

Vena saphena magna – peculiarities of origin, trajectory and drainage

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Abstract

Background: *Vena saphena magna* (VSM) – one of the two superficial venous collectors of the lower limb, the longest vein of the human body, is often accompanied by parallel veins, of which clinical significance may be different. The objective of the study was to investigate the individual anatomical variability of the VSM, on macroscopic aspect, in cadavers, of which variability is important for the vascular surgeon and / or for the cardiac surgeon.

Material and methods: This study was conducted on 22 formolized lower limbs using classical dissection methods. The observed anatomical variants were recorded and photographed.

Results: The dorsal venous arch of the foot, the origin of the VSM, was double in 2 cases (9.1%), and it was absent in one case (4.55%), thus two dorsal metatarsal veins continued proximally with two medial marginal veins. In the leg, VSM was double in one case (4.55%), and in other 14 cases (63.63%) it was accompanied by accessory saphenous veins. In the thigh, it was double in 3 cases (13.6%), and in 10 cases (45.5%) it was accompanied by accessory saphenous veins. The saphenofemoral junction was located at 4.23 ± 0.64 cm distance from the pubic tubercle; at 12.25 ± 1.1 cm away from the anterior superior iliac spine and at 4.3 ± 0.65 cm below the middle of the inguinal ligament.

Conclusions. The anatomical variability of the VSM includes its duplicity and/or presence of the accessory saphenous veins. The dorsal venous arch may be double or absent. The saphenofemoral junction is relatively fixed in relation to the neighboring bone landmarks.

Key words: great saphenous vein, accessory saphenous veins.

Cite this article

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Introduction

The venous anatomy of the lower extremity is substantially more variable and complicated than the corresponding arterial anatomy. The lower limb venous system includes superficial, deep, and perforating veins. The two major superficial veins of the lower limb, the great and small saphenous veins, are located above the deep or muscular fascia, within the subcutaneous tissue. The deep veins lie beneath the muscular fascia and accompany all major arteries. The perforating veins penetrate the muscular fascia and connect the superficial and deep veins [1-4]. A series of bicuspid valves together with venous muscle pumps ensure the return of blood against gravity to the heart. [5].

The *vena saphena magna* or great saphenous vein (GSV), the longest vein in the body, arises from the medial aspects of the dorsal pedal venous arch and empties into the femoral vein just below the inguinal ligament. During its course, it ascends anterior to the medial malleolus and along the medial border of the tibia, then it passes posterior to the medial condyle of the femur, and further it travels along the medial aspect of the thigh. In the proximal segment of the femoral trigon, the GSV pierces the *fascia cribrosa*, transverses the saphenous opening of the *fascia lata* and drains into the femoral vein forming the saphenofemoral junction [1-3]. The GSV lies in the saphenous compartment that is

bordered superficially by saphenous fascia and deeply by the muscular fascia, but its tributaries are external to the compartment [6, 7].

The GSV remains an essential component in strategies for coronary artery bypass grafting in humans. The vessel is used alone or in combination with arterial grafts and has the advantage of being available autologous vascular tissue in most patients in need of such surgeries [5]. The clinical usage of the GSV has made its anatomical variations noteworthy.

The GSV is often accompanied by its tributaries and at times tributaries can be confused with the GSV or be mistaken for GSV duplication. Accessory saphenous veins, tributaries of the great saphenous vein, also may be important in the pathophysiology of the chronic venous disease. There are two main saphenous tributaries in the calf, the anterior (or anterior arch vein) and the posterior (or posterior arch (Leonardo's) vein) accessory great saphenous veins, that join the GSV just distal to the knee [8, 9]. The clinically important posterior tibial perforating veins (Cockett perforators) join the posterior arch vein rather than the main trunk of the GSV [3]. In the thigh, the anterior and posterior accessory great saphenous veins ascend parallel to the GSV, external to the saphenous fascia [8, 9]. The venous drainage from the perineum and lower abdominal wall (superficial

external pudendal, superficial epigastric and superficial circumflex iliac veins) commonly joins the GSV near the saphenofemoral junction. The newly introduced term *confluenens venosus subinguinalis* (confluence of superficial inguinal veins) is a part of the GSV bordered by two valves: terminal valve, located close to the estuary of the vein into common femoral vein, and preterminal valve situated 3-5 cm against flow [9].

Numerous and variable perforating veins of the lower limb can be grouped into three groups of clinical significance – those of the foot, the calf and thigh perforators. The foot perforators are unique in that they normally direct flow toward the superficial veins [10, 11], while all others normally direct flow to the deep system. The medial calf perforators, including the paratibial (Sherman and Boyd perforators) and the posterior tibial perforators (Cockett perforators), are clinically most important. The perforators of the adductor canal (hunterian perforators) connect the GSV proximal to the knee with femoral or popliteal vein.

A thorough understanding of the high variable venous anatomy is essential for understanding the underlying pathophysiology as well as in directing treatment. Knowledge of anatomical variability of great saphenous vein is of great importance when assessing the surgical anatomy of the GSV.

As a consequence, the objective of this study was to evaluate anatomical variation of the GSV, its origin, course, tributaries and perforators that would be of great help in planning varicose vein treatment and coronary bypass procedures where it is used as autograft.

Material and methods

In the present study, twenty-two formalized lower limbs were dissected at the Department of Human Anatomy, in order to study the origin, course, tributaries and perforators of the GSV. The dissection of the GSV was performed by traditional techniques. After exposing the vein, we measured its external diameters, as well as distances from the saphenofemoral junction to the adjacent landmarks. The

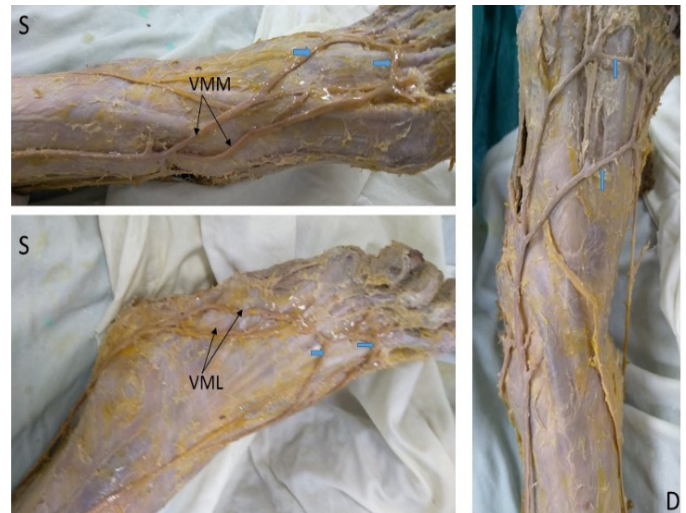


Fig. 1. Double dorsal pedal venous arch (arrows) that continues proximally with double medial and lateral marginal veins
VMM – *venae marginales mediales*, VML – *venae marginales laterales*.

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

Results

At the confluence of the medial extremity of the dorsal pedal venous arch with the *vena digitalis dorsalis pedis prima*, the medial marginal vein was formed, that ascends in front of the medial malleolus to continue proximally with the GSV. Such a situation was found in 86.35% of cases (19 limbs). In 9.1% of cases (2 limbs) at the dorsal faces of both feet of the same male corpse the double dorsal venous arch was found (fig. 1). It continued proximally with the double medial and lateral marginal veins, but at the distal extremity of the medial malleolus two medial marginal veins joined to form a single venous trunk that continued cranially with the GSV. In 4.55% 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 calf with double GSV (fig. 2).

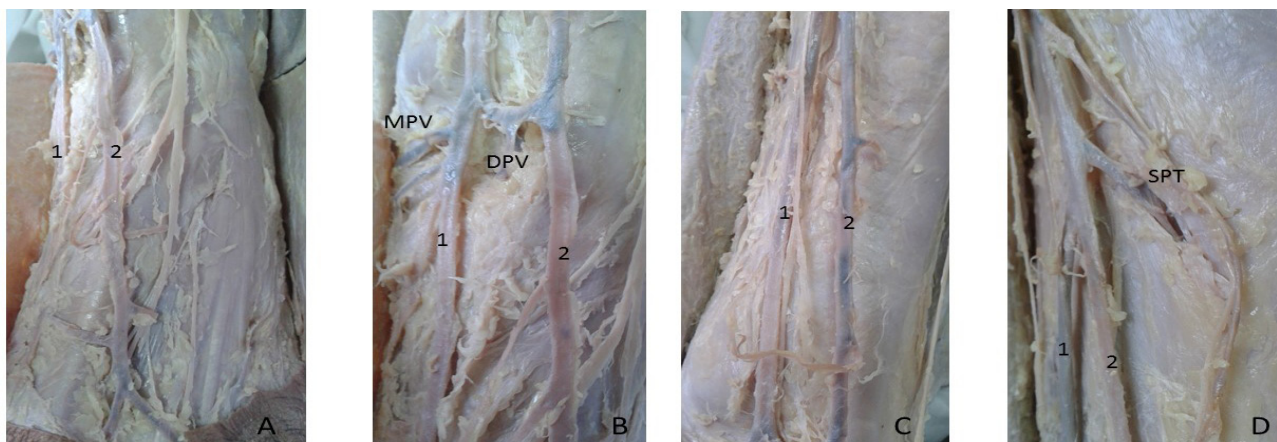


Fig. 2. Absence of the dorsal pedal venous arch

A) Two medial marginal veins on the dorsal surface of the foot, B) Two medial marginal veins at the ankle, with a communicating vein between them, receiving a dorsal perforating vein of the ankle, C) Two GSV in the distal third of the calf, D) Two GSV in the proximal third of the calf.

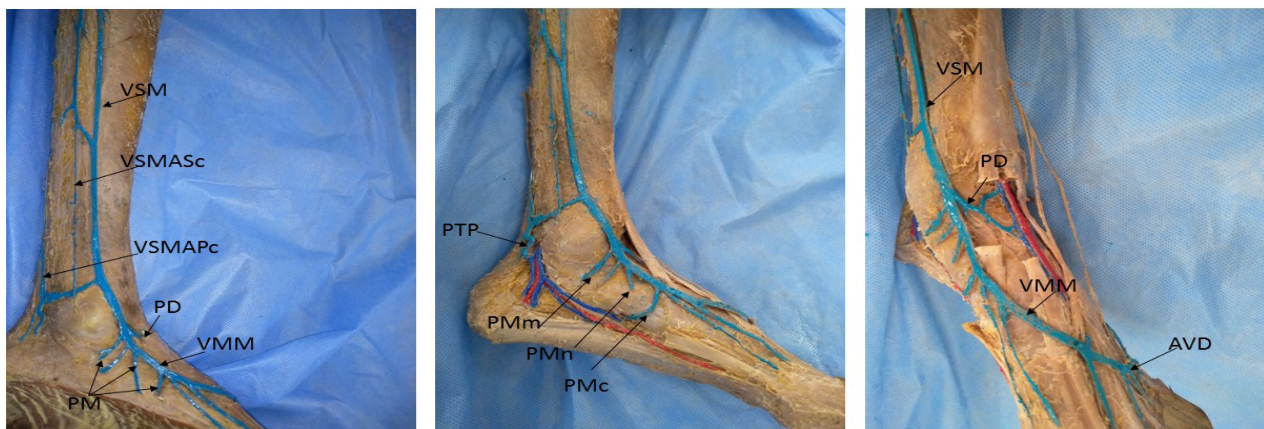


Fig. 3. The medial marginal vein and medial foot perforating veins

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.

The medial marginal vein commonly received 3-4 medial foot perforating veins that connected the medial marginal vein with the medial plantar veins. According to the topography there were malleolar, navicular and cuneiform perforating veins. At the ankle, the medial marginal vein also received a dorsal perforating vein that connected the above-mentioned vein with the anterior tibial or / and dorsal pedal veins (fig. 3).

In the calf the diameter of the GSV was ranged from 1 mm to 4 mm, and it was accompanied by the saphenous nerve. In 31.82% of cases (7 limbs) the GSV was solitary, in 4.55% of cases (1 limb) it was double, and in 63.63% (14 limbs) it was accompanied by accessory saphenous veins (fig. 4).

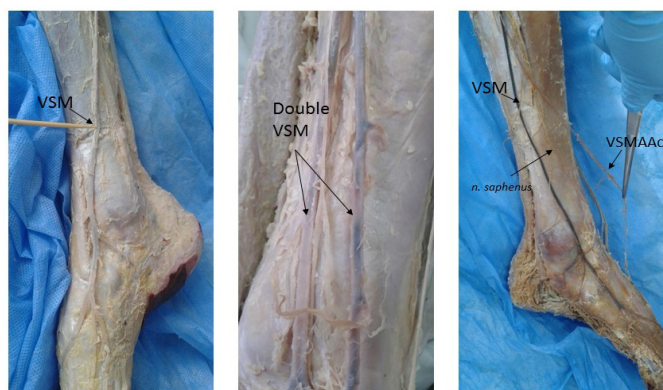


Fig. 4. The solitary GSV, double GSV and accessory saphenous veins of the calf

VSM – vena saphena magna, VSMAAc – vena saphena magna accessoria anterior cruris.

Among the tributaries of the GSV were the anterior accessory great saphenous vein of the leg (11 limbs), the posterior accessory great saphenous vein of the leg (13 limbs), and the superficial accessory great saphenous vein of the leg (2 limbs). The anterior accessory saphenous vein was the only accessory vein in 9.1% (2 limbs), the posterior accessory saphenous vein was the only accessory vein in 13.6% (3 limbs), both the anterior and posterior accessory saphenous veins were present in 40.9% (9 limbs). The posterior accessory saphenous vein was accompanied by the superficial accessory saphenous vein in 4.55% (1 limb), and three accessory saphenous veins were present in 4.55% (1 limb), (tab. 1).

In the distal third of the calf the posterior tibial perforating veins (Cockett perforators) connected to the GSV or to the posterior accessory great saphenous vein were found, in the proximal third of the calf the paratibial perforating veins were observed.

A short segment of the GSV ascending cranially posterior to the medial condyle of the femur, was connected to the small saphenous vein by 1-2 intersaphenous veins (fig. 5).

In the thigh the diameter of the GSV was ranged from 2.5 mm to 6 mm. A single trunk of the GSV 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% (10 limbs) the GSV was accompanied by the anterior or superficial accessory great saphenous veins. The anterior accessory great saphenous vein of the thigh was identified in 40.9% (9 limbs), the superficial accessory saphenous vein was observed in 9.1% (2 limbs), but the posterior accessory saphenous vein of the

Table 1

The incidence of the duplicated and accessory great saphenous veins

	Double GSV*	AAGSV*	PAGSV*	SAGSV*
In the calf	4.55% (1 limb)	50% (11 limbs)	59.1% (13 limbs)	9.1% (2 limbs)
In the thigh	13.6% (3 limbs)	40.9 (9 limbs)	68.2% (15 limbs)	9.1% (2 limbs)

*GSV – great saphenous vein; *AAGSV – anterior accessory great saphenous vein; *PAGSV – posterior accessory great saphenous vein; *SAGSV – superficial accessory great saphenous vein.

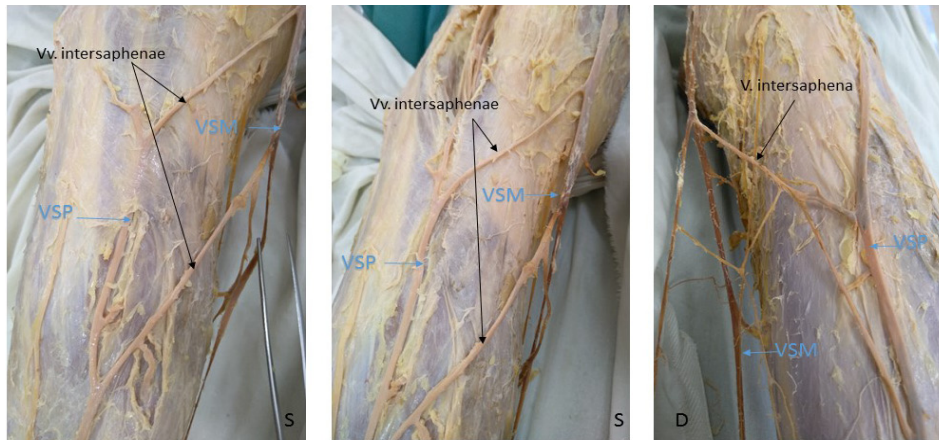


Fig. 5. The intersaphenous veins. VSM – vena saphena magna, VSP – vena saphena parva

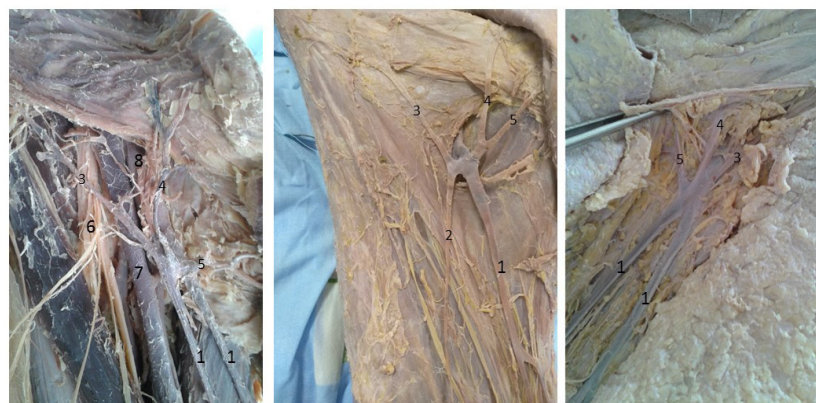


Fig. 6. “Venous star” described by Paturet

- 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

thigh was found in 68.2% (15 limbs) (tab. 1). In case of the double GSV, as well as in case of presence of the anterior or superficial accessory saphenous veins, the *confluens venosus subinguinalis* had the appearance of the “venous star” described by Paturet (fig. 6). 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 drained into the GSV distinctly below the saphenofemoral junction (from 4 cm to 10 cm).

One of the characteristics of the saphenofemoral junction is 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.



Fig. 7. Distances from the saphenofemoral junction to the adjacent anatomical landmarks

- SIAS – spina iliaca anterior superior, TB – tuberculum pubicum,
- mij lig. in. – middle of the ligamentum inguinale

Discussion

Although the venous patterns described in this study generally resembled previous descriptions, there were some differences between our own observations and those in the literature.

We observed some variation in the origin of the GSV. The presence of double dorsal venous pedal arch or its absence have not been previously mentioned in the literature. This doubling may have a physiological significance in the venous return mechanism. In turn, the absence of the dorsal venous pedal arch may be accompanied by double GSV.

A phlebographic study showed that a single trunk of the GSV was present in the calf in 45% of patients and in the thigh in 65% [12]. In our study the GSV was solitary in the calf in 31.9% and in the thigh in 40.9%.

A rare anatomical variation which consists in duplication of the GSV in our study was found in the calf in 4.55% (1 limb) and in the thigh in 13.6% (3 limbs). Two criteria make the differences between duplicated GSV and accessory saphenous vein. The two GSV lie in the same plane, parallel to the skin and run along the deep or muscular fascia. These two GSV will also have the same caliber draining a common cutaneous territory. An accessory saphenous vein is usually smaller in size and does not drain the same cutaneous territory [13]. Though the literature suggests that duplication of GSV is present in 1-20% of cases [14], true duplication defined by Union International de Phlebologie (UIP) in 2006 is present in 1.6 – 2% of cases [14]. The duplication of GSV can be described in three types based on its relationship with the femoral vein: duplication with a common junction, duplications with separate junctions, insular duplication with a common junction [13]. In our study the duplicated GSV drains in femoral vein separately at the saphenofemoral junction.

According to Yuce et al. [15] the frequency of posterior accessory great saphenous vein of the leg is more common in the left limbs (54%) than the right limbs (45%). The type of joining of the accessory veins to the GSV is above the knee level in 4%, at the knee level in 14%, and below the knee level in 70% of patients [15]. In our study the posterior accessory vein of the leg was identified in 59.1% (13 limbs), but four of them drained into the small saphenous vein.

Mühlberger D. et al. [16] found an average of 3.7 tributaries veins entering the GSV close to the saphenofemoral junction. The superficial epigastric vein was found in 78.3% of limbs, the superficial external pudendal vein was most frequent and was identified in 90.3% of limbs, the superficial circumflex iliac vein was found in 82.9% of limbs, the anterior and posterior accessory great saphenous veins were less frequently observed. The anterior accessory vein discharged into the GSV in 50.7%, and the posterior accessory vein in 67.7% [16]. According to Souroullas P. et al. [17], the median number of the saphenofemoral junction tributaries is 4, in 43% of cases at least one tributary drains directly into the femoral vein, commonly the deep external pudendal vein (91.9%). The anterior accessory great saphenous vein

of the thigh was identified in 35.8%, and the posterior accessory great saphenous vein of the thigh in 53.8% [17]. In our study we found the anterior accessory great saphenous vein in 40.9%, the posterior accessory great saphenous vein in 68.2%, and the superficial accessory great saphenous vein in 9.1%. A topic of discussion deals with posterior accessory great saphenous vein, that was situated distinctly below the saphenofemoral junction (from 4 cm to 10 cm).

According to Ndiaye A. et al. [18], on average, the saphenofemoral junction is projected out 10.88 cm from the anterior superior iliac spine, 3.83 cm from the pubic tubercle and 4.19 cm from the inguinal ligament. In our study the distances from the saphenofemoral junction to the adjacent landmarks were respectively 12.25 cm, 4.23 cm and 4.3 cm.

Mühlberger D. et al. [16] attests a complete “venous star” with five tributaries discharging into the GSV in 18.4% [16], but Ndiaye A. et al. states that a conventional type in a “vein star” shape is not the most frequent [18].

Conclusions

Dissection of 22 cadaveric feet revealed the presence of a previously unreported double dorsal venous pedal arch and its absence. This doubling may have a physiological significance in the venous return mechanism. In turn, the absence of the dorsal venous pedal arch may be accompanied by double GSV.

Duplication and persistence of accessory GSV were two major clinically significant anatomical variations of the GSV. Locating such variations of GSV is a challenging task for both diagnostic and therapeutic tactics.

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Authors' contribution

AB designed the trial, performed it, interpreted the data, drafted the first manuscript. IC interpreted the data, revised the manuscript. Both authors revised and approved the final version of the manuscript.

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Ethics approval and consent to participate

The protocol of this study was approved by Ethics Research Committee of *Nicolae Testemitanu* State University of Medicine and Pharmacy, Chisinau, the Republic of Moldova (protocol No 30/32 of 29.05.2014).

Conflict of Interests

The authors declare the absence of conflict of interests.

