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Endovenous laser therapy with echosclerotherapy as a hybrid method for chronic venous insufficiency: experience in 200 patients and literature review

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Abstract. – OBJECTIVE: Surgical treatment of chronic venous insufficiency (CVI) includes sclerotherapy, cryosurgery, CHIVA method (from the French for ambulatory conservative hemodynamic treatment venous insufficiency), chemical and mechanical obliteration, or phlebectomy. A hybrid treatment that combines sclerotherapy with endovenous laser ablation (EVLA) at 980 nm or 1470 nm or Nd:YAG laser at 1064 nm is also increasingly used. This paper synthesizes the current knowledge of CVI of the lower limbs and demonstrates promising clinical practice experiences using a hybrid method that combines EVLA with intraoperative or postoperative ultrasound-guided foam sclerotherapy (UGFS), also known as echosclerotherapy.

PATIENTS AND METHODS: A group of 200 patients was enrolled in the study. All patients underwent a hybrid method of treatment combining EVLA and UGFS. Under tumescent anesthesia, venipuncture of the great saphenous vein (GSV) trunk was performed, followed by 1470 nm laser therapy (80-100J/10W). During the procedure, 2% polidocanol foam was injected into the insufficient collateral veins extending from the main trunk of the GSV. After surgery, compression therapy in the form of grade II compression stockings was used. All patients underwent a follow-up duplex Doppler ultrasound four weeks after the procedure.

RESULTS: It was observed that 196 patients had complete obstruction of the femoral segment of the GSV, while four patients showed signs of minor recanalization of the femoral segment. After 12 months, 198 patients showed complete fibrosis, partial or complete absorption of the saphenous vein, and varicose lesions. Two patients underwent UGFS again after 12 months because of recurrent varicose lesions. At four weeks after UGFS, local pain of thrombosed varicose lesions was observed in 20% of patients. Hemosiderin staining was observed in 15% of patients, but this completely resolved within 6-12 months. In 1% of cases, symptoms of dyspnea and cough were reported, which resolved a few minutes after the procedure – approximately 1% of patients presented with symptoms of matting. There were no severe complications during the 12-month follow-up period.

CONCLUSIONS: A high efficiency of 98% was observed (196/200 patients) at the 12-month follow-up after hybrid EVLA with UGFS treatment. Follow-up UGFS at four weeks after laser ablation showed 99% efficacy at the 12-month postoperative follow-up. Major complications after the hybrid method treatment combining EVLA with UGFS were not observed. Hybrid methods are more effective (98-99%) and give a lower chance of relapse.

Key Words:
Chronic venous insufficiency, Endovenous laser ablation, Ultrasound-guided foam sclerotherapy, Echosclerotherapy procedure.

Introduction

Chronic venous insufficiency (CVI) of the lower extremities is a major health problem that causes severe complications. Safe, non-invasive, and effective treatments for CVI, with the potential for rapid recovery, minimal complications, and low risk of recurrence, are still being sought.

This study aimed to systematize the current theoretical and practical knowledge on the etiopathogenesis, diagnosis, and conservative and surgical treatments of CVI. The authors present and discuss their own experience in the field of specialist clinical practice and the performance of hybrid procedures, in this case combining the endovascular laser therapy (EVLA) method with intraoperative or postoperative ultrasound-guid-

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ed foam sclerotherapy (UGFS), also known as echosclerotherapy. The therapeutic efficacy of the methods discussed and the safety of their application in everyday medical practice was taken into account. This study also provides a literature review that summarizes scientific reports showing the benefits and clinical effects of methods discussed by other researchers worldwide.

Pathogenesis of CVI

The pathomechanism of CVI is based on the processes of activation of venous endothelial cells and the accumulation of white blood cells and secretion of inflammatory mediators leading to the remodeling of venous walls and valves; this results in the phenomenon of reflux and is manifested by varicose veins. In Europe and the US, the prevalence of CVI symptoms ranges between 20-60% in women and 10-50% in men. According to recent studies in Poland, CVI occurs in 51% of Polish women and 38% of Polish men[1,2].

In the United States, an estimated 6-7 million people are diagnosed with advanced venous disease and meet the diagnostic criteria for CVI. Among all patients with CVI, approximately 1-2.7% will develop venous ulceration. The development of ulceration is associated with a poor prognosis, with 40% of patients relapsing despite standard treatment. The treatment of CVI consumes approximately 2% of health care costs in the United States[3,4].

Chronic venous disease is classified as congenital, primary (idiopathic), or secondary form. The congenital form occurs when some veins are missing (aplasia), underdeveloped (hypoplasia), or abnormally developed (angiodysplasia)[2]. Recent studies suggest that approximately 70% of patients have primary CVI, and 30% have secondary CVI disease[5].

Known predisposing factors for this condition include hereditary tendencies, hormonal disorders, female gender, and triggers such as standing position, heavy lifting (strenuous exercise), or heat. A loss of elasticity, lumen dilatation, and venous insufficiency are manifested by valve leakage with a reversal of the flow direction (reflux), resulting in venous stasis in insufficient vessels. Loss of elasticity involves the degeneration of collagen fibers and the atrophy of muscle cells in the middle layer and adventitia[2].

The secondary venous disease follows on from thrombosis, trauma, or increased abdominal pressure. In thrombosis, the recanalization repair process leads to the thrombus dissolution or fibrosis, resulting in the destruction or injury of the valve apparatus. The vessel walls become thickened, and fibrous septa may appear in the lumen, resulting in impaired blood flow. Elevated abdominal pressure (related to pregnancy or obesity) can elevate pressure throughout the venous system, including the extremities, causing secondary valve insufficiency[2,6].

Clinical signs of CVI include venous dilatation and varicose veins, edema, skin lesions, pain, calf cramps, heaviness, and itching of the skin. Venous dilatation is initially visible as telangiectasias (dilatation of intradermal veins up to 1 mm) and reticular veins (so-called feeder veins – intradermal veins dilated up to 6 mm). These forms of venous dilation constitute an aesthetic problem and signal the beginning of venous insufficiency. Venous dilatation near the medial ankle is called *corona phlebectatica* and is usually accompanied by swelling in that area[2].

The heaviness of the lower extremities resulting from venous stasis combined with pain and paresthesia produces a set of symptoms called venous claudication[7]. Skin lesions occur as hyperpigmentation caused by venous stasis or hemosiderin deposition in the skin resulting in dermatitis, thrombophlebitis, or venous ulcers that take a long time to heal and are characterized by reduced pigmentation *(atrophie blanche* or permanent discoloration) in the area of the healed ulcer[8]. After thrombosis resolves, post-thrombotic syndrome sometimes develops, which is characterized by permanent skin discoloration and degradation or atrophy of the subcutaneous tissue. Hemosiderin, an iron-storage complex formed from the breakdown of hemoglobin, can also be deposited in the skin, often causing permanent discoloration[9].

In 1994, the American Committee for Vascular Research Standardization introduced the CEAP (clinical, etiological, anatomical, and pathophysiological) classification to describe CVI of the lower extremities in a more expanded way, taking into account clinical manifestations, etiology, anatomical location (A), and pathophysiology (P). The CEAP was developed to facilitate decision-making in the evaluation and treatment of CVI[6,10].

Regardless of the cause, persistently elevated venous hydrostatic pressure can cause lower extremity pain, edema, and venous microangiopathy. In addition, some patients develop permanent skin hyperpigmentation due to hemosiderin deposition in the surrounding tissue. Many of these patients also have lipodermatosclerosis, a skin thickening caused by the fibrosis of the subcutaneous fatty tissue. As the disease progresses, impaired microcirculation and weakened dermis can lead to ulceration[10,11].

Diagnosis of CVI

Currently, the gold standard for the first step in CVI diagnosis is non-invasive duplex Doppler ultrasound, which enables the detection of reflux, which conditions venous insufficiency. This examination also establishes venous patency, enables the evaluation of all three venous systems (superficial, deep, and communicating veins) in terms of their anatomy and function, and provides information on diseases outside the venous system such as hematoma, tumor, or Baker's cysts[12].

Photoplethysmography can also be performed to assess the degree of venous insufficiency by evaluating reflux and measuring return time. However, the Perthes test is used less and less frequently to differentiate between superficial and deep venous insufficiency; this test has been superseded by duplex Doppler ultrasound. Air plethysmography is also rarely used and it allows several parameters of the venous system to be determined, such as measuring the degree of venous reflux and the efficiency of the muscle pump, including the possibility of indirect measurement of venous pressure. Invasive methods include ascending and descending phlebography with a contrast agent and are mainly used to assess the deep and perforator vein systems[7].

Treatment of CVI

CVI treatments can be divided into conservative and surgical. Conservative treatment consists of physical and compression therapy with compression products (elastic bandages, knee socks, stockings, or tights in four compression classes)[7]. Conservative treatment also involves applying ointments and creams to reduce swelling and the sensation of heavy legs. Physiotherapy is also used, along with exercise programs for the muscles of the lower limbs, especially the calves that act as a muscle pump (second heart), thus preventing distal venous stasis. Pharmacotherapy in lower limb CVI involves using phlebotropic and rheological drugs that inhibit the consequences of excessive leukocyte activation, improve vascular elasticity and permeability, and improve flow through the microcirculatory system[13,14]. When using compression therapy, one should remember to exclude limb ischemia, fresh venous thrombosis, and skin inflammation[2]. Compression therapy has absolute contraindications, such as progressive limb ischemia, compensated circulatory failure, infected thrombosis, or *phlegmasia cerulea dolens*. Relative contraindications include oozing dermatoses, dysesthesia, peripheral neuropathy, and primary chronic arthritis[15,16].

Depending on the severity of CVI, surgical treatment consists of sclerotherapy (i.e., chemical obliteration), laser obliteration using Nd:YAG lasers with a wavelength of 1064 nm, diode lasers with wavelengths of 810, 960, 1470, and 1900 nm, radiofrequency ablation (RFA), the use of steam, glue, cryosurgery, the CHIVA method (from the French for ambulatory conservative hemodynamic treatment venous insufficiency), Flebogrif chemical ablation, mechanical obliteration, and traditional methods including phlebectomy, mini-phlebectomy, and vein stripping according to the Babcock and Van der Stricht method[17,18].

Sclerotherapy

The method of sclerotherapy has been known for over a century and a half, beginning in 1854 when a French surgeon named Joseph Pierre Eléonord Pétrequin injected iron-manganese perchlorate into a blood vessel. Since then, topically acting toxic agents have been used to close vessels, including alcohol, mercury preparations, sublimates, sodium chloride with procaine, sodium tetradecyl sulfate, hypertonic glucose solutions, sodium chloride, iodine salts, glycerol, and chrome alum, and bleomycin. Currently, a widely implemented agent is polidocanol in a 0.25-4% concentration. The basis of action is irreversible damage to the endothelium and tunica media, in which the thrombus is deposited, leading to gradual fibrosis and vessel obliteration[12,19-22].

Indications for sclerotherapy can be divided into aesthetic and therapeutic. For esthetic reasons, sclerotherapy of lower limbs is performed under the guidance of a vascular illuminator on dilated reticular veins, fine reticular veins, and telangiectasias[23,24]. For therapeutic reasons, the procedure is performed to reduce clinical symptoms (swelling, heaviness of legs, varicose lesions) and to prevent CVI complications in the form of venous thromboembolism. Varicose lesions are insufficient veins over 3-4 mm in diameter with venous reflux present. Sclerotherapy is performed under ultrasound guidance for isolated varicose lesions and dilatation of incompetent branches with competent main trunks of the great (GSV) and small saphenous vein (SSV) with CEAP scores of 2 and 3[25].

Intraoperative and postoperative sclerotherapy is also used during endovascular procedures for chemical obliteration of the main trunks of the superficial veins using catheters. Several weeks after surgery, sclerotherapy is also performed to close distal segments of great and small saphenous trunks and other incompetent collateral,

varicose, and perforator veins[26,27]. Sclerotherapy is often applied instead of phlebectomy, which is burdened with a higher number of complications[28]. Sclerotherapy is also performed in the case of healing venous ulcers resulting from advanced venous insufficiencies with CEAP scores of 5 and 6 to eliminate varicose lesions and close incompetent perforator veins when more invasive surgery poses a risk of coexisting infection[14,29,30].

A hybrid method combining EVLA and UGFS (echosclerotherapy) has largely replaced traditional surgery in treating primary varicose veins, recurrent varicose veins, and varicose lesions with active venous legs ulceration[21,31]. Echosclerotherapy is a minimally invasive, effective, and safe method for treating varicose veins[32]. Percutaneous sclerotherapy is a safe and effective method of treating vascular malformations of the head, neck, and face[33,34]. Foam sclerotherapy is sometimes performed as a primary procedure in CVI, resulting in a significant reduction in the diameter of the great saphenous vein and elimination of reflux[35].

In some centers, combined therapies, so-called hybrid treatments, are used. In hybrid treatment, sclerotherapy is performed simultaneously with EVLA with wavelengths of 980 nm or 1470 nm or Nd:YAG laser therapy with a wavelength of 1064 nm[19,24]. The procedure can be performed using endovascular catheters, administering the obliterating agent from a single puncture (venipuncture) to distant sections of incompetent vessels[36,37]. Traditional phlebectomy is often combined with sclerotherapy, increasing its effectiveness and reducing hematomas, scarring, complications, and recurrence[10,38].

Patients and Methods

Patients

In 2019-2020, the Hauzer Clinic (Żerniki Wrocławskie, Lower Silesia, Poland) performed 200 CVI treatments using a hybrid method that combined endovenous laser ablation (EVLA) of GSV trunks with intraoperative sclerotherapy and complementary ultrasound-guided foam sclerotherapy (echosclerotherapy; UGFS). The clinical trial consisted of 140 women and 60 men, ranging from 20 to 75 years. Exclusion criteria included age <20 and >75 years, New York Heart Association (NYHA) class IV, confirmed malignancy up to 10 years after recovery, implanted pacemaker, cardioverter-defibrillator, use of two or more anticoagulants, pregnancy, and lactation. The characteristics of patients undergoing EVLA/UGFS procedures are shown in Table I.

Procedure

All patients underwent ultrasound-guided mapping of the course of superficial veins on the lower limb before surgery. The next step was venipuncture of the GSV trunk below the knee joint under 2% xylocaine infiltration anesthesia, ultrasound-guided insertion of a guidewire up to the ostium of the great saphenous vein to the femoral vein, followed by insertion of an introducer with a catheter, removal of the guidewire and catheter, and ultrasound-guided insertion of a laser fiber 2-3 cm from the ostium of the GSV to the femoral vein. Tumescent infiltration anesthesia with Klein's solution was used.

The procedure was performed using Leonardo laser at 1470 nm with a linear fiber and continuous wave at 80-100J/10W, depending on the diameter of the vessel. During the procedure, after the fulguration of the proximal segment of the GSV trunk, one ampoule of foam created by the Tessari method with 2% polidocanol was injected through the lateral port of the introducer into the inefficient collateral veins extending from the main trunk of the GSV in the femoral segment; endovascular ablation was then continued. The duration of treatment was 20-40 minutes, depending on anatomical condition[39]. After surgery, compression therapy using grade II compression stocking was recommended for four weeks (Figures 1-6).

Table I. Clinical characteristics of patients undergoing EVLA/UGFS therapy.

Patients	Male	Female	Result
Age (years)	35-70	20-75	20-75
Number of patients (n)	60	140	200
CEAP	C2-C5	C2-C6	C2-C6

Abbreviations: CEAP: clinical, etiological, anatomical, and pathophysiological classification of CVI; M: mean; EVLA: endovenous laser ablation; UGFS: ultrasound-guided foam sclerotherapy.

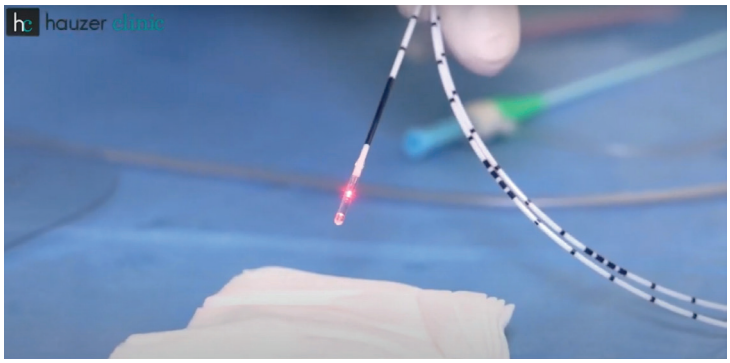

Figure 1. Biradial catheter for EVLA.

Results

All patients underwent a follow-up duplex Doppler ultrasound four weeks after EVLA treatment to confirm the effect of the procedure. There were 196 patients with complete obstruction of the femoral segment of the GSV and with fibrosis of collateral veins, while in four cases, signs of minor recanalization of the femoral segment were observed. In addition, all patients underwent complementary echosclerotherapy of the distal segment of the GSV trunk (insufficient collateral veins and perforators), administrating 1-2 ampoules of foam created by the Tessari method with 1% polidocanol. Standard compression therapy using a grade II compression stocking for four weeks was used after the complementary sclerotherapy procedure.

Follow-up duplex Doppler ultrasonography was performed in all patients at 6 and 12 months after EVLA. After 12 months, 198 patients showed complete fibrosis, partial or complete absorption of the saphenous vein and varicose lesions. In addition, two patients underwent further UGFS after 12 months because of recurrent varicose lesions.

At four weeks since UGFS, local pain of thrombosed fibrotic varicose veins was observed in 20% of patients, requiring local thrombectomy in isolated cases. Hemosiderin staining was observed in 15% of patients, but this completely resolved within 6-12 months. In 1% of cases, symptoms of dyspnea and cough were observed after UGFS, which resolved a few minutes after the procedure. Approximately 1% of cases presented with symptoms of matting. No severe complications were found. A summary of the clinical effects of EVLA/UGFS therapy and complication rates is shown in Table II.

Discussion

Savolyuk et al[38] found that the high-frequency laser method resulted in a complete fibrotic transformation of GSV/SSV in 97.06% of patients, while intravascular laser coagulation resulted in a complete transformation of fibrotic GSV/SSV in 98.21% of patients, and elimination of reflux by microfoam catheter echosclerotherapy resulted in a complete transformation of fibrotic GSV/SSV in 87.83% of patients. Only fibrosis/recanalization of the main GSV/SSV trunks were evaluated. Savolyuk et al[38] did not consider the insufficiency of collateral veins, branches, and perforators, nor did they study the efficacy of combination therapies.

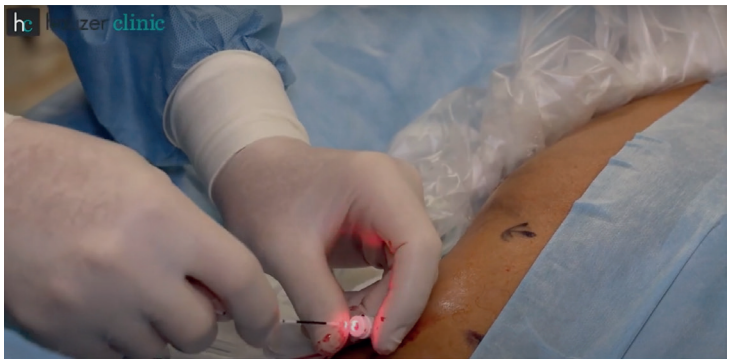

Figure 2. Insertion of a biradial catheter into the GSV.

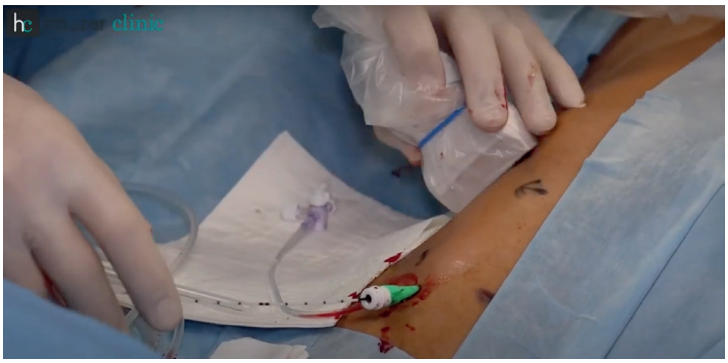

Figure 3. EVLA of GSV under ultrasound guidance.

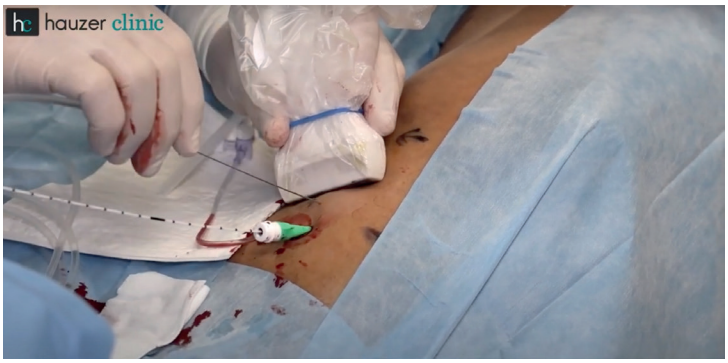

Figure 4. Tumescent anesthesia for EVLA.

Figure 5. Compression therapy after EVLA.

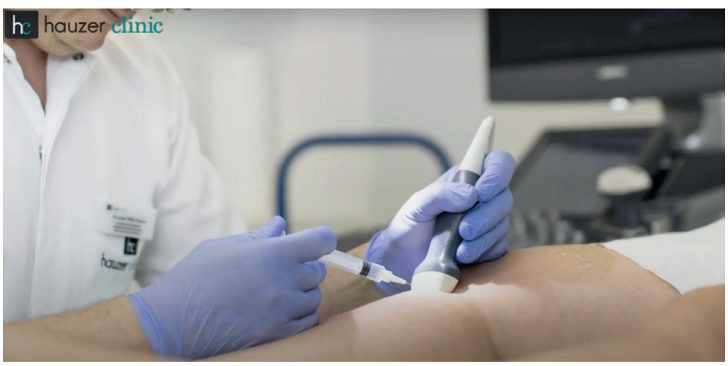

Figure 6. UGFS treatment procedure.

Table II. Characterization of the clinical effects of EVLA/UGFS therapy.

Post-treatment period	Fibrosis (n)	Recanalization (n)
4 weeks	196	4
6 months	198	2
12 months	198	2
Complications	**Percentage (%)**	
Local pain	20	
Hemosiderin staining	15	
Dyspnea or several-minute cough	1	
Matting	1	

Abbreviations: n: number of patients; EVLA: endovenous laser ablation; UGFS: ultrasound-guided foam sclerotherapy.

We believe it is crucial to conduct a 12-month follow-up for signs of recurrence of CVI in the form of insufficient medial, lateral, and posterior branches and additional trunks and isolated varicose lesions originating from insufficient perforators which is an important cause of recurrent varicose lesions. Clinicians increasingly use single-day, minimally invasive surgery. Longer-wavelength lasers are more comfortable for patients and produce fewer complications than shorter-wavelength lasers, making them more suitable for one-day surgery.

Zhang et al[40] compared the short- and medium-term efficacy, postoperative morbidity, and patient satisfaction of 1470 nm EVLA combined with foam sclerotherapy in one-day surgery, with 810 nm EVLA with high ligation combined with foam sclerotherapy in-hospital surgery in the case of GSV failure. A single-center cohort study of 194 patients was conducted at the Ninth People's Hospital in Shanghai, China. A group of 97 patients underwent 1470 nm EVLA combined with foam sclerotherapy in a one-day surgery (the 1470 nm group). In contrast, 97 patients underwent 810 nm EVLA with high saphenous vein ligation with foam sclerotherapy in guideline-recommended hospital surgery (the 810-nm group). There was no significant difference between the 1470 nm group and 810 nm group in terms of GSV occlusion rate (both 100%), incidence of complications, or recurrence rate (8.2% *vs.* 11.3%, respectively) at 1-12 months after surgery. Severe complications in patients who underwent 1470 nm laser treatment and 810 nm laser treatment were 0% and 1.0%, respectively. Minor complications in the group of patients who underwent 1470 nm laser treatment and 810 nm laser treatment were petechiae in 20.6% and 18.6%, edema in 69.1% and 63.9%, and paresthesia around the ankle in 0% and 3.1%, respectively. The advantage of the group undergoing the 1470 nm treatment over the group undergoing the 810 nm treatment was statistically significant in perioperative patient comfort and economic costs. Treatment with 1470 nm EVLA in combination with foam sclerotherapy in one-day surgery was found to have similar efficacy to 810 nm EVLA with high ligation in combination with foam sclerotherapy in-hospital surgery for GSV failure and to be more comfortable with minor incision, hospitalization procedure, and medical cost. This combined procedure may be a new option for patients afraid of hospitalization or who cannot be hospitalized[40].

Watanabe et al[41] combined endovascular therapy with sclerotherapy under ultrasound guidance for the comprehensive treatment of varicose veins of the lower extremities. EVLA was performed in one group, while EVLA/TLFS (transluminal injection of foam sclerotherapy) was performed in the other. After three months of follow-up, ultrasound showed abolition of reflux in GSVs in all patients. However, additional second-stage sclerotherapy was needed in the group treated with EVLA (n = 33, 66%) compared to the group treated with EVLA/TLFS (n = 2, 3%). The researchers concluded that TLFS combined with EVLA could be an easy, safe, and effective procedure with acceptable complications compared to EVLA alone and limits additional second-stage interventions. The purpose of this study was to evaluate the short-term efficacy, patient satisfaction, and impact of TLFS for the treatment of varicose veins of the GSV using the Venous Clinical Severity Score (VCSS)[41].

Theivacumar et al[42,43] showed that EVLA alone resulted in 93% GSV obstruction, while the primary determinant of successful GSV ablation after EVLA was laser energy. A subsequent study

found the need for additional sclerotherapy after EVLA for 42% of patients six weeks after the procedure due to residual varicose lesions. After EVLA laser ablation, 40-50% of patients with residual varicose veins required foam sclerotherapy (Table III).

Conclusions

In a follow-up observation, 12 months after CVI treatment with a hybrid method combining the EVLA treatment for varicose veins of the lower extremities with intraoperative sclerotherapy

Table III. Summary of selected clinical trials of EVLA/UGFS therapy.

Authors	Savolyuk et al[38]	Zhang et al[40]	Watanabe et al[41]	Theivacuma et al[43]	Theivacuma et al[42]
Journal	Wiadomości Lekarskie	Lasers in Medical Science	EJVES Vascular Forum	European Journal of Vascular and Endovascular Surgery	Journal of Vascular Surgery
Publication year	2020	2018	2020	2018	2008
Study protocol	Prospective observational study	Retrospective cohort study	Prospective cohort study	Prospective observational study	Randomized controlled trial
Study group	N/S	G1: M=52 / F=45 G2: M=50 / F=47	G1: M=32 / F=34 G2: M=37 / F=40	M=194 / F=378	G1: M=9 / F=13 G2: M=8 / F=13 G3: M=10 / F=12
Patients' age	G1: 43.2±4.3 G2: 41.4±3.6 G3: 39.6±3.8	G1: 57.31±7.24 G2: 59.27±9.49	G1: 66.0±12.0 G2: 67.0±12.0	16-86	G1: 30-69 G2: 27-70 G3: 31-68
CEAP	G1: C2-C6 G2: C2-C6 G3: C2-C6	G1: C3-C5 G2: C3-C5	G1: C2-C6 G2: C2-C6	C2-C6	G1: C2-C6 G2: C2-C6 G3: C2-C6
Treatment procedure	GSV/SSV G1 (n=102): EVEW 10-100 V G2 (n=112): EVLA 1470 nm G3 (n=115): UGFS	G1 (n=97): EVLA 1470 nm + UGFS G2 (n=97): EVLA 810 nm + UGFS	G1 (n=50): EVLA 1470 nm G2 (n=63) EVLA 1470 nm + TLFS	GSV G1 (n=599): EVLA 1887 J + 48 J/cm G2 (n=45): EVLA 1191 J + 37 J/cm	GSV G1 (n=): EVLA 64 J/cm G2 (n=): EVLA 61 J/cm G3 (n=): EVLA 62 J/cm
Clinical findings	Complete fibrotic transformation: G1 = 97.06% G2 = 98.21% G3 = 87.83%	100% occlusion rate in G1 and G2; recurrence rate in G1 = 8.2% and in G2 = 11.3%	Additional sclerotherapy in G1 = 66% and in G2 = 3%; VCSS in G1 = -3.3±1.7 and in G2 = -4.4±1.0	G1 = 93.0% total occlusion G2 = 42.2% partial occlusion and occlusion and 57.8% patent	Sclerotherapy needed: G1 = 61% G2 = 17% G3 = 36% G3 = 36% AVVSS improvement: G1 = 14.8 to 6.4 G2 = 15.8 to 2.5 G3 = 15.1 to 4.1 patient highest satisfaction in G2
Adverse events	None	G1 and G2: serious 0 and 1.0%; minor: ecchymosis 20.6 and 18.6%, edema 69.1 and 63.9%, paresthesia around ankle 0 and 3.1%	G1 and G2: serious 0.0%; thrombophlebitis in G1 = 0.0% and in G2 = 3.0%	Phlebitis = 10.2%, transient numbness = 1.1%, DVT = 0.2%	Phlebitis = 9.09% in G3, transient numbness = 4.54% in G3, DVT = 0.0%

Abbreviations: G: study group; M: male; F: female; CEAP: clinical, etiological, anatomical and pathophysiological classification of CVI; EVLC: endovenous laser coagulation; EVLA: endovenous laser ablation; UGFS: ultrasound-guided foam sclerotherapy; TLFS: transluminal injection of foam sclerotherapy; GSV: great saphenous vein SSV: small saphenous vein; VCSS: Venous Clinical Severity Score; AVVSS: Aberdeen Varicose Vein Severity Score; DVT: deep vein thrombosis; N/S: not specified.

and supplemental UGFS, the success rate of EVLA with intraoperative sclerotherapy of inefficient collateral veins and branches of the femoral segment was 98% (196/200 patients). Follow-up UGFS at four weeks after laser ablation showed 99% efficacy at the 12-month postoperative follow-up. Major complications after the hybrid method combining EVLA with UGFS were not observed. Hybrid methods are more effective (98-99%) and give a lower chance of relapse than monotherapies.

Informed Consent
Informed consent was obtained from all individual participants included in the study.

Conflict of Interest
The authors declare that they have no conflict of interests.

Financial Disclosure Statement
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There were no other contributors to the article than the Authors as well as there was no writing assistance required. The certificated English language services were provided.

Authors' Contribution
Conceived and designed the study: WH, JG. Search of information and database creation: JG, JR. Analyzed the data: WH, JR. Clinical and epidemiological explorations: WH, JG. Contributed documentation & illustrations: WH. Wrote the paper: WH, JG. Revised the paper: JR. Compiled the data: WH.

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