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Application of Endovenous Laser Treatment Combined with Foam Sclerotherapy for the Minimally Invasive Treatment of Great Saphenous Vein Varicosity

Peng Liu*, Jun Tang

Jingjiang Traditional Chinese Medicine Hospital, Jingjiang 214500, Jiangsu Province, China

Corresponding author: Peng Liu, suchouliu@163.com

Abstract: *Objective:* To evaluate the efficacy of endovenous laser treatment (EVLT) combined with foam sclerotherapy (FS) in the treatment of great saphenous vein varicosity (GSVV). *Methods:* A total of 50 patients with GSVV, treated between March 2021 and March 2024, were selected and randomly divided into two groups using a random number table. The combination group (25 cases) underwent EVLT combined with FS, while the conventional group (25 cases) underwent EVLT alone. The total effective rate, complication rate, disease severity score, and serological indicators were compared between the two groups. *Results:* The total effective rate in the combination group was higher, and the complication rate was lower compared to the conventional group ($P < 0.05$). One week after surgery, the disease severity score in the combination group was lower, coagulation function indicators were better, and inflammatory factor levels were lower compared to the conventional group ($P < 0.05$). *Conclusion:* EVLT combined with FS can improve the clinical efficacy in GSVV patients, prevent postoperative complications, reduce disease severity, protect patients' coagulation function, and alleviate postoperative inflammatory responses, showing significant advantages in combined surgery.

Keywords: Endovenous laser treatment; Foam sclerotherapy; Great saphenous vein varicosities; Minimally invasive treatment

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1. Introduction

Great saphenous vein varicosity (GSVV) is a common peripheral vascular disease of the lower extremities, caused by incomplete closure of the saphenofemoral venous valve, leading to blood reflux [1]. Additionally, factors such as valve dysfunction, reduced elasticity of the great saphenous vein wall, cold exposure, obesity, and advanced age are major causes of the disease. Minimally invasive treatment is the primary therapy for this

condition, as it is less invasive and can shorten postoperative recovery time. EVLT is a widely used minimally invasive procedure for this disease, with a relatively simple operation and high safety. However, laser surgery is less effective in treating venous clusters or small branch veins and cannot fully cover varicose veins [2]. Therefore, FS can be combined to treat tortuous branch veins or varicose vein clusters, enhancing surgical radicality and reducing postoperative complications. Based on this, this study selected 50 patients with GSVV to evaluate the efficacy of EVLT combined with FS surgery.

2. Materials and methods

2.1. General Information

Fifty patients with GSVV who were admitted for treatment between March 2021 and March 2024 were selected. They were randomly divided into two groups using a random number table: the combination group (25 cases), consisting of 15 males and 10 females, with ages ranging from 35 to 83 years, and a mean age of (53.45 ± 4.38) years, and a disease duration ranging from 2 to 11 years, with a mean of (5.94 ± 1.37) years. The conventional group (25 cases) included 16 males and 9 females, with ages ranging from 33 to 85 years, and a mean age of (53.72 ± 4.43) years, and a disease duration ranging from 3 to 11 years, with a mean of (6.81 ± 1.42) years. There were no significant differences in general data between the two groups ($P > 0.05$).

Inclusion criteria: Diagnosis of C2 to C5 according to the CEAP classification system by the International Union of Phlebology; complete clinical data; met the surgical indications; informed consent and agreement to participate in the study.

Exclusion criteria: Abnormal heart, liver, or kidney function; venous thrombosis or other related conditions; secondary varicose veins diagnosed by preoperative ultrasound; allergy to the drugs used in the study; mental disorders.

2.2. Methods

The preoperative preparations were the same for both groups. Patients were instructed to stand for more than 5 minutes and contract their gastrocnemius muscle to adequately fill the superficial varicose veins, which were then marked with a marker for accurate injection of the drug.

The conventional group underwent EVLT surgery: General or epidural anesthesia was administered. Using ultrasound, the main trunk of the great saphenous vein was accurately located. A horizontal incision (1.5 to 2.0 cm) was made near the groin, slightly below the fossa ovalis. The subcutaneous tissue was dissected layer by layer, and the vein trunk was located within the fat layer, then entered toward the proximal end into the femoral vein. Approximately 0.5 cm from the femoral vein, the vascular stump was sutured to prevent suture slippage. The main trunk of the great saphenous vein was also ligated. Another horizontal incision (0.5 cm) was made approximately 2 cm above the medial malleolus. After identifying the distal end of the vein trunk, a 5F guide wire was inserted and advanced to the ligated proximal end. A 5F straight-head catheter was then placed. The guide wire was removed, and a laser fiber was introduced into the catheter and advanced to the ligated proximal end. The catheter was then withdrawn toward the distal end by 3 to 5 cm, exposing the laser fiber tip. Before treatment, normal saline was injected into the subcutaneous and fat layers along the course of the vein to prevent laser burns to the skin or nerves. The laser device was activated, with a power setting of 8W. The speed of fiber movement was adjusted according to the treatment site. In continuous mode, the catheter and fiber were

synchronously withdrawn at a speed of 0.3 to 0.5 cm per second from the proximal end to the popliteal region. After reaching the popliteal fossa, pressure was applied to the vein trunk above the knee to ensure closure. The withdrawal speed was then increased to 1.0 cm per second to fully withdraw the catheter and fiber, and the laser was deactivated. Pressure was applied to the lower leg vein trunk, and the incision was sutured.

The combination group underwent EVLT combined with FS: After 5 minutes of compression along the course of the vein, FS was performed. A sterile tourniquet was applied at the base of the thigh to fill the branch veins. A 10G scalp needle was inserted into the varicose vein, connected to a syringe, and once blood return was noted, the air in the needle was evacuated, and saline was injected to allow the blood to flow back into the vessel. Two syringes (5 mL each) were prepared, one filled with 1.0 mL of polidocanol (1%) and the other with 4 ml of air. The solutions were mixed at a 1:5 ratio by rapidly pushing the syringes back and forth 20 times until a white foam was produced. The sclerosing agent was then injected into the vessel, with 1.5 mL injected at each puncture site. The injection speed was adjusted appropriately, and the injection was paused if significant resistance was encountered. During injection, the foam quality was observed, and large bubbles or gas were avoided. After the injection, an elastic bandage was applied, wrapping the toes to the groin area, with moderate compression.

2.3. Observation indicators

(1) Complications: Deep vein thrombosis (DVT), skin burns, subcutaneous bruising, throbbing pain or numbness in the affected limb.

(2) Disease severity score: Preoperatively and one week postoperatively, the Venous Clinical Severity Score (VCSS) was used to evaluate 10 items including varicose veins, pigmentation, and pain, with each item scored from 0 to 3, with higher scores indicating more severe conditions.

(3) Serological indicators: Fasting venous blood (3 mL) was drawn at the same time points, and an automated biochemical analyzer was used to assess coagulation function indicators, including tissue plasminogen activator (t-PA), plasminogen activator inhibitor (PAI-1), and fibrinogen (FIB). Inflammatory factors, including interleukin-2 (IL-2), C-reactive protein (CRP), and interleukin-10 (IL-10), were also measured.

2.4. Efficacy evaluation criteria

(1) Markedly effective: Ulcers in the foot-ankle area healed, and varicose veins disappeared.

(2) Effective: Ulcers in the foot-ankle area mostly healed, and varicose veins improved.

(3) Ineffective: No improvement in foot-ankle area ulcers, and no change in varicose veins.

2.5. Statistical analysis

Data were processed using SPSS 21.0 software. Measurement data were expressed as mean ± standard deviation (SD) and compared using *t*-tests. Count data were expressed as [*n* (%)] and compared using chi-squared (χ^2) tests. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Comparison of total effective rates between the two groups

Table 1 shows that the total efficacy rate in the combination group was higher than that in the conventional group ($P < 0.05$).

Table 1. Comparison of total effective rates between the two groups [*n* (%)]

Group	*n*	Markedly effective	Effective	Ineffective	Total effectiveness
Combination group	25	13	11	1	24 (96.00%)
Conventional group	25	9	10	6	19 (76.00%)
χ^2	-	-	-	-	4.153
P	-	-	-	-	0.042

3.2. Comparison of complication rates between the two groups

Table 2 shows that the complication rate in the combination group was lower than that in the conventional group ($P < 0.05$).

Table 2. Comparison of complication rates between the two groups [*n* (%)]

Group	*n*	DVT	Skin burns	Subcutaneous bruising	Throbbing pain or numbness	Complication rate
Combination group	25	0	0	1	1	2 (8.00%)
Conventional group	25	1	2	2	3	8 (32.0%)
χ^2	-	-	-	-	-	4.500
P	-	-	-	-	-	0.034

3.3. Comparison of disease severity scores between the two groups

There was no difference in disease severity scores between the two groups before surgery ($P > 0.05$). However, one week postoperatively, the disease severity score of the combination group was lower than that of the conventional group ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of disease severity scores between the two groups (mean ± SD, score)

Group	*n*	Preoperative	1 week postoperative
Combination group	25	12.19 ± 2.76	5.18 ± 1.66
Conventional group	25	12.26 ± 2.91	7.35 ± 1.72
t	-	0.087	4.539
P	-	0.931	0.000

3.4. Comparison of serological indicators between the two groups

There were no differences in coagulation function indicators and inflammatory factors between the two groups before surgery ($P > 0.05$). However, one week postoperatively, the combination group had better coagulation function indicators and lower levels of inflammatory factors than the conventional group ($P < 0.05$), as shown in **Tables 4 and 5**.

Table 4. Comparison of coagulation function indicators between the two groups (mean ± SD)

Group	t-PA (ng/L)		PAI-1 (ng/L)		FIB (g/L)	
	Preoperative	1 week postoperative	Preoperative	1 week postoperative	Preoperative	1 week postoperative
Combination group (n = 25)	15.86 ± 2.37	24.95 ± 3.78	47.23 ± 5.30	35.63 ± 3.40	3.65 ± 0.41	2.73 ± 0.31
Conventional group (n = 25)	15.82 ± 2.41	20.33 ± 3.65	47.17 ± 5.27	39.34 ± 3.32	3.67 ± 0.45	3.06 ± 0.37
t	0.059	4.396	0.040	3.904	0.164	3.418
P	0.953	0.000	0.968	0.000	0.870	0.001

Table 5. Comparison of inflammatory factor levels between the two groups (mean ± SD)

Group	IL-2 (pg/mL)		CRP (mg/L)		IL-10 (pg/mL)	
	Preoperative	1 week postoperative	Preoperative	1 week postoperative	Preoperative	1 week postoperative
Combination group (n = 25)	158.67 ± 30.47	121.93 ± 13.71	6.64 ± 0.75	4.86 ± 1.33	122.60 ± 14.52	156.71 ± 18.44
Conventional group (n = 25)	157.34 ± 30.53	130.65 ± 14.64	6.61 ± 0.79	5.77 ± 1.46	122.31 ± 14.47	143.66 ± 18.39
t	0.154	2.174	0.138	2.304	0.071	2.505
P	0.878	0.035	0.891	0.026	0.944	0.016

4. Discussion

Great saphenous vein varicosity is a peripheral vascular disease caused by multiple factors such as elevated intraluminal pressure and elastic fiber dysfunction in the vascular wall. Pathologically, it is characterized by poor metabolic capacity of the venous wall and venous hypoxia, which can increase the release of various inflammatory factors, leading to vascular remodeling [3]. This disease is a systemic inflammatory response, and the treatment principle is to suppress inflammation and prevent venous blood reflux.

Minimally invasive surgery is a common treatment for this condition, with EVLT being the main approach [4,5]. The treatment principle of EVLT is based on the generation of ultra-high thermal energy through laser heating, raising the temperature of the treated area to 300°C, coagulating the surrounding blood, and transmitting heat to the venous wall, causing vascular damage. Combined with compression techniques, it accelerates the closure of the venous wall [6]. The key feature of EVLT is the slow movement of the optical fiber tip from the proximal to the distal end, reducing the diameter of the main venous trunk and its blood flow. Furthermore, EVLT can gradually thin the fatty layer of the venous wall, reducing the distance between the energy emission point and the surface skin [7]. Accelerating the movement speed in the area below the knee helps prevent skin burns and saphenous nerve damage. Using a continuous mode during treatment avoids excessive laser energy, providing thermal protection. When combined with FS, it increases the area of contact between the sclerosing agent and the vascular endothelium, prolonging the treatment time within the lumen, thereby preventing vascular occlusion and other abnormalities [8]. Moreover, FS injection is simple and destroys

the vascular cells of varicose veins, promoting vascular occlusion and enhancing the treatment effect.

The results showed that the total efficacy rate of the combination group was higher than that of the conventional group ($P < 0.05$), which is consistent with the findings of Qian *et al.* [9]. The complication rate in the combination group was lower than that of the conventional group; one week postoperatively, the disease severity score of the combination group was lower than that of the conventional group, the coagulation function indicators were better, and the inflammatory factor levels were lower ($P < 0.05$). The reason for this is that EVLT combined with FS surgery can utilize the physical therapeutic advantage of polidocanol injection to stabilize the surface material of the vessel, prolong the retention time of the foam inside the vessel, and exert a blood-draining effect. Moreover, the entire FS treatment is guided by ultrasound, preventing wound stripping and minimizing surgical trauma [10,11]. The combination of these two procedures provides greater advantages, expanding the treatment range, thereby improving the overall efficacy, regulating venous coagulation function, and preventing complications such as thrombosis.

5. Conclusion

In conclusion, the combination of EVLT and FS surgery is highly effective, improving the condition, regulating coagulation function and the inflammatory response of the body, and offering a high level of surgical safety.

Disclosure statement

The authors declare no conflict of interest.

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