Duplication of the Great Saphenous Vein: A Definition Problem and Implications for Therapy

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BACKGROUND In the literature there is a range from 1% to 20 % of duplication (up to 20%) of the great saphenous vein (GSV) reported, because there is a lack of an accurate definition of the GSV and objective parameters for an anatomical identification.

OBJECTIVE To investigate the frequency of true duplications of the GSV.

MATERIALS AND METHODS A systematic review of the literature, a retrospective analysis of duplex examinations, and a prospective study of duplex examinations to investigate the frequency of true duplications of the GSV.

RESULTS In the literature review, a great variety of definitions is used for duplication of the GSV. Before the consensus of the Union International de Phlébologie (UIP) in 2006, Only in a small number of studies, the definition of the GSV in the saphenous compartment between the fascial blades is mentioned.

CONCLUSION Phlebographic studies have been the criterion standard for the identification of venous anatomy. Now, duplex is regarded as the criterion standard for accurate detection of the veins. True duplication of the GSV is less common than the previous literature has suggested, namely 1.6% to 2%. It is recommended that the duplicated GSV should be treated to avoid an important risk of recurrence of venous insufficiency.

The authors have indicated no significant interest with commercial supporters.

Off all the superficial veins, an insufficient GSV is the most important cause for chronic venous insufficiency and its complications such as a leg ulcer. Since the introduction by Keller in 1905 of stripping, despite new endovascular techniques, it is the most performed treatment for GSV incompetence in general hospitals. Of all venous leg ulcers, 50% are due to GSV incompetence only. Consequently, GSV incompetence is a major social and economic burden. GSV incompetence is mostly based on primary valvular incompetence (genuine varicosity) and seldom the result of other pathologies such as thrombophlebitis. Effective treatment options exist for varicose veins, but the success rate is related not only to adequate anatomic and functional information about the venous circulation, but also to the technique chosen. Currently, careful duplex ultrasound examination is used as part of the evaluation. It is widely accepted that the course of venous diseases can be detected using duplex ultrasound.[1,2] Until the consensus paper of the Union International de Phlébologie (UIP) in 2006, was published, there was confusion in the literature about the nomenclature of leg veins in general and particularly of the saphenous veins.[3,4]

The superficial venous system is connected to the deep venous system, which drains 90% of all blood out of the legs through the perforator veins. The GSV and the short saphenous vein (SSV) and

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ISSN: 1076-0512 • Dermatol Surg 2012;38:77–82 • DOI: 10.1111/j.1524-4725.2011.02154.x

its tributaries represent the most important hemodynamic veins of the superficial system of the leg. The GSV begins as a continuation of the dorsal venous arch in the foot, travels anteriorly to the medial ankle, and ascends on the medial side of the leg to drain ultimately at the saphenofemoral junction (SFJ) in the common femoral vein. The saphenous compartment is composed of a superficial saphenous fascia and a deep muscular fascia and contains the GSV accompanied by its saphenous nerve.[5] The GSV generally has two major tributaries below and one above the knee, but it also receives blood from the pelvic veins, the superficial epigastric vein, the iliac circumflex veins, and the anterior and posterior accessory saphenous veins (AASV or PASV). The AASV runs lateral to the GSV and is located in separate saphenous compartments distally. The AASV joins the GSV and lies within one saphenous compartment before entering the saphenofemoral junction. On B-mode ultrasound investigation, in transversal view, the AASV overlies and aligns with the femoral vein and artery, whereas the GSV passes more medially from these deep vessels. The GSV is generally described as a single trunk along the medial side of the thigh and calf, but few articles mention the incidence and pattern of duplication of the GSV. The two GSVs will lie in the same plane, parallel to the skin, and run along the aponeurotic deep fascia. These two GSV's will also have the same diameter draining a common cutaneous territory (Figure 1). An AASV is often mistaken for a duplication of the GSV, but the AASV is usually smaller and does not drain the same cutaneous territory as the GSV.[6]

A missed duplication of a GSV can be a partial explanation for recurrent varicose veins after surgery.[7] The lack of an accurate definition of the GSV and the lack of objective parameters for its identification before the consensus paper on the definition of the GSV can explain this difference.[8]

We undertook a study to investigate the frequency of true duplications of the GSV.

Figure 1. Duplex of the GSV, between the fascial blades, the "Egyptian Eye sign."

Materials and Methods

Our study consisted of three parts: a systematic review of the literature, a retrospective analysis of duplex ultrasound examinations, and a prospective study of duplex ultrasound examinations.

Our literature review refers to articles published in Pubmed, Embase, and the Cochrane library until March 2008. The languages we chose were English, German, Dutch, and French. Key words were "anatomy," "dissection," "duplication," "duplicated system," "double system of the GSV, SFJ, "ultrasound," and "ultrasonic examination of the long/(great) saphenous vein."

Inclusion Criteria

Prospective and retrospective studies on the description of the GSV using duplex ultrasound scanning, intraoperative findings, and phlebography or combinations of these three modalities were included.

The duplex ultrasound criterion was the following: situation of the GSV between its fascial blades, the typical Egyptian Eye sign of the GSV, also known as the saphenous eye. If the vein was situated outside the fascial blades, the vein was defined as vein a parallel to the GSV.

Exclusion criteria Studies describing the SSV, studies of nonhuman saphenous veins, and in vitro research studies were excluded. Studies mentioning only double segments of the GSV in the context of coronary by-pass surgery and studies not recording the number of double GSVs were not included. Case reports and studies without an English abstract were also excluded.

An experienced radiologist (LVD) performed a retrospective analysis. Two hundred forty consecutive duplex ultrasound examinations for venous reflux in the Department of Radiology, Erasmus Medical Centre, Rotterdam, The Netherlands, were reviewed and checked if a duplication of the GSV was described. Duplex ultrasound scanning was performed under standard conditions; a B-mode scanner with a 5- to 10-MHz transducer was used.

One experienced duplex examiner (MK) performed a prospective study. One hundred consecutive patients were seen for primary, never-treated varicose veins, and a duplex ultrasound examination was performed for each patient in a standing position.

A duplex ultrasound Envisor Philips HDI 4500 scanner with a 5- to 10-MHz transducer was used in B-mode scanning. The GSV and femoral vein were examined for reflux, occlusion with and without manual compression and Valsalva maneuver. The occurrence of duplicated systems of the GSV was scored. The GSVs were followed to their origin and to their location between or not between the fascial blades. The ultrasound markers of the venous anatomy of the GSV were used in accordance to the current consensus of the UIP. The saphenous eye consists of the superficial fascia and the deeper aponeurotic fascia (Figure 2). The eye is an intrafascial vein: the GSV. This eye sign allows us to distinguish the GSV from the parallel tributaries. This precise location of the GSV between the fascial blades indicates the difference between phlebography and duplex ultrasound, because fascial structures are not visualized with phlebography.

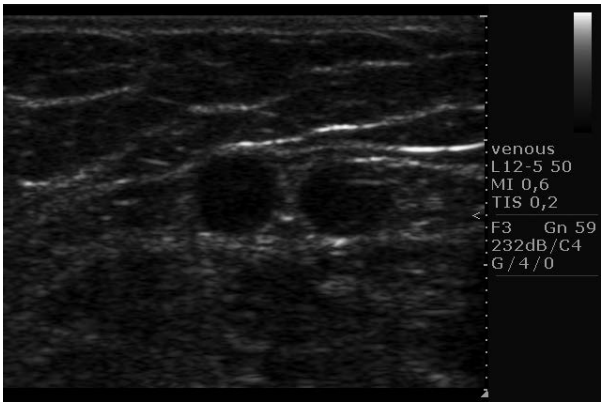

Figure 2. True duplication of the GSV, between the fascial blades.

Results

Of all the screened articles and abstracts, 48 reports were reviewed. Of all these studies, 16 fulfilled the inclusion criteria (Table 1). The review of the literature can be divided into surgical anatomical dissection studies, duplex ultrasound scanning, and phlebography or a combination of these parameters. In eight studies, anatomical dissection was used as the outcome parameter. The earliest study was by Glasser in 1942. He performed anatomical dissection on 100 limbs and found a double saphenous vein in three limbs. In 1968, Allen and colleagues found a double system in 18% of their 156 anatomical dissections. In 1975, Capuano and colleagues performed anatomical dissection of 40 GSVs and found five double veins. In 1985, during vascular surgery in 25 patients Burnand and colleagues found four double veins. In 1986, in a combination study of intraoperative anatomy, phlebography, and duplex ultrasound examination in 50 patients, Leopold and colleagues demonstrated four double trunks in subfascial plane and seven in different fascial planes. In 1986, a prospective study of anatomy and phlebography by Shah and colleagues showed variants of double systems in 35% of 331 patients. In 1993, in 25% of 20 GSVs, Kaiser and colleagues found a double system in a postmortem anatomical study. The most recent anatomical study in 1,089 limbs demonstrated a true duplication of the GSV

TABLE 1. Literature Review of Articles in Pubmed, Embase, and Cochrane

	References	*Investigations*	*Definition of Duplication Used*	*Number*	*Number of Duplication*
1	Glasser[10]	Anatomical dissection	Double saphenous vein	100 limbs	3%
2	Allan et al.[11]	Anatomical dissection	Duplicated vein, loops	165 limbs	18% loops in the tigh
3	Capuano et al.[12]	Anatomical dissection	Double vein Classification description	40 saphena magna	5 double veins
4	Burnand et al.[13]	Phlebography Intraoperative anatomy	Double vein	25 patients	4 double veins
5	Leopold et al.[14]	Phlebography, duplex Intraoperative anatomy	Double system, Fascial planae	50 patients	4 both trunks in subfascial planae, 7 in different fascial planae
6	Shah et al.[15]	Phlebography Intra operative anatomy	Variants of double systems	331 patients	35% double systems
7	Ruoff et al.[16]	Duplex	Duplication	102 limbs	18% duplications
8	Buchbinder et al.[17]	Duplex	Duplicate system	15 patients	1 patient
9	Kaiser et al.[18]	Postmortem anatomical study	Double system	20 greater saphenous veins	25%
10	Kupinski et al.[19]	Duplex	Complete double system, branching double system	1400 limbs	8% complete double system, 185 branching double system
11	Head et al.[20]	Duplex	Duplicated system	100 patients	11% duplication
12	Van Dijk et al.[21]	Duplex	Duplication	44 patients	20% duplication
13	Ricci et al.[22]	Duplex	True reduplication Eye sign, saphenous compartment	610 duplex examinations	1% true reduplication
14	Corrales et al.[23]	Phlebography	True and false duplication, complete double system, closed loop	103 saphenograms	49% forms of duplication, only 1 patient with complete double system in the tight, and 1 to the calf
15	Klitfod[24]	Duplex	Duplication	44 legs	4 long saphenous vein duplication
16	Donelli et al.[25]	Anatomy, surgical	True duplex-LSV	2089	188 (9%) duplication

in 9%. Seven studies used duplex examination as an outcome parameter.

Ruoff and colleagues found 18% duplication in 102 limbs in 1987. Also in 1987, in a duplex ultrasound study, Buchbinder and colleagues found a duplicate system in one of 15 patients. In a duplex ultrasound study, Kuprinski and colleagues found a branching double system in 8% of 1,400 limbs. In 1995, in a duplex ultrasound study, Head and colleagues demonstrated a duplicated system in 11 of 100 patients. Van Dijk and colleagues did a

duplex ultrasound study in 1996 and demonstrated a duplication of the GSV in 20% of 44 patients. In 1999, in a duplex ultrasound study, Ricci and colleagues used the term eye sign and saphenous compartment and found in a true duplication in 1% of 610 patients (6). In 2003, in a retrospective follow-up duplex ultrasound study, Klitfod found a duplication of the GSV in four of 44 patients.

One study used phlebography as a single outcome parameter. The combination studies of phlebography, duplex, and anatomical dissection are discussed above. In 2002, in 49% of a 103 phlebographies Corrales found forms of duplications and only one patient with a true duplication in the thigh and another patient with a duplication in the calf.

In the retrospective duplex study, in four of 240 cases (1.6%), a true duplication of the GSV was seen on duplex ultrasound scan. A partial duplication, in which the GSV is not embedded 100% between the fascial blades, was seen in 59 cases (24.6%). In our prospective study, two of the 100 (2%) duplex scans demonstrated a true duplicated system of the GSV, each vein embedded between the fascial blades. In 17 (17%) cases, partial duplication of the GSV occurred.

Discussion

Although there is much literature about the GSV, articles describing duplication of the GSV are not frequent, especially, articles using duplex ultrasound examination.

Only eight of the 16 included articles used duplex ultrasound was used for the investigation of the veins. Even in these articles, we found a wide range of duplicated GSVs (1–20%). The incidence of superficial veins parallel to the longitudinal axe of the GSV are a source for confusion. Sometimes there are defined as a duplication of a GSV, when the current definition is not respected. For this reason, the incidence of duplicated GSVs reported in the literature is highly variable, but partially duplicated systems are included. These so-called closed loops consist of partial duplication of the GSV, but the veins converge again above or at the level of the knee.

Phlebographic studies were the criterion standard identification of the venous anatomy and venous incompetence for a long time. Phlebography is still essential for the detection of complicated, mainly obstructive post-thrombotic syndrome, pelvic congestion syndrome, and phleboneuroma.[9]

Duplex ultrasound can now be regarded as the criterion standard for examination of venous anatomy and venous reflux. The latest generation of duplex scanning systems have higher resolution and lower back scattering in standard use (B-mode, 5–10 MHz probe). Consequently, today's duplex ultrasound systems easily detect veins, arteries, fascial blades, muscles edema, and even nerves.

This study indicates that true duplication of the GSV is less common than the literature has suggested, namely 1.6% to 2%. Combining the retrospective duplex ultrasound study and the prospective duplex ultrasound study, true duplication of the GSV occurs in 1.8% of the duplex examinations of the GSV (Figure 1).

A double GSV can be an explanation for recurrent incompetence of the GSV, due to a persistently duplicated trunk of the duplicated system. Consequently, precise pretreatment duplex ultrasound mapping will contribute to a better treatment plan, especially because new endovenous techniques such as endovenous laser therapy and duplex ultrasound-guided sclerotherapy are available now. Prospective studies with treatment outcomes based on these identification criteria are still not available. Nor is there any literature about the need to treat both GSVs or how often a competent second GSV will become incompetent after treatment of the insufficient GSV. However, a

duplication not treated is thought to be a candidate for a recurrence of varicose veins 1.

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