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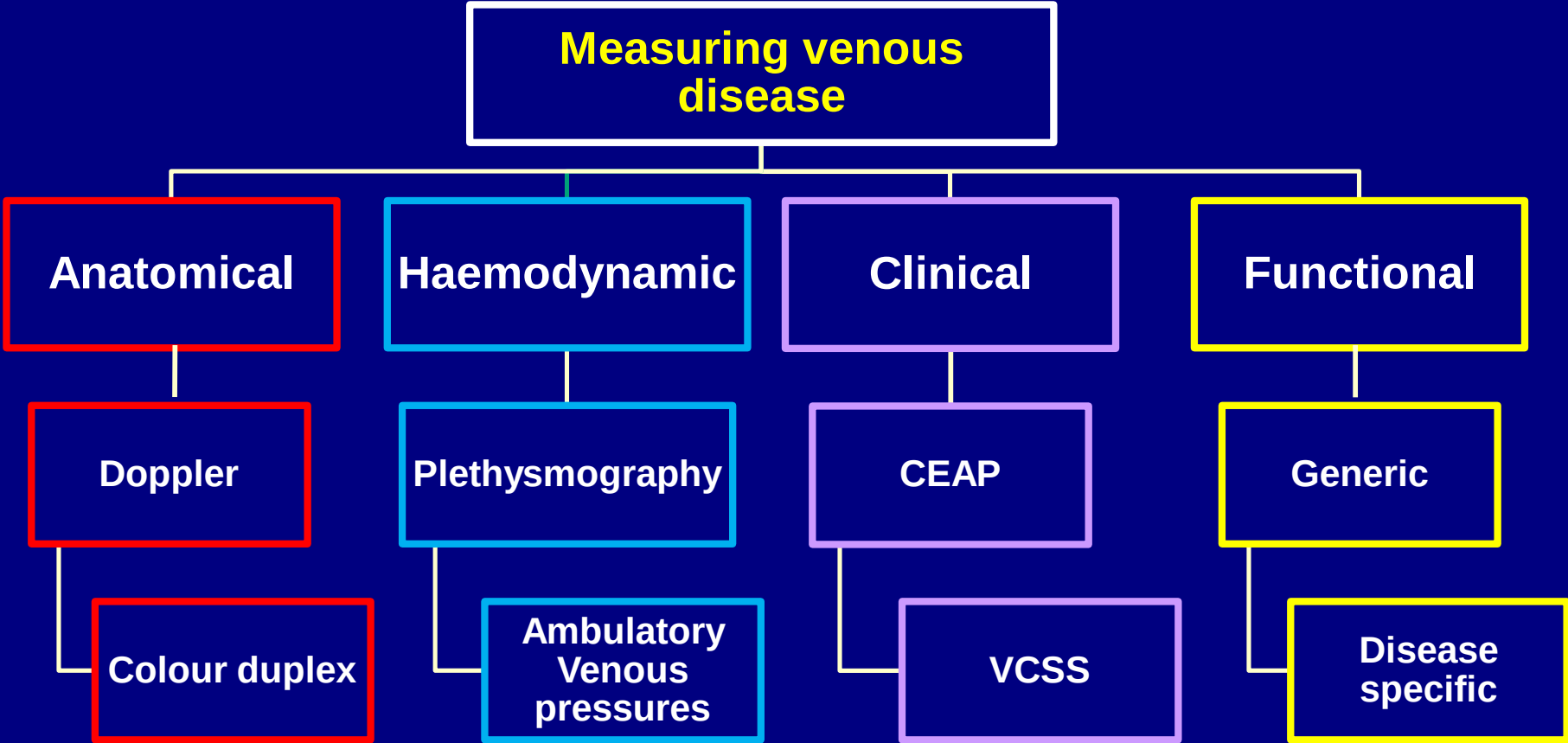
Haemodynamics of the development of varicose vein disease: do we really have new knowledge?

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Disclosures

- None

Measuring venous disease



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graph TD; A[Measuring venous disease] --> B[Anatomical]; A --> C[Haemodynamic]; A --> D[Clinical]; A --> E[Functional]; B --> F[Doppler]; F --> G[Colour duplex]; C --> H[Plethysmography]; H --> I[Ambulatory Venous pressures]; D --> J[CEAP]; J --> K[VCSS]; E --> L[Generic]; L --> M[Disease specific];
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The diagram is a hierarchical flowchart titled 'Measuring venous disease'. It branches into four main categories: Anatomical, Haemodynamic, Clinical, and Functional. Each category further branches into specific measurement techniques. Anatomical leads to Doppler, which leads to Colour duplex. Haemodynamic leads to Plethysmography, which leads to Ambulatory Venous pressures. Clinical leads to CEAP, which leads to VCSS. Functional leads to Generic, which leads to Disease specific. Each box is color-coded: red for Anatomical, cyan for Haemodynamic, purple for Clinical, and yellow for Functional.

Anatomical

Doppler

Colour duplex

Haemodynamic

Plethysmography

**Ambulatory
Venous
pressures**

Clinical

CEAP

VCSS

Functional

Generic

**Disease
specific**

- Use duplex ultrasound to confirm the diagnosis of varicose veins and the extent of truncal reflux, and to plan treatment for people with suspected primary or recurrent varicose veins.

Varicose veins: diagnosis and management

Clinical guideline

Published: 24 July 2013

nice.org.uk/guidance/cg168

Eur J Vasc Endovasc Surg (2015) 49, 678–737

Editor's Choice — Management of Chronic Venous Disease

Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)

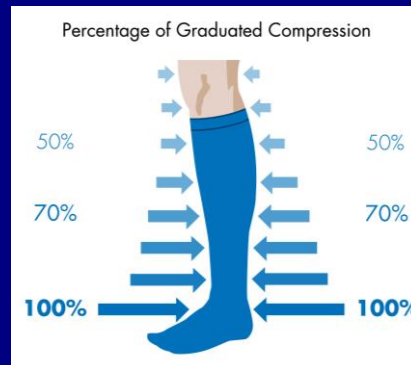
Recommendation 11	Class	Level
Duplex ultrasound is recommended as the <u>primary</u> diagnostic test of choice in suspected chronic venous disease, to reliably evaluate the specific venous anatomy and to identify the source and pattern of reflux.	I	A

Polm, A. Cavezzi, S. Chastanet, n, T. Noppeney, S. Onida, P. Pittaluga, us, R. Hinchliffe, I. Koncar, J. Lindholt, ng, E. Kalodiki, E. Korten, M. Lugli,

The care of patients with varicose veins and associated chronic venous diseases: Clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum

Peter Gloviczki, MD,^a Anthony J. Comerota, MD,^b ... MD,^c Bo G. Eklof, MD,^d
 David L. Gillespie, MD,^e Monika L. G ...
 Mark H. Meissner, MD,^f M. Hassan M ...
 Marc A. Passman, MD,^g Joseph D. Raf ...
 Thomas W. Wakefield, MD,^h Rochester, ...
 Cincinnati, Ohio; Springfield, Ill; Seattle, ...
 NY; and Ann Arbor, Mich

- 2.1 We recommend that in patients with chronic venous disease, a complete history and detailed physical examination are complemented by duplex scanning of the deep and superficial veins. The test is safe, noninvasive, cost-effective, and reliable.
- 1 A



Clinical Parameters?

Clinical classification

C₀: no visible or palpable signs of venous disease
C₁: telangiectasies or reticular veins
C₂: varicose veins
C₃: edema
C_{4a}: pigmentation or eczema
C_{4b}: lipodermatosclerosis or atrophic blanche
C₅: healed venous ulcer
C₆: active venous ulcer
S: symptomatic, including ache, pain, tightness, skin irritation, heaviness, and muscle cramps, and other complaints attributable to venous dysfunction
A: asymptomatic

Etiologic classification

Ec: congenital
Ep: primary
Es: secondary (postthrombotic)
En: no venous cause identified

Anatomic classification

As: superficial veins
Ap: perforator veins
Ad: deep veins
An: no venous location identified

Pathophysiologic classification

Basic CEAP

Pr: reflux
Po: obstruction
Pr,o: reflux and obstruction
Pn: no venous pathophysiology identifiable

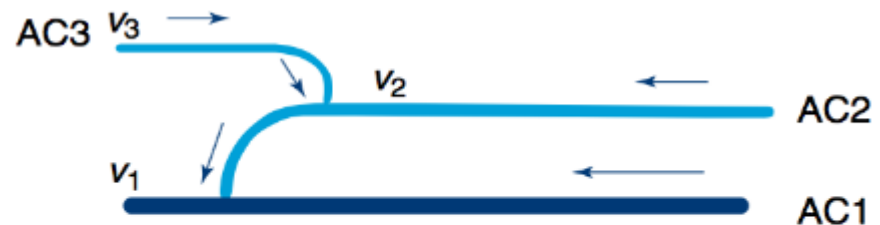
- Static
- Not designed to respond to treatment
- Single measure of disease status
- Supplemented by VCSS for severity

- Haemodynamic disturbance
- Inability of venous conduits to maintain a normal pressure and flow to the heart
- Reflux and obstruction
- Reflux Time (RT) > 0.5 s



Pathophysiology of Reflux

Sergio Giancesini and Paolo Zamboni



$$v_1 > v_2 > v_3$$



AC3 → AC2 → AC1

Anatomical Parameters?

The distribution and significance of varicosities in the saphenous trunk

	Group A	Group B	Group C
Nicos Labropoulos			
Antoniou P. Galanos			
CEAP class	2 + 3	4 + 5 + 6	C ₀ P _N

Table II. Great saphenous vein diameters

Locations	Group A			Group B			Group C		
	Mean	95% CI	Range	Mean	95% CI	Range	Mean	95% CI	Range
SFJ	7.6	7.37-7.82	4.5-26	9.4	8.96-9.84	5.1-32	5.7	4.9-6.5	4.4-7.8
Thigh									5.3
Knee									4.6
Calf	3.4	3.3-3.5	0.7-22	4.2	4.02-4.38	0.7-26	2.8	2.2-3.4	0.9-4.2
MM	2.8	2.71-2.89	2.2-7.2	3.3	3.15-3.45	2.6-8.4	2.6	2.3-2.9	1.9-3.7

Higher CEAP Class associated with larger vein diameters

Table III. Small saphenous vein diameters

Locations	Group A			Group B			Group C		
	Mean	95% CI	Range	Mean	95% CI	Range	Mean	95% CI	Range
TE	2.2	2.14-2.26	0.8-7.6	2.9	3.05	0.7-9.2	1.9	1.6-2.2	0.7-3.2
SPJ	4.3	4.14-4.46	2.4-21	5.1	4.82-5.38	2.6-24	3.2	2.7-3.7	1.8-4.6
Calf	3.1	2.98-3.22	0.7-23	3.5	3.35-3.65	0.8-25	2.3	1.9-2.7	0.7-3.5
LM	1.9	1.85-1.95	0.8-4.2	2.2	2.11-2.29	0.7-4.4	1.8	1.65-1.95	1.4-3.1

Superficial venous insufficiency: Correlation of anatomic extent of reflux with clinical symptoms and signs

Nicos Labropoulos, BSc, Miguel Leon, MD, Andrew N. Nicolaides, MS, FRCS, Athanasios D. Giannoukas, MD, Nicos Volteas, MD, and Philip Chan, MChir, FRCS, *London, United Kingdom*

Conclusions: We conclude that ache, ankle edema, and skin changes in limbs with reflux confined to the superficial venous system are predominantly associated with reflux in the below-knee veins. Ulceration is found only when the whole of the LSV is involved (8%) or when reflux is

RG 1994;20:953-8.)

More than just
reflux

Ache

ated to the

extent of reflux.

Incidence of skin changes went from 44% when the below-knee segment of the LSV was involved to 73% when reflux occurred throughout the LSV and SSV. Ulceration (14%) was found only in the latter situation.

From the American Venous Forum

Saphenous pulsation on duplex may be a marker of severe chronic superficial venous insufficiency

Christopher R. Lattimer, MBBS, FRCS, MS, FDOT, Mustapha Azzam, MD, DIC, MSc, PGD, Evi Kalodiki, MD, DIC, PhD, FRCS, Gregory C. Makris, MD, and George Geroulakos, MD, FRCS, DIC, PhD, London, United Kingdom



Fig 1. Duplex tracing of a typical saphenous pulse (SP) waveform. Each major tick represents 1 second. The background SP (4) is basic, irregular, and of varying amplitude. Inspiration, is seen at the end of the trace.

More than just reflux

Conclusions: The high prevalence of saphenous pulse in patients with severe chronic venous insufficiency and its association with clinical severity and saphenous reflux suggest that saphenous pulse should supplement duplex evaluation of chronic venous disease progression, recurrence after treatment, and as a hemodynamic marker of severity. (J Vasc Surg 2012;56: 1338-43.)

variation in patients with severe chronic venous insufficiency and significantly increases with clinical severity. As it is easy to record, it could be a useful tool to assess the relevance of the SP in terms of clinical severity.

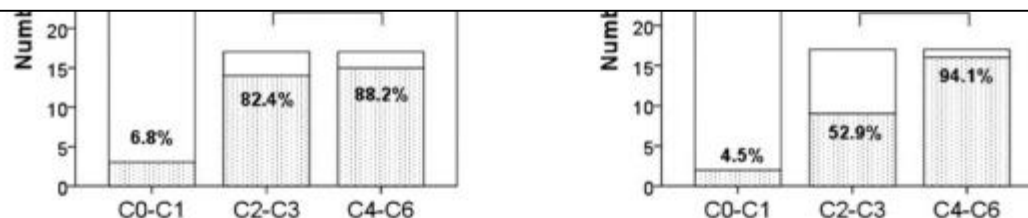


Fig 2. The prevalence of reflux (A) and saphenous pulse (SP) (B) across three levels of clinical severity. There was a significant stepwise increase in the prevalence of SP according to clinical severity with no detectable SP in approximately half of the subjects' legs with intermediate clinical severity (C_{2-3}).

A study to compare disease-specific quality of life with clinical anatomical and hemodynamic assessments in patients with varicose veins

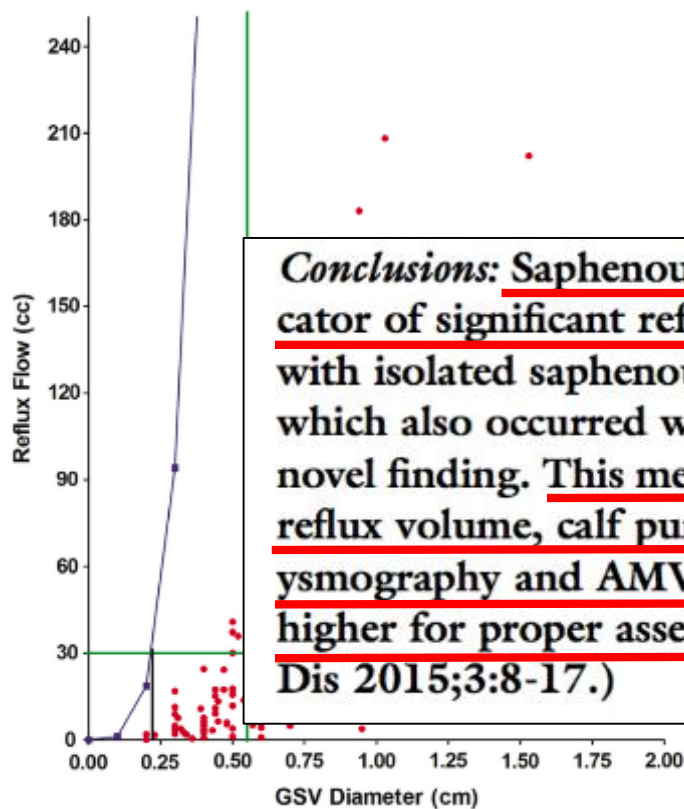
Amanda C. Shepherd, MBBS, Manj S. Gohel, MD, FRCS, Chung S. Lim, MBBS, and Alun H. Davies, DM, FRCS, *London, United Kingdom*

Relationship between changes in AVVQ, SQOR-V, and VRTs. Changes in venous refill times at 6 weeks did not correspond to changes in AVVQ (Spearman coefficient -0.067 ; $P = .587$) or with SQOR-V scores ($P = .437$; Spearman coefficient -0.073) in patients with unilateral disease.

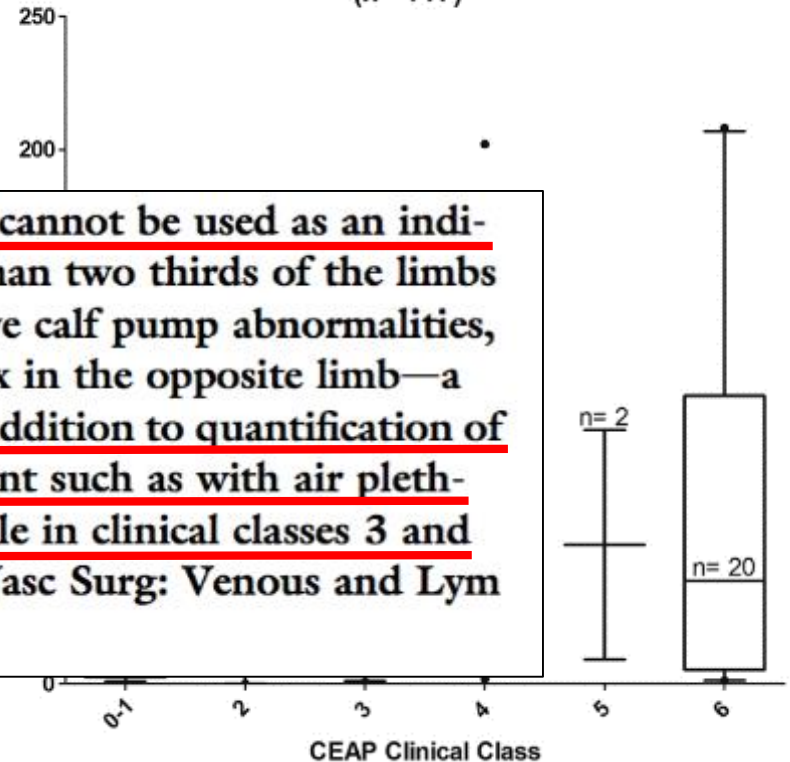
...no correlation in changes in VRT with either generic or disease-specific quality of life following intervention, suggesting that **hemodynamic measurement is a poor outcome assessment tool in patients with uncomplicated venous disease**

Quantifying saphenous reflux

Seshadri Raju, MD, FACS,^a Mark Ward Jr, MS,^a and Tamekia L. Jones, PhD,^b Jackson, Miss; and Memphis, Tenn



Reflux Volume vs. CEAP Clinical Class
(n= 117)



Conclusions: Saphenous size alone cannot be used as an indicator of significant reflux. More than two thirds of the limbs with isolated saphenous reflux have calf pump abnormalities, which also occurred without reflux in the opposite limb—a novel finding. This means that in addition to quantification of reflux volume, calf pump assessment such as with air plethysmography and AMVP is desirable in clinical classes 3 and higher for proper assessment. (J Vasc Surg: Venous and Lym Dis 2015;3:8-17.)

Correlation between the hemodynamic gain obtained by the inferior vena cava filters and chronic venous disease

Correlação entre o ganho hemodinâmico obtido com os filtros da veia cava inferior e a classificação da doença venosa crônica

Nei Rodrigues Alves Dezotti^I, Edwaldo Edner Joviliano^{II}, Takachi Nishimura^{III}

TABLE 1 - Mean, median and quartile (P25, P50 and P75%) values of the pre- and postoperative hemodynamic difference of the venous filling index (VFI) of groups C₂ + C₃, C₄ and C₅ + C₆

VFI Groups	N	1st Quartile(P25)	Median (P50)	3rd Quartile(P75)	Mean	Standard deviation
C ₂ + C ₃	38	0.07	0.72	2.36	1.34	1.80
C ₄	15	0.73	1.87	4.24	2.60	2.09
C ₅ + C ₆	10	1.21	2.75	6.33	3.29	3.13

TABLE 2 - Mean, median and quartile (P25, P50 and P75%) values of the pre- and postoperative hemodynamic difference of the ejection fraction (EF) of groups C₂ + C₃, C₄ and C₅ + C₆

VFI Groups	N	1st Quartile(P25)	Median (P50)	3rd Quartile(P75)	Mean	Standard deviation
C ₂ + C ₃	38	-24.83	-4.25	2.98	-9.84	22.05
C ₄	15	-38.60	-18.30	-7.90	-22.91	17.35
C ₅ + C ₆	10	-29.03	-14.75	16.95	-9.71	30.63

TABLE 3 - Mean, median and quartile (P25, P50 and P75%) values of the pre- and postoperative hemodynamic difference of the residual volume fraction (RVF) of groups C₂+C₃, C₄ and C₅+C₆

VFI Groups	N	1st Quartile(P25)	Median (P50)	3rd Quartile(P75)	Mean	Standard deviation
C ₂ + C ₃	38	-8.10	4.25	19.10	9.14	25.84
C ₄	15	-5.10	7.50	35.40	12.41	19.21
C ₅ + C ₆	10	-12.56	8.65	32.60	5.32	32.44

Reflux time estimation on air-plethysmography may stratify patients with early superficial venous insufficiency

C R Lattimer, E Kalodiki, M Azzam and G Geroulakos

Ealing Hospital & Imperial College, London SW7 2AZ, UK

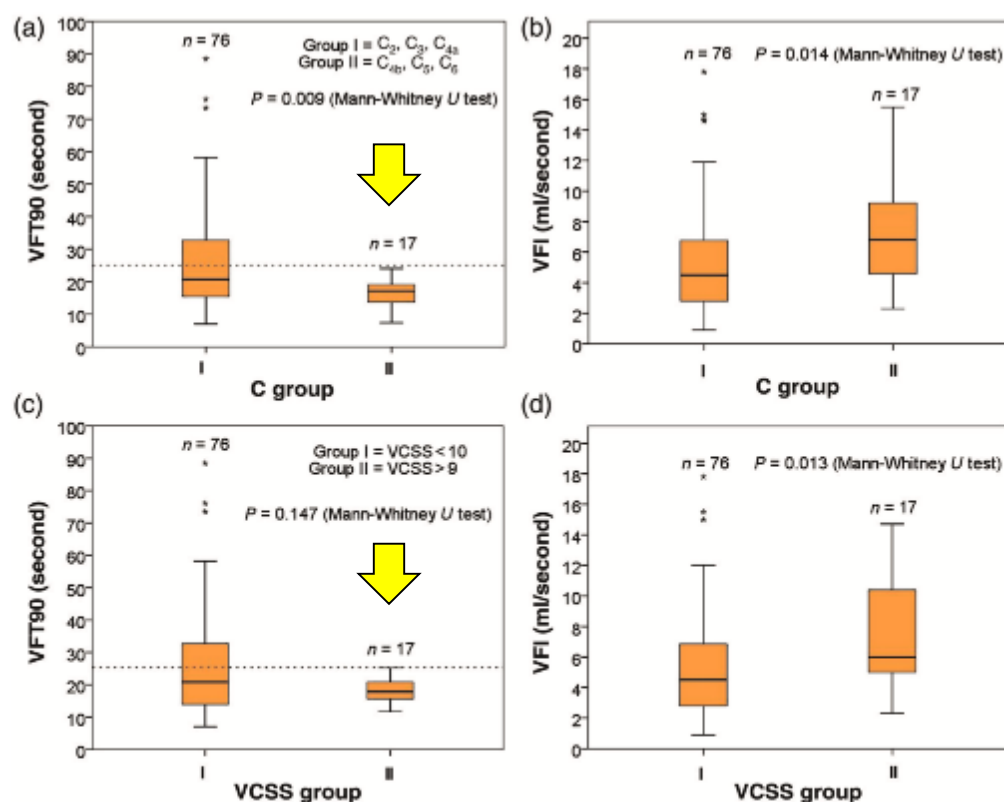


Figure 3 The VFT90 and the VFI benchmarked against two groups of severity of CVI. Although the median VFI is statistically higher in the more severe groups there was no discrimination (b, d). However, all 17 patients in the severe groups had a VFT90 < 25 seconds as demonstrated by the horizontal dashed line (a, c)

Table 2 Proposed stratification of patients with SVI based on clinical and haemodynamic assessments using CEAP and VFT90

Group	Description	Clinical	VFT90 (second)	Usage
S1	Mild	C _{2-4a}	>25	Cosmetic
S2	Moderate	C _{2-4a}	<25	Risk for skin changes
S3	Severe	C _{4b-6}	<25	Ulcer prevention and treatment

VFT90 – time to reach 90% of total venous volume

Conclusion

Patients with early clinical disease could be divided into two groups based on the severity of haemodynamic impairment. The use of the VFT90 in the stratification of patients for longitudinal natural history studies, treatment provision and response to treatment have yet to be determined.

Original article

Quantification of venous reflux parameters using duplex scanning and air plethysmography

T Yamaki, M Nozaki, H Sakurai, M Takeuchi, T Kono and K Soejima

Department of Plastic and Reconstructive Surgery, Tokyo Women's Medical University, Tokyo, Japan

Group I ($C_{1-3}E_{P,S}, A_{S,D,P}, P_{R,O}$),
 $n = 341$ patients

Group II ($C_{4-6}E_{P,S}, A_{S,D,P}, P_{R,O}$),
 $n = 233$ patients

The PRV and PRF are better parameters than the RT for discrimination of clinical severity in both superficial and deep venous insufficiency, and should be used to quantify venous valvular insufficiency.

Table 5 Duplex and APG-derived parameters in patients with superficial insufficiency

Parameters	Group I	Group II	P value*
<i>SFJ</i>	234 limbs	66 limbs	
Diameter (cm)	0.82 ± 0.21	0.97 ± 0.25	<0.0001
RT (s)	4.68 ± 2.59	3.67 ± 1.58	<0.0001
PRV (cm/s)	30.6 ± 19.8	50.4 ± 26.1	<0.0001
PRF (mL/s)	42.6 ± 41.5	73.1 ± 74.3	<0.0001
VV (mL)	88.1 ± 62.8	104.2 ± 36.9	<0.0001
VFI (mL/s)	3.62 ± 2.11	6.09 ± 2.95	<0.0001
EF (%)	50.3 ± 23.2	48.9 ± 17.3	0.887
RVF (%)	40.6 ± 25.0	46.1 ± 22.5	0.018
<i>GSV</i>	168 limbs	62 limbs	
Diameter (cm)	0.63 ± 0.15	0.72 ± 0.19	<0.0001
RT (s)	5.37 ± 3.28	4.13 ± 1.68	0.015
PRV (cm/s)	48.2 ± 22.4	70.3 ± 26.8	<0.0001
PRF (mL/s)	39.7 ± 33.9	50.3 ± 35.4	0.002
VV (mL)	90.0 ± 77.0	98.2 ± 34.4	0.002
VFI (mL/s)	3.31 ± 2.28	6.09 ± 3.20	<0.0001
EF (%)	48.8 ± 28.8	48.5 ± 15.6	0.497
RVF (%)	39.8 ± 24.7	45.5 ± 22.9	0.042
<i>SPJ</i>	39 limbs	17 limbs	
Diameter (cm)	0.67 ± 0.18	0.72 ± 0.15	0.267
RT (s)	5.37 ± 2.81	5.36 ± 3.30	0.653
PRV (cm/s)	32.1 ± 11.1	42.8 ± 15.6	0.022
PRF (mL/s)	26.1 ± 16.8	31.1 ± 20.0	0.357
VV (mL)	95.4 ± 37.3	101.9 ± 28.0	0.831
VFI (mL/s)	3.25 ± 1.30	4.26 ± 1.43	0.028
EF (%)	47.1 ± 21.0	42.8 ± 17.4	0.868
RVF (%)	34.0 ± 24.4	43.2 ± 19.2	0.113

Role of haemodynamic parameters

Guideline 3. Plethysmography

Guideline No.	3. Plethysmography	GRADE of recommendation	Level of evidence
The care of patients with varicose veins and associated chronic venous diseases: Clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum		1. Strong	A. High quality
		2. Weak	B. Moderate quality
			C. Low or very low quality
3.1	We suggest that venous plethysmography be used <u>selectively</u> for the noninvasive evaluation of the venous system in patients with simple varicose veins (CEAP class C ₂).	2	C
3.2	We recommend that venous plethysmography be used for the noninvasive evaluation of the venous system in patients with advanced chronic venous disease if duplex scanning does not provide definitive information on pathophysiology (CEAP class C ₃ -C ₆).	1	B

Management of Chronic Venous Disease

Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)

Recommendation 14	Class	Level	References
Plethysmography <u>may</u> be considered for the assessment of quantitative parameters related to venous function.	IIb	C	85, 180, 181

Thank you

