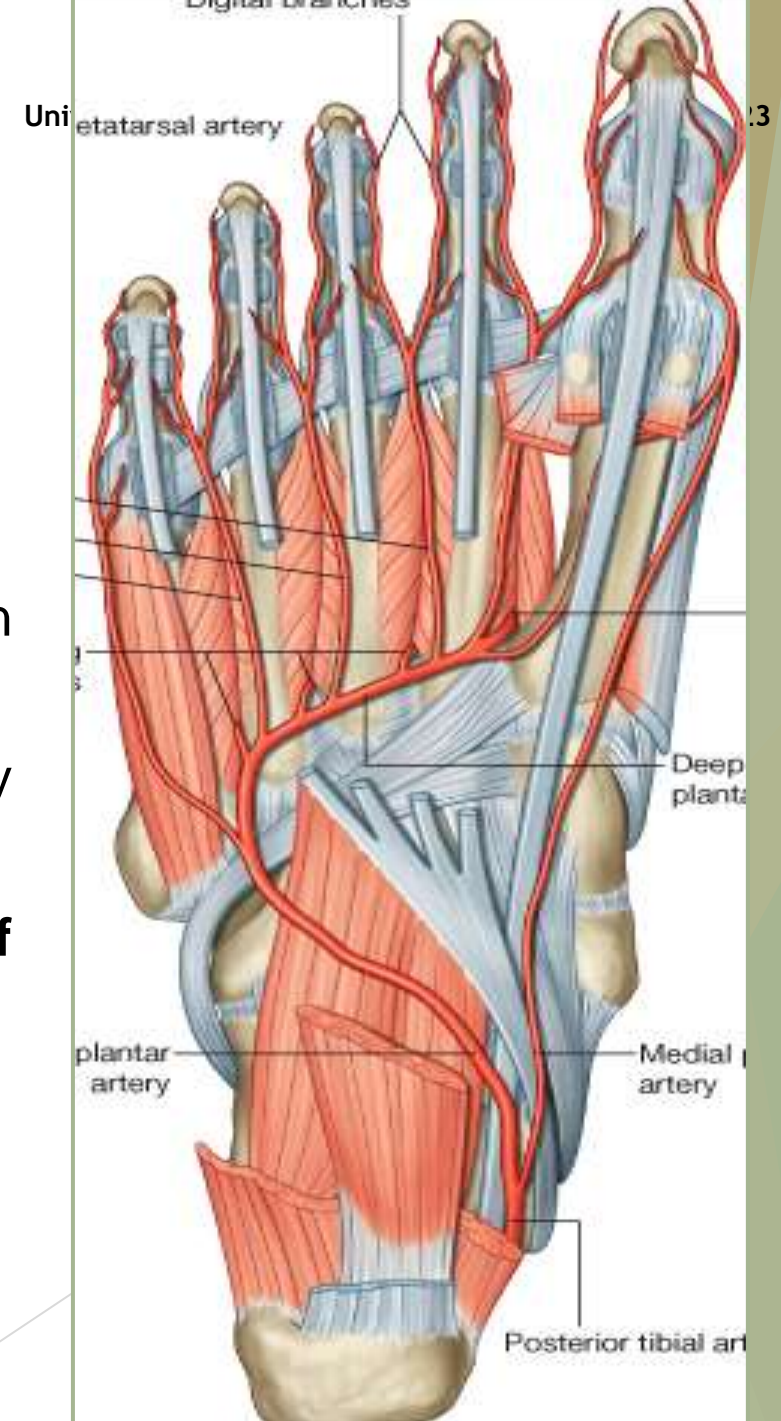
Occasionally, a **superficial plantar arch** is formed when the **superficial branch** anastomoses with the **lateral plantar artery** or the **deep plantar arch**



(B) Plantar aspect of foot

Lateral plantar artery

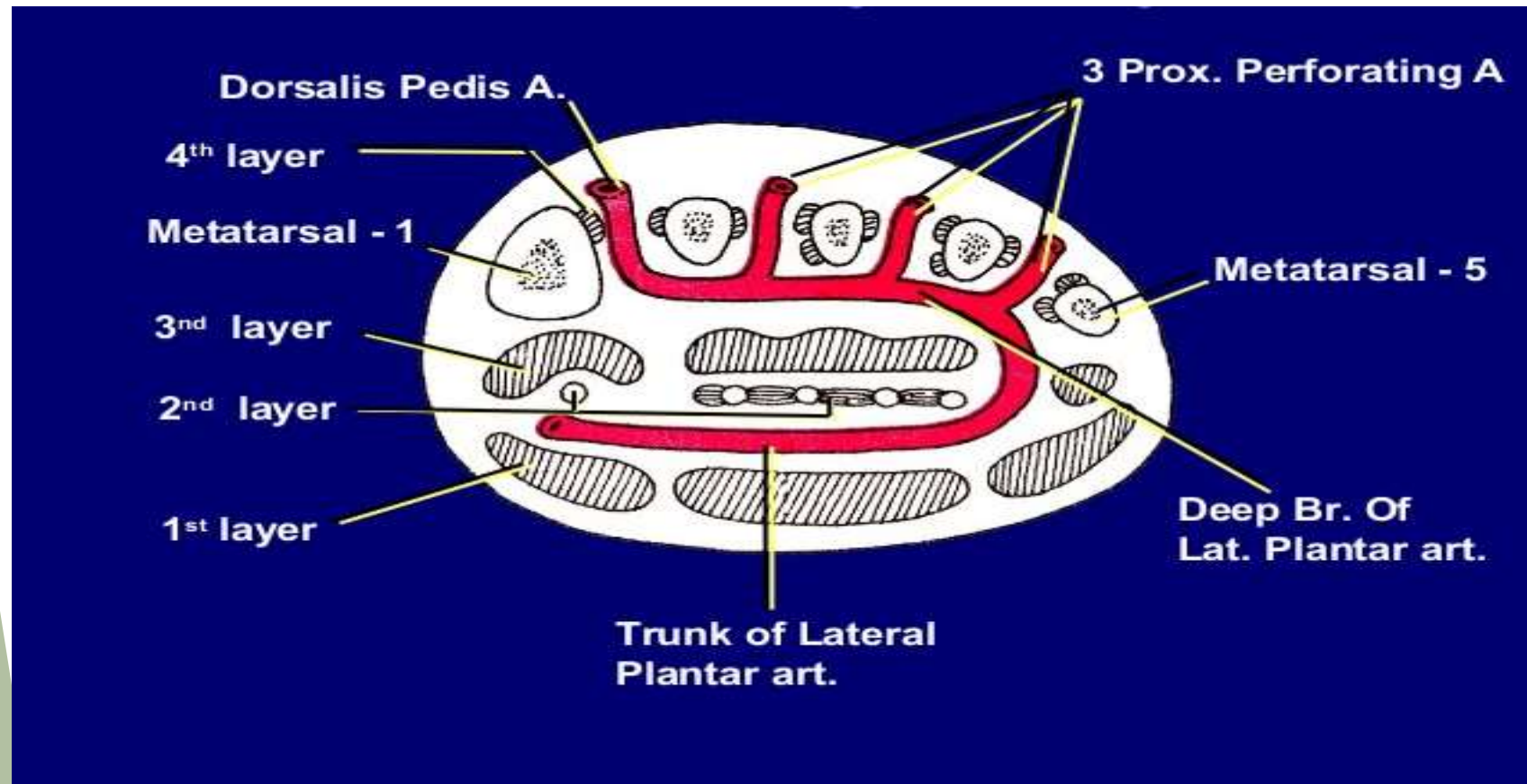
- much larger than the medial plantar artery
- It runs laterally and anteriorly, at first deep to the AH and then between the FDB and quadratus plantae
- At the base of the 5th metatarsal, the artery returns medially forming the **plantar arterial arch**
- It ends by anastomosing with the **deep plantar branch of dorsalis pedis**



Branches:

1- **Four plantar metatarsal** to the 4 clefts to divide into **plantar digital arteries**

2- **Perforating branches**; ascend in the lateral 3 spaces between the interossei to anastomose with branches of dorsalis pedis artery.



Nerves of the foot

Medial plantar nerve

Accompanies the artery in the same plane & gives:

1- **Muscular**; FHB, ABH, FDB & 1st lumbricals

2- **Articular** to tarsal joints

3- **Cutaneous branches**: the medial plantar nerve terminates near the bases of the metatarsals by dividing into three sensory branches (**common plantar digital nerves**). These branches supply the skin of the medial three and a half digits (including the dorsal skin and nail beds of their distal phalanges) and the skin of the sole proximal to them.

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Lateral plantar nerve



This is the smaller of the 2 terminal branches of the tibial nerve, it divides near the base of 5th metatarsal into:

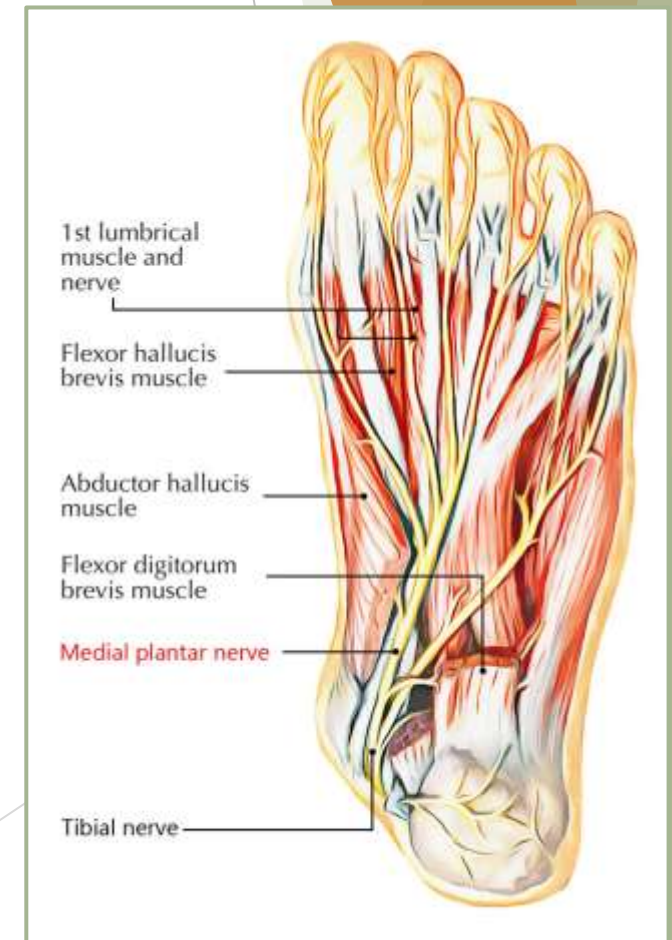
1- **Superficial branch**;

a) **Cutaneous branches** (one common and one proper) that supply the skin of the plantar aspects of the lateral one and a half digits, the dorsal skin and nail beds of their distal phalanges, and skin of the sole proximal to them.

b) **Muscular**; to flexor digiti minimi brevis & the two interossei of the 4th space

2- **Deep branch**; accompanies the deep planter arch between the 3rd & 4th layers of planter muscles & supplies:

- ✓ All remaining muscles of the foot
- ✓ Articular branches



Planter ligaments

Plantar calcaneonavicular ligament (Spring Ligament)

Extends between the sustentaculum tali and navicular

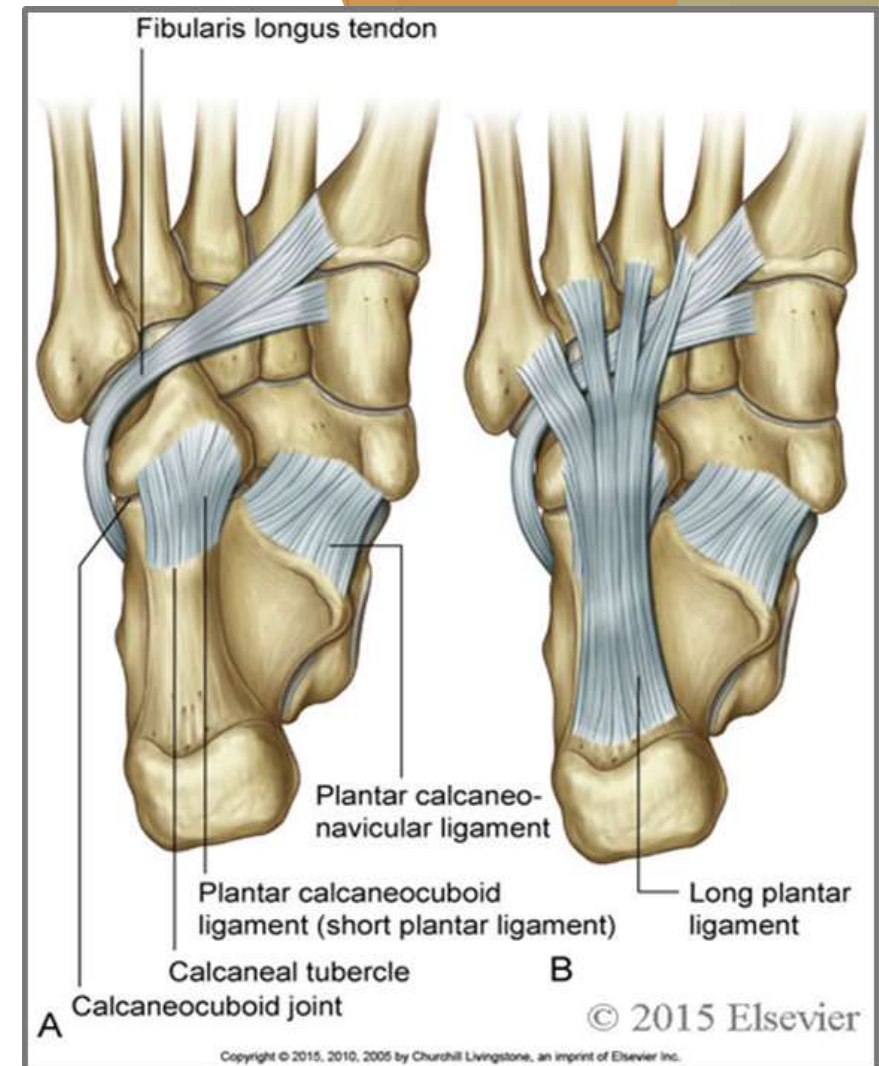
Calcaneo cuboid ligaments

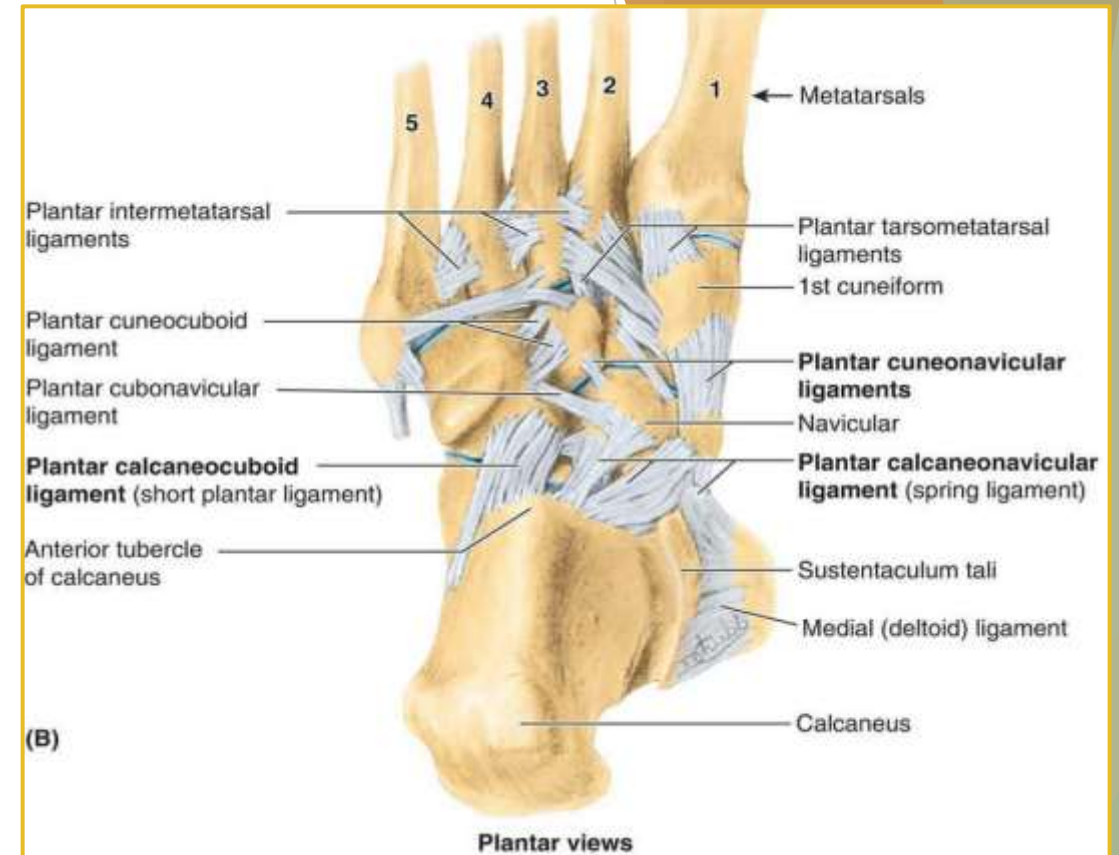
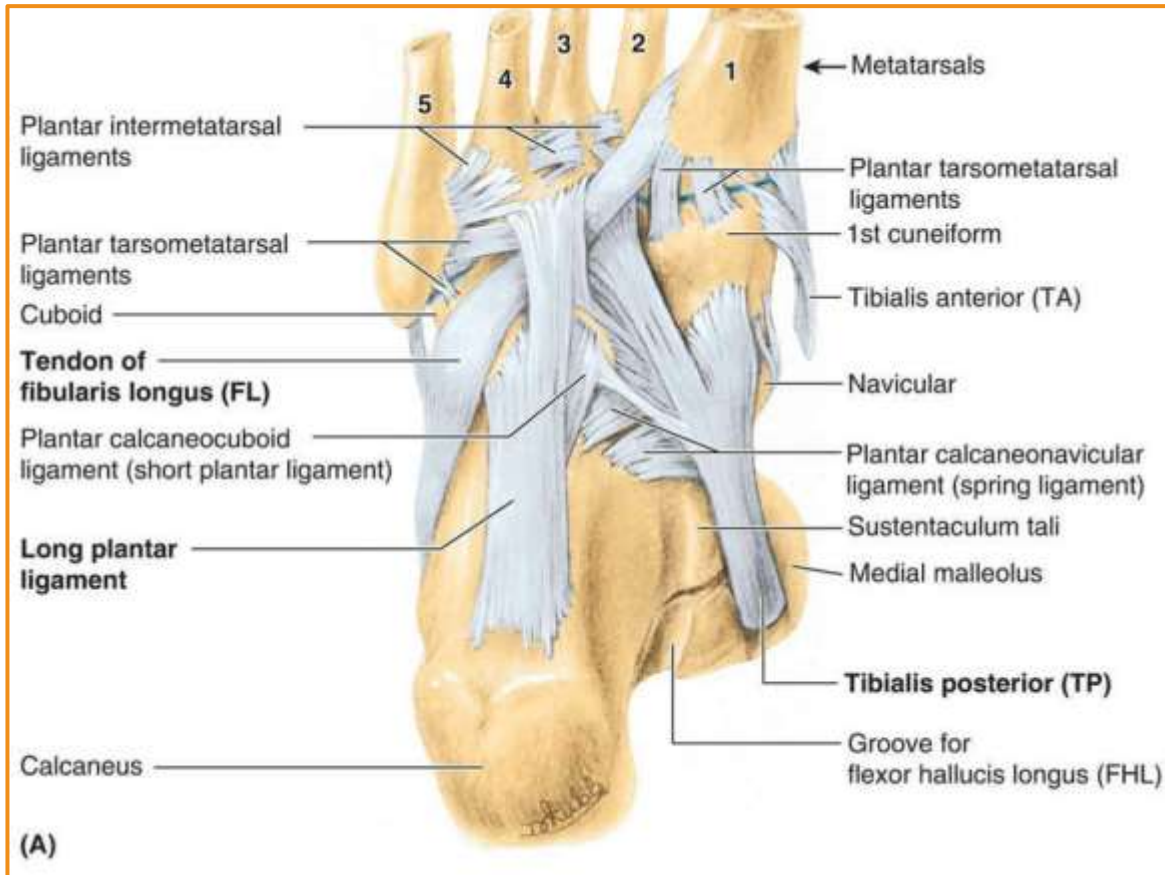
Long plantar ligament:

- Longest ligament in the foot
- Connects the calcaneus to cuboid. Some of its fibers extend to the bases of the metatarsals, thereby forming a tunnel for the tendon of the fibularis longus
- Passes superficial to the tendon of PL

Short plantar ligament:

- Deeper than long planter ligament
- connects the same bones
- Lies posterior to the tendon of PL

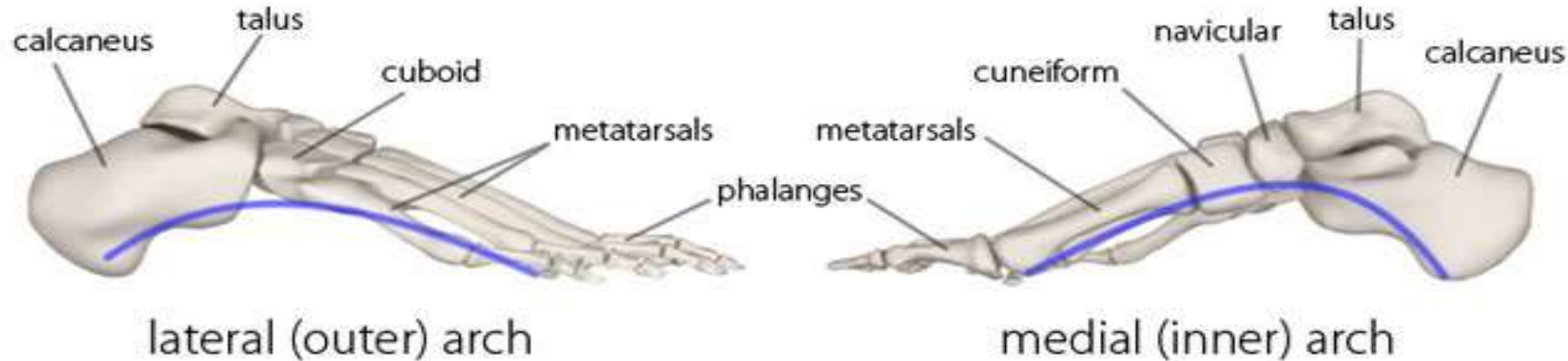




Plantar ligaments. A, B. Sequential stages of a deep dissection of the sole of the right foot showing the attachments of the ligaments and the tendons of the long evtor and invertor muscles.

ARCHES OF THE FOOT

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Lateral longitudinal arch

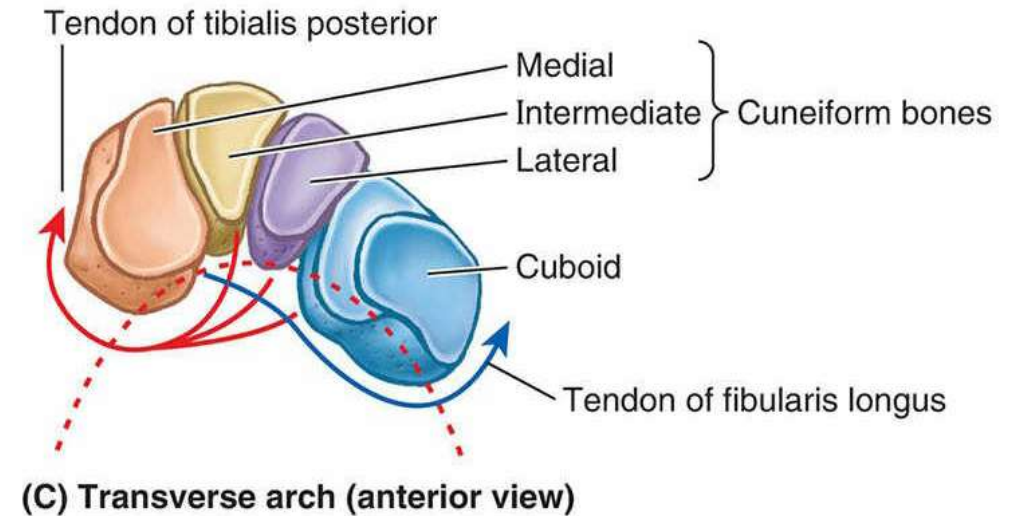
- ☐ Is much flatter than the medial & rests on the ground during standing
- ☐ Provides balance
- ☐ It is made up of the calcaneus, cuboid, and lateral two metatarsals.

Medial longitudinal arch

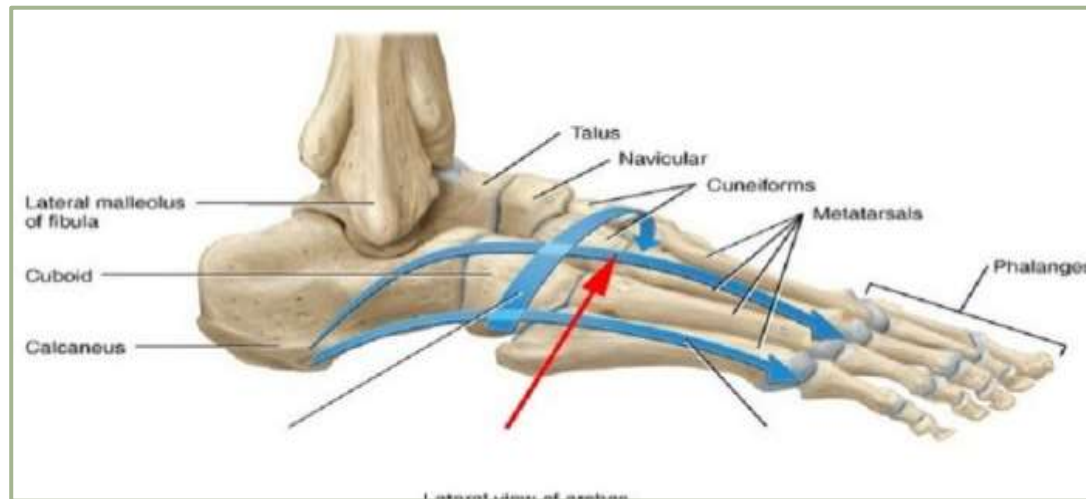
- ☐ is higher and more important.
- ☐ is primarily weight bearing
- ☐ is composed of the calcaneus, talus, navicular, three cuneiforms, and three metatarsals.
- ☐ tibialis anterior and posterior with peroneus longus tendons help to support this arch.

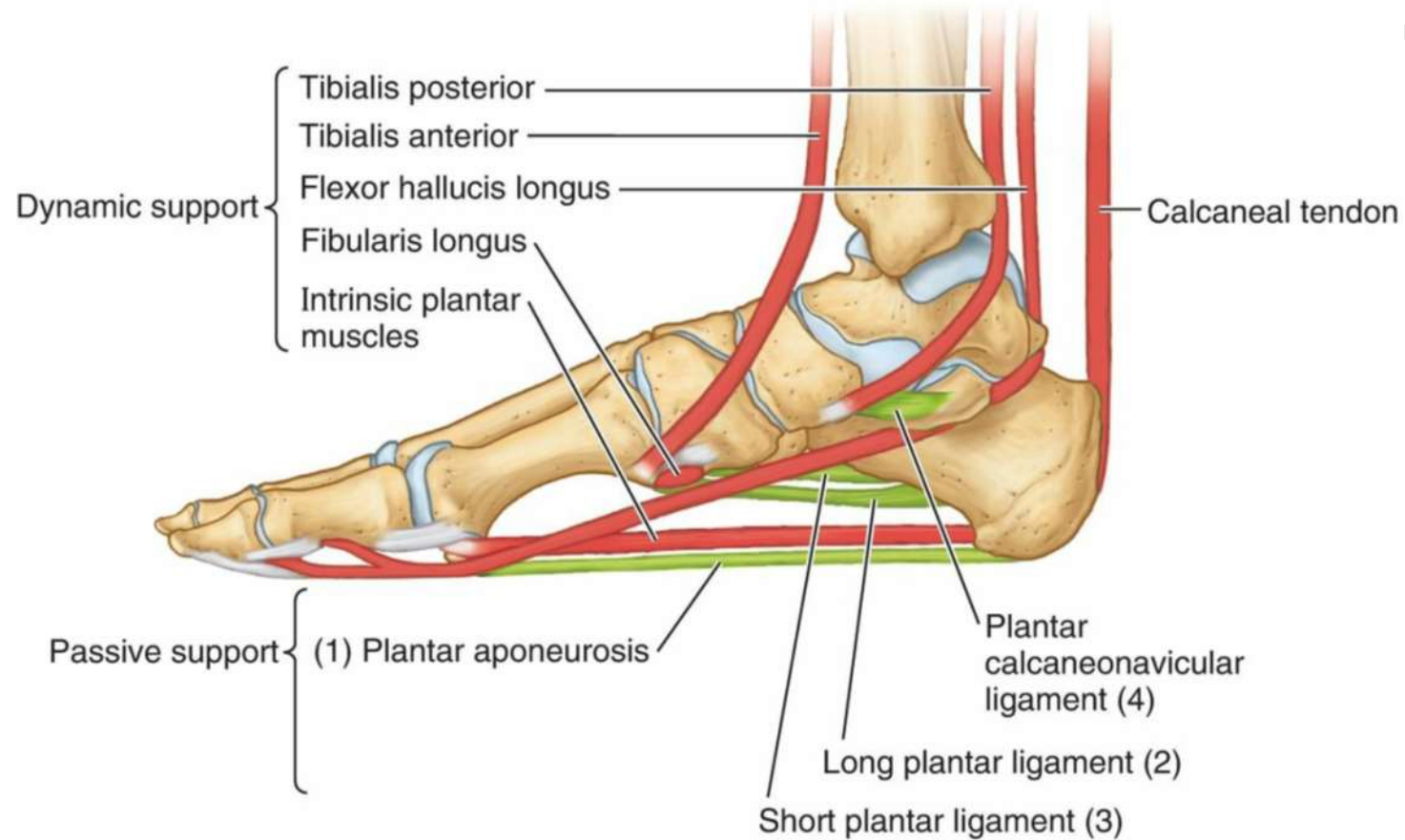
Transverse arch of the foot

- ❑ Runs from side to side
- ❑ It is formed by the cuboid, cuneiforms, and bases of the metatarsals.
- ❑ The medial and lateral parts of the longitudinal arch serve as pillars for the transverse arch.



The tendons of **the fibularis longus** and **tibialis posterior** help maintaining the curvature of the transverse arch.





(E) Medial longitudinal arch (medial view)

The integrity of the bony arches of the foot is maintained by both **passive factors** and **dynamic supports**

Passive factors

- ▶ The shape of the united bones
- ▶ layers of fibrous tissue that bowstring the longitudinal arch (superficial to deep):
 - ✓ Plantar aponeurosis.
 - ✓ Long plantar ligament.
 - ✓ short plantar ligament.
 - ✓ Plantar **calcaneonavicular** (spring) ligament.

Dynamic supports

- ❑ Active (reflexive) bracing action of **intrinsic muscles of foot** (longitudinal arch).
- ❑ Active and tonic contraction of muscles with **long tendons** extending into foot
- ✓ Flexors hallucis and digitorum longus for the longitudinal arch
- ✓ Fibularis longus and tibialis posterior for the transverse arch.

Of these factors, the **plantar ligaments** and the **plantar aponeurosis** bear the greatest stress and are most important in maintaining the arches of the foot.

Hallux valgus:

- Lateral deviation of great toe
- Head of 1st metatarsal projects medially
- Subcutaneous bursa develop over the head (bunion)



Hammer Toe

Claw Toes

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- **Hammer toe** is a foot deformity in which the
 - ✓ proximal phalanx is dorsiflexed (hyperextended) at the metatarsophalangeal joint
 - ✓ the middle phalanx strongly plantarflexed at the proximal interphalangeal joint.
 - ✓ The distal phalanx of the digit is often also hyperextended.
 - ✓ This gives the digit (usually the 2nd) a **hammer-like appearance**
- This deformity of one or more toes may result from weakness of the lumbrical and interosseous muscles

Claw toes are characterized by hyperextension of the metatarsophalangeal joints and flexion of the distal interphalangeal joints. Usually, the lateral four toes are involved.



*Thank
you*

