Small saphenous vein: where does reflux go?

Veia safena parva: para onde se dirige o refluxo?

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Abstract

Background: The anatomy of small saphenous vein (SSV) is very variable because of its complex embryological origin. SSV incompetence often causes reflux that goes to the perforating veins, sometimes not respecting the anatomical course. **Objective:** To analyze differences in reflux direction and reentry in the SSV. **Methods:** In this prospective, observational study, 60 lower limbs with SSV incompetence of 43 patients were assessed using a color Doppler ultrasound protocol. **Results:** Reentry variations were grouped into four types and subtypes. Percentage results were: Type A, perforating veins on the medial side = 25/60 cases (41.66%); subtypes: Cockett, Sherman, paratibial and vertex; Type B, lateral malleolus and perforating veins on the lateral side (fibular 17-26 cm) = 15/60 cases (25%); subtypes: fibular and malleolus; Type C, two branches = 19/60 cases (31.66%); subtypes: gastrocnemius and Cockett, gastrocnemius and malleolus, and/or fibular, Cockett and malleolus, Cockett-vertex and fibular; Type D, reflux in the superficial system = 1/60 cases (1.66%). **Conclusion:** On most of the lower limbs assessed, reflux did not follow the classical anatomic course. Our findings demonstrated a high degree of variation in reflux/reentry, but no SSV anatomical variations. Reflux seems to, either look for the most accessible anatomical connection for reentry or be originated in the distal area and then reach the SSV.

Keywords: venous insufficiency; reflux; small saphenous vein.

Resumo

Contexto: A veia safena parva (VSP) apresenta grande variabilidade anatômica graças à sua complexa origem embriológica. Na VSP insuficiente, o refluxo que se dirige para a perfurante de reentrada nem sempre obedece ao mesmo trajeto anatômico. **Objetivo:** Estudar a variabilidade da direção do refluxo da VSP e sua reentrada. **Métodos:** Neste estudo prospectivo e observacional, 60 membros inferiores com insuficiência de VSP em 43 pacientes foram avaliados por protocolo de eco-color Doppler. **Resultados:** As variações de reentrada foram agrupadas em quatro tipos, com seus respectivos subtipos. A porcentagem dos achados foi: Tipo A, perfurantes de face medial = 25/60 casos (41,66%), subtipos Cockett, Sherman, paratibiais e do vértice; Tipo B, maléolo externo e perfurantes da face lateral (externa) (fibulares 17-26 cm) = 15/60 casos (25%), subtipos fibulares e maléolo; Tipo C, em dois ramos = 19/60 casos (31,66%), subtipos gastrocnêmias e Cockett, gastrocnêmias e maléolo e/ou fibulares, Cockett e maléolo, Cockett-vértice e fibular; Tipo D, terminação no sistema superficial = 1/60 casos (1,66%). **Conclusão:** Na maior parte desta casuística, o refluxo não obedeceu ao percurso anatômico clássico. Demonstrou-se a variabilidade do trajeto do refluxo ou sua reentrada, e não a variabilidade anatômica da veia safena parva. Pode-se interpretar que o refluxo buscaria, como reentrada, a conexão anatômica mais acessível, ou então se originaria no setor distal, alcançando depois a veia safena parva.

Palavras-chave: insuficiência venosa; refluxo; veia safena parva.

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Financial support: None.
Conflicts of interest: No conflicts of interest declared concerning the publication of this article.
Submitted: 12.05.12. Accepted: 03.11.13.

The study was carried out at Centro Vascular Flemes, Buenos Aires, Argentina.
The study was approved by the Research Ethics Committee at Centro Vascular FLEMES, Ciudad Autónoma de Buenos Aires (protocol no. Flemes 03/2012).

INTRODUCTION

According to several descriptions, the small saphenous vein (SSV) has major anatomical variations due to its embryological origin. Embryology has shown that the limb bud develops around the fifth gestational week, when the embryo measures about 5 mm. The arteries initially run in the center of this bud, and the veins, in its periphery. Therefore, the arterial axis is in the center of the future limb, and return circulation, which will soon be carried out by the veins of the superficial system, is peripheral. The deep veins, which pass together with artery, develop later on[1,2].

During embryological development, the lower limb is laterally placed, and the predominant vessels originally supplying blood to the leg are sciatic, rather than femoral. Femoral vessels develop later on, after the limb rotates into a ventral position. The ischiadic artery, a branch of the umbilical artery, is the first to develop, followed by the iliac artery; therefore, the ischiadic, or posterior system, is predominant in the embryo. After rotation, femoral vessels become predominant and lead to the regression of the ischiadic, or posterior, vessels, which will lose importance in the adult limb[3].

The arterial system of the embryo is not primarily formed by femoral vessels, but, rather, by sciatic vessels. The genesis of the superficial venous system occurs before that of the deep system. The small saphenous vein (SSV) is the first important superficial vein in the lower limb, and the axial, or sciatic, vein, the first vein of the deep venous system, develops from an earlier vein even before the development of the great saphenous vein (GSV). During embryological development, several points of communication between the SSV, the ischiadic artery and the anterior veins, among others, are established as the GSV and the femoral vessels develop.

When the lower limb rotates, what was in the posterior face moves to the anterior face. Therefore, circulation, that depended on the axial sciatic vein and the SSV, now depends on the femoral vessels and the GSV. The communication between the two persists and gives origin, among others, to the Giacomini vein (intersaphenous anastomotic vein). Limb rotation and the change to an anteromedial axis will make several vessels disappear, particularly the axial vein, and only its sural portion, together with the fibular vein and veins below the joint, will remain and turn into the inferior gluteal vein. In its medial portion, the axial vein becomes part of the popliteal vein, which arises from an anastomosis of the femoral vein and axial veins, through the adductor magnus[1-3].

Consequently, the point where the SSP joins the popliteal vein is also very variable, as its formation depends on the regression of the axial vein. When a system that should have disappeared persists, some anatomic changes occur. If a venous system has multiple origins, the chance of anatomic variations is always greater[2,3].

The anatomic variability of the SSV is of great importance for treatments and surgeries, and its sites of variability are:

- saphenopopliteal junction;
- communication with the deep system or with the GSV; and
- site of passage of the SSV from superficial system to below the aponeurotic layer.

Oliveira A. et al. (2004)[4] conducted a study using color Doppler ultrasound and described the anatomic variation of SSV drainage, classifying it into three types and several subtypes that clearly express its great variability:

- Type I: into the popliteal vein, above the popliteal crease (52.8% of the cases).
- Type II: into the deep thigh veins, without communication with the popliteal vein (44.4% of the cases).
- Type III: into the GSV or gastrocnemius veins, below the popliteal crease (2.8% of the cases).

Some authors have studied the variations of the saphenopopliteal junction at a proximal level; these studies, however, usually included only healthy veins.

During diagnostic tests using color Doppler ultrasound, reflux is rarely confirmed at sites other than the SSV with type I drainage (high) or drainage at the saphenopopliteal junction, and reflux of the distal saphenopopliteal junction does not always follow the anatomic course of the SSV to the external malleolus, but, rather, flows toward the medial face of the leg and reenters the deep system through the vertex perforator or the Leonard arch and the Cockett perforator. Such findings suggested a study to analyze and follow the course of reflux distally. This study described the variations of site of perforator for reentry of the diseased SSV and built a map and iconographic record of SSV incompetence.

MATERIAL AND METHODS

This prospective, observational, noninvasive study was conducted from January to October 2012 and included 674 patients. Diagnostic tests of venous insufficiency of lower limbs showed that 60 limbs of 43 patients (6.38% of the patient sample) had incompetent SSV. Of these, 24 (54.8%) were women, and mean age was 43.27 years (36-80 years).

The course of the SSP was mapped and the point of reflux drainage was recorded for later analysis.

All patients were evaluated using an Ecocolor Doppler Phillips® HDI 3000 scanner or an Esaote® Mylab40 unit and a 5-10 MHz transducer.

For standardization, all tests were conducted by the same operator, while the patient was standing with the back turned to the examiner and the knee under study was slightly flexed[5,6].

Reflux was classified as the positive reversion of the Doppler wave for 2 seconds or longer, so that specifically in this study only the most severe reflux would be included to ensure better follow-up and visualization of reflux direction.

To detect perforators, a stiff ruler was used for measurements from the plantar support surface to the point of interest.

For 10 months, from January to October 2012, 674 diagnostic tests of venous insufficiency of lower limbs were conducted, and 60 patients were included in the study. All had incompetent SSV and reflux originating at the saphenopopliteal junction. In the limbs under study, the course of the SSV was mapped, and reflux drainage was recorded for later analysis.

Inclusion criteria were: severe reflux (2 s or longer) in the SSV originating at the saphenopopliteal junction and detected during clinical examination and color Doppler ultrasound scanning.

Exclusion criteria were: no venous insufficiency of the SSV from the saphenopopliteal junction; no history of SSV surgery; and refusal to participate in the study.

This study was approved by the Ethics in Research Committee of the Centro Vascular FLEMES, in Ciudad Autónoma de Buenos Aires, under number Exp.Nº Flemes/03/2012.

RESULTS

Findings were divided into groups according to type of perforator reentry:

- Reentry type A: perforator on the medial surface: 25/60 cases (41.66 %) (Table 1).
- Reentry type B: external lateral malleolus and perforator on the lateral (external) surface: 15/60 (25%) (Table 2).
- Reentry type C: bifurcation into perforators on medial and lateral (external) surface or gastrocnemius and distal perforators (gastrocnemius-Cockett, gastrocnemius-fibular/malleolus): 19/60 (31.66%) (Table 3).
- Reentry type D: drainage into superficial venous system: 1/60 (1.66%) (Figure 6).

DISCUSSION

Diseases affect the SSV at a lower frequency and less evidently than the GSV. However, SSV incompetence is almost always symptomatic and may be responsible for trophic disorders and ulcers, which result in greater severity and pain and are more difficult to treat[7].

The main focus of this study was the course of the SSV reflux and not the clinical consequences or SSV anatomic variations. Therefore, whether the right or the left limb was analyzed did not affect our findings.

Table 1. Subtypes A (Figures 1, 2 and 3).

Cockett, at 8 to 18 cm	Cases: 15/60 (25%)
Sherman, Paratibial, vertex, at 20 to 30 cm	Cases: 8/60 (13.33%)
Cockett 14-18 cm and vertex 27 cm	Cases: 2/60 (3.33%)

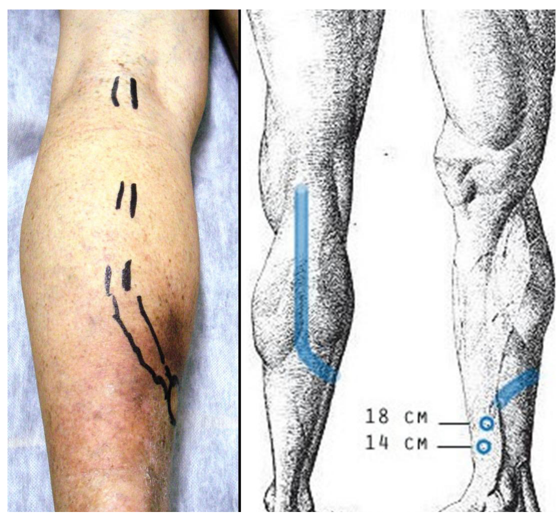

Figure 1. Type A: Subtype: Cockett (8-18cm).

Figure 2. Type A: Subtype vertex-Sherman (20-30cm).

Figure 3. Typo A, Subtype vertex (27 cm) and Cockett (14-18 cm).

Table 2. Sub-types B (Figure 4).

Malleolus	Cases: 12/60 (20%)
Fibular 18 and 26 cm	Cases: 2/60 (3.33%)
Fibular 17 cm and malleolus	Cases: 1/60 (1.66%)

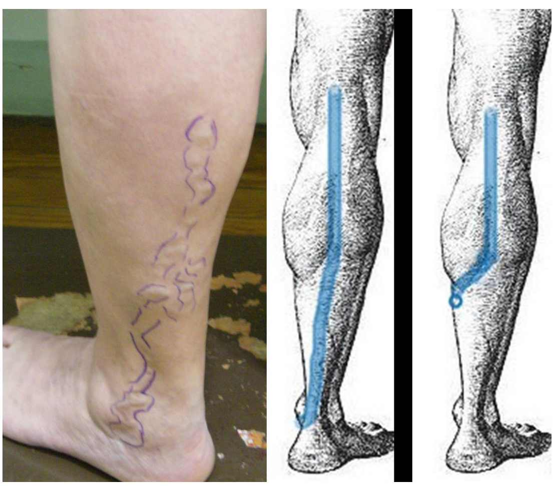

Figure 4. Type B, external lateral malleolus and lateral surface perforators.

Studies in the literature, such as the one conducted by Engelhorn et al. in 2004[8], found that SSV was normal in 1,132 limbs, that is, in 79.94% of the sample of 1,740 patients under study. They identified six types of SSV reflux, and the most common (8.47%) was isolated segmental reflux. Tributaries were the main cause of reflux and drainage site in SSV (70.24% and 83.33%)[8]. Our study described not only drainage into tributaries, but also the point of reentry, which differentiates it from other studies.

Moreover, an essentially clinical study conducted by Kurt et al. in 2007 did not find any statistical differences between age, body mass index, occupation or associated chronic diseases and deep or superficial venous incompetence. However, there was a statistically significant difference between venous incompetence and clinical severity represented by SSV diameter[9].

Cassou et al. (2007)[10] studied 1,184 lower limbs of 672 women and found that reflux begins, mainly, in saphenous vein segments, and that saphenous

Table 3. Sub-types C (Figure 5).

Gastrocnemius and Cockett	Cases: 2/60 (3.33%)
Gastrocnemius and malleolus or fibular	Cases: 5/60 (8.33%)
Cockett and malleolus	Cases: 4/60 (6.66%)
Cockett-vertex and fibular	Cases: 8/60 (13.33%)

Figure 5. Type C: bifurcation to medial surface perforators and external lateral malleolus or Cockett and fibular.

Figure 6. Type D: drainage into superficial venous system.

junctions are not the main sources of reflux in the superficial venous system.

The SSV has been classically described as originating in the external retromalleolar region, ascending along the midline of the posterior aspect of the calf and draining at the junction with the popliteal vein. Its first segment may be above the aponeurotic layer, but it is found below it along the rest of its course[11].

Anatomy atlases describe the great variability of this vein in its relation both to the aponeurotic layer and to where its "crosse" is located.

In our series, only one case was extra-aponeurotic along its entire course, and the fascia was perforated at the popliteal fossa. The level at which it starts to course below the aponeurotic layer is also variable, although in most cases it is in the lower third of the leg. We also found that the site of the saphenopopliteal junction is variable, and that it was most frequently found 2 cm above the popliteal crease.

Such variability confirms the absolute need to approach this vein after comprehensive color Doppler scanning, and to consider selecting ultrasound-guided treatments to avoid unexpected negative results[12].

In our sample, we found that reflux follows different paths or courses, which do not always correspond to the "expected" course according to anatomy. We defined reflux at 2 s instead of 0.5 s to be absolutely sure of the results of course description when studying some obvious and clear reflux at sites that might otherwise show inconclusive results.

The separation of reentries into groups revealed that 41.66% of the veins were on the medial surface, and that those on the external surface (malleolus and fibular) accounted for 25%. Bifurcated reflux, which followed two different courses, was equitably divided.

Following the progression of SSV reflux, we found that it moves toward the medial surface in the upper third of the leg and into the Leonardo arch or the Sherman perforators. In other cases, this division is at a little lower level (lower third of the leg) and goes up to the vertex perforator, or even lower, to the Cockett perforator (usually at 18 or 14 cm).

When the division is toward the lateral (external) surface, it goes from the middle third of the leg to the fibular perforator, at 19 to 23 cm.

Finally, some reflux courses toward the malleolus, and may be called "anatomic". The rest of the SSV, not affected by reflux, remains normal.

Reflux is often found along two or more courses, which corresponds to type C and accounts for 31.66% of the cases described here. The direction of reflux bifurcation is usually toward the malleolus/fibular perforators and perforators on the medial surface (Cockett 18). In these cases, there might be reflux of a larger volume toward the medial surface, and less reflux persists in the distal main trunk up to the lateral (external) region.

The other form of bifurcation was a first stage to a medial gastrocnemius perforator and then a distal branch that courses to the medial surface (Cockett) or the lateral external surface (fibular and malleolus)

There might be two basic explanations for the phenomenon described here, coinciding with the two theories currently used to explain the origin of venous insufficiency. If reflux has a proximal origin, it results from the insufficiency of the saphenopopliteal junction, and will move through the "easiest", or more easily accessible, course, that is, the reentry perforator that offers better drainage, probably due to a system of higher to lower pressure. We concluded that venous reflux seeks the lowest pressure.

The correspondence of cases with type I insufficiency (high drainage point) is very high. Reflux in veins that do not communicate with the popliteal vein is rare, probably because its different anatomy induces some hemodynamic "protection", which the SSV does not have in the popliteal fossa[5-7].

In contrast, if we, as several other current authors, maintain that venous disease begins distally, in the superficial system, reflux progression up to the saphenopopliteal junction will depend on the site where the disease originated.

Moreover, even when there are reentry perforators, the SSV may become varicose and lead to venous insufficiency with trophic changes; it should be expected, however, that SSV hypertension alleviates when reflux drains into perforators.

The two explanations seem to apply to different patients, as both forms of development of venous disease may be found in different cases.

CONCLUSION

The great variability of the SSV involves not only its drainage point, but also its distal segment. This study described the variability of reflux progression and reentry, but not the anatomic variability of its course and drainage.

The classical anatomic reflux course was not found in most of our sample.

Our findings are important both for diagnoses and surgical treatments, and may be interpreted as evidence that reflux seeks the easiest access for reentry.

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Final approval of the article*: GGR, CEQB, CR
Statistical analysis: GGR, CEQB, CR
Overall responsibility: GGR

* All authors should have read and approved of the final version of the article submitted to J Vasc Bras.