

Progression of reflux patterns in saphenous veins of women with chronic venous valvular insufficiency

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Abstract

Background: Venous ultrasonography identifies reflux patterns of the great and small saphenous veins (GSV, SSV), allowing evaluation of lower extremities for treatment planning and patient follow-up.

Objective: To determine progression of saphenous vein reflux patterns in women with primary venous valvular insufficiency.

Methods: Venous ultrasonography was performed in the extremities of 92 women, 43 ± 12 (23–77) years old, CEAP (clinical, aetiological, anatomical and pathological elements) clinical classes C1–C2. Two examinations were performed 33 ± 19 (8–89) months apart in patients without saphenous vein treatment. GSV and SSV reflux patterns were classified as segmental, multisegmental, distal, proximal, diffuse and normal. Prevalence was determined for each examination, separately for right and left extremities, and jointly. Prevalence was compared using χ^2 statistics.

Results: Reflux prevalence was higher for the GSV, 89% (164/184) and 88% ($n = 162$), than for the SSV, 24% ($n = 45$) and 30% ($n = 56$), respectively for first and second examinations ($P < 0.001$). Reflux pattern prevalence was not significantly different in the right and left extremities ($1.0 > P > 0.14$). Most prevalent patterns were (a) GSV segmental reflux initially, 41% (76/184), decreasing to 28% (52/184) ($P = 0.009$), and (b) GSV multisegmental reflux at the second examination, increasing from 26% (48/184) to 40% (73/184) ($P = 0.006$). Prevalence of other GSV or SSV reflux patterns did not change significantly ($0.88 > P > 0.19$).

Conclusions: We documented early findings and venous reflux progression in a specific population of women with varicose veins, reticular veins and telangiectasias. GSV segmental reflux was most prevalent initially, progressing to GSV multisegmental reflux.

Keywords: venous insufficiency; Doppler ultrasound; venous reflux; saphenous veins

Introduction

Chronic venous insufficiency is a frequent vascular disorder, commonly caused by dysfunction of valves in superficial, perforating and/or deep veins, increasing in prevalence with age.^{1–4}

Primary, secondary or congenital valvular insufficiency leads to venous reflux and onset of signs and symptoms associated with venous hypertension: pain, aching, swelling, oedema, varices, eczema, hyperpigmentation, other skin changes, lipodermatosclerosis and ulcers.^{5,6} Reflux in the superficial veins of the lower extremities, particularly in the saphenous veins, is highly prevalent, contributing to the onset of pathophysiological abnormalities and clinical signs and symptoms.^{3,7}

Great and small saphenous veins (GSV, SSV) reflux patterns are identified by colour-flow, duplex-Doppler ultrasonography.^{8–12} Such information,

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Accepted 11 January 2011

obtained non-invasively, contributes significantly to therapy planning and/or to the follow-up of the natural history of the chronic venous valvular insufficiency in a wide variety of patient populations.^{7,13–15}

Recently, we extrapolated one of the objectives of the creation of the CEAP (clinical, aetiological, anatomical and pathological elements) classification by a group of international experts and studied exclusively women with primary varicose veins without oedema (strictly clinical class C2).^{8,9,11} The assumption is that the specialty requires investigation of specific subgroups with minimal mingling of patient characteristics or treatment types. This philosophy is similar to the one described by Thibault *et al.*¹⁶ regarding duplex ultrasound mapping of subjects with cosmetic leg veins. The most common pattern of saphenous vein reflux in this specific sample population was segmental, mostly below-knee. The vast majority of saphenofemoral junctions did not have reflux. Other patterns of saphenous reflux, such as proximal, distal or diffuse from groin to ankle, were less prevalent. These findings were similar to those detected, to a lesser extent, in women with telangiectasias (strictly clinical class C1).⁹

The objective of this study was to evaluate progression of saphenous vein reflux patterns in women not submitted to varicose or saphenous vein treatment.

Methods

Patients referred to Angiolab – Curitiba, a private, ISO accredited non-invasive vascular laboratory, were candidates for the study. These patients consulted a variety of vascular specialists for possible treatment of superficial veins of the lower extremity. Reasons for request of the first or second ultrasound examination or non-treatment between the first and second ultrasound examinations were decided between the referring specialists and the patients. Referrals were approved by a variety of medical insurance companies with specific rules for venous duplex examinations. A prospective, longitudinal database was constructed to follow patients examined at Angiolab. A retrospective analysis of patients with multiple examinations was done in 2010. The project was approved by the Ethics Research Committee of Pontifícia Universidade Católica do Paraná under protocol number 2261.

Inclusion criteria

Women with chronic, venous, valvular insufficiency having telangiectasias, reticular veins, and/or vari-

cose veins and saphenous vein reflux were selected for this study. Women had to have two ultrasound (US) examinations in our laboratory.

The saphenous veins of these patients were never treated up to the time of the second examination. Each patient was examined twice before any type of saphenous vein treatment. Enrolment stopped at 100 women with two examinations but only women with bilateral US examinations, $n = 92$, were included in the final data analysis. Regarding the E, A, P of the CEAP classification, this study focused on primary aetiology, saphenous anatomy and reflux, not obstruction.

Exclusion criteria

All men were excluded to minimize gender variability.

Women with history of deep venous thrombosis, with or without deep vein reflux, findings of chronic venous obstruction, venous surgery or minimally invasive procedures including any treatment of saphenous veins or phlebectomy and foam sclerotherapy of superficial varicose veins, and/or venous malformations, were excluded. The use and extent of venotonic medication or compression stockings was not an exclusion criterion. The presence of deep venous reflux due to valvular insufficiency was not an exclusion criterion. Patients with unilateral examination ($n = 8$) only were excluded to avoid a tendentious difference between uneven entry of number of extremities. The assumption was that patients with more entries would influence results more than patients with lesser entries in a study.

Patient population

Two US examinations were performed in 184 extremities of 92 women, 43 ± 12 (23–77) years old at the time of the first examination. Time interval between the two examinations was 33 ± 19 (8–89) months. The studies were performed between the years 2003 and 2009. Those women represented a middle class, mostly of European descent, of a large state capital city, Curitiba, in the south of Brazil. Aesthetic and pathophysiological conditions were often considered for treatment in a population that usually frequented beaches, swimming pools and outdoor events.

The presence of both telangiectasias or reticular veins and varicose veins was common and complex, particularly as disease evolved between the first and second examinations. There were 28

(30%) C1 and 64 (70%) C2 women at the time of the first examination. Clinically, as a simplification, the subjects were classified as C1C2 with varying degrees of changing C1 or C2 between the examinations. Regarding venous clinical severity score, these patients described occasional pain, few scattered varicose veins, occasional ankle oedema and intermittent use of compression stockings. Their venous disability score varied under different conditions between 0 and 1.

US examination

Colour-flow, duplex-Doppler ultrasound equipments from Siemens® (Issaquah, Washington), Elegra or Antares Models, were employed for US examination. Six physicians with the same vascular ultrasound training lasting one year, and 4–20 years of experience afterwards, performed the examinations. This group of physicians has performed about 5000 venous examinations of the lower extremities per year in recent years. Selection of any physician performing the examinations was at random. The patients were examined supine initially to exclude recent or chronic deep venous thrombosis. Transducers centred at 5 MHz were employed to generate B-mode images at rest and during venous compression manoeuvres. The B-mode image was complemented with flow studies in colour-flow or duplex-Doppler modes. Flow phasicity with respiration and flow stoppage or augmentation with manual compressions performed proximally or distally to the transducer position were evaluated.

GSV and SSV were evaluated with the patient standing. Transducer frequencies were centred at 7 MHz. B-mode images were obtained in transverse and longitudinal planes. Colour-flow and duplex-Doppler modes were employed to detect venous reflux. Valsalva and manual compression/decompression manoeuvres were performed to evaluate flow and reflux. Valsalva manoeuvre tested for reflux at the saphenofemoral junction and as distally as indicated or feasible in cases of proximal vein reflux. Manual compression, performed at multiple levels and as many times as deemed necessary by the examining physician, provided flexibility to study segmental reflux. This approach considered a variety of source and drainage points and the differential diagnosis of venous back filling. On a technical note, the responses of multiple compression manoeuvres were closely connected to venous refilling. The physician manipulated conditions of venous filling and venous emptying during reflux evaluation. Reflux longer than 0.5 seconds in saphenous

veins were considered abnormal.¹⁷ The vast majority of refluxes lasted longer than one second. The same US technique was employed in both serial US examinations.

The saphenous veins were examined from their junctions to the ankle. Reflux patterns were categorized based on the sources and drainage points of reflux. Patterns of reflux were categorized as previously described.^{8,9,11}

Patterns of GSV or SSV reflux

The word 'saphenous' means GSV or SSV in this session. Figure 1 depicts patterns of GSV reflux. Saphenous vein reflux was classified according to the following definitions:

- (1) Segmental reflux: characterized by reflux source or origin from a tributary or perforating vein distal to the saphenous junction and reflux drainage through tributary or perforating vein at the thigh, knee or calf. The draining vein was at a position proximal to the ankle. The saphenous vein had a proximal and a distal normal segment;
- (2) Distal reflux: characterized by reflux source or origin from a tributary or perforating vein distal to the saphenous junction and reflux drainage through a vein or veins at the perimaleolar or ankle region (very distal drainage). The saphenous vein had a normal proximal segment;
- (3) Proximal reflux: characterized by reflux source at the saphenous junction and reflux drainage through a tributary or perforating vein at the thigh or calf but proximal to the ankle. The saphenous vein had a normal distal segment;
- (4) Multisegmental reflux: characterized by two or sometimes more refluxing segments.

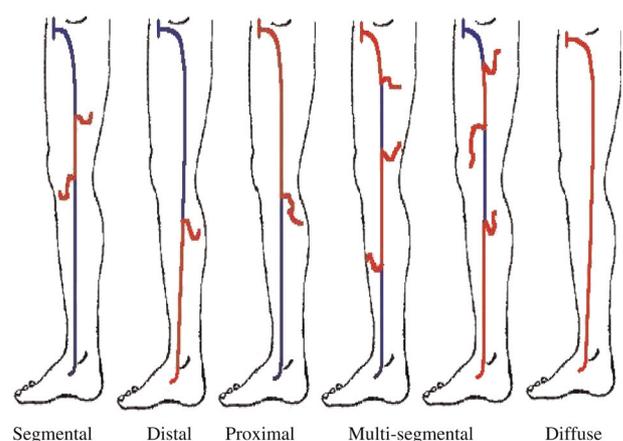


Figure 1 Great saphenous vein reflux patterns

There were five basic types of multisegmental reflux: proximal-segmental, proximal-distal, segmental-segmental, segmental-distal and proximal-segmental-distal. The saphenous vein had at least one normal segment: the proximal-segmental type had a mid and a distal saphenous normal segment; the proximal-distal type had a mid saphenous normal segment; the segmental-segmental type had a proximal, a mid and a distal saphenous normal segment; the segmental-distal type had a proximal and a mid saphenous normal segment; the proximal-segmental-distal type had two mid saphenous normal segments. All different patterns of multisegment reflux were grouped together in this analysis;

- (5) Diffuse reflux: characterized by reflux source at the saphenous junction and reflux drainage at the ankle level. The saphenous vein did not have a normal segment;
- (6) Perijunction reflux: characterized by reflux source and drainage at or near the junction but distinct from a classical femoral or popliteal junction–saphenous vein reflux. There could be three basic patterns involving the GSV or SSV and a third type involving veins at the junction but not the GSV or SSV: (1) junction to non-GSV or SSV; (2) perijunction vein to GSV or SSV; and (3) perijunction to non-GSV or SSV. An example of a perijunction source of reflux is the superficial epigastric vein. This pattern of reflux was not detected during this study and was not considered in results;

- (7) Normal pattern: characterized by the absence of reflux in the entire extension of the saphenous vein.

Statistics

Descriptive statistics described frequency or prevalence of each reflux pattern in the right or left lower extremity or for both extremities together. Changes or lack of changes in reflux patterns were described quantitatively. Prevalence comparisons were performed using the χ^2 test available for the Excel files. Prevalence of right versus left extremity patterns of reflux were compared separately for the first and second US examinations. Prevalence of first versus second US examinations were compared for the total number of extremities with two entries, right and left extremities, per patient.

Results

GSV versus SSV reflux

Reflux prevalence was significantly different at the $P < 0.001$ level, higher at the GSV, 89% (164/184) and 88% (162/184) for the first and second US examinations, than at the SSV, 24% (45/184) and 30% (56/184).

GSV analysis

Table 1 shows GSV reflux prevalence.

Table 1 Great saphenous vein reflux patterns

Reflux	First ultrasound examination				Second ultrasound examination					P
	R	L	PRL	R + L	R	L	PRL	R + L		
Seg	37 40%	39 42%	0.76	76 41%	26 28%	26 28%	1.0	52 28%	0.009	
M-Seg	25 27%	23 25%	0.74	48 26%	33 36%	40 43%	0.29	73 40%	0.006	
Distal	12 13%	11 12%	0.82	23 13%	13 14%	9 10%	0.36	22 12%	0.87	
Prox	6 7%	9 10%	0.42	15 8%	5 5%	6 7%	0.76	11 6%	0.42	
Diffuse	2 2%	0 0%	0.16	2 1%	3 3%	1 1%	0.31	4 2%	0.41	
Normal	10 11%	10 11%	1.0	20 11%	12 13%	10 11%	0.65	22 12%	0.74	
Total	92 100%	92 100%		184 100%	92 100%	92 100%		184 100%		

Reflux: segmental (Seg), multisegmental (M-Seg), distal, proximal (Prox), diffuse and no reflux (Normal)

Extremity: right and left

χ^2 statistical comparison probability: PRL between right and left lower extremities and P between first and second ultrasound examinations
Second ultrasound examination performed, on average, 33 months after the first in patients who had no saphenous vein treatment

First US examination findings

The segmental reflux pattern was the most common finding at the first US examination, both in the right and left lower extremities. The order of reflux pattern prevalence was segmental, multisegmental, distal, normal, proximal and diffuse. This order was the same for the right and left lower extremities.

Second US examination findings

The multisegmental reflux pattern was the most common finding at the second US examination. The order of reflux pattern prevalence was multisegmental, segmental, distal or normal, proximal and diffuse. Prevalence of distal pattern of reflux and normal pattern was very similar, without statistical significance and minimal numeric differences between right and left lower extremities or between first and second US examinations.

Right versus left extremity comparison

Patterns of reflux prevalence for the right versus left lower extremities were similar, without statistical significance ($1.0 > P > 0.14$). This finding justified analysis of first versus second US examination findings based on all extremities grouped together.

Statistical comparisons

The decrease in the frequency of segmental pattern of reflux and the increase in the frequency of multisegmental pattern of reflux between the first and second US examinations had statistical significance ($P = 0.009$ and 0.006 , respectively). The frequencies of the other patterns of reflux did not change significantly ($P > 0.4$).

Table 2 shows changes in GSV patterns of reflux between the first and second US examinations.

Segmental GSV reflux remained segmental in 51% (39/76) of the extremities detected in the first US examination, most likely progressed to multisegmental, distal or proximal in 41% (31/76), or apparently normalized in 8% (6/76) of the extremi-

ties. Multisegmental GSV reflux remained multisegmental in 77% (37/48) of the extremities detected in the first US examination or progressed to segmental, proximal, distal or diffuse in 23% (11/48) of the extremities. No multisegmental GSV reflux normalized during the two US examinations. Distal GSV reflux remained distal in 57% (13/23), worsened to multisegmental in 26% (6/23), and potentially regressed to segmental or normal in 17% (4/23) of the original distal reflux findings. Proximal GSV reflux remained proximal in 53% (8/15) or worsened to multisegmental or diffuse in 47% (7/15) of the limbs originally diagnosed with proximal reflux. One of two diffuse GSV reflux apparently 'regressed' to multisegmental reflux. Normal GSV remained normal in 75% (15/20) or developed segmental reflux in 25% (5/20) of the original normal extremities.

In general, 61% (113/184) of the GSV reflux patterns remained the same, 33% (60/184) worsened to patterns showing progression of reflux, 3% (5/184) apparently regressed segmentally and 4% (7/184) normalized.

SSV analysis

Table 3 shows SSV reflux prevalence. Most SSV were normal in the right and left extremities and at the first and second US examinations. Prevalence of all reflux patterns were less than 12%. Segmental SSV reflux was the most common pattern. Prevalence of reflux patterns was not significantly different for right or left extremities.

Table 4 shows changes in SSV patterns of reflux between the first and second US examinations.

Segmental SSV reflux remained segmental in 71% (12/17), progressed to multisegmental or distal in 12% (2/17) or normalized in 18% (3/17) of the extremities. Multisegmental SSV reflux remained multisegmental in 60% (3/5) or evolved to segmental in 40% (2/5) of the extremities. Distal SSV reflux

Table 2 Progression of great saphenous vein reflux patterns

First US	Second ultrasound (US) examination						Total
	Seg	M-Seg	Distal	Prox	Diffuse	Normal	
Seg	39	24	5	2	0	6	76
M-Seg	5	37	4	1	1	0	48
Distal	3	6	13	0	0	1	23
Prox	0	5	0	8	2	0	15
Diffuse	0	1	0	0	1	0	2
Normal	5	0	0	0	0	15	20
Total	52	73	22	11	4	22	184

Reflux: segmental (Seg), multisegmental (M-Seg), distal, proximal (Prox), diffuse and no reflux (Normal)

Second ultrasound examination performed, on average, 33 months after the first in patients who had no saphenous vein treatment

Table 3 Small saphenous vein reflux patterns

Reflux	First ultrasound examination				Second ultrasound examination				P
	R	L	PRL	R + L	R	L	PRL	R + L	
Seg	8 9%	9 10%	0.8	17 9%	10 11%	10 11%	1.0	20 11%	0.60
M-Seg	2 2%	3 3%	0.65	5 3%	2 2%	6 7%	0.15	8 4%	0.40
Istal	6 7%	3 3%	0.31	9 5%	8 9%	6 7%	0.58	14 8%	0.28
Rox	6 7%	6 7%	1.0	12 7%	4 4%	5 5%	0.73	9 5%	0.50
Diffuse	1 1%	1 1%	1.0	2 1%	3 3%	2 2%	0.65	5 2%	0.25
Normal	69 75%	70 76%	0.83	139 76%	65 71%	63 68%	0.75	128 70%	0.20
Total	92 100%	92 100%		184 100%	92 100%	92 100%		184 100%	

Reflux: segmental (Seg), multisegmental (M-Seg), distal, proximal (Prox), diffuse and no reflux (Normal)

Extremity: right and left

χ^2 statistical comparison probability: PRL between right and left lower extremities and P between first and second ultrasound examinations
Second ultrasound examination performed, on average, 33 months after the first in patients who had no saphenous vein treatment

remained distal in 89% (8/9), or apparently regressed to segmental in 11% (1/9) of the extremities. Proximal SSV reflux remained proximal in 42% (5/12), progressed to multisegmental or diffuse in 33% (4/12) or normalized in 25% (3/12) of the extremities. Two diffuse SSV reflux remained diffuse. Normal SSV remained normal in 89% (124/139) or acquired reflux in 11% (15/139) of the originally normal veins.

In general, 84% (154/184) of the SSV reflux patterns remained the same, 13% (23/184) progressed to more extensive patterns of reflux, 2% (3/184) regressed segmentally and 2% (4/184) normalized.

Discussion

Identification of specific patterns of GSV and SSV patterns of reflux using colour-flow, duplex-Doppler US allows for pretreatment diagnosis and follow-up

of valvular disease. We adopted the philosophy of studying specific populations to minimize variability of findings due to inclusion of patients with a variety of clinical conditions in data analysis. Only women with telangiectasias, reticular veins and varicose veins without prior saphenous vein treatment were included in this study. Also, only women with two investigations in the same laboratory were included. The venous clinical severity score varies from 0 to 30 and is not really sensitive to describe patients in early states of valvular insufficiency whose scores are in the 1–5 level. Although one-third of the patients were classified as C1 in the first examination, a clearly or exclusive C1-only classification at the time of the first and second examinations was debatable. The classification between reticular and early varicose veins was debatable. Therefore, the patients were grouped together. Such subgroup represents a sample of the early stage of venous valvular disorder.

Table 4 Progression of small saphenous vein reflux patterns

First US	Second ultrasound (US) examinations						Total
	Seg	M-Seg	Distal	Prox	Diffuse	Normal	
Seg	12	1	1	0	0	3	17
M-Seg	2	3	0	0	0	0	5
Distal	1	0	8	0	0	0	9
Prox	2	2	0	5	2	1	12
Diffuse	0	0	0	0	2	0	2
Normal	3	2	5	4	1	124	139
Total	20	8	14	9	5	128	184

Reflux: segmental (Seg), multisegmental (M-Seg), distal, proximal (Prox), diffuse and no reflux (Normal)

Second ultrasound examination performed, on average, 33 months after the first in patients who had no saphenous vein treatment

Despite a vast literature describing saphenous vein reflux, longitudinal work describing the natural history of venous valvular insufficiency represents a small minority of such investigations. Saryn *et al.*¹⁸ demonstrated the evolution of venous insufficiency and reflux in a small group of patients followed for 20 months. A German study investigated the evolution of venous disorders in children but presented little US data to determine valvular abnormalities directly.¹⁹ A longitudinal study demonstrated that 73% of extremities tested about 19 months apart did not have significant changes in US examinations.¹³ Most changes were detected in the GSV and its tributaries. Treatment based on old US examinations was not recommended.

This study investigated the evolution of saphenous vein reflux based on US examinations almost three years apart in a relatively young population of women with early stages of venous valvular disease. Prevalence of superficial or deep vein reflux in a specific general population can be high and dependent on gender, age and clinical CEAP stage.²⁰ A specific characteristic of this population was the small frequency of saphenofemoral junction reflux. Reflux prevalence was higher in the GSV than in the SSV as previously reported for other sample populations.^{3,9,11} Prevalence of GSV reflux is significant in women with varicose veins and even telangiectasias, clinical CEAP classes C2 or C1.^{9,11} Progression of reflux, however, is not fast. This study confirmed that, in about three years, there was no significant progression of reflux in about 2/3 of the GSV and 4/5 of the SSV examined.

The finding that GSV reflux is segmental in the early stages of venous valvular disorder goes against a history perception that GSV reflux starts at the saphenofemoral junction. It is more likely that initial reflux is localized,²¹ dependent on the weakest venous wall under pressure of a variety of venous haemodynamic conditions. A specific novelty is that reflux progression is from segmental to multisegmental patterns.

Apparent improvement was noted in about five percent of the extremities, some with normalization of saphenous flow. Such findings may be due to two combined reasons: (1) intra or intersonographer variability; and (2) the 0.5 second criterion may not be ideal for detection of significant reflux. Short reflux time of less than two to three seconds may be due to (a) normal venous refilling time between valve segments; or (b) valve leakage due to venous dilation and/or slow valve closure. Valve leakage due to valve dilation, often influ-

enced by temperature, can be a function of yearly seasons or time of the day. The hypothesis that some patients may have been taking better care of their veins cannot be ruled out also.

A topic for discussion would be treatment or not of segmental saphenous reflux. The women in this study apparently did not need treatment for an average of at least three years. The number of women with segmental reflux not treated and not examined a second time is unknown. Simplification of reflux patterns as simply saphenous reflux could lead to miscommunication and perhaps unnecessary saphenous vein exclusion treatment. A recommendation is that treatment should associate clinical findings with saphenous patterns of reflux. Alternative treatment can be selected as a function of reflux patterns. An example would be exclusion of varicose veins with ligation of the tributary source of a segmental saphenous reflux.

This study emphasized similarities between the right and left extremities. The data presented minimize or undermine several statistical approaches that are becoming popular nowadays. For example, should studies be performed only with one extremity per patient? Or should studies be performed including both extremities only? The comparison performed in this study justified a concomitant analysis of both extremities to give stronger statistical power to the comparisons performed.

Conclusion

In summary, about 90% of women with telangiectasias, reticular veins and/or varicose veins had GSV reflux. Reflux pattern remained unchanged in the majority of extremities for approximately three years. Initially, the most common GSV reflux was segmental, not affecting the saphenofemoral junction, and not extending to the ankle. Segmental GSV reflux progressed to multisegmental vein reflux. After three years, the most common GSV was multisegmental. The study concentrated in a specific patient population, and did not mix together genders or greatly distinct clinical presentations. A similar philosophy is recommended for studies investigating treatment or natural history to further expand the objectives of the CEAP consensus.

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