Patterns of saphenous reflux in women with primary varicose veins

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Objective: Varicose veins have been linked to great saphenous vein (GSV) reflux and in particular, with reflux at the saphenofemoral junction (SFJ). Early stages of disease, however, may be associated with limited, localized reflux in segments of the GSV and/or small saphenous vein (SSV). Ultrasound mapping of saphenous veins was performed to determine patterns of GSV and SSV reflux in women with simple, primary varicose veins.

Methods: Ultrasound mapping was performed prospectively in 590 extremities of 326 women with varicose veins (CEAP C_2 class) but without edema, skin changes, or ulcers (C_3 to C_6). Average age was 42 ± 13 (SD) years (range, 8 to 87). Patterns of GSV and SSV reflux, obtained in the upright position, were classified as I: perijunctional, originating from the SFJ or saphenopopliteal junction (SPJ) tributaries into the GSV or SSV; II: proximal, from the SFJ or SPJ to a tributary or perforating vein above the level of the malleoli; III: distal, from a tributary or perforating vein to the paramalleolar GSV or SSV; IV: segmental, from a tributary or perforating vein to another tributary or perforating vein above the malleoli; V; multisegmental, if two or more distinct refluxing segments were detected; and VI: diffused, involving the entire GSV or SSV from the SFJ or SPJ to the malleoli.

Results: Reflux was detected in 472 extremities (80%): 100 (17%) had reflux in both the GSV and SSV, 353 (60%) had GSV reflux only, and 19 (3%) had SSV reflux only, for a total prevalence of 77% at the GSV and 20% at the SSV. The most common pattern of GSV reflux was segmental (types IV and V) in 342 (58%) of 590; either one segment in 213 (36%) or more than one segment with competent SFJ in 99 (17%), or incompetent SFJ in 30 (5%), followed by distal GSV reflux (type III) in 65 (11%), proximal GSV reflux (type II) in 32 (5%), diffused throughout the entire GSV (type VI) in 10 (2%), and perijunctional (type I) in 4 (<1%). GSV refluxing segments were noted in the SFJ in 72 (12%) and in the thigh in 220 (37%), and leg (or both) in 345 (58%).

Conclusions: The high prevalence of reflux justifies ultrasound mapping of the saphenous veins in women with primary varicose veins. Correction of SFJ reflux, however, may be needed in ≤12% of the extremities, and only about one third CEAP C2 limbs may require treatment of a refluxing GSV in the thigh. (J Vasc Surg 2005;41:645-51.)

Patients with chronic venous insufficiency present with a variety of conditions, such as telangiectasias, varices, skin changes, and ulcers. The appearance of varicose veins in the lower extremities is a common reason for patients, particularly women, to seek medical attention. The relationship between varicose veins and saphenous vein valvular insufficiency has been known for centuries.[1] In addition to conservative therapy, surgical alternatives to interrupt reflux or to eliminate the refluxing saphenous vein have been advocated even in the presence of deep venous reflux or obstruction.[2-4] Options for treatment of the refluxing saphenous veins, either the great saphenous vein (GSV), the small saphenous vein (SSV), or both, are increasing and diversifying. Presently, the classic treatment of saphenofemoral junction (SFJ) or saphenopopliteal junction (SPJ) ligation and stripping may not be the most commonly used method.[5] Ablation by radiofrequency or laser, various forms of sclerotherapy, and conservative surgery that preserves short or long segments of the saphenous veins are commonly used.[6-16]

Studies reported in the past were confusing enough to warrant action by an international consensus group of experts that created the CEAP classification.[17] Since then, the CEAP characteristics of patient populations studied have been described in detail, but few studies have focused specifically and exclusively in very selected subgroups of patients. The objective of this investigation was to identify the source of reflux in the superficial venous system in women with primary varicose veins (C_2), therefore avoiding data contamination due to different genders and multiple clinical presentations. Color-flow duplex Doppler ultrasound scanning was used to identify reflux and perform an actual preoperative mapping of the saphenous veins.

PATIENTS AND METHODS

Data from ultrasound mapping of lower extremity veins were collected prospectively from 1,740 extremities of 910 consecutive patients, and 85% of the extremities examined were from women (1,485/1,740).

Patient selection. Only data from women with primary varicose veins (C_2) were included in the analysis. Men were excluded, as were women in clinical classes C_1 and C_3 to C_6 and those with a history of previous venous surgery, deep or superficial venous thrombosis, or both. The study included 590 extremities of 343 women: 247 were bilat-

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Competition of interest: none.

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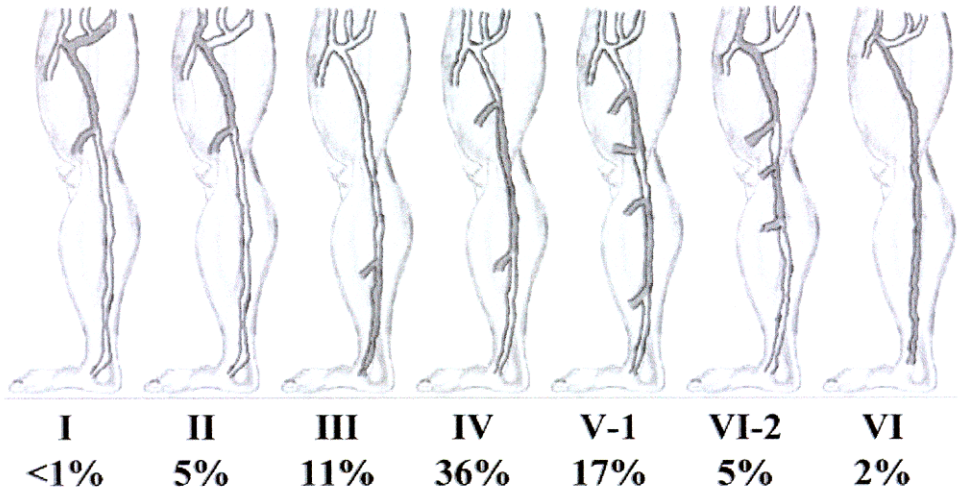

Fig 1. Patterns of great saphenous vein (GSV) reflux: *(I)* perijunctional from a saphenofemoral junction (SFJ) tributary into the GSV; *(II)* proximal GSV from the SFJ to a tributary or perforating vein; *(III)* distal GSV from a tributary or perforating vein to the paramalleolar level; *(IV)* segmental GSV from a tributary or perforating vein to another tributary or perforating vein. *(V-1)* multisegmental, nonrefluxing SFJ; *(V-2)* multisegmental, refluxing SFJ; and *(VI)* diffused throughout the entire GSV. Prevalence of each pattern is indicated as a percentage in the figure.

eral, and 96 were unilateral examinations. The average age was 42 ± 13 (SD) and ranged from 8 to 87 years.

Medical history and physical examination. The physician performing the ultrasound examination first interviewed the patients and obtained the following history and description of signs and symptoms:

- Family history of varicose veins was related to 417 extremities (71%);
- Telangiectasias were treated with sclerotherapy in 105 extremities (18%);
- Prior pregnancy (1 to 9) was mentioned in relation to 389 leg exams (66%);
- Pain was associated with 400 legs (68%);
- Complaints of tiredness were mentioned by 58%, weight sensation by 51%, burning sensation by 28%, itching by 4%, and paresthesias for only two extremities.

Seventy limbs (12%) were asymptomatic. The CEAP classification was confirmed by visual inspection and further reconfirmed after the ultrasound examination.

Ultrasound examination of superficial veins. All ultrasound examinations were performed by a physician trained in vascular surgery and/or vascular medicine. Interviews for medical history and explanation of the ultrasound procedure preceded the actual examination.

The ultrasound protocol screened for venous obstruction,[18] a condition that may alter the treatment of superficial veins, and focused on detailed mapping of superficial and deep venous reflux, with particular attention to preoperative mapping of superficial veins. All ultrasound examinations were performed with a Sonoline Siemens-Elegra ultrasound scanner (Issaquah, Wash).

The standing position was used to detect deep and superficial venous reflux with transducer frequencies between 7 and 12 MHz. Venous flow was examined in longitudinal sections using color flow. Duration of reverse flow was measured with pulsed Doppler. The common femoral, midthigh femoral, above-knee popliteal, and distal posterior tibial veins were examined for deep venous reflux. The GSV and SSV were imaged continuously from the respective femoral or popliteal junction to the paramalleolar level. The SSV in the calf and the above-knee SSV (vein of Giacomini) were imaged into the thigh, as dictated by the patient's anatomy. Nonsaphenous superficial veins in the anterior, lateral, and posterior aspects of the thigh were also imaged, but those findings are not part of this report.

Duration of reverse flow was measured after the release of distal muscular manual compressions. Multiple compressions distal to the site of the ultrasound recording were performed to improve confidence in reflux detection. Valsalva maneuver was also part of SFJ reflux evaluation. Reflux was established if the duration of reverse flow exceeded 500 milliseconds in the superficial veins or 1,000 milliseconds in the deep veins, as recently recommended by Labropoulos et al.[19-20]

Reflux patterns. Although not reported in detail here, sites of reflux source and drainage were mapped and measured in relation to the sole of the foot and referred to other anatomic landmarks such as the popliteal crease. Six patterns of reflux were identified in the GSV and SSV as shown in Fig 1 and Fig 2. SSV patterns of reflux were adapted according to the anatomic extension of the SSV into the thigh.

I. Perijunctional GSV or SSV reflux. GSV or SSV reflux originated from a tributary of the SFJ or the SPJ, extended most commonly for a short segment of the GSV or SSV, and drained through a tributary or

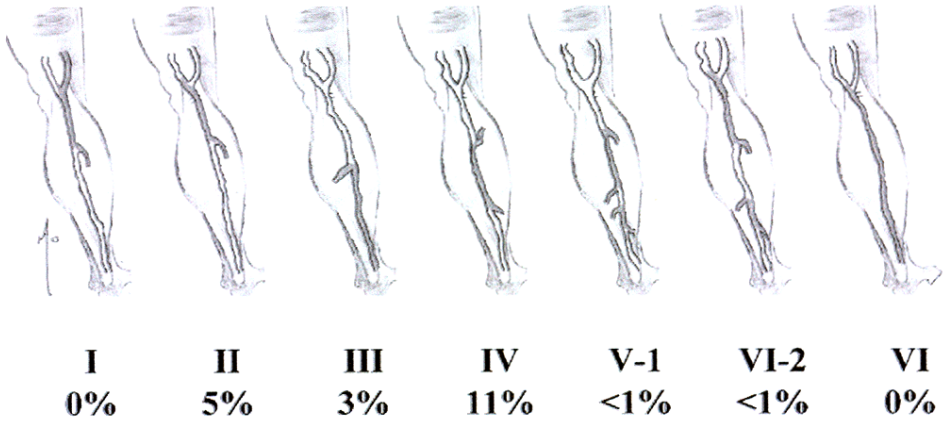

Fig 2. Patterns of small saphenous vein (SSV) reflux: *(I)* perijunctional from a saphenopopliteal junction (SPJ) tributary into the SSV; *(II)* proximal SSV from the popliteal junction to a tributary or perforating vein; *(III)* distal SSV from a tributary or perforating vein to the paramalleolar level; *(IV)* segmental SSV from a tributary or perforating vein to another tributary or perforating vein; *(V-1)* multisegmental, nonrefluxing SPJ; *(V-2)* multisegmental, refluxing SPJ; and *(VI)* diffused throughout the entire SSV. Prevalence of each pattern is indicated as a percentage in the figure.

perforating vein. Other types of reflux involving the SFJ or the SPJ, not reported in the analysis the saphenous veins, were the common femoral or popliteal to nonsaphenous tributary and the nonsaphenous tributary to other nonsaphenous tributaries.

II. Proximal GSV or SSV reflux. GSV or SSV reflux originated directly from the femoral or popliteal vein via the SFJ or SPJ (or thigh segment), extended through the GSV or SSV, and drained through a tributary or perforating vein in the thigh or upper calf. Valvular competence was detected in the distal segment of the GSV or SSV at the lower leg.

III. Distal GSV or SSV reflux. GSV or SSV reflux originated from a tributary or perforating vein, most likely at the lower thigh or upper calf, and extended to the paramalleolar level. The SFJ or SPJ and a proximal segment of the GSV or SSV were competent.

IV. Single segment GSV or SSV reflux. GSV or SSV reflux originated from a tributary or perforating vein and extended distally to another tributary or perforating vein above the malleoli. The SFJ or SPJ, a proximal segment and a distal segment of the GSV or SSV were competent.

V. Multisegmental GSV or SSV reflux. GSV or SSV reflux was characterized by two or more refluxing segments separated by an intermediate competent segment. This pattern was subdivided in two subgroups:

V-1. The SFJ or the SPJ junction was competent without reflux; and

V-2. The SFJ or the SPJ was incompetent, being the source of reflux of the first incompetent segment.

VI. Diffuse reflux of the entire GSV or SSV. GSV or SSV reflux originated at the SFJ or SPJ (or thigh segment) and extended to the paramalleolar level.

Statistical analysis. The following prevalences were compared statistically using z-scores for comparison of proportions: GSV versus SSV reflux prevalence; GSV competent junction versus refluxing junction prevalence; and saphenofemoral junction versus thigh versus knee versus calf GSV reflux prevalence.

RESULTS

GSV or SSV reflux was detected in 472 extremities (80%): 353 (60%) had reflux only in the great saphenous vein, 100 (17%) had reflux in both the GSV and SSV, and 19 (3%) had reflux only in the SSV. Prevalence of reflux was significant higher in the GSV (77%) than in the SSV (20%) ($P < .001$). Nonsaphenous reflux was noted in 118 extremities (20%), of which 16 (2.7%) had nonsaphenous perijunctional reflux. Deep venous reflux was detected in 14 (2%), and perforating vein reflux was noted in 137 extremities (23%). Prevalence or frequencies of various patterns of GSV and SSV reflux are presented in Table I.

Fig 3 is an example of the most common type of reflux, limited to a GSV segment.

Table II lists the prevalence of the anatomic location of a GSV with reflux. In most cases of SFJ involvement, reflux extended distally beyond the thigh segment of the GSV. However, reflux in a GSV thigh segment did not necessarily imply SFJ reflux as only 76 (35%) of 220 had reflux that started at the SFJ or was caused by a SFJ tributary. In addition to those extremities with reflux, segmental reflux was the most common pattern across the knee in the entire GSV. However, in only 75 (22%) of the 345 extremities with GSV reflux in the calf did GSV reflux extend to the paramalleolar level. Most GSV reflux in the calf was limited to the proximal and middle calf segments.

The prevalence of a competent SFJ was significantly higher than the prevalence of a refluxing SFJ ($P < .001$).

Table I. Prevelance of patterns of saphenous vein reflux in 590 extremities in women with primary varicose veins

Reflux Patterns	*Great Saphenous Vein*		*Small Saphenous Vein*	
	Number	*Percentage*	*Number*	*Percentage*
I (perijunctional)	4	<1	0	0
II (proximal saphenous)	32	5	29	5
III (distal saphenous)	65	11	20	3
IV (single segment)	213	36	63	11
V-1 (multisegment competent SFJ/SPJ)	99	17	4	<1
V-2 (multi-segment SFJ/SPJ reflux)	30	5	3	<1
VI (diffuse)	10	2	0	0
Total	453	77	119	20

SFJ, Saphenofemoral junction; *SPJ*, saphenopopliteal junction.

Prevalence of GSV reflux was significantly higher in the calf than in the thigh and in the thigh than in the knee. Despite an apparent tendency, the prevalence of reflux in the GSV knee segment was not significantly higher than the prevalence of reflux at the SFJ ($P = .058$). The prevalence of GSV single or multiple segmental reflux without junction involvement (53%) was significantly higher than the remaining types of reflux ($P < .001$). Prevalence of SSV segmental reflux was not significantly higher than all other types of SSV reflux ($P = .56$), but it was significantly higher than the second most common type, proximal SSV reflux ($P < .001$). The prevalence of proximal SSV or distal SSV reflux was not significantly different ($P = .24$).

DISCUSSION

This study focused on patterns of saphenous vein reflux on a very specific patient population: women with primary varicose veins referred to an outpatient vascular laboratory for vein mapping. The patients examined, mostly Brazilian women with concerns about the cosmetic appearance of their legs, have less disease than those treated at American wound care centers or hospitals. The patients' characteristics provided for a specific, focused analysis of patterns of saphenous reflux in a restricted, gender-specific class C_2 subgroup.

Reflux was significantly more prevalent at the GSV than at the SSV; only one of five legs studied had SSV reflux, whereas four of five had GSV reflux. These findings corroborate the relationship between GSV reflux and varicose veins and justify GSV mapping in women with simple varicose veins. GSV reflux was most common at the calf than at the thigh or SFJ. Indeed, ≤12% of the extremities evaluated had reflux at the SFJ, and only about one third of the extremities had reflux at the level of the thigh.

These findings fail to support the widespread surgical treatment of the SFJ in women with primary varicose veins. Even the growing practice of ablation of the thigh segment has to be tempered by these findings and should be used selectively. Detailed vein mapping with a clear determination of reflux source, drainage locations, and diameter measurements is recommended.[21,22]

For a sample population predominantly of young women with varicose veins, GSV diameters >8 mm at the SFJ, 6 mm at midthigh and 4 mm in the calf have a >90% positive predictive value for reflux.[21] GSV diameters of ≤5 mm at the junction, ≤3 mm at midthigh, and ≤2.5 mm in the calf have a ≥80% negative predictive value for lack of reflux. However, discrepancies between diameter and the presence or lack of reflux may be explained by patient size as represented, for example, by body mass.

This study corroborates findings by Labropoulos et al[23] regarding the origin of lower-limb, primary reflux. These authors investigated a mixed-gender, young population without symptoms, with prominent nonvaricose veins or with varicose veins. Significantly more reflux was reported for the calf saphenous veins than for the thigh or SFJ. Contrary to traditional belief, their conclusion suggested that reflux may not progress in a retrograde fashion but may have an ascending or multicentric progression.

This conclusion was even more striking in this study, which consisted only of women with varicose veins, without edema, and at early stages of disease, as demonstrated by the preponderance of segmental reflux without junction involvement. Prevalence of deep vein reflux was also low (2%) in this selected group of patients. A less strict criterion (500 vs 1000 milliseconds) would not have increased this prevalence significantly.[20]

In another publication, ache, ankle edema, and skin changes were correlated with reflux in the below-knee veins.[24] These findings undermine treatment of the SFJ with or without removal of the thigh segment of the GSV in early stages of disease. Published data are not uniform, however. Although studies have focused on primary varicose veins, the data presented were related to heterogeneous group of patients:

- Cooper et al[25] indicated that incompetent segments occurred most commonly above-knee.
- Wong et al[26] concluded that SFJ incompetence predominated in extremities with primary and recurrent varicose veins.
- Others reported that the SFJ was competent in about one half to one third of extremities with primary varicose veins, indicated that ligation alone would be inadequate treatment, and suggested that the develop-

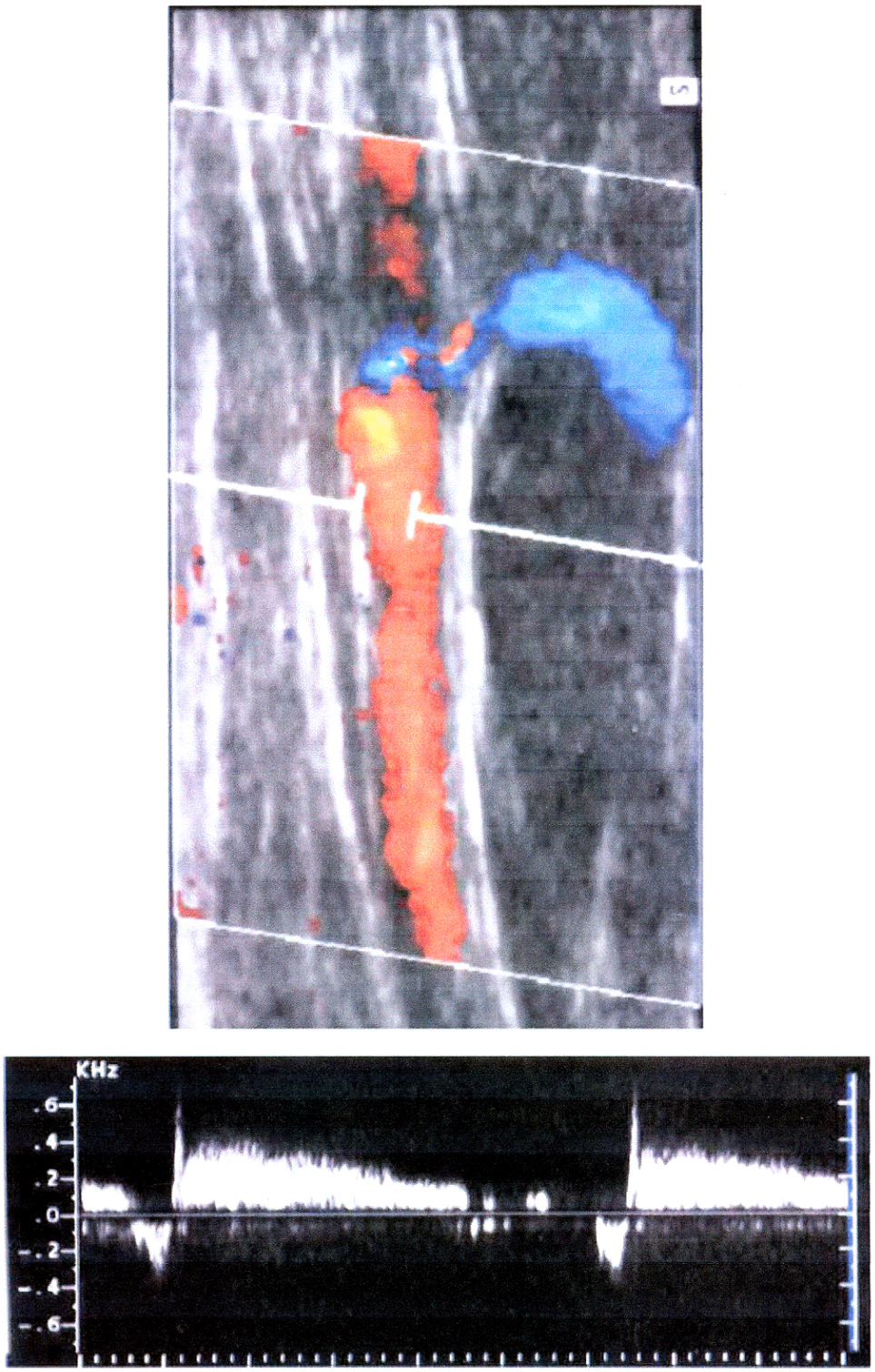

Fig 3. *A*, Refluxing great saphenous vein with a tributary as a source of reflux. Actual display was rotated by 90° to mimic the standing position of the patient during the examination. The transducer probe is at the right of the view. *B*, Reflux blood flow signal, above baseline, lasting >1 second as detected by duplex ultrasound scan.

Table II. Anatomy involved in great saphenous vein reflux in 590 extremities in women with primary varicose veins

Location	*Number*	*Percentage*
Saphenofemoral junction	72	12
Thigh segment	220	37
Knee segment	96	16
Calf segment	345	58

ment of primary varicose veins was an ascending rather than a descending phenomenon.[25,27]

- Goren and Yellin[28] concluded that one third to one half of clinical decisions opting for ankle-to-groin stripping and SFJ ligation, respectively, would result in unnecessary surgery.
- In a study that justifies distinction by gender, Fronek et al[29] indicated that flow-velocity response to automatic cuff inflation at the thigh or calf was decreased in the SFJ and SPJ of women compared with men.

The superiority of duplex ultrasound scanning over clinical examination for presurgical mapping has been well documented.[28,30] Although ultrasound determinations of reflux at the junctions and at specific locations above and below the knee may be adequate for diagnosis and epidemiologic studies, preoperative mapping must include the entire length of the saphenous veins.[13,21,31] Such mapping may lead to selective surgical treatment and avoidance of complications related to extensive surgery.[13,15-16]

Because most of the extremities only had saphenous vein reflux in the calf, alternative surgical treatment besides stripping or ablation could be considered. Stripping or ablation of calf veins risks nerve damage complications.[32-33] Ultrasound mapping provides an opportunity for conservative ligation and perhaps sclerotherapy of tributary and perforating veins acting as the main source of reflux.[13,34] Such procedures could be performed under ultrasound guidance in an outpatient setting.[35]

Technical details on how to elicit reflux are still debatable.[20,36] The standing position may be traditionally preferred, but the Edinburg epidemiologic study, for example, was conducted with patients standing at a 45° angle. Their protocol was adopted after a pilot study revealed significant patient discomfort in response to a prolonged period in the standing position.[36]

Labropoulos[20] demonstrated that the prevalence of superficial vein reflux decreased in the standing position only for the subgroup of normal subjects, and not necessarily for extremities with venous insufficiency. Although a standing position was accepted by the otherwise healthy patients of this study, ultrasound mapping performed in a reverse Trendelenburg position may be more practical in a hospital or wound care practice. Attention to incline a stretcher or bed to perform the ultrasound examination with dilated veins is recommended.

Use of a pneumatic cuff with an automatic inflator is appropriate to standardize reflux evaluation. In practice, however, this standard protocol limits access to segments being imaged and fails to mimic potential conditions that cause reflux. Multiple manual compressions and active dorsiflexion or plantar flexion have even been employed during studies using automatic cuff inflation. Multiple ways to elicit reflux are recommended for reliable preoperative mapping.

In summary, the prevalence of GSV valvular incompetence was significantly high in women with primary varicose veins to warrant ultrasound examination. Reflux predominated in calf venous segments rather than in the thigh or SFJ. Treatment in most of these patients could be limited to the varicose veins. Correction of SFJ incompetence may be considered only for a few, selected women. Only about one third of extremities may require treatment of the GSV at the thigh level by stripping or ablation. Finally, other types of treatment limited to the tributary or perforating vein determined by ultrasound examination to be the major source of GSV reflux could be investigated based on patterns of reflux. A detailed ultrasound mapping of sources and drainage of reflux is recommended prior to saphenous vein treatment.

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