ORIGINAL ARTICLE

CONTENTS

Justification of the choice of surgical treatment of varicose veins of the lower extremities depending on the physical and morphometric indicators of the thigh and the great saphenous vein

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ABSTRACT

Aim: To improve the results of traditional treatment and combined in patients with varicose veins, evaluate the long-term results of treatment depending on the magnitude of varicose transformation and morphometric parameters of the lower extremities.

Materials and Methods: We analyzed the results of examination and treatment of 228 patients with varicose veins (VV) of the lower extremities who underwent treatment at the Andriy Novak Surgical Clinic from 2012 to 2023. The inclusion criteria in the study were patients with VV (C2-C6 according to CEAP) who gave their voluntary consent to the examination and measurement. In order to compare the results of sclerosurgical and surgical treatment the ultrasound, and the frequency of pathological signs were used.

Results: It was obtained during the measurement of the limbs, when calculating the taper expressed in percentage, it was found that in people with a height of 180 cm and more and a weight of 80+ kg, taper reaches ≥15% in 68 (70%) patients ($p<0.001$). Analysis of long-term results in the two studied groups of patients revealed a statistically significant difference in the frequency of good results from medical interventions with an advantage in favor of surgical treatment (Fisher's criteria $p=0.014$).

Conclusions: To prevent and reduce the rate of unsatisfactory results when choosing a method of surgical treatment of varicose veins, morphometric indicators and thigh taper should be taken into account.

KEY WORDS: sclerotherapy, venous reflux, varicose disease, phlebectomy, crossectomy, conicity

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INTRODUCTION

Varicose vein disease (VVD) is a very common surgical pathology. Despite significant progress in the diagnosis and treatment of VVD, dissatisfaction with their results persists, due to the steady increase in the number of patients, a large percentage of complicated forms of the disease, significant treatment costs, and a high frequency of VVD relapses (VVR), which significantly reduces the quality of life of patients [1, 2].

Despite the active introduction of modern technologies, surgical treatment of VD is considered the most radical and rightfully constitutes the basis of medical care for patients with this pathology [3, 4].

According to the group of authors, currently extraction of the main trunks of the saphenous veins using probes of various modifications (stripping) is the main stage of radical surgical intervention in VD [5, 6]. However, many years of international experience in the application of the Babcock operation in practice has allowed us to identify not only its advantages, but also possible complications that may accompany such an intervention. Unlike surgical treatment, phlebosclerooblitteration is undoubtedly less traumatic, economically affordable, can be performed in outpatient settings, is accompanied by less cosmetic losses and a shorter period of medical and social rehabilitation [7]. In some countries, sclerotherapy is used in more than 80% of VD treatment [8].

According to modern thinking, sclerotherapy itself with subsequent compression is an equivalent stage of phlebosclerosis treatment. Unfortunately, it is practically impossible to predict the adequacy of great safein vein (GSV) compression in the postoperative period, and as a result, the effectiveness of sclerooblitteration in general.

Vertical trunk reflux along the GSV is a well-established pathogenetic mechanism for the development and

Table 1. Clinical distribution of patients according to the international CEAP classification before treatment

Class	Clinical characteristics of the class	Distribution of lower extremities by clinical classes	
		Group I n=189	Group II n=96
C0	No signs of venous pathology were detected during examination and palpation	-	-
C1	Telangiectasias, or reticular veins	-	-
C2	Varicose dilated subcutaneous veins	147(77.8%)	38(39.6%)
C3	Edema	5 (2.6%)	18(18.8%)
C4	Skin changes (hyperpigmentation, venous eczema, lipodermatosclerosis)	4(2%)	21(21.9%)
C5	Healed trophic ulcer	21(11.7%)	13(13.5%)
C6	Active trophic ulcer	12(6.3%)	6(6.2%)

Source: compiled by the authors of this study

progression of venous insufficiency in patients with GSV [9].

Today, the arsenal of funds aimed at its correction is very diverse, including radiofrequency or laser ablation. This is all due to the lack of a single universal treatment method for any clinical situation, on the one hand, the indication to improve the functional outcome of treatment, the cosmetic nature of the intervention, reduce the terms of medical and social rehabilitation, and improve the quality of life of patients with VD.

At the same time, a sufficiently large number of varicose vein recurrences, especially in ovGSVeight patients after traditional venectomy and trunk scleroobliteration, is noteworthy [1, 4, 7].

AIM

To improve the results of traditional treatment and sclerosurgery in patients with varicose veins, evaluate the long-term results of treatment depending on the magnitude of varicose transformation and morphometric parameters of the lower extremities.

MATERIALS AND METHODS

We analyzed the results of examination and treatment of 228 patients with varicose veins (VV) of the lower extremities who undGSVent treatment in the surgical clinic named after A. Novak from 2012 to 2023. The inclusion criteria in the study were patients with VD (C2-C6 according to CEAP) who gave their voluntary consent to the examination and measurement (Table 1). The exclusion criteria from the study were severe concomitant diseases, the presence of thrombosis or thrombophlebitis, and the patient's refusal to participate in the study.

At the same time, 153 patients in group I had two limbs treated in 36 patients, and in 75 patients in group II, two limbs were treated in 21 patients.

Group I consisted of 153 patients (189 limbs operated on), who undGSVent sclerosurgery. For the convenience of analysis, the number of operated limbs in patients with CEAP VD classes from C2 to C6 was counted - a total of 189 limbs. Thus, patients with C2-C4 classes undGSVent crossectomy+trunk catheter scleroobliteration, which amounted to 156 (82.5%) limbs. Crossectomy+trunk catheter scleroobl iteration+echosclerotherapy of perforating veins was performed in patients with C5, which amounted to 21 (11.1%) limbs. Patients with CEAP class C6 undGSVent short stripping of the great saphenous vein (GSV), distal scleroobliteration, and echoscleroobliteration of perforating veins on 12 (6.3%) limbs.

The second group of patients included 75 patients (96 limbs), who undGSVent surgical treatment, mainly phlebectomy according to Babcock-Narat. Similarly to group I, the classes and volume of surgical treatment were correlated with the number of operated limbs. In C2-C4 class, crossectomy + trunk phlebectomy + removal of varicose tributaries was performed - 77 (80.2%) limbs. In C5 class, crossectomy + trunk phlebectomy + ligation of incompetent perforating veins was performed - 13 (13.5%) limbs. In patients with C6 class, crossectomy + trunk phlebectomy + removal of varicose tributaries + ligation of incompetent perforating veins was performed according to CEAP, which amounted to 6 (6.2%) limbs.

Of the 228 patients, 59 were men (25.9%), 169 were women (74.1%). The age of the patients at the time of surgical treatment did not exceed 50 years, on average 47±2.8 years.

As can be seen from Table 1, patients were divided into 2 groups. During the treatment process, patients were provided with complete information about possible treatment options and the subsequent cohort of surgical or sclerosurgical treatment was chosen by the patient based on his own beliefs – that is, it was

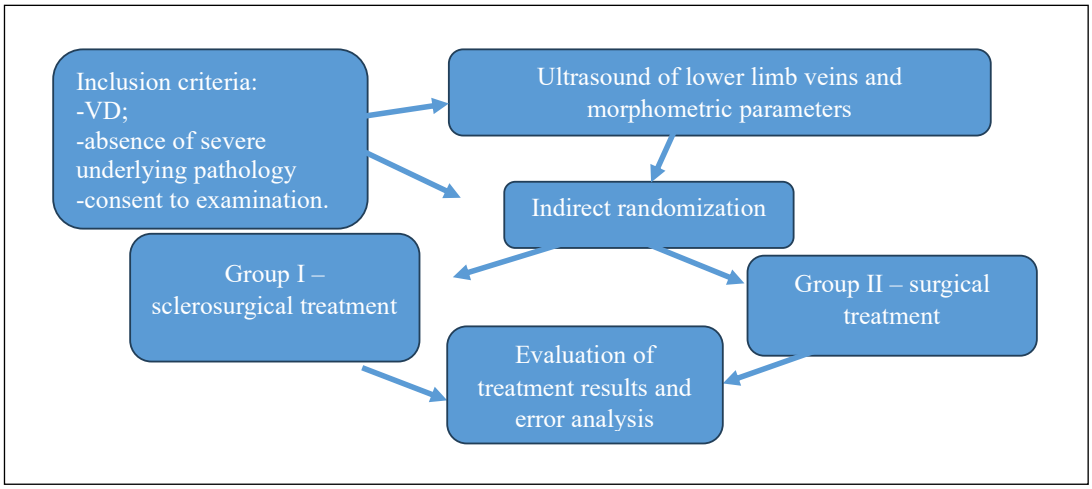

Fig. 1. Study design
Picture taken by the authors

carried out in a randomized manner. The study design is presented in (Fig. 1).

Ultrasound examination was performed on SonoAce R3, Medison (Korea) and Philips En Visor HD (USA) devices, equipped with linear sensors of 7-10 MHz and convex - 3.5-5 MHz. During ultrasound examination, visual inspection of the vessels of the venous bed in real time (B-mode) was combined with the study of the color cartogram and assessment of its spectral characteristics using functional tests of proximal and distal compression, cough test, Valsalva test, Siegel compression test. Angioscanning was necessarily performed in the longitudinal and transverse planes, both lower extremities were examined. Angioscanning was used to measure the diameter of the GSV. In order to compare the results of sclerosurgical and surgical treatment using the ultrasound method, the frequency of pathological signs such as: Varicose transformation of the ostium ducts (length of the GSV stump > 3 cm); GSV obliteration; partial recanalization; complete recanalization; incompetent femoral perforating veins; incompetent tibial perforating veins. The diameter of the GSV in the two groups of patients was not statistically different and did not exceed 10 mm in the upper third of the thigh.

The examination began in the horizontal position, with visualization of the great saphenous vein, peroneal veins, and groups of perforating veins of the leg. The common femoral vein was scanned medial to the artery of the same name, below the inner third of the inguinal fold.

In the upright position, the source of reflux, the distribution paths and the channels of reflux return to the deep venous system were monitored.

Using blind randomization, 98 patients were selected, who were measured for morphometric parameters such as: weight, height, thigh diameter in the upper and lower third, thigh length between diameters, and thigh conicity was determined. From group I, 58 (25.4%) patients (90 limbs operated) were examined, who undGSVent sclerosurgical intervention, from group II, 40 (17.5%) patients (54 limbs) were included, who undGSVent only surgical treatment.

All 98 patients had their femoral conicity measured in the upper and lower thirds according to mathematical modeling. Conicity (C) [10] is the ratio of the diameter of the base of the cone to its height. In the case of a truncated cone, it is the ratio of the difference in diameters of the cross sections D and d of the truncated cone to the distance between them:

$$C = \frac{D - d}{H}$$

where C is the conicity, D is the base diameter, d is the diameter of the smaller base and H is the distance between the bases (Fig. 2).

The severity of VD symptoms (before treatment and in the postoperative period) was assessed using the international CEAP classification. In the long-term postoperative period (5-9 years), three disease variants were recorded: VD regression compared to the initial status, progression, and lack of dynamics.

The criterion for regression of VD was considered to be a decrease in the clinical class and was assessed as good results. An increase in the clinical class according to CEAP was regarded as progression of VD despite the treatment performed and was assessed as an unsatisfactory result. The lack of dynamics in the long-term observation period was assessed on the basis of preservation of the initial clinical class and / or its return to the initial status after 5-9 years as a satisfactory result.

Statistical data were calculated using the Jamovi 2.38.8 software package. When analyzing the distri-

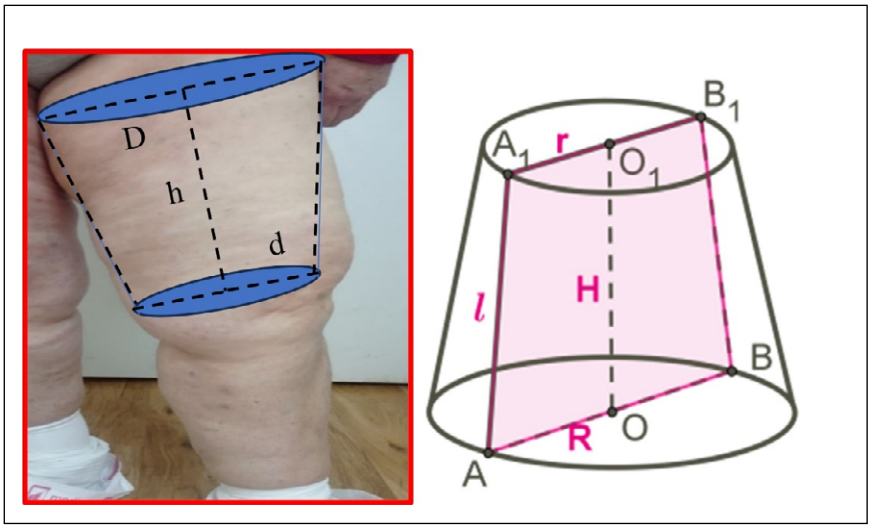

Fig. 2. Schematic representation of the conicity of the hip: R- large radius, r- small radius, H – height
Picture taken by the authors

bution of indicators, it was found that the distribution was correct, so the Student's T test was used. When calculating the average values, the average value and standard deviation (M ± sd) were used. The results are presented in percentage values and absolute values. The Spearman test was used to calculate the correlation dependence.

RESULTS

The postoperative observation period was 6-10 years after the operations. In order to compare the results of sclerosurgical and surgical treatment, the frequency of pathological signs was assessed using the ultrasound method (Table 2).

As can be seen from Table 2, a pathologically long stump of the GSV with varicose transformation of the ostium tributaries was observed in 8 (4.2%) and 6 (6.2%), respectively, and an «additional» erroneously left GSV trunk in 5 (2.6%) and 11 (11.5%) of the examined groups. Partial recanalization of the GSV trunk after sclerotherapy was observed in 54 (28.6%), complete recanalization in 30 (15.5%), which in our opinion was associated with poor compression in the postoperative period after sclerotherapy and an incompetent penetrating femoral vein in 18 (9.5%) cases.

The results of measuring lower limb circumference in patients with chronic venous insufficiency are presented in Table 3.

According to the data obtained during the measurement of the limbs, when calculating the conicity expressed in percentages, it was found that in people with a height of 180 cm and more and a weight of 80+ kg, conicity reaches ≥15% in 68 (70%) patients ($p<0.001$). When assessing the correlation according to Spearman, a high correlation was established between conicity in patients and morphometric indicators such as weight, height and diameter of the upper third of the thigh ($p<0.001$), when analyzing the influence of indicators on conicity of the thigh using linear regression, it was established that weight and height and diameter of the thigh in the upper third strongly affect the change in conicity of the thigh ($R2=0.745$). After analyzing the dependence of conicity on morphometric indicators using Student's T test for independent samples, it was found thatin healthy people with a height of <180 cm and a weight of less than 80 kg, the percentage of conicity was two times less - no more than 10% ($p<0.001$).

Sclerotherapy requires adequate compression for 7-9 days after surgery, which is impossible to achieve with a similar thigh shape.

If the pathological stump of the GSV with varicose transformation of the ostium tributaries, varicose transformation of the anterior accessory saphenous vein of the thigh were observed approximately equally in both groups of patients, and partial recanalization of the GSV (28.6%) and complete recanalization of the GSV (15.9%) were characteristic only with sclerotherapy.

Thus, when analyzing the results of DAS of the veins of the lower extremities performed in patients with VD in the long-term period after sclerosurgical and surgical interventions, no statistically significant difference was found between patients of the two studied groups for 10 out of 15 ultrasound criteria for comparison. Sonographic characteristics of patients with VD after sclerosurgical treatment and phlebectomy, the difference in which is statistically significant (6 out of 15), are not specific to one or the other method of treatment.

It should be noted that out of 10 signs that statistically significantly differ in frequency of observation after different treatment methods, 5 were registered more often after phlebectomy. Postoperative ultrasound monitoring not only objectifies the results of the

Table 2. Comparative assessment of the frequency of pathological ultrasound signs after sclerosurgical and surgical treatment

Pathological ultrasound signs	Sclerotherapy abs. and relative number of limbs n=189 (100%)	Phlebectomy abs. and relative number of limbs n=96 (100%)	Statistical significance (p)
Technical and tactical errors in operational interventions			
Pathological stump of the GSV, varicose transformation of the estuarine tributaries	8(4.2%)	6(6.25%)	p>0.05
"Additional" mistakenly left-over GSV trunk	5(2.65%)	11(11.5%)	p<0.05
Varicose transformation of the anterior accessory saphenous vein of the thigh	42(22.2%)	25(26.04%)	p>0.05
Partial recanalization of the GSV	54(28.6%)	-	-
Complete recanalization of the GSV	30 (15.9%)	-	-
"Lateral varicose veins"	5(2.6%)	18(18.7%)	p<0.05
Possible errors and/or progression of IH			
Varicose transformation of the estuarine tributaries (stump length is normal)	17(9%)	7(7.3%)	p<0.05
Varicose transformation of the intersaphenous vein	13(6.9%)	3(3.1%)	p>0.05
Insufficiency of the perforating veins of the lower leg	85(45%)	41(42.7%)	p<0.05
Insufficiency of the perforating veins of the thigh	18(9.5%)	9(9.4%)	p>0.05
Common femoral and femoral vein valve insufficiency	6(3.17%)	4(4.17%)	p>0.05
Popleteal vein valve failure	21(11.1%)	17(17.7%)	p<0.05
Insufficiency of the valves of the deep veins of the lower leg	31(16.4%)	28(29.2%)	p<0.05
Progression of VD			
"Cavernoma"	4(2.1%)	3(3.13%)	p>0.05
Varicose veins of the small safein vein (SSV) (previously intact)	19(10.1%)	24(30.2%)	p<0.05

Source: compiled by the authors of this study

Table 3. Results of basic topometric indicators in patients with CVI (n=98)

Sex	Weight (abs. and relative amount in %)		Growth (abs. and relative number in %)		Conicity (abs. and relative amount in %)	
Men n=24	≥80kg	12 (12.2%)	≥180cm	10(10.2%)	≥15%	19 (12.2%)
	<80kg	12 (12.2%)	<180 cm	14(14.3%)	<15%	5(12.2%)
Women n=74	≥80kg	50 (51.1%)	≥180cm	39(39.8%)	≥15%	49(12.2%)
	<80kg	24 (24.5%)	<180 cm	35(35.7%)	<15%	25(12.2%)

Source: compiled by the authors of this study

performed interventions, but also helps to determine the strategy of further treatment.

Analysis of long-term outcomes in the two studied groups of patients revealed a statistically significant difference in the frequency of good results from medical interventions with an advantage in favor of surgical treatment (for Fisher's criteria p=0.014) (Table 4).

The difference in the frequency of registered unsatisfactory results depending on the treatment methods in the long-term postoperative period is not statistically significant (p = 0.64). At the same time, according to the clinical class of the CEAP group of patients with the C4-C6 class who underwent sclerosurgical treatment amounted to only 37 (19.6%) of the total number of lower extremities (189), and in the control group (96 cats) patients with the C4-C5-C6 clinical class amounted to 40 (41.7%) cases, which is 29.5% more than in the main group. In addition, in the main group, crossectomy (CE) + short stripping with distal scleroobliteration was performed on 12 (6.3%) extremities. At the same time, in these patients with CEAP-6, an unsatisfactory result was not observed in any case.

Table 4. Summary table of the dynamics of regression of the clinical condition of CEAP after appropriate treatment by groups in the long-term postoperative period

Group II n=96 limbs			Group I n=189 limbs		
Clinical class according to CEAP		Treatment result	Clinical class according to CEAP		Treatment result
Before treatment	After treatment		Before treatment	After treatment	
C2-38	C1 – 16	16 - good	C2 -147	C1 - 39	39 - good
	C2 - 11	11- satisfactory	C2 - 91	91- satisfactory	
	C3 - 12	12 - unsatisfactory	C3 - 17	17 - unsatisfactory	
C3 - 18	C2 - 6	6 - good	C3 - 5	C2 - 0	0 - good
	C3 - 9	9- satisfactory	C 3 - 3	3- satisfactory	
	C4 - 3	3 - unsatisfactory	C4 - 2	2 - unsatisfactory	
C4 - 21	C3 - 5	5 - good	C4 - 4	C3 - 1	1 - good
	C4 - 16	16 - satisfactory	C4 - 3	3- satisfactory	
	C5 - 0	0 - unsatisfactory	C5- 0	0 - unsatisfactory	
C5 – 13*	C4 - 0	0 - good	C5 - 21	C4 - 0	0 - good
	C5 - 13	13- satisfactory	C5 - 21	21- satisfactory	
	C6 - 0	0 - unsatisfactory	C6 - 0	0 - unsatisfactory	

The presence of a significant number of observations with a return to the initial clinical class of CEAP in the long-term observation period was recorded in both groups of patients (in the main group - 114 (60.3%) limbs, in the comparison group - 52 (54.2%) limbs), apparently due to the fact that the use of the presented treatment methods in a number of cases is unable to control the progression of VD.

The prevalence of unsatisfactory results was observed in patients with C2 and C3 clinical scales according to the CEAP, in the main group 20 (10.6%) cases, in the control group 13 (13.5%) cases. Study of resultss-cleroobliteration (189 limbs 100%) in the long-term observation period based on the dynamics of the clinical picture of CVI with CEAP demonstrated a sufficiently high effectiveness of this type of intervention: the total number of positive results (good and satisfactory results 170 (90%), and with standard phlebectomy 83 (93%).

When analyzing the treatment results of patients who were measuredhip conusity it was found that in 98 patients, of which 58 (25.4%) patients (90 limbs operated) were examined from the first group of patients, unsatisfactory results were observed in 19 patients, the conusity of which was 20%. In the second group, 40 (17.5%) patients (54 limbs) were examined, who undGSVent only surgical treatment - unsatisfactory results were observed in 12 patients, but the conusity of the hip of these patients did not exceed 10%, which is probably due to an incorrectly chosen treatment tactic or an error made during the surgical treatment of VD.

DISCUSSION

Modern and high-quality medical compression hosiery should have several important properties, namely, the pressure should decrease in the proximal direction in a certain sequence: 100% - in the supraosteal area, 70% - at the level of the upper third of the lower leg, 40% - at the level of the upper third of the thigh. Such a regressive pressure gradient contributes to a better implementation of the mechanisms of compression effect and good tolerability of the hosiery by the patient.

When using elastic knitwear in patients with a pronounced conicity of 15% or more, the effect of compression knitwear will be proportionally worsened due to the increase in pressure on the proximal part of the limb.

In such cases, in our opinion, it is advisable to use such treatment methods as radiofrequency and/or laser ablation or phlebectomy and/or crossectomy with short stripping in this group of patients.

In our opinion, defining clear indications for this type of treatment is necessary in order to reduce the risk of possible complications, reduce the frequency of IH recurrence, and improve the results of scleroobliteration. In addition, the analysis of the specialized literature demonstrates different views of scientists on this problem. One group of scientists recommends catheter scleroobliteration in the case of uncomplicated forms of IH with an IH diameter of no more than 7-10 mm and the absence of varicose deformation of the tributaries [9, 11, 12].

Fig. 3. A – lower limb with a conicity of more than 20%; B – lower limb with a conicity of less than 20%
Picture taken by the authors

Another group of authors consider the limiting diameter of the trunk to be 15 mm, and even positive results of scleroobliteration at a diameter of 20 mm [13-15]. In addition, the circumference and shape of the thigh are important criteria for patient selection (Fig. 3 AB).

With pronounced fatty tissue, with a conical shape of the thigh, the probability of full compression in the postoperative period is minimal. In this case, surgical methods of correction should be preferred, namely phlebectomy.

Unfortunately, based on practical experience, even precise selection of patients for scleroobliteration with strict control of intraoperative algorithms and techniques for performing the procedure does not guarantee the expected treatment outcome.

CONCLUSIONS

1. The total number of positive (good and satisfactory) treatment outcomes demonstrated comparable efficacy of phlebectomy and sclerosurgery at 93% and 90%, respectively.
2. In people with a height of 180 cm and more and a weight of 80 kg and more, conicity reaches ≥15% in 68 (70%) patients ($p<0.001$). When assessing the correlation according to Spearman, a high correlation was established between conicity in patients and morphometric indicators such as weight, height and diameter of the upper third of the thigh ($p<0.001$)
3. When choosing a method of surgical treatment of varicose veins in order to prevent and reduce the rate of unsatisfactory results, morphometric indicators and thigh conicity should be taken into account.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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