

# Anatomy of the lower limb

## Superficial veins & nerve injuries

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## VENOUS DRAINAGE OF THE LOWER LIMB

The venous drainage of the lower limb is of huge clinical & surgical importance. Since the venous blood of the lower limb is drained against gravity, however, there are number of factors that help the drainage:

- 1- The contraction of the calf muscles (particularly soleus)
- 2- One-way valves that in many veins prevent blood reflux into superficial veins
- 3- Transmitted pulsation from adjacent arteries
- 4- Negative pressure in the thoracic cavity during inspiration
- 5- During recumbent position the blood, return back to the heart via gravity.

The veins of the lower limb is classified anatomically & functionally into 3 types:

- 1- Superficial veins
- 2- Perforating veins
- 3- Deep veins

### The superficial veins

They consist of great (long) & small (short) saphenous veins

#### Great saphenous vein

The great saphenous vein lies in the superficial fascia and is easily seen (Greek saphenous \_easily seen). The great saphenous vein is the longest vein of the body. It is formed on the dorsum of the foot by the union of the medial end of the dorsal venous arch & medial dorsal digital vein of the big toe. It runs superiorly 2.5 cm anterior to the medial malleolus accompanied by saphenous nerve (a branch of femoral nerve), crosses obliquely the medial surface of the lower third of tibia, and then ascends a little behind the medial border of tibia to reach the knee, where lies the posteromedial aspect of the knee joint, about one hand-breadth posterior to the patella, from this point it runs upwards along the medial side of the thigh to reach saphenous opening after piercing the cribriform fascia & femoral sheath drains into the femoral vein.

Tributaries:

- 1- In the leg: posterior arch vein; it is large & constant, collects blood from the posteromedial aspect of the calf & begins of a small venous arches connecting 3 medial ankle perforating veins
- 2- Communicating vein with small saphenous vein
- 3- In the thigh: **anterolateral vein**, it begins in the lower part of the thigh, crosses the anterior aspect of thigh & joins the great saphenous vein in the upper thigh.

**Posterolateral vein**, it begins from the posteromedial aspects of the thigh & joins the great saphenous vein.

- 4- Before piercing the cribriform fascia"
  - A- Superficial epigastric vein
  - B- Superficial circumflex iliac vein
  - C- Superficial external pudendal vein

## Valves in the great saphenous vein

There are 10-20 valves in the great saphenous vein, out of which there are 2 important valves:

- a) One lies just before it pierces the cribriform fascia
- b) The other, lies at the saphenofemoral junction, which withstands the pressure of blood column transmitted from external iliac vein. In about 80% of individuals, the external iliac vein has a valve that protects the saphenofemoral valve against high venous pressure. In remaining 20% cases who lack this valve become at risk of saphenofemoral valve failure & development of varicose veins.

### **Clinical correlation:**

**Great saphenous vein venesection:** *The great saphenous vein at ankle in front of medial malleolus is the most preferred site of venesection (cut-down) in emergency when the superficial veins elsewhere are collapsed and invisible, to insert the cannula for prolonged administration of intravenous fluids.*

**Great saphenous vein graft:** *In coronary by-pass operation to relieve the ischemia of the heart, a segment of great saphenous vein is removed and used for aortocoronary grafting to by-pass an arterial obstruction. Due to the presence of valves, the vein has to be reversed so that its valves do not obstruct the blood flow.*

## Small saphenous vein

It is formed inferior & posterior to the lateral malleolus as a continuation of the lateral end of the dorsal venous arch. It runs upward posterior to the lateral malleolus along the lateral edge of tendocalcaneus, accompanied by sural nerve on its lateral aspect. Then it runs in the middle of the back of the leg until it pierces the roof of the popliteal fossa where it drains into the popliteal vein, it is accompanied with the posterior cutaneous nerve of the thigh in its upper part near the popliteal fossa.

## Perforating veins

They are connecting between superficial & deep veins. They are called so (perforators) because they perforate the deep fascia. The perforators are classified into:

- 1- Direct perforators: they connect the superficial veins with the deep veins directly.
- 2- Indirect perforators: they connect the superficial veins with the deep vein through muscular venous sinuses, especially those of soleus muscle (**soleal sinuses**), which being filled with blood when the muscle is relaxed & with contraction it helps squeeze the blood out of calf muscles into deep veins & drain the blood distally (**second heart or calf pump**).

Locations of perforators

There are 4 fairly constant locations for perforators

- 1- An adductor canal perforator: it connects the great saphenous vein with the femoral vein in the lower part of adductor canal.
- 2- A knee perforator: it connects the great saphenous veins the posterior tibial venae comitantes below the knee.
- 3- Lateral ankle perforator: communicates the small saphenous vein with the peroneal venae comitantes
- 4- Three medial ankle perforators: (upper, middle & lower medial ankle perforators) they connect the great saphenous vein with the posterior tibial venae comitantes.

### **Clinical correlation**

**Deep venous thrombosis DVT:** *The perforating veins from the muscles draining into the deep veins have valves except those in the soleus, which are arranged in the form of venous sinuses. The blood flow is sluggish in the soleal sinuses particularly when the muscles are put to rest. Prolonged rest such as in long-distance flights or in*

bed by some patients after surgery is unwise because it may develop deep vein thrombosis, which may develop a life-threatening complication of the pulmonary embolism.

**Varicose veins:** they are dilated tortuous superficial veins filled with blood (might be thrombosed). This is commonly occurs following prolonged standing; due to incompetency of valves either in the perforating valves or that of saphenofemoral junction.

## **NERVE INJURIES**

### ***Injury of the femoral nerve***

It is rare but may be injured by a stab, gunshot wounds, or a pelvic fracture. The following are the characteristic clinical features:

#### **(a) Motor loss**

- The weak flexion of the thigh is due to paralysis of the iliacus and sartorius muscles.
- The inability to extend the knee is due to paralysis of the quadriceps femoris.

#### **(b) Sensory loss**

- The sensory loss over the anterior and medial aspects of the thigh is due to involvement of the intermediate and medial cutaneous nerves of the thigh.
- The sensory loss on the medial side of the leg and foot up to the ball of the great toe (first metatarsophalangeal joint) is due to involvement of the saphenous nerve.

### ***Injury of the obturator nerve***

The obturator nerve may be injured in the anterior dislocation of the hip joint, or during pelvic surgery.

The following are the characteristic clinical features:

- 1. Motor loss:** The loss of adduction of the thigh is due to paralysis of adductor muscles of the thigh except hamstring part of adductor magnus.
- 2. Sensory loss:** The sensory loss on the medial aspect of thigh is due to involvement of the cutaneous branch of the anterior division of the obturator nerve. Pain may be referred to the hip and/or knee joints.

### ***Injury of the sciatic nerve***

The sciatic nerve may be injured by misplaced therapeutic injection in the gluteal region (most common cause), penetrating wounds, posterior dislocation of the hip, fracture of the pelvis or total hip replacement surgery (1%). The following are the characteristic clinical features:

#### **1. Motor loss**

- (a) The inability to extend the thigh and flex the knee, due to paralysis of the hamstring muscles.
- (b) The loss of all movements below the knee with foot drop, due to paralysis of all the muscles of the leg and foot. The motor loss leads to flail foot and make severe difficulty in walking. The patient walks with high stepping gait.

**2. Sensory loss:** The sensory loss on the back of the thigh and whole of the leg and foot except the area innervated by the saphenous nerve, due to involvement of the cutaneous nerves derived from the tibial and common peroneal nerves.

**Sciatic nerve neuropathy:** As the sciatic nerve leaves the pelvis, sometimes, it passes through the piriformis muscle and at that point, it may become entrapped leading to **piriformis syndrome**. It is common anatomical variant but an extremely rare entrapment neuropathy.

***Sciatica:*** It is a clinical term applied to a clinical condition characterized by shooting pain felt along the course of distribution of the sciatic nerve (e.g., buttock, posterior aspect of thigh, lateral aspect of leg, and dorsum of the foot). It occurs due to compression and irritation of L4–S3 spinal nerve roots by herniated intervertebral disc of the lumbar vertebrae.

### ***Injury of the tibial nerve***

The tibial nerve may be injured by a lacerated wound in the popliteal fossa or posterior dislocation of the knee joint. The characteristic clinical features are as follows:

#### **1. Motor loss:**

- a) The foot is held dorsiflexed and everted, due to paralysis of the muscles of posterior compartment of the leg.
- b) The loss of prominence of calf and tendocalcaneus, due to paralysis of the triceps surae muscle (gastrocnemius and soleus).
- c) The loss of plantar flexion of foot, due to paralysis of the flexors of ankle.
- d) The inability to stand on the toes, due to loss of plantar flexion of foot.

#### **2. Sensory loss:**

The loss of sensation in the sole and plantar aspects of the toes including the dorsal aspects of their distal phalanges, due to involvement of the cutaneous branches.

***Tarsal tunnel syndrome:*** It occurs due to compression of the tibial nerve in the osseofibrous tunnel under the flexor retinaculum of the ankle. It clinically presents as pain and paresthesia in the sole of the foot, which often becomes worse at night.

### ***Injury of the common peroneal nerve***

The common peroneal nerve is extremely vulnerable to injury as it winds around the posterolateral aspect of the neck of the fibula. At this site it is injured or may be injured by the direct trauma, fracture neck of fibula, or lightly applied plaster cast. The characteristic clinical features are as follows

#### **1. Motor loss**

- (a) The **foot drop** is due to the paralysis of muscles of the anterior compartment of the leg (dorsiflexors of the foot).
- (b) The loss of extension of toes is due to the paralysis of extensor digitorum longus and extensor hallucis longus.
- (c) The loss of eversion is due to the paralysis of peroneus longus and peroneus brevis (evertors Of the foot).

**2. Sensory loss:** The sensory loss on the anterolateral aspect of the leg, due to involvement of the cutaneous branches, whole of dorsum foot except the area supplied by the saphenous nerve.

### **Lower limb dermatomes**

Dermatome is a single strip of skin that is supplied by a single spinal nerve with least overlap from other nerves. Regions that can be tested for sensation & are reasonably autonomous (have minimal overlap) are:

- Over the inguinal ligament **L1**
- Lateral side of the thigh **L2**
- Lower medial side of the thigh **L3**
- Medial side of the great toe **L4**
- Medial side of the second toe **L5**
- Little toe **S1**
- Back of the thigh **S2**

- Skin over the gluteal fold **S3**

The dermatomes of S4 & S5 are tested in the perineum.

### Lower limb myotomes

- Hip flexion **L1, L2**
- Knee extension **L3, L4**
- Knee flexion **L5, S2**
- Ankle planter flexion **S1, S2**
- Toes adduction **S2, S3**

<b>PULSES OF THE LOWER LIMB</b>	
<b>Pule</b>	<b>Anatomical location</b>
Femoral pulse	Midinguinal point: midway between the symphysis pubis & the anterior superior iliac spine
Popliteal pulse	Deep in the popliteal fossa
Dorsalis pedis pulse	Between the first & second metatarsals just lateral to the tendon of extensor hallucis longus
Posterior tibial pulse	Midway between the medial malleolus & heel bone (calcaneal tuberosity)