

 **Original Article** 

Endovenous Laser Ablation Combined with Stripping Technique for Large Saphenous Varicose Veins: The Selection of Operation Technique

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Objective: Saphenous varicose veins can be accomplished by various operative techniques that result in stripping, ablation, or ligation of the venous reflux section. Great saphenous vein (GSV) stripping is one of the standard operations for varicose veins to eliminate reflux of the sapheno-femoral junction. The goal of any treatment regimen is to eliminate the junctional varicose reflux to control congestive dysfunction. Endovenous laser ablation (EVLA) is safe and effective with less postoperative pain, bleeding, and peripheral nerve damage than open surgery. In this study, a patient with severe progression of primary saphenous varicose veins is presented. We report the outcome of combined surgical strategy and perioperative treatment for extremely swollen varicose veins of the lower limbs to improve leg symptoms and congestion and/or promote skin ulcer healing.

Materials and Methods: The subjects included 42 patients (51 limbs) who underwent EVLA with stripping. The patients comprised 24 males and 18 females, who presented a maximum GSV diameter >15 mm. The Clinical-Etiological-Anatomic-Pathophysiologic classification identified 9, 20, 9, 2, 6, and 5 limbs with C2, C3, C4a, C4b, C5, and C6, respectively, among the 42 patients.

Results: EVLA was used to treat GSV with a mean length of 16.1±2.8 cm. The mean of the maximum GSV diameter was 16.8±3.2 mm (14.6–21.8 mm). The preoperative visual

analog scale (VAS) score was 82.1±12.1. After operation, the VAS gradually deteriorated to 31.3±17.9 ($p<0.0001$), 2.8±3.6 ($p<0.0001$), and 1.2±1.8 ($p<0.0001$) in 7 days, 1 month, and 3 months, respectively.

Conclusion: We obtained a satisfactory outcome from our combined strategy and perioperative treatment for extremely swollen saphenous varicose veins. This approach may show the possibility that lower saphenous varicose veins can induce cosmetic and minimally invasive ameliorated intervention to avoid late-phase incompetent perforating veins.

Keywords: varicose vein, endovenous laser ablation, stripping

Introduction

Great saphenous vein (GSV) stripping is one of the standard operations for varicose veins with a goal of eliminating venous reflux. In Japan, endovenous laser ablation (EVLA) using a 1470 nm diode laser fiber with a Radial 2ring Fiber, radiofrequency ablation (RFA), and subfascial endoscopic perforator surgery have been covered by the country's health insurance since 2014. Considering convalescence, safety, and effectiveness, endovenous thermal ablation of incompetent saphenous veins has been recommended over vein stripping. Since 2015, taking cosmetic issues and operative invasiveness into consideration, we have performed EVLA combined with partial stripping on the proximal and distal sides, respectively, with minor incisions for the treatment of primary saphenous varicose veins, which present a maximum GSV diameter >15 mm and chronic congestive venous symptoms. Here, we report the postoperative outcome of our surgical strategy and the perioperative treatment for swollen varicose veins to improve cosmesis and/or skin ulcer healing.

Subjects and Methods

From January 2015 to January 2018, 511 surgical pa-

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Table 1 Patient characteristics and CEAP classification disease severity scores

Characteristics	No. (%)
Patients	42 patients; 51 legs
Male	24 (57.1%)
Age, years	66.4±10.4
Mean maximum GSV diameter, mm	16.8±3.2
CEAP	
C2	9 (17.6%)
C3	20 (39.2%)
C4a	9 (17.6%)
C4b	2 (3.9%)
C5	6 (11.7%)
C6	5 (9.8%)

GSV: great saphenous vein; CEAP: Clinical-Etiological-Anatomic-Pathophysiologic classification

tients visited our hospital with primary varicose veins in 631 patients. 442 patients (538 limbs) underwent EVLA or RFA standard operation at our hospital during the study period.

The subjects consisted of 42 patients (51 limbs) who underwent EVLA with stripping at our institution between January 2015 and January 2018. The patients included 24 males and 18 females aged 66.4 ± 10.4 years (mean), who presented with a maximum GSV diameter >15 mm. Mean body mass index (BMI) was 24.9 ± 4.9 . The Clinical-Etiological-Anatomic-Pathophysiologic (CEAP) classification identified 9, 20, 9, 2, 6, and 5 limbs with C2, C3, C4a, C4b, C5, and C6, respectively, among the 42 patients (Table 1). A Radial 2ring Fiber (ELVeS[®], 1470 nm wavelength diode fiber, CeramOptec GmbH, Bonn, Germany) laser device was used. The GSV diameter was measured in a standing position and mapped preoperatively by a clinical vascular technologist. A local committee in our hospital approved this procedure protocol.

We treated patients with large saphenous primary varicose veins showing symptoms of lower leg dullness, swelling, itching, night cramps, dermatitis, pigmentation, thrombophlebitis, and skin ulcers. Under ultrasonographic guidance, the patients were administered with tumescent local anesthesia (TLA) and intravenous anesthesia (Precedex[®], dexmedetomidine, Maruishi, Osaka, Japan) in the supine position. TLA solution was prepared by mixing 500 mL of physiological saline, 40 mL of epinephrine-containing lidocaine (1% Xylocaine[®] E, AstraZeneca, Osaka, Japan), and 10 mL of sodium bicarbonate (Meylon[®] Injection 7%, Otsuka, Tokushima, Japan).

In the first operative stage, the patient was positioned with the head tilted downwards, and 2 mL of TLA with ipsilateral femoral nerve block (1% Xylocaine[®] E) was administered under ultrasonographic guidance. The wire stripper or disposable plastic stripper (JMS, Hiroshima,



Fig. 1 CEAP C6: active ulcer patient, 45-year-old male was operated in proximal ablation and selective stripping one-third below the knee.
CEAP: Clinical-Etiological-Anatomic-Pathophysiologic classification

Japan) was inserted into the GSV in advance through a 7–10 mm skin incision made in the middle of the thigh and one-third below the knee. The GSV was then ablated under compression on the proximal side and 5–10 mm distal to the sapheno-femoral junction (SFJ) with a laser device (ELVeS[®] 1470 nm) of the linear endovenous energy density (LEED): 77–91 J (joule)/cm in the Trendelenburg position.

In the next stage, the intraluminal stripper was removed through the incision made one-third distance below the knee by proximally fixing the GSV via ligation, followed by applying compression pads over the treated areas. All the varicose vein branches were ligated and resected with stab avulsion in case of occlusion of incompetent perforators (Fig. 1).

The legs were examined using ultrasonography 1 and 7 days and 1 and 3 months post operation to assess the thrombus and recanalization of the saphenous vein. The focal pain experienced by the patients on a daily basis was evaluated using the visual analog scale (VAS), which measures 100 mm in length. During consultation, the patients were instructed to indicate the distance from the left end to the point of the imagined pain level, which was recorded as the VAS score. Most of the patients stayed only for a day in the hospital and were encouraged to wear a half-thigh-type elastic bandage or stocking for 24 h for a week without bathing. Furthermore, patients with severe pain were asked to continue with the compression therapy until their symptoms improved.

Statistical analysis was performed through the comparison of continuous variables using Student's t-test and Wilcoxon signed-rank test. Differences were considered significant for p-values of 0.05. VAS for pain and wound discomfort was measured 1 and 7 days and 1 and 3 months post operation.

Table 2 Postoperative data

Parameters	Results
1 day, pain of leg	57.12%
7 days, ecchymosis, bruising, %	82.41%
3 months, occlusion rate, %	100%
Mean GSV ablation length, cm	16.1±2.8 cm
Mean LEED, J/cm	132.8±10.2 J/cm

GSV: great saphenous vein; LEED: linear endovenous energy density

Results

Dull pain in the lower leg, swelling, itching, night leg cramps, pigmentation, thrombophlebitis, and skin ulcer were reported as preoperative symptoms. Patient characteristics and disease severity score by CEAP are summarized in Table 1. Mean BMI was 24.9 ± 4.9 (19.6–31.7), and 36.2% of the patients (15 of the 42) showed a high BMI (>25).

Ecchymosis and bruising occurred in 82.4% of the legs 7 days later. Skin ulcers in the lower extremities were present in 11 legs (21.5%). The major complications after EVLA or stripping, such as bruising, discomfort, thrombophlebitis, deep vein thrombosis (DVT), and pulmonary edema, were completely absent after 1 month of operation.

EVLA was used to treat GSV with a mean length of 16.1 ± 2.8 cm. The mean of the maximum GSV diameter was 16.8 ± 3.2 mm (14.6–21.8 mm). The mean LEED was 132.8 ± 10.2 J/cm. The mean of the total number of skin incisions made were 4.1 ± 1.9 parts (Table 2).

The GSV occlusion rate after 3 months was 100%. Endovenous heat-induced thrombus (EHIT) class 1 was observed in four cases (7.8%) on the next day. Although ecchymosis and bruising occurred in 82.4% of the patients 7 days later, the most frequent symptoms in the lower extremities, particularly EHIT, disappeared 2 to 3 weeks later. Furthermore, all EHIT cases were reduced without oral anticoagulation drug after 3 months.

The mean preoperative VAS score was 82.1 ± 12.1 . After operation, the VAS score gradually deteriorated to 31.3 ± 7.9 ($p < 0.0001$), 2.8 ± 3.6 ($p < 0.0001$), and 1.2 ± 1.8 , ($p < 0.0001$) in 7 days, 1 month, and 3 months, respectively. On postoperative day 1, the VAS score indicated a higher score of 84.9 ± 21.3 ($p = 0.089$) than the preoperative VAS score (Fig. 2).

Preoperative leg edema and venous insufficiency of the lower extremities improved in all patients within 1 to 3 months, and the GSV occlusion rate was 100% after 6 to 12 months. For the patient CEAP C4–6, bucladesine, sulfadiazine silver, and trafermin were administered as external medicines for foot care. Each symptom significantly improved after the operation in a few months. The

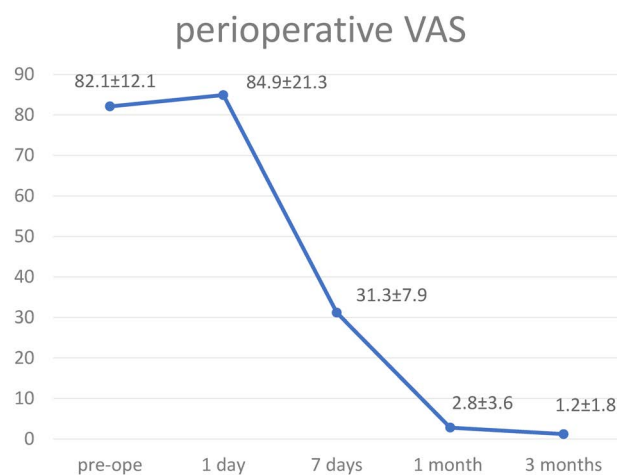


Fig. 2 Perioperative visual analog scale changes.

patients did not receive a second surgery because neither deep venous thrombus nor saphenous nerve injury occurred.

Discussion

In recent years, surgical procedures and devices for the treatment of saphenous varicose veins have changed. The major complications after EVLA and/or stripping includes pain, ecchymosis, bruising, sensory disturbance, leg discomfort, thrombophlebitis, DVT, and pulmonary embolism. RFA and 1470 nm EVLA have been used toward alleviating pain and reducing postoperative recurrence since it became covered by Japan's health insurance in 2015, despite their potential complications of phlebitis, infection, sensory nerve injury, and skin burn or discoloration.^{1,2)} EVLA is minimally invasive and, therefore, improves the cosmetic outcome, resulting in lesser postoperative pain and faster recovery. In 2016, Kurihara et al. reported that 0.4% and 2.7% DVT in the calf veins were detected after treatment with 1470 nm EVLA and EHIT classes 2 and 3, respectively. Furthermore, EHIT cases were resolved within 2–4 weeks in most patients.³⁾

EVLA with a 980 nm diode laser fiber (ELVeS) was reported to be a minimally invasive procedure with improved recovery of postoperative venous function compared with air plethysmography and is similar to stripping.⁴⁾ Furthermore, the 1470 nm EVLA reduced the postoperative recovery time, wound-related complications, and the incidence of skin disorders, such as ecchymosis and bruising, which was significantly lower than that with a 980 nm diode laser fiber (ELVeS). Since 2011, we have chosen EVLA 980 nm as a primary operative method for saphenous varicose veins with a maximum GSV diameter >15 mm. In the period until 2015, we examined the indication for EVLA or stripping with a maximum GSV diameter under 15 mm. In this hospital,

EVLA using 1470nm 2ring fiber was adopted in 2015. Patients with saphenous varicose vein with a maximum venous diameter under 10–15 mm are mostly treated with ablation. We began to undertake combined EVLA with partial stripping, presenting a maximum GSV diameter >15mm and chronic congestive venous symptoms. We have measured the maximum GSV diameter near junctional EVLA area regardless of the saccular or cylindrical type. We should have measured the mean GSV diameter on three points to pursue more accurate results. Now, we have changed the ultrasound procedure so that the mean diameter of the great saphenous vein is >10mm at three points can be measured.

The presence of incompetent tributaries after high ligation is known to cause recurrence. Clinical problems in the late phase are caused by a connection between a remaining segment of GSV and new vessels or incompetent tributaries. Recanalization is recognized as one of the operative complications in the late phase, not only in the case of SFJ but also for incompetent perforators. Fernández et al. reported that post-EVLA operation, 1,559 patients with BMI >30 kg/m², vein diameter >8.5 mm, and LEED <70J/cm had a significantly greater risk of postoperative recanalization using the 980nm diode laser fiber at 14W (watts) in the continuous mode.⁵⁾ Of these, selective/partial stripping and high ligation of GSV were performed on seven and six patients, respectively, by a surgeon previously (until 2018, a total of 1,000 cases were treated through EVLA or RFA at our institution). GSV recanalization was observed in four patients (0.004%) treated by 980nm EVLA. Furthermore, postoperative venous stasis due to reflux may be induced by the remaining branches near the SFJ and the residual branches in the future. Potential factors affecting recurrence are preoperative venous function and the extent of venous reflux (superficial/deep/perforator). Although post-ablation recanalization rate of the treated GSV was encountered more in EVLA than in stripping, the superficial venous recanalization was not likely to be associated with clinical recurrence or quality of life.⁶⁾ Ablation of the Dodd and Boyd perforators may contribute to the prevention of recurrence of skin congestive disorder and a low incidence of incompetent perforators. In the present study, the resection of incompetent perforator veins is important for maintaining an adequate level of venous filling index.⁷⁾ Although this may not lead to recurrence, it is considered to have an influence on the recurrence of venous reflux in the lower extremities. Improved venous stasis in the lower extremities reduce postoperative superficial venous hypertension and cure the congestive skin ulcer. We selected stripping on the distal side one-third below the knee with partial ligation to prevent the Dodd and Boyd perforators from regurgitating in the future.

Generally, post-EVLA ecchymosis and bruising at the treated site was observed in most of the patients, which disappeared within 2 to 3 weeks.^{1,2)} In 2016, Satokawa et al. demonstrated the delivery of 980nm ELVeS laser energy at a mean output power of 10W and mean LEED of 76.7J/cm.¹⁾ We selected 1470nm ELVeS in continuous mode for ablation on a mean high LEED of 132.8J/cm in the Trendelenburg position and compression of SFJ lesion of large saphenous varicose veins during the start of ablation.

In our report, male and severe CEAP classification was more common than that in usual reports.^{1,8-10)} Furthermore, most patients had a history of doing a standing job for an extremely long time. The results of this report show that 57.1% were males, 43.1% were identified with C4, C5, and C6, 21.3% presented with skin ulcers, and very few cases showed severe symptoms. Superficial venous hypertension has been cited as the putative etiologic factor in advanced chronic venous insufficiency with venous skin ulcer (CEAP C5 and 6).⁸⁾ Stuart et al. reported that the deteriorating CEAP grade is associated with an increase in the number of medial calf perforators.⁹⁾ Incompetent perforator veins tended to appear more frequently in the high CEAP stage: C4 (83%), C5, and C6 (90%).

On postoperative day 1, the VAS score indicated a higher peak by a narrow margin than that of the preoperative scale. We selected VAS score for pain not for primary efficacy but for safety assessment after operation. The high-energy EVLA used in our study may have influenced the postoperative ablation wound pain on the next day. However, a preoperative VAS score of 82.1 is exceptionally high. The VAS score for pain and discomfort was mostly measured during outpatient visits and may be related to postoperative symptom alleviation as the result. Postoperative VAS score for wound pain and discomfort of treated site were significantly lower 7 days post operation ($p<0.0001$). Moreover, the VAS score was significantly reduced 1 month later ($p<0.0001$) in patients complaining of skin congestive insufficiency. Although most of the patients complained of ablation and stripping discomfort derived from ecchymosis and bruising, the symptoms disappeared within 3 to 6 days. Postoperative ecchymosis or bruising was mostly observed in the stripping surgical site of legs. Our strategy suggests that EVLA combined with stripping significantly improved the time period for recovery in comparison to that with the conventional stripping technique.

Conclusion

In this study, we obtained a satisfactory outcome from our combined strategy and perioperative treatment for extremely swollen saphenous varicose veins. The results

were limited by the relatively small patient group, presenting with large saphenous varicose veins. Despite single-center limitations, this approach shows the possibility that lower saphenous varicose veins can induce cosmetic and minimally invasive ameliorated intervention to avoid late-phase incompetent perforating vein. Further observation is necessary to certify whether venous branches and perforating or deep venous reflux is associated with the clinical recurrence of recanalization and neonate branch.

Disclosure Statement

The authors declare no conflict of interest.

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