

THE SAPHENOUS VEINS – THEIR ORIGIN, DRAINAGE AND VARIANT ANATOMY**A.B. Bendelic, V.C. Bendelic, I.M. Catereniuc***Nicolae Testemitanu State University of Medicine and Pharmacy, Chisinau, Republic of Moldova*

Key words: superficial veins of the lower limb, saphenous veins, saphenofemoral junction, saphenopopliteal junction.

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Abstract. The superficial veins of the lower limb, the saphenous veins, are subject to significant anatomical variability. The knowledge of variant anatomy of the saphenous veins is essential to surgical procedures such saphenous ablation or using them as a graft in coronary bypass surgery.

The objective of the study was to investigate the morphological variation in origin and drainage of the saphenous veins due to their importance in vascular surgery.

Materials and methods. The study involved classic dissection conducted on 24 formalized lower limbs within the Department of Anatomy and Clinical Anatomy of Nicolae Testemitanu State University of Medicine and Pharmacy, Chisinau, Republic of Moldova

Results. The origin of the saphenous veins, the dorsal venous arch, was present in 87.5% (21 limbs), it was double in 8.3% (2 limbs) and absent in 4.2% (1 limb). The great saphenous vein drained into the femoral vein forming the saphenofemoral junction, the last one being present in all the cases. The distance from the saphenofemoral junction to the anterior superior iliac spine showed a value of 12.25 ± 1.1 cm, the distance from the junction to the pubic tubercle was 4.23 ± 0.64 cm, and the distance from the junction to the middle of the inguinal ligament had a value of 4.3 ± 0.65 cm. However, the saphenopopliteal junction was found in 45.8% of cases (11 limbs), in other 50% of cases (12 limbs) the small saphenous vein ascended proximally on the posterior surfaces of the thigh as the cranial extension of the small saphenous vein, and in 4.2% of cases (1 limb) it flowed into the medial gastrocnemius veins. The cranial extension of the small saphenous vein in 29.2% (7 limbs) drained both into the great saphenous vein and into the muscular veins (via perforators of the thigh), in 12.5% (3 limbs) it continued with Giacomini's vein and drained into the great saphenous vein, and in 8.3% (2 limbs) it continued directly with the deep femoral vein.

Conclusions. Both the origin and drainage of the saphenous veins present anatomical variability. Knowledge of drainage of the saphenous veins is essential in pre-operative assessment of patients and may also lead to improvements in surgical techniques.

ПІДСКІРНІ ВЕНИ – ЇХ ПОХОДЖЕННЯ, РОЗГАЛУЖЕННЯ ТА ВАРІАНТИ АНАТОМІЇ**А.Б. Бенделік, В.К. Бенделік, І.М. Катеренюк**

Ключові слова: поверхневі вени нижньої кінцівки, підшкірні вени, сафенофеморальне з'єднання, сафено-підколінне з'єднання.

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Резюме. Поверхневі вени нижньої кінцівки, підшкірні вени, схильні до значної анатомічної мінливості. Знання варіантної анатомії підшкірних вен є важливим для хірургічних процедур, таких як абляція підшкірної залози або використання їх як трансплантата в коронарному шунтуванні.

Мета дослідження - вивчити морфологічні варіації походження та дренажу підшкірних вен через їх важливість у судинній хірургії.

Матеріал і методи. Дослідження включало класичну дисекцію, проведеною на 24 формалізованих нижніх кінцівках на кафедрі анатомії та клінічної анатомії Кишинівського державного університету медицини та фармації імені Ніколая Тестеміцану.

Результати дослідження. Початок підшкірних вен – дорсальна венозна дуга – у 87,5 % (21 кінцівка), подвійний – у 8,3 % (2 кінцівки) і відсутній – у 4,2 % (1 кінцівка). Велика підшкірна вена впадала в стегову вену, утворюючи сафенофеморальне з'єднання, останнє в усіх випадках. Відстань від сафенофеморального з'єднання до передньої верхньої ості клубової кістки становила $12,25 \pm 1,1$ см, відстань від з'єднання до лобкового горбка – $4,23 \pm 0,64$ см, відстань від з'єднання до середини пахової зв'язки – $4,3 \pm 0,65$ см. Однак у

45,8% випадків (11 кінцівок) виявлено підшкірно-підколінне з'єднання, в інших 50% випадків (12 кінцівок) мала підшкірна вена піднімалася проксимально по задній поверхні стегна як краніальне продовження малої підшкірної вени, і в 4,2% випадків (1 кінцівка) впадала в медіальні литкові вени.

Краніальний відросток малої підшкірної вени у 29,2 % (7 кінцівок) впадав як у велику підшкірну вену, так і в м'язові вени (через перфоратори стегна), у 12,5 % (3 кінцівки) продовжувався веною Джакоміні та впадав у велику підшкірну вену, а у 8,3% (2 кінцівки) продовжувався безпосередньо в глибоку стегнову вену.

Висновки. Як походження, так і дренаж підшкірних вен мають анатомічну варіативність. Знання про дренажування підшкірних вен є важливим для передопераційної оцінки пацієнтів, а також може призвести до вдосконалення хірургічних методів.

Introduction. The venous anatomy of the lower limbs is somewhat different from the corresponding arterial anatomy. According to the relation to the muscular fascia the veins of the lower limbs are subdivided into three groups: deep, superficial and perforating veins. The veins that lie beneath the muscular fascia, accompanying the major arteries, are the deep veins; those that are above the muscular fascia, in the subcutaneous tissue, are the superficial veins; and those that penetrate the muscular fascia and connect the superficial and deep veins are the perforating veins [6,7].

The two major superficial veins of the lower limbs are the great saphenous vein (*vena saphena magna*) and the small saphenous vein (*vena saphena parva*).

In this article we will examine the variant anatomy of the superficial veins of the lower limbs, knowledge of which is of great importance when assessing the surgical anatomy of the saphenous veins.

Both the great saphenous vein and the small saphenous vein derive from the dorsal venous arch of the foot.

The great saphenous vein originates in the medial extremity of the dorsal venous arch of the foot as the medial marginal vein. It is the longest vein in the human body, as it travels through the entire length of the lower limb. It ascends anteriorly to the medial malleolus, and then passes along the medial surface of the tibia to the knee joint. The great saphenous vein runs further posterior to the medial condyle of the femur, and from there it ascends medially in the thigh to drain into the femoral vein. In the femoral triangle it perforates the muscular fascia and join the femoral vein at the saphenofemoral junction, 2-4 cm distal to the inguinal ligament.

The great saphenous vein receives the following tributaries: perforating veins, accessory saphenous veins, superficial circumflex iliac vein, superficial epigastric vein and external pudendal veins.

The great saphenous vein can be congenitally duplicated in approximately 1% of cases [3].

The small saphenous vein arises from the lateral extremity of the dorsal venous arch of the foot as the lateral marginal vein. It ascends posteriorly to the lateral malleolus, and then runs upward along the lateral border of the calcaneal tendon. Running upward it reaches the middle of the posterior surface of the leg. It then passes between the two heads of the gastrocnemius muscle and ends in the popliteal vein forming the saphenopopliteal

junction. However, there are many variations in the termination of the small saphenous vein, including without connection to the popliteal vein. Before it penetrates the muscular fascia, it may branch out a cranial extension of the small saphenous vein that goes upward to join the great saphenous vein through the posterior thigh circumflex vein (the vein of the Giacomini) [6].

The tributaries of the small saphenous vein are the perforating veins and the accessory saphenous veins.

The mid-portion of the small saphenous vein may be duplicated in 4% of individuals [3].

The objective of the study was to evaluate the anatomical variants of the saphenous veins at their origin and drainage that would be of great help in planning varicose vein treatment and coronary bypass procedures.

Materials and methods. In the present study, twenty-four formolized lower limbs were dissected at the Department of Anatomy and Clinical Anatomy of *Nicolae Testemitanu* State University of Medicine and Pharmacy, in order to evaluate the origin and the drainage of the saphenous veins. Using the classical dissection twenty-four small saphenous veins and twenty-two great saphenous veins were exposed.

The anatomical variants were recorded and compared with those of the previous studies.

Results and discussion. The origin of the saphenous veins, the dorsal venous arch of the foot, located at the base of the metatarsal bones, was formed by confluence of four dorsal metatarsal veins. The perforating vein of the first intermetatarsal space was present in all of studied cases and it connected the dorsal venous arch of the foot with the plantar venous arch (deep venous system). The extremities of the dorsal venous arch continued proximally with the medial and lateral marginal veins. Such a situation was found in 87.5% of cases (21 limbs). In 8.3% of cases (2 limbs) at the dorsal surface of both feet of the same male corpse the double dorsal arch was found. The double venous arch continued proximally with double medial and double lateral marginal veins. In 4.2% of cases (1 limb) the dorsal venous arch was absent and two dorsal metatarsal veins continued cranially with two medial marginal veins, which in turn continued in the leg with double great saphenous vein. However, the other two dorsal metatarsal veins joined to form the lateral marginal vein that continued with the small saphenous vein.

We found no data about absence or double venous arch

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of the foot in the specialty literature.

The medial extremity of the dorsal venous arch, the medial marginal vein, ascended in front of the medial malleolus to continue proximally with the great saphenous vein. The medial marginal vein, in turn, received 3-4 medial foot perforating veins, which connected the medial marginal vein with the medial plantar veins. According to their topography, Uhl J-F et al. [12] described malleolar (or talar), navicular and cuneiform perforating veins; the malleolar perforating vein being one of the three roots of the great saphenous vein formation, along with the medial marginal vein and the dorsal perforating vein of the ankle (fig. 1). The dorsal perforating vein of the ankle linked the medial marginal vein with the dorsalis pedis veins.

The lateral extremity of the dorsal venous arch, the lateral marginal vein, run behind of the lateral malleolus to continue proximally with the small saphenous vein. The

lateral marginal vein received two lateral foot perforating veins that derived from the lateral plantar veins. The lateral perforating veins were described by Uhl J-F et al. [12] as calcaneal and cuboidal perforating veins. These two lateral foot perforating veins often joined into a common trunk becoming in this way the main root of the small saphenous vein formation, along with the lateral marginal vein. In our study, the common trunk of the lateral foot perforators was present in 66.7% of cases (fig. 2).

In front of the lateral malleolus the lateral marginal vein often divided in 2-3 trunks and resulting veins surrounded the lateral malleolus to form the malleolar plexus, which varied in shape and size (fig. 3).

The perforating veins of the foot are characterized by a directed venous flow from the deep veins to the superficial veins, due to the presence of the unidirectional valves or the absence of valves, a unique feature of the venous system of the lower limbs [15].

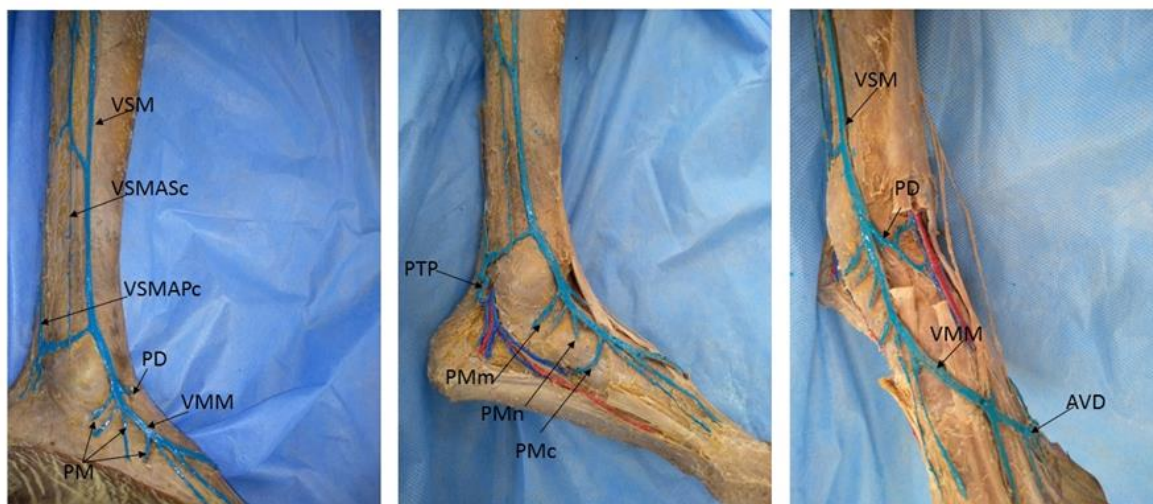


Fig. 1. The medial marginal vein and the medial foot perforating veins. ADV – arcus venosus dorsalis pedis; VMM – vena marginalis medialis; PM (PMm, PMn, PMc) – venae perforantes pedis mediales; PD – vena perforans tarsalis dorsalis; PTP – vena perforans cruris tibialis posterior; VSM – vena saphena magna; VSMAPc – vena saphena magna accessoria posterior cruris; VSMASc – vena saphena magna accessoria superficialis cruris

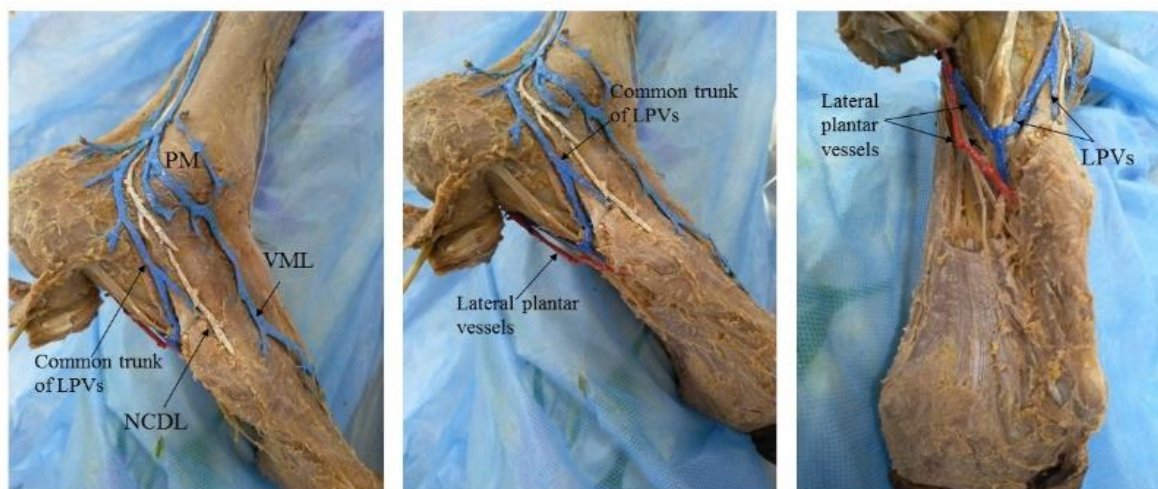


Fig. 2. The lateral marginal vein and the common trunk of the lateral foot perforating veins VML – vena marginalis lateralis, PM – plexus malleolaris, LPVs – lateral perforating veins of the foot, NCDL – nervus cutaneus dorsalis lateralis



Fig. 3. The malleolar plexus as the origin of the small saphenous vein
 VSP – vena saphena parva, PM – plexus malleolaris, VML – vena marginalis lateralis, LPVs – lateral foot perforating veins, NS – nervus suralis, NCDL – nervus cutaneus dorsalis lateralis

In the region of the leg the great saphenous vein was solitary in 31.82% of cases (7 limbs), was double in 4.55% of cases (1 limb), and was accompanied by the accessory saphenous veins in 63.63% of cases (14 limbs). The anterior accessory great saphenous vein of the leg was found in 50% (11 limbs), the posterior accessory great saphenous vein – in 59.1% (13 limbs) and the superficial accessory great saphenous vein of the leg – in 9.1% (2 limbs).

The posterior accessory great saphenous vein of the leg (Leonardo's vein) when present, first ascended parallel to the small saphenous vein in the distal and middle thirds of the calf with numerous anastomoses (communicating veins) between them, then in the proximal third surrounded the medial surface of the leg to flow into the great saphenous vein. In 4 of 13 cases the posterior accessory great saphenous vein of the leg drained into the small saphenous vein.

According to an ultrasound study performed on 200 limbs, the incidence of the posterior accessory great saphenous vein of the leg is 49.5%; to the right being present with an incidence of 45% and to the left – 54%. The confluence of the posterior accessory saphenous vein of the leg with the great saphenous vein is located above the knee level in 4% of cases, at the knee level – in 14% of cases, below the knee level – in 74% of cases [16].

In the thigh a single trunk of the great saphenous vein was observed in 40.9% of cases (9 limbs), a duplicated vein was found in 13.6% of cases (3 limbs), and in 45.5% of cases (10 limbs) was accompanied by the anterior or superficial accessory great saphenous vein.

The duplication of the great saphenous vein, a rare anatomic variant, in our study was observed in 4.55% (1 limb) in the region of the leg and in 13.6% (3 limbs) in the region of the thigh.

Although, the specialized literature suggests that the great saphenous vein is present in 1-49% of cases [10], L'Union Internationale de Phlébologie in 2006 defines the

great saphenous vein duplicity as being present in 1.6-2% of cases [5, 10]. According to Caggiati A. et al. [4] the duplication of the great saphenous vein occurs only in 1% of cases and the accessory saphenous veins with parallel path, but located more superficially, are found in 26% of cases.

The anterior great saphenous vein of the thigh is detected in 14% of patients with varicose veins [9] and can be confused with great saphenous vein. It is located anterior and lateral to the great saphenous vein, while the latter is located medially and along the femoral artery and vein.

In case of the double great saphenous vein, as well as in case of presence of the anterior or superficial accessory great saphenous veins of the thigh, the *confluens venosus subinguinalis* located close to saphenofemoral junction had the appearance of the "venous star" described by Paturet (fig. 4).

In our study the confluence received the following tributaries: the superficial circumflex iliac vein in 72.7% (16 limbs), the superficial epigastric vein in 68.2% (15 limbs), the superficial external pudendal vein in 68.2% (15 limbs), the deep external pudendal vein in 9.1% (2 limbs), the anterior accessory great saphenous vein of the thigh in 40.9% (9 limbs), the superficial accessory great saphenous vein of the thigh in 4.55% (1 limb).

The posterior accessory great saphenous vein of the thigh was observed in 68.2% of cases (15 limbs), but it drained into the great saphenous vein distinctly below the saphenofemoral junction (from 4 cm to 10 cm).

Muhlberger D. et al. [8] found an average of 3.7 tributaries draining into the great saphenous vein near the saphenofemoral junction, including the superficial circumflex iliac vein in 82.9% of cases, the superficial epigastric vein in 78.3%, the superficial external pudendal vein in 90.3%. The accessory saphenous veins were less frequent, the anterior accessory great saphenous vein being identified in 50.7% and the posterior accessory great

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saphenous vein in 67.7% of cases.

According to Souroullas P et al. [11] the median number of the saphenofemoral junction's tributaries is 4, in 43% of cases at least one tributary flows into the femoral vein, usually this being the deep external pudendal vein (91.9%). The anterior accessory great saphenous vein was identified in 35.8% and the posterior accessory great saphenous vein in 53.8% of cases.

One of the characteristics of the saphenofemoral junction was its anatomical fixity in relation to the adjacent anatomical landmarks: the anterior superior iliac spine, pubic tubercle and inguinal ligament (fig.7). The distance from the saphenofemoral junction to the anterior superior iliac spine showed an average value of 12.25 ± 1.1 cm, the distance from the junction to the pubic tubercle was 4.23 ± 0.64 cm, and the distance from the junction to the middle of the inguinal ligament had an average value of 4.3 ± 0.65 cm.

The small saphenous vein ascended first between the lateral malleolus and the Achilles tendon, then along the lateral border of the calcaneal tendon. At the borderline between the tendon and muscular part of the triceps surae muscle the small saphenous vein was placed in the middle

of the posterior surface of the calf and finally ascended cranially along the groove between two heads of the gastrocnemius muscle to the popliteal fossa.

The saphenopopliteal junction was found in 45.8% of cases (11 limbs), in other 50% of cases (12 limbs) the small saphenous vein ascended proximally on the posterior surfaces of the thigh as the cranial extension of the SSV, and in 4.2% of cases (1 limb) it flowed into the medial gastrocnemius veins.

In 5 (20.8%) from 11 limbs the small saphenous vein drained only into the popliteal vein forming the saphenopopliteal junction, in other 6 limbs (25%) the small saphenous vein divided into two trunks: one formed the saphenopopliteal junction, the other continued proximally on the posterior side of the thigh with cranial extension.

In the other 12 limbs (50%) the small saphenous vein ascended proximally on the thigh without having connections with the popliteal vein: in 7 limbs (29.2%) it drained into the great saphenous vein and into the muscular veins (via perforators of the thigh), in 3 limbs (12.5%) it continued with Giacomini's vein and drained into the great saphenous vein, and in 2 limbs (8.3%) it continued directly with the deep femoral vein (fig. 5).



Fig. 4. „Venous star” described by Paturet. 1 – vena saphena magna; 2 – vena saphena magna accessoria anterior femoris; 3 – vena circumflexa ilium superficialis; 4 – vena epigastrica superficialis; 5 – vena pudenda externa superficialis; 6 – nervus femoralis; 7 – arteria femoralis; 8 – vena femoralis

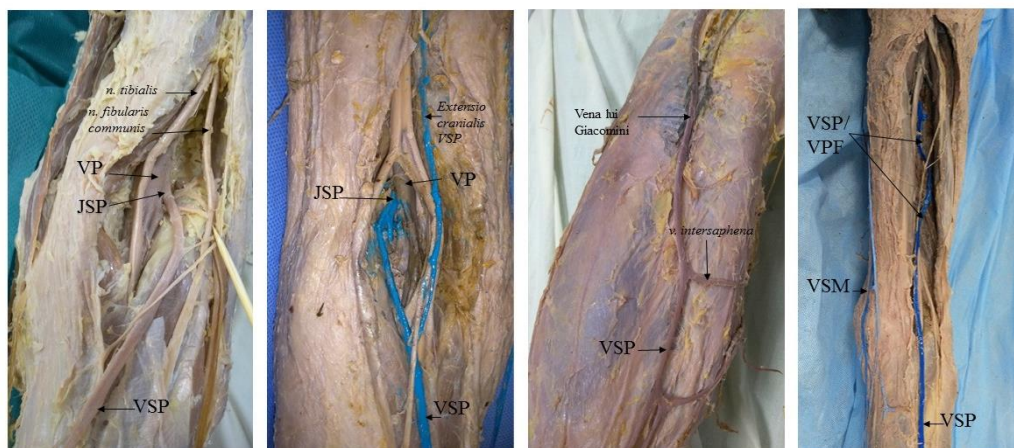


Fig. 5. Variations in the termination of the small saphenous vein. VSP – vena saphena parva; VP – vena poplitea; JSP – junctio saphenopoplitea; VPF – vena profunda femoris; VSM – vena saphena magna

Uhl J.-F. et al. [13, 14] describes five types of drainage of the small saphenous vein: two with the presence of saphenopopliteal junction (types A and B) and other three with absence of the saphenopopliteal junction (types C, D and E):

- type A: normal position of the saphenopopliteal junction (83%);
- type B: higher position of the saphenopopliteal junction (6%);
- type C: absence of the saphenopopliteal junction, the cranial extension of the small saphenous vein continues as Giacomini's vein (5%);
- type D: absence of the saphenopopliteal junction, the cranial extension of the small saphenous vein ends deep in the thigh muscles (5%);
- type E: absence of the saphenopopliteal junction, the lower termination of the small saphenous vein at the leg level (1%).

According to the embryogenesis of the vessels of the lower limbs in the literature the other types of the small saphenous vein inflow are described [1, 2]:

- type I: the small saphenous vein flows into the popliteal vein forming the saphenopopliteal junction; this type being divided into subtypes: a) the small saphenous vein drains only into the popliteal vein, b) the small

saphenous vein divides into two venous trunks: one drain into the popliteal vein, the second continues as Giacomini's vein and drains into the great saphenous vein;

- type II: the small saphenous vein extends proximally on the thigh and drains into: a) the deep veins of the thigh, b) both the deep veins of the thigh and the great saphenous vein, c) directly into the great saphenous vein;
- type III: the small saphenous vein flows into the veins of the leg without reaching the popliteal vein, draining into: a) the gastrocnemius veins or b) the great saphenous vein.

Conclusions. Both the origin and drainage of the saphenous veins present anatomical variability. The origin of the saphenous veins, the dorsal venous arch of the foot, can be double or absent. The accessory saphenous veins are found along the trajectory of the great saphenous vein however the double great saphenous vein is a rare anomaly.

Knowledge of drainage of the saphenous veins is essential in pre-operative assessment of patients and may also lead to improvements in surgical techniques.

Prospects for further research. The combination of the variant anatomy of the saphenous veins and their embryogenesis could have a promising research work for better comprehension and clinical management of venous disease.

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