Early Access
Original Article

Veins and Lymphatics

eISSN 2279-7483
https://www.pagepressjournals.org/index.php/vl/index

Veins and Lymphatics 2026 [online ahead of print]

To cite this article:
Pallini C, Arizzi V, Bellandi Alberti PL, et al. Endovascular treatment of the small saphenous vein: comparison between laser ablation and radiofrequency - real-life cases from two Italian centers. Veins and Lymphatics 2026;15:14886. doi:10.4081/vl.2026.14886

Endovascular treatment of the small saphenous vein: comparison between laser ablation and radiofrequency - real-life cases from two Italian centers

Cristina Pallini,[1] Valeria Arizzi,[2] Pier Luca Bellandi Alberti,[3] Carlo Rivellini,[4] Chiara Lomazzi[1]

[1]Maggiore Policlinico Hospital, Department of Cardiothoracic and Vascular Surgery, Milan;

[2]Manerbio Hospital, ASST Garda, Department of General Surgery, Brescia;

[3]Life Clinic, Health Connections, Bergamo;

[4]Mondovì Hospital, Department of General Surgery, Cuneo, Italy;

Abstract

Thermal endovascular techniques, including Endovenous Laser Ablation (EVLA) and Radiofrequency Ablation (RFA), have currently progressively replaced traditional surgery in the treatment of venous insufficiency. Despite this, the literature on the Small Saphenous Vein (SSV) remains heterogeneous, due to the anatomical variability of the venous course, its proximity to the sural nerve, and the limited duration of available follow-up. The purpose of this study is to review the literature of recent years in endovascular treatment of SSV and analyze real-life cases from two Italian centers.

Forty-two patients treated between August 2021 and October 2025 were included: 24 underwent RFA at the Policlinico di Milano and 18 treated with EVLA at the Manerbio Hospital. The variables considered included additional procedures for varicose vein treatment, type of anesthesia, and length of stay. The primary outcomes included the rate of ultrasound-guided occlusion, the occurrence of perioperative and postoperative complications, such as sural nerve neuropathy, Endovenous Heat-Induced Thrombosis (EHIT), bleeding, bruises, and infections, and the need for further treatments during the subsequent follow up.

Concurrent varicose vein treatment was more frequent in the RFA group, with varying techniques. Local anesthesia was the most commonly used method, and the average hospital stay was one day. Both centers reported a 100% occlusion rate, with no recanalizations or need for reoperation. No major complications were observed, and no damage to the sural nerve was recorded.

EVLA and RFA have been confirmed as safe and effective techniques for the treatment of SSV insufficiency in a real-world setting. The choice of method appears to be determined primarily by the center's experience, the technology availability, and the patient's anatomical characteristics, ensuring high efficacy and a comparable safety profile.

Key words: small saphenous vein, endovenous laser ablation, radiofrequency ablation.

Correspondence: Cristina Pallini, Maggiore Policlinico Hospital, Department of Cardiothoracic and Vascular Surgery, Milan, Italy.

E-mail: cristina.pallini@gmail.com

Introduction

Saphenous incompetence of the Great Saphenous Vein (GSV) and, to a lesser extent, of the Small Saphenous Vein (SSV), is a major cause of venous reflux and the clinical manifestations of chronic venous disease, including pain, edema, varicose veins, and trophic lesions. SSV is implicated in about 10-20% of varicose vein cases. In recent years, thermal endovascular techniques have progressively replaced traditional ligation and stripping surgery, thanks to less trauma, faster recovery, and comparable anatomical and clinical outcomes. However, most of the literature and large trials concern the GSV; regarding the SSV, the data are limited and characterized by greater heterogeneity. The aim of this paper is to summarize the current literature on endovascular treatment of the SSV using EVLA and RFA, highlighting the differences in efficacy, occlusion rate and safety.

The SSV is characterized by wide variability in its course and entry into the popliteal vein. Its anatomical structure makes the SSV more susceptible to nerve injury during surgical and endovascular procedures than the GSV. For this reason, technical choices, such as the access site, the distal extension of the treatment, and the selection of the technology used, significantly influence the risk/benefit ratio of the procedure. The principle of EVLA is based on photothermal coagulation of the vein wall using laser energy delivered through an intravenous fiber. The main technical factors include the wavelength (810-1940 nm), the fiber type (bare-tip/radial), and the Linear Energy Density (LEED, expressed in J/cm). The direct thermal effect causes endothelial damage, wall collapse, and subsequent fibrosis, resulting in vessel occlusion. In contrast, RFA uses resistive heating of the vein wall induced by a radiofrequency catheter. The system operates at a controlled temperature or according to a pre-set application time, generating protein denaturation and coagulation until the lumen is occluded. Both techniques allow for targeted intervention on the vein, reducing heat transmission to surrounding tissue, improving contact between the fiber and the wall, and protecting adjacent structures, including the sural nerve. Additionally, several studies on the treatment of SSV recommend avoiding too distal ablation, both in terms of the insertion site and

the extent of treatment, particularly below the mid-calf, to reduce the risk of sural nerve injury. Available evidence indicates that EVLA applied to SSV ensures high short-term occlusion rates, with values reaching approximately 98% at 3 months. Medium- term and long-term results are variable, influenced by numerous factors, including the technique, the length of the treated segment, and the timing of follow-up. RFA also shows comparable closure rates, documented in observational studies with medium-term follow-up. Sural nerve injury, manifesting as paresthesia, hypoesthesia, or neuropathic pain, is the most significant complication in the treatment of SSV. Limiting ablation above the mid-calf, combined with careful tumescence, significantly reduces this risk. The literature reports variable paresthesia rates, ranging from 1-3%. The management of SSV insufficiency by endovenous ablation has been the subject of numerous studies, although the literature specific to SSV is far less than that for GSV. The 2016 Cochrane systematic review by Paravastu *et al.* examined the efficacy and safety of EVLA, RFA, and foam sclerotherapy compared with traditional surgery in the management of SSV insufficiency.[1] The results indicate that EVLA and RFA achieve occlusion rates similar to those of traditional surgery in the short term, confirming the efficacy of both techniques. Sural nerve injury is the main neurological complication, but it tends to be transient. The overall quality of evidence was moderate-low, primarily due to the limited number of studies and the short follow-up periods available. Therefore, it is currently not possible to definitively establish the superiority of one technique over the other, specifically for SSV. The authors underline the need for larger Randomized Controlled Trials (RCTs) with extended follow-up. The study by Park J. *et al.* evaluated the medium-term results of RFA in the management of SSV insufficiency in 39 patients.[2] The SSV obliteration rate was 93.4% at 1 year and 89.1% at 2 years. Clinical improvement was confirmed by CEAP and CIVIQ2 scores. A higher preoperative reflux rate was identified among the predictors of recanalization. Sural neuritis occurred in a few cases. A small number of studies reports solid long-term data on the treatment of SSV with EVLA: in a study that followed 42 patients, after a mean follow-up of 114 months, only 5% required further treatments. Almost all patients maintained a stable clinical improvement, accompanied by a low

recanalization rate.[3] Another prospective study on EVLA evaluated patients with saphenous insufficiency at 12 months: in the 62 cases of SSV insufficiency, no recanalizations were diagnosed by ultrasound.[4] In addition to these SSV-specific reports, larger retrospective datasets on thermal ablation provide important complementary information on durability and recanalization patterns across both GSV and SSV trunks. In a retrospective review of 1,475 thermal ablations, including 401 SSV procedures, Aurshina *et al.* reported low recanalization rates for both GSV and SSV and found no significant difference between RFA and EVLA in recurrence rates at short- and mid-term follow-up.[5] More recently, a large Vascular Quality Initiative (VQI) analysis published in Annals of Vascular Surgery evaluated 16,937 thermal ablation procedures performed in 13,263 patients between 2015 and 2019, including both GSV and SSV treatments.[6] Although not specific to the SSV, this study is highly relevant because it confirmed that larger saphenous vein diameter (≥10 mm) was not associated with worse recanalization-free survival after thermal ablation, supporting the use of endovenous thermal techniques even in larger-caliber trunks and providing a robust real-world benchmark for anatomical durability. A 2025 meta-analysis including 68 studies compared the main treatments of SSV insufficiency.[7] In the short-term follow-up (≤3 months), RFA showed an anatomical success rate of 98.4%, while EVLA showed excellent medium-long term results (96.1% medium term, 94.3% long term). The most frequent complication was sural nerve injury, with an incidence of around 3%. The ESVS 2022 guidelines[8] recommend, for the treatment of symptomatic reflux of the SSV, to prefer endovenous thermal ablation or, alternatively, non-thermal techniques. The choice of technique must take into account patient preference, the anatomical configuration of the vein, the experience of the center and the surgeon's expertise. Although preliminary results are favorable, the availability of studies with extended follow-up remains limited. Therefore, it is necessary to conduct prospective, multicenter studies, characterized by large samples and prolonged follow-up, in order to obtain more robust and generalizable estimates of anatomical and clinical outcomes. Despite growing evidence on the use of EVLA and RFA in the treatment of small saphenous vein insufficiency, significant gaps remain in the literature, especially

regarding real-world clinical practice. Specific data on SSV are limited, characterized by short follow-up and a small sample size. There is a lack of multicenter studies with detailed clinical and ultrasound evaluations that directly compare the two techniques and document the durability of results, neurological complications, and long-term clinical outcomes. This study aims to analyze real-life case series of patients treated for SSV insufficiency at two Italian centers between 2021 and 2025, comparing EVLA and RFA in terms of anatomical efficacy, safety, and clinical outcomes.

Materials and Methods

A retrospective, observational study was conducted on adult patients with an ultrasound diagnosis of SSV insufficiency, treated with endovenous thermal ablation at two Italian centers: Ospedale Maggiore Policlinico in Milan and Manerbio Hospital in Brescia. The observation period was between August 2021 and October 2025. Patients were treated with RFA at the Policlinico in Milan and with EVLA at the Manerbio Hospital. A total of 42 patients were included, of whom 24 were treated with RFA at the Policlinico in Milan and 18 were treated with EVLA at the Manerbio Hospital in Brescia.

Despite the high anatomical variability of the small saphenous vein outlet, the majority of cases included in the study had the typical termination at the popliteal vein. In both patient groups, the mean diameter of the small saphenous vein was 4.0±0.19 mm, associated with significant reflux (≥0.5 seconds) and a patent, competent deep venous system at the popliteal level. Two cases in the RFA group presented anatomical variations: in one patient, the SSV outlet was wide (>2 cm), while in the other, the SSV communicated with a gastrocnemius vein.

Detailed data for each case, including the saphenous outlet, the diameter of the treated SSV, and the continence/incontinence of the deep venous circulation at the popliteal level, are reported in Table 1.

In the RFA group, the mean age of patients was 55.9 years, with a female quantity of 71% and a male one of 29%. In the EVLA group, the mean age was 56.6 years, with a female predominance of 67% and a male one of 33%. In the RFA group, procedures were performed using the ClosureFast 7-3-60 catheter under local anesthesia in 23 of 24 patients; in a single case, a popliteal plexus block was performed. Additional procedures were performed in several patients to treat concomitant varices, including: 19 cases of Müller varicectomy of the thigh and leg, 2 cases of perforating vein ligation of the leg, 1 case of ultrasound-guided perforating vein sclerotherapy, 3 cases of foam sclerotherapy of peripheral varices, and 3 cases of sclerotherapy of peripheral varices. In two patients, the RFA procedure of the small saphenous vein was completed with ligation of the saphenous-popliteal cross.

In the EVLA group, treatment was performed using a 6-Fr Radial double-ring laser fiber with a wavelength of 1470 nm. In all cases, the procedure was completed under local anesthesia and was well tolerated. A power setting of 5 watts was set, calibrated to the diameters of the treated veins. Vein shrinkage, tactile sensitivity, and a harmonious pullback were the primary technical skills guiding the procedure. In addition to the primary procedure, 9 patients underwent Müller phlebectomies of the thigh and leg for the concomitant treatment of superficial varicose veins.

Both techniques were conducted following the fundamental principles of endovenous ablation: ultrasound-guided introduction of the fiber into the venous lumen, infusion of peri-saphenous Klein solution to ensure tumescent anesthesia along the treated segment, and controlled heating of the venous wall to achieve definitive occlusion of the vessel. The choice of additional methods was guided by the extent of varicose disease and the surgeon's experience. The outcomes considered included the percentage of ultrasound-guided occlusion of the treated vein in the post-procedural evaluation, the incidence of peri- and post-operative complications such as sural nerve neuropathy, EHIT, bleeding, bruising, and surgical site infections, as well as the possible occurrence of recanalization or the need for further treatments during follow-up. The length of hospital stay was also analyzed.

Results

The occlusion rate of the small saphenous vein was 100% in both centers cases, both in the immediate postoperative period and in available follow-up, with no cases of recanalization. No major complications were observed in either treatment group. Specifically, no sural neuropathies, either transient or permanent, were observed, and no episodes of EHIT, clinically significant ecchymoses or hematomas, or surgical site infections were documented. Associated procedures were more frequent in the RFA group, in which varicectomy and complementary sclerosing procedures were performed, while in the EVLA group phlebectomies were performed in approximately half of the patients. The mean hospital stay was comparable between the two centers: 1.25 days for the RFA group and 1 day for the EVLA group, with no need for re-hospitalization in any case.

Discussion

In this real-life observational study, both thermal endovascular techniques demonstrated high efficacy in the treatment of small saphenous vein insufficiency, with a 100% occlusion rate. This result is consistent with the main recent literature findings, which report success rates between 95% and 99% for both methods. Our findings are also in line with larger retrospective series and registry-based analyses showing durable anatomical results after thermal ablation. In particular, the retrospective study by Aurshina *et al.* found similarly low recanalization rates in saphenous trunks, with no significant difference between RFA and EVLA, while the recent VQI analysis by Pisharody *et al.* confirmed, in a very large real-world cohort, that even larger-diameter saphenous veins do not appear to have inferior recanalization-free survival after thermal ablation.[5,6] Although these studies are not exclusively focused on the SSV, they strengthen the interpretation of our data and support the overall durability of endovenous thermal treatment in routine clinical practice.

The absence of sural nerve injury in our cohort is a particularly relevant finding. Given the close anatomical relationship between the SSV and the sural nerve, postoperative neuropathy remains the most characteristic neurological complication of SSV treatment. In this context, the ESVS 2022 guidelines favor endovenous thermal ablation over conventional surgery for symptomatic SSV reflux is particularly pertinent, as surgery at the saphenopopliteal junction has historically carried a greater risk of nerve injury.[9] The absence of neuropathic complications among the treated patients was likely attributable to careful ultrasound-guided access, adherence to the mid-calf safety limit, and adequate tumescent infiltration with Klein solution. Similarly, no cases of EHIT, a rare but potentially serious event, were recorded, in accordance with the most recent ESVS guidelines. The overall safety of both techniques was excellent: no clinically significant hematomas, surgical site infections, bleeding episodes or documented recanalization occurred. This result is particularly relevant considering that, in the RFA group, a great proportion of patients underwent additional procedures, potentially associated with a higher risk of adverse events. It is important to emphasize the need for a complete and in-depth preoperative hemodynamic assessment of the small saphenous vein. Such evaluation should consider variations in the SSV outlet, as well as the possible presence of gastrocnemius vein converging into the SSV instead of directly into the popliteal vein. Recognition of these anatomical patterns is crucial to correctly identify the SSV segment requiring thermal ablation, to optimize procedural planning, minimize the risk of nerve injury, and reduce the likelihood of recanalization or incomplete treatment.

Regarding the choice of thermal ablation technique, at Manerbio Hospital only EVLA was performed, due to the center's established expertise and training in laser ablation, as RFA is not part of their routine procedural practice. At the Policlinico in Milan, both RFA and EVLA are within the center's technical capabilities; however, for organizational reasons, only RFA was performed during the study period. Therefore, the differences observed between the two centers primarily reflect local experience and logistical availability, rather than patient selection criteria or clinical indications.

All procedures at both centers were performed by experienced and qualified teams.

In two cases treated with RFA, surgical ligation of the saphenopopliteal junction was performed due to specific anatomical features. In one case, the SSV outlet was wide (>2 cm), while in the other case, the small saphenous vein communicated with a twin vein. In these situations, ligation was necessary to ensure complete occlusion of the refluxing segment and to reduce the risk of recanalization.

The average hospital stay was short in both groups, confirming the minimally invasive nature of endovascular techniques and the quick return to daily activities.

Conclusions

The study underlines how both endovenous thermal ablation techniques, RFA and EVLA, represent effective and safe options for the treatment of small saphenous vein insufficiency in a real-world clinical setting. Both groups achieved a 100% occlusion rate with no evidence of sural neuropathy nor other complications, with a favorable tolerability profile and rapid postoperative discharge. Standardization of the procedural pathway at the two centers, both with extensive phlebology experience, likely contributed to the reduced incidence of adverse events. Based on the currently available data, RFA and EVLA can be considered substantially equivalent methods in terms of anatomical efficacy and safety, while the choice of one over the other appears to be influenced more by the center's experience, the availability of each technology, and the patient's specific anatomical characteristics. Prospective multicenter studies, conducted on larger samples and with prolonged follow-up, will be necessary to more precisely define the durability of the occlusion and to identify any differences in long-term clinical outcomes.

References

1. 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.

2. Park JY, Galimzahn A, Park HS, et al. Midterm results of radiofrequency ablation for incompetent small saphenous vein in terms of recanalization and sural neuritis. Dermatol Surg 2014;40:383-9.

3. Pavei P, Spreafico G, Bernardi E, et al. Favorable long-term results of endovenous laser ablation of great and small saphenous vein incompetence with a 1470-nm laser and radial fiber. J Vasc Surg Venous Lymphat Disord 2021;9:352-60.

4. Spreafico G, Piccioli A, Bernardi E, et al. Endovenous laser ablation of great and small saphenous vein incompetence with a 1470-nm laser and radial fiber. J Vasc Surg Venous Lymphat Disord 2014;2:403-10.

5. Aurshina A, Alsheekh A, Kibrik P, et al. Recanalization after endovenous thermal ablation. Ann Vasc Surg 2018:52:158-62.

6. Pisharody V, Gunasti J, Garcia I, et al. Recanalization in large-diameter saphenous veins after thermal ablation: a retrospective review of vascular quality initiative data. Ann Vasc Surg 2026:123:199-206.

7. Oud S, Alozai T, Jamaludin FS, et al. Anatomic success of treatment modalities for small saphenous vein incompetence: a systematic review and network meta-analysis. Eur J Vasc Endovasc Surg 2026;71:135-45.

8. De Maeseneer MG, Kakkos SK, Aherne T, et al. 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.

9. De Maeseneer MG, Kakkos SK, Aherne T, et al. 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 Feb;63(2):184-267.

Contributions: all the authors made a substantive intellectual contribution. All the authors have read and approved the final version of the manuscript and agreed to be held accountable for all aspects of the work.

Conflict of interest: the authors declare no potential conflict of interest.

Funding: none.

Ethics approval and consent to participate: not applicable.

Informed consent: the manuscript does not contain any individual person's data in any form.

Patient's consent for publication: the patients gave their written consent to use their personal data for the publication of this paper and any accompanying images.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

Table 1. Case-specific data: Small Saphenous Vein (SSV) mean diameter, saphenous outlet and deep venous continence at the popliteal level.

	RFA group (n=24)	**EVLA group (n= 18)**
Saphenopopliteal junction	96%	100%
SSV-gastrocnemius vein communication	4%	
Popliteal deep vein continence	100%	100%
SSV mean diameter	4.0±0.19 mm	4.0±0.19 mm

RFA, Radiofrequency Ablation; EVLA, Endovenous Laser Ablation; SSV, Small Saphenous Vein