TJVS Turkish Journal of Vascular Surgery

Turk J Vasc Surg 2022;31(3):140-7
DOI: 10.9739/tjvs.2022.1304

Available online at www.turkishjournalofvascularsurgery.org

Original Article

Effect of surgical techniques in the treatment of small saphenous vein insufficiency on clinical outcomes

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Received: June 07, 2022 Accepted: June 28, 2022 Published online: August 23, 2022

Abstract

Aim: This study aims to explore the effects of three techniques on postoperative symptom recurrence and clinical outcome and define the predictors.

Material and Methods: A total of 121 patients (63 males, 58 females; mean age: 47.4±11.3 years; range, 32 to 73 years) who underwent stripping (n=45), ligation alone (n=36), or ligation and foam sclerotherapy (2% polidocanol, n=40) for varicosities due to small saphenous vein (SSV) insufficiency between January 2004 and December 2011 were included in the retrospective study. Preoperative and postoperative CEAP (Clinical, Etiological, Anatomical, and Pathophysiological), symptom recurrence, and Doppler findings were evaluated with univariate and multivariate analyses.

Results: The mean follow-up was 25.8±20.4 months. The operation type did not have any effect on postoperative symptom recurrence, high CEAP (≥3), or clinical outcomes. Predictor of postoperative symptom recurrence was preoperative high CEAP (p=0.001, relative risk [RR]: 4.8); predictor of high postoperative CEAP was postoperative perforating vein insufficiency (p=0.001, RR: 5.148). In the ligation group, a preoperative SSV diameter >5 mm was predictive for both postoperative symptom recurrence (p=0.039, RR: 7.8) and high postoperative CEAP (p=0.002, RR: 1.901), and preoperative deep vein insufficiency was also predictive for postoperative symptom recurrence (p=0.044, RR: 1.304). In the stripping group, postoperative neuropathy was significant (p=0.041, RR: 4.168). There was no difference in Kaplan-Meier symptom-free survival curves (p=0.651), venous clinical severity scores, or Aberdeen Varicose Vein Questionnaire scores among groups.

Conclusion: High ligation is not a good option for patients with large SSV diameters or deep vein insufficiency. High ligation with stripping comes with an increased risk of sural neuropathy. High ligation with foam sclerotherapy should be considered an effective method with the ability of the foam to spread over the branches and microvenous structures. Performing operations before progression to high CEAP classes or greater SSV diameters is considerable.

Keywords: Foam sclerotherapy, high ligation, small saphenous vein, stripping, venous insufficiency

CITATION
Yaprak Engin A, Islamoglu F. Effect of surgical techniques in the treatment of small saphenous vein insufficiency on clinical outcomes. Turk J Vasc Surg 2022;31:140-7.

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INTRODUCTION

Trials mostly focus on great saphenous vein (GSV) insufficiency. However, 15% of varices are associated with small saphenous vein (SSV) reflux [1]. Success rates of surgery from different centers varies between 24 and 100% [2]. There is limited data comparing surgical techniques focused on the SSV.

High ligation with stripping (HLS) became widespread in the SSV subsequent to the outcomes in the GSV. However, sural nerve damage is a discouraging complication due to the close relationship of the SSV with the sural nerve [3]. High ligation (HL) without stripping was an alternative to protect the sural nerve, nevertheless, with more frequent recurrence [4]. Foam sclerotherapy (FS) has become an attractive option and has been used under ultrasound guidance in recent studies. Foam sclerotherapy combined with HL, which was used in this study, was proposed as an effective and safe method for the GSV [5].

Surgery is almost abandoned due to inferior recovery time and early quality of life results. However, the outcomes of surgery may still enlighten the SSV system. Hence, we aimed to compare three operative techniques for SSV insufficiency, HLS, HL alone, and high ligation with foam sclerotherapy (HLFS), and investigate predictors of clinical outcomes.

MATERIAL AND METHODS

The retrospective study was conducted with 112 patients (63 males, 58 females; mean age: 47.4±11.3 years; range, 32 to 73 years) at the Ege University Faculty of Medicine, Department of Cardiovascular Surgery between January 2004 and December 2011. The patients were treated due to lower extremity venous reflux in a single center by the same surgeon with three different techniques, HLS (n=45, 37.19%), HL alone (n=36, 29.75%), or HLFS (n=40, 33.05%), and the patients were grouped based on the surgical technique. The patients were evaluated in the outpatient clinic. Symptoms (varicosities, swelling throughout the day, nocturnal cramps, and cutaneous changes), CEAP (Clinical, Etiological, Anatomical, and Pathophysiological) classes, the venous clinical severity score (VCSS), and Aberdeen Varicose Vein Questionnaire (AVVQ) scores were recorded at every visit. Symptomatic patients with reflux and signs of clinical signs of classes C2-C6 were referred for surgery.

The change in the choice of technique over time should be emphasized. In the early period, HLS was performed, relying on the outcomes of GSV counterparts. Gradually, HL alone was preferred to prevent sural neuropathy. As experience in HLFS had grown, it became the most preferred operation technique for SSV in the last period between 2004 and 2011. After 2011, thermal ablation techniques started to be more commonly performed; therefore, data scan was stopped.

High ligation and division of the SSV and reachable junctional branches were performed for all patients. Ligation and division of concomitant incompetent perforators through small additional incisions were performed for all of the patients. In the HLS group, the SSV was completely resected with a stripper by inversion stripping technique. Manual compression for the following 5 min was performed. In the HLFS group, the SSV was found through popliteal and ankle incisions. After ligation of the SSV in both ends, an open tip embolectomy catheter was inserted through SSV from the distal to the proximal end. Polidocanol (2%, 2 mL, AETHOXYSKLEROL®; Chemische Fabrik Kreussler & Co. GmbH, Wiesbaden, Germany) was foamed with pumping cycles of liquid and air in and out of a double syringe system (Tessari technique) with a ratio of air to sclerosant of four to one [6]. The leg was slightly elevated, the foam was slowly injected through the catheter, and the catheter was synchronously pulled down with the leg leveling down at a similar pace. When it came out of the vein, venotomy was immediately ligated to avoid extravasation of the foam. Manual compression was performed for 5 min. For all patients, mini-phlebectomy was performed through small incisions for the varicose veins, and an elastic bandage was used after the procedure. All concomitant GSV insufficiencies were treated by the HLFS technique.

Oxerutin was used in the postoperative period for all patients. Follow-up was performed in postoperative 1, 6, and 12 months and annually thereafter. At every follow-up, patients were questioned for symptoms, and the physical examination, CEAP classification, VCSS, and AVVQ scores were recorded. Sural neuropathy was defined as burning pain, hypoesthesia, dysesthesia, or paraesthesia over the posterolateral side of the distal third of the leg or the lateral aspect of the foot, confirmed with a sural nerve neurodynamic test.

The groups were compared for preoperative patient characteristics, postoperative symptom recurrence, CEAP, deep vein insufficiency, perforating vein insufficiency, sural neuropathy rates, VCSS, and AVVQ scores. The predictors of postoperative symptom recurrence, CEAP, and sural neuropathy were questioned. Further analysis was performed in case of difference.

Statistical analysis

Statistical analyses were performed using IBM SPSS, version 21.0 software (IBM Corp., Armonk, NY, USA). Categorical data were expressed as frequency and percentage, and continuous data were presented as mean and standard deviation. Patient demographics and clinical outcomes were analyzed using a t-test for continuous data, and the chi-square test and Fisher exact test were used for categorical data. Preoperative and postoperative changes of symptoms were compared using linear trend analysis. Symptom-free survival was examined using Kaplan-Meier analysis. Cox

proportional hazards model and multivariate stepwise logistic regression analysis were used for correlation of symptom-free survival and risk factors of postoperative symptoms. A p value of <0.05 was considered statistically significant.

RESULTS

There were no significant differences in preoperative patient characteristics among groups (Table 1). The mean follow-up duration was 25.8±20.4 months. Operation technique did not have any effect on postoperative symptom recurrence, postoperative CEAP C class ≥3 (referred to as high CEAP), or clinical outcomes.

High ligation had the highest symptom recurrence rate (44% vs. 26.66% and 15% for the HLS and HLFS groups, respectively) and the highest rates of high postoperative CEAP. Sural neuropathy was most common after HLS (17.77% vs. 2.77% and 5% for HL and HLFS, respectively). Detailed information on postoperative outcomes is shown in Table 2.

Table 1. Patient demographics

	HLS group		HL group		HLFS group		
	n	Mean±SD	n	Mean±SD	n	Mean±SD	p
Age (year)		48.9±9.3		47.9±11.9		49.3±12.5	0.86
Sex							0.216
Female	19		22		22		
Male	26		14		18		
Work*							0.464
+	23		18		25		
–	22		18		15		
Family history							0.528
+	25		24		28		
–	20		12		14		
Diabetes							0.525
+	44		34		37		
–	1		2		3		
Hypertension							0.099
+	28		29		32		
–	17		7		8		
Smoking							0.971
+	38		30		33		
–	7		6		7		
SSV+GSV/ SSV	37 / 8		31 / 5		33 / 7		0.878
DVT							0.261
+	35		28		36		
–	10		8		4		
Preoperative CEAP							0.548
<3	29		27		29		
≥3)	16		9		11		
Preoperative SSV diameter							0.159
<5 mm	23		24		28		
≥5 mm	22		12		12		
Preoperative PVI							0.550
+	39		28		32		
–	6		8		8		
Preoperative DVI							0.389
+	38		29		29		
–	7		7		11		

SD: Standard deviation; HLS: High ligation and stripping; HL: High ligation alone; HLFS: High ligation and foam sclerotherapy; SSV: Small saphenous vein; GSV: Great saphenous vein; DVT: Deep venous thrombosis; CEAP: Clinical, Etiological, Anatomical, and Pathophysiological; PVI: Perforating vein insufficiency; DVI: Deep venous insufficiency; * Positions with prolonged standing/sitting.

Table 2. Postoperative outcomes

	HLS group		HL group		HLFS group		
	n	%	n	%	n	%	p
Symptom recurrence							0.017
No	33	26.6	20	44.4	34	15	
Yes	12		16		6		
Postoperative CEAP							0.198
<3	42	7.1	33	9.1	40	0	
≥3	3		3		0		
Postoperative PVI			31/5				0.174
No	39	15.4	31	16.1	29	37.9	
Yes	6		5		11		
Postoperative neuropathy	37/8	21.6	35/1	2.8	38/2	5.2	0.036
Postoperative DVI							0.340
No	36	25	31	16.1	29	37.9	
Yes	9		5		11		

HLS: High ligation and stripping; HL: High ligation alone; HLFS: High ligation and foam sclerotherapy; CEAP: Clinical, Etiological, Anatomical, and Pathophysiological; PVI: Perforating vein insufficiency; DVI: Deep venous insufficiency.

Univariate predictors of postoperative symptom recurrence are presented in Table 3. The only multivariate predictor was preoperative high CEAP (p=0.001, RR=4.808). Univariate predictors of high postoperative CEAP are displayed in Table 4. The only multivariate predictor of high postoperative CEAP was postoperative perforating vein insufficiency (p=0.001, RR=5.148).

Table 3. Predictive factors of postoperative symptom recurrence

	Univariate (*p*)	Risk ratio	95% CI	Multivariate (*p*)
Operation type	0.017	0.745	0.430-1.291	0.294
SSV+GSV vs. SSV	0.017	1.613	0.939-2.771	0.083
Preoperative CEAP	<0.001	4.808	1.909-12.046	0.001
Working	0.027	0.484	0.181-1.298	0.150
Family history	0.040	0.323	0.113-0.929	0.056

CI: Confidence interval; SSV: Small saphenous vein; GSV: Great saphenous vein; CEAP: Clinical, Etiological, Anatomical, and Pathophysiological.

Table 4. Predictive factors of postoperative CEAP

	Univariate (*p*)	Risk ratio	95% CI	Multivariate (*p*)
Postoperative PVI	<0.001	5.148	1.914-13.843	0.001
Sex	0.011	1.716	0.952-2.779	0.091
Preoperative CEAP	0.001	0.587	0.197-1.414	0.224
Thrombosis	0.001	0.426	0.102-1.016	0.111

CEAP: Clinical, Etiological, Anatomical, and Pathophysiological; CI: Confidence interval; PVI: Perforating vein insufficiency.

Further analysis for the HL group was performed due to higher rates of postoperative symptom recurrence. Univariate predictors of postoperative symptom recurrence in the HL group are shown in Table 5. The multivariate predictors were preoperative deep venous insufficiency (p=0.043, RR=1.304) and SSV diameter ≥5 mm (p=0.039, RR=7.869). Univariate predictors of high postoperative CEAP in the HL group are shown in Table 6. Only SSV diameter ≥5 mm was a multivariate predictor for high postoperative CEAP (p=0.002, RR=1.901).

Table 5. Predictive factors of postoperative symptom recurrence-ligation subgroup

	Univariate (*p*)	Risk ratio	95% CI	Multivariate (*p*)
Family history	0.031	1.090	0.161-7.373	0.929
Preoperative DVI	0.005	1.304	0.015-6.182	0.043
Preoperative CEAP	0.012	10.312	0.806-131.940	0.073
Diameter (</≥5 mm)	0.011	7.869	1.113-55.650	0.039

CI: Confidence interval; DVI: Deep venous insufficiency; CEAP: Clinical, Etiological, Anatomical, and Pathophysiological.

Table 6. Predictive factors of postoperative CEAP in the ligation subgroup

	Univariate (*p*)	Risk ratio	95% CI	Multivariate (*p*)
Working	0.001	6.380	0.360-112.926	0.206
Preoperative CEAP (<3/≥3)	0.002	6.561	0.158-273.343	0.323
Diameter (<5/≥5 mm)	0<001	1.901	0.001-2.143	0.002

CEAP: Clinical, Etiological, Anatomical, and Pathophysiological; CI: Confidence interval.

The only significant multivariate predictor of postoperative sural neuropathy was the operation type to be HLS (p=0.041, RR=4.165).

Venous clinical severity scores and AVVQ scores postoperatively improved in all groups, except for AVVQ scores of the HL group, which has failed to show significant improvement (p=0.061). There was no significant difference among groups (Table 7).

Table 7. Quality of life scores

	HLS group Mean±SD	HL group Mean±SD	HLFS group Mean±SD	*p*
VCSS				
Preoperative	5.9±1.3	5.8±0.9	5.6±0.7	NS
Postoperative	0.9±0.8	0.8±0.6	1.9±0.7	NS
p	**0.018**	**0.021**	**0.049**	
AVVQ				
Preoperative	19.5±5.3	18.9±5.8	19.1±5.7	NS
Postoperative	4.9±1.5	4.6±1.2	7.7±3.2	NS
p	**0.033**	**0.030**	0.061	

HLS: High ligation and stripping; HL: High ligation alone; HLFS: High ligation and foam sclerotherapy; SD: Standard deviation; VCSS: Venous Clinical Severity Score; NS: Non-significant; AVVQ: Aberdeen Varicose Vein Questionnaire Score.

In the symptom-free survival curve by Kaplan-Meier analysis, the effect of the operation technique did not reach statistical significance (p>0.05; Figure 1).

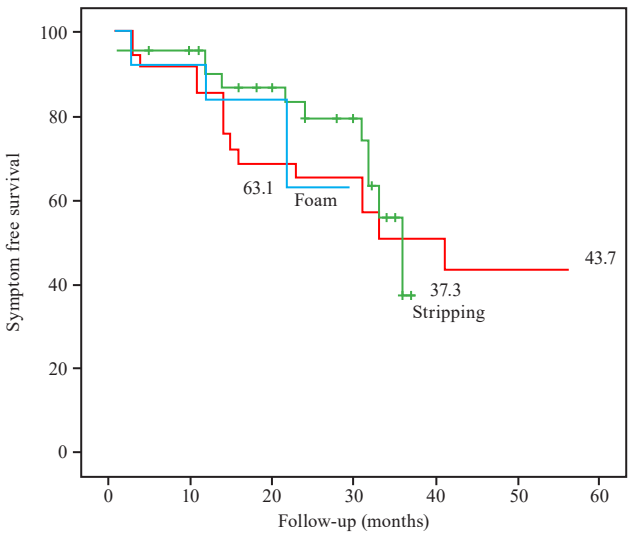

Figure 1. *Kaplan-Meier curve for symptom-free survival.*

There was no need for hospitalization and no morbidity or mortality. There were no complications in the early postoperative period in terms of hematoma, deep vein thrombosis, wound infection, pigmentation, matting, or hemorrhage.

DISCUSSION

The SSV system is a more complex system than the GSV with many anatomic variations, connections with multiple systems, and proximity to sural nerve, making it difficult to clearly understand and treat [7]. Treating the SSV system carries as much weight as the GSV; however, it has been underestimated and has not been equally investigated [8].

There are many studies showing that conventional surgery and endovenous techniques of SSV treatment have similar results [9,10]. Different surgical techniques are compared to endovenous techniques; however, they are not compared among each other, and there is little data comparing surgical techniques of SSV. Furthermore, foam sclerotherapy was performed by ultrasound guidance in the majority of recent studies.

The current cohort consists of three surgical techniques of SSV varying according to the overall tendency in SSV treatment. High ligation with stripping was recommended by Society for Vascular Surgery and American Venous Forum in the 2011 practice guideline. However, before 2011, when the procedures in this trial were performed, there was not a precise recommendation [11].

The surgical technique did not affect postoperative symptom recurrence, though symptom recurrence was more common after HL. Venous clinical severity score and AVVQ were pre- and postoperatively applied for each patient to determine the change in clinical outcome after the operations. Venous clinical severity scores showed improvement in all groups and showed no differences in intergroup analyses. Two groups had significant improvements in AVVQ, while the ligation group failed to reach statistical significance. However, intergroup analyses showed no differences among groups. The results of quality of life scores are consistent with the postoperative symptom recurrence results. Among many variables, the only predictive factor for postoperative symptom recurrence was having a preoperative CEAP class >2. Finding results in line with the prior trials with different techniques underlines the importance of the preoperative situation of the patient and makes us consider intervening by Doppler findings before the obvious clinical signs [5,12]. Similarly, in the ligation subgroup, postoperative symptom recurrence was found to be associated with preoperative increased SSV diameter and preoperative deep venous insufficiency. Additionally, increased preoperative SSV diameter was also accompanied by an increased rate of high postoperative CEAP class. Thus, all these parameters and their effect on each other seem to interlace, pointing out the significance of the preoperative status more.

In a study of the relationship between SSV insufficiencies and clinical status, it was reported that in higher CEAP classes, the

number of incompetent perforators per leg was increased [7]. In the current study, with the same opinion, all incompetent perforators were ligated. It has been shown that the same relationship continued in the postoperative period leading to an increase in rates of recurrent varicose veins, high CEAP, and ulcer recurrence [13-15]. Consistent with the literature, it was found that postoperative perforating vein insufficiency is a risk factor for high postoperative CEAP.

While no difference was shown among techniques, the stripping group had the highest neuropathy rates, and the HL group had the highest postoperative symptom recurrence and high CEAP rates. It has been previously reported that in patients with SSV system insufficiencies, 35% did not have reflux in the saphenopopliteal junction (SPJ), [7] which may explain the high symptom recurrence rate in the HL group. In the current trial, a diameter >5 mm was found to be an independent risk factor of both postoperative symptom recurrence and high CEAP class in the HL group. This suggests that HL alone is not the best option for SSV insufficiency, particularly for large diameters. Nevertheless, it has been demonstrated that leaving the SFJ patent is associated with recurrent reflux in the GSV [16,17]. The same result is expected for the SSV. In accordance with these results, there are trials reporting higher rates of reflux in the midterm after ultrasound-guided foam sclerotherapy (UGFS) [18]. In HL, the saphenous trunk is left patent, whereas the junction is left patent in UGFS. Considering both HL and UGFS results may lead us to an opinion that the major point is the ability to treat more than one component of the SSV system in a single technique. It has been established that the clinical severity was increased by the number of SSV segments involved [7,19]. Instead of the total abandonment of the ligation technique, it may be more useful to combine it with other techniques. Every technique has its advantages and disadvantages. In this study, the stripping group had the highest postoperative neuropathy rates with a fourfold increase, suggesting a combination of HL with FS rather than stripping. Keeping this in mind, HLFS is expected to improve outcomes compared to UGFS or HL alone. Ligation of the saphenous trunk at the junction has the potential to prevent embolic complications in the early postoperative period and junctional reflux for a longer time, while FS may give the chance to protect the sural nerve and the ability to occlude multiple components in one simple operation. It should be considered that increased blood flow during FS injection may wash out or dilute the foam and decrease its effect on the endovenous surface [20]. It is aimed to permanently decrease the blood flow to prevent failure by combining FS with HL. For further effect, incompetent perforators are also ligated and divided before injection. Other critical points are slow injection of the foam through a catheter and positioning the leg. The foam has a tendency to go upwards. The vein and its superficial varicose network are emptied by leveling up the leg, while leveling down the leg during injection keeps the foam where it is injected and avoids transition to the deep venous system.

Today, the use of endovenous techniques is widespread. Likewise, in the last guideline of the European Society for Vascular Surgeons for chronic venous disease published in 2022, endovenous thermal ablation is recommended in preference to surgery or foam sclerotherapy [21]. The evidence was a Cochrane review comparing endovenous laser ablation (EVLA) to surgery, which found that one-year ultrasound recurrence favored EVLA [22]. Another reason to offer EVLA was its lower sural neuropathy rates, which were similar to our rates in the HLFS group in a meta-analysis (6.8% in the meta-analysis and 5.8% in the HLFS group of the current cohort) [23]. Conventional surgery groups in these large studies combine all surgical techniques. There is insufficient data comparing surgical techniques in SSV with each other. In addition, there is limited data on direct comparison of FS and endothermal techniques. They probably grounded their recommendation on the meta-analysis [23], showing that the procedural occlusion rate of UGFS was worse than endothermal techniques. However, foam sclerotherapy was performed by ultrasound guidance in the majority of recent studies. We believe this paper fills a gap in this topic and offers a different surgical technique that excludes many problems.

In previous trials on UGFS, the occlusion rates were varied, and the information about the technique was not detailed. The variability of outcome may be related to the differences in practice and experience [16]. High ligation with foam sclerotherapy has the advantage of ease in standardization. When compared to FS, it was shown that HLFS had lower short-term recanalization rates [24] and better long-term clinical outcomes [25]. Furthermore, HLFS of the GSV was reported to have similar results to standard surgery in both the short and long term [26,27]. These results about the GSV, which has a longer trace and wider caliber, may become more apparent with the SSV.

The current study was limited by its retrospective design and small size.

In conclusion, we propose that HLFS should be considered an effective method with the ability of the foam to spread over the branches and microvenous structures. Performing operations before progression to high CEAP classes or greater SSV diameters is crucial.

Ethics Committee Approval: The study protocol was approved by the Ege University Faculty of Medicine Ethics Committee (date/no: 27.12.2012/12-12/2). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Researched literature and conceived the study, were involved in protocol development, gaining ethical approval, patient recruitment and data analysis: A.Y.E., F.I.; Wrote the first draft of the manuscript: A.Y.E.; Reviewed and edited the manuscript and approved the final version of the manuscript: F.I.; All authors read and approved the final version of the manuscript.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Almgren B, Eriksson I. Valvular incompetence in superficial, deep and perforator veins of limbs with varicose veins. Acta Chir Scand 1990;156:69-74.
2. Tellings SS, Ceulen RP, Sommer A. Surgery and endovenous techniques for the treatment of small saphenous varicose veins: A review of the literature. Phlebology 2011;26:179-84.
3. Winterborn RJ, Campbell WB, Heather BP, Earnshaw JJ. The management of short saphenous varicose veins: A survey of the members of the vascular surgical society of Great Britain and Ireland. Eur J Vasc Endovasc Surg 2004;28:400-3.
4. O'Hare JL, Vandenbroeck CP, Whitman B, Campbell B, Heather BP, Earnshaw JJ; Joint Vascular Research Group. A prospective evaluation of the outcome after small saphenous varicose vein surgery with one-year follow-up. J Vasc Surg 2008;48:669-73.
5. Islamoglu F. An alternative treatment for varicose veins: Ligation plus foam sclerotherapy. Dermatol Surg 2011;37:470-9.
6. Tessari L. Nouvelle technique d'obtention de la scleromousse. Phlebologie 2000;53:129.
7. Labropoulos N, Giannoukas AD, Delis K, Kang SS, Mansour MA, Buckman J, et al. The impact of isolated lesser saphenous vein system incompetence on clinical signs and symptoms of chronic venous disease. J Vasc Surg 2000;32:954-60.
8. Paravastu SCV, Dodd PDF. Endovenous ablation therapy (LASER or radiofrequency) or foam sclerotherapy versus conventional surgical repair for short saphenous varicose veins. Cochrane Database of Systematic Reviews 2013;12:CD010878.
9. Roopram AD, Lind MY, Van Brussel JP, Terlouw-Punt LC, Birnie E, De Smet AA, et al. Endovenous laser ablation versus conventional surgery in the treatment of small saphenous vein incompetence. J Vasc Surg Venous Lymphat Disord 2013;1:357-63.
10. Samuel N, Carradice D, Wallace T, Mekako A, Hatfield J, Chetter I. Randomized clinical trial of endovenous laser ablation versus conventional surgery for small saphenous varicose veins. Ann Surg 2013;257:419-26.
11. Gloviczki P, Comerota AJ, Dalsing MC, Eklof BG, Gillespie DL, Gloviczki ML, et al. The care of patients with varicose veins and associated chronic venous diseases: Clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. J Vasc Surg 2011;53(5 Suppl):2S-48S.
12. Daylan A, İslamoğlu F. Comparative analysis of the results of cyanoacrylate ablation and radiofrequency ablation in the treatment of venous insufficiency. J Vasc Surg Venous Lymphat Disord 2022;10:661-8.e2.
13. Bush RG, Bush P, Flanagan J, Fritz R, Gueldner T, Koziarski J, et al. Factors associated with recurrence of varicose veins after thermal ablation: Results of the recurrent veins after thermal ablation study. Scientific World Journal 2014;2014:505843.
14. van Gent W, Wittens C. Influence of perforating vein surgery in patients with venous ulceration. Phlebology 2015;30:127-32.
15. Tenbrook JA Jr, Iafrati MD, O'donnell TF Jr, Wolf MP, Hoffman SN, Pauker SG, et al. Systematic review of outcomes after surgical management of venous disease incorporating subfascial endoscopic perforator surgery. J Vasc Surg 2004;39:583-9.
16. van der Velden SK, Biemans AA, De Maeseneer MG, Kockaert MA, Cuypers PW, Hollestein LM, et al. Five-year results of a randomized clinical trial of conventional surgery, endovenous laser ablation and ultrasound-guided foam sclerotherapy in patients with great saphenous varicose veins. Br J Surg 2015;102:1184-94.
17. Rass K, Frings N, Glowacki P, Hamsch C, Gräber S, Vogt T, et al. Comparable effectiveness of endovenous laser ablation and high ligation with stripping of the great saphenous vein: Two-year results of a randomized clinical trial (RELACS study). Arch Dermatol 2012;148:49-58.
18. Toniolo J, Chiang N, Munteanu D, Russell A, Hao H, Chuen J. Vein diameter is a predictive factor for recanalization in treatment with ultrasound-guided foam sclerotherapy. J Vasc Surg Venous Lymphat Disord 2018;6:707-16.
19. Ibegbuna V, Delis KT, Nicolaides AN. Haemodynamic and clinical impact of superficial, deep and perforator vein incompetence. Eur J Vasc Endovasc Surg 2006;31:535-41.
20. Parsi K, Exner T, Connor DE, Herbert A, Ma DDF, Joseph JE. The lytic effects of detergent sclerosants on erythrocytes, platelets, endothelial cells and microparticles are attenuated by albumin and other plasma components in vitro. Eur J Vasc Endovasc Surg 2008;36:216-23.
21. De Maeseneer MG, Kakkos SK, Aherne T, Baekgaard N, Black S, Blomgren L, et al. Editor's Choice - European Society for Vascular Surgery (ESVS) 2022 clinical practice guidelines on the management of chronic venous disease of the lower limbs. Eur J

Vasc Endovasc Surg 2022;63:184-267.

22. Paravastu SC, Horne M, Dodd PD. Endovenous ablation therapy (laser or radiofrequency) or foam sclerotherapy versus conventional surgical repair for short saphenous varicose veins. Cochrane Database Syst Rev 2016;11:CD010878.
23. Li X, Yang B, Li X, Ren S. Prospective comparison of effect of ligation and foam sclerotherapy with foam sclerotherapy alone for varicose veins. Ann Vasc Surg 2018;49:75-9.
24. Boersma D, Kornmann VN, van Eekeren RR, Tromp E, Ünlü Ç, Reijnen MM, et al. Treatment modalities for small saphenous vein insufficiency: Systematic review and meta-analysis. J Endovasc Ther 2016;23:199-211.
25. Belcaro G, Cesarone MR, Di Renzo A, Brandolini R, Coen L, Acerbi G, et al. Foam-sclerotherapy, surgery, sclerotherapy, and combined treatment for varicose veins: A10-year, prospective, randomized, controlled, trial (VEDICO trial). Angiology 2003;54:307-15.
26. Jia X, Liu XP, Xiong J, Zhang HP, Liu M, DU X, et al. Foam sclerotherapy of the great saphenous vein with sapheno-femoral ligation compared to standard stripping: A prospective randomized controlled trial. Zhonghua Wai Ke Za Zhi 2010;48:1731-4.
27. Kalodiki E, Lattimer CR, Azzam M, Shawish E, Bountouroglou D, Geroulakos G. Long-term results of a randomized controlled trial on ultrasound-guided foam sclerotherapy combined with saphenofemoral ligation vs standard surgery for varicose veins. J Vasc Surg 2012;55:451-7.