Association between segmental aplasia of great saphenous vein and varicose veins of lower limbs, evaluated using color Doppler ultrasonography

Associação entre aplasia segmentar de veia safena magna e varizes em membros inferiores avaliada pelo ecocolor Doppler

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Abstract

Background: There are individual differences in the diameter of the great saphenous vein (GSV) in both normal and non-functional limbs and it is possible to identify these differences using color Doppler ultrasonography. **Objectives:** To assess the association between segmental GSV aplasia and the presence of varicose veins and/or GSV insufficiency in lower limbs using color Doppler ultrasonography, in patients with chronic venous disease (CVD). **Methods:** A total of 1,408 patients with complaints compatible with CVD of lower limbs were examined using color Doppler ultrasonography. The age range of the sample was from 17 to 85 and 1,286 of the patients were female. People with clinical classifications (CEAP) ranging from C0 to C4 were included. On the basis of clinical examination, the sample was subdivided as follows: group A patients had varicose veins and group B patients were free from varicose veins. Color Doppler ultrasonography was used to determine whether there was GSV aplasia, by analysis of its route into the saphenous compartment, and the presence of varicose veins in different sites. Statistical analysis was conducted using the chi-square test or Fisher's exact tests followed by an analysis of residuals in tables, with a 5% significance level. **Results:** In group A, there were 479 (83.9%) patients with GSV insufficiency, 169 (38.2%) with aplasia and 71 (80.7%) with both insufficiency and aplasia. In group B, there were 92 (16.1%) patients with GSV insufficiency, 273 (61.8%) with aplasia and 17 (19.3%) with both insufficiency and aplasia. **Conclusion:** Segmental GSV aplasia was more common in lower limbs with no varicose veins and/or insufficiency, but there was a higher incidence of patients with both aplasia and insufficiency in the group with varicose veins.

Keywords: venous reflux; saphenous vein (abnormalities); color Doppler ultrasonography; venous insufficiency; anatomy.

Resumo

Contexto: Há diferenças individuais no diâmetro da veia safena magna (VSM) em membros normais e doentes; sendo possível a identificação dessas alterações pelo ecocolor Doppler. **Objetivo:** Avaliar a associação da aplasia segmentar da VSM com a presença de varizes e/ou insuficiência da mesma em membros inferiores, usando o ecocolor Doppler em pacientes com clínica de doença venosa crônica (DVC). **Métodos:** 1.408 pacientes com queixas compatíveis de DVC de membros inferiores, sendo 1.286 do sexo feminino, com idade entre 17 e 85 anos, examinados com ecocolor Doppler. Foram incluídos aqueles com classificação CEAP clínica C_0 a C_4. Pela avaliação clínica, a amostra foi distribuída em grupo A, pacientes com varizes, e grupo B, aqueles sem varizes. O ecocolor Doppler determinou se havia aplasia da VSM pela análise do seu trajeto no compartimento safeno e presença de veias varicosas nos diferentes sítios. Para estatística, foram considerados os testes Qui-quadrado ou Exato de Fisher e uma análise de resíduos em tabelas, com nível de significância de 5%. **Resultados:** No grupo A houve 479 (83,9%) de VSM insuficientes, 169 (38,2%) com aplasia e 71 (80,7%) com insuficiência e aplasia associadas. No grupo B, houve 92 (16,1%) de VSM insuficientes, 273 (61,8%) com aplasia e 17 (19,3%) com insuficiência e aplasia associadas. **Conclusão:** A aplasia segmentar da VSM ocorre mais em membros inferiores que não apresentam varizes e/ou insuficiência da mesma, mas considerando-se a presença da associação de aplasia e insuficiência, houve maior incidência no grupo de membros que apresentavam varizes.

Palavras-chave: refluxo venoso; veia safena (anormalidades); ultrassonografia; Doppler em cores; insuficiência venosa; anatomia.

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INTRODUCTION

A good understanding of the venous anatomy is very important to enable vascular ultrasonographers to identify diagnoses and contributes to indicating treatment for diseases of the venous system.[1]

The great saphenous vein (GSV) is easy to identify in the thigh because it is located within the compartment known as the "Egyptian eye" or "saphenous eye" which is delimited by the muscular fascia and the saphenous fascia and because of this any vein that is outside of this compartment is considered a tributary or accessory.[1-5]

There are differences between individuals in terms of the diameter of the GSV in normal limbs that are dependent on several different factors (age, exercise of muscles, thickness of subcutaneous cellular tissues) and diameters in diseased limbs also very, as has been demonstrated in microscopy studies.[2,4,6] A smaller than normal GSV diameter and a GSV that cannot be seen within the saphenous compartment are defined, respectively, as hypoplasia and aplasia and these conditions generally affect specific segments of the vein. In such cases there is usually a vein outside of the compartment that courses in parallel and where the hypoplasia or aplasia returns to the compartment, connecting the segments of the saphenous vein.[7]

Although aplasia or hypoplasia of the GSV is very common, there are few studies dealing with this anatomic abnormality.[4,7]

This article deals with the term aplasia as used to describe a segment of the GSV that cannot be seen within the saphenous compartment using color Doppler ultrasonography.

The objective of the present study was to evaluate the association of aplasia of the GSV with varicose veins and/or GSV insufficiency in the lower limbs using color Doppler ultrasonography in a sample of patients with venous disease diagnosed clinically.

METHOD

This was a prospective, cross-sectional study of a sample of 1,408 consecutive patients with complaints compatible with venous disease of the lower limbs. The age range of the sample was from 17 to 85 years, 1,286 of the patients were female and 122 were male. They were examined using color Doppler ultrasonography over a 6-month period. Data collected when taking patient histories and during physical examinations were recorded on a specially designed form.

This sample does not represent the general population, but a group of patients with symptomatic chronic venous disease (CVD). Patients were excluded if they had undergone a previous operation for varicose veins, had a history of deep venous thrombosis, were expectant mothers or if they had been classified as CEAP classes 5 or 6, the majority of whom have a prior history of varicose vein operations or deep venous thrombosis. The sample therefore comprised patients with CEAP clinical classifications C_0 to C_4.

On the basis of clinical assessment, the sample was subdivided into two groups, group A, comprising patients with varicose veins (C_2 to $C_{4a,b}$), and group B, comprising patients free from varicose veins (C_0-C_1).

Color Doppler ultrasonography was conducted as recommended in the literature,[8] with patients in an orthostatic position (standing upright) for examination of the superficial vein system, in particular the GSV of all lower limbs analyzed, using linear transducers from 5 to 7 MHz and convex transducers from 2 to 3 MHz for obese patients. This evaluation determined whether there was aplasia of the GSV by analyzing its path within the saphenous compartment. Limbs were then analyzed for the presence of varicose veins in other locations, irrespective of the source of reflux, i.e., with origins in the saphenous veins, irrespective of their anatomic path, or tributary branches. The criterion for definition of insufficiency was a reflux time longer than 500 ms.[9]

At the end of collection, data were stored using Microsoft® Excel® and the Statistical Analysis System (SAS) was used for analysis and interpretation of results.[10] The chi-square test or Fisher's exact test for associations and homogeneity were used to investigate possible associations between certain variables of interest and the outcome variable: varicose veins (group with varicose veins versus group free from varicose veins). For cases that were significant, an analysis of residuals in a table was also performed.[11] For all analyses, the significance cutoff was set at 5% ($p<0.05$).

This study was approved by the Ethics Committee at the Universidade Estadual de Maringá, PR, Brazil, under CAAE number 34386814.5.0000.0104.

RESULTS

A total of 2,665 lower limbs were examined from a sample of 1,408 patients, with a predominance of females (91.3%).

The classification of GSV aplasia described by Seidel et al.[12] was adopted for the color Doppler ultrasonography GSV examinations. This classification includes six types, as follows: Type I - exhibiting aplasia only in the thigh segment; Type II - aplasia in the leg segment; Type III - aplasia in the distal

segment of the thigh and proximal segment of the leg; Type IV - vein in the saphenous compartment in the thigh and aplasia of the whole segment in the leg; Type V - vein in the saphenous compartment only in a short proximal segment in the thigh, outside of the compartment distally; and Type VI - vein with a short segment in the saphenous compartment only in the distal leg (Figures 1-3).

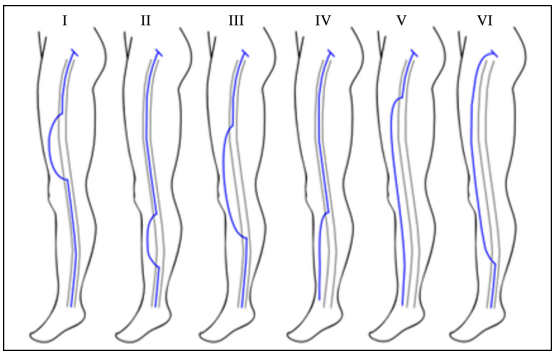

Figure 1. Classification of the types of aplasia of the GSV described by Seidel et al.[12]

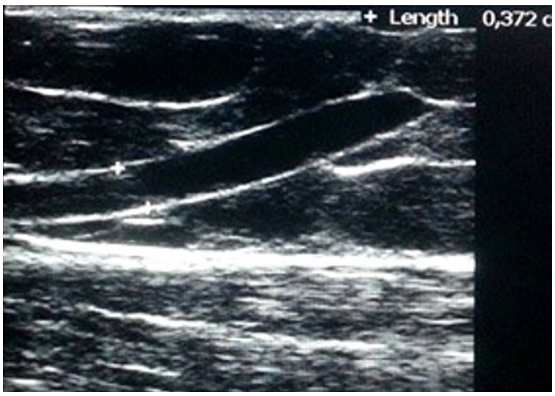

Figure 2. GSV exiting the saphenous compartment via the saphenous fascia in the proximal 1/3 of the thigh.

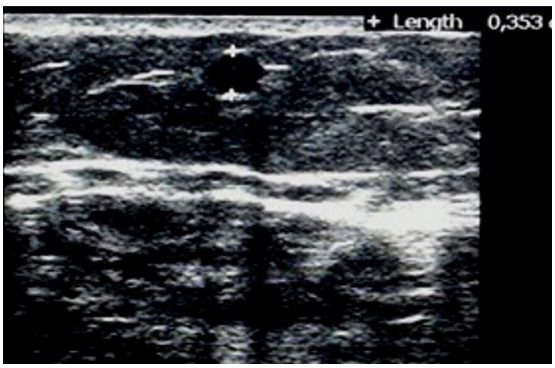

Figure 3. Superficial branch outside of the saphenous compartment in the thigh.

Table 1 shows the distribution of limbs in relation to presence of insufficiency and/or aplasia of the GSV in both groups, irrespective of the number of limbs in which the GSV was within the saphenous compartment and of the absence of signs of reflux

The chi-square test of homogeneity showed that there is evidence that the groups classified by presence or absence of varicose veins differed ($p<0.0001$). Furthermore, the frequencies of "yes" and "no" for each type of GSV differed, with respective *p*-values of ($p=0$) insufficiency, ($p=0$) aplasia and ($p=0.001$) insufficiency associated with aplasia.

Still using the chi-square test for analysis, a *p*-value of 0 shows that there is evidence of an association between factor and outcome, to 5% significance, and with an OR = 6.7 (4.04; 11.26), allowing for the conclusion that exposure to insufficiency+aplasia is associated with a 6.7 times greater likelihood of having varicose veins than exposure to aplasia alone.

The types of aplasia found in the total sample of 2,665 limbs are detailed in Table 2.

Applying Fisher's exact test ($p=0.67$) and the Williams test ($p=0.67$), the results indicate that the assumption of homogeneity between groups should not be rejected, i.e. the frequencies of "yes" and "no" are the same for all types of aplasia. This conclusion is confirmed by the analysis of residuals in the table.

The evaluation of presence of an insufficient GSV segment against type of aplasia for limbs in each group was conducted as a descriptive analysis because, despite the size of the sample, there were nevertheless few limbs that exhibited this association, with multiple levels of aplasia types and segments with reflux, and because of the large number of "zeros", the statistical analysis was not conducted as a matter of course, i.e. for the whole of Table 3.

The results show that in group A there was a larger number of limbs with both GSV insufficiency and GSV aplasia than in group B and, furthermore, that among the overall number of limbs with aplasia in both groups, there was a predominance of reflux in the proximal segment (within the saphenous compartment) and the epifascial branch (Table 3, Figure 4).

In summary, the totals for each segment with reflux enabled testing of the homogeneity between groups A and B using binomial tests. These results, shown in Table 4, provide evidence for homogeneity between groups A and B for all segments.

DISCUSSION

The international anatomic nomenclature serves as a basis for communication for research, treatment and exchange of information in phlebology and so

Table 1. Number of limbs with GSV insufficiency and/or aplasia in groups A and B.

	Insufficiency	Aplasia	Insufficiency + Aplasia
Group A (with varicose veins)	479 (83.9%)	169 (38.2%)	71 (80.7%)
Group B (free from varicose veins)	92 (16.1%)	273 (61.8%)	17 (19.3%)
Total	571	442	88

Chi-square test: p<0.0001.

Table 2. Distribution of the limbs by group, according to the type of GSV aplasia, and p values identified by the analysis of residuals.

Type of aplasia	Groups		Total	Analysis of residuals
	A(%)	B(%)		
I	8 (44.4)	10 (55.6)	18	p = 0.29
II	27 (44.3)	34 (55.7)	61	p = 0.15
III	117 (36.7)	202 (63.3)	319	p = 0.14
IV	6 (40)	9 (60)	15	p = 0.44
V	10 (35.7)	18 (64.3)	28	p = 0.38
VI	1 (100)	0 (0)	1	p = 0.10
Total	169	273	442	

Fisher's exact test p=0.67; Test G (Williams) p=0.67.

Table 3. Distribution of insufficient segments with each type of GSV aplasia in limbs from groups A or B.

	Type of Aplasia/ Groups													
	I		II		III		IV		V		VI		Total	
Segment with reflux	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Proximal segment	0	0	1	0	1	2	2	0	2	0	0	0	6	2
Proximal segment + epifascial branch	3	0	3	0	25	9	1	1	1	0	0	0	33	10
Epifascial branch	0	0	1	0	7	2	0	0	0	0	0	0	8	2
Epifascial branch + distal segment	0	0	0	0	3	0	0	0	1	0	0	0	4	0
Distal segment	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Entire vein	1	0	4	0	11	2	0	0	2	1	1	0	19	3
Total	4	0	10	0	47	15	3	1	6	1	1	0	71	17

Table 4. Binomial test applied to data shown in Table 3, considering totals for Groups A and B.

Segment with reflux	Total		*p*-value
	A	B	
Proximal segment	6	2	0.3352
Proximal segment + epifascial branch	33	10	0.1820
Epifascial branch	8	2	0.4773
Epifascial branch + distal segment	4	0	0.0704
Distal segment	1	0	0.3120
Entire vein	19	3	0.2189
Total	71	17	

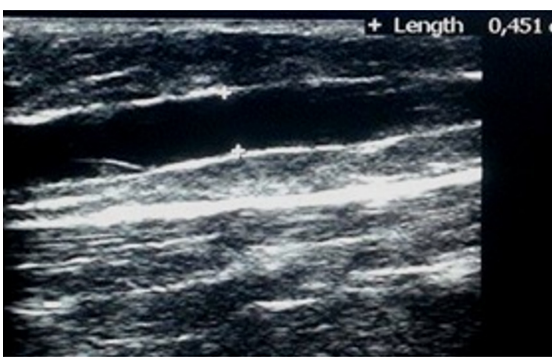

Figure 4. Dilated superficial branch in the leg.

it is important that only veins located within the saphenous compartment should be considered to be true GSV,[3,7,8,13-17] irrespective of possible reductions in their diameter or when they cannot be located in certain segments, in which cases, the correct terms are segmental hypoplasia or aplasia, respectively.[4,18]

On color Doppler ultrasonography, the GSV is easily identified in the thigh within the saphenous compartment, known as the "saphenous eye" or "Egyptian eye"[1,7,19] which is not the case at the level of the knee, where the reference used for identification is the triangle formed by the tibia, medial gastrocnemius muscle and, superficially, the fascial sheath. The examinations analyzed in the present study were conducted in accordance with the literature.[8]

Since there was no interest in making sex-distinction inferences in the statistical analysis of the results, the

predominance of female patients in the sample did not affect the results.

The etiology of anatomic abnormalities of the GSV has not been defined, but it is assumed that they are the result of developmental defects by which vessels with favorable hemodynamic conditions prevail over others, which undergo atrophy.[2,4,7]

IN an analysis of limbs with hypoplastic segments, Caggiati and Mendoza[4] studied 676 limbs with normally functioning GSVs and found 86 limbs that had hypoplastic segments, while an analysis of 320 limbs with GSV insufficiency showed that 79 had hypoplasia. In both groups, hypoplasia predominated in the segment between the proximal third of the leg and the distal third of the thigh, similar to what was observed in the present study.

Next, an analysis will be conducted of the aplastic segments and presence or absence of GSV insufficiency in the limbs of patients with or without clinical signs of venous insufficiency.

The results of this study show that 61.8% of limbs with aplasia were in group B, which is significantly greater than in group A, which accounted for 38.2%. This result is different from the results for which groups had insufficiency or insufficiency combined with aplasia, where the percentage was greater for limbs in group A (Table 1).

Ricci and Caggiati[17], Ricci and Cavezzi[20] and Caggiati and Mendoza[4] analyzed samples that differed from the sample analyzed here in that they compared groups of patients with primary varicose veins with people without varicose veins and competent GSV, concluding that segmental hypoplasia is more common among patients with varicose veins than among healthy people and they also referred to the presence of hypoplasia as a possible factor in pathogenesis of varicose veins. This hypothesis was not shared by Oğuzkurt[5] who, having listed as a study limitation the lack of a control group containing normal people, stated that it was not possible to conclude whether the segment with aplasia had any clinical importance in the pathogenesis of varicose veins.

Comparing just the 1,255 limbs from group A of the present study with the 200 limbs that had varicose veins studied by Ricci and Cavezzi,[20] the conclusions contrast, since those authors concluded that there was absence or hypoplasia of the GSV in the knee, with a prevalence of tributaries, in almost 30%, whereas in the present study 128 of the 169 GSV with aplasia (75.7%) exhibited this abnormality at the medial surface of the knee. However, results were similar in terms of the low rate of complete GSV incompetence, with rates of 6% and 3.9%, respectively.

In a different study[5] that analyzed a sample of patients with clinical signs of CVD, one third of the patients exhibited segmental aplasia of the GSV with similar frequencies among patients with and without GSV insufficiency. The results showed that segmental aplasia was observed in 16.6% of the total and was more frequent, in percentage terms, in the group of limbs without varicose veins, but without statistical significance ($p>0.05$).

In the conclusions of an article by Ricci and Cavezzi,[20] the incidence of segmental hypoplasia of the GSV was higher among people with varicose veins than among those without varicose veins (43 vs. 30%), but without statistical significance; which coincides with a study by Caggiati and Mendoza,[4] who observed segmental hypoplasia in 25% of limbs with GSV reflux due to incompetence at the saphenofemoral junction and in 12% of limbs without GSV reflux, stating that hypoplastic segments do not allow venous reflux, which is diverted into superficial branches. In our study, 71 (14.8%) patients in group A, which included 479 GSV with insufficiency, exhibited some type of aplasia, while in group B, 17 (18.5%) of 92 with insufficiency had an aplastic segment.

The percentages of veins with segmental aplasia in the subsets of the sample studied by Oğuzkurt[5] are equivalent, with 34% among those with GSV insufficiency and 31% among those with normal GSV, with a predominance of type 1, corresponding to type III in this study.

According to Caggiati and Mendoza,[4] segmental hypoplasia of the GSV leads to hemodynamic overload of the accessory saphenous and the result is merely physiological compensatory dilation of the tributaries, but, in limbs with a predisposition to varicose disease, there is greater overload of the accessory saphenous vein which results in larger varicose veins, earlier, which are clinically more evident than in patients with GSV incompetence.

It is important to define these anatomic abnormalities because, if there is a drainage vein connecting the two segments of the vein then proximal incompetence is usually transferred to the distal segment, but if there is no connection between them, only one segment will develop incompetence.[6]

These findings could have an important role in routine practice and significance for the pathophysiology of varicose disease. The presence of the wall of this compartment supplementing muscle contraction could modify the diameter of the vein and, consequently, modulate its blood flow, as happens in the deep vein system and, as such, the saphenous fascia would

still preserve the GSV from excessive pathological dilation, providing mechanical protection.[12,20]

Knowledge of the presence of segmental hypoplasia or aplasia of the GSV is important because if there is a reduction in diameter then there may be difficulty in advancing endoluminal instruments such as vein strippers and laser fibers or for thermoablation, and thermal damage to the skin may also occur because of the more superficial location of tributaries branches. Notwithstanding, abnormalities in anatomic course do not invalidate its use, as long as it has been evaluated in advance using color Doppler ultrasonography and an adequate diameter is preserved.

CONCLUSIONS

It can be concluded that segmental aplasia of the GSV occurred more often in lower limbs that do not exhibit varicose veins and/or GSV insufficiency, but that the combination of aplasia and insufficiency had a higher incidence in the group of limbs that did exhibit varicose veins.

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