Knee, Leg, Ankle and Foot

Prof. Aranjan Karunanayake
MBBS, DM, DOH&S, Dip.Tox, Dipin. Coun, D.Sp.Med, FSS, MBASEM (UK), MSc.SEM (UK)

Knee joint

- Synovial modified hinge joint.
- Joint between femur, tibia and patella.
- Muscles, ligaments, menisci and capsule support it.
- Anterior cruciate - hyperextension injuries.
- Menisci - twisting injuries while knee is flexed.

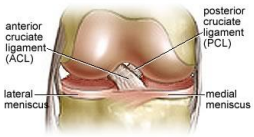
Medial meniscus gets injured more than lateral meniscus

Injuries to Ligaments

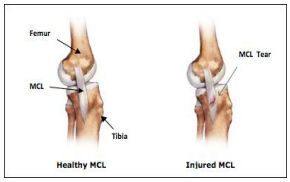
Posterior cruciate - damaged in hyper flexion injuries,

Medial collateral – vulgus strain.

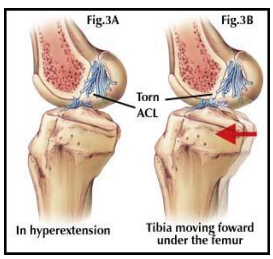
Lateral collateral – varus strain



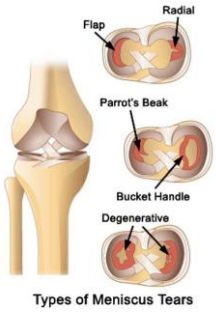
Vulgus strain on knee



Hyper extension injury to knee



Meniscal injury



Bursa related to knee

Supra patella – largest. Communicates with knee

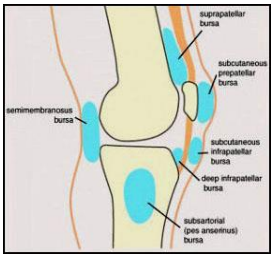
Infra patella – subcutaneous and deep.

Pre patella - subcutaneous

Semimembranosus bursa

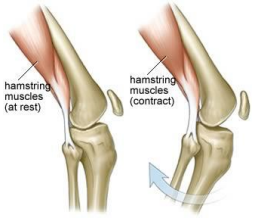
Pes anserine bursa.

Can get inflamed during friction and cause pain



Movements of knee

Flexion – hamstring muscles mainly but gastrocnemius also helps.



Movements of knee

Extension - Quadriceps femoris

Locking of the knee joint - The femur medial rotates on the tibia during last stages of extension. In locking knee is in full extension.

Action of quadriceps, size differences of femoral condyles and oblique pull of ligaments causes locking.

Popliteus helps in unlocking of the knee joint by lateral rotating the femur.

Arterial and Nerve supply

There is an anastomosis of branches of femoral, popliteal and tibial arteries.

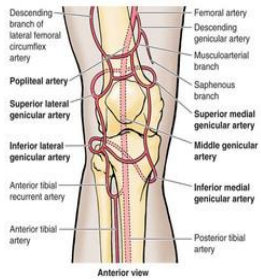
These arteries gives several genicular arteries.

Nerve supply –

Femoral,

Obturator

Sciatic nerve branches



Objectives-

Describe the bones of the leg and foot

Describe the muscles of the leg and foot

Describe the compartments of the leg

Describe the ankle joint

Describe the compartments of the foot with arches.

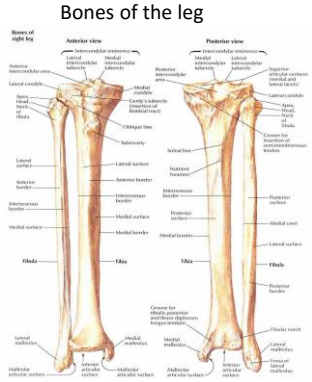
Describe the muscles acting on the ankle and foot

Describe the vascular and nerve supply to the lower limb.

Describe the arches of the foot

Applied and clinical anatomy of lower limb.

Bones of the leg



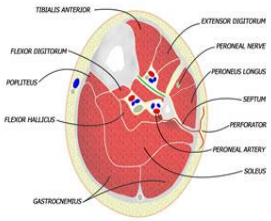
Compartments of the leg

Anterior, lateral, posterior. Medial compartment is subcutaneous

If there is bleeding pressure can rise and cause necrosis in these compartments.

4 compartments are present in posterior leg.

Tibialis posterior lies in deepest and gastrocnemius lies in the most superficial compartment



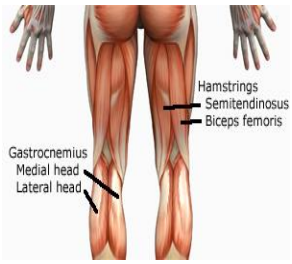
Superficial muscles of back of leg

Muscles-

Medial and lateral head of gastrocnemius.

Supplied by Tibial nerve.

Causes plantar flexion at ankle joint with soleus



Deep muscles of the back of leg

Soleus

Flexor digitorum longus (FDL)

Flexor hallucis longus (FHL)

Popliteus – helps to unlock the knee joint

Tibialis posterior

Help in flexion of the ankle joint. FDL and FHL flexes the toes and hallux

Supplied by tibial nerve

Muscles of anterior and lateral compartments

Anterior –

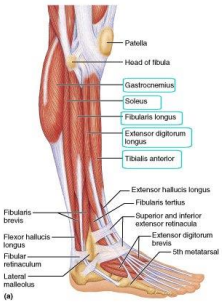
Tibialis anterior, extensor hallucis longus, extensor digitorum longus, peroneus tertius.

They are dorsiflexors of ankle joint. Supplied by deep peroneal nerve

Lateral –

Peroneus longus and Peroneus brevis

They are everters of ankle joint and supplied by superficial peroneal nerve



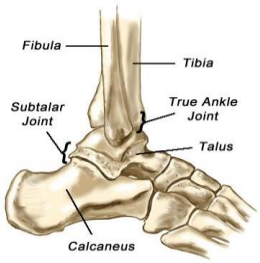
Ankle Joint

Joint between tibia, fibula and talus.

Joint between talus and calcaneous is called subtalar joint.

It is a synovial joint of hinge variety.

Bony socket, capsule, ligaments and muscles surrounding the joint provides stability.



Movements

Plantar flexion

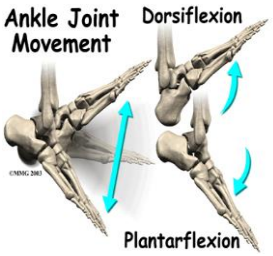
and

Dorsi flexion occurs in the tibio talo joints.

Inversion

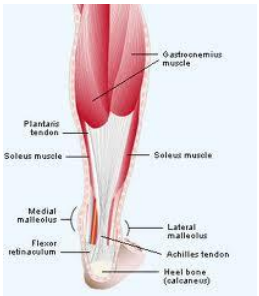
and

Eversion occurs in the subtalar joints.



Muscles acting on the ankle joint

Posterior leg muscles causes plantar flexion. Especially by tendo Achilles. Plantar flexion is more than dorsi flexion because the talus is broader anteriorly.



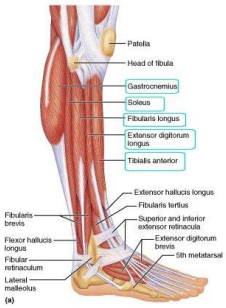
Muscles acting on the ankle

Dorsi flexion is caused by Tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneus tertius.

These are supplied by deep peroneal nerve. If paralysed causes a foot drop.

Peroneus longus and brevis causes eversion of the foot.

Supplied by superficial peroneal nerve



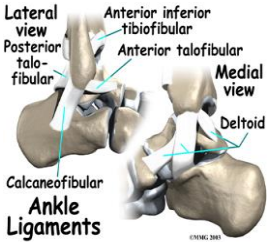
Ligaments of the ankle

Deltoid ligament-

Strong ligament on medial side of ankle. Slips extend from tibia to talus and calcaneal and navicular bones.

Talo fibular ligaments-

Anterior talo fibular, posterior talo fibular and calcaneo fibular ligaments are the parts. Anterior talo fibular is the commonly injured ligament and injuries occur usually during inversion type of injury.



Movements and injuries

Eversion can cause medial ligament injuries.

Inversion can cause lateral ligament injuries.

Rotatory movements can cause high ankle injury.

Arterial supply

Femoral artery and its branches to thigh.

Anterior tibial – anterior leg and dorsum of foot. Anterior tibial continues into the dorsum of the foot as dorsalis pedis artery.

Peroneal (fibular) – is a branch of posterior tibial artery. It supplies the lateral compartment.

Posterior tibial supplies the posterior compartment and the sole of the foot.

Arteries of foot

Anterior tibial becomes dorsalis pedis artery.

Posterior tibial gives rise to medial and lateral plantar arteries

Nerves of lower limb

Femoral nerve and branches

Supply the anterior and lateral thigh

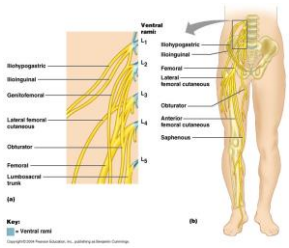
Sciatic nerve – posterior thigh muscles

Obturator – medial thigh

Tibial nerve – branch of sciatic nerve. Supply posterior leg muscles and muscles of sole of foot

Superficial peroneal – supplies muscles of lateral compartment of leg and sensory supply to leg and foot.

Deep peroneal – supplies dorsiflexors of foot and sensory to 1st cleft of foot



Sensory supply

Obturator

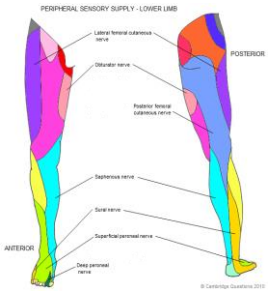
Femoral and its branches

Posterior cutaneous nerve of thigh

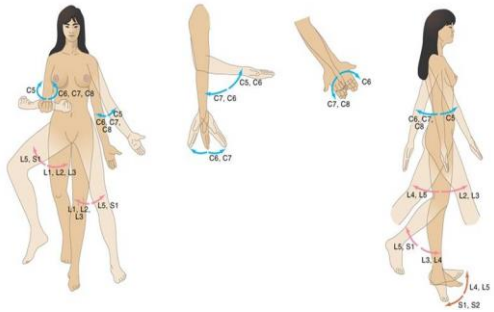
Saphenous nerve

Sural nerve

Superficial and deep peroneal nerve.



Myotomes of Upper and lower limbs



Venous system of lower limbs

The veins of the lower extremities can be divided into

Deep veins (surrounded by muscular tissue)

The superficial veins include the greater and lesser saphenous veins, along with their major tributaries.

Perforator veins penetrate the fascia that surrounds the muscle bundles and divert blood from the superficial to the deep venous system

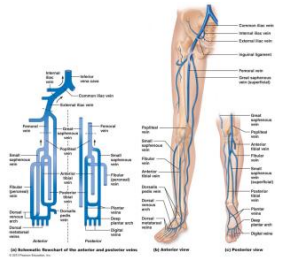
These veins are thin walled and low pressure vessels. Has valves.

Factors that facilitate flow towards the thorax

Low central pressures in the chest cavity.

Active propulsion of blood by muscular contraction in the calves and thighs during ambulation.

Valves that prevent the backward flow of blood.



Deep venous system

The deep veins include the

Anterior tibial

Posterior tibial

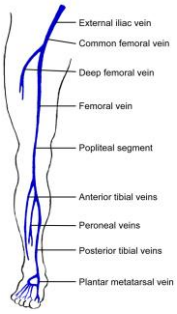
Peroneal

Gastrocnemius

(veins in the calf)

Popliteal veins behind the knee, Femoral veins in the thigh.

Deep veins are ultimately responsible for most of the venous drainage from the lower extremities.



Superficial venous system

Two main veins.

Greater saphenous vein –

Starts from dorsal venous arch and ascends along the medial side of the calf and thigh and ultimately drains into the femoral vein at the groin, through the sapheno femoral junction.

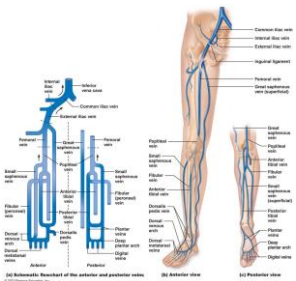
Major tributaries (branches) include the dorsal venous arch in the foot, posterior arch vein in the leg, posteromedial vein and anterolateral vein in the thigh, inferior epigastric vein, external pudendal and circumflex iliac veins in the groin.

Useful for venous cut down.

Tourniquet might trap the saphenous nerve

Short (lesser) vein –

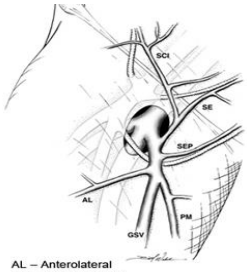
Starts from dorsal venous arch and ascends on the postero lateral aspect of the calf and drains into the popliteal venous system behind the knee, through the saphenopoplitеal junction. Sometimes the lesser saphenous vein drains into other venous channels.



Tributaries at sapheno femoral opening

- Superficial external pudendal
- Superficial epigastric
- Superficial circumflex iliac
- Antero lateral
- Postero medial

These may need to be ligated during surgery for varicose veins.



AL – Anterolateral
PM – Posteromedial
SEP – Superficial external pudendal
SE – Superficial epigastric
SCI – Superficial circumflex iliac

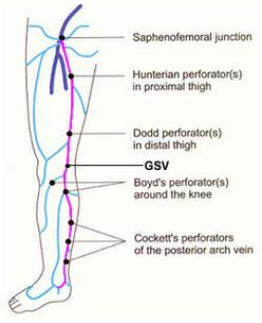
Perforating venous system

There are a number of perforating veins that communicate between the superficial and deep venous systems.

These perforating veins are quite variable in their location and prevalence.

The function of perforating veins is to direct blood flow from the superficial venous system to the deep venous system. When incompetent can give rise to the development of varicose veins.

Classically defined perforating veins include the Hunterian and Dodd perforators in the thigh, the Boyd and Cockett perforators in the calf, and a number of perforators in the foot.



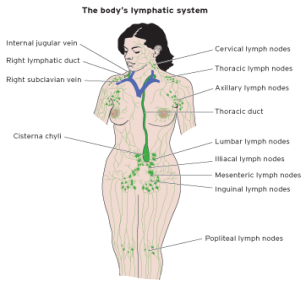
Varicose veins and ulcers

Lymphatic drainage

Lymphatics of lower limb drain into

Popliteal and inguinal lymph nodes.

Inguinal lymph nodes are arranged into superficial and deep lymph nodes. These lymph nodes are arranged into vertical and horizontal groups.



Lymph Oedema

Filarial infections

Malignancy

Treatment for malignancy

<u>Bones of ankle and foot-</u>

Talus

Calcaneus

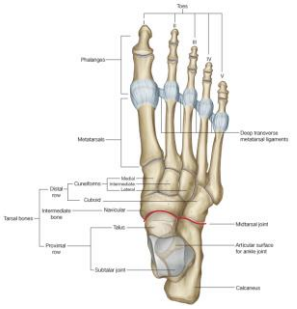
Naviculum

Cuboid

Medial, intermediate and lateral cuneiforms

5 metatarsals

Phalanges – 2 for 1st Toe and other 4 toes have 3 phalanges each.



Plantar aponeurosis

Formed by deep fascia.

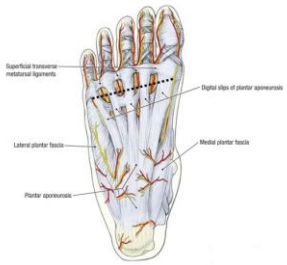
Apex lies proximally and base lies distally. Base divides into five slips.

Its connected with the skin and flexor sheaths of toes

Supports the arches (like a tie beam), protects soft tissues.

Sends medial and lateral vertical intermuscular septa.

Thin transverse septa arises from vertical septa to divide foot into compartments.



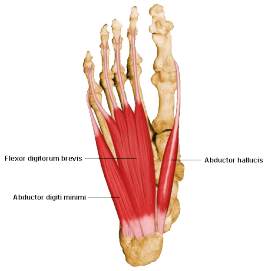
Muscles of 1st layer

1.Abductor hallucis

2.Flexor digitorum brevis

(supplied by medial plantar)

3.Abductor digiti minimi is supplied by lateral plantar nerve



Muscles of 2nd layer

1.Flexor digitorum longus

2.Flexor hallucis longus

Intrinsic muscles

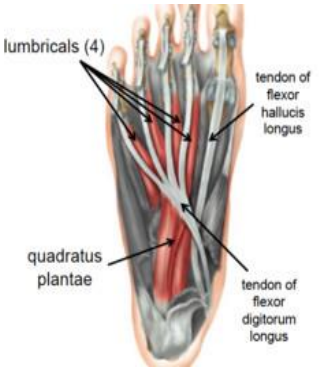
3. lumbricals

4. Quadratus plantae

1st lumbrical by medial plantar nerve and other 3 lumbricals and quadratus plantae by lateral plantar nerve

Lumbrical causes flexion at metacarpo phalangeal joints and extension at interphalangeal joints.

Quadratus plantae straightens the pull of long flexor tendons



Muscles of 3rd layer

1.Adductor hallucis

2.Flexor digiti minimi brevis

(supplied by lateral plantar nerve)

3.Flexor hallucis brevis

Supplied by medial plantar nerve

Muscles of 4th layer

3 plantar interossei

4 dorsal interossei

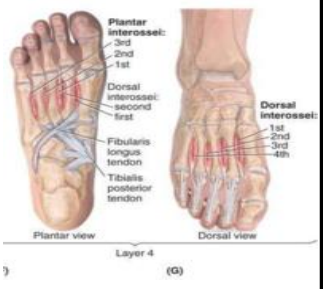
Tendons of tibialis posterior

Tendon of peroneus longus

(Interossei are supplied by lateral plantar nerve)

Palmar causes adduction and dorsal causes abduction

In addition causes flexion at metacarpo phalangeal joints and extension at the inter phalangeal joints.



Ligaments of the foot-

Supports arches like tie beams.

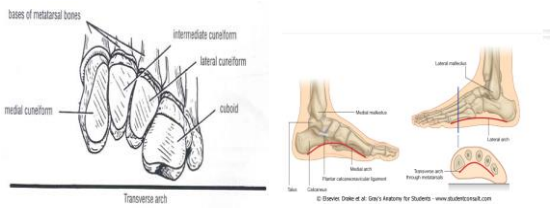
1.Long plantar

2.Short plantar

3.Calcaneo navicular ligament

4.Calcaneo cuboid ligament

Two transverse and longitudinal arches



Functions of the arches-

Protects soft tissues in the sole

Helps to walk on uneven surfaces

Increases the efficacy of actions of tendons of foot during walking and running

Supports of the arches of the foot

1.Tie beam like supports

a)Plantar aponeurosis

b).Ligaments

c).Short muscles of the foot

2.Tie rods like support

Muscles of the leg that reaches the foot such as tibialis posterior, flexor digitorum longus, peroneus longus.

3. Shape of the bones

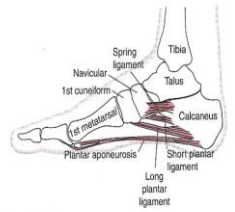
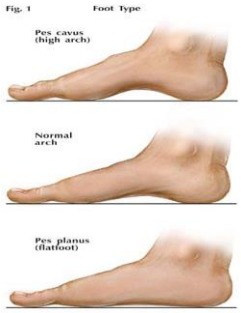


Figure 19-18. Support structures of the right foot, medial view.

Arch abnormalities



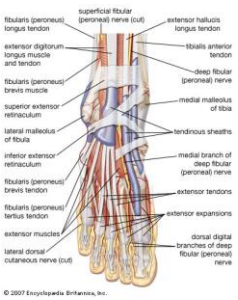
Clinical problems due to arches

Arch pain

Sesamoiditis

Tendons of the dorsum of the foot

1. Tibialis anterior
2. Extensor hallucis longus
3. Extensor digitorum
4. Peroneus tertius



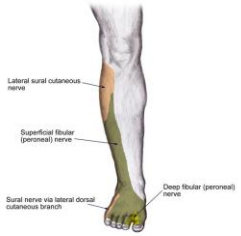
Nerves of the leg and dorsum of the foot

1.Superficial peroneal nerve

2.Deep peroneal nerve

3.Sural nerve

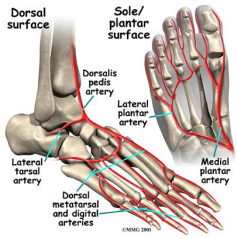
4.Saphenous nerve



Arterial supply to the foot

Anterior tibial artery becomes the dorsalis pedis artery.

Dorsalis pedis artery gives the arcuate artery and 1st dorsal metatarsal artery. They give rise to metatarsal, digital and perforating arteries.

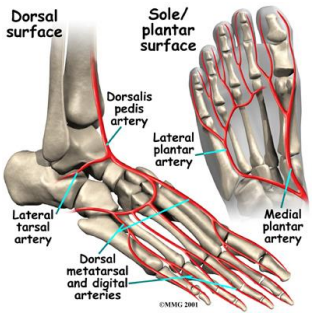


Arterial

Sole of the foot is supplied by posterior tibial artery.

It divides into medial and lateral plantar arteries.

They give rise to metatarsal and digital arteries.



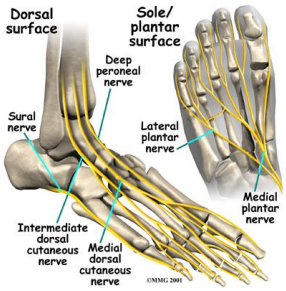
Nerves of the sole of the foot

Tibial nerve divides into medial and lateral plantar nerves.

Medial plantar is the larger branch.

However lateral plantar supplies more intrinsic muscles of the foot.

Both supplies the skin of the sole.



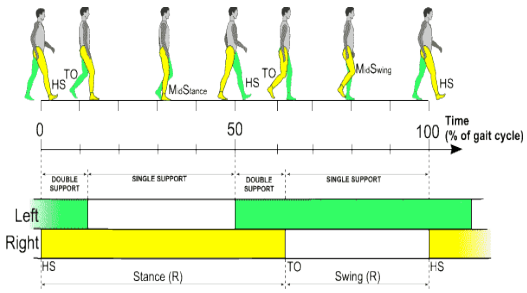
Types of Tibial fractures

Fractures of malleoli (medial and lateral) and Talus

Lower limb stress fractures

Metatarsal and Phalangeal fractures

Gait cycle



Lower limb length measurements

<u>True length</u> –

It is measured from anterior superior iliac spine to the medial malleolus.

<u>Apparent length –</u>

It is measured from umbilicus to the medial malleolus