

Correlation between the hemodynamic gain obtained after operation of primary varicose veins and chronic venous disease classification¹

Correlação entre o ganho hemodinâmico obtido após a operação de varizes dos membros inferiores e a classificação da doença venosa crônica

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ABSTRACT

CONTEXT: Previous studies have demonstrated improvement of venous hemodynamics after surgical treatment of primary varicose veins of the lower extremities using air plethysmography (APG).

PURPOSE: To correlate the venous hemodynamics obtained by APG with the CEAP classification after surgical treatment of primary varicose veins.

METHODS: We studied 63 limbs of 39 patients (35 women and 4 men) aged on average 46.3 years, operated upon at the University Hospital, Faculty of Medicine of Ribeirão Preto, University of São Paulo, during the period from January 2001 to December 2004. The 63 limbs were divided into the three following groups according to CEAP classification: group C₂ + C₃ (38 limbs), group C₄ (15 limbs) and group C₅ + C₆ (10 limbs). The patients were evaluated clinically before and 30 to 40 days after surgery by preoperative duplex ultrasonography and pre- and postoperative APG.

RESULTS: There was an apparent hemodynamic improvement after surgical treatment of the varicose veins in the two groups of lower severity, but the improvement was significant in the most severe group based on venous filling index.

CONCLUSION: Surgical treatment was beneficial for all three groups, but the greatest hemodynamic gain was observed in the group of highest clinical severity (group C₅ + C₆).

Key words: Varicose Veins. Lower Extremity. Plethysmography.

RESUMO

CONTEXTO: Estudos prévios tem demonstrado a melhora da hemodinâmica venosa após o tratamento cirúrgico das varizes primárias dos membros inferiores utilizando a pletismografia a ar (PGA).

OBJETIVO: Correlacionar a hemodinâmica venosa obtida pela PGA com a classificação CEAP após tratamento cirúrgico das varizes primárias dos membros inferiores.

MÉTODOS: Foram estudados 63 membros inferiores em 39 pacientes (35 mulheres e 4 homens), com idade média igual a 46,3 anos, operados no Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo, no período de janeiro de 2001 a dezembro de 2004. Os 63 membros inferiores foram subdivididos em três grupos de acordo com a classificação CEAP, adotando-se o critério lesão de pele como referência, sendo: grupo C₂ + C₃ (38 membros) grupo C₄ (15 membros) e grupo C₅ + C₆ (10 membros). Os pacientes foram avaliados clinicamente pré e pós-operatório (30 a 40 dias após), mapeamento dúplex pré-operatório e PGA pré e pós-operatória.

RESULTADOS: Houve aparente melhora hemodinâmica após tratamento cirúrgico de varizes nos dois grupos de menor gravidade, mas foi significativa no de maior gravidade com base no índice de enchimento venoso.

CONCLUSÃO: O tratamento cirúrgico beneficiou os três grupos, mas o maior ganho hemodinâmico foi observado no grupo de gravidade clínica maior (grupo C₅ + C₆).

Descritores: Varizes. Extremidade Inferior. Pletismografia.

Introduction

Primary varicose veins of the lower extremities represent one of the most frequent affections in patients who seek care at vascular surgery outpatient clinics, generating a treatment demand that often exceeds the capacity of the Brazilian public health system¹.

The clinical manifestations of patients with varicose veins are related to vein valvular incompetence and the consequent venous reflux. Surgical treatment is used to correct the reflux points in order to relieve venous stasis in an attempt to prevent, or at least delay, the progression of venous diseases to more clinically severe stages.

Many authors have used air plethysmography (APG) separately or not for pre- and postoperative evaluation and have made several comparisons, concluding that APG is a good method for the assessment of venous hemodynamics after surgery of primary varicose veins²⁻¹⁰. APG, introduced by Christopoulos *et al.*^{2,11}, measures the various degrees of venous reflux in chronic venous disease by studying the function of the calf muscle pump, the ejection fraction (EF), the residual volume fraction (RVF), as well as the venous filling index (VFI). It also records the overall parameters of venous function including calf venous volume (VV), important for the understanding of the physiopathology of venous diseases.

The classification of chronic venous diseases (CEAP) has been recently established by a consensus of the medical societies of vascular surgery in order to obtain uniformity in publications on this subject¹².

In view of the fact that, after operation of varicose veins there is a gain in venous hemodynamics, the objective of the present study was to correlate this hemodynamic gain with the CEAP classification and to assess whether the gain is the same for all levels of clinical severity of this classification.

Methods

Thirty-nine patients (63 limbs) were evaluated prospectively, 35 of them (88.6%) women and 4 (1.4%) of them men, aged on average 46.3 years. The patients were seen at the Outpatient Clinic of the Division of Vascular and Endovascular Surgery, Department of Surgery and Anatomy, Faculty of Medicine of Ribeirão Preto, University of São Paulo (FMRP-USP), and were operated upon by a single surgeon of this Division during the period from January 2001 to December 2004, and selected according to the inclusion and exclusion criteria listed below. The study was approved by the Research Ethics Committee of the University Hospital of Ribeirão Preto, SP, and all subjects gave written informed consent to participate.

Inclusion criteria were: patients with symptomatic varicose veins classified according to the International CEAP classification as follows: Clinical criterion – C₂ to C₆, Etiological criterion - E_p, Anatomical criterion - A_s, and Physiopathological criterion - P_r. Exclusion criteria were: patients with a history of varicose vein operation, patients with congenital malformations, diabetes mellitus, heart disease, arterial and lymphatic

vasculopathies, collagenoses and myopathies, traumatic injuries with or without associated fractures, and isolated or associated arthropathies, and patients who did not give written informed consent.

Thus 63 limbs were included in the study, classified as: C₂ = 6 (9.5%), C₃ = 32 (50.8%), C₄ = 15 (23.8%), C₅ = 7 (11.1%) and C₆ = 3 (4.8%).

The patients were then reassigned to 3 groups according to the “skin lesion” criterion:

- Group C₂ + C₃ (38 limbs): no skin lesion (presence of varicose veins without ochre dermatitis, dermatofibrosis or dermatosclerosis);

- Group C₄ (15 limbs): intermediate skin lesion (ochre dermatitis with or without dermatofibrosis or dermatosclerosis, or both);

- Group C₅ + C₆ (10 limbs): with skin lesion (skin with dermatofibrosis and dermatosclerosis with healed or open phlebopathic ulcers).

The limbs were evaluated by pre- and postoperative clinical examination, preoperative duplex ultrasonography and pre- and postoperative APG (30 to 40 days after surgery).

Clinical examination

The patient was examined in the standing position in an illuminated environment, thus permitting the filling and visualization of the superficial varicose veins. The medial, lateral, anterior and posterior surfaces of the lower extremities were evaluated.

The exam was carried out according to classical semiologic standards by inspection, palpation, percussion and auscultation, in addition to the tourniquet test.

Duplex ultrasonography

Duplex ultrasonography was performed in order to exclude patients with diseases of the deep venous system. High-frequency linear probes (7.0 to 10 MHz) were used, capable of producing images in the B mode, color Doppler and spectral curves from the pulse Doppler. An Aspen-Siemens® instrument (Erlangen, Germany) was used. A vein presenting reflux lasting more than 0.5 seconds was considered to be insufficient.

The exams were performed by a single independent examiner, who communicated the results to the senior investigator.

Air plethysmography

The exams were carried out simultaneously by two examiners preoperatively and between the 30th and 45th postoperative day in the Laboratory of Noninvasive Vascular Investigation of the Division of Vascular and Endovascular Surgery, FMRP-USP, in the afternoon. The maneuvers were started only after demonstration of the exam to the patient and verification that the patient understood it.

Function of the calf muscle pump was studied by APG. Using an SDV 3000 Angiotec® instrument (Belo Horizonte, Brasil) with computer- automated calibration. The technique described and standardized by Christopoulos *et al.*¹ was used for the study and the following parameters were evaluated: VFI, EF and RVF. Literature values considered to be normal are: VFI < 2, EF > 40% and RVF < 35%¹³.

The difference between the pre- and postoperative values of VFI, RVF and EF were considered to represent the hemodynamic changes of each LL operated upon for varicose veins. These hemodynamic changes were correlated between groups C₂+C₃, C₄ and C₅+C₆ in order to determine whether the hemodynamic change obtained with surgical treatment was correlated with clinical severity.

Surgical treatment

Surgical treatment was performed in order to correct the reflux points in the lower extremities studied. of the 63 LL studied, 55 were submitted to radical magna saphenectomy (RMS) and to varicose vein exeresis (VE) with perforating ligation (PL) and 8 were submitted to RMS + PL + VE.

Statistical analysis

The three variables that represent the differences after surgical treatment, i.e., preoperative VFI – postoperative VFI, preoperative EF – postoperative EF, and preoperative RVF – postoperative RVF, did not show normal distribution by the Kolmogorov-Smirnov test ($p < 0.01$). Thus, the data were analyzed by nonparametric tests, with the level of significance set at $p \leq 0.05$.

The hemodynamic change was analyzed after exeresis of the varicose veins and was correlated with the clinical criterion of CEAP based on the nonparametric Kruskal-Wallis test and the *post hoc* Dunn test if necessary.

Results

The median, quartile and mean values of the difference obtained between the pre- and postoperative values of the variables VFI, EF and RVF and their correlation with the CEAP classification are presented in Tables 1, 2 and 3, respectively.

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

W = 6.39

n = number of limbs

p = 0.04

VFI values = (preoperative VFI – postoperative VFI) ml/s

It can be seen that the difference of VFI tended to increase in all groups, but the values of group C₅+C₆ were significantly

higher than those of group C₂+C₃. There was no difference between group C₂+C₃ and group C₄ or between C₄ and C₅+C₆ (Table 1).

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

W = 4.14

n = number of limbs

p = 0.13

EF values = (preoperative EF– postoperative EF) %

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

W = 0,32

p = 0,85

n = number of limbs; RVF values = (preoperative RVF– postoperative RVF) %

There was no difference between groups regarding EF or RVF, i.e., the hemodynamic changes of EF and RVF were not correlated with clinical severity (Tables 2 and 3).

Discussion

Many studies have quantitated the venous reflux obtained by APG and have demonstrated that the parameters obtained can be correlated with the clinical stages and can also be used to monitor the results of venous surgery after different types of intervention^{2,3,5-14}. The importance of superficial venous reflux in advanced stages of venous diseases has been studied by several investigators, who concluded that more than 50% of their patients with phlebopathic ulcers only had superficial venous insufficiency¹⁵.

The objective of the present study was to assess the hemodynamic changes occurring after venous surgery in patients with superficial venous insufficiency and with a competent deep venous system and to correlate these changes with the CEAP classification.

Pre and postoperative analysis of VFI and of its correlation with the CEAP classification revealed that, the greater the clinical severity, the greater the hemodynamic change after surgical treatment. The C₅+C₆ group had the greatest hemodynamic change, i.e., the VFI of this group had higher preoperative values and was significantly reduced after surgery.

Apparently, the two groups of patients with less severe disease (C₂+C₃ and C₄) benefited from surgical treatment in terms of VFI, but the greatest hemodynamic gain was obtained in the group of greater clinical severity (C₅+C₆). It was also observed that EF and RVF did not contribute to a correlation of the hemodynamic change obtained after surgical treatment with the clinical CEAP classification.

Christopoulos *et al.*¹⁶ studied the pre and postoperative hemodynamic alterations of 42 limbs surgically treated for varicose veins using APG. The preoperative VFI of these limbs was more than 2 ml/s and was reduced after surgical treatment in 24 limbs (57.1%). EF increased and RVF decreased after surgery. They did not calculate a correlation with the CEAP classification because the classification had not yet been established in the literature.

Gillespie *et al.*³ also assessed the venous hemodynamics after different types of surgery for varicose veins and concluded that APG is an efficient and noninvasive method for the quantitative assessment of the results of reconstructive venous surgery. They also concluded that the VFI is the best variable to be used to represent the degree of venous reflux. In the present study, we did not correlate the hemodynamic changes with the technique or type of surgery performed, but only with the CEAP classification.

Jiang *et al.*⁵, after evaluating 253 limbs with recurrent varicose veins concluded that more severe physiological disorders are a priority in terms of surgical reintervention and that VFI is the parameter that best indicates venous reflux and clinical severity. Similar results regarding VFI were detected in a previous study by the authors¹⁷, i.e., the higher the VFI the more severe the clinical CEAP classification.

Nishibe *et al.*⁷ and Miyazaki *et al.*⁹ used APG as a noninvasive method for the evaluation of changes in venous hemodynamics before and after different types of superficial venous surgeries. They concluded that there was no difference between types of superficial venous surgery regarding venous hemodynamics as long as the technique used normalized VFI, which is considered to be the best parameter representing venous reflux.

Park *et al.*¹⁰ analyzed 1756 limbs of 1620 patients operated upon for primary varicose veins and, on the basis of the variables obtained by APG, concluded that there was a postoperative hemodynamic gain. Although this study involved a large number of patients, the authors did not correlate the hemodynamic gain with CEAP classification.

In the present study, although EF and RVF did not discriminate the postoperative hemodynamic change that occurred in the three patient groups, VFI was able to demonstrate that the group of highest severity according to the CEAP classification obtained the highest gain of venous hemodynamics.

Thus, superficial venous surgery is considered to be an appropriate form of treatment in the attempt to interrupt the physiopathological course of venous hypertension at any level of clinical severity. Although the two groups of patients with less severe disease (C₂+C₃ and C₄) apparently benefited from treatment, the group with highest disease severity (C₅+C₆) obtained the highest hemodynamic gain.

Conclusion

Surgical treatment was beneficial for all three groups, but the greatest hemodynamic gain was observed in the group of highest clinical severity (group C₅ + C₆).

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