# Anatomy for the Phlebologist

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Superficial and deep venous systems of lower limbs

The return of the blood to the heart is the primary function of the venous system. This is achieved via a pumping mechanism which relies on a unidirectional valvular system. Valve-containing vessels pass from the deep dermis into the superficial layer of the fat. These vessels range from 70 to 120 microns in diameter. Post-capillary venules join these larger vessels from all directions. Valves are found at most places where the small vessels join the larger ones, but valves are also present within the large vessels not associated with tributaries. Venous valves have two cusps with associated sinuses. The free edges of the valves are always directed away from the smaller vessel and toward the larger ones. In other words, valves utilized in the venous system are 'one-way' valves. In normal state, they let the blood get through but not back.

Healthy venous valves   Varicose veins
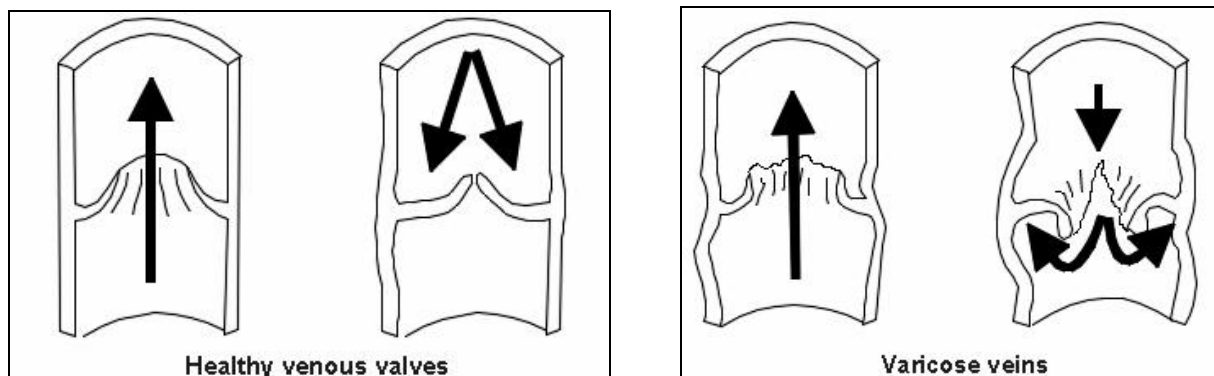
The peripheral venous system is divided into superficial and deep compartments. The superficial and deep venous systems communicate via the 'perforating' veins. The perforating veins also contain valves which in normal physiological state allow flow from the superficial to deep system. Thus, the orientation of the valves allows a unidirectional flow of blood from small tributaries into the main trunks, from the superficial venous system into the deep venous system and from the peripheral venous system into the central venous system. Backflow from deep to the superficial veins and backflow from proximal to distal segments of any given truncal vein is prevented by the orientation of these 'one-way' valves. The deep and superficial veins of the lower limb occupy two distinct compartments separated by the deep fascia. The deep compartment functions as the 'ventricle' of the calf pump. The deep veins can be divided into two groups: inter-muscular and intra-muscular veins. The soleal sinuses and gastrocnemius veins lie within the muscles. The posterior tibial, anterior tibial and peroneal veins lie between the muscles. All the deep veins of the calf join to form the popliteal vein which is the calf pump outflow tract. This outflow tract continues through the thigh pump in the subsartorial canal that protects it from compressive forces generated by the thigh. This outflow tract continues through the abdomen and the thorax where it is subject to intermittent positive and negative pressures associated with respiration.

Basic Venous Physiology

The calf muscle pump generates systolic pressures of 200-300 mmHg. The foot pump also plays an important role in venous return in that it contains a pump powerful enough to propagate a column of blood to the right atrium. It also coordinates the actions of the venous pump of the calf. The large gastrocnemius and soleal veins form the main chamber of the pump but all other deep veins play a role. Similar to flow of blood from the left atrium to the left ventricle during diastole, blood flows from the superficial to deep venous system when the calf muscle pump relaxes via a pressure gradient of 100-110 mmHg. This flow occurs through the perforating veins. It is therefore normal to have a low pressure in the superficial system during exercise and when supine. Superficial vein pressure only rises when standing still and when the calf pump fails. Venous hypertension during exercise is the ultimate cause of almost all venous pathology.

The main physiological functions of the venous system include: (1) Thermoregulation (2) Storage of blood –70% of blood volume is contained within the venous system at any time and (3) Regulation of cardiac output. The primary function of the superficial venous system is thermoregulation. Blood vessels in human skin are under dual vasomotor control, involving separate nervous signals for vasocontriction and for vasodilatation. In the superficial venous system, vasoconstrictor fibres are the predominant vasomotor innervation. Removal of this vasoconstrictor signal allows vasodilatation which is important in dissipation of heat. Response to cold is also influenced by the superficial venous system. Constriction of arterioles and the superficial veins allows heat conservation by diverting venous blood through the perforators into the deep veins, which lie closer to arteries. In the deep veins, the cool venous blood returning to the core can take up heat from the warm blood in the adjacent deep limb arteries. Thus, some of the heat contained in the arterial blood as it enters the limbs takes a 'short circuit' back to the core, and when the arterial blood reaches the skin, it is already cooler than the core. Superficial veins also act as alternative output channels for the foot pump and are called into use when the deep veins are obstructed by muscular contraction, thrombosis or injury.

Valvular failure leads to reversal of flow in the vessel. Turbulent flow below a leaking valve causes a saccule to develop. Best known example is the formation of a saphena varix below the terminal valve of the long saphenous vein. Venous incompetence and calf pump failure lead to venous stasis and venous hypertension. Incompetent veins deal with the consequent hypertension by progressive enlargement and hypertrophy. This leads to the tortuous appearance of 'varicose' veins. Blood in incompetent reticular veins can flow back into post-capillary venules causing the appearance of 'telangiectasias'.

Skin changes of chronic venous disease- haemosiderin pigmentation, lipodermatosclerosis, atrophie blanche, stasis dermatitis, ulceration- are secondary to the phenomenon of venous hypertension. A thorough understanding of these pathological processes is fundamental in planning appropriate management for these patients. This is especially important in management of chronic venous insufficiency as any attempt at the treatment of venous stasis and ulceration must first address the issue of the underlying venous hypertension.

The Superficial Venous System

The superficial venous system can be divided into three interconnecting medial, posterior and lateral systems. The **great saphenous vein (GSV)** and its tributaries form the medial system, the **small saphenous vein (SSV)** and its tributaries form the posterior system and **the lateral thigh and the lateral calf vein** and their tributaries form the lateral system. The proximal GSV and the proximal 2/3 of SSV is under the superficial fascia and hence 'invisible'. The word 'saphenous' itself is derived from the word 'saphena' meaning invisible and was first coined by the Persian Physician, Mathematician and Philosopher, **Avicenna** (Ibn Sina), in the 10th century AD.

The GSV and SSV normally receive blood only from the foot and the low pressure dermal and subcutaneous plexi. They drain directly into the outflow tract via the saphenofemoral (SFJ) and saphenopopliteal junctions (SPJ) respectively. They also have numerous other communications with the deep compartment via the perforating veins.

Avicenna (980-1037)
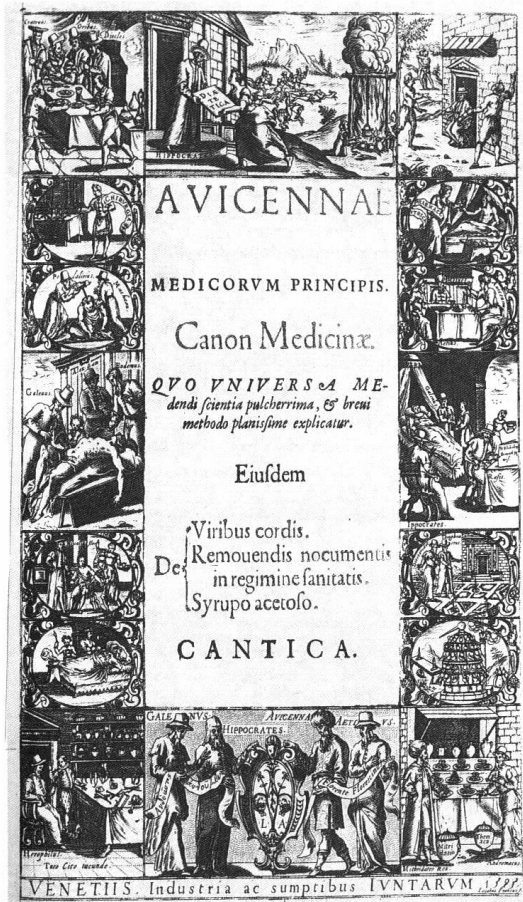
Frontispice de la version latine du Canon de la Médecine, imprimée à Venise en 1544

Anatomy of the great saphenous vein (GSV)

The GSV originates in the medial foot and passes upward anterior to the medial malleolus, then crosses the medial tibia in a posterior direction to ascend in the medial line across the knee. Above the knee it continues anteromedially above the deep fascia to the thigh, where it passes through the foramen ovale and joins the common femoral vein at the groin crease. Large tributaries of the GSV are easily mistaken for the main trunk. Most patients have at least two major tributaries below the knee (the anterior superficial tibial vein and the posterior arch vein) and at least two above the knee (the anterolateral vein of the thigh and the posteromedial vein of the thigh). Up to 20% of patients have a duplicated main GSV trunk in the thigh. The GSV terminates at the SFJ. The SFJ is at the level of the groin crease and is covered by the superficial fascia. That ends proximally at the inguinal ligament. The term 'confluence of the superficial inguinal veins', also known as the 'crosse', corresponds to the veins of the SFJ. The GSV has a constant terminal valve 1-2 mm distal to the SFJ. A pre-terminal valve is located 2 cm distal to the terminal valve. The most important tributaries join the GSV between the two valves.
Proximal tributaries of GSV drain venous blood from the abdominal wall and pudendal areas and from lateral to medial. The flow in superficial abdominal veins (superficial epigastric vein and superficial circumflex iliac vein) is bidirectional and a 'downward flow' from theses veins into the SFJ is also normal.

There are many intercommunications between the three superficial systems. The GSV and SSV communicate via a number of 'inter-saphenous' veins the most prominent of which is the vein of Giacomini. The normal direction of blood flow is from the small saphenous system to the GSV via these intersaphenous veins.

The GSV communicates with the lateral system as well. The anterior thigh circumflex vein (anterolateral vein of the thigh, ALVT) joins the lateral thigh vein with the GSV at or near the SFJ. The normal flow would be from the lateral thigh vein to the GSV via the ALVT. Please note that the normal direction of flow in the lateral thigh vein is from proximal thigh to the lateral knee perforator and into the deep system. In other words, a 'downward' flow in that vein is physiological and normal.

The named tributaries of the GSV in proximal thigh are the anterior accessory great saphenous vein of the thigh (AAGSV), previously called the pre-saphenous arch vein and the posterior accessory great saphenous vein of the thigh (PAGSV), previously called the post-saphenous arch vein. The AAGSV runs parallel to the GSV in the thigh but located anteriorly within a fascial compartment in the thigh in its own fascial compartment. In most cases, there is a constant lymph node in the angle between the GSV and AAGSV before they merge. The venous network of the lymph node that surrounds the AAGSV may be large and incompetent and form a source for reflux. The PAGSV ascends parallel to GSV but located posteriorly within a fascial compartment but is not as often present as AAGSV and its connection to GSV is not constant.

The posterior thigh circumflex vein (posteromedial vein of the thigh), is a tributary of GSV or PAGSV which ascends obliquely in the posterior thigh. It may originate in the SSV, its thigh extension, or the lateral venous system.

The named tributaries of the GSV below the knee are the posterior arch vein (PAV) (new terminology: posterior accessory great saphenous vein of the leg) and the superficial anterior tibial vein (SATV) (new terminology: anterior accessory saphenous vein of the leg). The PAV is important as it contains the important Cockett perforators which communicate between this vein and the posterior tibial veins. The Gastrocnemius perforators are also important as quite often they are incompetent and contribute to lower leg varicosities. These perforators communicate between the PAV or intersaphenous veins and the gastrocnemius veins.

The valves in the GSV vary from ten to twenty in number; they are more numerous in the leg than in the thigh.
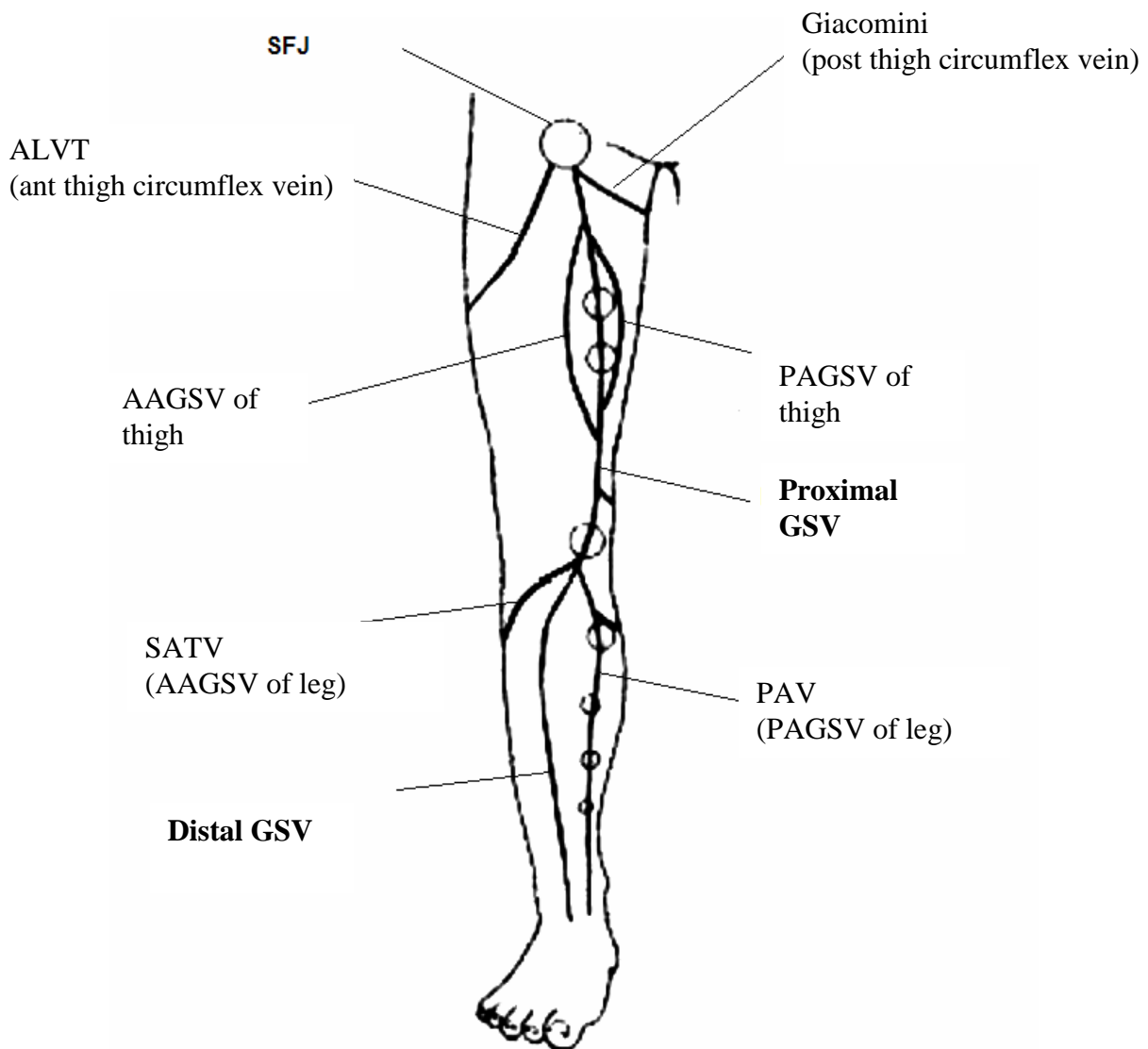
Anatomy of the small saphenous vein (SSV)

The SSV originates in the lateral foot as a continuation of the lateral marginal foot vein. It passes posteriorly lateral to the Achilles tendon in the lower calf. The SSV usually lies directly above the deep fascia in the midline as it reaches the upper calf. It travels in an inter-fascial compartment defined by the deep muscular fascia and the superficial fascia. The distal compartment appears on transverse ultrasound scan as an 'Egyptian eye'.

SSV enters the popliteal space between the two heads of the gastrocnemius muscles. In two thirds of cases, it joins the deep popliteal vein above the knee joint, and in one third of cases, it joins with other veins (most often the GSV or the deep muscular veins of the thigh). The saphenopopliteal junction (SPJ) most often lies 2-4 cm above the popliteal skin crease but its exact location is variable. Gastrocnemius veins may join the popliteal vein, upper SSV, or their confluence at the SPJ. The SSV may merge with the gastrocnemius vein before joining the popliteal vein in 10-30% of the limbs.
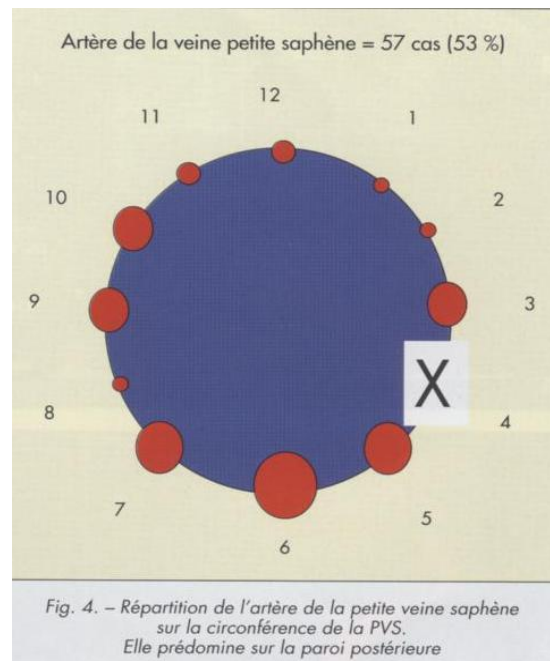
The SSV possesses from nine to twelve valves, one of which is always found near its termination in the popliteal vein. In the lower third of the leg the SSV is in close relation with the sural nerve, in the upper two-thirds with the medial sural cutaneous nerve.
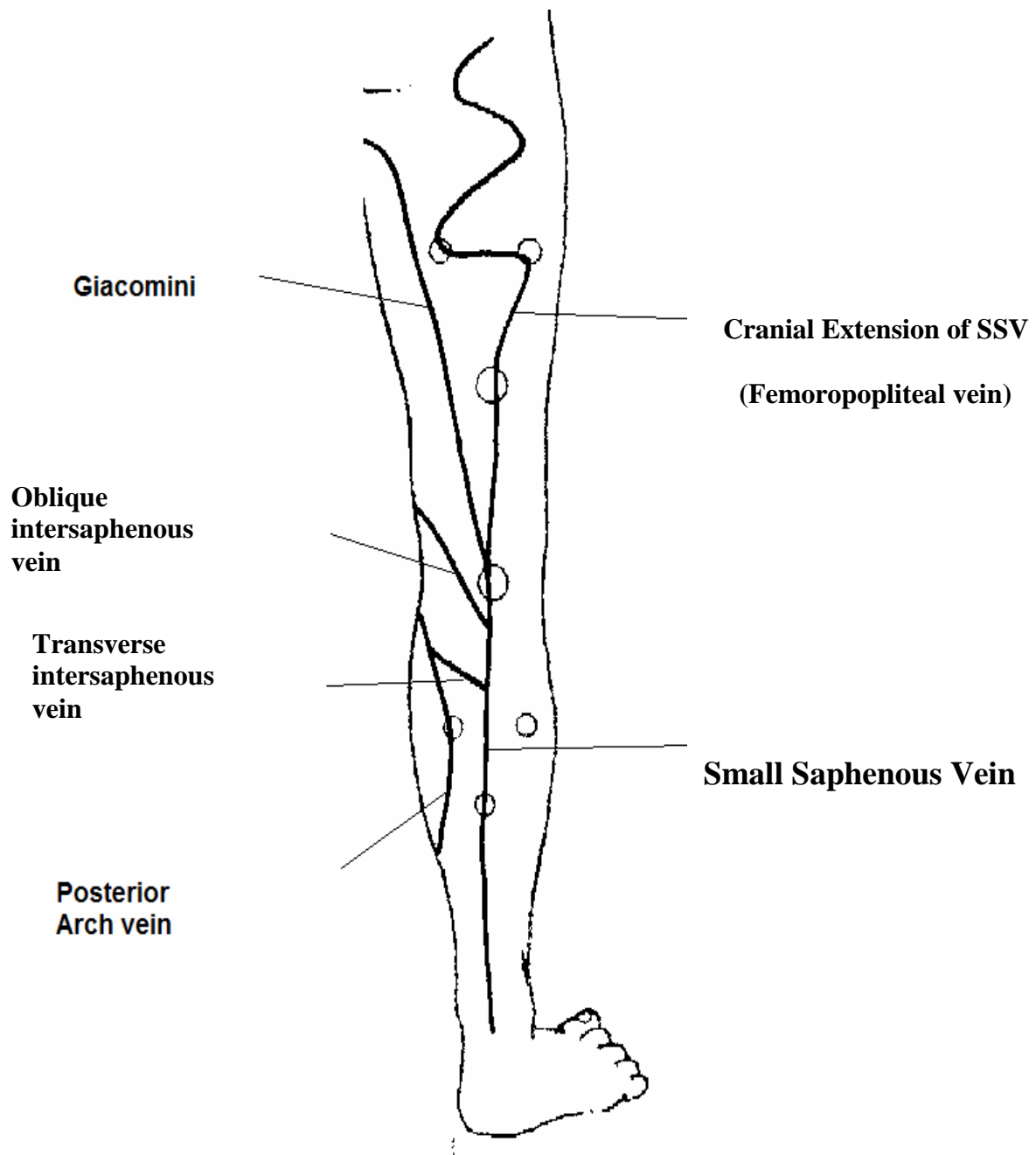
The **thigh extension of the SSV (TE)**, courses in groove between the biceps femoris and semimembranosus muscles and is present in 95% of the limbs. It has been called the 'femoropopliteal vein' or the 'cranial extension. The TE is recognized on ultrasound by its intra-fascial position into a triangle shaped compartment and is defined by the semitendinosus muscle medially, the long head of the biceps laterally and the superficial fascia that stretches over the intermuscular groove. This vein does not terminate in GSV and usually terminates in a perforator of the post thigh joining the profunda femoris, or continue straight up into the gluteal area as a single vein or divided into multiple veins, or divide into many muscular branches in the post thigh. If the TE joins the posterior thigh circumflex vein and join the GSV, it is termed **the vein of Giacomini**.

The **sciatic nerve vein** accompanies the sciatic nerve. Symptoms of 'sciatic' pain may be present when this vein is incompetent.

The **small saphenous artery** in its varied forms has been described by M. Schadeck (Schadeck, M. Sclerotherapy of Small Saphenous Vein: How to Avoid Bad Results. Phlebologie 2004, 57, No2, 165-169). This artery can easily be mistaken for a vein and injected during ultrasound guided sclerotherapy. The diagram below demonstrated the frequency of the location of this artery in relation to the SSV. Injection of this artery can lead to skin necrosis.

Relationship of Small Saphenous Artery to SSV

Artère de la veine petite saphène = 57 cas (53 %)

Fig. 4. – Répartition de l'artère de la petite veine saphène
sur la circonférence de la PVS.
Elle prédomine sur la paroi postérieure

Sydney Skin+Vein Clinic   - KR -   Superficial   4:43:23 PM

SSV ARTERY

Giacomini

Cranial Extension of SSV

(Femoropopliteal vein)

Oblique
intersaphenous
vein

Transverse
intersaphenous
vein

Small Saphenous Vein

Posterior
Arch vein

Perforating Veins

Many superficial collecting veins deliver their blood into the GSV and SSV, which deliver most of their blood into the deep system through the saphenofemoral junction (SFJ) and the saphenopopliteal junction (SPJ). However, the SPJ and SFJ are not the only pathways from the superficial system to the deep system. Both the superficial collecting web and the superficial truncal veins are also connected to a variable number of perforating veins that pass through anatomic defects in the deep fascia to join directly with the deep veins of the calf or thigh. Perforating veins usually contain venous valves that prevent reflux of blood from the deep veins into the superficial system. A few named perforating veins are fairly constant in location and are named only as vague groupings.

Every single perforator has an accompanying artery and care should be taken during UGS not to inject these arteries inadvertently.
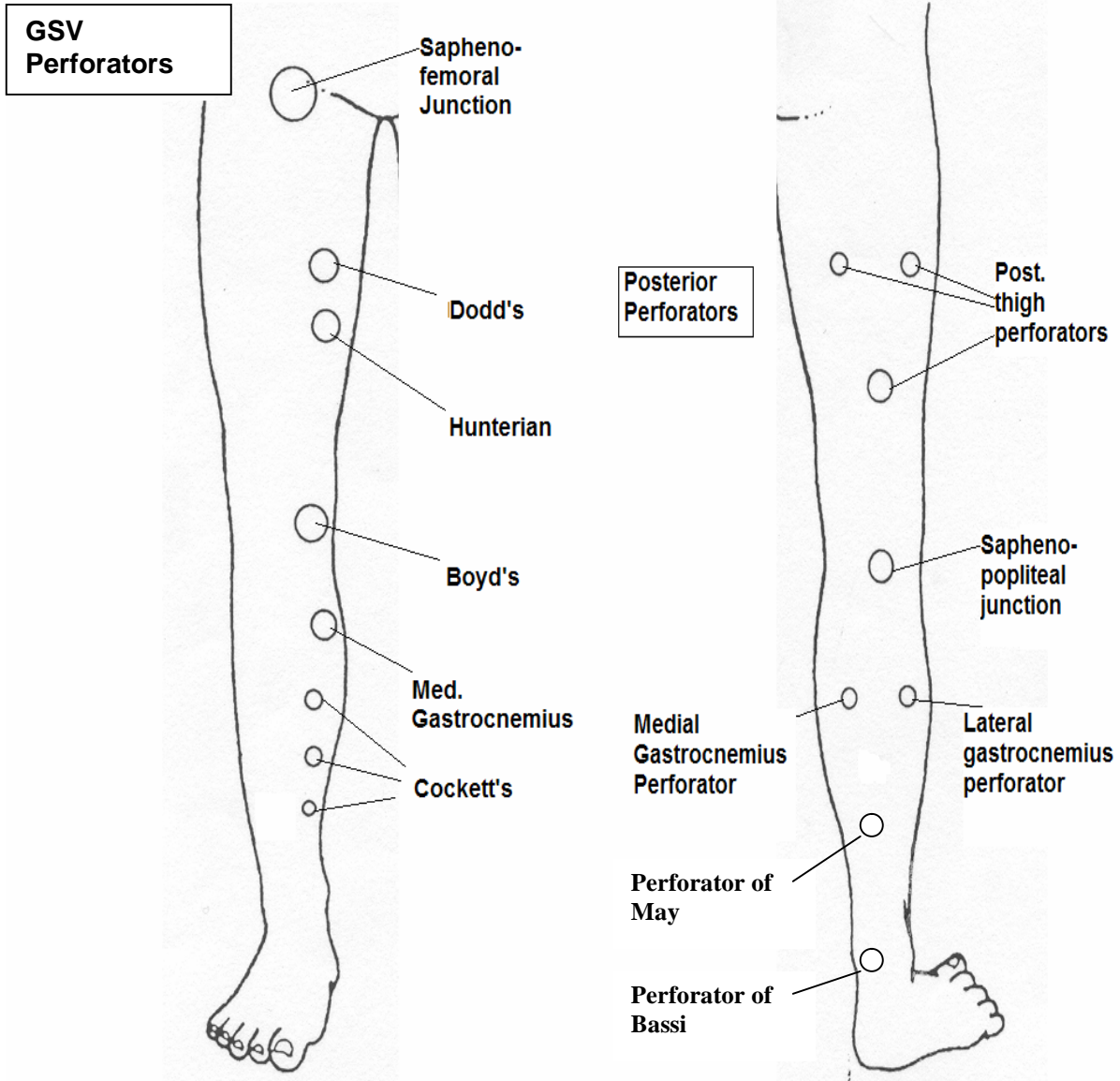
GSV System Perforators

- **Perforators of the femoral canal** (former Dodd perforators) connect the GSV to the FV. Hunterian perforators are located distal to Dodd and connect the GSV to the FV.
- **Para-tibial perforators** (formerly Sherman and Boyd) connect the main trunk of GSV or its tributaries to the PTV or calf muscle plexus. These perforators lie close to the medial surface of the tibia.
- **Posterior tibial perforators** (formerly Cockett's) connect the PAV to PTV. The three groups are the 'upper, middle, and lower.
- **Anterior leg perforators** pierce the ant. tibial compartment fascia to connect the ant GSV tributaries to the ATV.
- **Medial gastrocnemius perforator** connects the PAV to the medial gastrocnemius vein.

SSV System Perforators

- **Soleal (intergemellar) perforator** (former perforator of May) connects the SSV with the soleal veins.
- **Para-Achillean perforators** (former perforator of Bassi) connect the SSV with peroneal veins.
- **Perforator of the popliteal fossa** runs subcutaneously along the posterior aspect of the calf, sometimes parallel to the SSV and typically forms a junction with the popliteal vein lateral to the SPJ.
- **Posterior thigh perforators** include posteromedial thigh perforators that pierce the adductor muscles, sciatic perforators lying along the midline of the posterior thigh, posterolateral thigh perforators piercing the biceps femoris and semitendinosus muscles (former Hach perforators) and pudendal perforators.

Important Lower Limb Perforators

GSV Perforators

Sapheno-femoral Junction

Dodd's

Hunterian

Boyd's

Med. Gastrocnemius

Cockett's

Posterior Perforators

Post. thigh perforators

Sapheno-popliteal junction

Medial Gastrocnemius Perforator

Lateral gastrocnemius perforator

Perforator of May

Perforator of Bassi

Lateral System Perforators

Lateral calf perforators connect veins of the lateral venous plexus with the peroneal veins. **Lateral gastrocnemius perforator** connects the lateral calf vein to the peroneal veins.

Lateral thigh perforators pierce the muscles of the lateral thigh.

Other Perforators

Perforators of the knee are designated medial or lateral knee perforators, suprapatellar and infrapatellar perforators.

Perforators of the foot are divided into dorsal, medial, lateral and plantar perforators. Ankle perforators are divided into medial, anterior and lateral.

Perforators of the gluteal muscle are divided in superior, mid, and lower perforators.
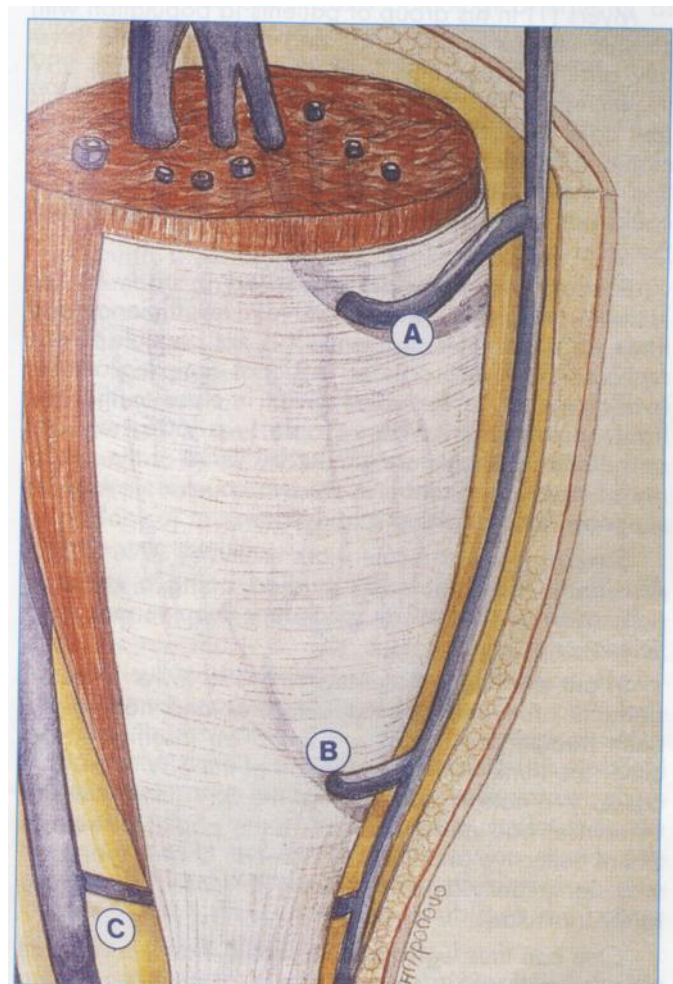
Schematic diagram demonstrating gastrocnemius perforators

Anatomy of foot veins

The dorsal venous arch and the medial and lateral marginal veins are the anatomic origins of the GSV and SSV. These are placed under the superficial fascia. On the dorsum of the foot the dorsal digital veins receive, in the clefts between the toes, the intercapitular veins from the plantar cutaneous venous arch and join to form short common digital veins which unite across the distal ends of the metatarsal bones in a dorsal venous arch. Proximal to this arch is an irregular venous net-work which receives tributaries from the deep veins and is joined at the sides of the foot by a medial and a lateral marginal vein, formed mainly by the union of branches from the superficial parts of the sole of the foot. On the sole of the foot the superficial veins form a plantar cutaneous venous arch which extends across the roots of the toes and opens at the sides of the foot into the medial and lateral marginal veins. Proximal to this arch is a plantar cutaneous venous net-work which is especially dense in the fat beneath the heel; this net-work communicates with the cutaneous venous arch and with the deep veins, but is chiefly drained into the medial and lateral marginal veins.

Lateral venous system

This system is a fairly independent superficial system although it may receive reflux from SFJ via the ALVT. The lateral system includes the lateral thigh and lateral calf veins. It may represent the embryonic lateral marginal vein. Telangiectasias of the lateral upper thigh and lateral lower calf are usually due to an incompetent lateral venous system. The lateral knee, lateral thigh and calf perforators are usually incompetent leading to the incompetence of the lateral system, and hence the telangiectasia.

Lateral Thigh Vein

Anterolateral Vein of the Thigh

Lateral Calf Vein

Infra-red Thermography of Incompetent Lateral thigh System
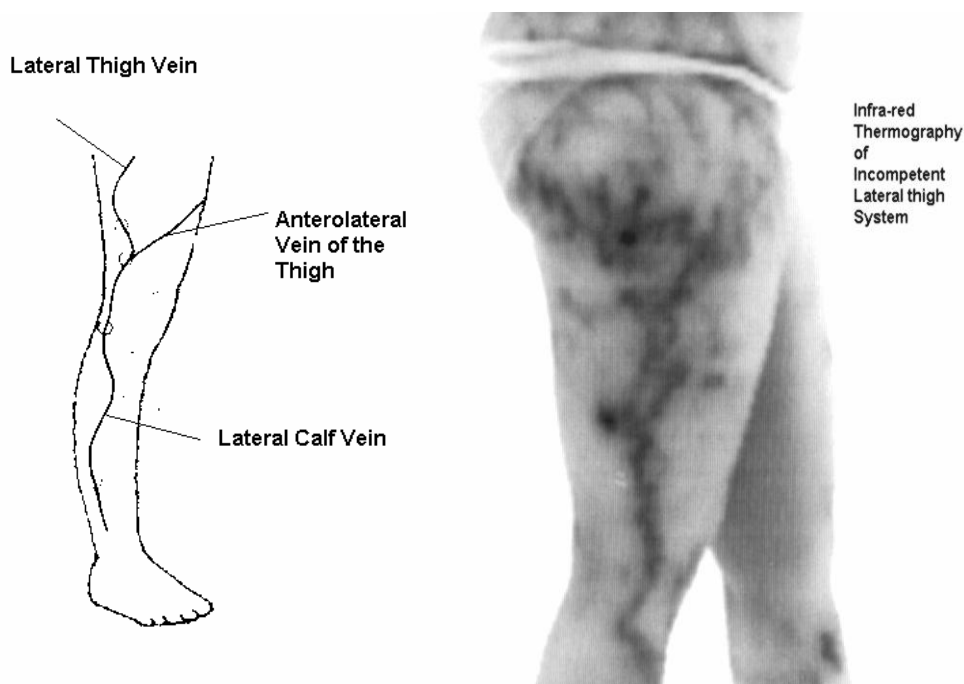
The Deep Venous System

All venous blood eventually is received by the deep venous system on its way back to the right atrium of the heart. The principal deep venous trunk of the leg is called the popliteal vein (PV) from below the knee until it passes upward and anteriorly through the adductor canal in the distal thigh, where it is called the femoral vein (FV) for the remainder of its course in the thigh. In most cases there are five major named tributaries to the deep venous system, three below (posterior tibial, anterior tibial and peroneal veins) which form the popliteal vein and two above the knee (femoral and profunda femoris veins) which form the common femoral vein.

Deep Veins of the Calf

In the lower leg, three groups of *inter-muscular* deep vein. These veins are all paired.

- The **anterior tibial veins** are the upward continuation of the venæ comitantes of the dorsalis pedis artery. They leave the front of the leg by passing between the tibia and fibula, over the interosseous membrane, and unite with the posterior tibial, to form the **popliteal vein.**
- The **posterior tibial veins** accompany the posterior tibial artery pass upward posteromedially beneath the medial edge of the tibia.
- The **peroneal vein** passes upward posteriorly through the calf.

Intra-muscular deep veins include the **gastrocnemius** and the **soleal** groups. Venous sinusoids within the calf muscle coalesce to form soleal and gastrocnemius intramuscular venous plexi, which join the peroneal vein in mid-calf. In most patients, each one of these is actually a pair of veins flanking an artery of the same name; thus there are actually six named deep veins below the knee in a typical patient. Just below the knee, the four anterior and posterior tibial veins join with the two peroneal veins to become the single large popliteal vein.

The **gastrocnemius veins** are situated within the medial and lateral gastrocnemius muscles. Lateral gastrocnemius veins have a much smaller caliber than medial gastrocnemius veins. A dense intramuscular venous plexus unites to form a common extra-muscular trunk which travels for 1 to 4 cm in the loose adipose connective tissue of the popliteal fossa. This common extra-muscular trunk of the gastrocnemius vein terminates:

• directly in the popliteal vein, very obliquely, forming an acute angle, almost vertically above the popliteal vein; this allows the gastrocnemius veins to ensure a shock-absorbing role in the case of sudden pressure variations in the popliteal vein;

• in the saphenopopliteal junction at the level of the concavity of the short saphenous vein: this type of termination makes saphenopopliteal junction ligation flush with the popliteal vein more difficult;

• simultaneously in the popliteal vein and short saphenous vein via a lambda-shaped termination.

In the popliteal fossa, the gastrocnemius veins and small saphenous veins have a different macroscopic appearance. The gastrocnemius veins are bluish and have a fine, poorly muscular, but highly elastic wall. In contrast, the small saphenous vein, situated more superficially, retains the pearly appearance of veins of the subcutaneous plexus. The intramuscular gastrocnemius veins form a dense venous plexus, which branches and anastomoses within the mass of muscle tissue. In the lower part of the calf, one of the largest branches emerges from the medial gastrocnemius muscle, where the muscle mass gives way to membranous tissue, this constitutes the gastrocnemius perforating vein or Gillot's lower pole perforating vein.
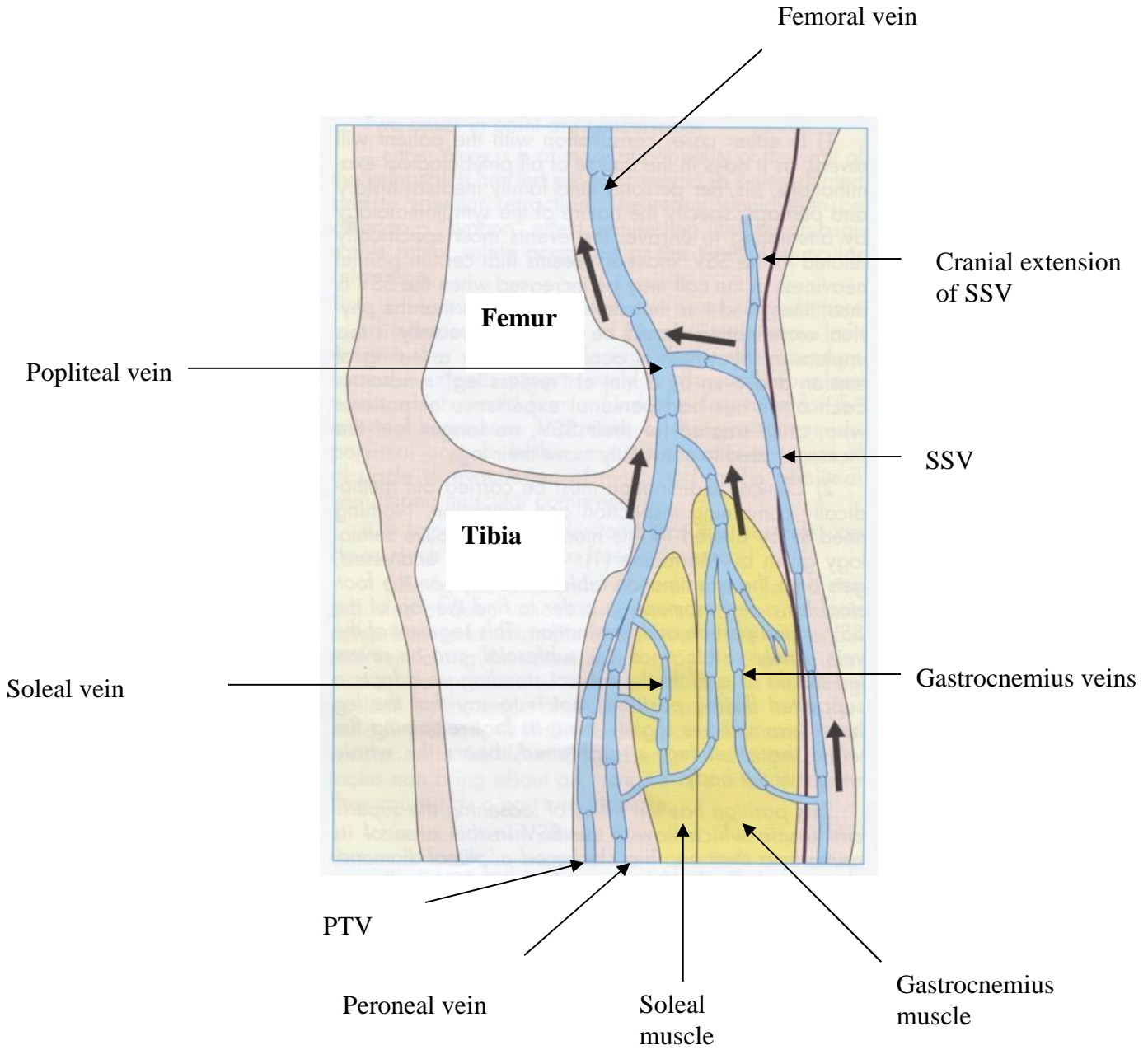
Incompetence of a gastrocnemius vein, usually the medial, may cause swelling and discomfort within the calf yet nothing is apparent. Awareness may be precipitated by attempting to wear tight fitting boots or trousers when the difference in calf circumference is recognised yet there is no ankle oedema. Next a venous flare or dilated venules appear over a perforator site, usually the mid-calf perforator, but sometimes the Boyd's perforator, filling the posterior arch tributary of the greater saphenous vein.

Incompetence of a gastrocnemius vein is suggested by the history and clinical examination. Reflux is demonstrated by Doppler ultrasound and accurately localized by duplex ultrasound with colour-flow imaging. The anatomy is clearly visualized by venography. Large gastrocnemius veins are seen in athletes and ballerinas with well-developed calf muscles and such veins are physiological and should not be interrupted. It is imperative that reflux is demonstrated before surgical treatment is offered. Incompetence of gastrocnemius veins contributes to the so called 'restless leg syndrome'.

The soleus veins are situated in a deeper muscle plane. They unite to form one or several main trunks, which terminate in either the posterior tibial vein or the peroneal vein. In contrast with the gastrocnemius veins, their extramuscular portion is very short. However like the gastrocnemius veins, they receive a perforating vein at the lower pole of the muscle, which communicates with the gastrocnemius venous plexus or directly with the short saphenous superficial network.

The general arrangement of the intramuscular plexus of soleus veins is variable. It can be predominantly vertical and terminate via a single common trunk in the posterior tibial or peroneal network, or it can be predominantly horizontal and comprise an anastomosis with the posterior tibial or peroneal network via multiple intramuscular arches at different levels.

Deep Veins of the Calf

Femoral vein

Cranial extension of SSV

Femur

Popliteal vein

SSV

Tibia

Soleal vein

Gastrocnemius veins

PTV

Peroneal vein

Soleal muscle

Gastrocnemius muscle
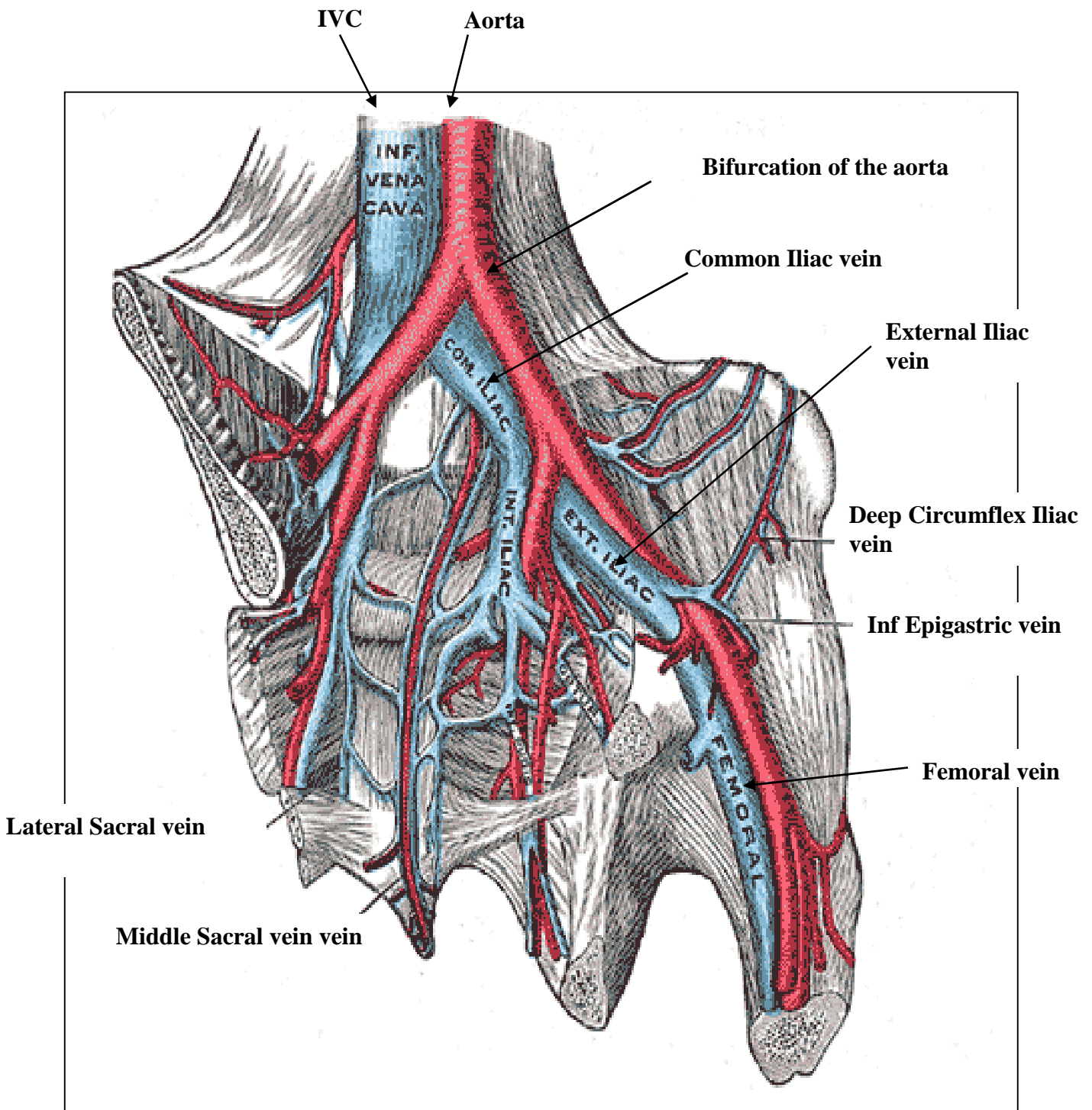
Deep Veins of the Thigh

The **popliteal vein** (PV) courses proximally behind the knee and then passes anteromedially in the distal thigh through the adductor canal, at which point it is called the **femoral vein** (FV). The PV and the FV are one and the same, and this is the largest and longest deep vein of the lower extremity. The profunda femoris vein (PF) is a short, stubby vein that usually has its origin in terminal muscle tributaries within the deep muscles of the lateral thigh, but may communicate with the popliteal vein in up to 10% of patients. FV usually lies posterolaterally to the femoral artery in the thigh and then moves medially at the groin. In approximately 25% of people the femoral vein is directly posterior to the artery at the groin.
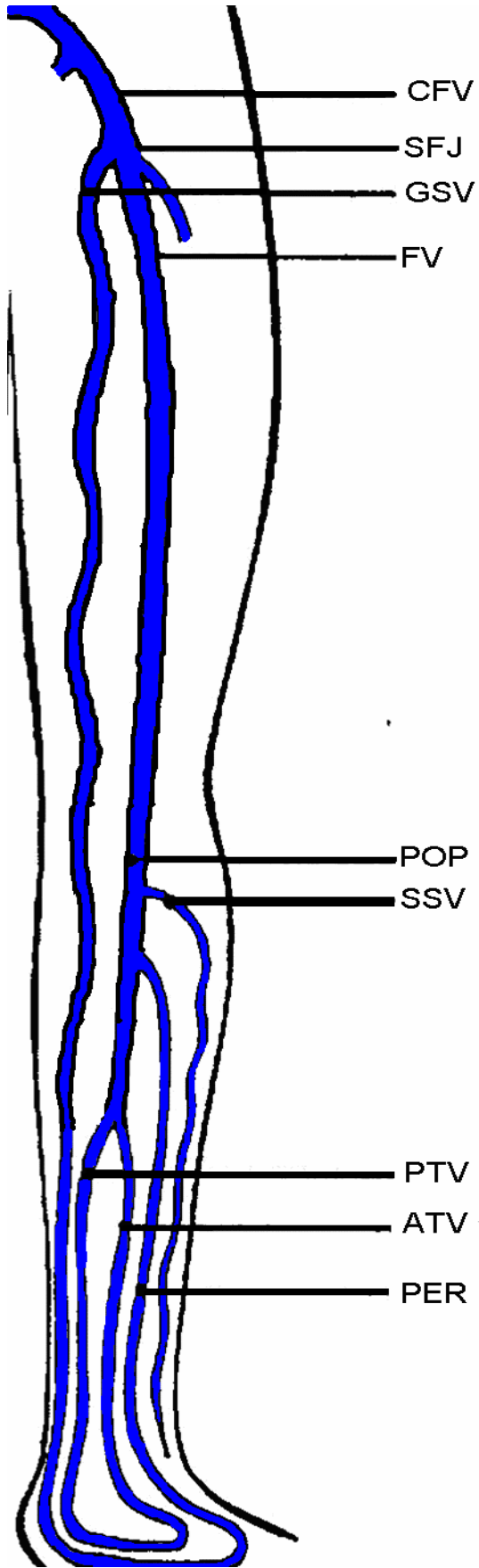
In the proximal thigh, the FV and the PF join together to form the common femoral vein (CFV), which passes upward above the groin crease to become the iliac vein. The FV is sometimes incorrectly referred to as the "superficial femoral vein" despite the fact that it is not a part of the superficial venous system.

The **external iliac vein**, the upward continuation of the femoral vein, begins behind the inguinal ligament, and, passing upward along the brim of the lesser pelvis, ends opposite the sacroiliac articulation, by uniting with the hypogastric vein to form the **common iliac vein**. On the right side, it lies at first medial to the artery: but, as it passes upward, gradually inclines behind it. On the left side, it lies altogether on the medial side of the artery. It frequently contains one, sometimes two, valves.   The external iliac vein receives the inferior epigastric, deep iliac circumflex, and pubic veins.

The **inferior epigastric vein** is formed by the union of the venæ comitantes of the inferior epigastric artery, which communicate above with the superior epigastric vein; it joins the external iliac about 1.25 cm. above the inguinal ligament. The **deep iliac circumflex vein** is formed by the union of the venæ comitantes of the deep iliac circumflex artery, and joins the external iliac vein about 2 cm above the inguinal ligament. The **pubic vein** communicates with the obturator vein in the obturator foramen, and ascends on the back of the pubis to the external iliac vein. The **hypogastric vein** begins near the upper part of the greater sciatic foramen, passes upward behind and slightly medial to the hypogastric artery and, at the brim of the pelvis, joins with the external iliac to form the common iliac vein.

The **common iliac veins** are formed by the union of the external iliac and hypogastric veins, in front of the sacroiliac articulation; passing obliquely upward toward the right side, they end upon the fifth lumbar vertebra, by uniting with each other at an acute angle to form the inferior vena cava. The **right common iliac** is shorter than the left, nearly vertical in its direction, and ascends behind and then lateral to its corresponding artery. The **left common iliac,** longer than the right and more oblique in its course, is at first situated on the medial side of the corresponding artery, and then behind the right common iliac. Each common iliac receives the iliolumbar, and sometimes the lateral sacral veins. The left receives, in addition, the middle sacral vein. No valves are found in these veins.

IVC   Aorta

Bifurcation of the aorta

Common Iliac vein

External Iliac vein

Deep Circumflex Iliac vein

Inf Epigastric vein

Femoral vein

Lateral Sacral vein

Middle Sacral vein vein

CFV

SFJ

GSV

FV

**Deep
Inter-muscular Veins
of
Lower Limbs**

POP

SSV

PTV

ATV

PER

Important nerves of lower limbs

The **saphenous nerve** is the largest cutaneous branch of the femoral nerve. It approaches the femoral artery where this vessel passes beneath the Sartorius, and lies in front of it, behind the aponeurotic covering of the adductor canal, as far as the opening in the lower part of the Adductor magnus. Here it quits the artery, and emerges from behind the lower edge of the aponeurotic covering of the canal; it descends vertically along the medial side of the knee behind the Sartorius, pierces the fascia lata, between the tendons of the Sartorius and Gracilis, and becomes subcutaneous. The nerve then passes along the tibial side of the leg, accompanied by the GSV, descends behind the medial border of the tibia, and, at the lower third of the leg, divides into two branches: one continues its course along the margin of the tibia, and ends at the ankle; the other passes in front of the ankle, and is distributed to the skin on the medial side of the foot, as far as the ball of the great toe, communicating with the medial branch of the superficial peroneal nerve. The saphenous nerve, about the middle of the thigh, gives off a branch which joins the subsartorial plexus. At the medial side of the knee it gives off a large infrapatellar branch, which pierces the Sartorius and fascia lata, and is distributed to the skin in front of the patella. This nerve communicates above the knee with the anterior cutaneous branches of the femoral nerve; below the knee, with other branches of the saphenous; and, on the lateral side of the joint, with branches of the lateral femoral cutaneous nerve, forming a plexiform net-work, the plexus patellæ. The infrapatellar branch is occasionally small, and ends by joining the anterior cutaneous branches of the femoral, which supply its place in front of the knee. Below the knee, the branches of the saphenous nerve are distributed to the skin of the front and medial side of the leg, communicating with the cutaneous branches of the femoral, or with filaments from the obturator nerve.

The **sciatic nerve** lies in the space between the popliteal vein and the SSV. It supplies nearly the whole of the skin of the leg, the muscles of the back of the thigh, and those of the leg and foot. It is the largest nerve in the body, measuring 2 cm. in breadth, and is the continuation of the flattened band of the sacral plexus. It passes out of the pelvis through the greater sciatic foramen, below the Piriformis muscle. It descends between the greater trochanter of the femur and the tuberosity of the ischium, and along the back of the thigh to about its lower third, where it divides into two large branches, the tibial and common peroneal nerves. This division may take place at any point between the sacral plexus and the lower third of the thigh. When it occurs at the plexus, the common peroneal nerve usually pierces the Piriformis.
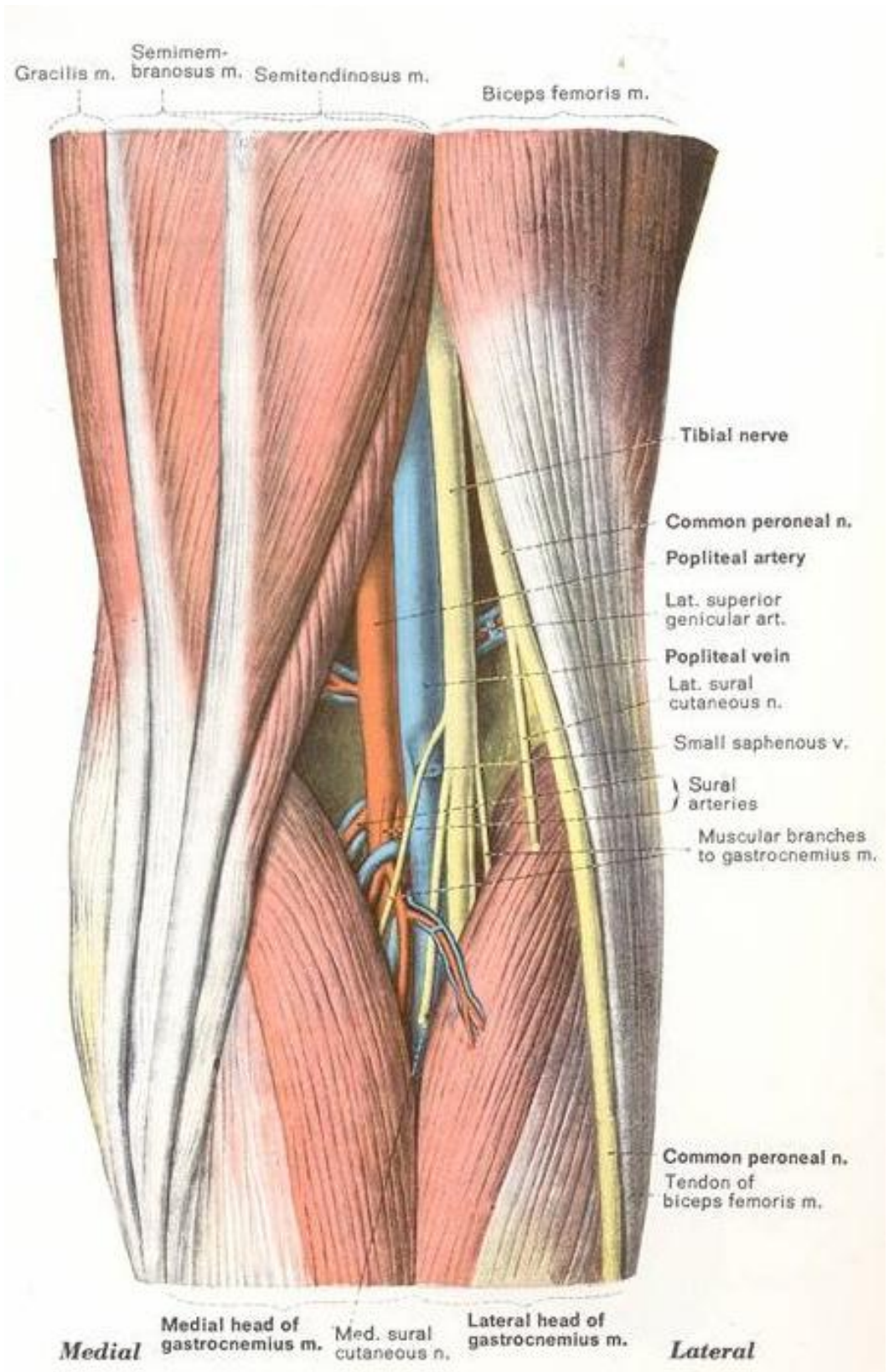
The **common peroneal nerve** is derived from the dorsal branches of the fourth and fifth lumbar and the first and second sacral nerves. It descends obliquely along the lateral side of the popliteal fossa to the head of the fibula, close to the medial margin of the biceps femoris muscle. It lies between the tendon of the biceps femoris and lateral head of the gastrocnemius muscle, winds around the neck of the fibula, between the Peronæus longus and the bone, and divides beneath the muscle into the superficial and deep peroneal nerves. Previous to its division it gives off articular and lateral sural cutaneous nerves.

In most instances (80%), the **sural nerve** is formed in the distal portion of the leg by the union of the medial sural cutaneous nerve and the peroneal communicating branch. In 20% of cases, the peroneal communicating branch is absent. In such cases, the sural nerve is derived from the medial sural cutaneous nerve alone. The lateral sural cutaneous nerve is laterally situated and usually divides into medial and lateral branches. In a few cases, its medial division may contribute to the sural nerve through the peroneal communicating branch.

The sural nerve passes downward near the lateral margin of the tendo calcaneus, lying close to the SSV, to the interval between the lateral malleolus and the calcaneus. It runs forward below the lateral malleolus, and is continued as the lateral dorsal cutaneous nerve along the lateral side of the foot and little toe, communicating on the dorsum of the foot with the intermediate dorsal cutaneous nerve, a branch of the superficial peroneal. In the leg, its branches communicate with those of the posterior femoral cutaneous. The medial calcaneal branches perforate the laciniate ligament, and supply the skin of the heel and medial side of the sole of the foot.

Though the sural nerve is considered to be a sensory nerve, motor fibres have been found in 4.5% of nerves. In the current case, since the nerve passed through the gastrocnemius muscle, it is likely that it gave motor branches to the muscle as it passed through it. Presence of motor fibres may play important role in sural nerve biopsy and pathological findings. This abnormal course of the sural nerve can produce pain up on the contraction of the gastocnemius or altered sensation over the area of its distribution. Pain associated with sural nerve entrapment in athletes and in scar tissue after the injury of gastrocnemius has already been reported. In the former case, the sural nerve was entrapped in the superficial sural aponeurosis. In the case reported here, the nerve passed through the fleshy part of gastrocnemius.

Gracilis m. Semimem-branosus m. Semitendinosus m. Biceps femoris m.

Tibial nerve

Common peroneal n.

Popliteal artery

Lat. superior genicular art.

Popliteal vein

Lat. sural cutaneous n.

Small saphenous v.

Sural arteries

Muscular branches to gastrocnemius m.

Common peroneal n.
Tendon of biceps femoris m.

Medial Medial head of gastrocnemius m. Med. sural cutaneous n. Lateral head of gastrocnemius m. *Lateral*

Venous system of upper limbs, neck and chest

Cephalic and **basilic** veins are the superficial veins of the arm. On the dorsum of the hand and in front of the wrist superficial venous plexuses are easily seen through the skin. From these the blood passes up the forearm chiefly on its flexor surface by the *radial, median* and *anterior* and *posterior ulnar veins.* Just below the crease of the elbow the median vein communicates with the deep veins and then divides into two branches like the limbs of a Y. Of these the inner is the *median basilic* and is noticeable as the vein from which patients were usually bled, while the outer is the *median cephalic.* After a course of an inch or two the median basilic is joined by the anterior and posterior ulnar veins and the median cephalic by the radial. After this junction the median basilic is continued up the inner side of the arm as the *basilic vein.*

Basilic vein is the largest arm vein measuring 6 – 8 mm. Its course is along the medial (ulnar) aspect of the arm. It pierces the deep fascia about the middle of the arm and in the axilla joins the venae comites of the brachial artery to form the *axillary vein,* which lies on the inner side of its artery.

The median cephalic vein after joining the radial runs up the outer side of the arm as the *cephalic vein.* **Cephalic vein**, measuring 4 – 6 mm, runs along the lateral (radial) aspect of the arm emptying into the axillary vein. Although the basilic vein is larger, the cephalic vein is more superficial and easier to dissect out. Therefore it is often the preferred vein for dialysis fistulas or grafts. A little below the clavicle it passes through the costocoracoid membrane to enter the upper part of the axillary vein. Conversely, it may take an acute angle before it enters the axillary vein sometimes making negotiation with a catheter or wire difficult.

Deep forearm veins

These are 2 or 3 veins each that course with and are named like the corresponding arteries of the forearm (radial & ulna). **Brachia**l veins are the deep veins of the upper arm, usually paired and smaller than the superficial veins. They travel in the upper arm parallel to (on either side) the brachial artery and join with the basilic vein to form the axillary vein.

Axillary Vein

The axillary vein begins at the junction of the basilic and brachial veins. It runs medial, anterior and caudal to the axillary artery, to the lateral border of the first rib where it becomes the subclavian vein. It lies caudal to the lateral half of the clavicle, slightly medial to and partly overlies the axillary artery. The artery and vein are within the axillary fascia. The brachial plexus (nerves) runs between artery and vein. Valves may be present near the junction of the brachial and basilic veins.

Subclavian Vein

The subclavian vein runs from the lateral border of the first rib to the sternal end of the clavicle where it joins the internal jugular vein and becomes the brachiocephalic vein. It lies posterior and superior to the subclavian artery. A pair of valves is not uncommon at the termination of the subclavian vein. The subclavian vein becomes the axillary vein at the lateral margin of the first rib. The thoracic ducts enter the superior aspect of the subclavian vein near its junction with the internal jugular vein.

Superficial veins of the right upper limb
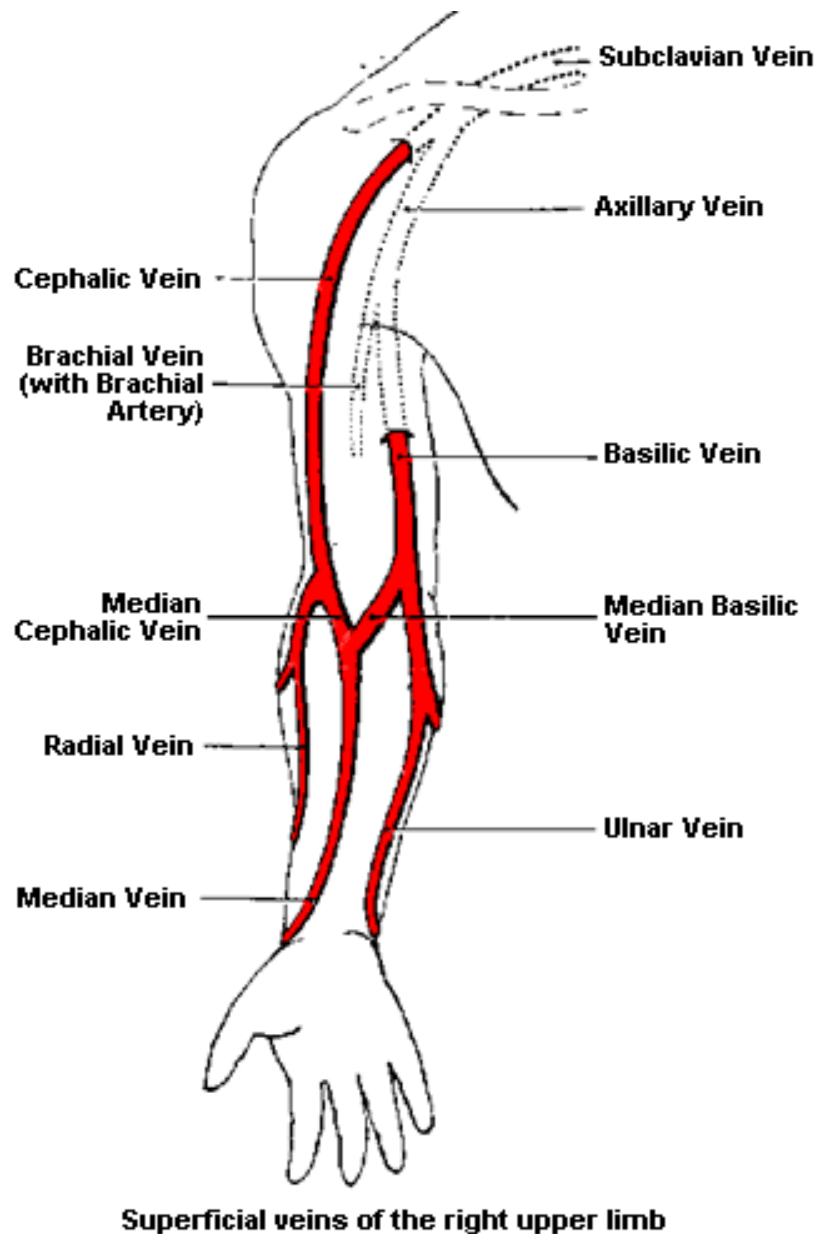
Internal jugular vein (IJ)

The internal jugular vein exits the jugular foramen of the skull base and courses inferiorly along with the carotid artery and vagus nerve. The IJ begins posterior to the carotid artery at the cranium but spirals around the artery and ends up anteriorly at the level of the chest. It lies between the two heads of the sternocleidomastoid muscle in the mid portion and finally lies posterior to the clavicular head of the muscle. It joins with the subclavian vein to become the brachiocephalic vein.

External jugular (EJ)

The external jugular vein (EJ) begins approximately at the level of the angle of the mandible (from the junction of the posterior auricular and the retromandibular veins) and courses posterior to the sternocleidomastoid muscle to enter inferiorly into the subclavian vein. Occasionally both the IJ and EJ may have incomplete or valve like structures.

Intercostal veins

There are both anterior and posterior intercostal veins. The posterior division enters into the azygous and hemiazygous systems. The anterior division empties into the internal mammary vein. They lie beneath the ribs and serve as a collateral pathway in the presence of central deep venous thrombosis (DVT).

Facial veins

The venous drainage of the face largely parallels the arterial supply. In general, the named arteries are anterior to the veins. The veins are straight whereas the arteries have a more tortuous course. The facial veins lack valves, therefore a two-way flow of blood is possible.

The **supratrochlear vein** (**frontal vein**) begins on the forehead in a venous plexus which communicates with the frontal branches of the superficial temporal vein. The veins converge to form a single trunk, which runs downward near the middle line of the forehead parallel with the vein of the opposite side. The two veins are joined, at the root of the nose, by a transverse branch, called the nasal arch, which receives some small veins from the dorsum of the nose. At the root of the nose the veins diverge, and, each at the medial angle of the orbit, joins the supraorbital vein, to form the angular vein. Occasionally the frontal veins join to form a single trunk, which bifurcates at the root of the nose into the two angular veins.

The **supraorbital vein** begins on the forehead where it communicates with the frontal branch of the superficial temporal vein. It runs downward superficial to the Frontalis muscle, and joins the frontal vein at the medial angle of the orbit to form the angular vein. Previous to its junction with the frontal vein, it sends through the supraorbital notch into the orbit a branch which communicates with the ophthalmic vein; as this vessel passes through the notch, it receives the frontal diploic vein through a foramen at the bottom of the notch.

The **angular vein** formed by the junction of the frontal and supraorbital veins, runs obliquely downward, on the side of the root of the nose, to the level of the lower margin of the orbit, where it becomes the anterior facial vein. It receives the veins of the ala nasi, and communicates with the superior ophthalmic vein through the nasofrontal vein, thus establishing an important anastomosis between the anterior facial vein and the cavernous sinus. The angular vein anastomoses with the **ophthalmic vein**. Also it anastomoses with the venous systems of the eyelid and the forehead as well as the **infraorbital vein**.

The **facial vein** commences at the side of the root of the nose, and is a direct continuation of the angular vein. It lies behind the facial artery and follows a less tortuous course. As it travels downward along the medial cheek and the lower face, it is in communication with blood from the lateral nasal branches and the labial veins. As with its corresponding artery, it is deep to and thus covered by the superficial facial muscles. Over the lower cheek it is connected to the **deep facial vein** that parallels the buccal branch of the internal maxillary artery. It anastomoses with the ptergoid plexus located medial to the upper ramus of the manible. The facial vein crosses over the lower border of the manible anterior to the masseter muscle and passes over the submandibular glands (in contrast with the anterior facial artery that passes behind the gland) and enters the **internal jugular vein**. It communicates with the **retromandibular vein** that connects with the **external jugular vein**. The so-called dangerous triangle of the medial face- involving the upper lip and the paranasal area- is a result of the communications of the facial vein with the **cavernous sinus**, either directly through the ophthalmic vein or indirectly through the pterygoid plexus.

The facial vein has no valves, and its walls are not so flaccid as most superficial veins. Tributaries.—The facial vein receives a branch of considerable size, the deep facial vein, from the pterygoid venous plexus. It is also joined by the superior and inferior palpebral, the superior and inferior labial, the buccinator and the masseteric veins. Below the mandible it receives the submental, palatine, and submaxillary veins, and, generally, the vena comitans of the hypoglossal nerve.

The **superficial temporal vein** parallels the artery and supplies venous drainage to the scalp and the forehead. It begins on the side and vertex of the skull in a plexus which communicates with the frontal and supraorbital veins, with the corresponding vein of the opposite side, and with the posterior auricular and occipital veins. From this net-work frontal and parietal branches arise, and unite above the zygomatic arch to form the trunk of the vein, which is joined in this situation by the middle temporal vein, from the substance of the Temporalis. It then crosses the posterior root of the zygomatic arch, enters the substance of the parotid gland, and unites with the internal maxillary vein to form the posterior facial vein. It may end within or below the gland as it empties into the internal jugular vein. It also communicates with the anterior jugular vein along with the facial vein. Tributaries.—The superficial temporal vein receives in its course some parotid veins, articular veins from the temporomandibular joint, anterior auricular veins from the auricula, and the transverse facial from the side of the face. The middle temporal vein receives the orbital vein, which is formed by some lateral palpebral branches, and passes backward between the layers of the temporal fascia to join the superficial temporal vein.
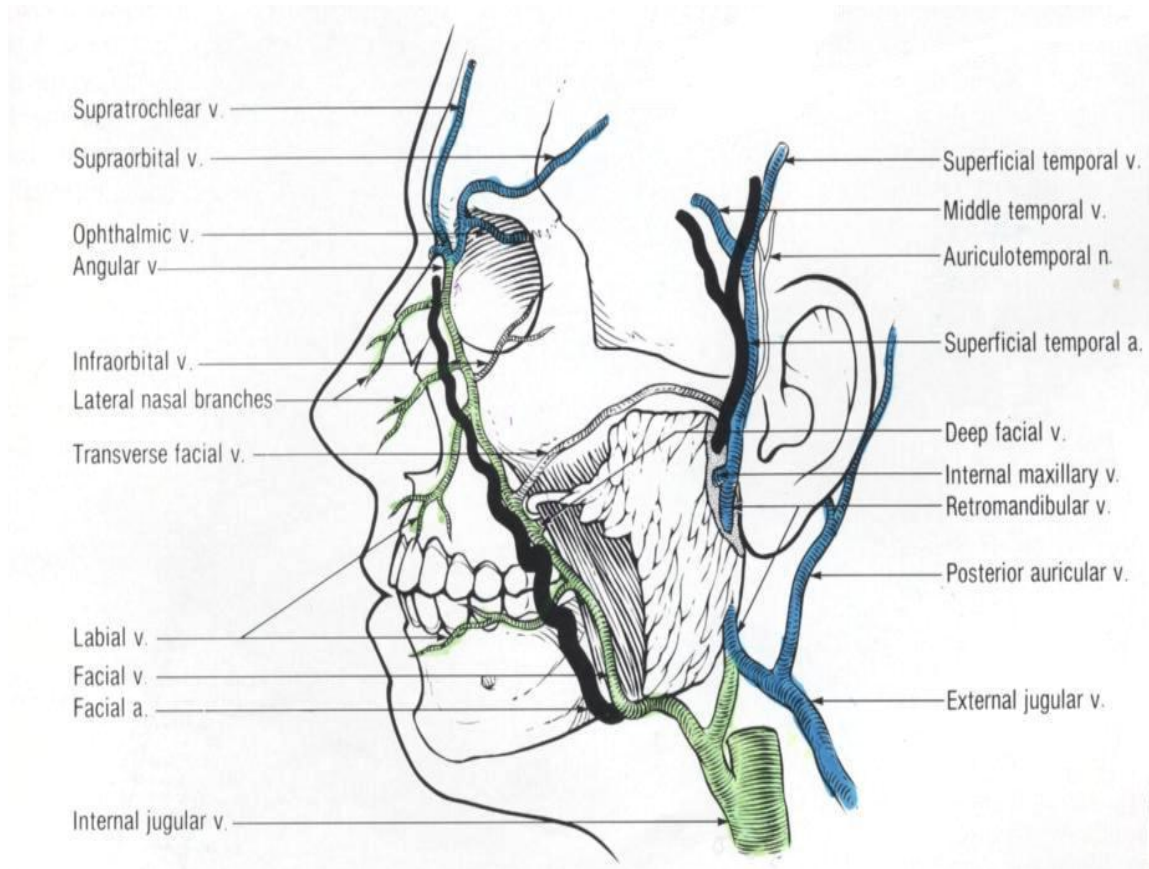
The **posterior auricular vein** begins upon the side of the head, in a plexus which communicates with the tributaries of the occipital and superficial temporal veins. It descends behind the auricula, and joins the posterior division of the posterior facial vein to form the external jugular. It receives the stylomastoid vein, and some tributaries from the cranial surface of the auricula.

The **occipital vein** begins in a plexus at the back part of the vertex of the skull. From the plexus emerges a single vessel, which pierces the cranial attachment of the Trapezius and, dipping into the suboccipital triangle, joins the deep cervical and vertebral veins. Occasionally it follows the course of the occipital artery and ends in the internal jugular; in other instances, it joins the posterior auricular and through it opens into the external jugular. The parietal emissary vein connects it with the superior sagittal sinus; and as it passes across the mastoid portion of the temporal bone, it receives the mastoid emissary vein which connects it with the transverse sinus. The occipital diploic vein sometimes joins it.
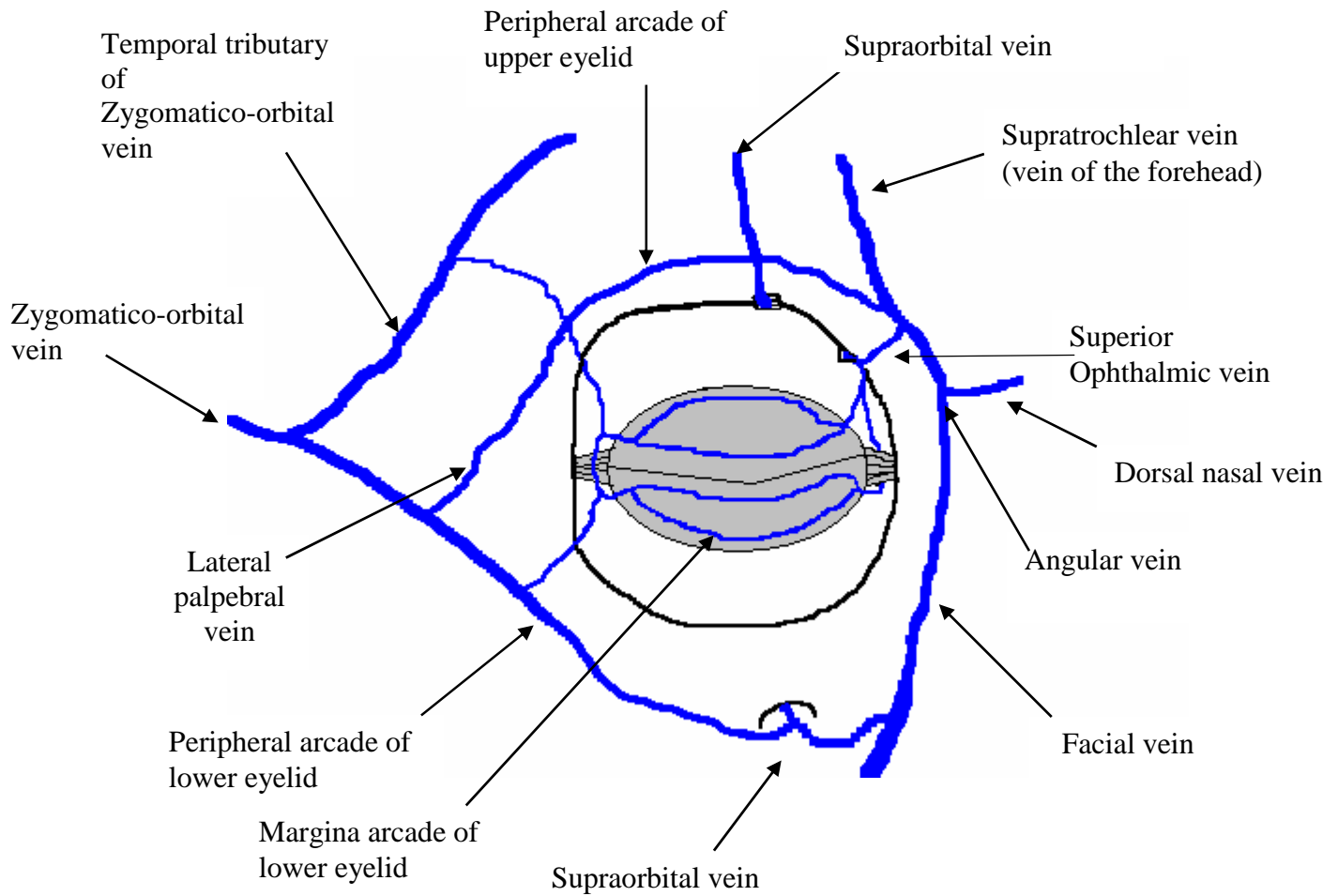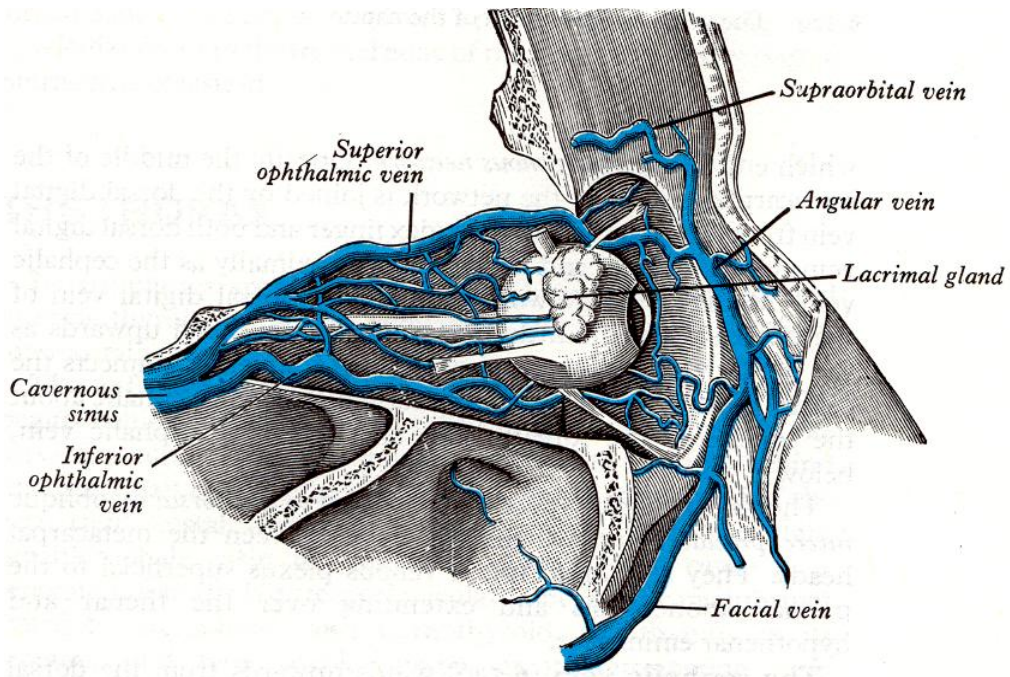
Veins of the eyelids

The veins of the eyelids are divided into two major sections: the pretarsal and posttarsal veins. The **pretarsal veins** are **superficial** veins that are connected medially to the angular vein and laterosuperiorly to the superficial temporal and lacrimal veins. The **posttarsal** division is composed of the **deeper** veins that connect the orbital veins with the deeper branches of the anterior facial vein and the pterygoid plexus. These veins also anastomose medially and laterally with the veins of the pretarsal division.

The major venous drainage of the eyelids is to the superficial temporal and the angular and facial veins. The angular vein is on the superficial surface of the medial canthal tendon and approximately 8mm medial to the medial canthus. It connects with the frontal-supraorbital system superiorly and the facial vein inferiorly. As in the arterial system, there are venous arcades that drain into these major venous drainage systems.

Sclerotherapy of temple and orbital veins

From time to time, patients request removal of veins around the orbit and on the temples. These veins seem to become more prominent especially after a face lift procedure. This procedure seems to restrict the drainage of these veins in some patients, hence making the veins more prominent after surgery. Ambulator phlebectomy can be attempted, however some of these veins may be too small to be hooked out. Care should be taken during sclerotherapy as the drainage of the angular vein is to the cavernous sinus via the superior ophthalmic vein and hence there is a theoretical risk of cavernous sinus thrombosis and blindness.

Temporal tributary
of
Zygomatico-orbital
vein

Peripheral arcade of
upper eyelid

Supraorbital vein

Supratrochlear vein
(vein of the forehead)

Zygomatico-orbital
vein

Superior
Ophthalmic vein

Dorsal nasal vein

Lateral
palpebral
vein

Angular vein

Peripheral arcade of
lower eyelid

Facial vein

Margina arcade of
lower eyelid

Supraorbital vein

Anterior tributary
of superficial
temporal vein

Parietal tributary
of superficial
temporal vein

Temporal tributary
of
Zygomatico-orbital
vein

Angular vein

Superficial
temporal vein

Peripheral arcade of
lower eyelid

Zygomatico-orbital
vein

Supraorbital vein

Superior
ophthalmic vein

Angular vein

Lacrimal gland

Cavernous
sinus

Inferior
ophthalmic
vein

Facial vein

Intra-abdominal veins

The common femoral vein, after passing deep to Poupart's ligament, becomes the ***external iliac*** which runs along the brim of the true pelvis and, after a course of some three inches, joins the ***internal iliac*** which drains the pelvis and so forms the *common iliac vein.* In front of the body of the fifth lumbar vertebra the common iliac veins of the two sides unite to form the ***inferior vena cava.***

Inferior Vena Cava (IVC)

The IVC is formed from the junction of the common iliac veins at approximately the L5 level. It courses upwards towards the heart anteriorly and to the right of the spine. It lies to the right of the aorta and is oval in shape. It runs up to an opening in the diaphragm. On its way it receives spermatic or ovarian veins from the genital glands, *renal veins* from the kidneys, and *lumbar veins* from the abdominal walls. Before reaching the diaphragm it lies in a groove in the back of the liver and receives the *hepatic veins* from that organ. The hepatic portal system which lies in the abdomen will be treated later.

The renal veins enter the IVC at approximately the lower third of L1. The left renal vein enters slightly higher than the right. Both can be duplicated. IVC duplication .2%, Left renal vein duplication 11- 17%. The **renal veins** are of large size, and placed in front of the renal arteries. The left is longer than the right, and passes in front of the aorta, just below the origin of the superior mesenteric artery. It receives the left spermatic and left inferior phrenic veins, and, generally, the left suprarenal vein.

Hepatic and portal veins

These consist of a right, middle and left. All three may join and enter the IVC as a common trunk but most commonly the right enters by itself and in 80% the middle and left hepatic veins have a common trunk. The middle hepatic vein lies in the interlobar fissure separating the R and L lobes of the liver. Caudate veins (usually 2-3) drain separately into the IVC, several cm's below the main hepatic veins.

The veins which drain the blood from the stomach, intestines, spleen and pancreas unite to form a large vein which begins behind the head of the pancreas and ends by dividing into right and left branches in the transverse fissure of the liver. This is the *portal vein* which lies in front of the inferior vena cava and is about three inches long. Its formative tributaries are the *superior* and *inferior mesenteric* and the *splenic veins.* These accompany the arteries of the same name, and their most usual method of termination is that the inferior mesenteric runs up and joins the splenic to the left of the middle line of the body, and this, after running horizontally to a point a little to the right of the middle line, joins the superior mesenteric, and so the portal vein is formed.

There are two marked characteristics of the portal system; one is that it has no valves and the other that it begins and ends in capillaries, since the two terminal branches of the portal vein branch and rebranch. In the lower part of the rectum the veins run partly into the portal and partly into the general system, and in this dependent position they are liable to become varicose and to form haemorrhoids. The histology of the veins corresponds very closely to that of the arteries (q.v.); their walls are, however, much thinner and there is less muscular and elastic tissue. At certain places, especially where tributaries come in, the endothelial lining is raised to form semilunar pocket-like valves. In most cases there are two cusps to each valve, but three or one are sometimes found. The opening of the pocket is of course arranged so that it shall only be filled when there is a tendency to regurgitation of the blood.

Veins of the thorax and pulmonary veins

Veins of the Thorax

The IVC, after piercing the diaphragm, has a very short thoracic course and opens into the lower and back part of the right auricle of the heart. The **right** and **left innominate veins** are formed behind the sternal end of the clavicle by the union of the subclavian and internal jugulars of their own side. The left vein is much longer than the right and runs nearly horizontally behind the upper half of the manubrium sterni to join its fellow on the right side of that bone just below the first rib. By the junction of these the **superior vena cava** is formed, which runs down to the right auricle of the heart. The chief tributaries of the innominate veins are the *vertebral,* the *internal mammary* and the *inferior thyroid.* The intercostal veins open into the *azygos veins,* which begin in the abdomen sometimes by a vertical trunk joining the - lumbar veins known as the *ascending lumbar,* sometimes on the right side by a communication with the inferior vena cava. The right azygos vein is known as the *vena azygos major* and passes through the aortic opening of the diaphragm. Entering the thorax, it rubs up in front of the thoracic vertebrae, to the right of the aorta and thoracic duct, and receives the intercostal veins of the right side. At the level of the fourth thoracic vertebra it arches forward to open into the posterior surface of the superior vena cava.

On the left side, the upper intercostal veins join to form the left superior intercostal vein, which opens into the left innominate. Lower down the intercostal veins trom the fourth to the seventh spaces form the *superior hemiazygos vein* or hemiazygos accessoria, which runs down on the left of the spinal column and, crossing it about the level of the eighth or ninth thoracic vertebra, opens into the vena azygos major. The lower intercostal veins on the left side join the *inferior hemiazygos vein* which runs up and opens either into the superior hemiazygos or into the azygos major below the opening of that vein.

Pulmonary veins

The veins emerging from the lungs bring back the oxygenated blood from those organs to the left ventricle of the heart and also the greater part, if not all, of the blood carried by the bronchial arteries to nourish the lungs. The existence of bronchial veins is asserted, but they are extremely difficult to demonstrate, and if present are quite incapable of returning all the blood which the bronchial arteries carry to the lungs. There are three pulmonary veins coming out of the right lung, while on the left there are only two. On the right side, however, two of the three veins usually unite in the root of the lung, so that there are, as a rule two pulmonary veins entering the left auricle of the heart on each side, but it is not uncommon to find three on the right side or one on the left. The pulmonary veins have no valves and return the blood carried to the lungs by the pulmonary arteries as well as most, if not all, of that carried by the bronchial arteries

Pelvic veins

The **ovarian veins** correspond with the spermatic in the male; they form a plexus in the broad ligament near the ovary and uterine tube, and communicate with the uterine plexus. They end in the same way as the spermatic veins in the male. Valves are occasionally found in these veins. These veins ascend in the retroperitoneum adjacent to the psoas muscle in pairs, which combine to form a single vein prior to termination. The right ovarian vein terminates in the inferior vena cava at an acute angle. The left ovarian vein terminates in the left renal vein at a right angle. Occasionally, valves are present in the ovarian veins. The veins enlarge greatly during pregnancy to accommodate increased blood volume. Following childbirth, a period of venous stasis occurs. Incompetence of these veins contributes to **pelvic congestion syndrome**.

Other Important Veins

With the exception of the fetal umbilical vein which passes upward and backward from the umbilicus to the liver, and the iliolumbar vein which usually joins the common iliac vein, the tributaries of the hypogastric vein correspond with the branches of the hypogastric artery. It receives (a) the gluteal, internal pudendal, and obturator veins, which have their origins outside the pelvis; (b) the lateral sacral veins, which lie in front of the sacrum; and (c) the middle hemorrhoidal, vesical, uterine, and vaginal veins, which originate in venous plexuses connected with the pelvic viscera.

  1. The **superior gluteal veins** are venæ comitantes of the superior gluteal artery; they receive tributaries from the buttock corresponding with the branches of the artery, and enter the pelvis through the greater sciatic foramen, above the Piriformis, and frequently unite before ending in the hypogastric vein.

  2. The **inferior gluteal veins** (sciatic veins), or venæ comitantes of the inferior gluteal artery, begin on the upper part of the back of the thigh, where they anastomose with the medial femoral circumflex and first perforating veins. They enter the pelvis through the lower part of the greater sciatic foramen and join to form a single stem which opens into the lower part of the hypogastric vein.

  3. The **internal pudendal veins** are the venæ comitantes of the internal pudendal artery. They begin in the deep veins of the penis which issue from the corpus cavernosum penis, accompany the internal pudendal artery, and unite to form a single vessel, which ends in the hypogastric vein. They receive the veins from the urethral bulb, and the perineal and inferior hemorrhoidal veins. The deep dorsal vein of the penis communicates with the internal pudendal veins, but ends mainly in the pudendal plexus.

4. The **obturator vein** begins in the upper portion of the adductor region of the thigh and enters the pelvis through the upper part of the obturator foramen. It runs backward and upward on the lateral wall of the pelvis below the obturator artery, and then passes between the ureter and the hypogastric artery, to end in the hypogastric vein.

5. The **lateral sacral veins** accompany the lateral sacral arteries on the anterior surface of the sacrum and end in the hypogastric vein.

6. The **middle hemorrhoidal vein** takes origin in the hemorrhoidal plexus and receives tributaries from the bladder, prostate, and seminal vesicle; it runs lateralward on the pelvic surface of the Levator ani to end in the hypogastric vein. The hemorrhoidal plexus (plexus hæmorrhoidalis) surrounds the rectum, and communicates in front with the vesical plexus in the male, and the uterovaginal plexus in the female. It consists of two parts, an internal in the submucosa, and an external outside the muscular coat. The internal plexus presents a series of dilated pouches which are arranged in a circle around the tube, immediately above the anal orifice, and are connected by transverse branches.

The lower part of the external plexus is drained by the inferior hemorrhoidal veins into the internal pudendal vein; the middle part by the middle hemorrhoidal vein which joins the hypogastric vein; and the upper part by the superior hemorrhoidal vein which forms the commencement of the inferior mesenteric vein, a tributary of the portal vein. A free communication between the portal and systemic venous systems is established through the hemorrhoidal plexus. The veins of the hemorrhoidal plexus are contained in very loose, connective tissue, so that they get less support from surrounding structures than most other veins, and are less capable of resisting increased blood-pressure.

The **pudendal plexus** lies behind the arcuate public ligament and the lower part of the symphysis pubis, and in front of the bladder and prostate. Its chief tributary is the deep dorsal vein of the penis, but it also receives branches from the front of the bladder and prostate. It communicates with the vesical plexus and with the internal pudendal vein and drains into the vesical and hypogastric veins. The prostatic veins form a well-marked prostatic plexus which lies partly in the fascial sheath of the prostate and partly between the sheath and the prostatic capsule. It communicates with the pudendal and vesical plexuses.

The **vesical plexus** envelops the lower part of the bladder and the base of the prostate and communicates with the pudendal and prostatic plexuses. It is drained, by means of several vesical veins, into the hypogastric veins.

The **dorsal veins of the penis** are two in number, a superficial and a deep. The superficial vein drains the prepuce and skin of the penis, and, running backward in the subcutaneous tissue, inclines to the right or left, and opens into the corresponding **superficial external pudendal vein**, a tributary of the GSV. The deep vein lies beneath the deep fascia of the penis; it receives the blood from the glans penis and corpora cavernosa penis and courses backward in the middle line between the dorsal arteries; near the root of the penis it passes between the two parts of the suspensory ligament and then through an aperture between the arcuate pubic ligament and the transverse

ligament of the pelvis, and divides into two branches, which enter the pudendal plexus. The deep vein also communicates below the symphysis pubis with the internal pudendal vein.   34

The **uterine plexuses** lie along the sides and superior angles of the uterus between the two layers of the broad ligament, and communicate with the ovarian and vaginal plexuses. They are drained by a pair of uterine veins on either side: these arise from the lower part of the plexuses, opposite the external orifice of the uterus, and open into the corresponding hypogastric vein.

The **vaginal plexuses** are placed at the sides of the vagina; they communicate with the uterine, vesical, and hemorrhoidal plexuses, and are drained by the vaginal veins, one on either side, into the hypogastric veins.

The **spermatic veins** emerge from the back of the testis, and receive tributaries from the epididymis; they unite and form a convoluted plexus, called the pampiniform plexus, which constitutes the greater mass of the spermatic cord; the vessels composing this plexus are very numerous, and ascend along the cord, in front of the ductus deferens. Below the subcutaneous inguinal ring they unite to form three or four veins, which pass along the inguinal canal, and, entering the abdomen through the abdominal inguinal ring, coalesce to form two veins, which ascend on the Psoas major, behind the peritoneum, lying one on either side of the internal spermatic artery. These unite to form a single vein, which opens on the right side into the inferior vena cava, at an acute angle; on the left side into the left renal vein, at a right angle. The spermatic veins are provided with valves. 107 The left spermatic vein passes behind the iliac colon, and is thus exposed to pressure from the contents of that part of the bowel.

Selected Veins of the Pelvis and Perineum

Vein	Tributaries	Drains Into	Regions Drained	Notes
deep dorsal v. of the clitoris	many unnamed tributaries	vesical venous plexus	erectile tissue of the clitoris	deep dorsal v. of the clitoris passes anterosuperior to the urogenital diaphragm (between the arcuate pubic ligament and the transverse ligament of the perineum) to enter the pelvic cavity; an unpaired vein
deep dorsal v. of the penis	many unnamed tributaries	prostatic venous plexus	erectile tissue of the penis	deep dorsal v. of the penis passes anterosuperior to the urogenital diaphragm (between the arcuate pubic ligament and the transverse ligament of the perineum) to enter the pelvic cavity; an unpaired vein
deep external pudendal v.	part of the drainage of the superficial dorsal v. of the penis/clitoris	femoral	skin and superficial fascia of the penis/clitoris; pubic region	deep external pudendal v. shares its region of drainage with the superficial external pudendal v.
internal pudendal v.	deep dorsal v. of the penis/clitoris, v. of the bulb, posterior labial/scrotal v., inferior rectal v.	internal iliac	crus and bulb of the clitoris/penis; urogenital region, anal region	internal pudendal v. passes through the pudendal canal

Vein	Tributaries	Drains Into	Regions Drained	Notes
of clitoris, deep dorsal	many unnamed tributaries	vesical venous plexus	erectile tissue of the clitoris	deep dorsal v. of the clitoris passes anterosuperior to the urogenital diaphragm (between the arcuate pubic ligament and the transverse ligament of the perineum) to enter the pelvic cavity; an unpaired vein
of clitoris, superficial dorsal	no named tributaries	superficial external pudendal v.	skin and superficial fascia of the clitoris	superficial dorsal v. of the clitoris is located superficial to the deep fascia of the clitoris
of penis, deep dorsal	many unnamed tributaries	prostatic venous plexus	erectile tissue of the penis	deep dorsal v. of the penis passes anterosuperior to the urogenital diaphragm (between the arcuate pubic ligament and the transverse ligament of the perineum) to enter the pelvic cavity; an unpaired vein
of penis, superficial dorsal	no named tributaries	superficial external pudendal v.	skin and superficial fascia of the penis	superficial dorsal v. of the penis is located superficial to the deep fascia of the penis
ovarian v.	no named tributaries	right: inferior vena cava; left: left renal v.	ovary and the distal part of the uterine tube; ureter	connects with the uterine v.; a pampiniform plexus occurs, but is not as well developed as that seen in the male
pampiniform venous plexus	no named tributaries	becomes the testicular vein at the deep inguinal ring	testis, epididymis, ductus deferens	pampiniform venous plexus surrounds the testicular a. to cool arterial blood before it reaches the testis

Vein	Tributaries	Drains Into	Regions Drained	Notes
plexus, pampiniform venous	no named tributaries	becomes the testicular vein at the deep inguinal ring	testis, epididymis, ductus deferens	pampiniform venous plexus surrounds the testicular a. to cool arterial blood before it reaches the testis
plexus, prostatic venous	deep dorsal v. of the penis	internal iliac v.	penis and the prostate gland	prostatic venous plexus is connected with the vesical venous plexus
plexus, rectal venous	no named tributaries	superior, middle & inferior rectal vv.	rectum and anal canal; anus	rectal venous plexus is a site of portal-caval anastomosis
plexus, uterine venous	multiple tributaries from the uterus; deep dorsal v. of the clitoris	uterine vv. to the internal iliac v.	uterus & uterine tubes	connects with the ovarian v. and the vaginal venous plexus
plexus, vaginal venous	multiple tributaries from the vagina	vaginal v. to the internal iliac v. or uterine v.	vagina	connects with the uterine venous plexus, the vesical venous plexus and the rectal venous plexus
plexus, vertebral venous, external	intervertebral vv.	adjacent segmental vv.; vertebral v. in the cervical region	vertebral column and associated muscles	two plexuses are described: anterior and posterior; connects with the internal vertebral venous plexus

Vein	Tributaries	Drains Into	Regions Drained	Notes
plexus, vertebral venous, internal	anterior and posterior longitudinal vertebral sinuses	adjacent segmental vv.	spinal cord, meninges, vertebral column	connects with the external vertebral venous plexuses; valveless; a route for potential spread of metastases from the pelvis to the brain
plexus, vesical venous	multiple tributaries from the bladder in both sexes	superior and inferior vesical vv. to the internal iliac v.	urinary bladder	in the male - connects with the prostatic venous plexus and the rectal venous plexus; in the female - connects with the rectal venous plexus, uterine venous plexus and vaginal venous plexus
portal v.	formed by the union of the superior mesenteric v. and the splenic v.; tributaries: posterior superior pancreaticoduodenal v., right gastric v., left gastric v.	divides into right and left branches before entering the liver; into the liver sinusoids	all of the gut and its glands	portal v. connects with the vena caval drainage at 1) esophagus, 2) rectum, 3) umbilicus, 4) retroperitoneal gut structures; portal v. courses between two capillary beds (gut and liver)

Vein	Tributaries	Drains Into	Regions Drained	Notes
prostatic venous plexus	deep dorsal v. of the penis	internal iliac v.	penis and the prostate gland	prostatic venous plexus is connected with the vesical venous plexus
pudendal, deep external	part of the drainage of the superficial dorsal v. of the penis/clitoris	femoral	skin and superficial fascia of the penis/clitoris; pubic region	deep external pudendal v. shares its region of drainage with the superficial external pudendal v.
pudendal, internal	deep dorsal v. of the penis/clitoris, v. of the bulb, posterior labial/scrotal v., inferior rectal v.	internal iliac	crus and bulb of the clitoris/penis; urogenital region, anal region	internal pudendal v. passes through the pudendal canal
pudendal, superficial external	part of the drainage of the superficial dorsal v. of the penis/clitoris	GSV	skin and superficial fascia of the penis/clitoris; pubic region	superficial external pudendal v. shares its region of drainage with the deep external pudendal v.

Vein	Tributaries	Drains Into	Regions Drained	Notes
rectal venous plexus	no named tributaries	superior, middle & inferior rectal vv.	rectum and anal canal; anus	rectal venous plexus is a site of portal-caval anastomosis
superficial dorsal v. of the clitoris	no named tributaries	superficial external pudendal v.	skin and superficial fascia of the clitoris	superficial dorsal v. of the clitoris is located superficial to the deep fascia of the clitoris
superficial dorsal v. of the penis	no named tributaries	superficial external pudendal v.	skin and superficial fascia of the penis	superficial dorsal v. of the penis is located superficial to the deep fascia of the penis
superficial external pudendal v.	part of the drainage of the superficial dorsal v. of the penis/clitoris	GSV	skin and superficial fascia of the penis/clitoris; pubic region	superficial external pudendal v. shares its region of drainage with the deep external pudendal v.
testicular v.	pampiniform plexus	left: left renal v.; right: inferior vena cava	testis, ureter	left testicular v. is longer than the right testicular v.
uterine venous plexus	multiple tributaries from the uterus; deep dorsal v. of the clitoris	uterine vv. to the internal iliac v.	uterus & uterine tubes	connects with the ovarian v. and the vaginal venous plexus

Vein	Tributaries	Drains Into	Regions Drained	Notes
vaginal venous plexus	multiple tributaries from the vagina	vaginal v. to the internal iliac v. or uterine v.	vagina	connects with the uterine venous plexus, the vesical venous plexus and the rectal venous plexus
vena cava, inferior	formed by the union of the paired common iliac vv; tributaries: lumbar vv. 1-4, right ovarian/testicular v., renal vv., right suprarenal v., inf. phrenic v., hepatic vv.	right atrium	all of the body below the level of the respiratory diaphragm	the inferior vena cava is longer than the abdominal aorta
vertebral venous plexus, external	intervertebral vv.	adjacent segmental vv.; vertebral v. in the cervical region	vertebral column and associated muscles	two plexuses are described: anterior and posterior; connects with the internal vertebral venous plexus
vertebral venous plexus, internal	anterior and posterior longitudinal vertebral sinuses	adjacent segmental vv.	spinal cord, meninges, vertebral column	connects with the external vertebral venous plexuses; valveless; a route for potential spread of metastases from the pelvis to the brain
vesical venous plexus	multiple bladder tributaries	Sup. and inf. vesical vv. to the internal iliac v.	urinary bladder	in the male - connects with the prostatic venous plexus and the rectal venous plexus; in the female - connects with the rectal, uterine and vaginal venous plexus