Clinical and hemodynamic significance of corona phlebectatica in chronic venous disorders

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Background: Corona phlebectatica (corona) is a clinical sign associated with chronic venous disorders but is not yet included in the CEAP classification. Our aim was to analyze the clinical and hemodynamic correlations of corona to determine its significance and potential usefulness in classification grading and systems such as the CEAP classification.
Methods: A full clinical and duplex ultrasound record of 287 patients was collected by 60 vascular physicians from 10 European countries. They used the same computer software. This was designed to improve the interobserver consistency of computer-assisted procedures for clinical data gathering. *Corona* was defined as fan-shaped intradermal telangiectases in the medial and sometimes lateral portions of the ankle and foot. This definition was further refined into three severity grades of light, moderate, and severe, according to reference pictures provided by the software. To avoid overpowering the statistical tests, only data from right lower limbs were analyzed.
Results: In this series of 287 unselected patients, a corona was detected in 96 right lower limbs (27.7%) and graded as light in 61 (21.1%), moderate in 24 (8.3%), and severe in 11 (3.8%). The presence of a corona and its severity grade were found significantly related to two risk factors of chronic venous disorders (age and personal history of deep vein thrombosis), the presence of so-called venous symptoms, including pain, pruritus, burning sensation, feeling of swelling, cramps, heavy legs; and most individual items of CEAP clinical classes (varicose veins, edema, all skin changes, C5; and open ulcers, C6). Furthermore, among the patients without skin changes (classes C1 to C3), the presence and grade of corona appeared to be significantly associated with the severity of the disease, with increasing CEAP ($P < .05$), disability ($P < .03$), and anatomic ($P < .01$) scores. The presence of a corona and its severity grade were also found significantly related to the CEAP clinical classes themselves ($P < .001$), the CEAP disability ($P < .001$) and clinical severity scores ($P < .001$), and the presence of superficial reflux in the saphenous and nonsaphenous territories ($P = .05$) and in the perforators ($P < .001$). The presence of a deep venous reflux was not found to be significant in this series. The relative risk of finding incompetent leg or calf perforators by duplex ultrasound is 4.4 times greater in patients with corona ($P < .001$). A comparison between the CEAP classification without corona and a modified classification including corona in C3 shows a better reliability coefficient of Cronbach.
Conclusion: Corona strongly correlates with the clinical severity and hemodynamic disturbances of the disease. The inclusion of corona in the C3 class should probably improve the reliability of the CEAP clinical classes. (J Vasc Surg 2005;42:1163–8.)

Corona phlebectatica paraplantaris (corona) was described in 1960 by H. R. van der Molen[1-3] as a consequence of venous stasis. His description included three elements: (1) the *Besenreiser,* or dilated intradermal venules (ramifications of "birch twigs"), located at the medial or lateral aspects of the foot, or both, next to the malleolar areas (Fig 1) and (2) extending to the plantar arch as 6 to 8 blue cups that quickly disappear with the elevation of the limb (these elements are due to the dilatation of the triangular-shaped venous convergence coming from the plantar arch) (Fig 2), and (3) stasis spots (epidermal capil-

laries), which are nummular purple-colored areas that disappear when pressed with a finger (Fig 3).

Corona was used in the Basle study as the definition of the first grade of chronic venous insufficiency,[4] as well as in subsequent literature that used the Widmer classification.[5,6] It is taken into account in the CEAP classification as C1[7] and described as "malleolar flare."[8] Our objective was to study the relationship between corona and the clinical and hemodynamic parameters of chronic venous disorders to determine its possible place in the CEAP classification.

MATERIAL AND METHODS

A cooperative group of vascular physicians tested new software tailored for venous patients to create a Computerized Venous Registry.[9,10] A first study evaluating informational content of the clinical "C" of CEAP was performed in a series of 872 patients.[11] Further data were collected later and used in the present study. A full completion of the clinical items needed for the documentation of the "C" component of the CEAP was required as well as documentation of the other elements as carefully as possible. Any patient aged ≥18 years old consulting for chronic

Fig 1. Corona phlebectatica: ramifications of dilated venules *(white arrow)* of the medial aspect of the foot.

Fig 3. Corona phlebectatica: stasis spots *(white arrows)*.

Fig 2. Corona phlebectatica: cupular-shaped elements arch made by the triangular confluence of two dilated veins of the plantar arch *(arrows)*.

- Telangiectases and reticular veins (C1).
- Varicose veins (C2).
- Edema (C3) when ascribed by the clinician to venous dysfunction. Several prompts were made in the CVR software to help the investigator rule out edema of non-venous origin (cardiac, renal, hepatic, and lymphatic).
- Eczema, pigmentation (C4a), and lipodermatosclerosis (C4b) or white atrophy ("atrophie blanche"), defined as an area of whitish and atrophic skin surrounded by dilated capillaries and pigmentation occurring before ulceration (differentiated from ulcer scar from the patient's history).[14] It was considered "a skin change ascribed to venous disease" and therefore assigned to class C4b.[12]
- Healed (C5) and open ulcerations (C6).

The presence of corona was specifically recorded and assessed in three severity grades: mild, moderate, and severe. The software screen provided illustrations with pictures of these three grades to improve interobserver reproducibility.

The software also asked for additional clinical items. Ankle stiffness was evaluated by physical examination and assessed in three severity grades (0 = absence; 1 = reducible ankylosis [ankle stiffness]; and 2 = nonreducible ankylosis). Venous symptoms were defined as every symptom attributable to venous dysfunction, such as aching, pain, congestion, skin irritation and muscle cramps, heaviness, tension, feelings of swelling and itching brought on by prolonged standing, and heat. Symptoms were recorded even in the absence of any associated physical or duplex ultrasound signs of chronic venous disorders (class C0s). Other anamnestic information such as a history of deep venous thrombosis was collected.[15]

The data were analyzed to evaluate the relationship between corona and the clinical and hemodynamic parameters of the chronic venous insufficiency. All patients were studied by duplex ultrasound scans. Significance of reflux was based on the physician's judgment (all investigators being recognized experts in venous assessment) and produced by manual

venous disorders was included. No obligation was made to include a consecutive series of patients. No vascular malformations were found.

The Computer Venous Registry (CVR) software provides an automatic rating in the CEAP classification and scores each limb. It facilitates completeness of the records because it asks for missing items to produce a correct designation in the CEAP classification. The software provides illustrations of clinical items when requested by the user. Because the data were collected in 1999, the CVR software does not use the new definitions from the International Union of Phlebology consensus conference in Rome.[12,13] Instead, it uses the "old" scoring system of the CEAP (not the new Rutherford scores) and also the "old" disability score.[7,8]

The CEAP clinical items include:

Table I. Main characteristics of the patients' series (287 records)

	Women (n = 218) 75.9%*	Men (n = 69) 24.1%*
Age	51.5 years (52; 25)	58.2 years (59.5; 25)
Weight	65 kg (63; 15)	78.9 kg (80; 17)
Height	1.64 m (1.65; 8)	1.755 m (1.75; 10)
Body mass index	24.2 kg/m² (23.3; 5.3)	25.6 kg/m² (25.0; 4.8)

*Data presented as median; interquartile.

compression/relaxation of the calf muscle. No specific cut-off duration of reflux was included in the software.

The hemodynamic data included all items of the "A" of CEAP. For the superficial veins (As), these were the long saphenous vein above and below the knee, the small saphenous vein, and nonsaphenous veins; for the perforators (Ap), the thigh and leg perforators; for the deep veins (Ad), the inferior vena cava, common, internal, and external iliac veins; pelvic veins; common, femoral, and deep femoral veins; popliteal vein, leg veins (tibial and fibular), and muscular veins (soleal and gastrocnemial). In addition, some non-CEAP items were checked separately: the calf perforators, upper-leg (superior paratibial or Boyd) and lower-leg perforators (posterior tibial or Cockett). Reflux from the saphenofemoral and saphenopopliteal junctions, Giacomini, and pudendal network were also assessed.

Statistical analysis. The statistical analysis was performed on 287 right limbs to rule out the problem of overestimation of statistical power due to the nonindependence of both limbs in a single person. χ^2 Tests were performed, and Spearman rank correlation coefficients were calculated using SPSS software (version 11.0) (SPSS, Chicago, Ill).

We used the α Cronbach coefficient to evaluate the internal reliability of the clinical classes.[16] This is not a statistical test, but a coefficient measuring the consistency (or reliability) of a set of items to know how well they represent a single, unidimensional latent construct. The α Cronbach coefficient measures the average inter-item correlation: if it is high, that is evidence that these items are measuring the same underlying construct. This is really what is meant when the terms *high* or *good* reliability are used.

RESULTS

The series consisted of 287 patients whose full clinical and hemodynamic data were recorded between October 1 and December 31, 1998. Corona was present in 96 right lower limbs (33.5%) classified as 61 light (21.1%), 24 moderate (8.3%), and 11 severe (3.8%). The main characteristics of the patients are summarized in Table I.

Regarding the "C" CEAP classes, a significant relationship exists between the presence of corona and the rank of clinical classes, as shown in Fig 4 (χ^2, $P < .0001$; Spearman rank correlation coefficient, $r = 0.33$). There is also a rank correlation between the CEAP C classes and corona grades ($P < .002$; $r = 0.31$). However, as shown in Table II, the
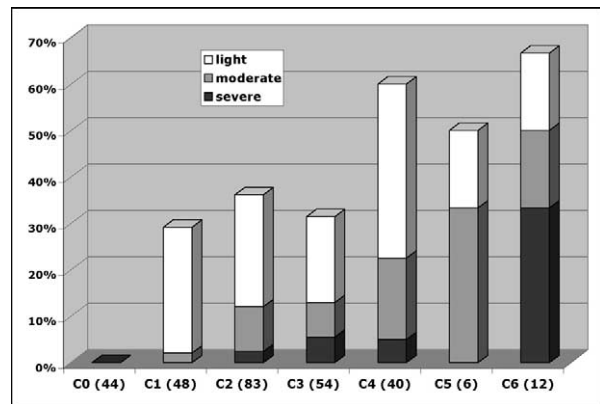

Fig 4. Relationship between corona and "C" severity classes of CEAP. Presence of corona by χ^2, $P < .001$; Spearman rank correlation coefficient, $r = 0.33$. Corona grade 1 to 3 by χ^2, $P = .002$; Spearman rank correlation coefficient, $r = 0.31$,

Table II. Presence of corona according to the CEAP clinical classes

CEAP clinical class	Corona absent	Corona present	Sensibility (%)
C0	44	0	0
C1	34	14	29.6
C2	53	30	36.1
C3	37	17	31.5
C4	16	24	60
C5-C6	7	11	61

sensibility of corona is not very different between the lower clinical classes, particularly when we compare C2 and C3.

A significant relationship was found between corona and age ($P < .001$) and also with personal history of deep vein thrombosis ($P < .02$). By contrast, no significant relationship was found with gender, body mass index, flat foot, ankle stiffness, or personal history of pulmonary embolism.

Higher clinical classes and more severe clinical and disability scores were observed in the corona group (Table III). This indicates a significant relationship with the severity parameters of venous disease, although the Spearman rank correlation coefficient was only 0.36. The relationship between corona and the presence of any venous symptom (Table IV) was also significant ($P < .0001$, $r = 0.26$). Corona is significantly related to the presence of most clinical venous and cutaneous features of chronic venous disorders (Table IV), with the exception of healed ulcers and white atrophy. This is probably due to the small number of patients.

The duplex ultrasound assessment of reflux (Table V) showed that the proportion of limbs with corona was significantly increased with increasing numbers of incompetent venous segments ($P > .0001$). This was confirmed by the significant relationship between corona and the CEAP anatomic score ($P < .0001$) (Fig 5).

Table III. Relationship between corona and CEAP scores

CEAP scores	CPh−	CPh+	P*	Corona grades			$r^{\dagger}$	P*
				Gr1	Gr2	Gr3		
Clinical score (median, interquartile)	1 (1.6)	2.2 (3)	.001	0.9 (1.2)	1.3 (1.5)	2 (2.3)	0.36	.01
Disability score (median, interquartile)	0.5 (0.7)	0.9 (0.7)	.001	0.7 (0.6)	1.2 (0.8)	1.4 (1)	0.43	.002

CPh−, Patients without corona; *CPh+*, patients with corona.
*By χ^2 test.
†By Spearman rank correlation coefficient.

Table IV. Relationship between corona and clinical items

Clinical terms	Presence of corona				Corona grades			$r^{\dagger}$	P*
	N (287)	No (%)	Yes (%)	P*	Gr1 (%)	Gr2 (%)	Gr3 (%)		
Any symptom	182	54.5	81.3	<.001	78.7	83.3	90.8	—	NS
Varicose veins	113	36	55.2	.001	70.5	91.7	90.9	0.24	.05
Venous edema	95	29.8	1.7	.03	34.4	45.8	72.7	0.22	.05
Skin changes (any kind)	58	12	36.5	<.0001	24.6	29.2	18.2	—	NS
Healed ulcer	8	1.6	5.2	NS	3.3	8.3	9.1	—	NS
Open ulcer	12	2.1	8.3	.01	3.3	8.3	36.4	0.29	.001

*By χ^2 test.
†Spearman rank correlation coefficient.

Table V. Relationship between corona and venous segmental reflux

Sites of reflux (287 patients)	No corona (%)	Corona (%)	P*	RR
Superficial				
LSV thigh (87)	26	39	.03	1.5
LSV leg (88)	27	38	.08	1.4
SSV (31)	8	16	.06	2
Nonsaphenous (76)	20	40	<.001	2
Any superficial (153)	46	69	<.001	
Number of incompetent segments			<.002	0.16
Perforators				
Thigh (38)	7	25	<.0001	3.6
Calf (43)	7	31	<.0001	4.4
Leg any (84)	9	49	<.0001	5.4
Cockett (57)	13	34	<.0001	2.6
Boyd (48)	9	32	<.0001	3.5
Any perforator (93)	22	53	<.0001	2.4
Number of incompetent perf.			<.0001	0.44
Deep veins				
Any deep reflux (30)	9	14	NS	1.5

RR, Relative risk; *NS*, not significant.
Regarding the corona grading (1 to 3), none of the hemodynamic parameters are significant for the deep veins.
*By χ^2 test: measures the probability of the relationship.

Among the various anatomic locations of reflux, a significant relationship was found to be only present for superficial vein reflux and perforators, but not for deep veins. This lack of significance is probably due to a lack of power (ie, a small number of patients in each group). Regarding incompetence of the perforators, the statistical significance is high for leg and calf ($P < .0001$) as well as for the thigh perforators (Table V). Among the deep veins, no significance was found for the leg or for the gastrocnemial, pelvic, femoral, popliteal, and iliac levels, but the power of the comparisons was low owing to a small number of cases.

The results regarding corona and the CEAP anatomic scores are interesting. If we except the deep veins, a significant relationship exists between corona grades and the mean anatomic scores (Fig 5). Furthermore, in the presence of a corona, the prevalence of an anatomic score of >4 is significantly higher in the C2 class (Fig 6).

To go further, we tried to bring some more evidence that the true place for corona should be in C3 with the edema. For this purpose, we compared the clinical "C" classes of the "classical" CEAP and the modified "M" classes of a virtual classification *including corona* in the C3 class, together with the venous edema (Table VI). The criteria for this comparison was the internal reliability of the clinical classes evaluated by the α Cronbach coefficient,[16] as we did in a previous report about the information content of the clinical CEAP classes.[11] The results show that for nearly all combinations including C3 as associated criteria in the same leg, we have an increase of the α Cronbach coefficient. This increase is from 12% to 51% (bold face in Table VI). The higher value (51%) is shown for the association C1 + C2 + C3. For the classes including C4 to C6 criteria, we did not observe any significant change.

DISCUSSION

This study suggests that corona strongly correlates with the clinical severity and hemodynamic disturbances of the disease and, particularly, with the incompetence of the leg and calf perforators.
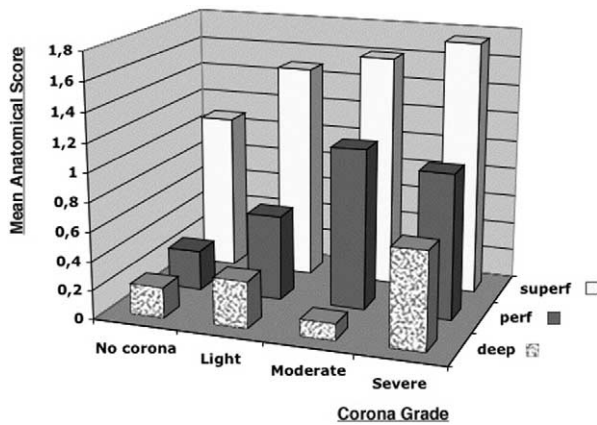
Fig 5. Relationship between corona and CEAP mean anatomic scores. Corona grade 0 to 3 by the Student's *t* test: mean global anatomic score, $P = .0001$; mean perforator score, $P = .0001$; mean superficial score, $P < .02$; mean deep score, not significant.
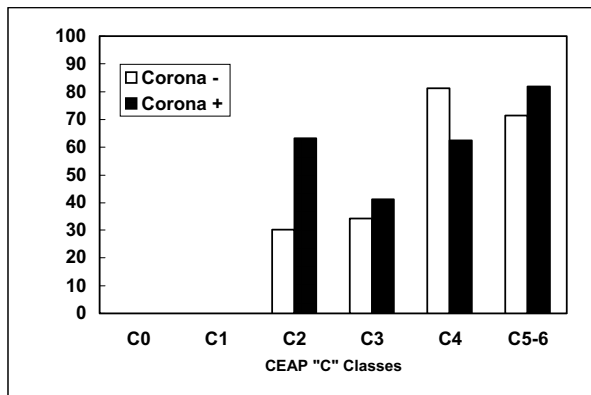

Fig 6. Prevalence of anatomic scores >4 in patients with and without corona. By the Student's *t* test for class C2, $P = .003$; and for classes C3 to C6, not significant.

Validity of the results. The reliability of the above results depends on the conditions of data collection. Therefore, every effort was made to ensure the interobserver reproducibility as much as possible through use of reference illustrations and reminders of definitions. We previously used the same software to test the reproducibility and found a κ coefficient of 0.51 when testing the interobserver reproducibility of telangiectases,[17] and for corona,[18] it was 0.61. In any case, poor reliability would have produced increased variability and decreased power of the comparisons, which means that we are confident about the relevance of the positive results we obtained.

Significance of corona. In a previous report in which we studied a different series of 874 patients, we found a significant association of corona[11] with clinical severity classes (χ^2, $P < .001$; Spearman rank correlation coefficient, $r = 0.28$), which suggested that corona should not be considered to be similar to telangiectases and reticular

veins in other locations. The present study confirms our previous results in the other series of patients and shows that the strength of the association is increased when the severity grade of corona is taken into account (χ^2, $P < .0001$, Spearman rank correlation coefficient, $r = 0.36$) (Fig 1).

Although we did not check the distal venous pressure in the present study, the significant relationship between corona and distal reflux corroborates the hypothesis of van der Molen[3] that corona should be a consequence of the venous stasis of the foot, related to a prolonged or severe venous hypertension. This was also the hypothesis described by Cockett and Elgan[19] as the "ankle blow out syndrome," which was recently supported by the data of the Edinburgh study (Ruckley et al).[20] It is also consistent with the Hirai[21] findings that showed a significant relationship between some coronas and venous photoplethysmography (shortened half-filling time in corona group).

Our duplex ultrasound findings show that corona is associated with a higher rate of venous reflux, preferentially in a perforator or the great saphenous vein territory (Table V). From a practical point of view, these results show that for a C2 patient, the relative risk of finding an incompetent leg or calf perforator is 4.4 times higher if a corona is present (2.5 times higher for thigh perforators).

All of these data are consistent with the relevance of corona as a strong indicator of severity in patients with chronic venous disorders. Furthermore, the analysis of the comparison between the clinical "C" classes of the "classical" CEAP and the modified "M" classes of a virtual classification, *including corona* in the C3 class by the α Cronbach coefficient, suggest that the reliability of the system is improved with corona placed in C3 with the edema. Hence, we think that this information should be taken into account in the CEAP clinical classes, differentiating them from the "C1" of the other kinds of telangiectases. Indeed, C3 would be the most appropriate location in which to place it. This would be in accordance with the Widmer classification and the German approach.[4-6]

CONCLUSION

This study confirms that corona is a significant sign in the clinical evaluation of patients with chronic venous disorders. It is a reliable severity indicator, being significantly related to most of the other clinical and hemodynamic severity measures. Hence, corona has to be checked during any clinical exam. Moreover, as suggested by van der Molen and Widmer long ago, the hemodynamic data of this study confirm that corona is a strong indicator of severe venous stasis and probably one of the first signs of decompensation in chronic venous insufficiency. Actually, the relationship of corona and venous reflux is mostly significant for the distal segments of the limb (perforators, leg great saphenous vein, or nonsaphenous reflux).

It is likely that the inclusion and placement of corona in C3 clinical class should improve the internal reliability of the CEAP classification. Corona seems to be a valuable tool to evaluate the severity of the chronic venous disorder, but

Table VI. Internal reliability of classic "C" compared with modified "M" clinical classes compared with the α Cronbach coefficient*

Criteria associated in the same leg (classic C)	Reliability: α Cronbach coefficient	Criteria associated in the same leg (modified C)	Reliability: α Cronbach coefficient	Mean increase (%)
C1+C2	0.23	M1+M2	0.17	−26
C2+C3	0.43	M2+M3	0.53	23
C3+C4	0.53	M3+C4	0.54	2
C4+C5	0.36	C4+C5	0.36	0
C5+C6	0.3	C5+C6	0.3	0
C1+C2+C3	0.33	M1+M2+M3	0.5	51
C1+C2+C3+C4	0.48	M1+M2+M3+C4	0.56	16
C1+C2+C3+C4+C5	0.49	M1+M2+M3+C4+C5	0.56	14
C1+C2+C3+C4+C5+C6	0.51	M1+M2+M3+C4+C5+C6	0.57	12
C2+C3+C4+C5+C6	0.57	M2+M3+C4+C5+C6	0.58	2
C3+C4+C5+C6	0.52	M3+C4+C5+C6	0.5	−4
C4+C5+C6	0.42	C4+C5+C6	0.42	0

The coefficient means that the average inter-classes correlation is high.
*A better reliability is obtained with the modified classes for the lowest classes as expected.

longitudinal studies remain necessary in order to validate its predictability.

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