The Giacomini vein – so small and inconspicuous?

Vena giacomini – so klein und unscheinbar?

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ABSTRACT

In Giacomini's first description (1873), a vein was reported that runs via the popliteal fossa (without entering the popliteal vein) to the dorsal thigh and then passed to join the great saphenous vein. Since then, numerous other types of termination (including those that lead into the popliteal vein) have been published. In clinical practice, however, this vein receives little attention. The probability of detecting an insufficiency of the Giacomini vein is almost 12 times higher, especially in the presence of an insufficiency of the small saphenous vein.

There are two reflux types of Giacomini's vein. In retrograde reflux, venous blood enters the small saphenous vein via the great saphenous vein, the iliac veins or the perforating veins of the thigh. In the much rarer antegrade reflux, a paradoxical (ascending) reflux occurs in the Giacomini's vein during muscular diastole. Surgical therapy focused exclusively on the saphenous vein without consideration of the reflux types may possibly result in overtreatment of the patient and should be avoided in an age of therapeutic diversity and a vein-preserving approach.

Due to the anatomical narrowing of the popliteal fossa and the increasing popularity of endoluminal-thermal procedures in the past, knowledge of the topographical anatomy is essential, especially to avoid neurological complications.

ZUSAMMENFASSUNG

In Giacominis Erstbeschreibung (1873) wurde über eine Vene berichtet, die über die Fossa poplitea zum dorsalen Oberschenkel (ohne in die V. poplitea einzumünden) weiter nach medial zieht, um in die V. saphena magna zu münden. Seither wurden zahlreiche weitere Mündungstypen (auch mit Einmündung in die V. poplitea) publiziert. Im klinischen Alltag erfährt diese Vene hingegen nur wenig Beachtung. Die Wahrscheinlichkeit, eine Insuffizienz der V. giacomini nachzuweisen, ist v. a. bei simultanem Vorliegen einer insuffizienten V. saphena parva um das knapp 12-Fache erhöht. Man unterscheidet 2 Refluxtypen der V. giacomini. Beim retrograden Reflux gelangt venöses Blut über die V. saphena magna, die Beckenvenen oder die Perforansvenen des Oberschenkels in die V. saphena parva. Beim wesentlich selteneren anterograden Reflux kommt es zu einem paradoxen (aufsteigenden) Reflux in der V. giacomini während der muskulären Diastole. Eine ausschließlich V.-saphena-fokussierte chirurgische Therapie ohne Berücksichtigung der Refluxtypen kann möglicherweise in einer Überbehandlung des Patienten enden und sollte im Zeitalter der therapeutischen Vielfalt und eines möglichst venenerhaltenden Vorgehens vermieden werden.

Aufgrund der anatomischen Enge der Fossa poplitea und der in der Vergangenheit zunehmend an Beliebtheit gewonnenen endoluminal-thermischen Verfahren ist die Kenntnis der topografischen Anatomie insbesondere zur Vermeidung von neurologischen Komplikationen von essenzieller Bedeutung.

Introduction

In his *Osservazioni anatomiche per servire allo studio della circolazione venosa delle estremità inferiori* published in 1873, Carlo Giacomini, an Italian anatomist, neuroscientist, and professor at the University of Turin, was the first to describe the vein that since then bears his name [1]. Giacomini reported a vein that he viewed as a continuation of the small saphenous vein (*V. saphena parva*) running across the popliteal fossa (without opening into the popliteal vein) to the back of the thigh, turning medially to drain into the great saphenous vein (*V. saphena magna*) [1–3].

The many anatomical variations of the superficial veins in the popliteal fossa and the posterior thigh are due in part to the developmental history of the superficial venous system. Development of the two epifascial veins of the lower limb largely follows the nerves [4]. While the great saphenous vein follows branches of the preaxial femoral nerve, the situation is more complex for the small saphenous vein. In its initial segment, from the dorsum of the foot to the end of the fibula, it accompanies the sural nerve, which belongs to the sciatic (ischiadic) nerve system, the axial nerve of the embryo [4]. Its middle segment from the mid-calf to the thigh accompanies the posterior cutaneous nerve of the thigh belonging to the postaxial embryonic nerves [4]. Two anastomoses conduct all or only part of the postaxial flow to the neighbouring – axial and preaxial – outflows. Drainage (1) to the axial, the greater part of the popliteal vein: the anastomosis leaves the postaxial vessel (the small saphenous vein) at the level of the popliteal fossa and forms a saphenopopliteal junction with variable topography; and (2) to the preaxial, from which the great saphenous vein arises [4]. In this case, the postaxial outflow extends above the popliteal fossa: it lies in the vertical axis of the popliteal fossa alongside the posterior cutaneous nerve of the thigh and immediately beneath the fascia. When it reaches the thigh, it perforates this fascia and runs subcutaneously [4]. This explains the physiological direction of flow in the Giacomini vein from distal to proximal. The nomenclature of the Giacomini vein is not standardised and there are several synonyms, such as the 'thigh extension of the small saphenous vein' [3], the 'femoropopliteal vein' [5], 'posterior subaponeurotic vein of the thigh' [6], 'posterior lateral descending branch of the great saphenous vein' [7], 'proximal small saphenous vein' [8], 'posterior saphenous vein' [9], and 'medial accessory saphenous vein' [10, 11]. Its designation as the femoropopliteal vein is misleading in several ways. Firstly, the Giacomini vein connects the popliteal vein with the femoral vein in only a minority of cases and, secondly, it suggests a pathological direction of flow from the femoral vein to the popliteal vein.

Based on its constant diameter, the Giacomini vein is an arcade; based on its topography it is the terminal intersaphenous arcuate vein [12].

The term 'femoropopliteal vein' corresponds much better to another vascular formation also described by Giacomini [13]. In this case, the small saphenous vein terminates in the popliteal vein and there is no Giacomini vein; there is, however, an easily recognisable vein accompanying the posterior cutaneous nerve of the thigh, which Giacomini called the femoropopliteal vein. This vessel has the same connections to the small saphenous vein as the Giacomini vein and runs proximally with the posterior cutaneous nerve of the thigh; but instead of becoming subcutaneous and running anteriorly to drain into the great saphenous vein, it terminates in the fatty tissue of the posterior upper thigh. This tributary branch apparently drains blood from proximal to distal into the small saphenous vein, as there are two valves which are arranged so as to prevent the proximal flow of blood (▶ **Table 1**).

Other authors reserve the term 'Giacomini vein' exclusively for the extrafascial connection between the proximal extension of the small saphenous vein and the middle or lower third of the great saphenous vein. In the present article, we follow Giacomini's original description, in which the Giacomini vein represents the proximal extension of the small saphenous vein (▶ **Fig. 1**).

Course and prevalence

The Giacomini vein runs on the muscle fascia at the back of the thigh to where the belly of the semitendinosus meets with the biceps femoris (long head) superficially below the skin in the midline (▶ **Fig. 2**).

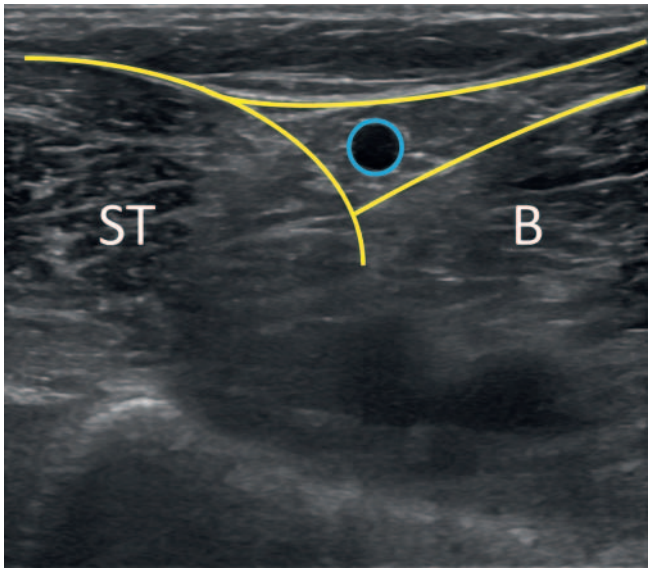
At this juncture, the Giacomini vein either terminates in a posterolateral perforating vein running to the deep veins (formerly

▶ **Table 1** Overview of different veins with a similar course through the posterior thigh.

designation	course	direction of flow	saphenopopliteal junction	prevalence
giacomini vein; terminal intersaphenous arcuate vein	from the small saphenous vein, running proximally within the fascia; penetrating the fascia then running medially around the thigh as the posterior accessory saphenous vein, terminating in the great saphenous vein	proximal	may be present or absent	approx. 70–80 %
femoropopliteal vein	from the fatty tissue of the posterior thigh to the small saphenous vein	distal	has to be present	approx. 15 %
sciatic vein	from the small saphenous vein, running proximally beneath the fascia with the sciatic nerve, to one of the inferior gluteal veins	proximal	may be present or absent	< 1 %

▶ **Fig. 1** Giacomini vein: The small saphenous vein (vsp = SSV) continues in the thigh as the almost-identical-calibre Giacomini vein (vG = GV); then winds round the proximal thigh and terminates in the great saphenous vein (vsm = GSV). In the popliteal fossa, there is a robust perforating vein to the popliteal vein (forming the saphenopopliteal junction). vsaa (= AASV): anterior accessory saphenous vein. Left leg. Source: Brenner E. Anatomie des oberflächlichen Venensystems des Beines. Phlebologie 2018; 47: 352–362. DOI:10.1055/s-0038-1675460.

known as the Hach perforator) or pierces the fascia to run freely in a proximal direction in the subcutaneous fatty tissue, [14] and finally empty into the great saphenous vein as the posterior accessory saphenous vein.



▶ **Fig. 2** Ultrasound scan in transverse section, showing the interfascial course of the Giacomini vein. ST: semitendinosus muscle; B: biceps femoris muscle.

The prevalence of the Giacomini vein varies from one author to another and depends on the nature of the investigation. Giacomini found his eponymous vein in 37 out of 51 legs (72 %) [13]. In post-mortem studies, the Giacomini vein has been found in up to 86 % of the legs examined [2, 15]. A study using duplex ultrasound to examine 301 legs suspected of chronic venous insufficiency showed a Giacomini vein in 70.4 % [16]. In 45.3 % of cases, the Giacomini vein drained into the deep venous system, while 64.2 % penetrated the fascia and terminated in the superficial venous system (usually via the posterior accessory saphenous vein). The presence or absence of a saphenopopliteal junction does not basically depend on the presence of a Giacomini vein [16]. Furthermore, evidence of a saphenopopliteal junction does not affect the other anatomical features of the Giacomini vein [16].

Taking Gillot's strict definition into account [4, 12], we have to assume that the prevalence of the Giacomini vein is almost 100 %. From the figures actually reported, the obvious conclusion is that this terminal intersaphenous arcuate vein disappears again in some individuals due to various influences such as compression on sitting.

Delis et al. showed that isolated reflux could be demonstrated in only 4.7 % of Giacomini veins, in contrast to the trunk veins which were incompetent in 53.3 % of the legs examined. However, the probability of demonstrating an incompetent Giacomini vein increased almost 12-fold when there was reflux in the small saphenous vein [16]. In clinical practice, therefore, whenever there is small saphenous vein incompetence it is worthwhile performing a targeted examination of the Giacomini vein to determine any incompetence and the type of reflux concerned.

Anatomy

Relations to the fascia

The small saphenous vein and the Giacomini vein run enclosed in their own fascial sheath. Schweighofer et al. showed that this fascia starts near the lateral malleolus and extends proximally over the whole leg. Analogous to a perforating vein, the small saphenous vein only pierces the popliteal fascia when it drains into the popliteal vein at its junction [17]. Other authors have reported that fascia can no longer be seen between the proximal small saphenous vein and the popliteal vein due to recession of the muscle fascia on the heads of the gastrocnemius in the calf and that of the posterior thigh [14, 18]. Accordingly, the small saphenous vein runs from the ankle to the popliteal fossa on the muscle facia and beneath the saphenous fascia, which is not as robust in its lowest third as it is near the knee joint [14].

Venous valves

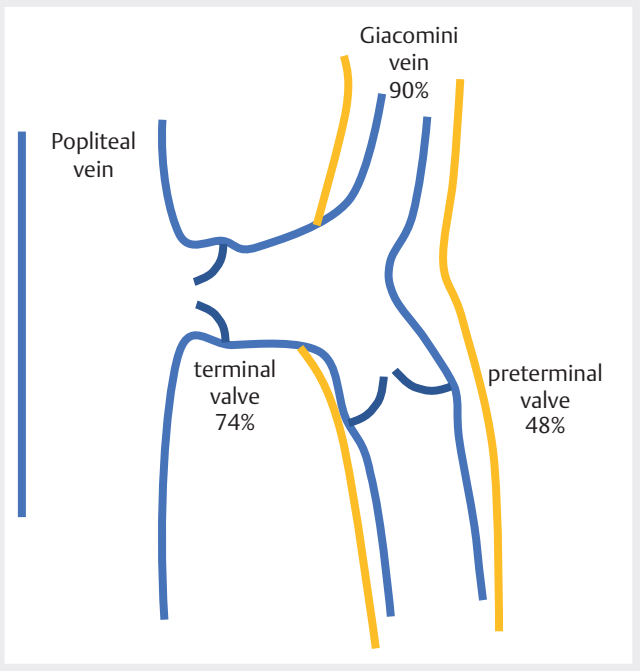
The terminal valve of the small saphenous vein is found in the immediate vicinity of the popliteal vein at the saphenofemoral junction, while the preterminal valve is usually distal to the origin of the Giacomini vein [17] (▶ **Fig. 3**).

There are conflicting data on the number of valves to be found in the small saphenous vein. It is possible that the number of such valves in adults at the end of their lives is considerably smaller than previously assumed [19, 20]. Schweighofer et al. found on average only 1.8 valves in the proximal 20 cm of the small saphenous vein [17]. So far, there are no data on the distribution of valves within the Giacomini vein.

Topographic anatomy of the popliteal fossa

Given the anatomical narrowness of the popliteal fossa and the increasing popularity of endovenous thermal procedures in the past, knowledge of the topographic anatomy is essential to prevent neuronal complications. The topography of the nerves in the popliteal fossa also varies depending on the individual variability of the saphenopopliteal junction. In the popliteal fossa, the tibial nerve lies lateral to the junction in some 65 % of cases [17]. Even though it is relatively rare, the common fibular nerve runs medial to the junction in up to 2.5 % and crosses the popliteal fossa obliquely in these cases [17].

In the popliteal fossa, the tibial nerve gives off branches including the sensory medial sural cutaneous nerve, which joins the lateral sural cutaneous nerve from the peroneal nerve and is then known in the leg as the sural nerve. Cases of neuronal complications found in the current literature mainly concern medial sural cutaneous nerve injury in the middle third of the lower leg and, more distally, damage to the sural nerve. There are only isolated reports of damage to nerve structures from endovenous ablation of the Giacomini vein, even although this is anatomically possible [21]. Apart from the sensory medial sural cutaneous nerve, the topographical proximity of the tibial nerve, the sciatic nerve, and especially the posterior cutaneous nerve of the thigh must be remembered precisely when treating the Giacomini vein as the posterior extension on the back of the thigh [22, 23]. In addition, a



▶ **Fig. 3** Diagram of the saphenopopliteal junction. SSV: small saphenous vein. Source: Arrien GmbH.

refluxing sciatic vein, which is present in about 1 % of cases, may sometimes be mistaken for the Giacomini vein; thermal ablation then inevitably damages the accompanying sciatic nerve [24, 25]. The subcutaneous sciatic vein is the main trunk of the original deep vein system (the axial vein of the embryo) [26]. It runs in the immediate vicinity of the sciatic nerve and drains into one of the inferior gluteal veins. After the originally insignificant femoral vein forms and connects with the sciatic vein in the popliteal fossa, the proximal part of this vein atrophies and remains only as a vas nervorum [27]. A persistent sciatic vein is very rare (< 1 % [28]) and is found particularly in Klippel-Trenaunay syndrome [29]. It may have an important role as a collateral for the femoral vein, but may also have quite serious consequences [30] (▶ **Table 1**).

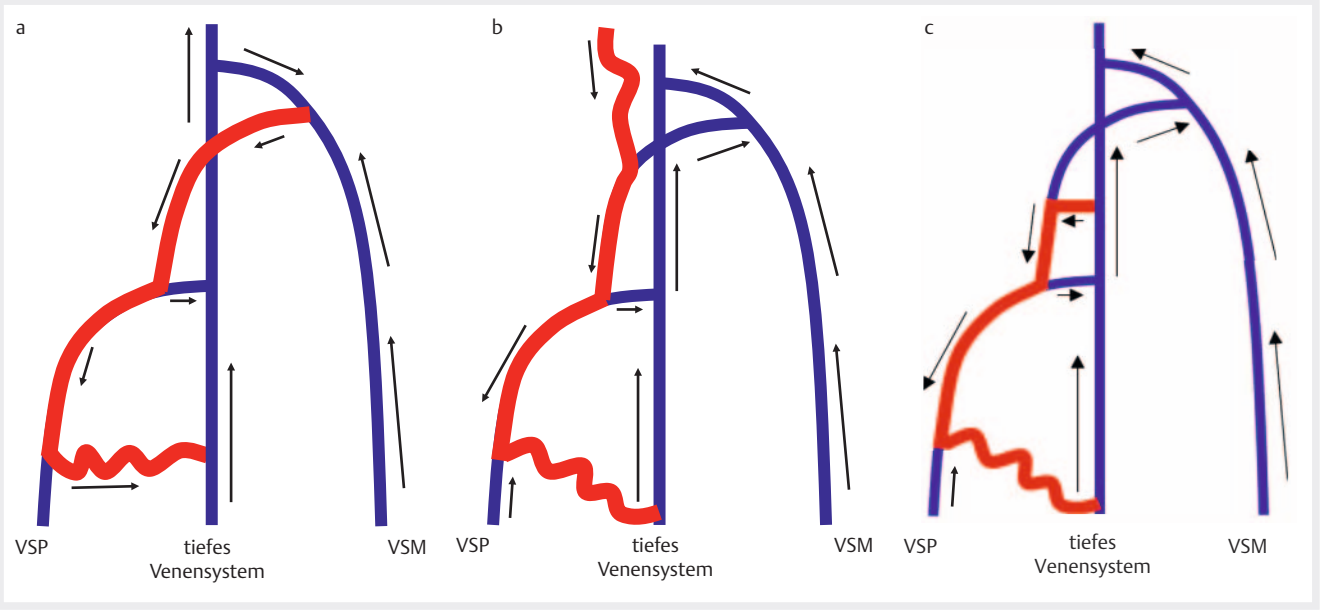
Pre-interventional ultrasound mapping before even minor procedures should examine not only the veins but also the neuronal structures and the arteries accompanying the small saphenous vein in the calf in order to plan treatment properly and omit any unnecessary therapeutic measures [22, 31–33].

Types of reflux in the Giacomini vein and therapeutic options

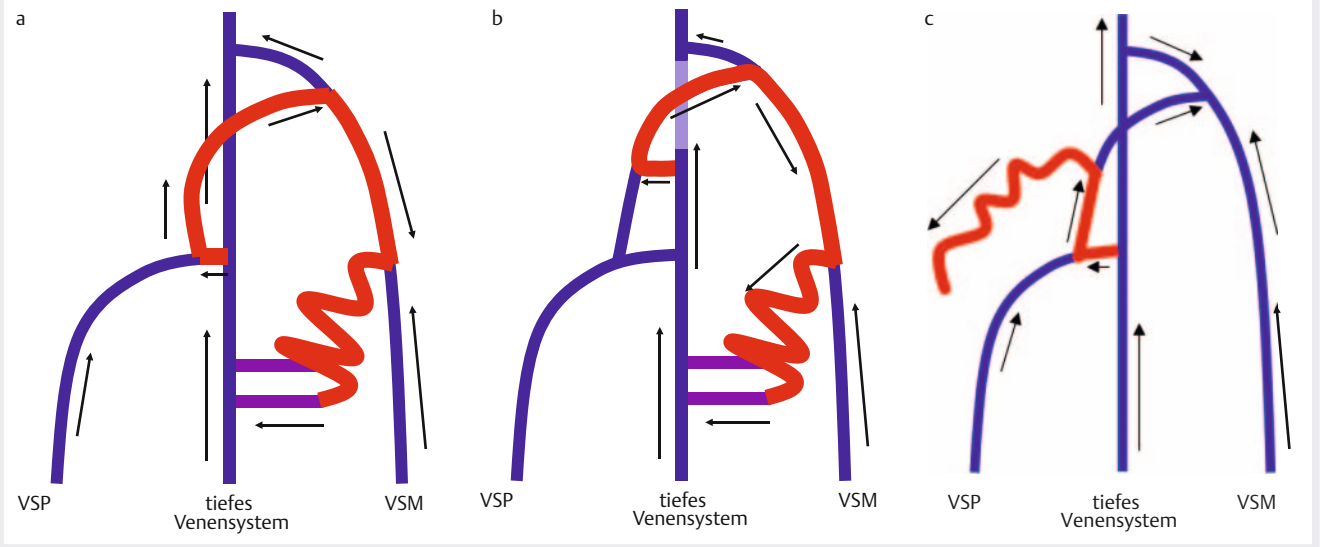
As a connection between two trunk veins, the direction of flow in the Giacomini vein is described as being antegrade (from the small saphenous vein to the great saphenous vein).

Basically, we have to distinguish two types of reflux in the Giacomini vein: antegrade and retrograde reflux.

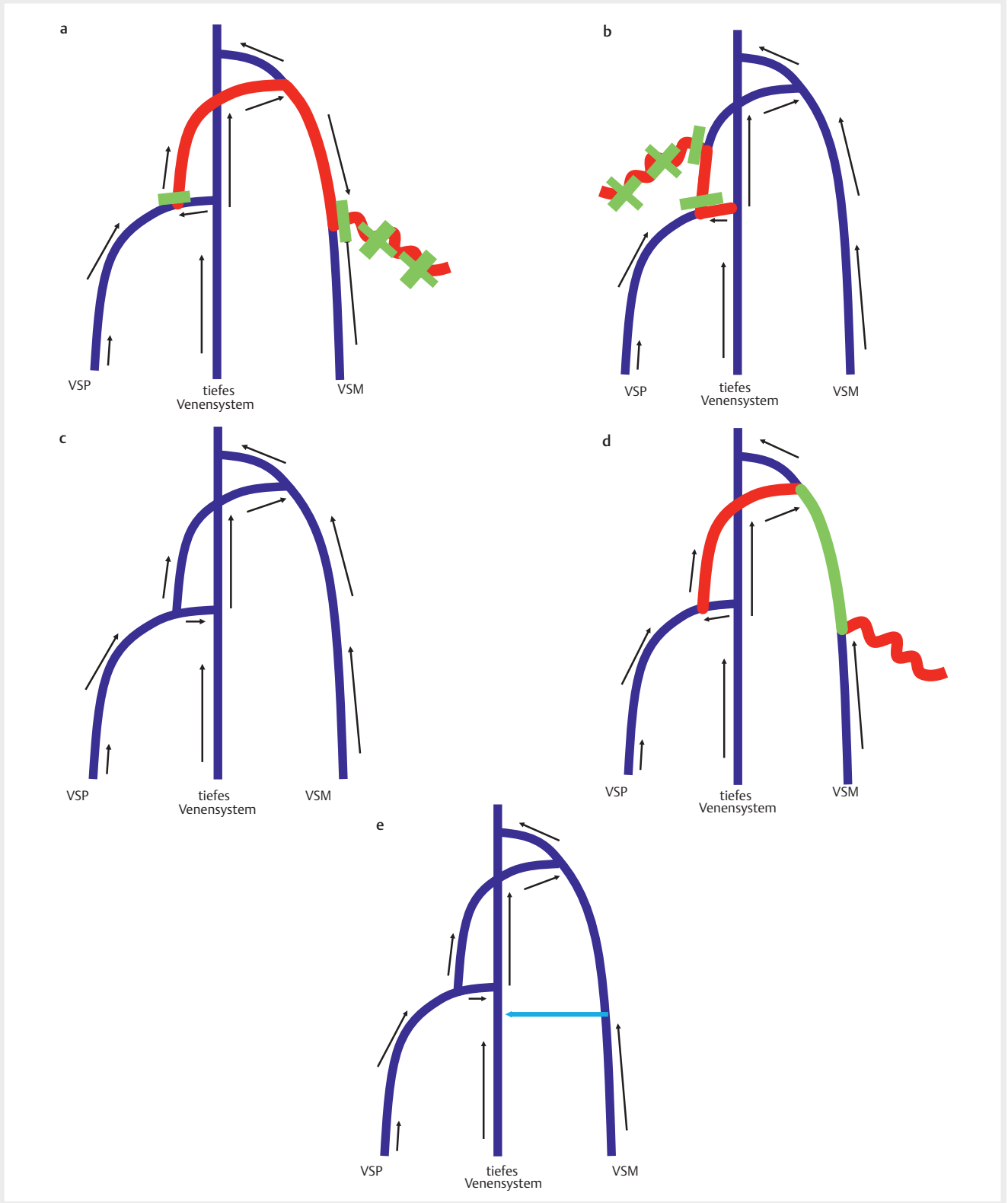
With retrograde reflux in the Giacomini vein, venous blood from the great saphenous vein, the pelvic vein, or perforating veins in the thigh flows into the small saphenous vein (▶ **Fig. 4a–c**).



▶ **Fig. 4 a–c** Diagrams showing retrograde reflux. **a** Reflux from the great saphenous vein (in this case from the common femoral vein; it would also be possible from a tributary at the SFJ) passing into the Giacomini vein anastomosis with filling of the small saphenous vein: incomplete small saphenous vein incompetence of the cranial great saphenous type. Source: Arrien GmbH. **b** Reflux from the lesser pelvis via subcutaneous tributaries with connections to the Giacomini vein and filling of the small saphenous vein: incomplete small saphenous vein incompetence of the cranial pudendal type. Source: Arrien GmbH. **c** Reflux in the Giacomini vein from the posterior perforating vein of the thigh with filling of the small saphenous vein (incomplete incompetence of the cranial perforator type). Source: Arrien GmbH.



▶ **Fig. 5** Diagrams showing antegrade reflux. **a** Diastolic reflux at the saphenopopliteal junction with transmission of the reflux to the Giacomini vein (Hach class I, complete small saphenous vein incompetence). Filling of the great saphenous vein via the anastomosis with reflux to below the knee. Hach class III incomplete great saphenous vein incompetence of the posterior small saphenous type. Source: Arrien GmbH. **b** as a, with the difference that the source of reflux is not the small saphenous vein but rather corresponds to a posterior perforating vein in the thigh with filling of the Giacomini vein. Hach class III incomplete great saphenous vein incompetence of the posterior perforator type. Source: Arrien GmbH. **c** Diastolic reflux at the saphenopopliteal junction with transmission of the reflux to the Giacomini vein (Hach class I complete small saphenous vein incompetence) and filling of tributaries in the posterior thigh. Source: Arrien GmbH.



▶ **Fig. 6** Diagrams showing treatment options for antegrade reflux. **a** Division of the Giacomini vein at the small saphenous vein (green line) and phlebectomy of the tributaries in the lower leg. Source: Arrien GmbH. **b** Division of the Giacomini vein at the small saphenous vein (green line) and phlebectomy of the tributaries in the thigh. Source: Arrien GmbH. **c** Haemodynamic result after the interventions shown in **a** and **b**. Source: Arrien GmbH. **d** Treatment of the refluxing part of the great saphenous vein, with endovenous thermal laser ablation (the green line corresponds to the thermally treated area). Source: Arrien GmbH. **e** Haemodynamic result after the intervention shown in d: the blood flow from the distal great saphenous vein drains via perforating veins of the calf muscles (light blue arrow). Source: Arrien GmbH.

In all cases, there is incomplete small saphenous vein incompetence with a competent saphenopopliteal junction. These conditions are referred to as incomplete small saphenous vein incompetence of the posterior great saphenous type or pelvic type [3, 34].

With respect to the far less common antegrade reflux, we understand this to be a paradoxical (ascending) reflux that occurs during muscular diastole (when the calf muscles relax after their contraction). In particular, the saphenopopliteal junction is incompetent (in terms of a perforating vein incompetence), the Giacomini vein fills antegradely, and proximally the great saphenous vein which, in turn, usually fills a varicose tributary vein distal to the knee (Hach class I, complete small saphenous vein incompetence and Hach class III, incomplete great saphenous vein incompetence of the posterior type) (▶ **Fig. 5**).

Alternatively, only the small saphenous vein and the Giacomini vein are affected, with refluxing tributaries at the back of the thigh. Escribano showed that this type of reflux is present in about 1 % of primary varicose veins [3, 35]. The physical explanation of this apparent paradox is the 'siphon effect'. It is important to note that any flow detected in muscular diastole has to be considered pathological and should be clarified by duplex ultrasound.

Systolic 'reflux' in the Giacomini vein has to be distinguished from the retrograde outflow of blood into the opening of the small saphenous vein with flow into the Giacomini vein, antegrade flow to the great saphenous vein, and drainage into the femoral vein. This systolic flow in the Giacomini vein corresponds to a bypass in the case of occlusion of the deep veins of the thigh (true bypass after thrombosis or functional bypass, e. g. with muscle hypertrophy) and must not be confused with incompetence of the Giacomini vein [3, 36].

Considering that the Giacomini vein transmits great saphenous vein incompetence to the small saphenous vein, a radical surgical approach was endorsed in the past, with high ligation and stripping of both trunk veins, plus phlebectomy of the Giacomini vein [37, 38]. More recently, understanding of the anatomy and function with the aid of ultrasonography and the newer endovenous thermal procedures, sclerotherapy, and minor surgery with a targeted technique and knowledge of the type of reflux have allowed a true minimally invasive approach to this type of venous incompetence [35, 39–42].

With antegrade reflux of the Giacomini vein with great saphenous vein incompetence of the posterior small saphenous type (▶ **Fig. 5a**) or with reflux in tributaries on the posterior thigh (▶ **Fig. 5c**), Escribano et al. demonstrated a therapeutic alternative on 15 legs, which was interesting from the pathophysiological point of view. They merely divided the Giacomini vein from the small saphenous vein and performed phlebectomy of the varicose tributary veins in the posterior thigh or on the great saphenous vein in the calf (using the CHIVA strategy on the Giacomini vein). The diameter of the Giacomini vein decreased from 5.8 mm to a more normal 3.6 mm and the antegrade reflux disappeared. The flow at the saphenopopliteal junction, which had been incompetent and the source of reflux before the intervention, likewise returned to normal and the junction was competent after the procedure. There was a recurrence in two legs, after 6 and 12 months (13 %) [35] (▶ **Fig. 6a–c**).

Theivacumar et al. reported on two patients with antegrade reflux of the Giacomini vein and a refluxing connection to the great saphenous vein who were treated with endovenous laser ablation solely in the middle and distal segments of the great saphenous vein. After ablation of the great saphenous vein, the Giacomini vein was again competent in both cases, without the vein itself having been treated directly. At the 12-month follow-up examination, recurrence was ruled out in both cases [39] (▶ **Fig. 6d, e**).

Conflict of Interest

The authors declare that they have no conflict of interest.

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