



**ВОЛГОГРАДСКИЙ
ГОСУДАРСТВЕННЫЙ
МЕДИЦИНСКИЙ
УНИВЕРСИТЕТ**

The lower extremity. Foot

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The bones of the foot



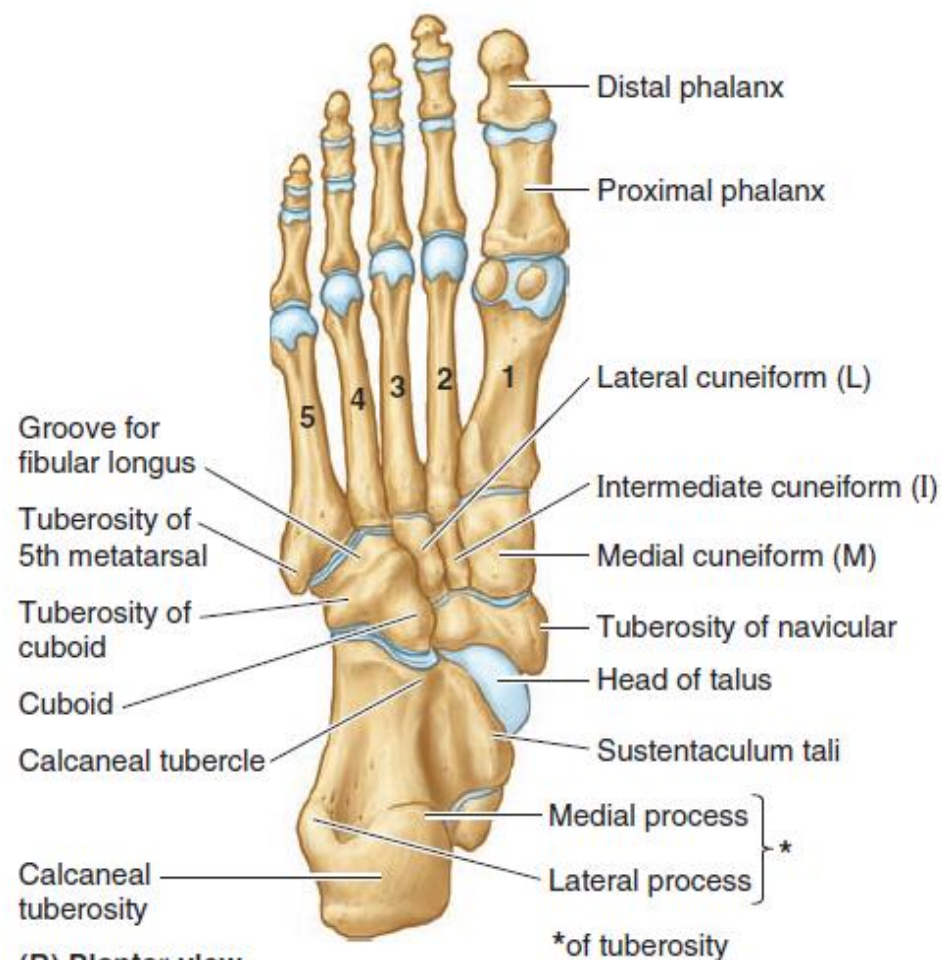
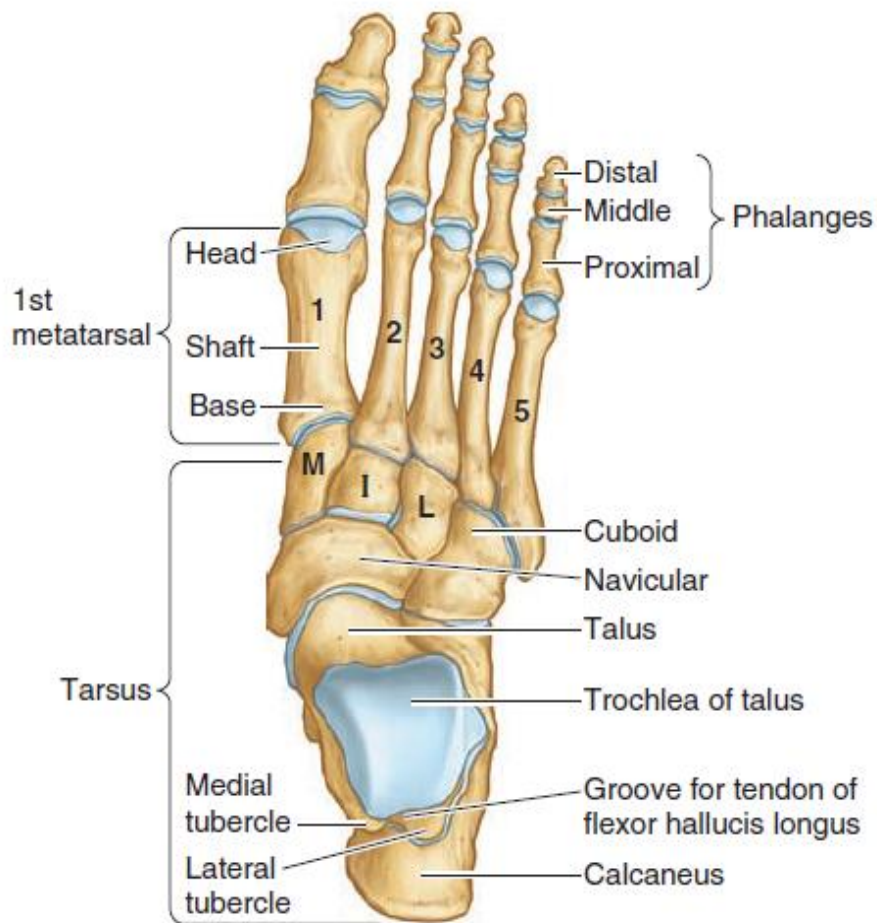
The bones of the foot include the tarsus, metatarsus, and phalanges. The tarsus consists of seven bones: calcaneus, talus, cuboid, navicular, and three cuneiforms. Only the talus articulates with the leg bones. The calcaneus (heel bone) is the largest and strongest bone in the foot.

The bones of the foot



The metatarsus consists of five long bones (metatarsals), which connect the tarsus and phalanges. They are numbered from the medial side of the foot. The 1st metatarsal is shorter and stouter than the others. The 2nd metatarsal is the longest. Each metatarsal has a base (proximally), a shaft, and a head (distally). The bases of the metatarsals articulate with the cuneiform and cuboid bones.

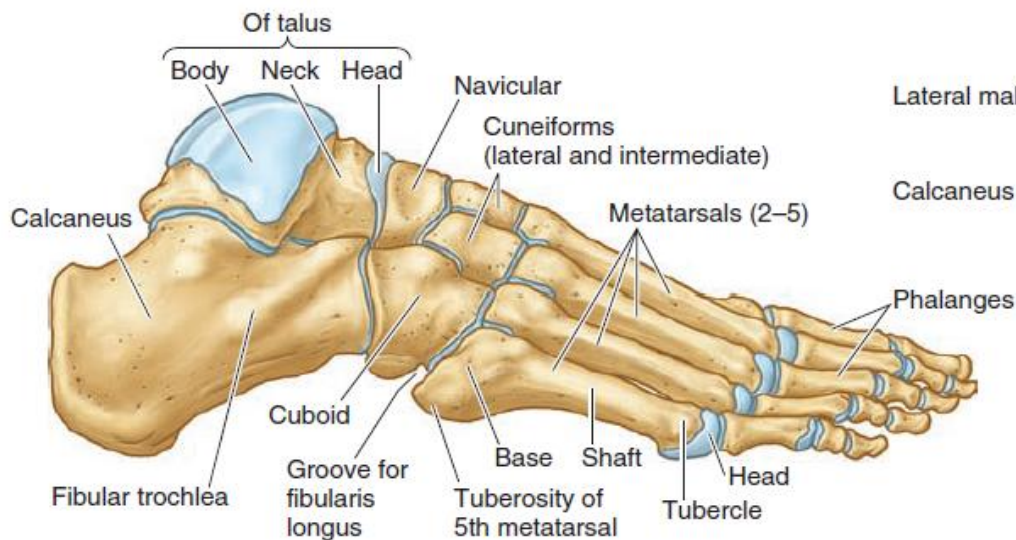
The bones of the foot



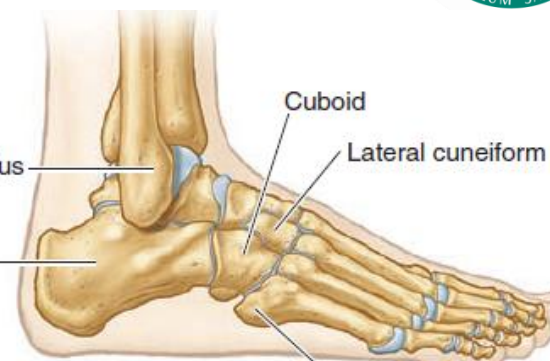
(A) Dorsal view

(B) Plantar view

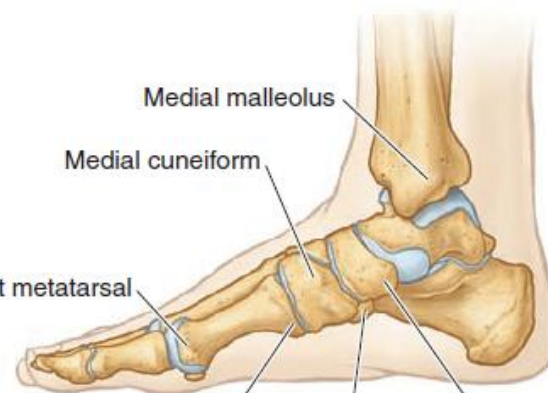
The bones of the foot



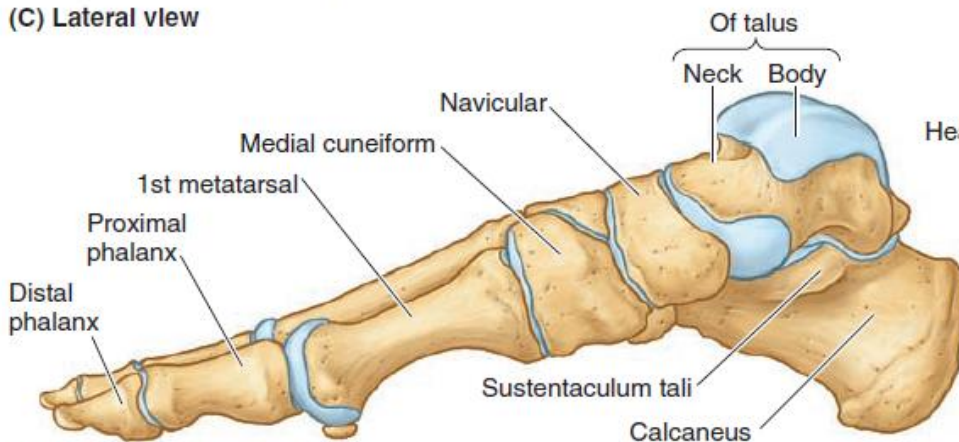
(C) Lateral view



(D) Lateral view



(E) Medial view



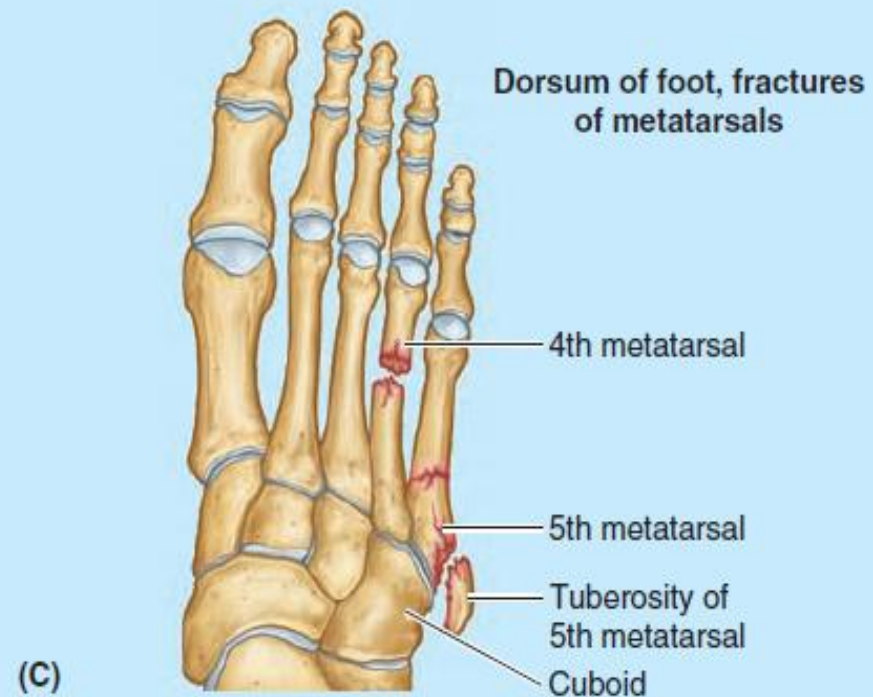
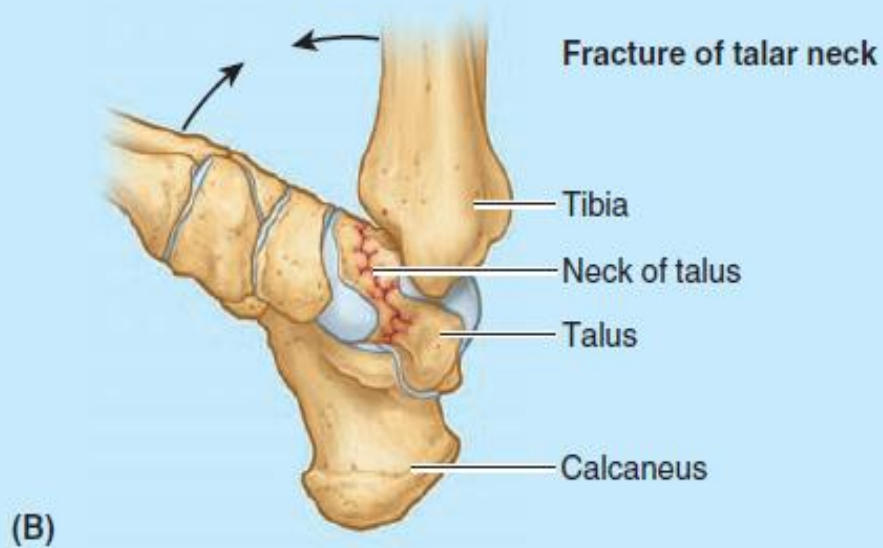
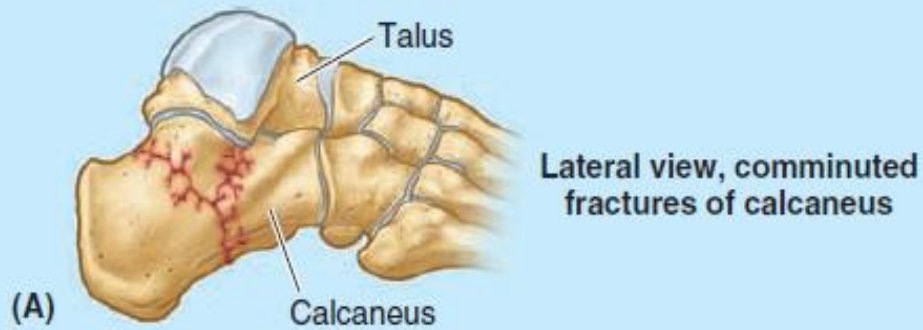
(F) Medial view

The bones of the foot



The heads of metatarsals articulate with the proximal phalanges. There are 14 phalanges. The 1st digit (great toe) has two phalanges (proximal and distal); the other four digits each have three phalanges: proximal, middle, and distal. Each phalanx has a base (proximally), a shaft, and a head (distally).

Fractures of Foot Bones



Fractures of Foot Bones



Calcaneal fractures occur in people who fall on their heels (e.g., from a ladder). Usually, the bone breaks into several fragments (*comminuted fracture*) that disrupt the subtalar joint, where the talus articulates with the calcaneus. Fractures of the talar neck may occur during severe dorsiflexion of the ankle, for example, when a person is pressing extremely hard on the brake pedal of a car during a head-on collision

Fractures of Foot Bones

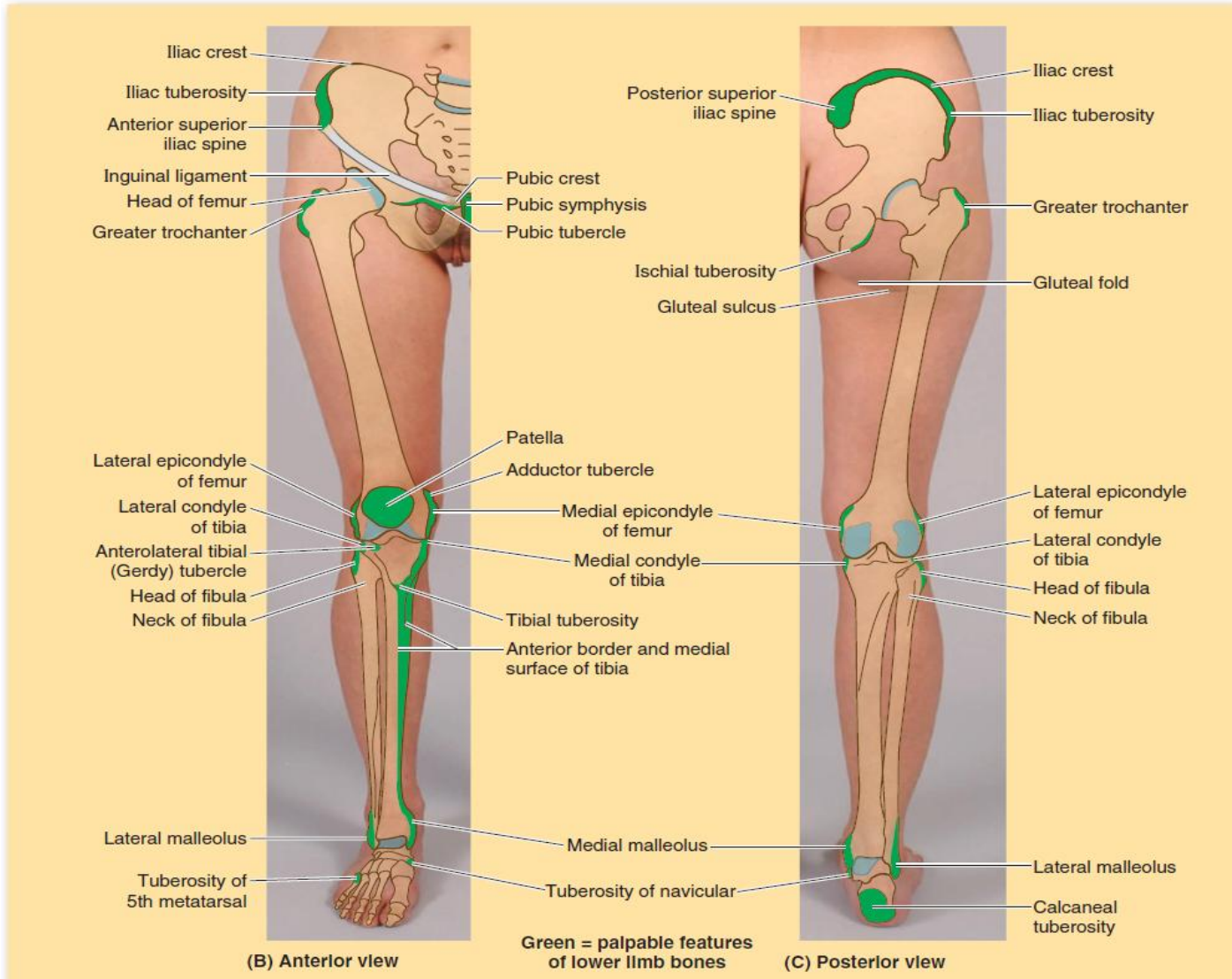


Metatarsal and phalangeal fractures

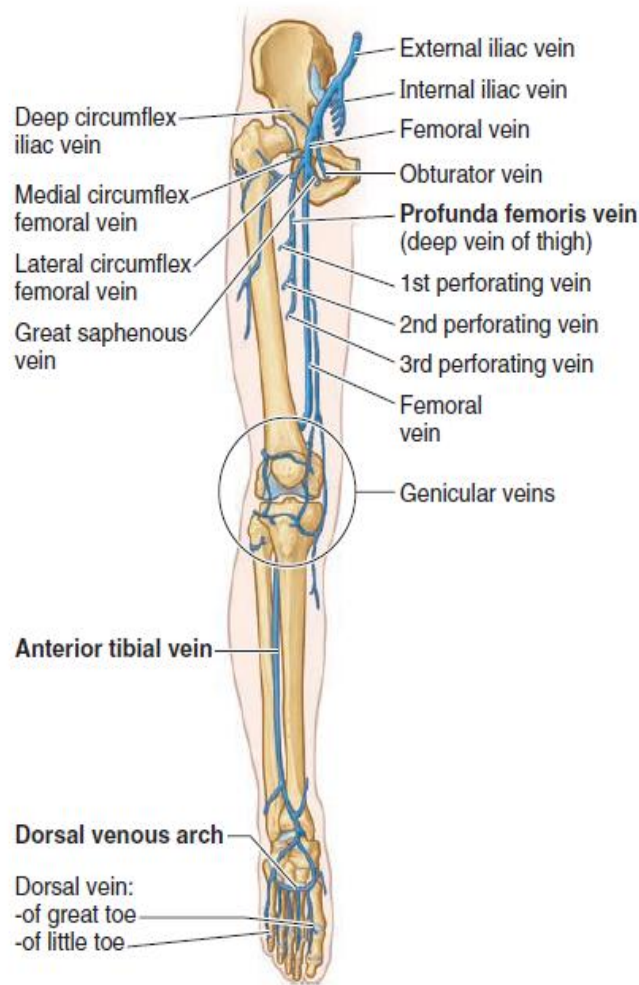
are a common injury in endurance athletes and may also occur when a heavy object falls on the foot.

Metatarsal fractures are also common in dancers, especially female ballet dancers using the demi-pointe technique. The “dancer’s fracture” usually occurs when the dancer loses balance, putting the full body weight on the metatarsal and fracturing the bone

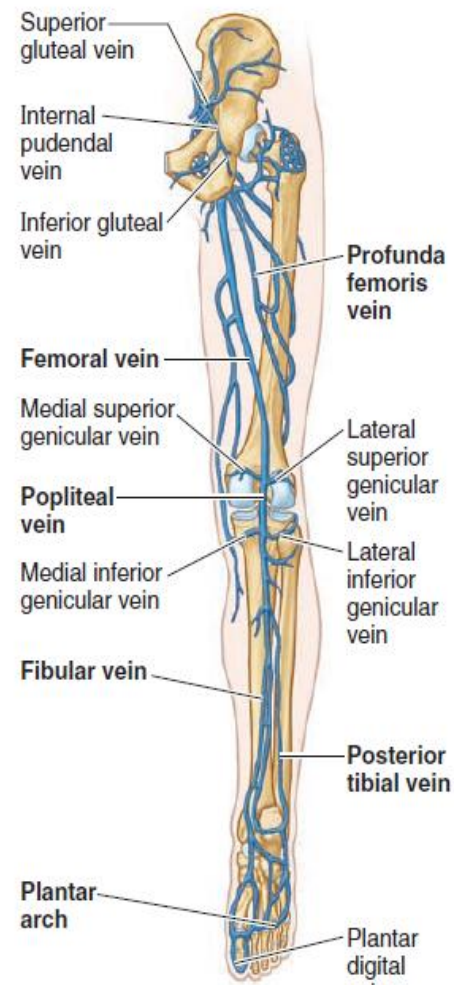
The landmarks of the lower extremity



Deep venous drainage of lower limb

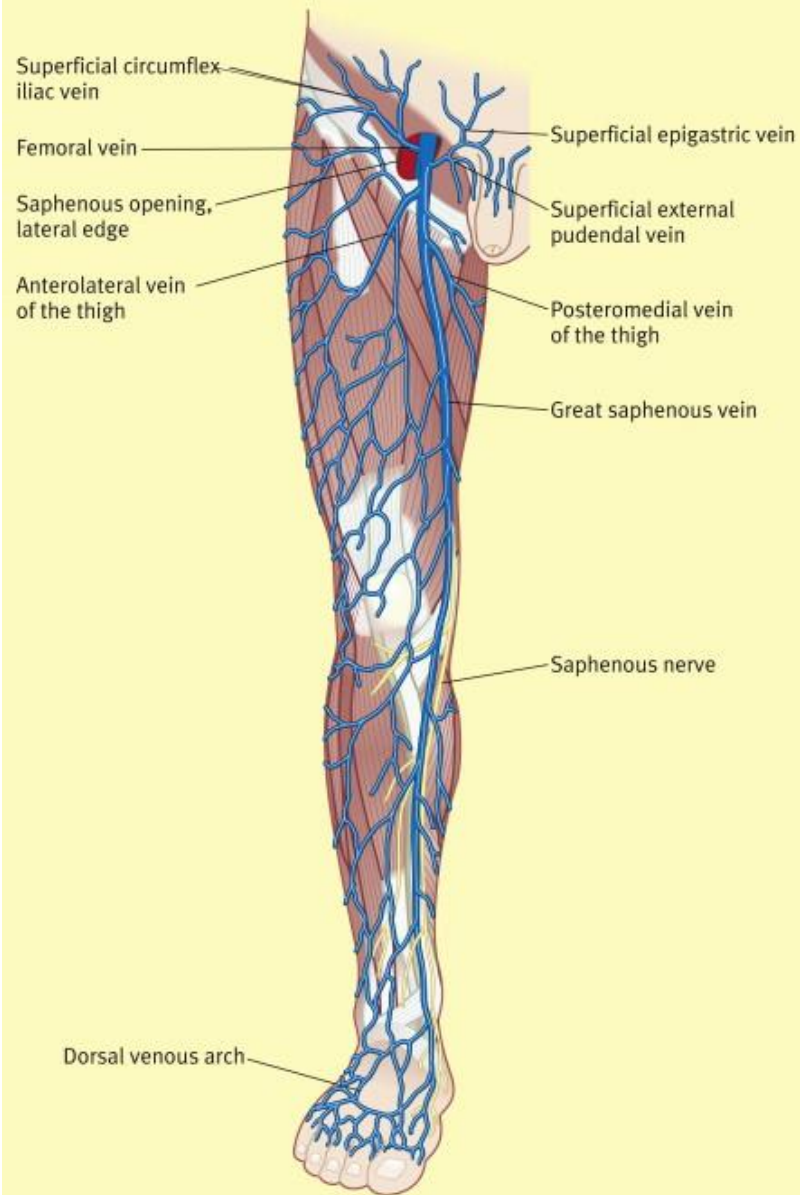


(A) Anterior view

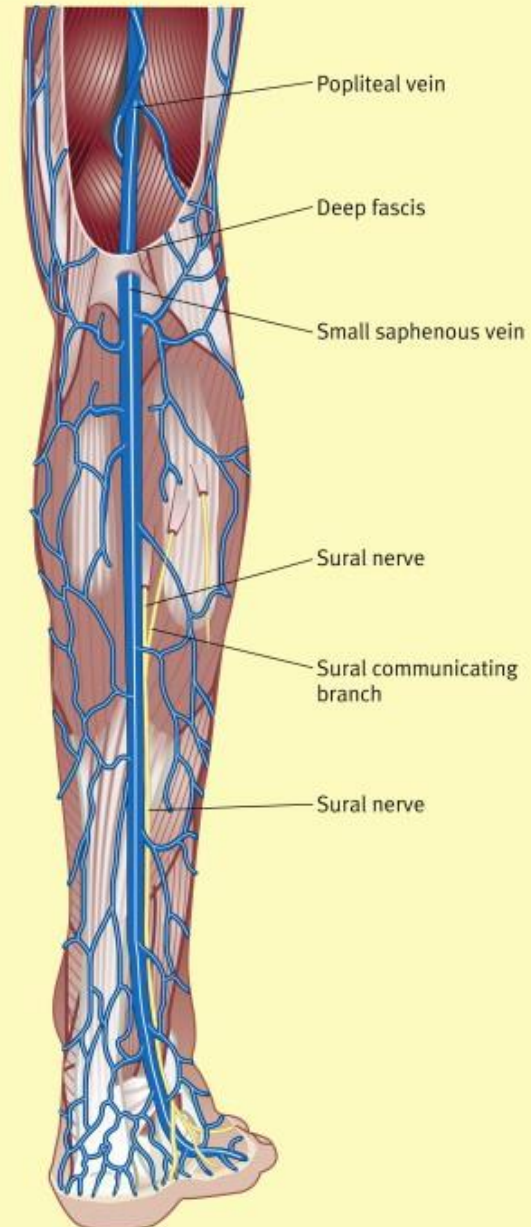


(B) Posterior view

Superficial venous drainage of lower limb



a The great long saphenous vein and its tributaries



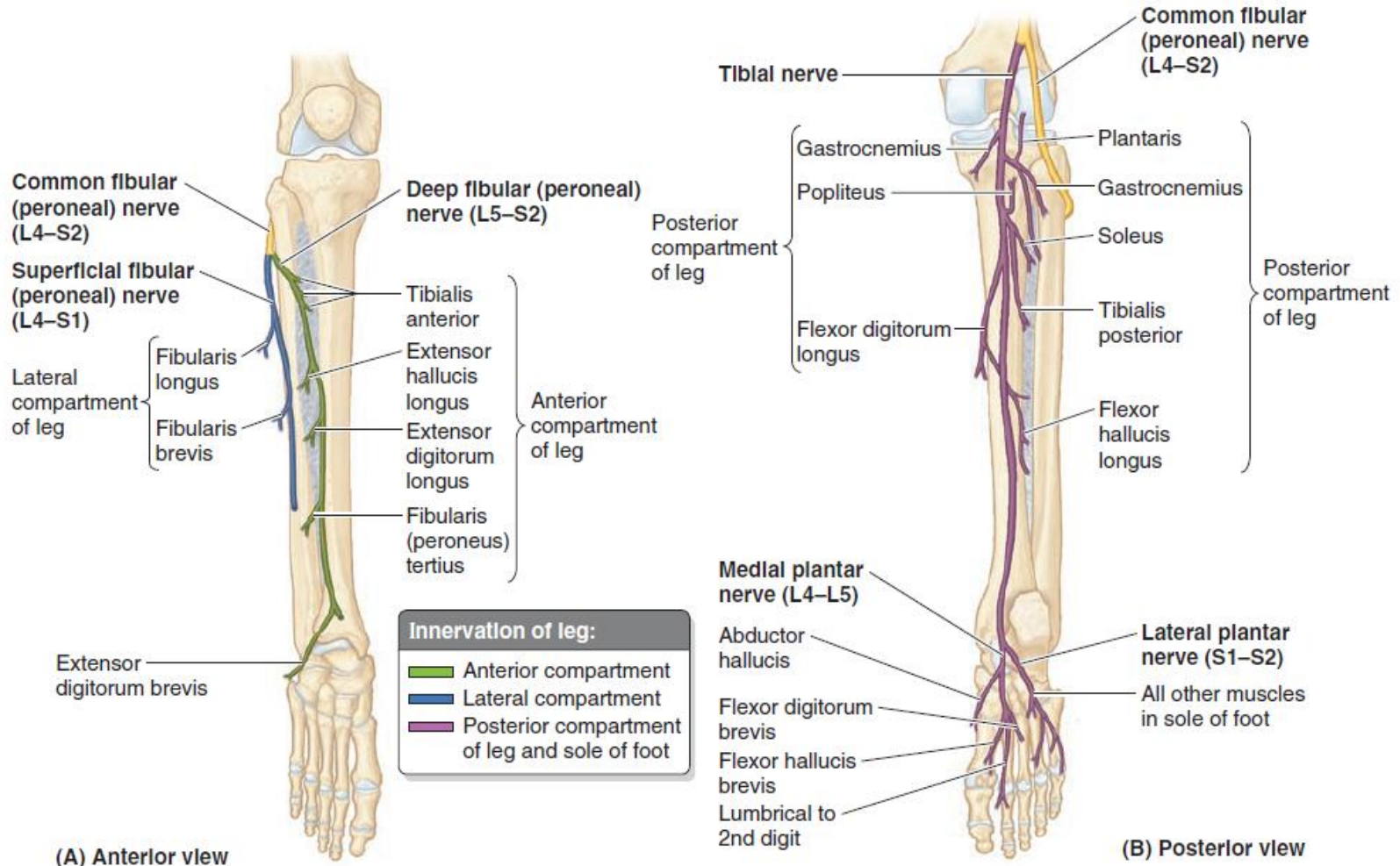
b The small short saphenous vein and its tributaries

Regions of the lower limb

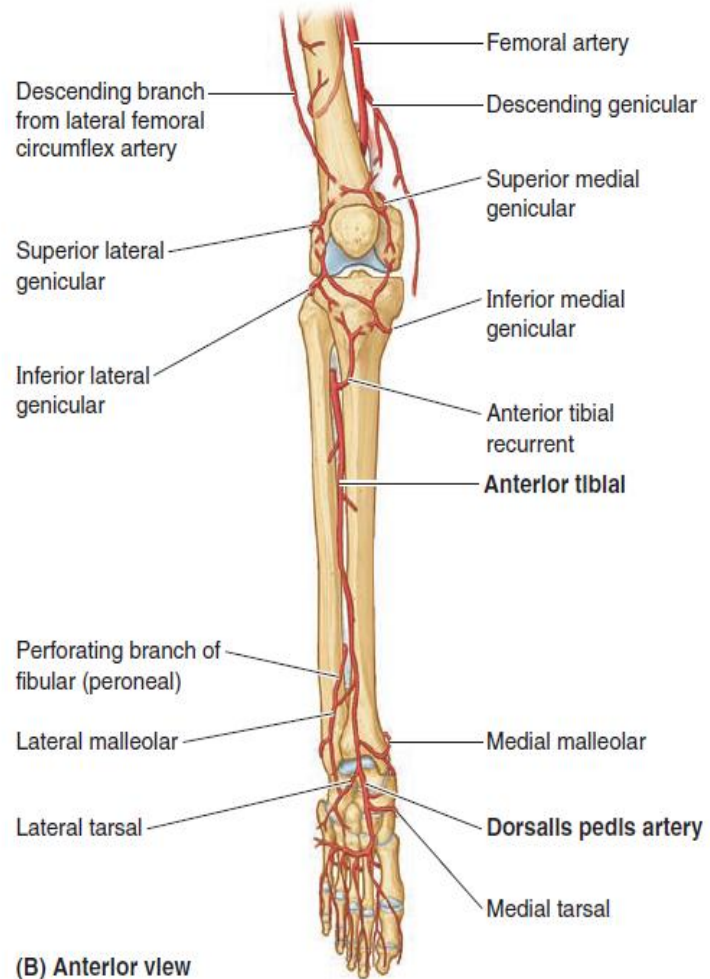
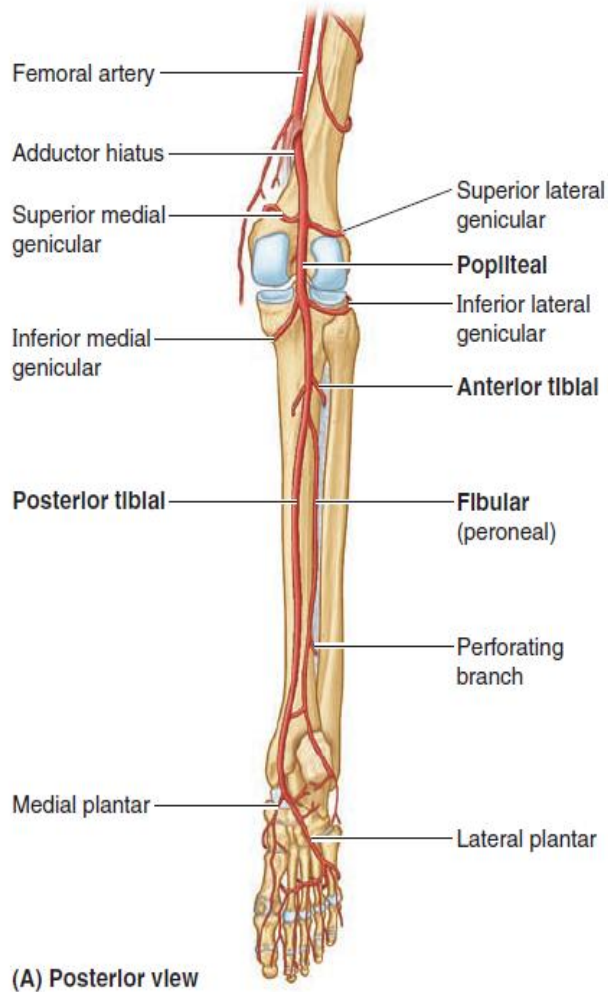


- Therefore, the lower limbs comprise the following six regions:
- Buttock or gluteal region
- Thigh or femoral region
- Knee or knee region
- Leg or leg region
- Ankle or talocrural region
- Foot or foot region

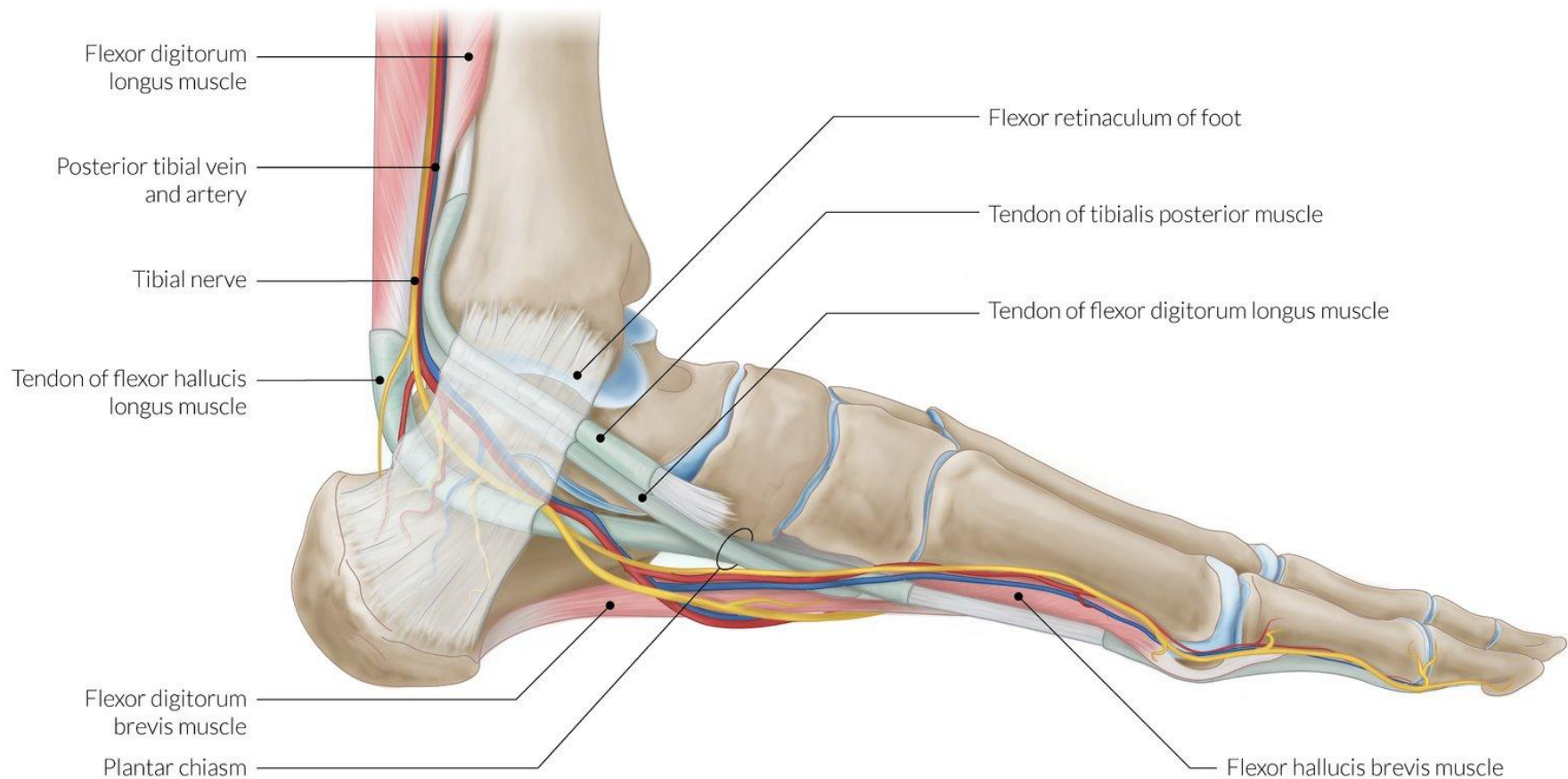
Leg region. Nerves of the leg



Leg region. Arteries of the leg



Medial malleolar (calcaneal) canal of Richet



Foot region



The foot and its bones may be considered in terms of three anatomical and functional parts:

- The hindfoot: talus and calcaneus
- The midfoot: navicular, cuboid, and cuneiforms
- The forefoot: metatarsals and phalanges

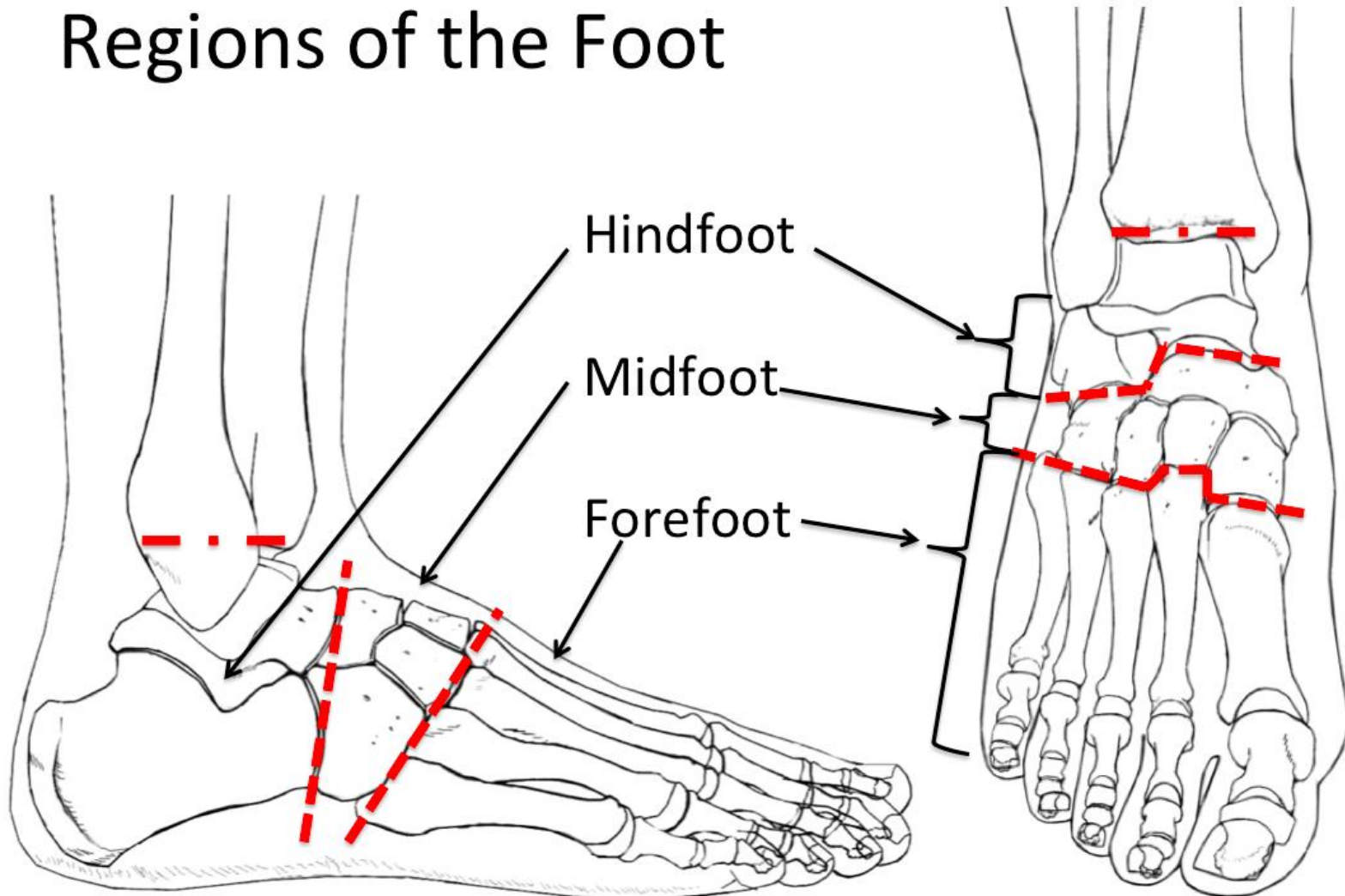
The regions of the foot include

- The plantar region (sole): the part contacting the ground
- The dorsal region of foot (dorsum of the foot): the part directed superiorly

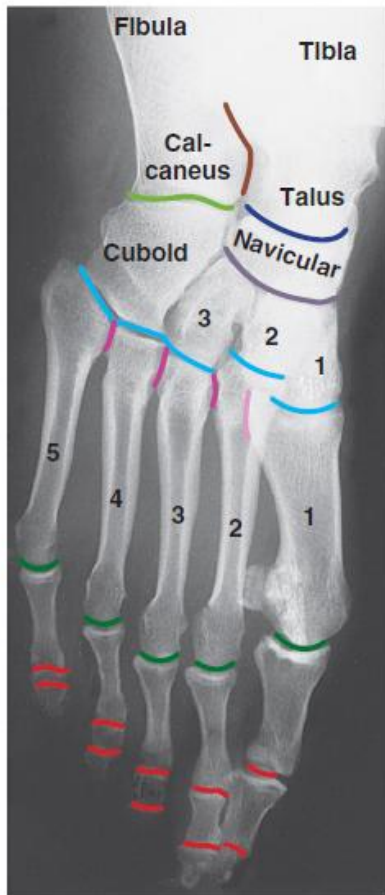
Foot region



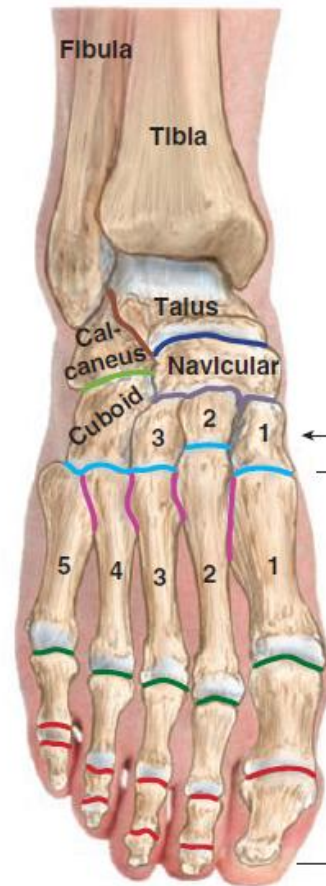
Regions of the Foot



Joints of foot

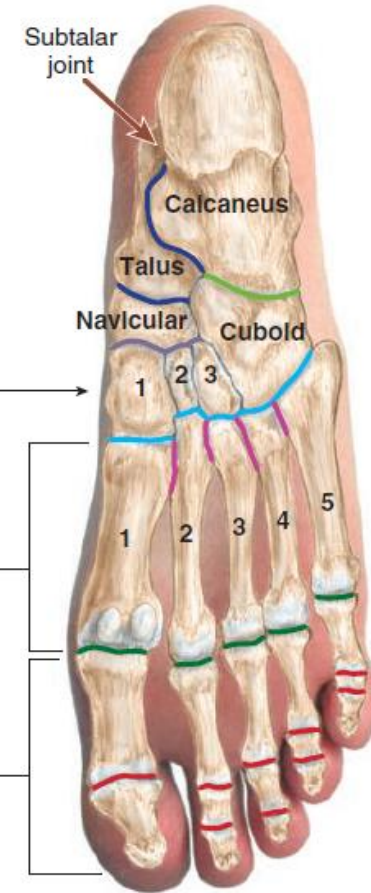


Oblique radiograph



Dorsal surface

Joints of foot	
	Subtalar
	Talocalcaneonavicular*
	Calcaneocuboid*
	Cuneonavicular joint
	Tarsometatarsal
	Intermetatarsal
	Metatarsophalangeal
	Interphalangeal



Plantar surface

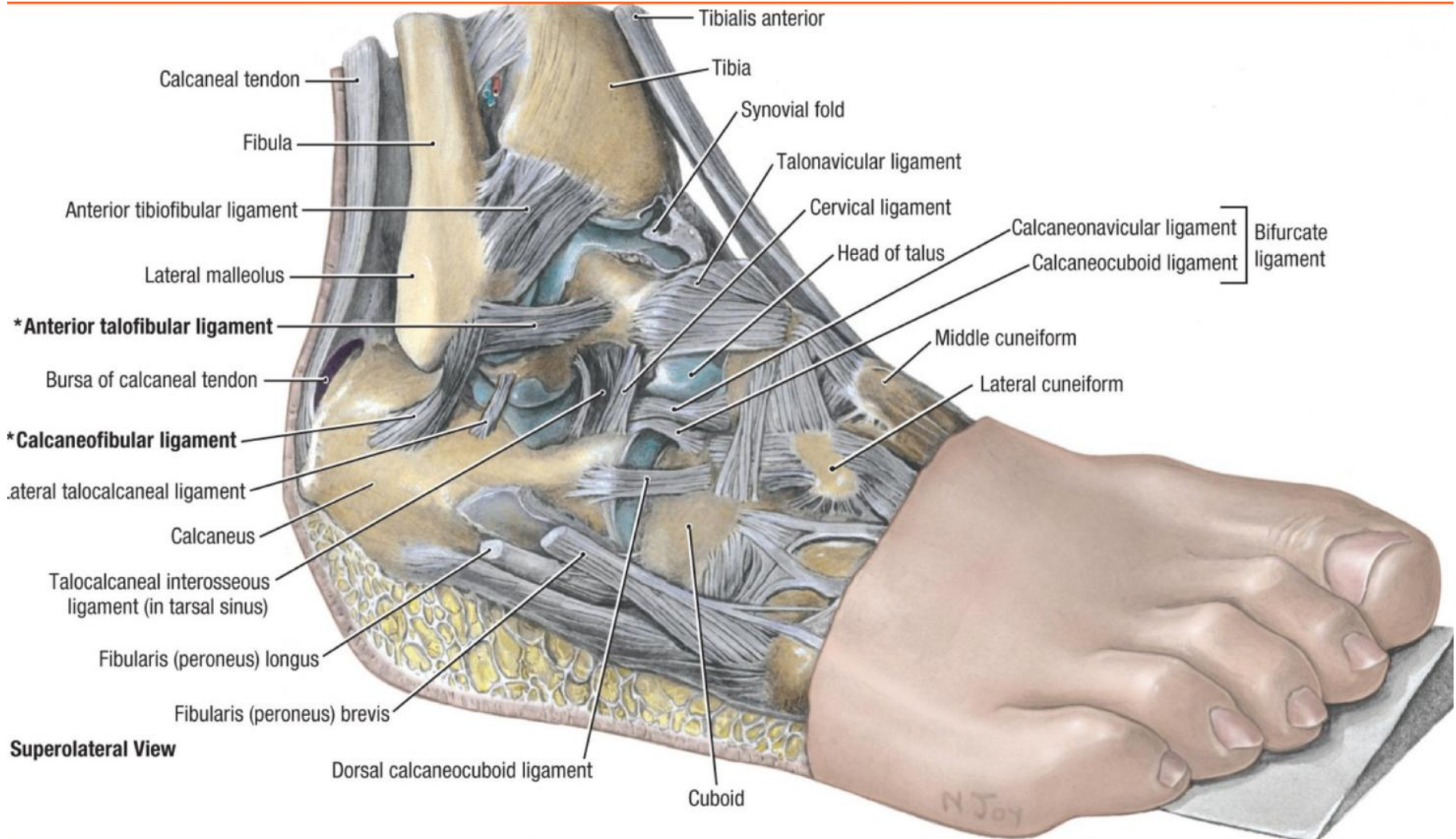
* Transverse tarsal joint (talonavicular part of talocalcaneonavicular joint and calcaneocuboid joint)



Joints of foot

The bifurcate ligament is Y shaped. Its stalk is connected to the anterolateral part of the sulcus calcanei. Its medial limb (calcaneonavicular part) is connected to the dorsolateral surface of the navicular bone and its lateral limb (calcaneocuboid part) to the dorsomedial surface of the cuboid bone. The 2 limbs supply support to the joints.

Joints of foot



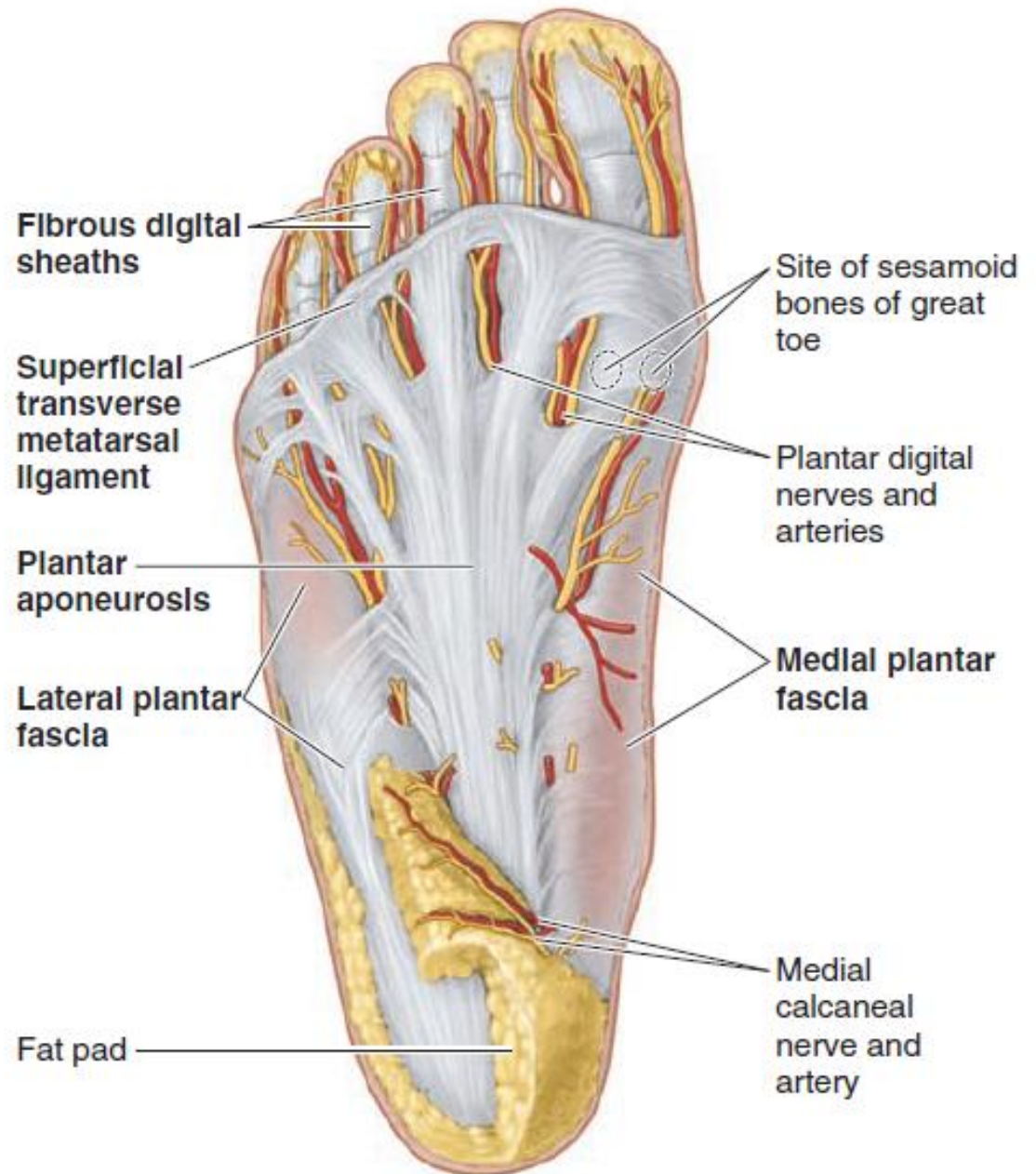
Foot region



The deep fascia is thin on the dorsum of the foot, where it is continuous with the inferior extensor retinaculum. Over the lateral and posterior aspects, the deep fascia of the foot is continuous with the plantar fascia, the deep fascia of the sole, which has a thick central part, the plantar aponeurosis, and weaker medial and lateral parts

Foot region

Plantar aponeurosis



Sole of foot (plantar aspect),
Inferior view

Foot region

Plantar aponeurosis



The plantar aponeurosis is extended during standing position. Thus, tearing or inflammation (plantar fasciitis) often occurs in individuals who do a lot of standing or walking, viz. traffic police personnel. It results in pain and tenderness in the sole of the foot particularly underneath the heel while standing. Repeated attack of the plantar fasciitis causes calcification in the posterior attachment of the plantar aponeurosis forming a calcaneal spur.

Foot region

Ankle and foot
(left lateral
view)



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Foot region



In the forefoot and midfoot, vertical intermuscular septa extend superiorly from the margins of the plantar aponeurosis toward the 1st and 5th metatarsals, forming three compartments of the sole






- Medial compartment of the sole, covered superficially by medial plantar fascia, contains the abductor hallucis, flexor hallucis brevis, tendon of the flexor hallucis longus, and medial plantar nerve and vessels.

Foot region



- Central compartment of the sole, covered by the plantar aponeurosis, contains the flexor digitorum brevis, flexor digitorum longus, quadratus plantae, lumbricals, adductor hallucis, distal part of tendon flexor hallucis longus, and lateral plantar nerve and vessels.
- Lateral compartment of the sole, covered by the thinner lateral plantar fascia, contains the abductor digiti minimi and flexor digiti minimi brevis.

Foot region

Key	
	Medial compartment of sole
	Central compartment of sole
	Lateral compartment of sole
	Interosseous compartment of foot
	Dorsal compartment of foot

Dorsal fascia

Plantar fascia



Transverse section of foot compartments (anterior view)

Dorsal and plantar view of the muscles of the foot



Abductor digiti minimi muscle of the foot

Quadratus plantae muscle

Abductor hallucis muscle

Flexor digiti minimi brevis muscle

Flexor hallucis brevis muscle

Lumbrical muscles of the foot

Adductor hallucis muscle

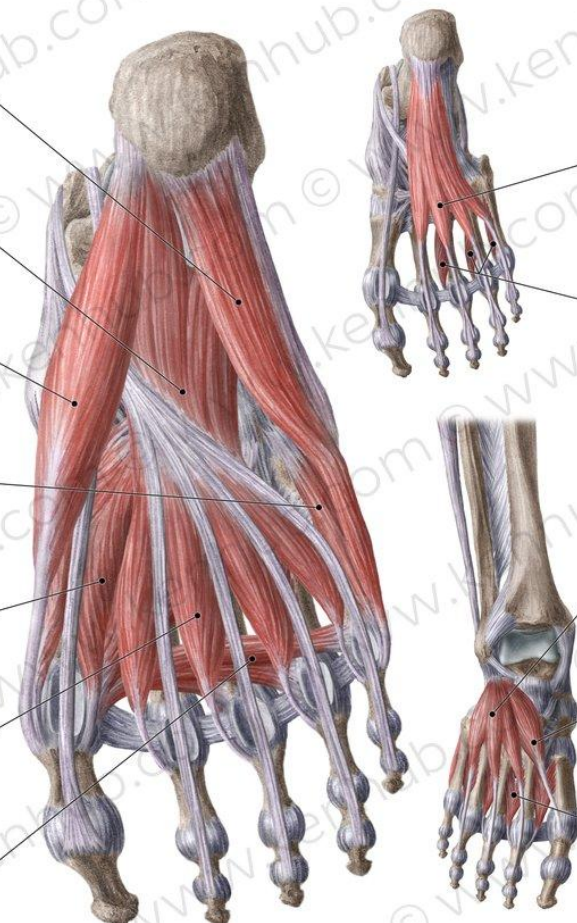
Flexor digitorum brevis muscle

Plantar interossei muscles

Extensor digitorum brevis muscle

Extensor hallucis brevis muscle

Dorsal interossei muscles of the foot



Foot region



Of the 20 individual muscles of the foot, 14 are located on the plantar aspect, 2 are on the dorsal aspect, and 4 are intermediate in position. From the plantar aspect, muscles of the sole are arranged in four layers within four compartments.

Muscles of the dorsum of the foot

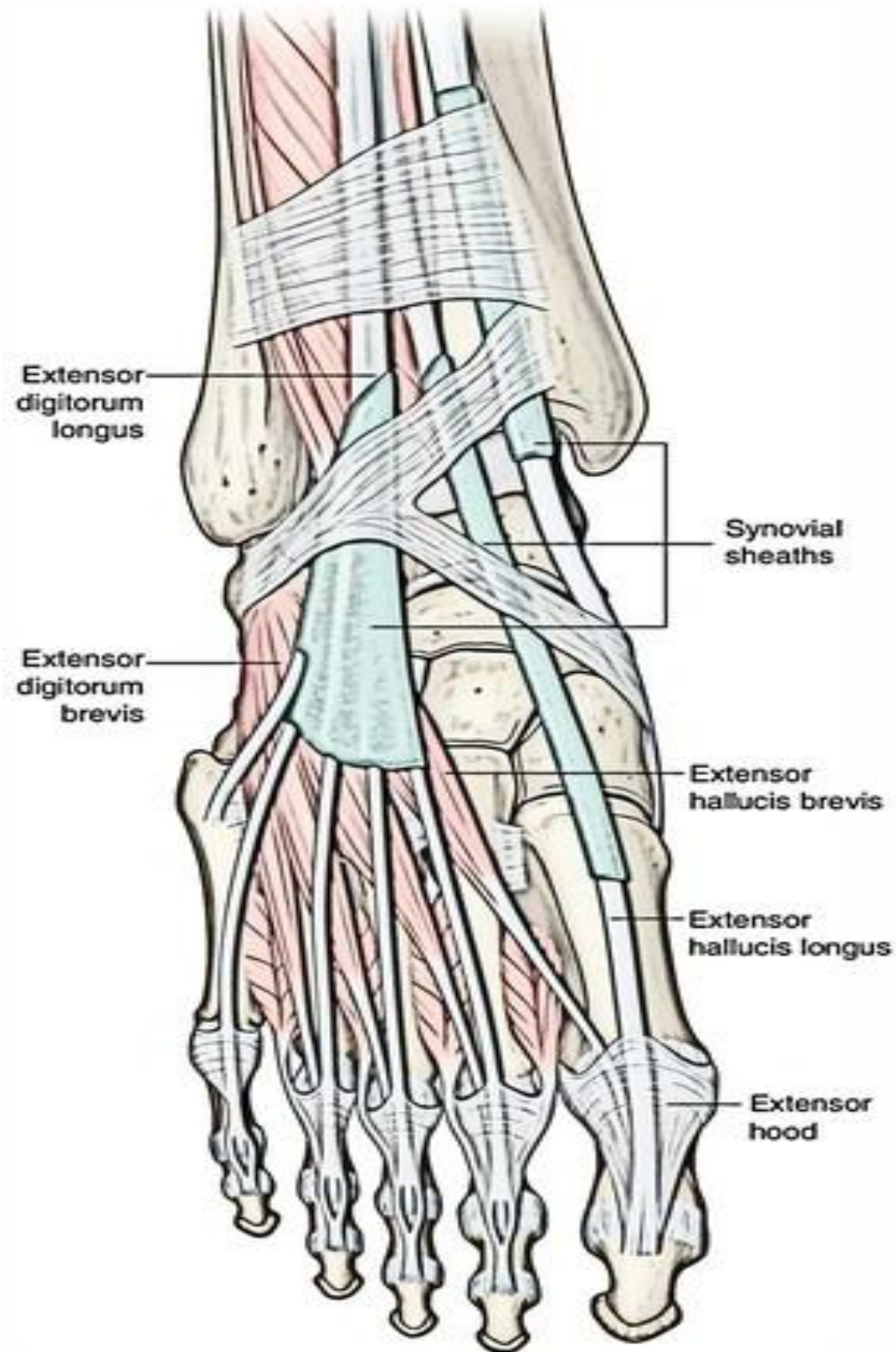


Extensor digitorum brevis

It's a small muscle situated on the lateral part of the dorsum of the foot, deep to the tendons of extensor digitorum longus. It's the only muscle on the dorsum of the foot and creates a fleshy swelling anterior to the lateral malleolus.

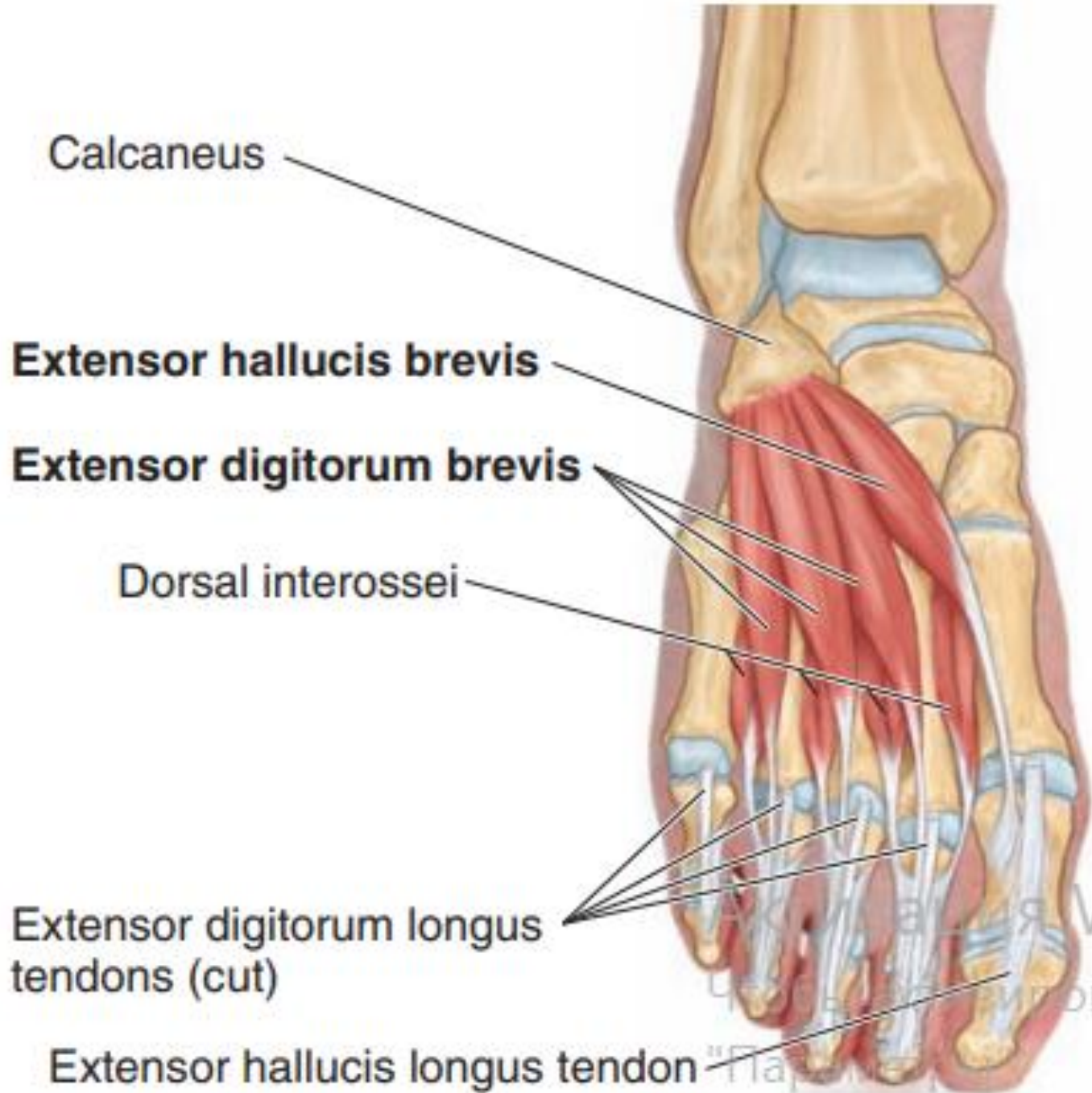
Muscles of the dorsum of the foot

Extensor digitorum brevis



Muscles of
the
dorsum of
the foot

Extensor
digitorum
brevis



Muscles of the dorsum of the foot



Extensor digitorum brevis

Origin

It originates from the anterior part of the superior surface of calcaneum, medial to the connection of the stalk of inferior extensor retinaculum.

Muscles of the dorsum of the foot



Extensor digitorum brevis

Insertion

The muscle splits into 4 tendons for the medial 4 toes. The tendon to the big toe crosses in front of dorsalis pedis artery and inserts on the dorsal surface of the proximal phalanx of the big toe. The Lateral 3 tendons join the lateral side of the tendons of the extensor digitorum longus to the 2nd, third, and fourth toes.

Muscles of the dorsum of the foot



Extensor digitorum brevis

Insertion

Medial most part of the extensor digitorum brevis, which creates the tendon for the big toe, splits or becomes different early. It's called extensor hallucis brevis.

Muscles of the dorsum of the foot



Extensor digitorum brevis

Nerve supply

It's by the lateral terminal branch of the deep peroneal nerve.

Actions

Extensor hallucis brevis (EHB) stretches the metatarsophalangeal joint of the big toe.

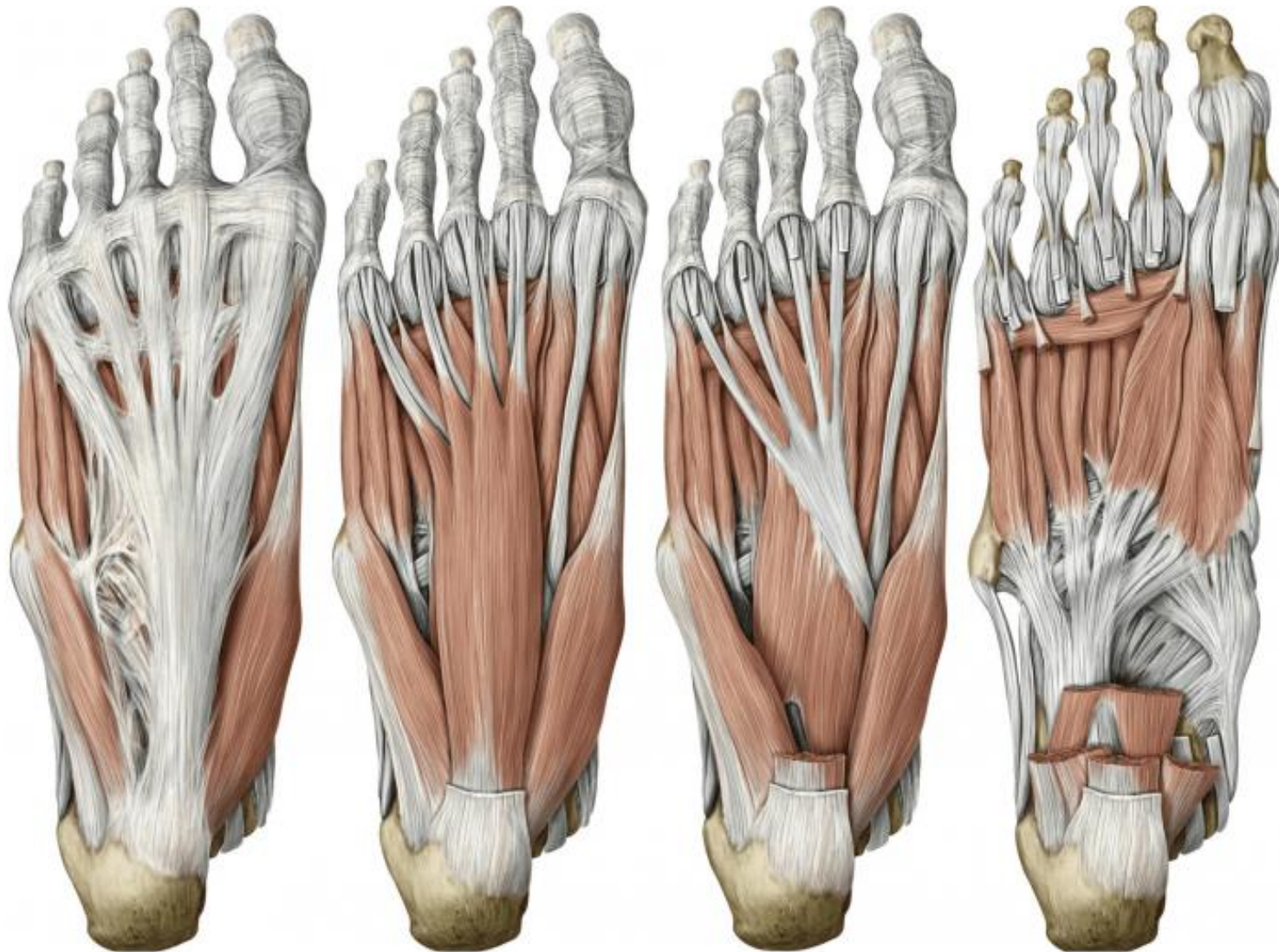
The other 3 tendons stretch the metatarsophalangeal and interphalangeal joints of 2nd, third, and fourth toes, especially when the foot is dorsiflexed.

Plantar side of the foot (muscles of the sole of the foot)

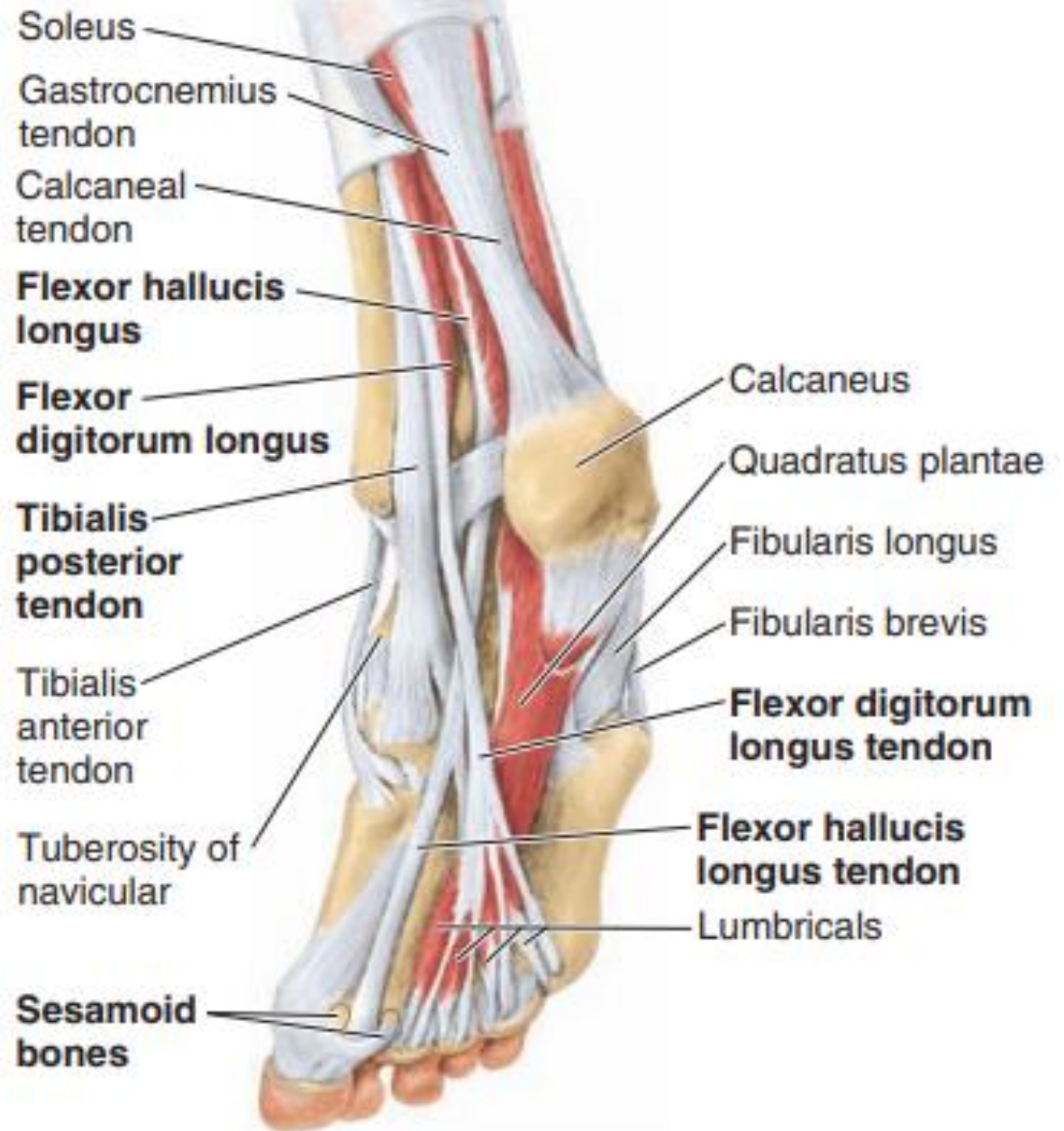


There are 18 intrinsic muscles and 4 extrinsic tendons in the sole of the foot. The muscles of the sole are described in 4 layers from superficial to deep.

Plantar view of the muscles of the foot



Relationships of tendons of deep posterior compartment muscles posterior to medial malleolus and in sole of foot



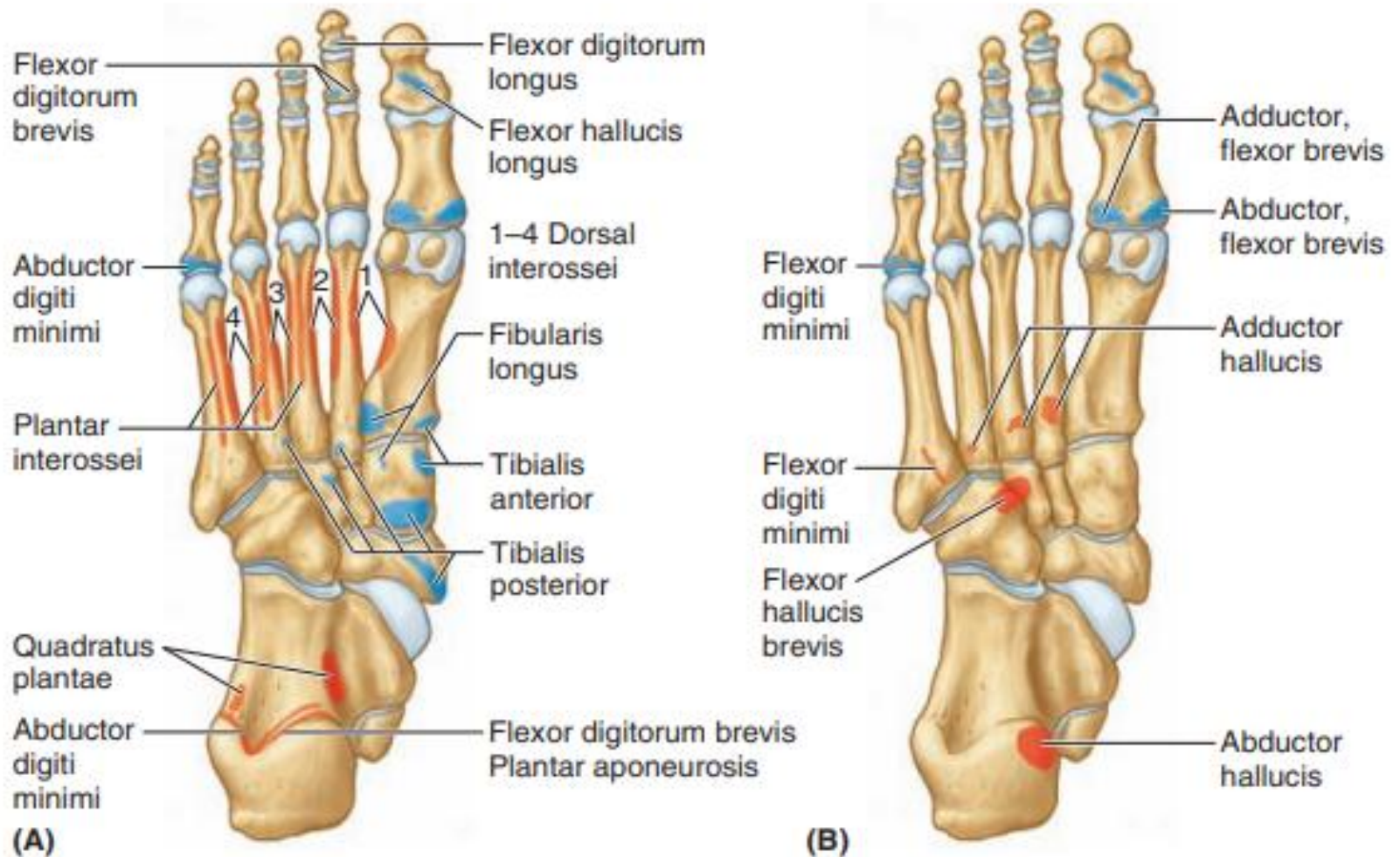
Postero-inferior view

Muscle layers of the sole of the foot

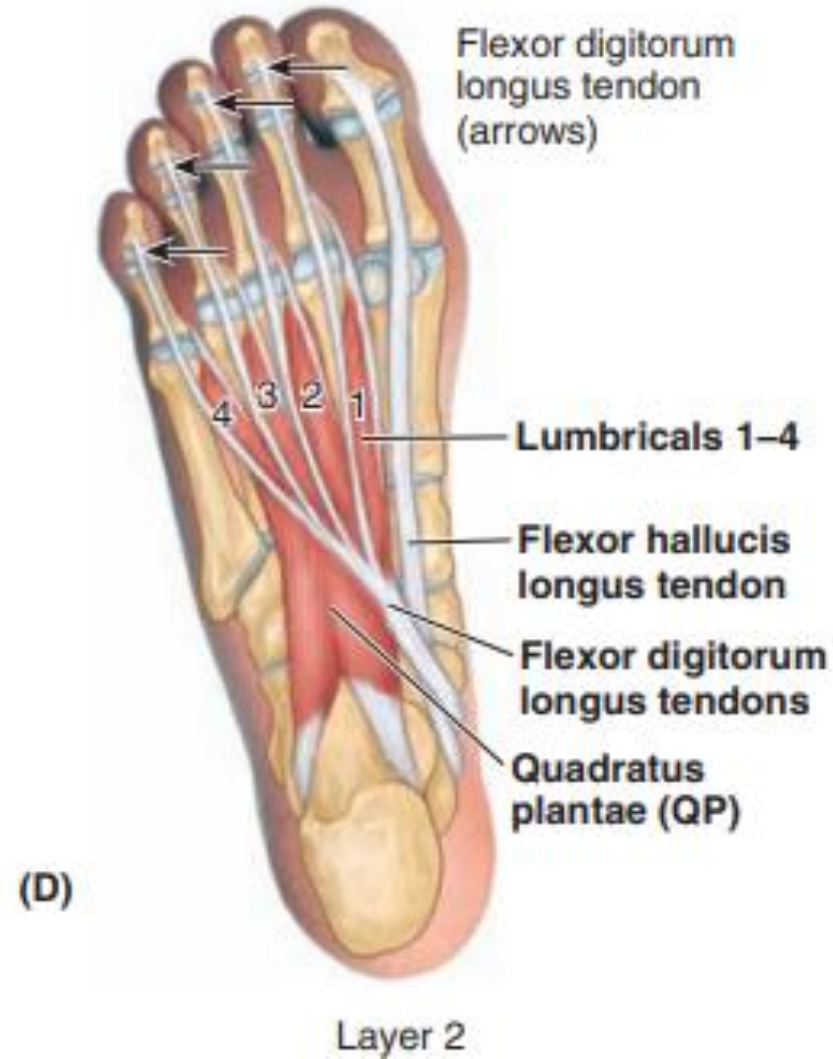
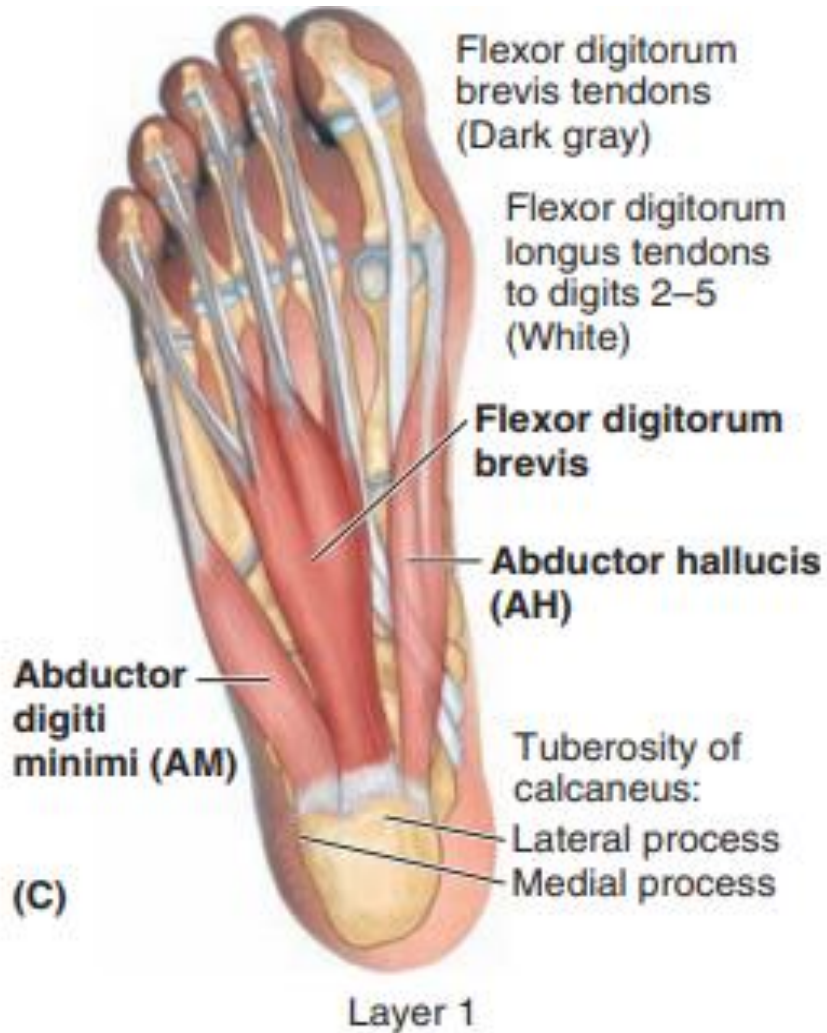
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Layer	Muscles	Features
First layer	<ol style="list-style-type: none">1. Flexor digitorum brevis.2. Abductor hallucis.3. Abductor digiti minimi	They cover whole of the sole
Second layer	<ol style="list-style-type: none">1. Flexor digitorum accessorius Four lumbricals.2. Two tendons (tendon of flexor digitorum longus and tendon of flexor hallucis longus)	Flexor digitorum accessorius and lumbricals are attached to the tendon of flexor digitorum longus
Third layer	<ol style="list-style-type: none">1. Flexor hallucis brevis.2. Flexor digiti minimi brevis.3. Adductor hallucis	<ol style="list-style-type: none">1. They are confined to the metatarsal region of the sole.2. Two of these muscles act on the big toe and one on the little toe
Fourth layer	<ol style="list-style-type: none">1. Interossei (3 plantar interossei and 4 dorsal interossei).2. Tendon of tibialis posterior.3. Tendon of peroneus longus	They fill up the intermetatarsal spaces

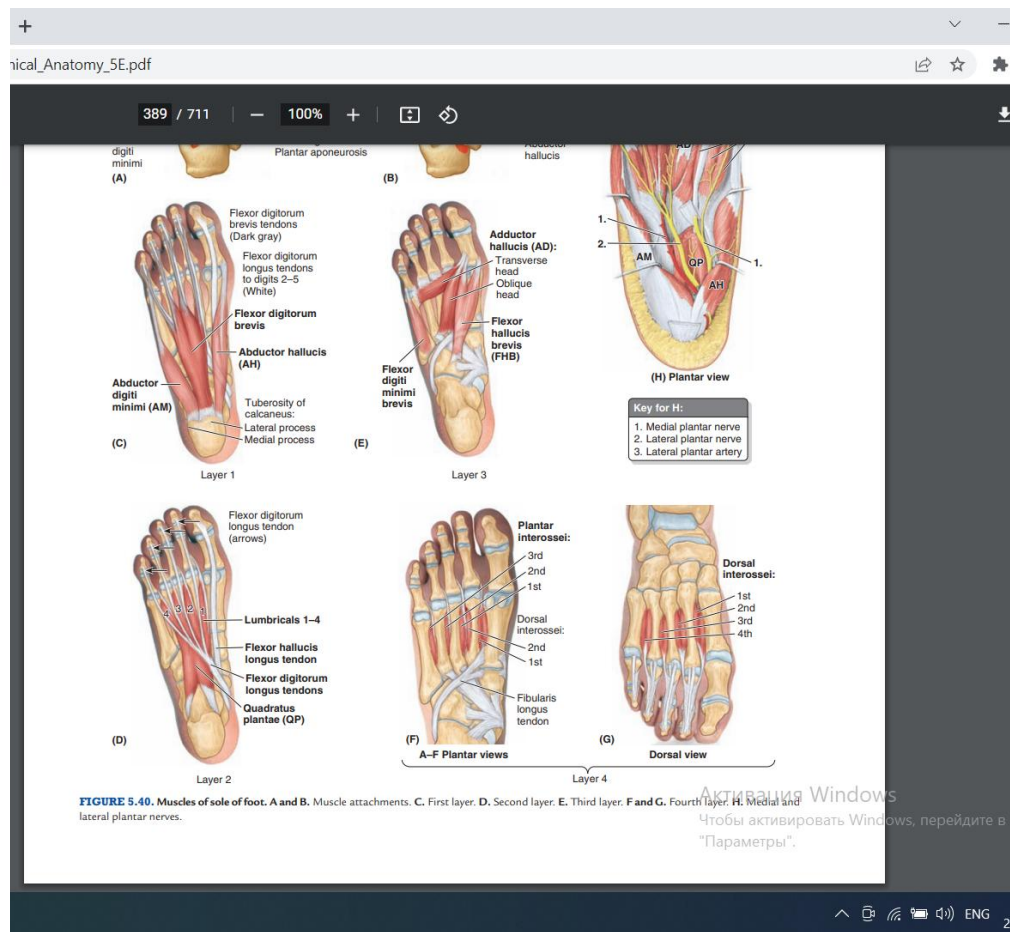
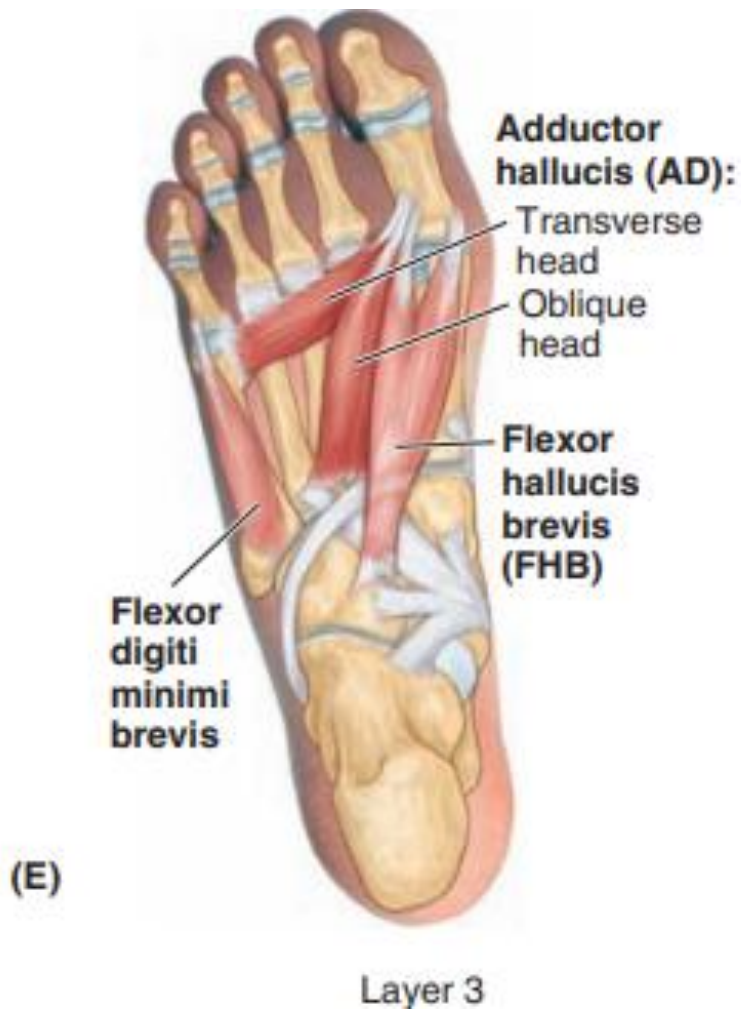
Muscle attachments



Muscle layers of the sole of the foot



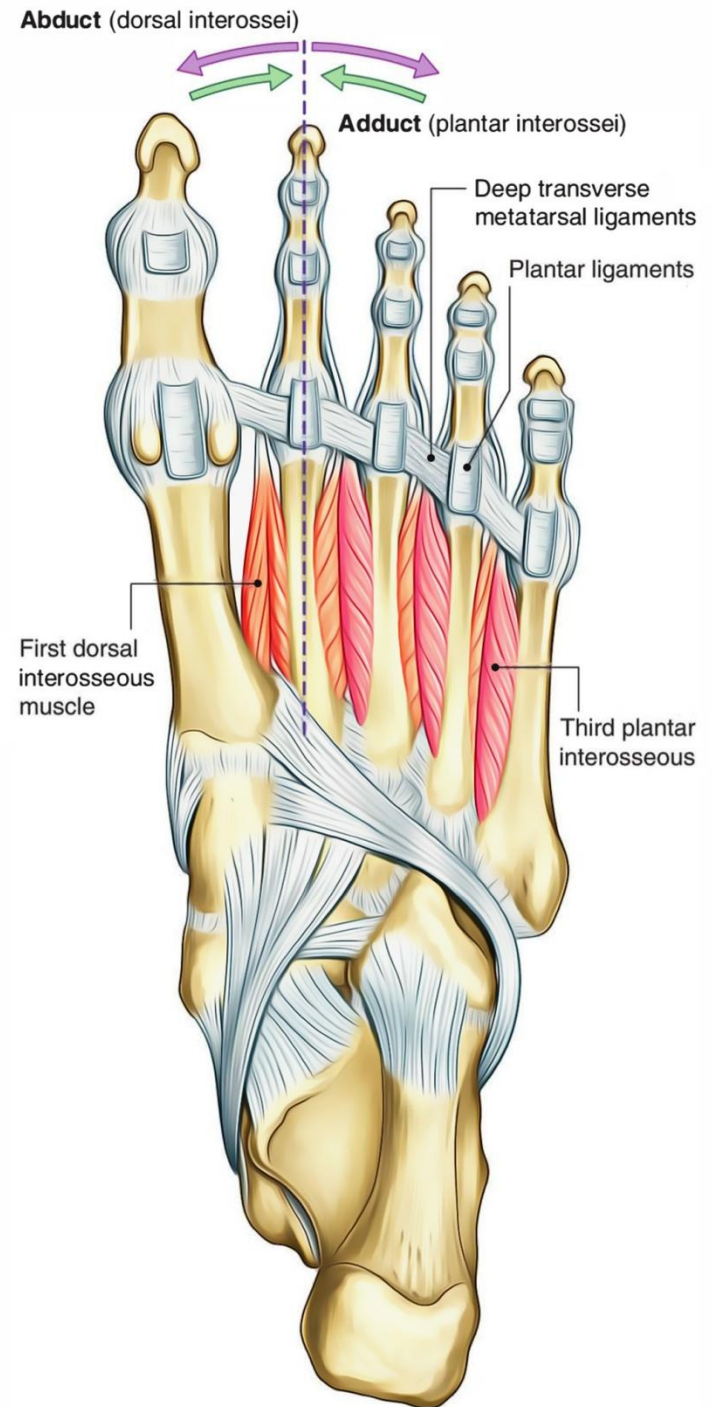
Muscle layers of the sole of the foot



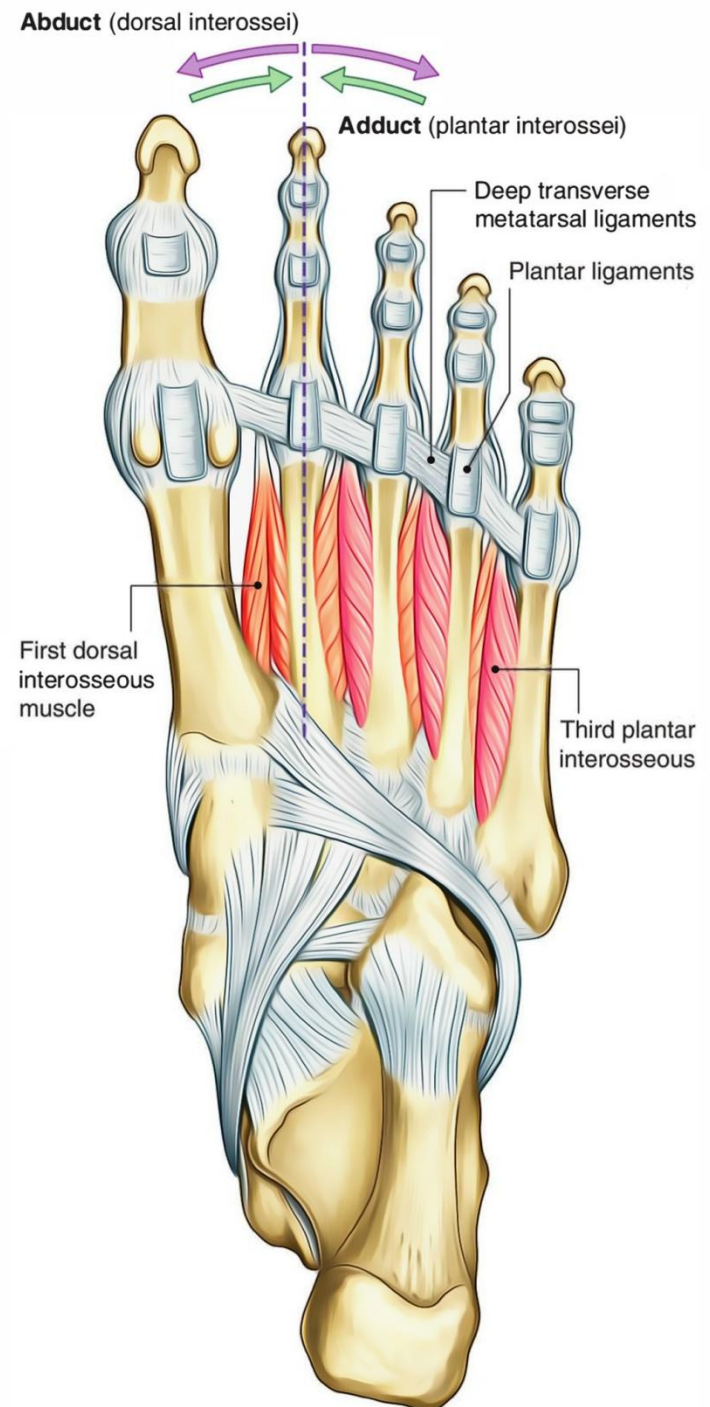
The plantar interossei are found in the lateral three interosseous spaces and are smaller than their dorsal equivalents, fusiform in shape.

From the plantar and medial aspect of the base and proximal end of the shaft of the metatarsal each plantar interosseus originates.

To insert into the medial side of the base of the proximal phalanx of the same toe, the tendon that is created passes forwards and deep to the deep transverse metatarsal ligament.

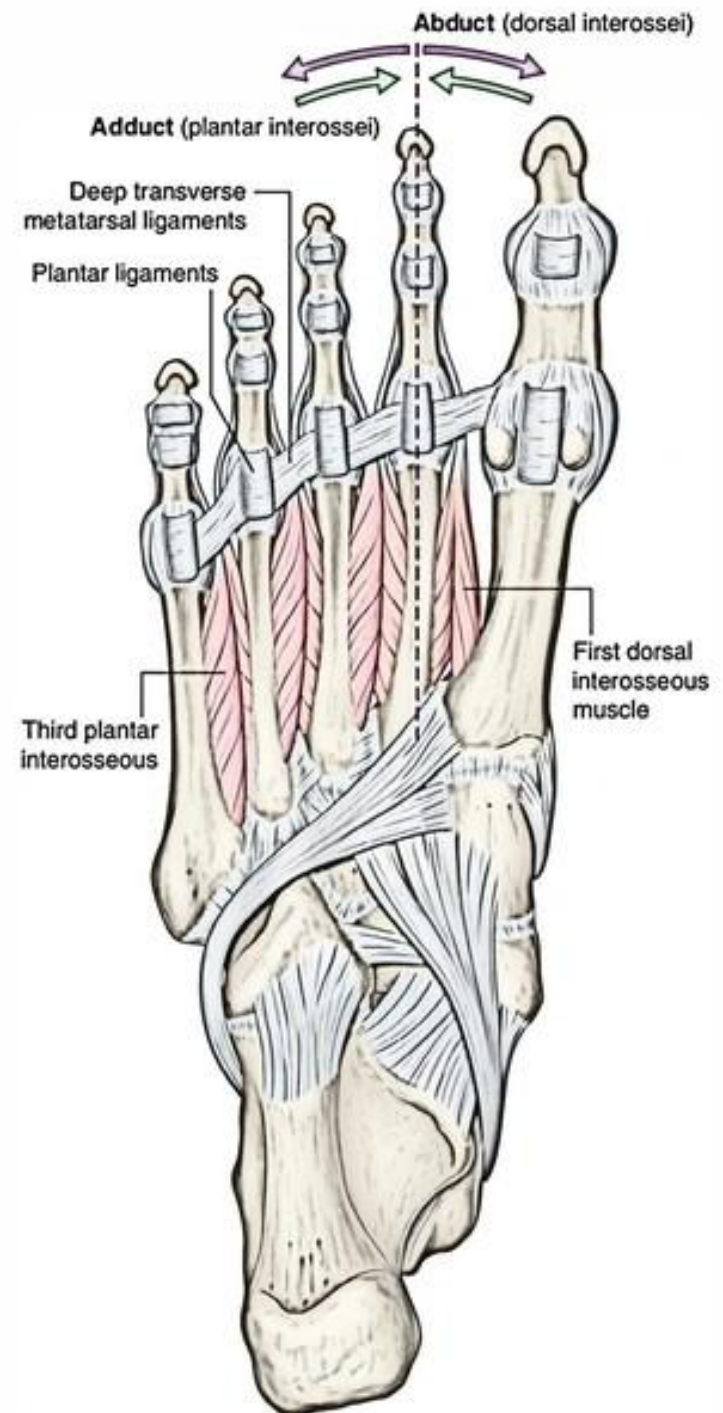


All four dorsal interossei muscles emerge from the sides of adjacent metatarsals and are bipennate. The tendons of the dorsal interossei insert into the base of the proximal phalanges of the toes and free margin of the extensor hoods.



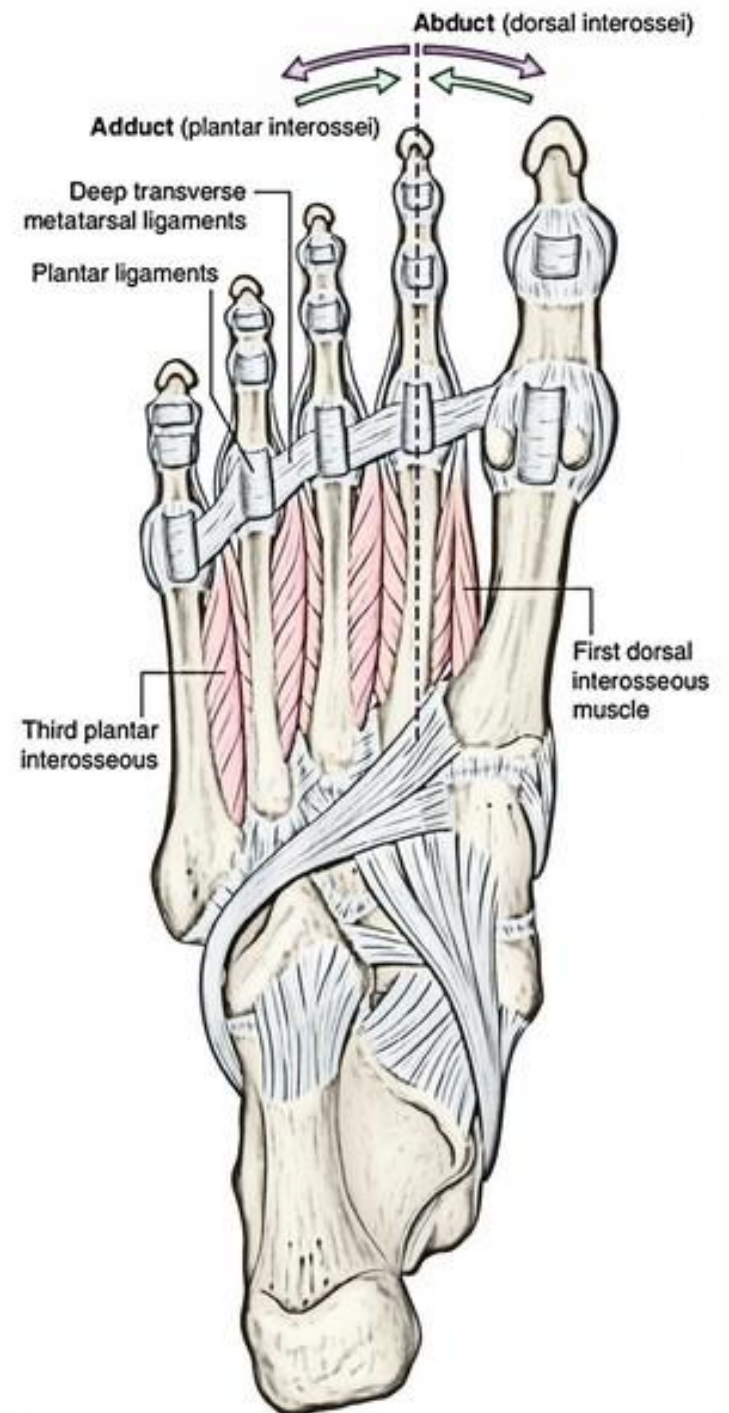
Action

The plantar interossei adduct the third, fourth and fifth toes in the direction of the second. In conjunction with the dorsal interossei they flex the metatarsophalangeal joints of the lateral three toes.

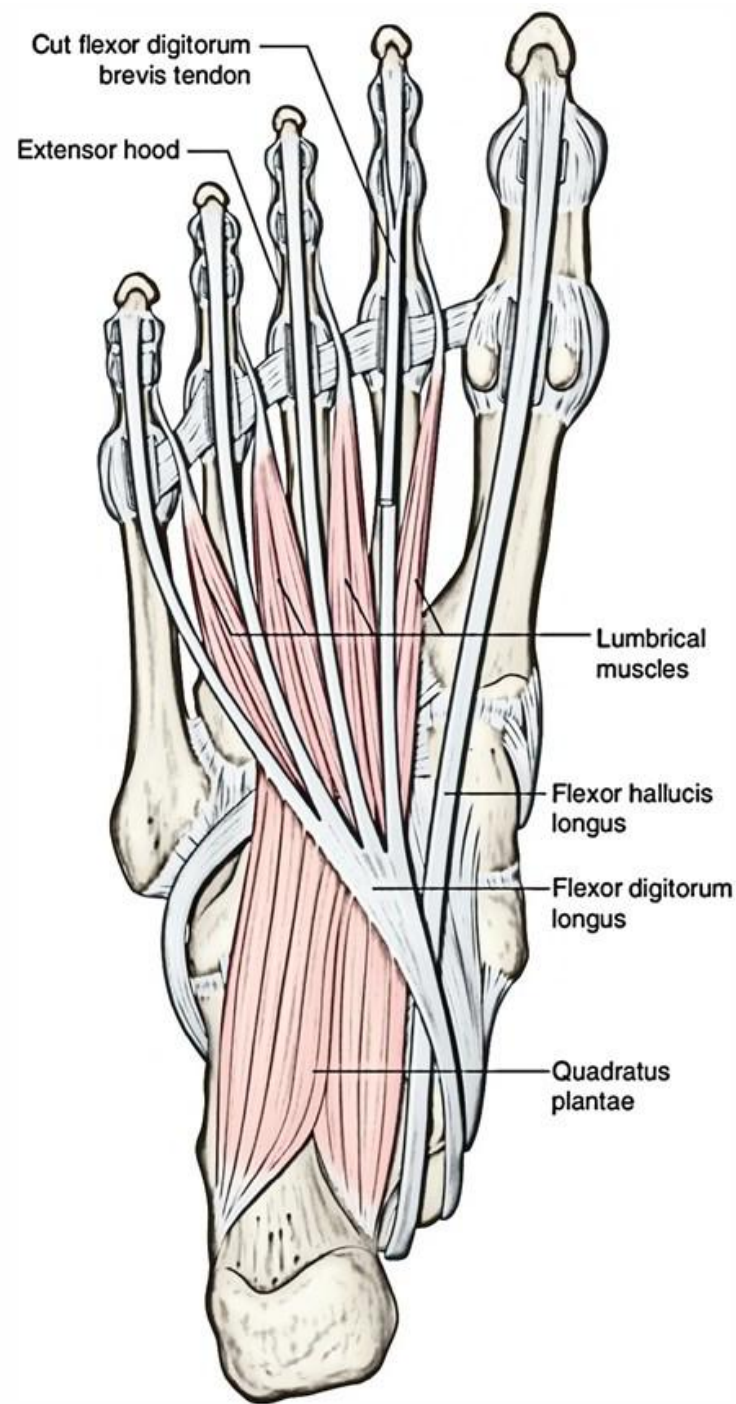


Action

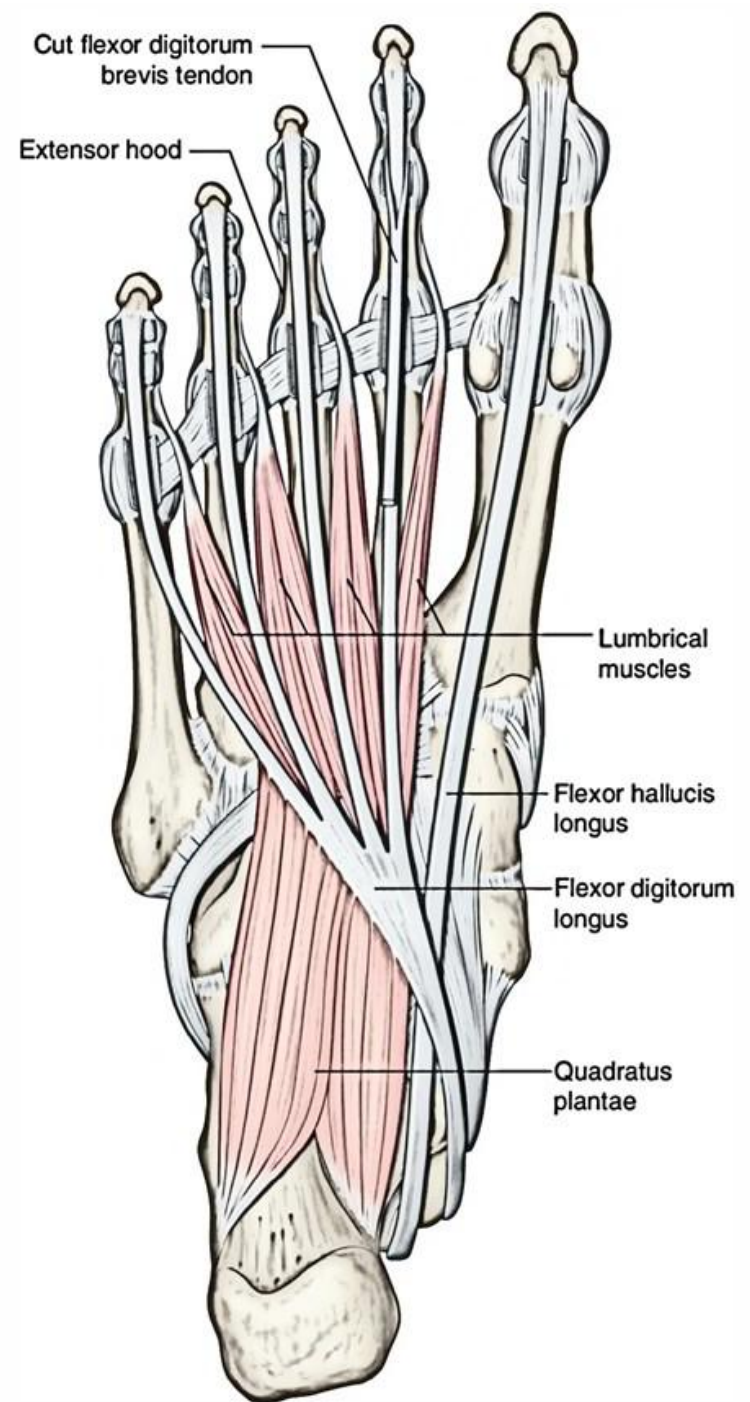
The dorsal interossei produce flexion of the metatarsophalangeal joint, acting with the plantar interossei. The dorsal interossei abduct the toes at the metatarsophalangeal joint, however, this action, as such, is of little importance in the foot.



The lumbrical muscles are four worm-like muscles in the foot level that pass dorsally to insert into the free medial margins of the extensor hoods of the four lateral toes and originate from the tendons of the flexor digitorum longus.

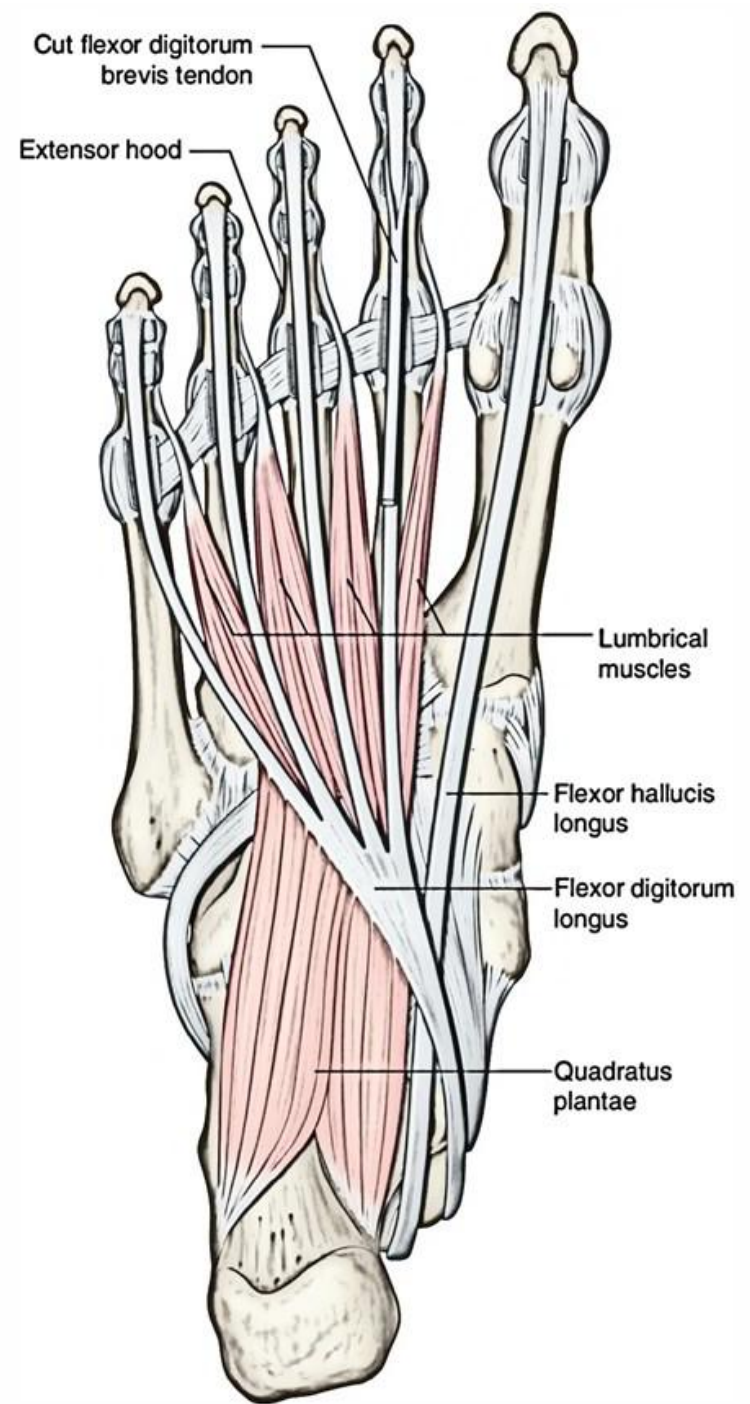


The first lumbrical originates from the medial side of the tendon of the flexor digitorum longus that is associated with the second toe. The staying three muscles emerge from the sides of surrounding tendons and are bipennate.



Action

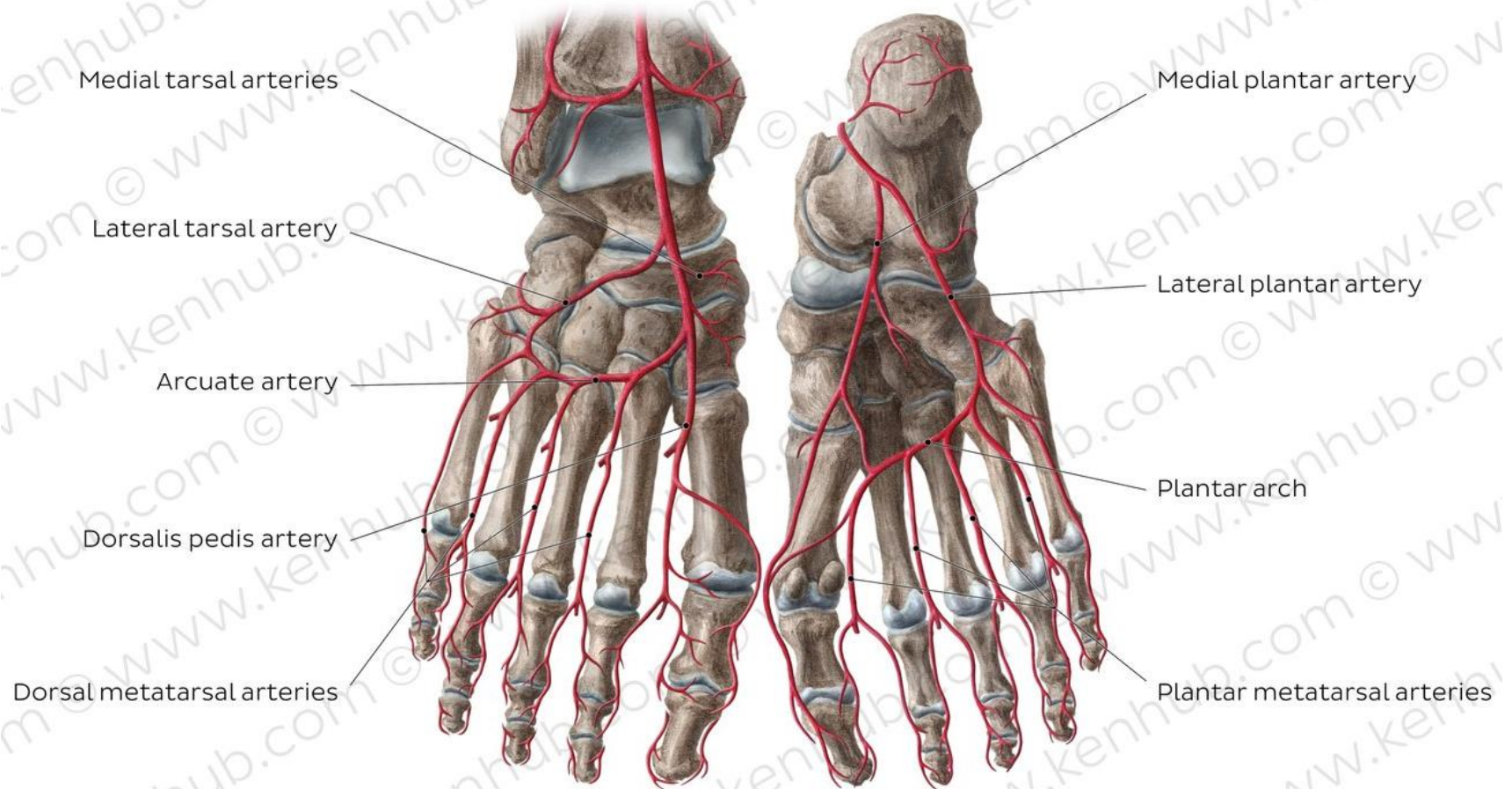
Contraction of the lumbricals produces flexion of the toes at the metatarsophalangeal joint, by their connection to the proximal phalanx. Because they also enter into the extensor hood, the lumbricals extend the interphalangeal joints.



The muscles of the foot are of little importance individually because fine control of the individual toes is not important to most people. Rather than producing actual movement, they

are most active in fixing the foot or in increasing the pressure applied against the ground by various aspects of the sole or toes to maintain balance.

Arteries of the foot



Arteries of the foot



The arteries of the foot are terminal branches of the anterior and posterior tibial arteries, the dorsal and plantar arteries, respectively. The dorsalis pedis artery (dorsal artery of foot), often a major source of blood supply to the forefoot, is the direct continuation of the anterior tibial artery.



Arteries of the foot

The dorsalis pedis artery begins midway between the malleoli (at the ankle joint) and runs anteromedially, deep to the inferior extensor retinaculum between the extensor hallucis longus and the extensor digitorum longus tendons on the dorsum of the foot.

Arteries of the foot



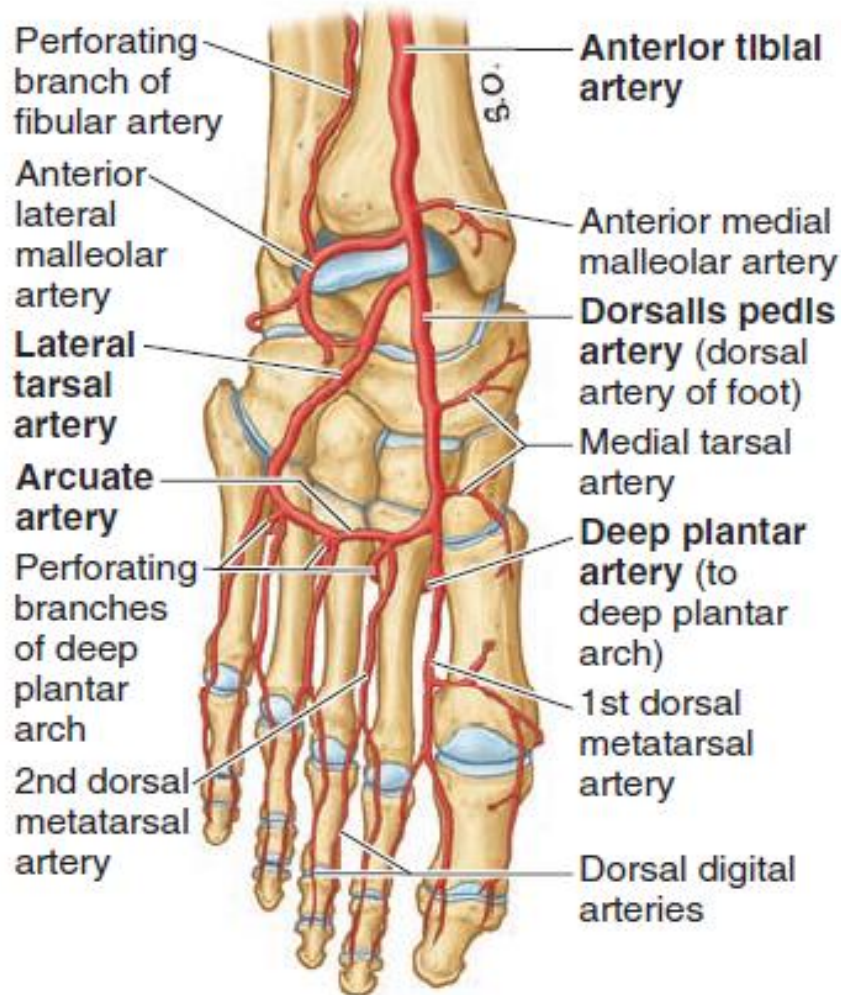
The dorsalis pedis artery gives off the lateral tarsal artery and then passes distally to the first interosseous space, where it gives off the arcuate artery and then divides into the 1st dorsal metatarsal artery and a deep plantar artery.

Arteries of the foot

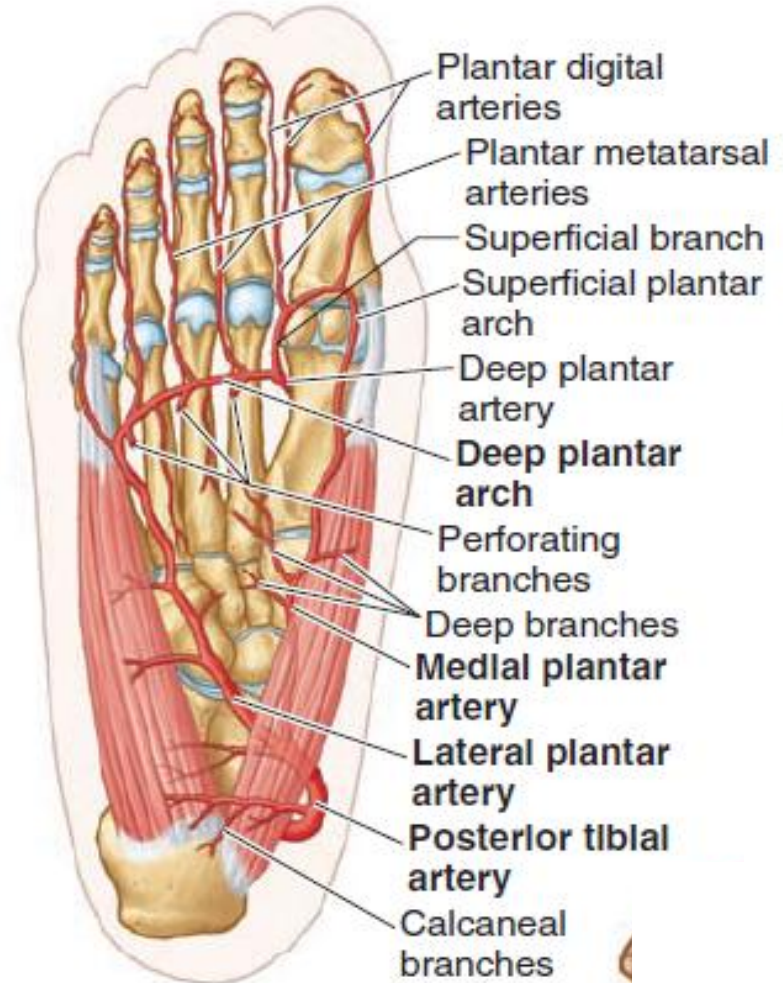


The deep plantar artery passes deeply between the heads of the first dorsal interosseous muscle to enter the sole of the foot, where it joins the lateral plantar artery to form the deep plantar arch. The arcuate artery gives off the 2nd, 3rd, and 4th dorsal metatarsal arteries, which run to the clefts of the toes, where each of them divides into two dorsal digital arteries.

Arteries of the foot



(A) Dorsal surface



(B) Plantar surface

Arteries of the foot



The sole of the foot has prolific blood supply from the posterior tibial artery, which divides deep to the flexor retinaculum. The terminal branches pass deep to the abductor hallucis as the medial and lateral plantar arteries, which accompany similarly named nerves.

Arteries of the foot



The medial plantar artery supplies the muscles of the great toe and the skin on the medial side of the sole and has digital branches that accompany digital branches of the medial plantar nerve.



Initially, the lateral plantar artery and nerve course laterally between the muscles of the first and second layers of plantar muscles. The deep plantar arch begins opposite the base of the 5th metatarsal as the continuation of the lateral plantar artery, coursing between the third and the fourth muscle layers. The arch is completed medially by union with the deep plantar artery, a branch of the dorsal artery of the foot.



As it crosses the foot, the deep plantar artery gives rise to four plantar metatarsal arteries; three perforating branches; and many branches to the skin, fascia, and muscles in the sole. The plantar digital arteries arise from the plantar metatarsal arteries near the base of the proximal phalanx, supplying adjacent digits.



Venous Drainage of Foot

There are both superficial and deep veins in the foot.

The deep veins consist of inter-anastomosing paired veins accompanying all the arteries internal to the deep fascia.

The superficial veins are subcutaneous, are unaccompanied by arteries, and drain most of the blood from the foot.

Venous drainage of foot



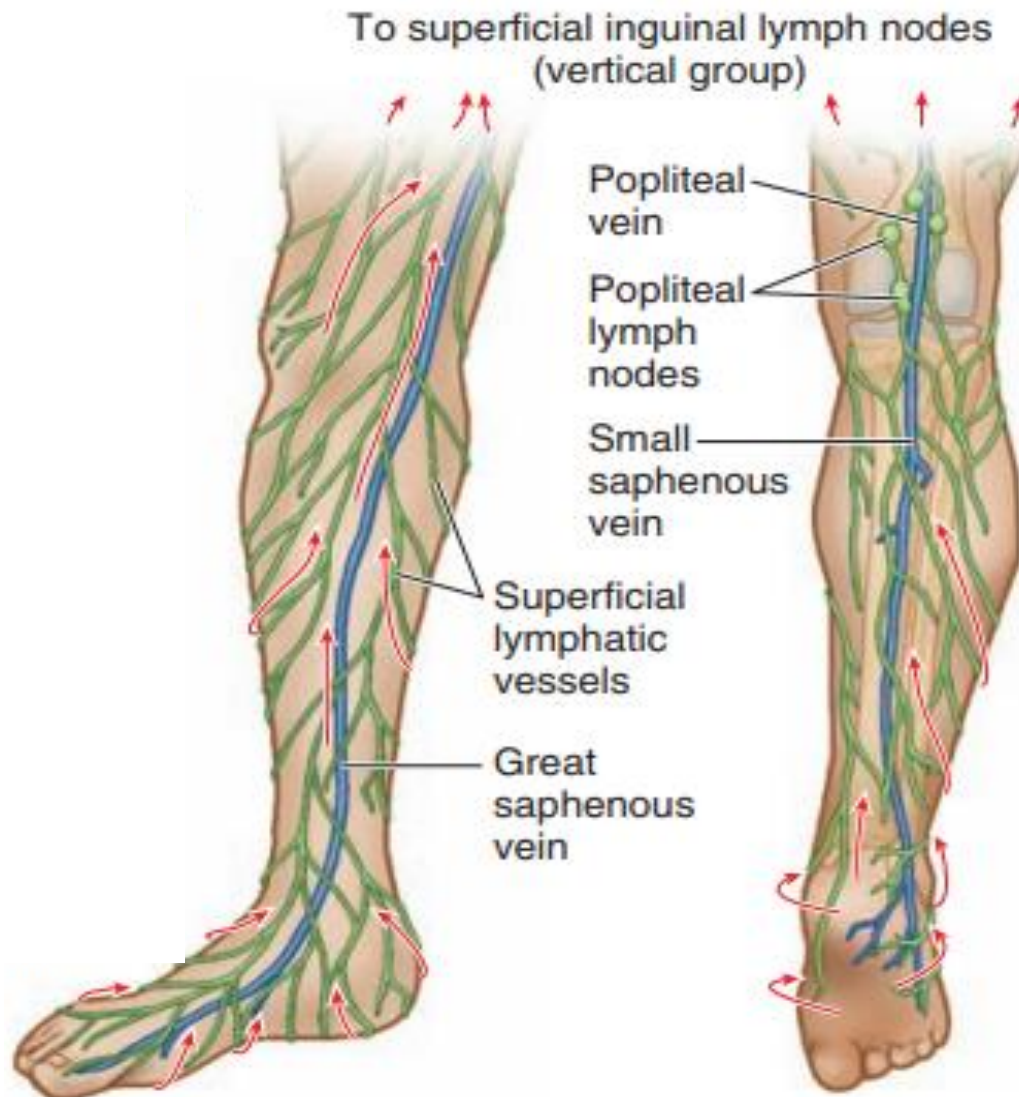
Dorsal digital veins continue proximally as dorsal metatarsal veins, which join to form the subcutaneous dorsal venous arch, proximal to which a dorsal venous network covers the remainder of the dorsum of the foot.



Venous drainage of foot

Superficial veins from a plantar venous network drain around either the medial or the lateral border of the foot to converge with the dorsal venous arch and network to form medial and lateral marginal veins, which become the great and small saphenous veins, respectively.

Venous and lymphatic drainage of the foot



Lymphatic drainage of the foot



The lymphatics of the foot begin in the subcutaneous plexuses. The collecting vessels consist of superficial and deep lymphatic vessels, which follow the superficial veins and major vascular bundles, respectively. Superficial lymphatic vessels are most numerous in the sole.

Lymphatic drainage of the foot



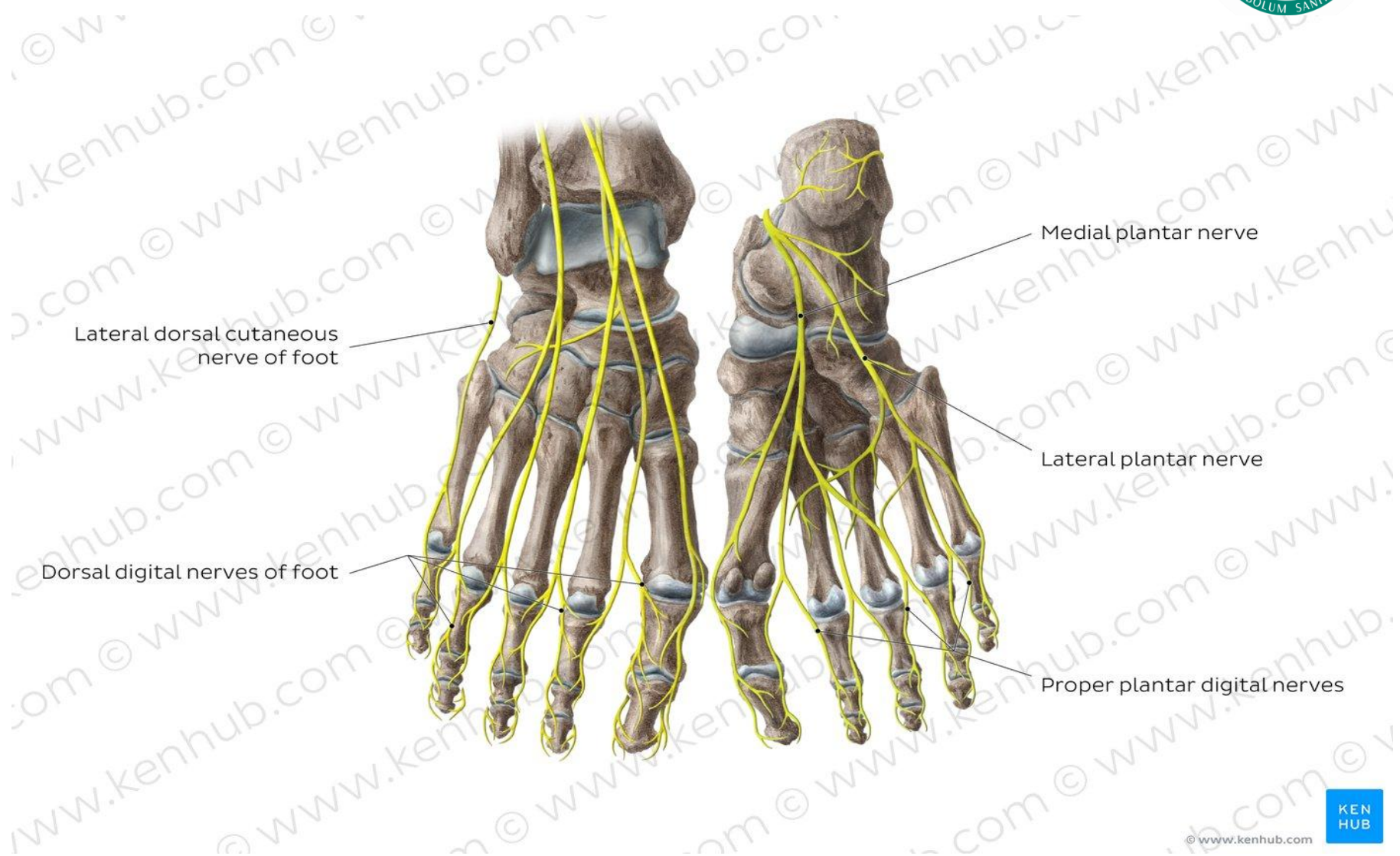
The medial superficial lymphatic vessels leave the foot medially along the great saphenous vein and accompany it to the superficial inguinal lymph nodes, located along the vein's termination, and then to the deep inguinal lymph nodes.

Lymphatic drainage of the foot



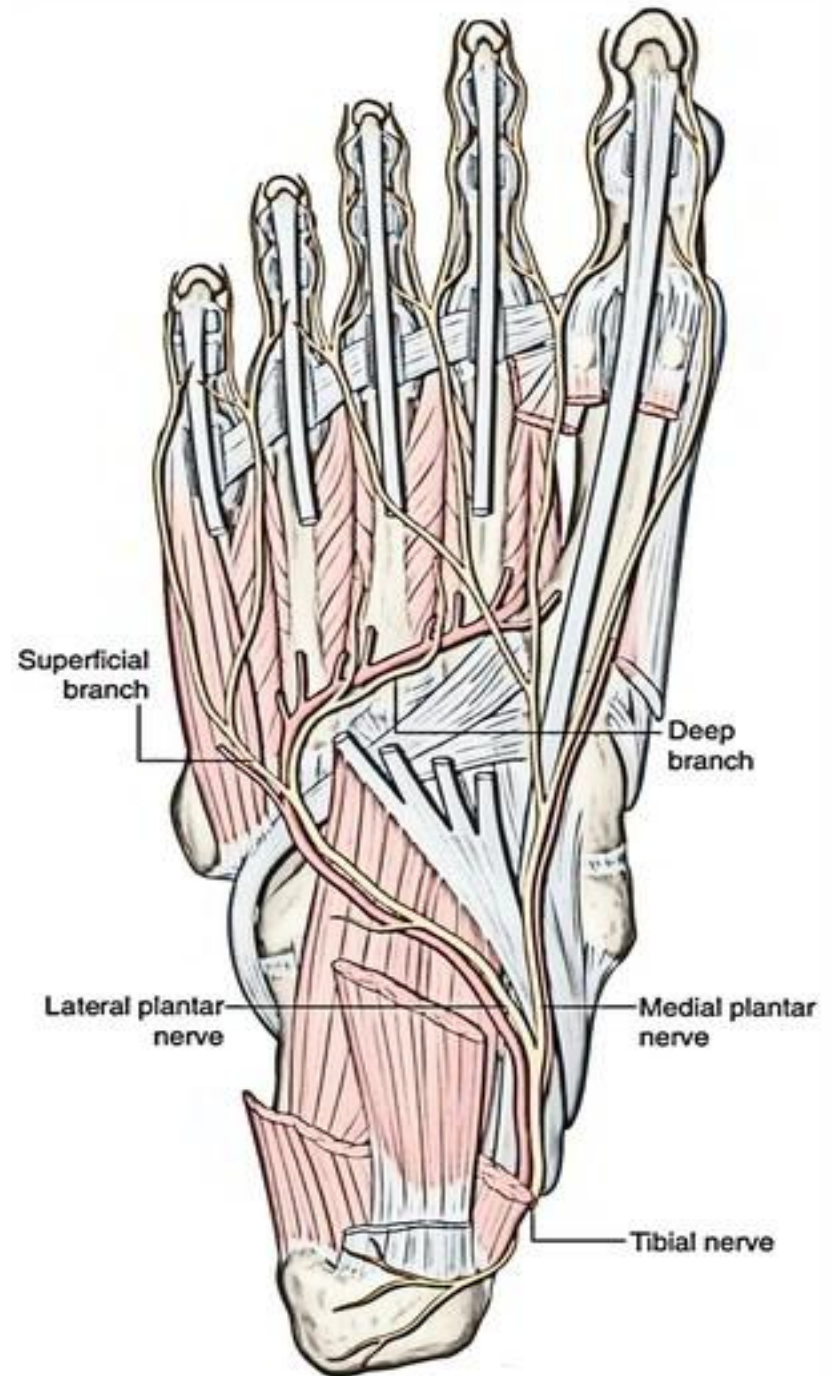
The lateral superficial lymphatic vessels drain the lateral side of the foot and accompany the small saphenous vein to the popliteal fossa, where they enter the popliteal lymph nodes. The deep lymphatic vessels from the foot also drain into the popliteal lymph nodes. Lymphatic vessels from them follow the femoral vessels to the deep inguinal lymph nodes. All lymph from the lower limb then passes to the iliac lymph nodes.

Nerves of the foot



Nerves of the foot

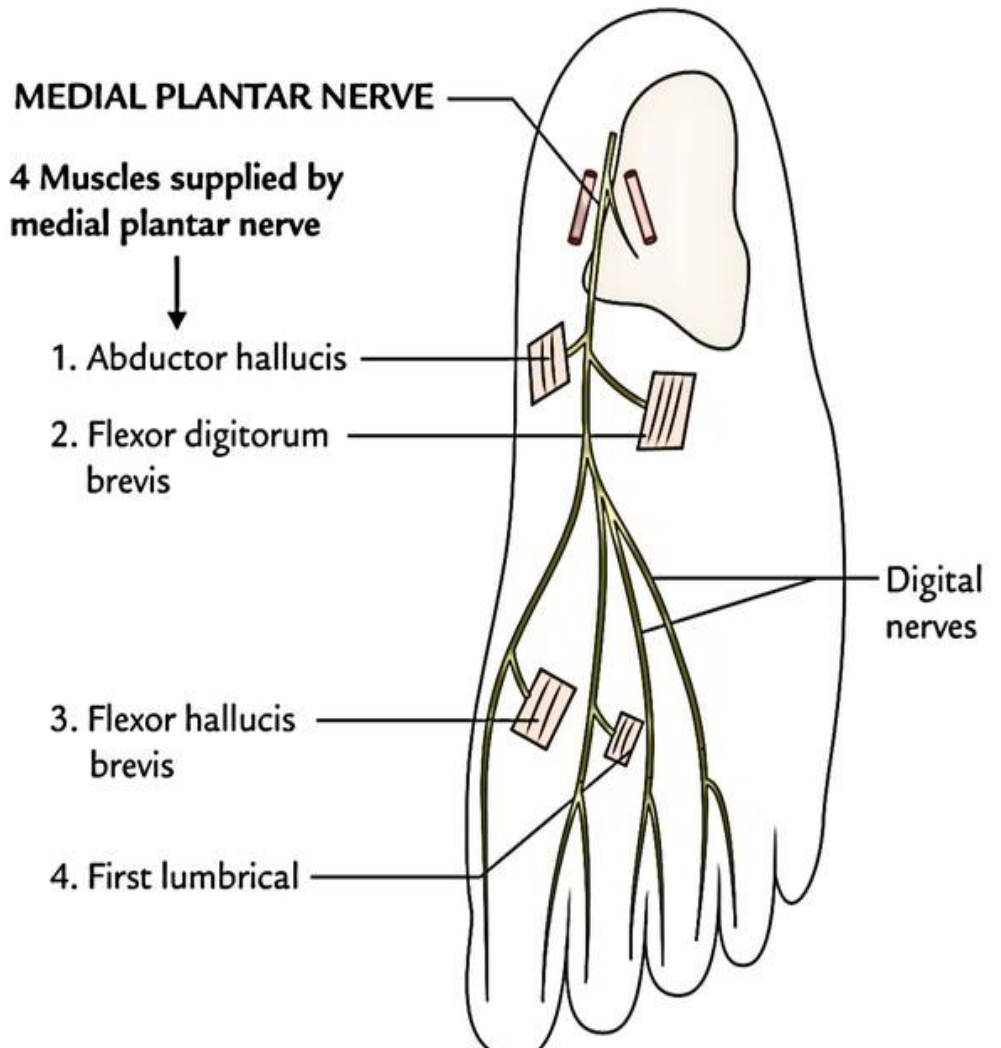
Plantar Nerves are the nerves that go through the ankle joint to the sole of the foot. There are 2 plantar nerves- medial and lateral.



Nerves of the foot



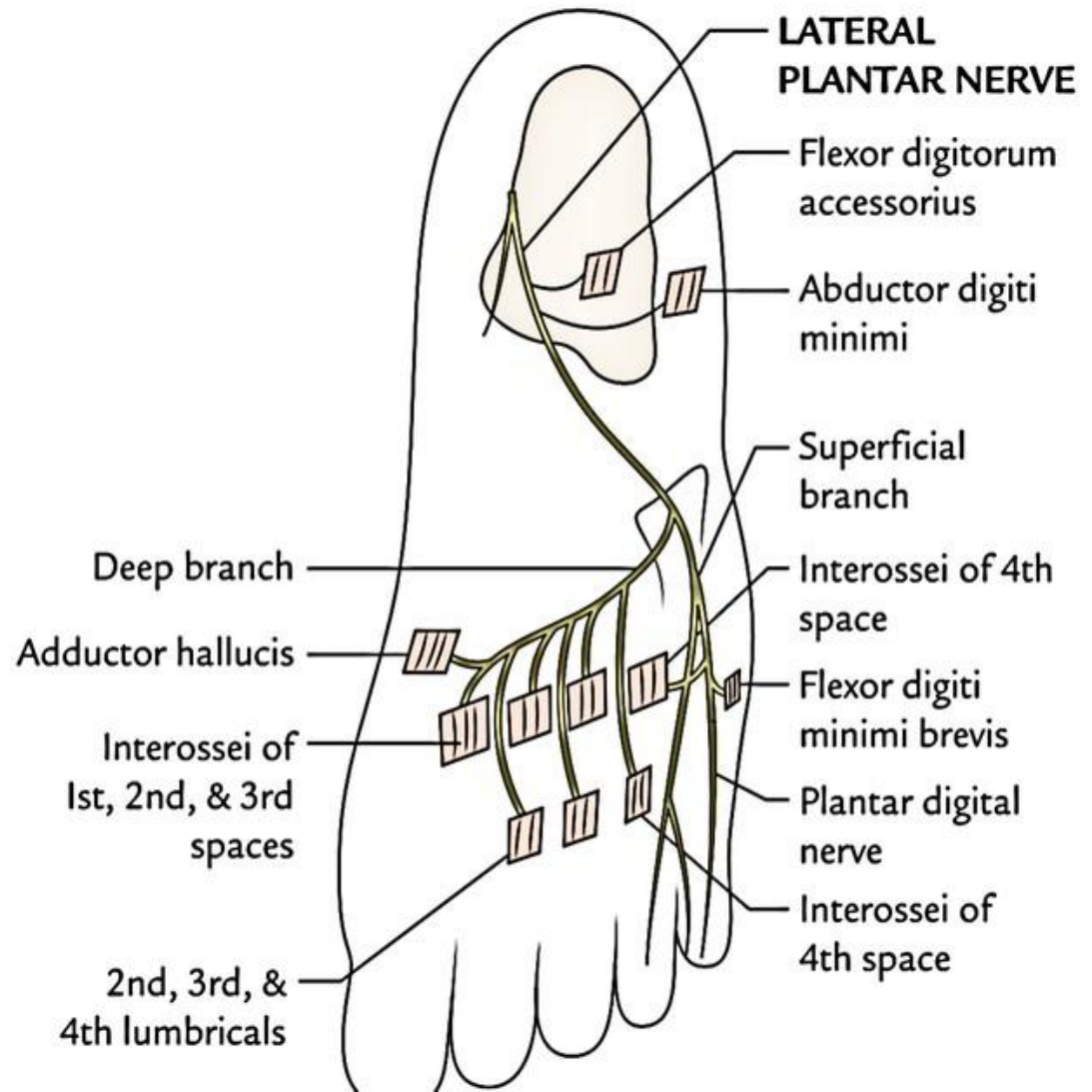
There are 2 plantar nerves- medial and lateral.



Nerves of the foot



There are 2 plantar nerves - medial and lateral.



Motor innervation of the medial and lateral plantar nerves



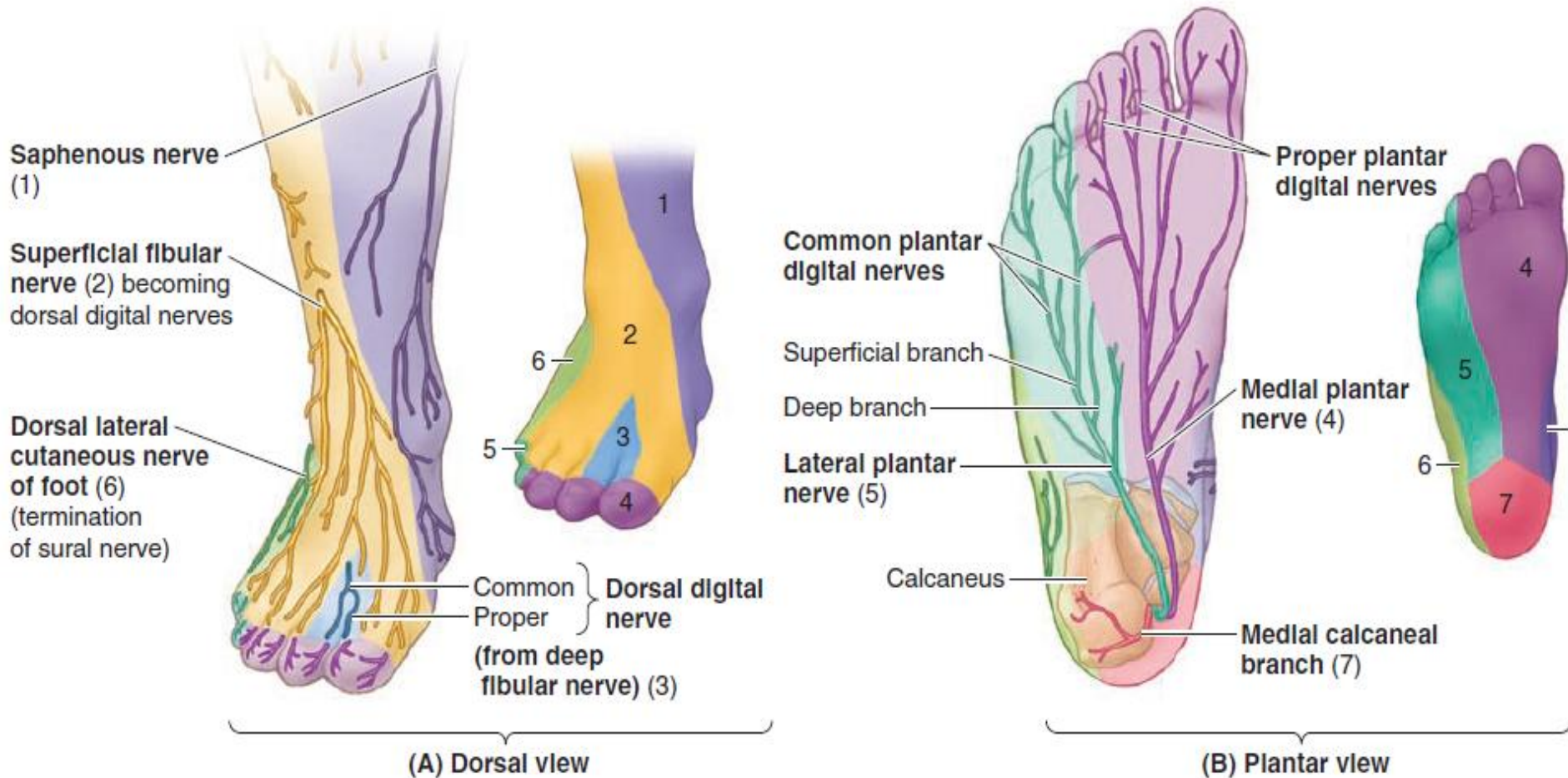
Medial plantar nerve

- Abductor hallucis
- Flexor digitorum brevis
- Flexor hallucis brevis
- First lumbrical

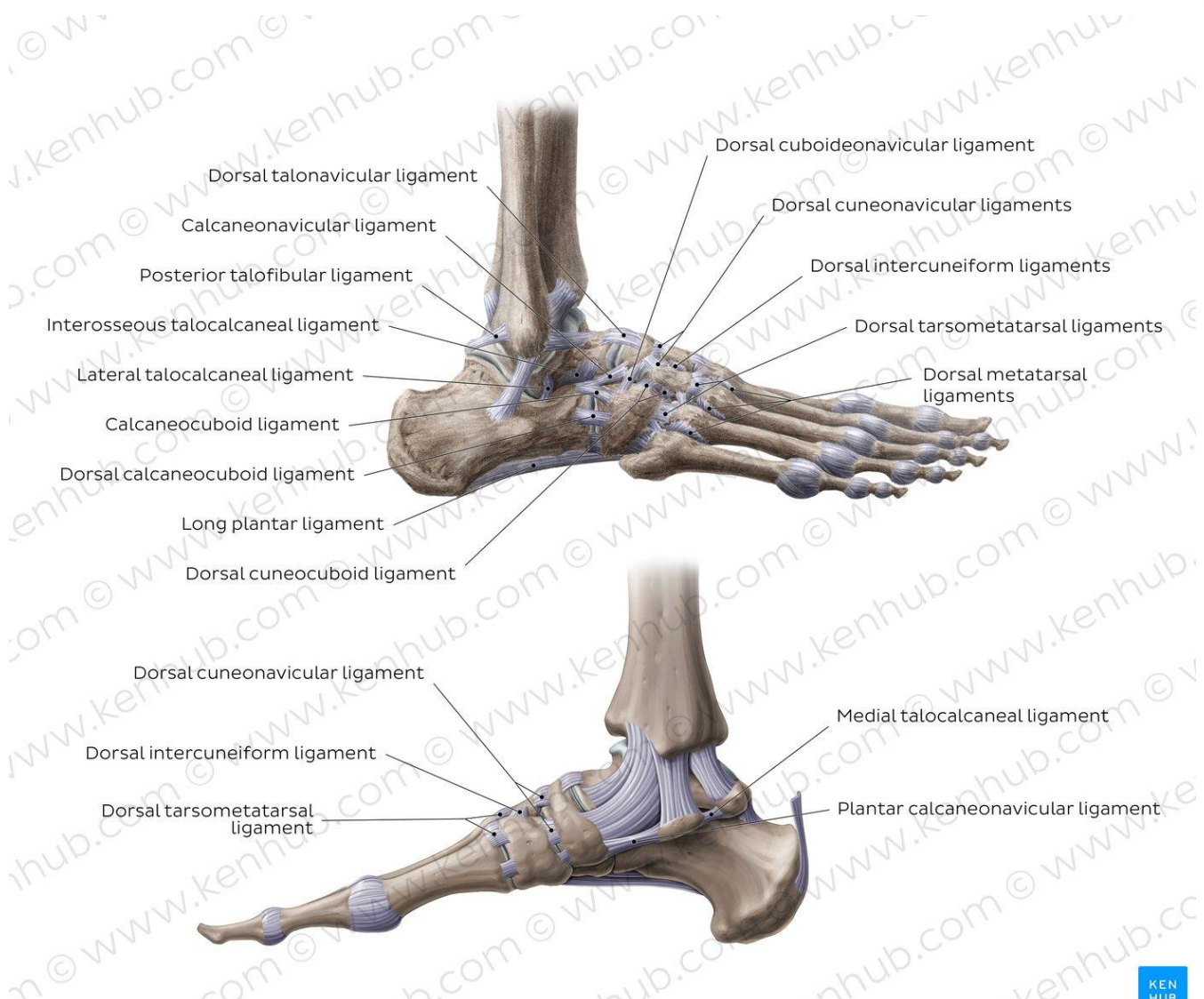
Lateral plantar nerve

- Flexor digitorum accessorius
- Abductor digiti minimi
- Abductor hallucis
- Flexor digiti minimi brevis
- All interossei
- Second, third, and fourth lumbricals

Cutaneous innervation of foot



Ligaments of the foot



Ligaments of the foot



Beginning proximally at the subtalar (talocalcaneal) joint. In the upper image, we see the lateral, anterior and interosseous talocalcaneal ligaments, while in the lower image we can identify the medial and posterior talocalcaneal ligaments. Moving distally to the ligaments of the talocalcaneonavicular joint: the dorsal talonavicular and the calcaneonavicular ligaments are visible laterally, and the plantar calcaneonavicular ligament medially.

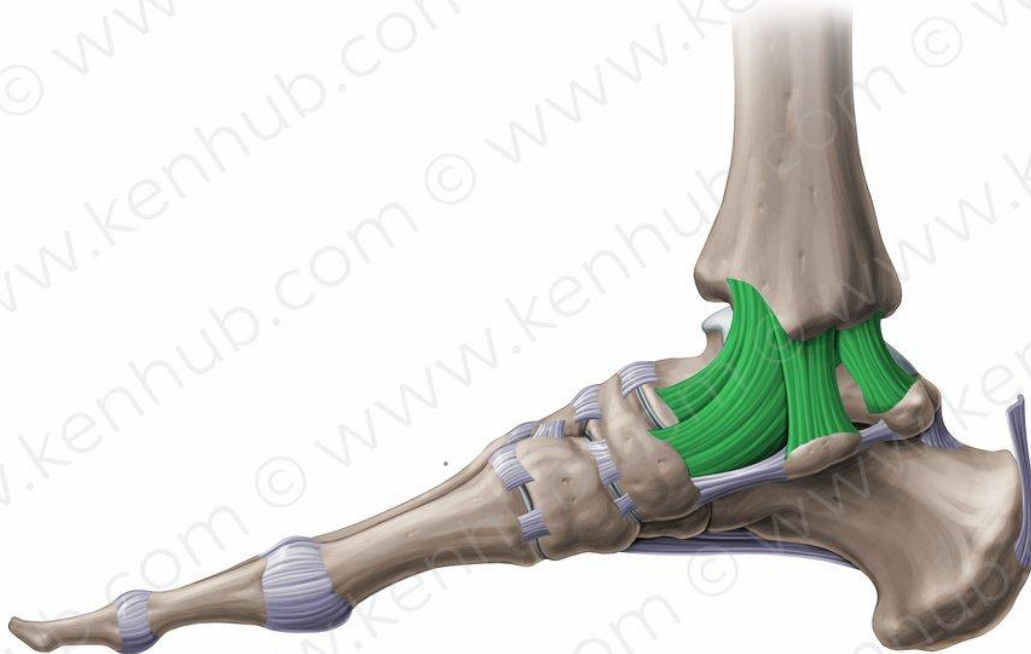
Ligaments of the foot



Next, the ligaments of the calcaneocuboid joint: the calcaneocuboid, the dorsal calcaneocuboid and the long plantar ligaments (lateral view). We can also see some ligaments of the cuboideonavicular joint, such as the dorsal cuboideonavicular, and cuboideonavicular ligaments.



Ligaments of the foot



Medial collateral ligament of ankle joint

(Ligamentum collaterale mediale tali)

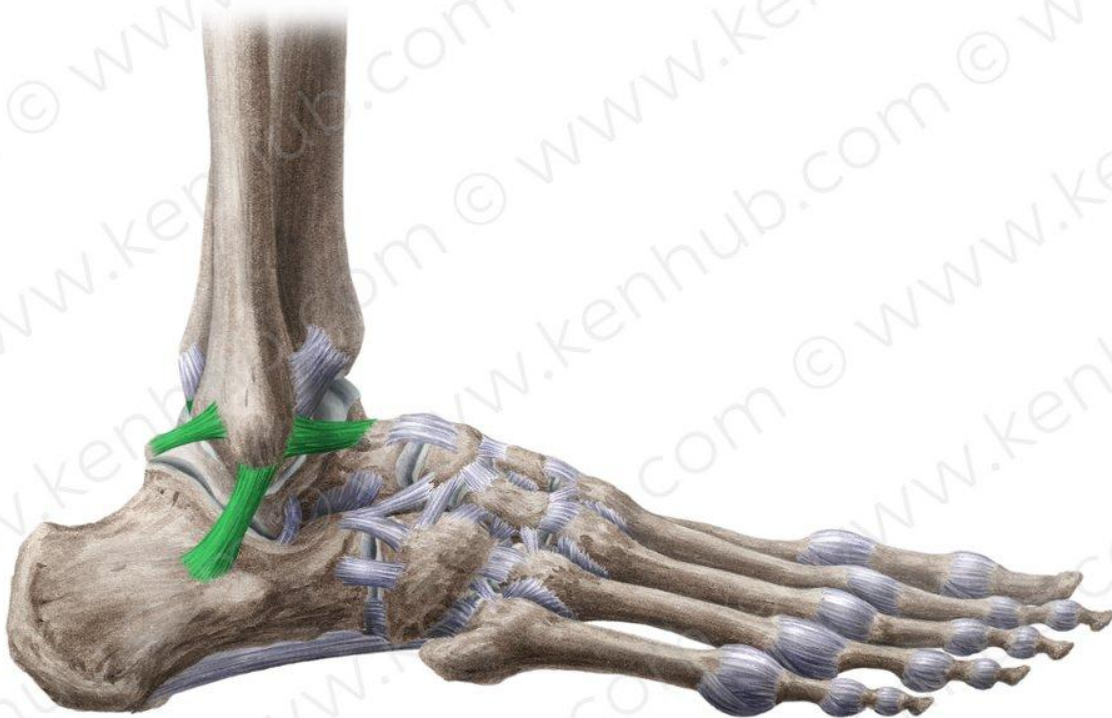
Synonym: Deltoid ligament of ankle joint

Ligaments of the foot



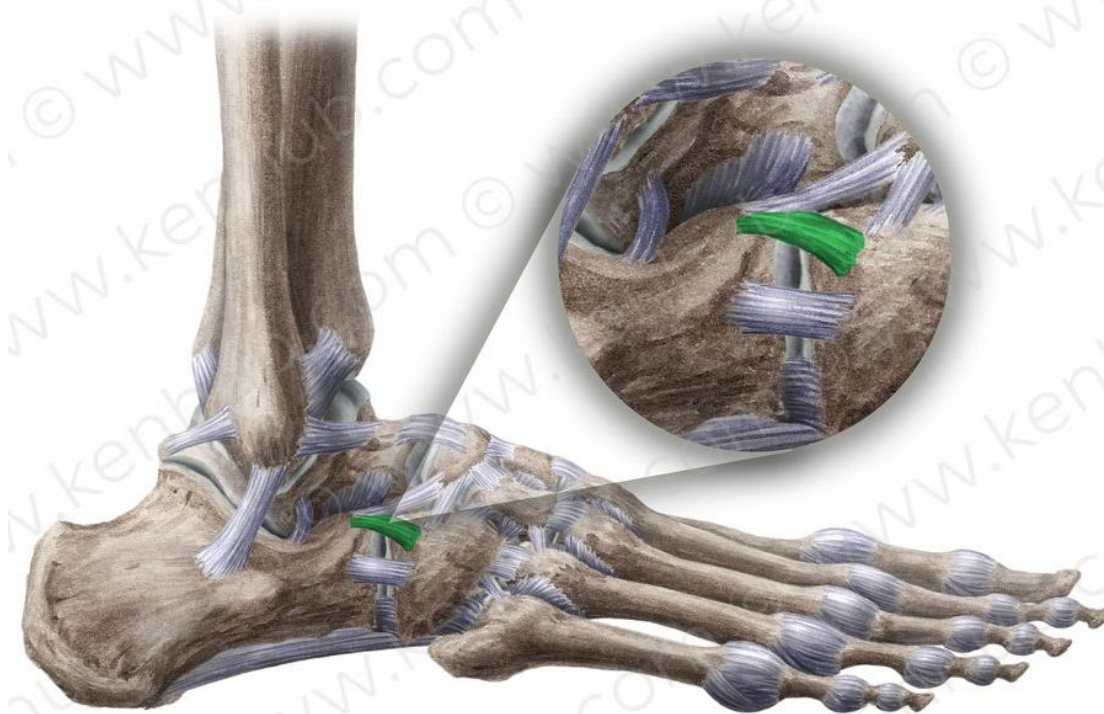
Lateral collateral ligament
of ankle joint

(Ligamentum collaterale
laterale tali)





Ligaments of the foot

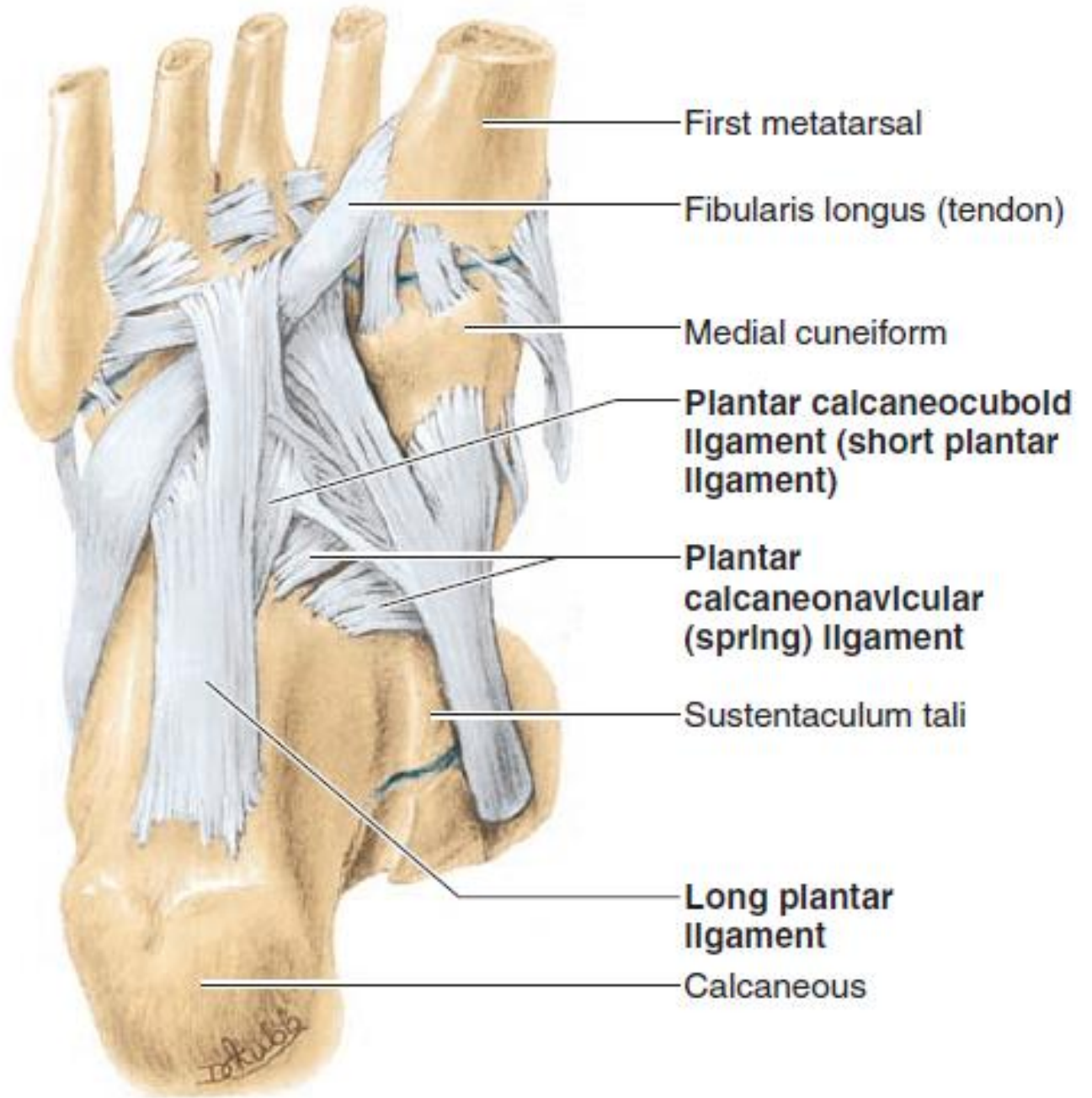


Calcaneocuboid ligament

(Ligamentum
calcaneocuboideum)

Synonyms: Calcaneocuboid part
of bifurcate ligament, Pars
calcaneocuboidea ligamenti
bifurcati

Ligaments of
the plantar
aspect of the
foot



Plantar surface

Ligaments of the plantar aspect of the foot



The major ligaments of the plantar aspect of the foot are

- Plantar calcaneonavicular (spring) ligament, which extends across and fills a wedge-shaped gap between the sustentaculum tali and the inferior margin of the posterior articular surface of the navicular. This ligament supports the head of the talus and plays an important role in the transfer of weight from the talus and in maintaining the longitudinal arch of the foot.

Ligaments of the plantar aspect of the foot



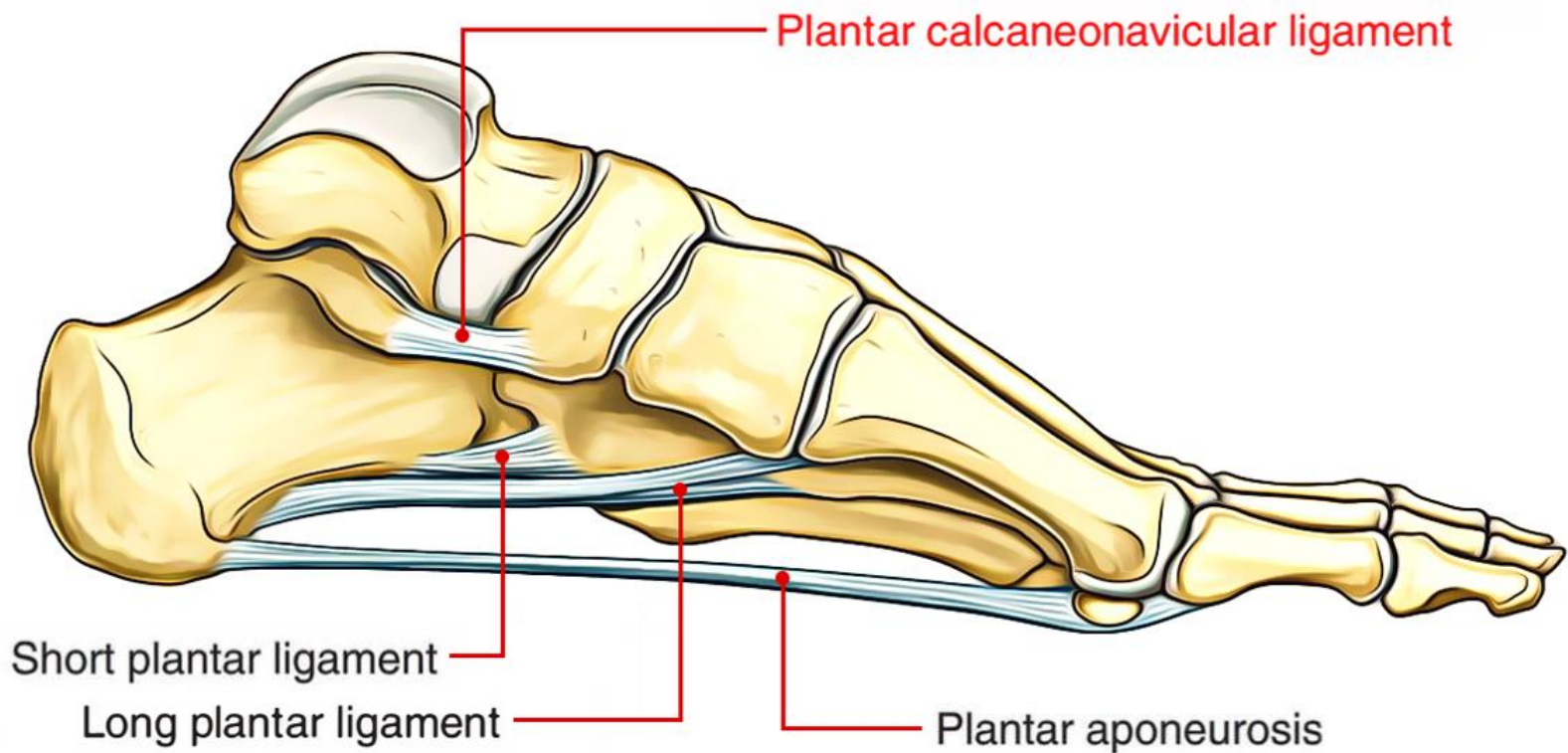
- Long plantar ligament, which passes from the plantar surface of the calcaneus to the groove on the cuboid. Some of its fibers extend to the bases of the metatarsals, thereby forming a tunnel for the tendon of the fibularis longus. The long plantar ligament is important in maintaining the longitudinal arch of the foot.

Ligaments of the plantar aspect of the foot



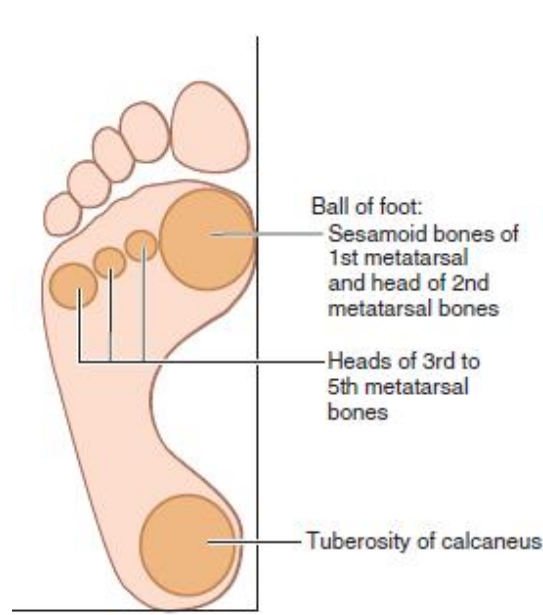
- **Plantar calcaneocuboid (short plantar) ligament**, which is located deep to the long plantar ligament. It extends from the anterior aspect of the inferior surface of the calcaneus to the inferior surface of the cuboid. It is also involved in maintaining the longitudinal arch of the foot.

Ligaments of the plantar aspect of the foot

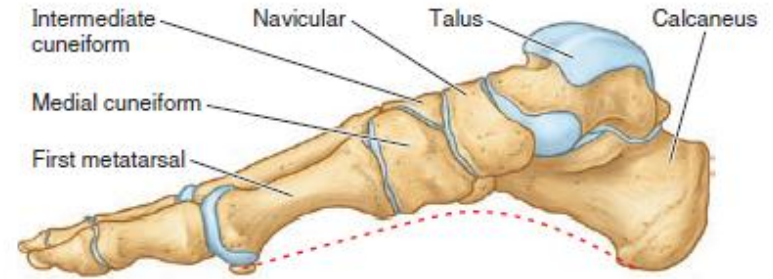


Arches of Foot

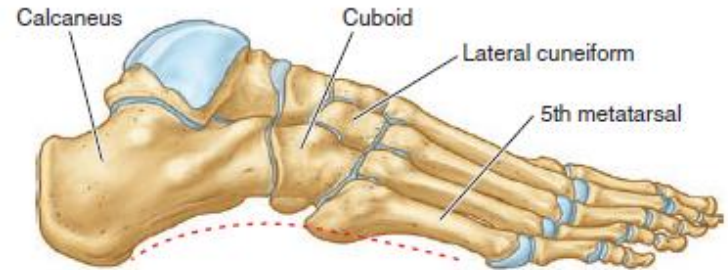
Passive and dynamic supports of foot. There are four layers of passive support (1-4).



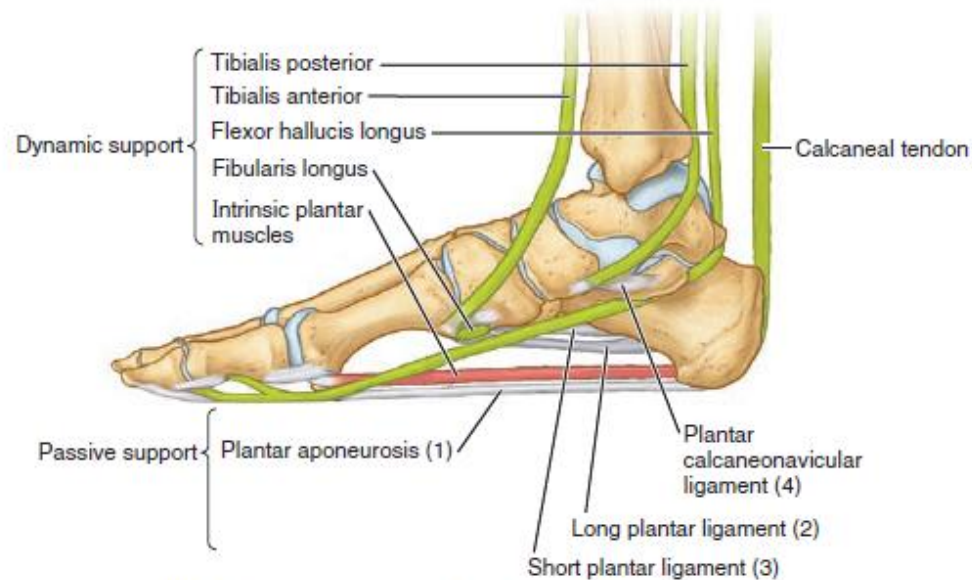
(A) Plantar view



(B) Medial longitudinal arch (medial view)



(B) Lateral longitudinal arch (lateral view)



(C) Medial longitudinal arch (medial view)



Arches of foot

The foot is composed of numerous bones connected by ligaments that provide considerable flexibility which allow it to deform with each ground contact, thereby absorbing much of the shock. Furthermore, the tarsal and metatarsal bones are arranged in longitudinal and transverse arches passively supported and actively restrained by flexible tendons that add to the weight-bearing capabilities and resiliency of the foot



Arches of foot

The longitudinal arch of the foot is composed of medial and lateral parts. Functionally, both parts act as a unit, with the transverse arch spreading the weight in all directions. The medial longitudinal arch is higher and more important than the lateral longitudinal arch. The medial longitudinal arch is composed of the calcaneus, talus, navicular, three cuneiforms, and three metatarsals. The talar head is the keystone of the medial longitudinal arch.



Arches of Foot

The lateral longitudinal arch is much flatter than the medial longitudinal arch and rests on the ground during standing. It is composed of the calcaneus, cuboid, and lateral two metatarsals.

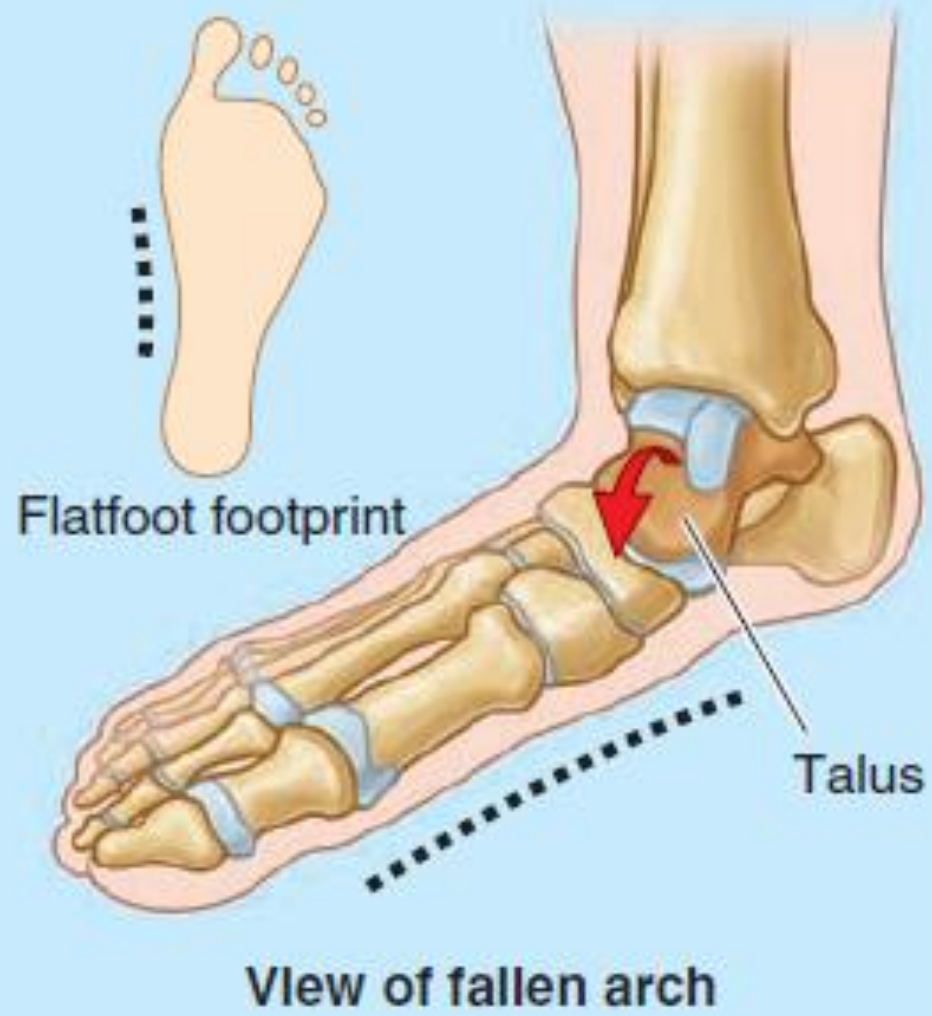
The transverse arch of the foot runs from side to side. It is formed by the cuboid, cuneiforms, and bases of the metatarsals. The medial and lateral parts of the longitudinal arch serve as pillars for the transverse arch.

Pes planus (Flatfeet)



Acquired flatfeet (“fallen arches”) are likely to be secondary to dysfunction of the tibialis posterior owing to trauma, degeneration with age, or denervation. In the absence of normal passive or dynamic support, the plantar calcaneonavicular ligament fails to support the head of the talus. Consequently, the talar head displaces inferomedially and becomes prominent.

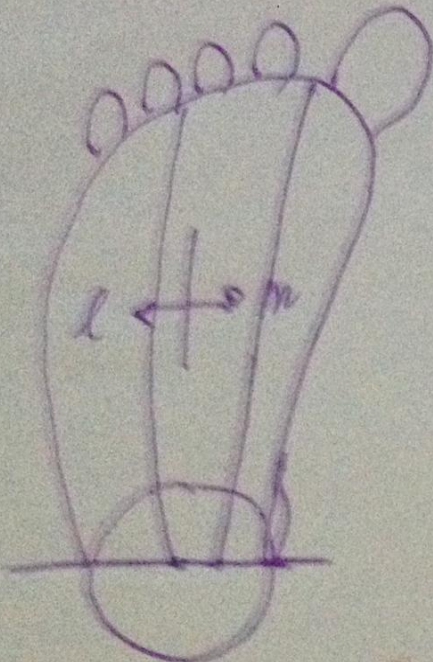
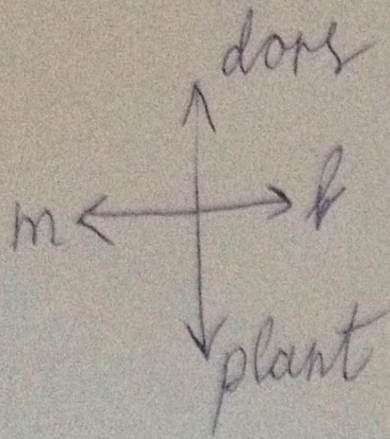
Pes planus (Flatfeet)



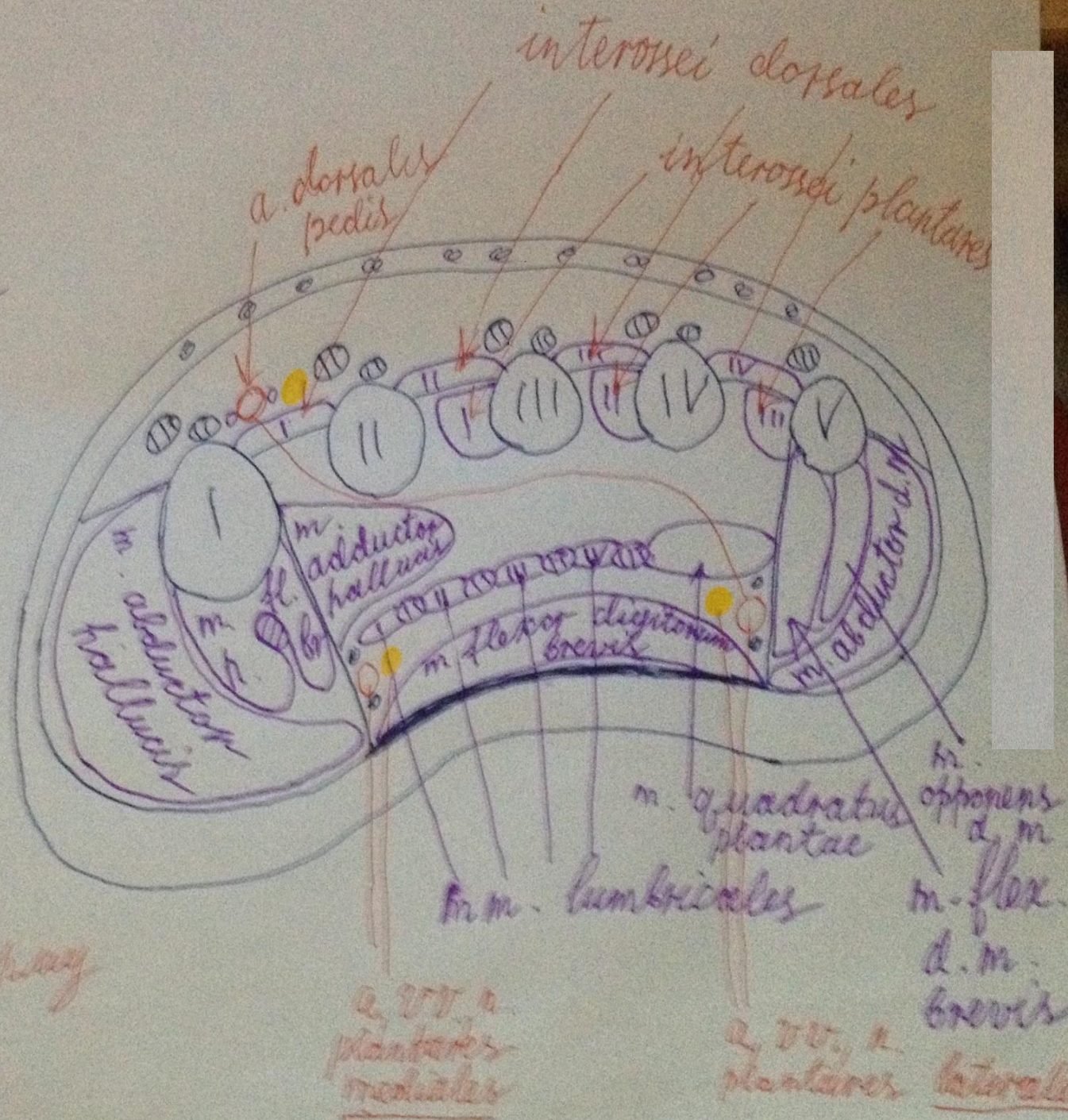
Pes planus (Flatfeet)



As a result, some flattening of the medial longitudinal arch occurs, along with lateral deviation of the forefoot. Flatfeet are common in older people, particularly if they undertake much unaccustomed standing or gain weight rapidly, adding stress on the muscles and increasing the strain on the ligaments supporting the arches.



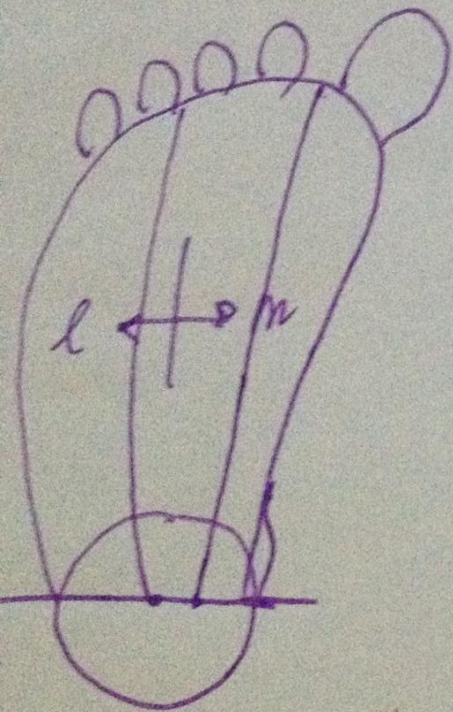
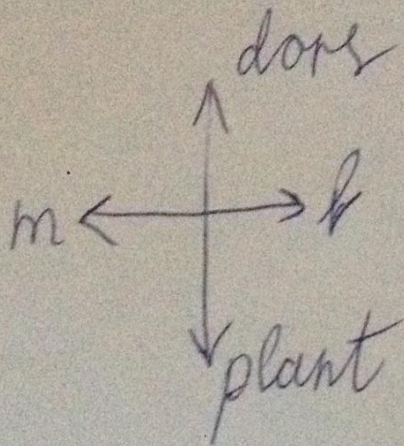
Jaypee vs Deopray
(corona)



a. vv. a. plantares mediales

a. vv. a. plantares laterales

lateral



изображ. по Дерофу
(схема)

