

# Duplex ultrasound findings and clinical classification of lower extremity chronic venous insufficiency in a Thai population



Tanapong Panpikoon, MD, Banjongsak Wedsart, MD, Tharintorn Treesit, MD, Orapin Chansanti, MD, and Chinnarat Bua-ngam, MD, *Bangkok, Thailand*

## ABSTRACT

**Background:** The objective of this study was to evaluate the association between the clinical classification of chronic venous insufficiency and duplex ultrasound findings.

**Methods:** A total of 1010 limbs with clinically suspected chronic venous insufficiency were stratified according to the Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification and underwent duplex ultrasound evaluation consecutively between January 2012 and June 2015. Venous thrombosis, venous reflux, and anatomic distribution of the deep and superficial venous systems were investigated across the CEAP clinical classes.

**Results:** There were 259 male limbs (25.6%) and 751 female limbs (74.4%) in clinical class C0 (24 limbs [2.4%]), C1 (130 limbs [13.1%]), C2 (452 limbs [44.8%]), C3 (183 limbs [18.1%]), C4 (163 limbs [16.1%]), C5 (31 limbs [3.1%]), and C6 (27 limbs [2.7%]). The mean age in clinical class C4-C6 ( $60.77 \pm 14.67$  years) was statistically significantly higher than in C0-C3 ( $55.73 \pm 18.85$  years;  $P < .001$ ). Male limbs were shown to have a predilection for presenting with clinical class C4-C6 over female limbs (36.3% vs 16.9%; odds ratio, 2.8; 95% confidence interval, 2.0-3.8). Positive findings were predominantly displayed in clinical class C4-C6 compared with C0-C3 (deep venous thrombosis, 3.2% vs 1.3%; deep venous reflux, 30.8% vs 26.9%; superficial vein thrombosis, 2.7% vs 2.0%; superficial venous reflux, 56.6% vs 47.6%; perforator vein reflux, 12.7% vs 8.2% [ $P = .049$ ]). A low prevalence of small saphenous vein and perforator vein reflux in C1 limbs (0.3% and 4.6%) and C3 limbs (3.8 and 6.6%) was discovered.

**Conclusions:** The prevalence of CEAP class C0-C3 was found to be higher than C4-C6. However, men were shown to have a predilection for presenting in clinical class C4-C6 over women. The mean age of patients with clinical class C4-C6 limbs was statistically significantly higher than of those with clinical class C0-C3 limbs. The prevalence of deep venous reflux, superficial venous reflux, and coincident deep and superficial venous reflux in clinical class C4-C6 limbs was higher than in clinical class C0-C3 limbs. Detection of incompetent perforator veins was shown to have a statistically significant correlation with clinical class C4-C6 limbs. (*J Vasc Surg: Venous and Lym Dis* 2019;7:349-55.)

**Keywords:** Chronic venous insufficiency; Duplex ultrasound; CEAP clinical classification

Chronic venous insufficiency (CVI) is a pathologic condition characterized by an increase in venous hypertension and stasis consequences from valvular incompetence regardless of venous outflow obstruction; both the superficial and the deep venous systems can be affected. The most common type of CVI is primary varicose veins resulting from saphenous vein insufficiency, which can be readily detected by duplex ultrasound, a widely

acceptable diagnostic imaging modality.<sup>1-3</sup> As a worldwide problem, CVI is a commonly reported chronic medical condition, a source of morbidity, and a sizable economic burden in the Western world, with a prevalence of approximately 2% to 56% in men and <1% to 73% in women.<sup>4</sup> The broad range is due to variability in populations examined (age, sex, race, methods, and even definition of the same disease).<sup>2,4-7</sup> Some Asian and Thai population data have suggested that the characteristics of venous disease and the pattern of venous reflux in these patients may be different from the Western population.<sup>4,8,9</sup> There was only one previous study comparing the clinical presentation and patterns of venous reflux in Thai patients with CVI with a control group (Thai patients without CVI). However, the sample size (41 cases each in the CVI and control groups) was relatively small and included only patients with Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification C4 to C6.<sup>8</sup> Recognizing the dominant pattern of CVI in our population and its association with clinical presentation (CEAP) might help reduce the overall

From the Department of Diagnostic and Therapeutic Radiology, Faculty of Medicine, Ramathibodi Hospital, Mahidol University.

Author conflict of interest: none.

Correspondence: Tanapong Panpikoon, MD, Department of Diagnostic and Therapeutic Radiology, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, 260 Rama VI Rd, Bangkok 10400, Thailand (e-mail: [tanapong.panpikoon@gmail.com](mailto:tanapong.panpikoon@gmail.com)).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X

Copyright © 2018 by the Society for Vascular Surgery. Published by Elsevier Inc. <https://doi.org/10.1016/j.jvs.2018.08.012>

procedural time without compromising diagnostic sensitivity and specificity, which may ultimately optimize the appropriate treatment. The objective of this study was to evaluate the relationship between the clinical presentation of CVI in a Thai population and duplex ultrasound findings. The association of duplex ultrasound findings with other aspects, including age and sex, was also investigated.

## METHODS

**Patients.** The duplex ultrasound scans of the lower extremity venous systems of patients who either presented with clinical CVI or were referred to the Department of Diagnostic and Therapeutic Radiology, Faculty of Medicine, Ramathibodi Hospital, were consecutively reviewed from January 2012 to June 2015. The Institutional Review Board approved the study, and informed consent was waived.

The study included those patients whose nationality was Thai presenting with CVI symptoms in clinical class C1 to C6 limbs according to the CEAP classification, developed by an international consensus conference to provide a basis for uniformity in reporting, diagnosis, and treatment of CVI. Those with a known history of recent deep venous thrombosis (blood clots in the leg vein seen within 1 month before the examination), obstructive peripheral artery disease, vascular abnormality of the lower extremities (eg, arteriovenous fistula, arteriovenous malformation, and aneurysm), previous vascular surgery, and tumor of the lower extremities were excluded.

Demographic data including age, sex, signs and symptoms, underlying disease, and side of lower limb CVI were recorded.

**Investigators.** All examinations were performed by six radiologists who had experience in venous duplex ultrasound ranging from 6 to 30 years.

**Ultrasound examinations.** All patients underwent ultrasound examination on a Philips iU22 (Philips Healthcare, Andover, Mass) scanner with high-frequency (9-2 MHz) linear array transducers.

**Technique.** The patients were positioned semiupright at 30 to 60 degrees. The duplex ultrasound examination was performed according to standard division protocol as follows:

- Deep venous system
  - Common femoral vein
  - Femoral vein
  - Popliteal vein
- Superficial venous system
  - Great saphenous vein (GSV) above the knee
  - GSV below the knee
  - Small saphenous vein (SSV)
- Perforating veins

## ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective, observational study
- **Key Findings:** In 1010 limbs of 585 Thai patients with chronic venous disease, 44.8% had C2 disease. Patients with C4-C6 limbs were older than those with C0-C3 limbs ( $60.77 \pm 14.67$  years vs  $55.73 \pm 18.85$  years;  $P < .001$ ), and men were more likely than women to have C4-C6 limbs (36.3% vs 16.9%; odds ratio, 2.8, 95% confidence interval, 2.0-3.8). Duplex ultrasound evaluation showed superficial reflux in 49.6%, deep reflux in 27.7%, and perforator reflux in 9.2%. Isolated small saphenous vein and perforating vein reflux, without great saphenous vein (GSV) reflux, were encountered in only 0.5% and 1%.
- **Take Home Message:** In 1010 limbs of 585 Thai patients with chronic venous disease, almost half had GSV reflux; short saphenous vein and perforator reflux was rare (<1%) in those without GSV reflux.

The following parameters were collected:

- Deep venous system
  - Deep venous thrombosis
    - Acute deep venous thrombosis
    - Chronic deep venous thrombosis
  - Deep venous reflux
- Superficial venous system
  - Superficial venous thrombosis
  - Superficial venous reflux
- Perforating veins
  - Reflux
  - No reflux

The diagnosis of reflux was established if the duration of reverse flow exceeded 1000 milliseconds in deep veins, 500 milliseconds in superficial veins, and 300 milliseconds in perforating veins. The duration of the standard protocol for CVI examination by Doppler ultrasound in our institute lasts about 30 to 60 minutes in each limb.

**Statistical analysis.** Continuous variables were expressed as mean and standard deviation and discrete variables as number and percentage. Bivariate analysis of association calculated cross-classification with Pearson  $\chi^2$  statistics for the independence of nominal variables and the  $\chi^2$  test for trend for ordinal variables. The strength of association between the outcome variable CEAP (C4-C6) and each variable considered was assessed using odds ratios (ORs) and their 95% confidence intervals (CIs). All statistical tests were performed using a two-tailed analysis. A  $P$  value of  $<.05$  was considered statistically significant. Statistical analyses were performed using the Statistical Package for Social Sciences version 17.0 software (SPSS Inc, Chicago, Ill).

**Table I.** Demographic data in the studied population distributed by Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification

Demographic data	C0	C1	C2	C3	C4	C5	C6	Total
<b>Sex</b>								
Male	6 (0.6)	6 (0.6)	98 (9.7)	55 (5.4)	66 (6.5)	21 (2.1)	7 (0.7)	259 (25.6)
Female	18 (1.8)	124 (12.3)	354 (35)	128 (12.7)	97 (9.6)	10 (1.0)	20 (2.0)	751 (74.4)
Total	24 (2.4)	130 (12.9)	452 (44.8)	183 (18.1)	163 (16.1)	31 (3.1)	27 (2.7)	1010 (100)
<b>Side</b>								
Left	7 (0.7)	62 (6.1)	239 (23.7)	95 (9.4)	83 (8.2)	17 (1.7)	17 (1.7)	520 (51.5)
Right	17 (1.7)	68 (6.7)	213 (21.1)	88 (8.7)	80 (7.9)	14 (1.4)	10 (1.0)	490 (48.5)
Total	24 (2.4)	130 (12.9)	452 (44.8)	183 (18.1)	163 (16.1)	31 (3.1)	27 (2.7)	1010 (100)

Values are reported as number (%).

## RESULTS

There were 1010 consecutive lower extremities (259 male limbs from 153 men and 751 female limbs from 432 women). There were 585 patients (153 men and 432 women) in the study. A total of 425 patients (106 men and 319 women) were examined bilaterally, whereas 160 patients (47 men and 113 women) were examined unilaterally. The mean age of the patients was  $56.8 \pm 14.2$  years (range, 20-95 years). Each limb was considered a case. Of the 1010 lower limbs, 51.5% (520 limbs) were left sided and 48.5% (490 limbs) were right sided. The details of the numbers and percentages according to CEAP classes C0 to C6 are illustrated in Table I.

The three most common clinical classifications were C2 (452 limbs [44.8%]), C3 (183 limbs [18.1%]), and C4 (163 limbs [16.1%]; Table I). The mean age of patients with C4-C6 limbs was  $60.77 \pm 14.67$  years vs  $55.73 \pm 18.85$  years of patients with C0-C3 limbs ( $P < .001$ ). Men were nearly three times as likely as women to present with C4-C6 limbs (36.3% vs 16.9%; OR, 2.8; 95% CI, 2.0-3.8; Tables II and III).

It was demonstrated that there were 669 limbs from the total 1010 limbs (66.2%) with duplex ultrasound-detected abnormalities. Nearly half of them was

diagnosed with superficial venous reflux (49.6%); the rest included deep venous thrombosis (1.7%), deep venous reflux (27.7%), superficial venous thrombosis (2.2%), and perforating vein reflux (9.2%; Table IV).

Regarding the total 17 cases of deep venous thrombosis, two cases were acute thrombosis, whereas 15 cases were most likely chronic thrombosis. Despite that deep venous thrombosis was found mostly in C3 limbs (9 cases), seven cases were located in the femoral vein; the highest prevalence was in C5 limbs (4 in 31 cases [12.9%]) compared with C3 limbs (9 in 183 cases [4.9%]; Table V).

Deep venous reflux were discovered mostly in C2 limbs (129 cases [28.5%]), followed by C3 limbs (57 cases [5.7%]) and C4 limbs (46 cases [4.6%]). The prevalence of deep venous reflux was 28.5% in C2 limbs (129/452 cases), 31.1% in C3 limbs (57/183 cases), and 28.2% in C4 limbs (46/163 cases), which was less than that in C5 limbs (13/31 cases [41.9%]) and C6 limbs (9/27 cases [33.3%]; Table IV). The 280 cases of deep venous reflux were found most often in the common femoral vein (127 cases [12.6%]), followed by the common femoral vein and femoral vein (42 cases [4.2%]) and the femoral vein itself (37 cases [3.7%]; Table VI).

Superficial venous thrombosis was reported most often in C2 limbs (7 cases [0.7%]), C3 limbs (6 cases [0.6%]), and

**Table II.** Age distribution by Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification

CEAP class	No.	Age, years			
		Mean	SD	Minimum	Maximum
C0	24	56.4	17.727	19	81
C1	130	53.15	13.454	22	79
C2	452	54.33	13.115	18	87
C3	183	61.03	13.337	21	95
C4	163	61.75	13.766	27	83
C5	31	60.94	16.641	20	82
C6	27	54.70	16.636	19	83
Total	1010	56.83	14.180	20	95

SD, Standard deviation.

**Table III.** Age and sex distribution in C0-C3 and C4-C6 symptom groups

	CEAP class		P value
	C0-C3	C4-C6	
Male limbs	165 (20.9)	94 (42.5)	<.001 (OR, 2.799; 95% CI, 2.0-3.8)
Female limbs	624 (79.1)	127 (57.5)	
Age, years	55.73 ± 13.849	60.77 ± 14.671	<.001

CEAP, Clinical, Etiology, Anatomy, and Pathophysiology; CI, confidence interval; OR, odds ratio.  
Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.

C4 limbs (5 cases [0.5%]). The prevalence of superficial venous thrombosis was 1.5% in C2 limbs (7/452 cases), 3.3% in C3 limbs (6/183 cases), and 3.1% in C4 limbs (5/163 cases).

From the total of 501 cases of superficial venous reflux, 248 cases (49.5%) were found in C2 limbs, 90 (17.9%) in C4 limbs, and 89 (17.8%) in C3 limbs (Table VII). The prevalence of superficial venous reflux was 54.9% (248/452 cases) in C2 limbs, 48.6% (82/183 cases) in C3 limbs, and 55.2% (80/163 cases) in C4 limbs; the highest frequency was observed in C5 limbs (21/31 cases [67.7%]; Table IV). Deep venous reflux was present in 22.8% of all limbs (231/1010 limbs) and 46.1% of limbs with superficial venous reflux (n = 501 limbs with superficial reflux; Table IV).

The combination of superficial and deep venous reflux was demonstrated in C2 limbs (122 cases [12.1%]), C3 limbs (36 cases [3.6%]), and C4 limbs (37 cases [3.7%]). The prevalence was 26.9% (122/452 cases) in C2 limbs, 19.6% (36/183 cases) in C3 limbs, and 22.7% (37/163 cases) in C4 limbs. The predominant prevalence was noted in

either C5 limbs (12/31 cases [38.7%]) or C6 limbs (7/27 cases [25.9 %]).

Of the superficial venous reflux cases, 91% (456/501 cases) was GSV reflux and 8.9% (45/51 cases) was SSV reflux. Of the 456 cases of GSV reflux, the most common pattern was reflux in GSV from above to below the knee (249 cases [54.6%]). Segmental GSV reflux (isolated reflux in GSV below the knee) was detected in 76 (16.7%) of the total 456 cases of GSV reflux (Table VII).

Isolated SSV and perforating vein reflux (without GSV reflux) was encountered in only five cases (0.5%) and 10 cases (1%) of the total 1010 cases, respectively.

The prevalence of superficial venous reflux and perforating vein reflux broken down into class C0-C3 and C4-C6 is illustrated in Table VIII. Even though the superficial venous reflux and perforating vein reflux were discovered chiefly in the C4-C6 group, the incompetent perforator vein particularly displayed a statistical significance ( $P = .049$ ).

**Table IV.** Prevalence of deep and superficial venous thrombosis, deep and superficial venous reflux, and perforating vein reflux distributed by Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification

	C0 (n = 24)	C1 (n = 130)	C2 (n = 452)	C3 (n = 183)	C4 (n = 163)	C5 (n = 31)	C6 (n = 27)	Total (N = 1010)
Deep system								
Thrombosis	0 (0.0)	0 (0.0)	1 (0.2)	9 (4.9)	2 (1.2)	4 (12.9)	1 (3.7)	17 (1.7)
			10 (1.3)			7 (3.2)		
Reflux	4 (16.7)	22 (16.9)	129 (28.5)	57 (31.1)	46 (28.2)	13 (41.9)	9 (33.3)	280 (27.7)
			212 (26.9)			68 (30.8)		
Superficial system								
Thrombosis	0 (0.0)	3 (2.3)	7 (1.5)	6 (3.3)	5 (3.1)	0 (0.0)	1 (3.7)	22 (2.2)
			16 (2.0)			6 (2.7)		
Reflux	6 (25.0)	33 (25.4)	248 (54.9)	89 (48.6)	90 (55.2)	21 (67.7)	14 (51.8)	501 (49.6)
			376 (47.6)			125 (56.6)		
Combined deep and superficial system								
Reflux	1 (4.2)	16 (12.3)	122 (26.9)	36 (19.6)	37 (22.7)	12 (38.7)	7 (25.9)	231 (22.8)
			175 (22.2)			56 (25.3)		
Perforating vein								
Reflux	1 (4.2)	6 (4.6)	46 (10.2)	12 (6.6)	19 (11.7)	5 (16.1)	4 (14.8)	93 (9.2)
			65 (8.2)			28 (12.7)		

Values are reported as number (%).

**Table V.** Prevalence of deep venous thrombosis distributed by Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification

	C0 (n = 24)	C1 (n = 130)	C2 (n = 452)	C3 (n = 183)	C4 (n = 163)	C5 (n = 31)	C6 (n = 27)	Total (N = 1010)
<b>Acute thrombosis</b>								
CFV	0 (0)	0 (0)	0 (0)	1 (0.5)	1 (0.6)	0 (0)	0 (0)	2 (0.2)
FV	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0.0)
PV	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0.0)
<b>Chronic thrombosis</b>								
CFV	0 (0)	0 (0)	1 (0.2)	3 (1.6)	0 (0)	0 (0)	0 (0)	4 (0.4)
FV	0 (0)	0 (0)	0 (0)	4 (2.2)	0 (0)	2 (6.5)	1 (4.2)	7 (0.7)
PV	0 (0)	0 (0)	0 (0)	1 (0.5)	1 (0.6)	2 (6.5)	0 (0)	4 (0.4)
Total	0 (0)	0 (0)	1 (0.2)	9 (4.9)	2 (1.2)	4 (12.9)	1 (4.2)	17 (1.7)

CFV, Common femoral vein; FV, femoral vein; PV, popliteal vein.  
Values are reported as number (%).

## DISCUSSION

A higher negative rate (341/1010 cases [33.76%]) of duplex ultrasound findings in patients with clinically suspected CVI has been demonstrated in comparison with most previous data.<sup>8,10,11</sup> There are two main reasons for this: first, all disease spectra were evaluated, not limited only to C4-C6 as in most previous studies; and second, the examination was performed in a semiupright rather than in a standing position.

The prevalence of CVI was discovered to be higher in female limbs than in male limbs, 77.4% vs 25.6% (751 vs 259/1010 cases), in this study. On the contrary, a higher proportion of male limbs (36.3%) than of female limbs (16.9%) was found in clinical class C4-C6, corresponding with recent studies.<sup>2,4,7,12</sup> However, Garcia-Gimeno et al<sup>13</sup> reported that clinical class C4-C6 was higher in women (OR, 1.3; 95% CI, 1.01-1.78;  $P < .05$ ). Cosmetic concerns of women (C0-C2) may urge them to seek early treatment to prevent disease progression to severe or complicated CVI, as mentioned in previous reports.<sup>4,14</sup>

The mean age of this study population was <60 years, similar to a previous study in the Thai population.<sup>8</sup>

Of note, the mean age of patients in clinical class C4-C6 was observed to be significantly higher than of those in clinical class C0-C3 ( $60.77 \pm 14.67$  years vs  $55.73 \pm 18.85$  years;  $P < .001$ ) and was similar to the previous studies from Italy, Scotland, and Australia (most venous ulcers occurred in patients >60 years).<sup>15-17</sup> Although many studies have shown that the prevalence of venous disease increases with age,<sup>4</sup> none of them has demonstrated the entrenched relationship between clinical severity and age.

The study revealed that CVI might affect slightly more left limbs (520 cases [51.5%]) than right limbs (490 cases [48.5%]), as shown in a previous study in an Indian population.<sup>18</sup> This might be related to the anatomy of the left iliac artery that crosses over the left iliac vein. However, other studies have shown an equal involvement of both lower limbs.<sup>19</sup>

Corresponding with preceding evidence,<sup>20</sup> the prevalence of venous thrombosis in both deep (1.7%) and superficial (2.2%) venous systems disclosed in this study was subtle because most patients suffering from venous obstructions usually presented with an acute venous

**Table VI.** Prevalence of deep venous reflux distribution by Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification

	C0 (n = 24)	C1 (n = 130)	C2 (n = 452)	C3 (n = 183)	C4 (n = 163)	C5 (n = 31)	C6 (n = 27)	Total (N = 1010)
CFV	3 (12.5)	17 (12.9)	57 (12.6)	20 (10.9)	24 (14.7)	2 (6.4)	4 (14.8)	127 (12.6)
FV	0 (0.0)	3 (2.3)	20 (4.4)	5 (2.7)	7 (4.3)	1 (3.2)	1 (3.7)	37 (3.7)
PV	0 (0.0)	0 (0.0)	11 (2.4)	6 (3.3)	3 (1.8)	4 (12.9)	0 (0.0)	24 (2.4)
CFV + FV	0 (0.0)	1 (0.8)	20 (4.4)	10 (5.5)	8 (4.9)	2 (6.4)	1 (3.7)	42 (4.2)
CFV + PV	0 (0.0)	1 (0.8)	12 (2.6)	7 (3.8)	1 (0.6)	1 (3.2)	2 (7.4)	24 (2.4)
FV + PV	0 (0.0)	0 (0.0)	2 (0.4)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.3)
CFV + FV + PV	1 (4.2)	0 (0.0)	7 (1.5)	8 (4.4)	3 (1.8)	3 (9.7)	1 (3.7)	23 (2.3)
Total	4 (16.6)	22 (16.9)	129 (28.5)	57 (31.1)	46 (28.2)	13 (41.9)	9 (33.3)	280 (27.7)

CFV, Common femoral vein; FV, femoral vein; PV, popliteal vein.  
Values are reported as number (%).

**Table VII.** Prevalence of superficial venous reflux distribution by Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) classification

	C0 (n = 24)	C1 (n = 130)	C2 (n = 452)	C3 (n = 183)	C4 (n = 163)	C5 (n = 31)	C6 (n = 27)	Total (N = 1010)
GSV above knee	2 (8.3)	15 (11.5)	69 (15.3)	21 (11.5)	19 (11.6)	3 (9.7)	2 (7.4)	131 (13.0)
GSV below knee	1 (4.2)	4 (3.1)	34 (7.5)	14 (7.6)	15 (9.2)	5 (16.1)	3 (11.1)	76 (7.5)
GSV above and below knee	2 (8.3)	11 (8.5)	126 (27.9)	47 (25.7)	46 (28.2)	10 (32.2)	7 (25.9)	249 (24.6)
Total GSV	5 (20.8)	30 (3.0)	229 (50.7)	82 (44.8)	80 (49.1)	18 (58.0)	12 (44.4)	456 (45.1)
		346 (43.8)			110 (49.8)			
SSV	1 (0.1)	3 (0.3)	19 (4.2)	7 (3.8)	10 (6.1)	3 (9.7)	2 (7.4)	45 (4.5)
		30 (3.8)			15 (6.8)			
Total reflux	6 (0.6)	33 (23.1)	248 (54.9)	89 (48.6)	90 (55.2)	21 (67.7)	14 (51.8)	501 (49.6)
		376 (47.6)			125 (56.6)			

GSV, Great saphenous vein; SSV, small saphenous vein.  
Values are reported as number (%).

problem rather than with either a chronic complaint or venous insufficiency. By contrast, CVI is distinctly associated with venous reflux.

The prevalence of deep venous reflux in this study (27.7%) was relatively reduced compared with past studies in series of primary CVI. Others reported variability in the prevalence of deep venous reflux ranging from 35.3% in limbs with primary CVI to 92.3% in limbs with post-thrombotic CVI in limbs with venous ulcer and 55% in another series of patients with venous ulcers.<sup>9,11</sup>

Notwithstanding that superficial venous reflux was the major discovery in our study (49.6%), the proportion was nearly less than half of recent reports ranging from 71% to 100%.<sup>8,9,21</sup> This may be in favor of the diversification of clinical presentation across studies. Of those 789 cases (78.1%) of clinical class C0-C3 and 221 cases (21.9%) of clinical class C4-C6 collected in this study, the prevalence of isolated superficial venous reflux and coincident deep and superficial venous reflux in clinical class C4-C6 was 81.9%, comparable to previous studies in Thai and Indian populations. The prevalence of the coincidence found in clinical class C4-C6 from another Thai population was 71%,<sup>8</sup> whereas the prevalence of superficial venous reflux in clinical class C3-C6 of an Indian population was 100%.<sup>9</sup> This discrepancy was similarly

spotted in the prevalence of perforator vein reflux, which was 9.2% of the total, whereas up to 12.7% in clinical class C4-6 was reported, closely akin to previous studies in the same population group in Spain and Turkey with a prevalence ranging from 11.0% to 20.8%.<sup>13,18</sup> However, a larger clinical class C4-6 population needs to be further investigated.

Intriguingly, the prevalence of SSV reflux of 6.7% discovered was relatively low, especially in clinical class C4-C6, which was remarkably less than in the previous study in the Thai population (39%).<sup>8</sup> This could be influenced by the different hydrostatic pressure in a semiupright position of 30 to 60 degrees used in this study that may diminish the power of SSV reflux detection compared with examination in an upright position.

Given the low incidence and prevalence of SSV and perforator vein reflux in C1 limbs (0.3% and 4.6%) and C3 limbs (3.8 and 6.6%), omitting SSV and perforator vein examination in C1 and C3 limbs may reduce the duration by one-third from the conventional protocol.

Of the superficial venous reflux, a statistically significant correlation between an incompetent perforator vein and clinical class C4-C6 of CVI was demonstrated ( $P = .049$ ), corresponding with previous documents.<sup>22</sup> However, a further investigation with a larger prospective population is warranted.

There were several limitations in this study, including a retrospective review of duplex ultrasound findings of examinations that have been performed by different radiologists, resulting in incomplete assessment of interobserver and intraobserver agreement. The examination position in our study is semiupright, which may intensify the false-negative rate for the SSV reflux. Last, despite being the largest CVI study in a Thai population, this scale remains relatively modest in comparison with other international studies. To reduce bias and to improve reliability and validity, a prospective study with a larger population needs to be conducted.

**Table VIII.** Superficial venous reflux distribution in C0-C3 and C4-C6 symptom groups

	CEAP		P value
	C0-C3, No. (%)	C4-C6, No. (%)	
GSV reflux	346 (43.9)	110 (49.8)	.126
SSV reflux	30 (3.8)	15 (6.8)	.065
Perforating vein reflux	65 (8.2)	28 (12.7)	.049

CEAP, Clinical, Etiology, Anatomy, and Pathophysiology; GSV, great saphenous vein; SSV, small saphenous vein.

## CONCLUSIONS

The mean age in clinical class C4-C6 is statistically significantly higher than in clinical class C0-C3. The negative rate of duplex ultrasound findings was slightly more pronounced than in other studies and might have resulted from the diversity of clinical presentations. The duplex ultrasound examination in clinical class C4-C6 patients in the semiupright position at 30 to 60 degrees demonstrated the comparable prevalence of deep venous thrombosis, deep venous reflux, coincident deep and superficial venous reflux, GSV reflux, and perforator vein reflux with the previous reports. The prevalence of deep venous reflux, superficial venous reflux, and coincident deep and superficial venous reflux in clinical class C4-C6 limbs is higher than in clinical class C0-C3 limbs. Detection of incompetent perforator veins was shown to have a statistically significant correlation with clinical class C4-C6 symptoms. The remarkably low prevalence of SSV and perforator vein reflux found in C1 and C3 limbs may suggest a protocol amendment by skipping SSV and perforator vein examination in C1 and C3 limbs to reduce examination time.

## AUTHOR CONTRIBUTIONS

Conception and design: TP

Analysis and interpretation: TP, BW, TT, OC, CBN

Data collection: TP, BW, TT, OC, CBN

Writing the article: TP, BW, TT, OC, CBN

Critical revision of the article: TP

Final approval of the article: TP, BW, TT, OC, CBN

Statistical analysis: Not applicable

Obtained funding: Not applicable

Overall responsibility: TP

## REFERENCES

1. Cina A, Pedicell A, Stasi CD, Porcelli A, Fiorentino A, Cina G, et al. Color-Doppler sonography in chronic venous insufficiency: what the radiologist should know. *Curr Probl Diagn Radiol* 2005;34:51-62.
2. Eberhardt RT, Raffetto JD. Chronic venous insufficiency. *Circulation* 2005;111:2398-409.
3. Coleridge-Smith P, Labropoulos N, Partsch H, Myers K, Nicolaidis A, Cavezzi A. Duplex ultrasound investigation of the veins in chronic venous disease of the lower limbs—UIP Consensus Document. Part I. Basic principles. *Eur J Vasc Endovasc Surg* 2006;31:83-92.
4. Beebe-Dimmer JL, Pfeifer J, Engle JS, Schottenfeld D. The epidemiology of chronic venous insufficiency and varicose veins. *Ann Epidemiol* 2004;15:175-84.
5. Raju S, Neglén P. Chronic venous insufficiency and varicose veins. *N Engl J Med* 2009;360:2319-27.
6. Hanrahan LM, Kechejian GJ, Cordts PR, Rodriguez AA, Araki CA, LaMorte WW, et al. Patterns of venous insufficiency in patients with varicose veins. *Arch Surg* 1991;126:687-91.
7. Lees TA, Lambert D. Patterns of venous reflux in limbs with skin changes associated with chronic venous insufficiency. *Br J Surg* 1993;80:725-8.
8. Kanchanabat B, Wongmahisorn Y, Stapanavatr W, Kanchanasuttirak P, Manomaiphiboon A. Clinical presentation and patterns of venous reflux in Thai patients with chronic venous insufficiency (CVI). *Eur J Vasc Endovasc Surg* 2010;40:399-402.
9. Irodi A, Keshava SN, Agarwal S, Korah IP, Sadhu D. Ultrasound Doppler evaluation of the pattern of involvement of varicose veins in Indian patients. *Indian J Surg* 2011;73:125-30.
10. Saliba OA Jr, Giannini M, Rollo HA. Noninvasive diagnostic methods to evaluate venous insufficiency of the lower limbs. *J Vasc Bras* 2007;6:266-75.
11. Myers KA, Ziegenbein RW, Zeng GH, Matthews PG. Duplex ultrasonography scanning for chronic venous disease: patterns of venous reflux. *J Vasc Surg* 1995;21:605-12.
12. Kurt A, Ünlü UL, Ipek A, Tosun Ö, Gümüş M, Zan E, et al. Short saphenous vein incompetence and chronic lower extremity venous disease. *J Ultrasound Med* 2007;26:163-7.
13. Garcia-Gimeno M, Rodriguez-Camarero S, Tagarro-Villalba S, Ramalle-Gomara E, Garcia JA, Arranz MA, et al. Reflux patterns and risk factors of primary varicose veins' clinical severity. *Phlebology* 2013;28:153-61.
14. Criqui MH, Jamosmos M, Fronck A, Denenberg J, Langer R, Bergan J. Chronic venous disease in an ethnically diverse population. *Am J Epidemiol* 2003;158:448-56.
15. Cesarone MR, Belcaro G, Nicolaidis AN, Geroulakos G, Griffin M, Incandela L, et al. 'Real' epidemiology of varicose veins and chronic venous diseases: the San Valentino Vascular Screening Project. *Angiology* 2002;53:119-30.
16. Fowkes FG, Evans CJ, Lee AJ. Prevalence and risk factors of chronic venous insufficiency. *Angiology* 2001;52:S1-6.
17. Baker SR, Stacey MC. Epidemiology of chronic leg ulcers in Australia. *Aust N Z J Surg* 1994;64:258-61.
18. Özgür Ö, Alimoglu E, Çeken K, Apaydın A, Sindel HT. Chronic venous insufficiency patterns in lower extremity veins detected by Doppler ultrasound. *Dicle Med J* 2013;40:543-8.
19. Engelhorn CA, Manetti R, Baviera MM, Bombonato GM, Lonardoni M, Cassou MF, et al. Progression of reflux patterns in saphenous veins of women with chronic venous valvular insufficiency. *Phlebology* 2012;27:25-32.
20. Necas M. Duplex ultrasound in the assessment of lower extremity venous insufficiency. *Australas J Ultrasound Med* 2010;13:37-45.
21. Kundu S, Grassi CJ, Khilnani NM, Fanelli F, Kalva SP, Khan AA, et al. Multi-disciplinary quality improvement guidelines for the treatment of lower extremity superficial venous insufficiency with ambulatory phlebectomy from the Society of Interventional Radiology, Cardiovascular Interventional Radiological Society of Europe, American College of Phlebology and Canadian Interventional Radiology Association. *J Vasc Interv Radiol* 2010;21:1-13.
22. Delis KT. Leg perforator vein incompetence: functional anatomy. *Radiology* 2005;235:327-34.

Submitted Apr 2, 2018; accepted Aug 29, 2018.