The anatomy of the small saphenous vein: Fascial and neural relations, saphenofemoral junction, and valves

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Purpose: **Varicose veins are a frequent burden, also in the small saphenous system. Yet its basic anatomy is not described consistently. We therefore investigated the fascial and neural relationships of the small saphenous vein (SSV) as well as the frequency and position of valves and the different junctional patterns, also considering the thigh extension.**

Materials and Methods: **We dissected the legs of 51 cadavers during the regular dissection course held in winter 2007 at Innsbruck Medical University, with a total of 86 SSVs investigable proximally and 94 SSVs distally.**

Results: **A distinct saphenous fascia is present in 93 of 94 cases. It starts with a mean distance of 5.1 cm (SD 1.2 cm) proximal to the calcaneal tuber, where the tributaries to the SSV join to form a common trunk. The neural topography at the level of the gastrocnemius muscle's origins shows the medial sural cutaneous nerve in 88% medially and in 12% laterally to the SSV, the tibial nerve in 64% medially and in 36% laterally, and the common fibular nerve in 98% medially and in 2% laterally to the vein. The saphenopopliteal junction (SPJ) resembled in about 37% type A (UIP-classification), 15% type B, and 24% type C. A total of 17% of specimens showed a venous web or star at the popliteal fossa and 6% had a doubled junction. A thigh extension could be demonstrated in about 84%. A most proximal valve was present in only 94% at a mean distance of 1.2 cm (SD 1.4 cm) to the SSVs orifice. A consecutive distal valve was only present in 65% with a mean distance of 5.1 cm (SD 2.3 cm).**

Conclusion: **Two fascial points or regions can be described in the SSVs' course and its own saphenous fascia is demonstrated macroscopically in almost all cases. The neural topography is highly individual. The SPJ is highly individual where we found hitherto unclassified patterns in a remarkable number of veins. Venous valves are not as frequent as we supposed them to be. Furthermore, not all most proximal valves seem to be terminal valves. (J Vasc Surg 2010;51: 982-9.)**

Clinical Relevance: **Our study's aim is to support the basic understandings of the small saphenous system by providing exact anatomic data. This will help to understand physiology as well as pathophysiologic possibilities at the small saphenous system. On the other hand, our study especially can provide assistance for the vascular surgical approach at the popliteal fossa and also distally to the beginning of the trunk of the short saphenous vein itself.**

The knowledge about the venous system is rapidly increasing and is now in a period of massive reconsideration. An ultrasound (US) scan has become the gold standard modality in phlebologic assessment.[1,2] Moreover, in scientific settings, a US scan revealed new anatomic as well as physiologic and pathologic information on the venous system. For instance, it has been demonstrated that in healthy veins no reversal of blood flow is necessary for closing the terminal valve of the great saphenous vein (GSV); a decrease of blood flow velocity and not a retrograde wave causes a venous valve to close.[3]

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The ways of determining the fascial relations of the small saphenous vein (SSV) have changed due to the usage of US scans. The long accepted penetration of the crural fascia became doubted, and it could be demonstrated that the SSV lies in its own fascial compartment all along its course.[4] This can easily be visualized and helps to differentiate between the SSV and its tributaries.

The termination of the SSV has been classified with great variability concerning its communication with the popliteal vein (PV).[1,5-9] A short time ago, a new internationally accepted classification system for the saphenopopliteal junction (SPJ) was estabished.[10-12] This system does not emphasize the junctional height but concentrates on the aspect of the SPJ itself in combination with its thigh extension (TE; Fig 1, types A-C).

Concerning clinical anatomy, the proximity of the SSV to nerves must be kept in mind. Neural injury during varicose surgery is known to be a major complication. Moreover, it is also one of the major reasons for legal action against phlebologists.[13] However, detailed information on the exact topography is reported contradictory.[4-7,14] This is more important as nerves are thought to be guiding structures for venous development.[15]

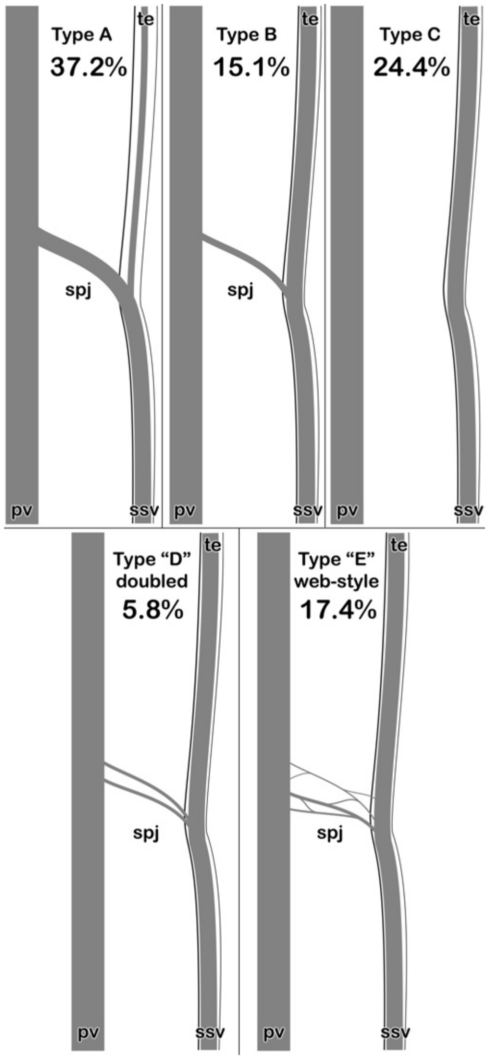

Fig 1. Different types of the saphenopopliteal junction (spj). Types A-C are labeled according to the UIP-consensus;[10-12] we suggest to expand this typology by adding type "D" representing a doubled saphenopopliteal junction, and type "E" representing a web-style saphenopopliteal junction. *pv,* popliteal vein; *ssv,* short saphenous vein; *te,* thigh extension.

We had two aims for our study. First, we wanted to determine whether there are always valves within the SSV near the SPJ and where they are located exactly. The second aim was to find out some specific details on topographic anatomy concerning the SSV (ie, fascial and neural relationship, frequency of the TE, and distinct types of terminations following the UIP-criteria)[12] in a prospective manner, keeping the capabilities of US scan in mind. Cadaveric dissection was selected to provide basic research background and provide data for future comparison for US scan-based studies.

As we dissected some interesting aspects of the morphology of the TE, we planned a consecutive study, which we will present as Part II.

MATERIALS AND METHODS

Between October and December 2007, during the regular dissection course at the Innsbruck Medical University, we studied the SSVs of 51 cadavers. The corpses were fixed by phenolic acid and formaldehyde.[16] Their mean age was 82.5 years (SD 8.8) and their mean height was 168 cm (SD 9.0); details are given in Table I. The Department of Anatomy, Histology, and Embryology, Division of Clinical and Functional Anatomy, provided all cadavers. They were assigned for the specific use of the anatomic dissection course held for students in their second year, and were bequested to the Division by informed consent.[17]

The cadavers were pre-dissected by students who performed most of the skin removal. In total, our investigation covered 86 SSVs at the knee level and 94 at the ankle level. Reasons for non-examination are listed in Table II. After locating the SSV in the lateral retromalleolar region, we exposed the saphenous fascia and marked its macroscopic beginning, ie, the start of a common trunk covered by a saphenous fascia, by tying a supination knot with Ethicon Vicryl 1.0 (Johnson & Johnson, Norderstedt, Germany) through the SSV. Next, we followed the vein to the point of a clear macroscopic change in its fascial relationship and marked this point in the same way. After opening the crural and popliteal fascia along the SSV, we carefully dissected the vein and displayed the SPJ if existent. In cases with a lumen wide enough for opening and a clear SPJ, we opened the vein longitudinally with a scalpel and dentist's forceps starting 20 cm distally to the junction and proceeding in proximal direction, to avoid harming the valves, until the PV. Finally, we cleaned the lumen of the SSV with diluted phenolic solution.

In a prepared protocol, we documented the beginning of the saphenous fascia by tape measurement from the calcaneal tuber median on the lower leg to the level of the distal knot. Then we documented the location of the SSV to the nerves at the level of the origin of both heads of the gastrocnemius muscle and performed a tape measurement in situ from the distal margin of the orifice of the SSV into the PV to the nodule of existing valves and the proximal knot, respectively. The presence of a TE was documented and the level of its origin from the SSV was measured starting from the SSVs' orifice. The SPJs were categorized, and finally we photographed interesting findings with a Nikon D100 (Nikon Corporation, Tokyo, Japan) and a Power Shot A610 (Canon Corporation, Kanagawa, Japan). The analysis of the data collected was done by Excel 2002 (Microsoft Inc, Redmond, Wash) and SPSS 15 (SPSS, Inc, Chicago, Ill).

RESULTS

Fascial relationship. The existence of a distinct saphenous fascia can be demonstrated in 93 of 94 cases (98.94%), whereas in one leg (1.06%) no particular saphenous fascia was detectable. The offset of the common trunk, ie, the beginning of the SSV, was situated at an average level of 5.1 cm (SD 1.2 cm) proximal from the calcaneal tuber (Fig 2).

Table I. Demographical data of the investigated specimens

	Female					*Male*				
	N	*Mean*	*SD*	*Min*	*Max*	*N*	*Mean*	*SD*	*Min*	*Max*
Age (years)	29	84.09	8.802	62.33	94.50	29	81.21	9.098	62.75	99.08
Height (cm)	29	163.23	7.691	151	182	22	174.59	6.522	162	188

Table II. Summary of reasons for non-examination

	Right	*Left*
Proximal area not investigated due to:		
Amputation	2	
Previous surgery	1	1
Unintentionally removed by students	5	4
Too small SSV for general dissection	1	1
No dissection performed	1	
Distal area not investigated due to:		
Amputation	2	
Previous surgery	1	1
Unintentionally removed by students	1	
No dissection performed	2	
Crural fascial region not measured (though proximally investigated):		
Venous web, braches too small	6	5
Unintentionally removed by students	3	2
TE only, no SPJ	10	11
No distinct change in fascial relation	5	3
Doubled vein		1
One lumen, too small	1	
Neural relations not documented (though proximally investigated):		
Not documented		1
Venous web, uncertain situation		2
Valves' position not measured (though proximally investigated):		
Venous star	2	
Venous web (type E)	7	6
TE only, no SPJ (type C)	10	11
Lumen too narrow for opening	6	8
Doubled SPJ (type D)	1	4

SSV, Short saphenous vein; *TE,* thigh extension; *SPJ,* saphenopopliteal junction.

Fig 2. Distal entry of the short saphenous vein to the saphenous compartment. *t,* Tributary veins to the short saphenous vein; *s,* sural nerve; *arrow,* entry point of the short saphenous vein to the saphenous compartment.

At a mean distance to the SSVs' orifice of 18.2 cm (SD 6.1 cm; median 17.0 cm; minimum 8 cm; maximum 34 cm), we found in 39 of 86 cases (45.35%) a point or region of crural fascial changes. Distally to this point, we found the classical situation with a thicker crural fascia and a thinner superficial fascial sheet covering the SSV. Proximally to this point, the superficial sheet got much thicker, whereas the underlying crural fascia thinned. (The reasons for non-measurement are listed in Table II).

Neural relationship. At the level of the origin of the gastrocnemius muscle, we recorded the topographic situation of the SSV in 83 cases. Table III summons the results in detail; Table II lists the exclusion criteria.

Saphenopopliteal junction. Out of the investigated 86 SSVs, only 65 (75.58%) formed a distinct SPJ where the SSV joined the PV, whereas in the remaining cases the SSV continued up the thigh (n = 21; 24.42%) without any connection to the PV.

Table III. Localization of the short saphenous vein (SSV) in relation to the nerves at the level of origin of the gastrocnemicus muscle's heads

	Medially		*Laterally*	
	N	*%*	*N*	*%*
SSV is located:				
to the medial sural cutaneous nerve	73	87.95	10	12.05
to the tibial nerve	53	63.86	30	36.14
to the common fibular nerve	81	97.59	2	2.41

We found several muscular veins (MVs) at almost each popliteal fossa. They arose constantly from both heads of the gastrocnemius muscle, from the biceps femoris muscle, and the semimembranosus muscle. These MVs either joined the SPJ when existing, or entered the PV directly.

According to the UIP-system, we could relate only 76.74% (66/86) of SPJs to either group A, B, or C (Fig 1). Those specimens which could not be classified (23.26%; 20/86) presented either a doubled small junction to the

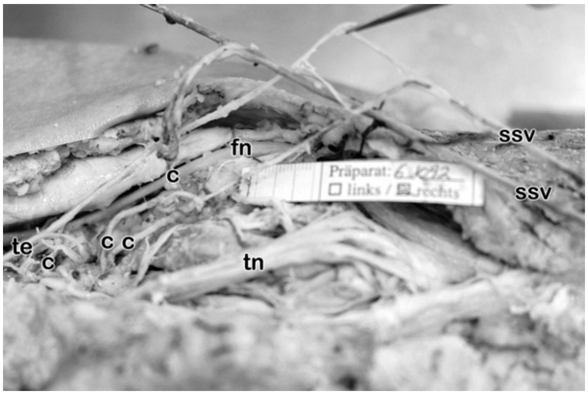

Fig 3. Web-style saphenopopliteal junction (type "E"). The short saphenous venin (SSV) is doubled itself (right margin), the upper portion continues up the thigh (TE); both portions are connected with several thin, regularly shaped veins with the PV. *ssv,* Short saphenous vein; *te,* thigh extension of the ssv; *c,* multiple connections of the ssv to the popliteal vein; *tn,* tibial nerve; *fn,* common fibular nerve.

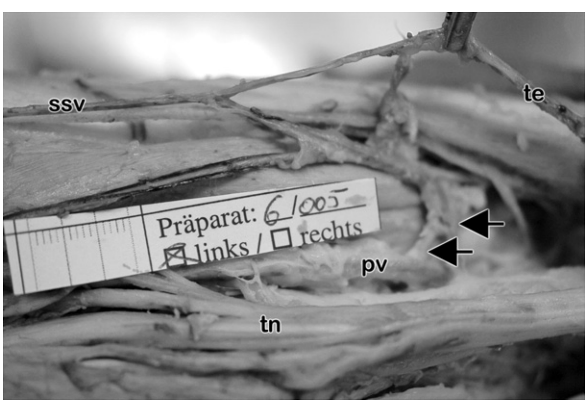

Fig 4. Doubled saphenopopliteal junction (type "D"). *ssv,* Short saphenous vein; *te,* thigh extension of the ssv; *pv,* popliteal vein; *tn,* tibial nerve; *arrows,* doubled saphenopopliteal junction.

PV (type "D", doubled SPJ; Fig 3) or a venous web (type "E", web-style SPJ; Fig 4) or a venous star at the popliteal fossa. Incidences of each type are listed in Fig 1.

Venous valves. Only in 31 legs (36.05%) were we able to detect one distinct SPJ having a lumen wide enough for opening the vein and examining their valves. Two veins contained no valve within the investigation's range. The remaining 29 legs (93.55%) showed at least one valve with a mean distance of 1.2 cm (SD 1.4; median 0.9 cm; range, 0.0-6.3 cm; Fig 5). Out of these veins, 20 (64.52%) possessed a second valve with an average distance of 5.1 cm to the SSVs' orifice (SD 2.3 cm; median 4.6 cm; range, 2.0-12.0 cm). Four legs (12.90%) had an additional third valve, two veins (6.45%) had four, and one SSV (3.23%) contained five consecutive valves. This calculates for a mean number of 1.8 valves within a distance of 20 cm from the SSVs' orifice. Reasons for non-investigation are listed in Table II.

DISCUSSION

Despite the fact that US scan is the gold standard in clinical settings, anatomic dissection gives, when available, a thorough insight in both the construction of the human body, in this case the venous system, and the interpretation of images derived from distinct echogenic properties of different tissues. Therefore, even these days, anatomic dissection is a mandatory tool for medical education and research.

Fascial relationships. The great variability of the SSVs' representation in the literature starts with its very origin and with the fascial classification. During centuries, and still today, the SSV is described to pierce the crural fascia at an individual level.[1,7,18-20] This is remarkable, because already in 1926, it was stated that there are, according to dissections, three main possibilities considering the fascial relationships (piercing, running between superficial and deep fascia, or being situated between layers of the superficial fascia).[5] However, in 2001, US scans and some precise microscopically-assisted dissection techniques led to the realization that the SSV does not pierce the crural fascia anywhere. Hence, it is not a classic superficial vein, but the SSV runs between the main crural fascia and a membranous layer of the superficial fascia.[4] This enables us to distinguish between the interfascial SSV and its subcutaneous, epifascial tributary veins in US scans.[4,9,10,21] Moreover, this is the basis for applying tumescent anesthesia not only at the GSV but also the SSV.[22,23]

Concerning our data, we can confirm that layers of the superficial fascia cover the SSV from its very beginning. We can state that a real fascial tunnel or "dedoublement aponéurotique"[6] can be shown directly at the beginning of the trunk of the SSV by proper anatomic dissection. The beginning of the trunk keeps a remarkably constant distance to the calcaneal tuber. Although it has been demonstrated by US scan that the tributaries of the lateral foot are also covered by its own fascia,[24] we believe that the real initiation of the vein is not the lateral margin of the foot,[1,7,20] but that it is situated constantly in the lateral retromalleolar region.[5,6,19] Here, the SSV collects several tributaries such as the lateral marginal vein or the lateral malleolar plexus.[15] Furthermore, a surgeon can be sure to find the trunk of the SSV in this area with a minimal incision in about 95%, according to our data.

The question is what the so-called piercing of the crural fascia does represent. In our dissections, we found an area in the midcalf where the fascial relationship obviously changed. One can easily get the impression that proximally from this point or area the SSV is situated subfascially upon the gastrocnemius muscle. This point, however, should better be thought of as a region, where fascial covering and fascial relationship of the SSV change. The superficial fascial parts get much thicker and therefore one can easily consider them to build exclusively the crural fascia.[4] We conclude, due to our findings and due to the recent descriptions, that

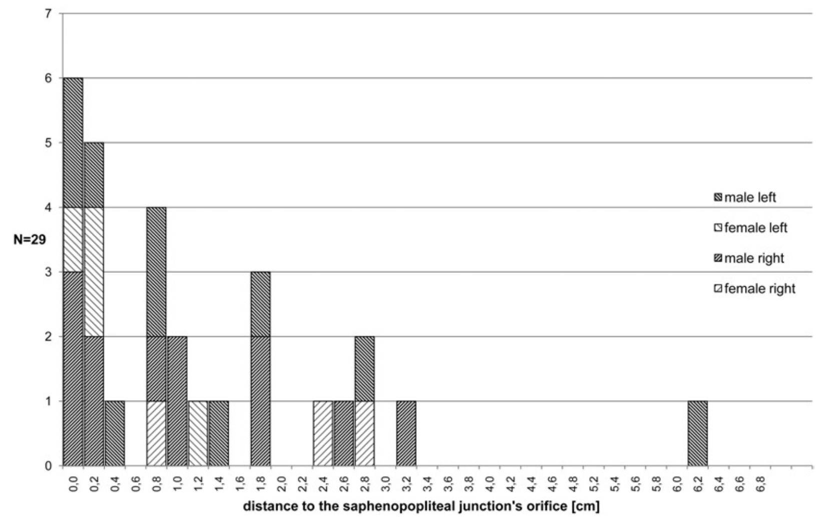

Fig 5. Location of the most proximal valves within the saphenopopliteal junction.

there is a proximal fascial region in the course of the SSV. It is situated at an individually different level and, in former times, it was called "piercing" point of the fascia. We believe that the individually different levels may explain the divergent descriptions.[18] Nevertheless, the hypothesis of fascial piercing has to be regarded as disproved.

However, there is still a clinical implication to be aware of. Hach et al[1] defined three different stages of primary varices of the SSV. In stage 2, only a part of the trunk of the SSV is affected by the varicose degeneration. He supposed that primary varicose degeneration often ends where the SSV changes from the subfascial to the subcutaneous space. Despite the fact that there is neither a subfascial nor a subcutaneous part, the clinical stages still remain the same. Thus, the degeneration often seems to end at the proximal fascial region. Summing up, we can conclude that the proximal fascial point cannot be defined well due to individual fascial changes. Therefore, we should speak about a proximal or, even better, midcalf region, which has an impact on pathophysiology and clinical stages of primary varices of the SSV. It should, therefore, be kept in mind and given attendance to while doing a clinical investigation in a patient with signs and symptoms of small saphenous varices.

Neural relationships. Although it is known that neural injuries are one of the major complications of SSV surgery,[13,25] it is still a matter of discussion whether the technique of stripping itself,[13] or direct iatrogenic neural injuries at the popliteal fossa, are more important.[25-27] Moreover, it is still unclear which nerve is the most endangered one.[27]

Hence, it is surprising that the literature lacks an exact topographic description. Several authors mentioned the topography concerning the sural nerve (SN) and the tibial nerve.[4-6,14,28] However, the data are inconsistent, which may be due to the variability of the venous system itself but also to the different regions where the neural relationships have been assessed. Especially for the SN, the data presented are contradictory. This might be because several authors tend to already name the medial sural cutaneous nerve (MSCN) as the proper SN. Furthermore, the proper SN can also be found superficially to the SSV and crossing the vein, which it is supposed to do in the majority of cases.[5] The vein and the SN are separated by specific connective tissue.[5,29] However, this tissue does not protect the nerve from injuries during iatrogenic maneuvers.

Our data assists the surgical approach to the SPJ, but one should be aware that the common fibular nerve may also turn directly around the SPJ, as it did in two legs of our study. As the neural topography is individually at the popliteal fossa, it is currently a must to assess it prior to any intervention and will help to reduce neural injuries.[30] Yet, there is a need for further investigations.

Variability at the saphenopopliteal junction. A connection with the deep venous system, the PV, was present in only about three-quarters of our cases; the fourth quarter presented a "thigh extension only" type C. When an SPJ was present, it always entered the PV either directly (types A, B, and D) or by forming a more or less dense venous web (type E), which was also joined by the different MVs. We encountered those MVs at almost each popliteal fossa. They arose constantly from both heads of the gastrocnemius muscle, which is well described in literature. Additionally, they arose from the biceps femoris muscle and the semimembranosus muscle. This stands in contradiction to earlier findings in which the veins of the biceps and semimembranosus muscle rarely have been seen.[31,32]

Over the years, different classifications of the SPJ have been created, making any comparison of clinical findings very difficult. Firstly, low and high terminations have been described.[1,5,7] This system was subdivided into several segments to specify the junctional levels within ranges of centimeters above or below the crease of the knee joint.[6,8,9] A newer, simpler classification describes just three groups of junctions. Group A comprises the classic SPJ, group B those with a "connection to the deep stem more cranially," and group C contains all cases with an existing upward extension of the SSV without connection to the popliteal deep venous system.[4] This system was the basis for the UIP classification, which differs in the description of groups A and B.[12] Therefore, it is not surprising that our data show remarkably different numbers of frequencies in both groups A and B, but not in group C.[4]

However, both the old and the new UIP classifications strictly concentrate on the SSV and its junction. They do not consider the special situations like venous stars (2 cases), webs (13 legs), or doubled junctions (5 cases).

The venous star was quite similar to that of the GSV, but its tributary veins were not other superficial but muscular ones. One might argue that "type D" comprises the "real" SPJ and an additional "popliteal area vein" (PAV).[31,32] Such a vein may terminate into the SSV, a gastrocnemial vein, or directly to the PV, but arise in the superficial fat over the popliteal space, the lower posterior thigh, and upper calf,[32] whereas in our cases the SSV sends two vessels towards the PV. Another possibility for type D would be the presence of a popliteal fossa perforating vein of type 1 presentation together with a normal SPJ,[33] where the perforator comes from the SSV. Nevertheless, such a perforator would enter the PV at its lateral side,[33] whereas our doubled SPJ entered the PV at its dorsal aspect, as is the normal situation also for a single SPJ.

In those cases with a venous web (type E), the MVs contributed to the network as did the PAVs.[31,32] Deriving from the web, multiple small connections to the PV could be demonstrated. Type E might be interpreted as (truncular) venous malformation (VM), but one has to consider their definition: "Venous malformations are present at birth either as a blue mass of a faint bluish patch. They enlarge and worsen until puberty [. . .]. The spongy blue mass may be flattened by pressure. [. . .] Phleboliths are palpable [. . .]. VMs infiltrate the skin, muscles, and even bones and joints [. . .]."[34] This is in fact different from our findings, where a network or plexus of fine distinct venous vessels existed without any infiltrative tendency, which was supplied by the SSV, PAVs, and several MVs and drains by means of several small veins into the PV. These vessels do not have an irregular ectactic aspect (Fig 3).

In our opinion, all those variants may be a strong implication that the junction of the SSV at the popliteal fossa is not supposed to be the end of the SSV. Keeping in mind those variants and the "classical SPJ" and considering that in almost 90% there exists a TE, it is easy to reach the conclusion that the SPJ may also be interpreted as a perforating vein. This is also true for all the cases with either doubled junctions or a venous web, thus variants forming a group of perforating veins. This corresponds well to the embryologic hypothesis combined with the neural guidance theory of angioformation.[8,15,28]

For this reason, further investigations have to be carried out in order to clarify both the regular termination of the SSV and the meaning of the TE. Furthermore, the exact topography of the muscular veins in respect to the SSV and the PV remains unclear but would be of great help for surgical procedures. Such studies will also help to underline or rule out our hypothesis that the SPJ may only be a perforating vein or a group of perforators, respectively. Our data on the frequency of different types of SPJs indicate what has to be kept in mind doing US scans or surgery at the popliteal fossa. Despite the classic types A, B, and C,[12] the variants "doubled junction" (D) and "web-style" (E) must not be forgotten (Figs 2-4); type E to prevent unforeseen bleeding,[26,31] and both types in the discussion on recurrence of varices after interventions at the SSV.[8,35]

Venous valves. The knowledge about venous hemodynamics is on the verge of a paradigm shift, especially on the function of the venous valves.[36] They are supposed to prevent the blood flow from reversing.[1] Some valves in strategic positions should prevent reflux from the deep into the superficial venous system or protect the trunk of the SSV just behind the beginning of the TE.[37] However, under physiologic circumstances no reflux is needed to induce a closing of venous valves. Just a small change in the velocity of blood flow at the level of the valves is necessary to induce a closure.[3] Whereas in healthy veins reflux obviously does not occur in pathologically changed veins, it occurs mainly by utilizing provoking maneuvers.[36]

One intends to state that in veins without valves, varicose degeneration is only a matter of time. Moreover, it was shown for the GSV that a vein with fewer valves is more probable to dilate and to acquire a serpentine shape.[38] However, in approximately 30% of macroscopically healthy GSVs, there is no terminal valve (TV) located at the saphenofemoral junction.[39] Our data show similar situations with 2 of 31 healthy SSVs having no valve at the SPJ. This stands once again in strong contradiction to the reflux hypothesis of varicose degeneration.

A TV of the SSV is supposed to be located in each SSV within a range of 5 to 10 mm from the orifice of the SSV into the PV.[37] In our investigation, we found the most proximal valve within a range of 0.0 cm to 6.3 cm. This shows a remarkable difference in the detection rate and the localization of valves comparing color Doppler scan investigations.[37] Hence the definition where the TVs are situated needs to be reconsidered as a valve, which is situated as far as 6.3 cm away from the orifice to the deep venous system, will have only a minor strategic position in preventing refluxes. It seems that one should not classify each most proximal valve as a terminal valve.[39]

Analyzing the distribution of the most proximal valve (Fig 5), one can see that there is a cut off at 2.0 cm. This is a coincidence with the minimum distance of a second valve, if one existed at all. Therefore, it seems to be a logical step to set the discriminating distance to 2.0 cm. Yet, this implies that the SSV only possesses a real TV in about three/quarters of all cases (74.19%, n = 23/31) which would be a number approximately similar to the GSV.

Following US scan-studies, the pre-terminal valve (PTV) should safeguard the trunk of the SSV and mark the distal end of the SPJ or "crosse." It is supposed to be

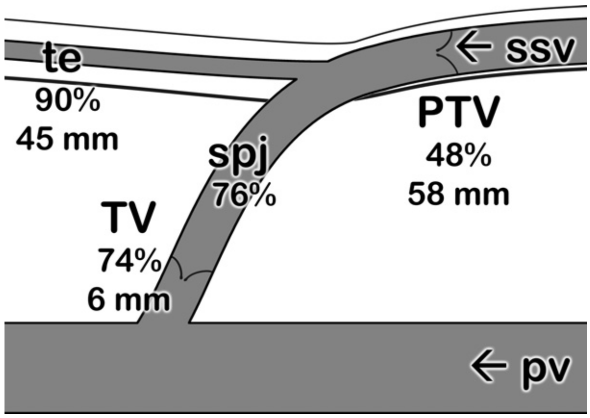

Fig 6. Idealized saphenopopliteal junction. *ssv,* Short saphenous vein; *pv,* popliteal vein; *spj,* saphenopopliteal junction; *te,* thigh extension; *TV,* terminal valve; *PTV,* preterminal valve; *arrow,* direction of physiologic blood flow distances were measured from the entrance of the SPJ into the PV.

positioned slightly distally from the orifice of the TE.[12,37] Only eight SSVs of our study met these strict conditions. One more SSV would have fulfilled the demands, the distance, however, between the TE and valve was 8.0 cm. Five legs had their second valve directly proximal to the junction between the SSV and its TE and four legs did not have a second valve although they presented a TE. Classifying all valves distal to the TEs' junction as a PTV, we found a PTV in 48.39% (Fig 6).

Another aspect is the mean number of valves within the SSV. Between 0 and 11 valves develop in fetal SSVs (0-11;[40] 5-9[41]). However, for adults information gains in variability and a range between 4 and 13 valves is supposed to be found (9-12[19]; Ø 8[1]; Ø 8.2[7]; 4-13[5]). Neither gender nor age should have an influence on the number of valves in the SSV.[5] All these numbers seem to be high compared to the mean number of valves we found in our investigated area (1.8). We concede that we did not investigate the whole length but only the most proximal 20 cm of the SSV. Yet, it was demonstrated that in fetal growth valves occur more frequently in proximal parts of the SSV than in distal ones.[41] How can this small number of valves be explained? As to the fact that there is a study with an even smaller sample size,[40] we can rule out that the number of specimens is the reason. Another possible factor might be the individual age of the specimens, despite previous results.[5]

AUTHOR CONTRIBUTIONS

Conception and design: GS, DM, EB
Analysis and interpretation: GS, EB
Data collection: GS, DM
Writing the article: GS, EB
Critical revision of the article: GS, EB
Final approval of the article: GS, DM, EB
Statistical analysis: GS, EB
Obtained funding: Not applicable
Overall responsibility: EB

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