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Can plethysmography have a greater place in the diagnosis, treatment and follow-up of chronic venous insufficiency?

Temmuz Taner[1], Hakan Güven[2]

[1]Department of Cardiovascular Surgery, Bursa City Hospital, Bursa, Turkey; [2]Department of Cardiovascular Surgery, Private Heart and Arrhythmia Hospital, Bursa, Turkey

ABSTRACT

Objectives: Chronic venous insufficiency (CVI) is one of the most common venous diseases. CVI is an important clinical picture with a high prevalence, low quality of life, and high diagnosis and treatment costs. Therefore, diagnosis, follow-up, and treatment are important for the patient's socioeconomic and life quality. In this study, we aimed to better examine a test used in the diagnosis, treatment, and follow-up of CVI.

Methods: In this retrospective study, 683 patients diagnosed with CVI, who had endovenous laser ablation (EVLA) indications were evaluated between June 2013 and November 2018. EVLA procedure performed on all patients. Preoperative, postoperative 1st and 6th month Doppler USG (ultrasonography), plethysmography, and VCSS (Venous Clinical Severity Score) questionnaire was made to all patients.

Results: As a result of our study, we found that there was a significant difference between the preoperative plethysmography and VCSS results of the patients and the postoperative 1st and 6th month results. With the significant difference in the VCSS questionnaire, we have shown that plethysmography gives accurate results in the diagnosis and treatment of CVI since it is an individual, quantitative, and easy test.

Conclusions: EVLA is an effective and safe method in patients with venous insufficiency. Since Doppler USG is person and device dependent, we think that plethysmography, which can be used in every clinical setting and provides quantitative results independent of the person, can be used more frequently in the diagnosis and treatment of venous insufficiency. In addition, we think that plethysmography can be used as a valuable additional method in the diagnosis and follow-up of such patients, due to the venous hemodynamic data that Doppler USG cannot provide.

Keywords: Chronic venous disease, plethysmography, endovenous laser ablation

Chronic venous insufficiency (CVI) is one of the most common vascular diseases. It describes the morphological and functional disorders in the venous system. CVI is an important clinical picture with a high prevalence, reducing the patient's quality of life and high cost of diagnosis and treatment [1, 2].

It has a wide range of symptoms that can result in itching, burning, restlessness, discoloration, swelling in the legs, prominent veins, venous ulcers in the ankles. In general, the biggest effect is to reduce the pa-

Corresponding author: Temmuz Taner, MD.,
Phone: +90 224 975 00 00, E-mail: temmuztaner@gmail.com

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tient's quality of life. However, because it is a non-life-threatening and non-specific disease, it is a disease that tends to be overlooked by patients and doctors [3]. Treating CVI is very important in improving the patient's venous hemodynamics and clinic. Clinical worsening in patients awaiting or delayed elective surgery has been shown in many studies [4]. It is important to eliminate this mechanical leakage before permanent and irreversible damage occurs [4].

Treatment of saphenofemoral junction insufficiency can be grouped under 3 main headings as medical, open surgery, and endovascular treatments. Open surgery; high ligation at the saphenofemoral junction (SFJ) stripping of the above-knee great saphenous vein (GSV) and pack excisions have been the gold standard until today [5]. With the development of endovascular treatments, increasing experience, and seeing the results; endovascular treatments, which are alternatives to open surgery, have begun to take their place in new guidelines.

A good anamnesis and clinical examination are usually sufficient for the diagnosis. Information such as the severity, anatomical location and extent of the regurgitation are revealed by Doppler USG examination [6]. Invasive, standard venography, computerized tomographic venography, and magnetic resonance venography are available but not widely used [7]. In addition, plethysmographic tests can be used to determine venous hemodynamics. Strain-gauge venous occlusion plethysmography (SGVOP) provides objective data about venous outflow and venous capacity [3, 8]. Plethysmographic methods have been frequently used in many studies on venous insufficiency, especially in medical treatment efficacy studies [9, 10].

Although venous hemodynamic measurements are considered important evidence in proving efficacy, they are not widely used in practice today. The presence and severity of the regurgitation, as well as the saphenous diameter in measurements made with Doppler USG, play a key role in determining the treatment, but venous hemodynamics in the entire leg is not considered. This means ignoring the changes in venous volume in the process of venous hypertension, which we consider the initial pathology of the disease. In this study, we aimed to evaluate the place of plethysmography in the diagnosis of CVI and in the follow-up of the patient clinic and venous hemodynamics after EVLA.

METHODS

This retrospective study was conducted in Bursa Arrhythmia and Heart Hospital by scanning and documenting the files of patients diagnosed with CVI, who had EVLA indication and EVLA procedure performed in June 2013 and November 2018. Regional Ethics Committee approval was obtained for this retrospective review study (Uludag University Clinical Research Ethics Committee, Date: 10 November 2022, Decision no. 2022-17/25).

Patients with reflux of more than 0.5 seconds at the saphenofemoral junction detected by Doppler USG and with a GSV greater than 5.5 mm were included in the study. Patients who had the insufficiency but have no complaints, whose GSV diameter is more than 10 mm, patients with a doubled saphenous vein, patients with anterior or posterior accessory saphenous vein varicose veins, patients with excessive bend in the saphenous magna, patients with femoral or popliteal vein insufficiency, patients with previous deep vein thrombosis, patients using oral anticoagulants such as warfarin, patients with peripheral artery disease (ankle-brachial index below 0.9) were excluded from the study.

Between June 2013 and November 2018, 683 patients who were randomly selected and diagnosed with GSV insufficiency by Doppler USG were included in the study. EVLA was applied in a standard way to all patients with EVLA indications. Venous Capacity (VC), Venous Refilling Time (VRT), and Venous Pump Capacity (VPC) measurements were made with SGVOP at preoperative (VC-0, VRT-0, and VPC-0) and postoperative 1st (VC-1, VRT-1, and VPC-1)and 6th months (VC-6, VRT-6, and VPC-6). Doppler USG was performed at 1 month for the evaluation of the procedure.

VCSS was used to evaluate patients' clinical state. VCSS records of the patients were made. Preoperative and postoperative measurements were compared with each other and statistical significance was checked. All EVLA procedures were performed by the same surgeon, and SGP measurements were performed by the same technician.

Statistical Analysis

Whether the data were suitable for normal distribution was examined using the Shapiro-Wilk test. De-

Table 1. Frequency distribution regarding the demographic characteristics of the participants

	Data
Gender, n (%)	
Female	408 (59.7)
Male	275 (40.3)
Age (year)	53.30±15.13 53 (28-80)
GSV diameter (mm)	7.57±1.18 7.70 (5.5-9.5)
GSV length (cm)	20.23±6.82 20 (9-32)

Data are shown as mean±standard deviation or median (minimum-maximum) or number (percent). GSV= Great saphenous vein

scriptive statistics for categorical variables are given as frequency and percentage. Descriptive statistics for continuous variables are given as median (minimum-maximum) for those that do not conform to the normal distribution. In the comparison of dependent groups, Wilcoxon sign-rank test was used for those who did not comply with the normal distribution. Statistical analysis was done in SPSS 22.0 package program. The level of significance was taken as α=0.05.

RESULTS

The mean age of 683 patients included in the study was 53.30±15.13 years, with 408 (59.7%) females and 275 (40.3%) males (Table 1).

When the preoperative measurements were compared with the postoperative 1st and 6th month measurements, a statistically significant improvement was found in all parameters (P<0.001). Similarly, when the postoperative 1st month and 6th month measurements were compared, a statistically significant improvement was found in all parameters (P<0.001) (Table 2).

DISCUSSION

Chronic venous insufficiency (CVI) is a pathology that occurs as a result of deterioration of the hemodynamics and anatomy of the venous system in the lower extremities. Clinically, it can be defined as a very common condition that includes various subjective symptoms such as pain, itching, restlessness in the legs, swelling of the legs, cramps, and skin changes [2, 4].

The main pathology constituting chronic venous insufficiency is insufficiency, occlusion, or the combination of these two factors. The result is increased

Table 2. Comparison of venous capacity, venous refilling time, venous pump capacity, venous clinical severity score variables in the treatment group according to their pre-treatment values

	(n=683)	Binary comparisons	P value
VC-0 (%)	7.90 (4.8-10.7)	(VC-0)-(VC-1)	**< 0.001**
VC-1 (%)	6.70 (4.0-9.1)	(VC-0) - (VC-6)	**< 0.001**
VC-6 (%)	7.00 (4.1-9.4)	(VC-1) - (VC-6)	**< 0.001**
VRT-0 (seconds)	15.50 (5.2-24.0)	(VRT-0) - (VRT-1)	**< 0.001**
VRT-1 (seconds)	24.70 (15.7-37.2)	(VRT-0) - (VRT-6)	**< 0.001**
VRT-6 (seconds)	25.20 (16-38)	(VRT-1) - (VRT-6)	**< 0.001**
VPC-0 (%)	4.80 (0-8)	(VPC-0) – (VPC-1)	**< 0.001**
VPC-1 (%)	2.50 (1.1-3.9)	(VPC-0) – (VPC-6)	**< 0.001**
VPC-6 (%)	2.60 (1.1-4.0)	(VPC-1) – (VPC-6)	**< 0.001**
VCSS-0	6.00 (1-11)	(VCSS-0) – (VCSS-12)	**< 0.001**
VCSS-6	3.00 (1-5)		

Data are shown as median (minimum-maximum). VC= venous capacity, VRT= venous refilling time, VPC= venous pump capacity, VCSS= venous clinical severity score variables, 0= Preoperative, 1= postoperative 1st month, 6= postoperative 6th month, 12= postoperative 12th month

ambulatory venous pressure, in other words, venous hypertension [4].

Treatment of the disease may start with lifestyle changes depending on the severity and symptoms of the disease and may require medical and surgical treatment.

We aimed to see the stage of the disease and the clinic of the patient after surgery by performing presurgical scoring tests and SGVOP in patients diagnosed with venous insufficiency and having severe symptoms in our clinic. Thus, in addition to anamnesis, physical examination and Doppler USG in the diagnosis, treatment option, and follow-up of CVI we planned to evaluate whether an objective test such as SGVOP could be used more in the clinic.

Venous valves are bicuspid. They are important structures in the venous system that ensure that the flow is unidirectional and in the opposite direction to gravity. Venous blood moves against gravity with the muscle pump function created by ambulation and the effect of venous valves. Venous valves prevent the transmission of venous pressure created by the pump function of the muscle to the superficial veins and capillaries and when the venous pressure drops at the end of muscle contraction, they prevent the backflow of blood in the venous system [11]. The deterioration of any component in this valve system appears as venous insufficiency.

The first step in the diagnosis of venous insufficiency is a detailed history and physical examination. Then, color Doppler ultrasonography (USG), and plethysmography, which are non-invasive imaging methods, are important in the diagnosis. In the third step, invasive computed tomography (CT) venography, magnetic resonance (MR) venography and venography are used, which require the use of opaque materials.

The VCSS system includes 10 clinical definitions scored from 0 to 3, consisting of pain, varicose veins, venous edema, skin pigmentation, inflammation, induration, number of active ulcers, duration of active ulceration, size of ulcer and use of compressive therapy, which can be used to assess changes in response to treatment [12]. In our study, as in other studies, it was used for subjective identification in terms of clinical follow-up [13].

Color Doppler USG is the most commonly used among these methods. It gives sufficient information about the diameter of the target veins, the adequacy of the valves, the beginning of the collaterals, and the presence of the accessory saphenous vein. However, the biggest disadvantages of Doppler USG are it is subjective who is doing the examination and device Also being able to cooperate with the patient is not always possible. In addition, it does not give quantitative value other than flow measurement hemodynamically.

In this article, we used SGP alongside Doppler USG. The reason for using this method is that it is easily accessible, can be done quickly and most importantly, it gives quantitative results independent of the person doing it or the device. It also provides quantitative data on venous hemodynamics such as Venous Capacity, Venous Fill Time and Venous Pump Capacity. In the European Society for Vascular Surgery (ESVS) 2022 guideline, IIb class C level, "Air plethysmography can be considered to quantify reflux and/or obstruction in patients with chronic venous disease, especially when duplex ultrasound results do not match clinical findings." is recommended [14]. However, no recommendations were made about other plethysmographic methods. The development of technology and the increase in sensor sensitivity are progressing in a way that may change these recommendations in the future.

The first step in the treatment of venous insufficiency is patient education. Losing weight, exercising frequently, lifestyle changes, intermittent leg elevation, not standing for a long time or staying seated are indispensable parts of the treatment. Compression therapy comes next. The most commonly used method is compression stockings. In the 2021 Peripheral Arterial and Vein Diseases National Treatment Guidelines, it has been shown as a 1A recommendation for preventing the progression of the disease and relieving symptoms [15].

Venoactive drugs used in medical treatment consist of several heterogeneous drug groups. They can be of vegetable origin or synthetic [16]. The important thing is to know that venoactive drugs will not cure the existing disease, but will only relieve the symptoms. They reduce edema, pain, restlessness, and muscle cramps.

Indications for interventional treatment vary according to the patient's symptoms, objective findings related to varicose veins, and complications. The aim

is to eliminate all varicose veins and the cause of venous hypertension, achieve maximum cosmetic improvement, prevent recurrence, relieve symptoms, prevent complications, and treat the disease.

Although interventional methods vary according to the patient's clinic and venous pathology, they can be grouped as sclerotherapy, transcutaneous laser, endovenous thermal, and mechanical-chemical ablation. Traditional open surgical treatment also maintains its importance in the treatment of venous insufficiency. We preferred the EVLA method for our patients within the indications. EVLA is a safe and effective method that is increasingly used in the treatment of venous insufficiency. The new hemodynamics that will occur after EVLA relieves the patient's complaints and symptoms [17]. However, the same success does not occur in every patient and the importance of pre- and post-treatment evaluation becomes even more important. Plethysmography is a method that can objectively and accurately evaluate venous hemodynamics in a short time [4]. For this reason, we evaluated venous hemodynamics by performing plethysmography on the lower extremity before the operation, after the operation, and 6 months after the operation. Likewise, we compared the results of Doppler USG and plethysmography in the diagnosis, course, and follow-up of the disease.

There is a significant difference and improvement between our venous capacitance, and venous refilling time (VC-0, VRT-0) values in the preoperative evaluation, and our postoperative 1st month (VC-1, VRT-1) values. It was also found a significant difference and improvement between the postoperative 1st (VC-1 and VRT-1) and 6th month (VC6 and VRT6) values, and finally, our evaluation between our preoperative values and our 6th month values (VC0 and VC6, VRT-1 and VRT-6) also significant improvement. This shows that venous hemodynamics changes before and after the operation, and plethysmography presents it quickly and easily with quantitative values.

The significant difference between the preoperative scores of the patients (VCSS-0) and the scores at the 6th month postoperatively (VCSS-6) shows that our surgeries were also clinically successful and significantly reduced the complaints of our patients. We think that the fact that the plethysmographic data of the patients whose scores have changed has also progressed compared to the preoperative period, which shows that plethysmography correctly shows the improvement in venous hemodynamics and that this situation is reflected in the patient's clinic.

Limitations

The main limitation of the study was the small number of patients and the retrospective design.

CONCLUSION

EVLA is an effective and safe method in patients with venous insufficiency and decreased quality of life due to this pathology. Although Doppler USG is the most commonly used method in diagnosis and treatment; It can cause problems in diagnosis and follow-up due to the fact that it depends on the person doing it and the device used. However, it does not provide sufficient information about venous hemodynamics. For this reason, in addition to Doppler USG, we think that plethysmography, which can be used in every clinical setting and provides quantitative and independent results, can be used more frequently in the diagnosis and treatment of venous insufficiency.

Authors' Contribution

Study Conception: HG; Study Design: HG, TT; Supervision: HG; Funding: N/A; Materials: N/A; Data Collection and/or Processing: TT; Statistical Analysis and/or Data Interpretation: TT; Literature Review: TT; Manuscript Preparation: TT and Critical Review: TT.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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