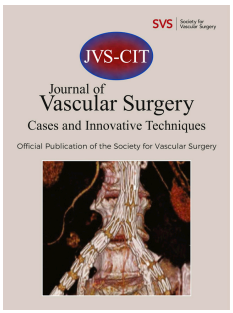
Journal Pre-proof



Segmental point obliteration technique (SPOT) for nerve-sparing endovenous laser ablation of the below-knee great saphenous vein

Chih-Chun Yang, MD

PII: S2468-4287(26)00352-7

DOI: https://doi.org/10.1016/j.jvscit.2026.102468

Reference: JVSCIT 102468

To appear in: *Journal of Vascular Surgery Cases, Innovations and Techniques*

Received Date: 10 July 2026

Revised Date: 8 August 2026

Accepted Date: 18 August 2026

Please cite this article as: C.-C. Yang, Segmental point obliteration technique (SPOT) for nerve-sparing endovenous laser ablation of the below-knee great saphenous vein, *Journal of Vascular Surgery Cases, Innovations and Techniques* (2026), doi: https://doi.org/10.1016/j.jvscit.2026.102468.

Article Type: Innovative Technique

Journal: Journal of Vascular Surgery Cases, Innovations and Techniques (JVS-CIT)

Title: Segmental point obliteration technique (SPOT) for nerve-sparing endovenous laser ablation of the below-knee great saphenous vein

Author: Chih-Chun Yang, MD

Affiliation: Good Leg Clinic, Taichung, Taiwan

Corresponding Author

Chih-Chun Yang, MD

Good Leg Clinic, No. 8, Dunmu 6th St, Beitun District, Taichung City, 406, Taiwan

Email: yycoolj@gmail.com

Tel: +886-4-2437-9900

Word count (main text, excluding abstract and references): 1136

Abstract word count: 98

Keywords: Endovenous laser ablation; Great saphenous vein; Saphenous nerve; Paresthesia; Varicose veins

Conflict of Interest: None

Funding: None

Author Contributions: Chih-Chun Yang — conception and design, performance of the procedures, data collection and analysis, drafting and critical revision, and final approval of the manuscript.

Segmental point obliteration technique (SPOT) for nerve-sparing endovenous laser ablation of the below-knee great saphenous vein

ABSTRACT

Endovenous thermal ablation of the below-knee great saphenous vein (GSV) risks saphenous nerve injury because the vein and nerve lie in close apposition. We propose the segmental point obliteration technique (SPOT), which delivers intermittent point-by-point laser pulses (6 W, ≈1 mm) instead of continuous pullback, with an interval of 1 to 2 seconds between pulses. In 13 patients (19 limbs) followed for 1 month, no paresthesia occurred and all limbs occluded completely. SPOT appears feasible for nerve-sparing below-knee GSV ablation, although more comparative longer-term studies are needed to determine its efficacy and overall role in below-knee GSV treatment.

Keywords: Endovenous laser ablation; Great saphenous vein; Saphenous nerve; Paresthesia; Varicose veins.

INTRODUCTION

Endovenous thermal ablation is first-line treatment for great saphenous vein (GSV) insufficiency, and guidelines recommend treating the full length of the incompetent vein when reflux extends below the knee.[1,2] Above-knee–only ablation produces markedly higher reintervention rates than extended ablation[3-5] and leaves persistent below-knee reflux in 41% to 82% of limbs; mid-term symptomatic recurrence is likewise lower when the entire refluxing GSV is ablated.[4,6]

The saphenous nerve runs in close and variable apposition to the GSV in the distal calf.[7] Perivenous tumescence reduces the risk of nerve injury but does not eliminate it, and thermal ablation of this segment carries a reported risk of paresthesia of approximately 4% to 16%.[8,9]

Reducing power lowers this risk but couples it to occlusion efficacy: because lowering power also lowers the dose delivered to the vein wall, energy density must be interpreted together with the power used.[10] We reasoned that changing *how* energy is delivered—rather than only *how much*—might separate these effects, and we propose the segmental point obliteration technique (SPOT).

TECHNIQUE

Ethics. All patients gave written informed consent for the procedure and for publication of anonymized data and images. This report of a standard outpatient procedure was exempt from institutional review board approval.

Setting and equipment. Procedures are performed under local tumescent anesthesia in an outpatient setting using a 1470-nm diode laser (Veincare; WONTECH, Daejeon, South Korea) with a radial fiber selected by maximum treated vein diameter: a 400-μm fiber (BA400R; WONTECH) for veins smaller than 5 mm and a 600-μm fiber (BA600R; WONTECH) for 5 mm or larger.

Access and tumescence. Under ultrasound guidance the GSV is accessed at the most distal point of reflux and the fiber tip advanced to 2 cm distal to the saphenofemoral junction. Tumescent solution (1000 mL of 0.9% saline, 20 mL of 2% lidocaine, 1 mL of 1:1000 epinephrine, and 20 mL of 7% sodium bicarbonate) is infiltrated circumferentially along the whole segment.

Two-zone protocol. The zone transition is the intraoperative level at which the vein lies within 5 mm of the skin and tumescent separation of the nerve becomes more difficult. *Zone 1 (above-knee)*, where the nerve is anatomically distant, is treated with standard continuous pullback at 6–7 W (linear endovenous energy density [LEED], 60–70 J/cm); *Zone 2 (below-knee)* with SPOT (Fig 1).

SPOT parameters. Instead of continuous pullback, SPOT delivers discrete 1-second pulses at 6 W (6 J per spot), applied 8 to 10 times per centimeter (Table I). After each pulse the fiber is withdrawn approximately 1 mm and the tip reconfirmed sonographically before the next pulse, giving an inter-pulse interval of approximately 1 to 2 seconds. The 1-mm spacing approximates the fiber's effective heating diameter, producing contiguous treatment, while each pause allows partial heat dissipation absent from continuous pullback. This "stop-and-shoot" approach is demonstrated in Video 1.

Adjunctive procedures. Residual superficial tributaries are treated in the same session by ambulatory phlebectomy when indicated.

Outcome assessment. The primary outcome, saphenous nerve paresthesia, was defined as patient-reported paresthesia, dysesthesia, or hypoesthesia in the saphenous nerve distribution, elicited by direct questioning at each visit; where reported, the affected area was mapped with a blunt point. Asymptomatic limbs underwent no routine sensory testing, and nerve conduction studies were not performed.

RESULTS

Between January and June 2026, 13 consecutive patients (19 limbs) with symptomatic C3–C6 below-knee GSV insufficiency underwent ablation with SPOT (Table I). Seven patients (53.8%) were women, 6 (46.2%) were treated bilaterally, and 10 (76.9%) underwent concomitant phlebectomy. No paresthesia occurred at 1 week (0/19). At 1 month all 19 limbs showed complete duplex occlusion (100%; 95% CI, 82.4%–100%; Fig 2) with no paresthesia (0/19; 95% CI, 0%–17.6%). No deep vein thrombosis, endovenous heat-induced thrombosis, skin burn, or wound infection occurred (Table II).

DISCUSSION

In this initial series no paresthesia occurred and all assessed limbs occluded completely, suggesting that intermittent point-by-point delivery is feasible below the knee.

To our knowledge, SPOT is the first below-knee GSV technique to protect the nerve by delivering energy as discrete, spaced points with inter-spot cooling. Existing nerve-sparing approaches reduce the delivered power or use nonthermal energy.[11,12] Utoh and Tsukamoto reported no saphenous nerve injury after reducing below-knee power to 5 W (20–25 J/cm) with continuous ablation in 370 limbs.[12] Because lower power and energy density may leave vein-wall injury incomplete, SPOT maintains power at the above-knee level and an energy density of 48 to 60 J/cm, altering only the mode of delivery. We hypothesize that the pauses limit cumulative thermal spread to the nerve—a mechanism this series cannot confirm—consistent with data showing that delivery mode, not total energy alone, influences vein-wall injury.[13] Compared with radiofrequency ablation, which heats a 7-cm segment continuously for 20 seconds per activation, SPOT applies 1 second to approximately 1 mm, shortening continuous heating at any point.[14] We believe this further limits thermal exposure of adjacent tissues including the nerve, but its magnitude, and whether a dispersed thermal effect lessens nerve injury itself, await experimental verification.

Factors other than SPOT could account for these results. Tumescent anesthesia itself reduces the risk of nerve injury[7] and was applied identically in both zones; it does not, however, eliminate the excess risk of the below-knee segment, where published series report higher nerve injury after full-length than above-knee ablation despite routine tumescence (15.7% vs 4.5% at 1 month).[9] SPOT is applied in addition to tumescence and is intended to reduce that residual risk further. A single-arm series nonetheless cannot isolate the contribution of any individual component. Most patients also underwent phlebectomy, which can itself place the nerve at risk;

the absence of paresthesia despite this exposure is reassuring but equally cannot be attributed to SPOT.

SPOT requires continuous ultrasound visualization of the fiber tip and should not be attempted when the tip cannot be seen. Point-by-point delivery increases operator dependence and procedural time.

Limitations. This single-arm, single-operator series lacked a control group and blinded assessment. The sample is small: with no events in 19 limbs the exact 95% confidence interval extends to 17.6%, so a clinically relevant rate cannot be excluded, and the series argues against rates as high as 15.7%[9] but cannot distinguish SPOT from published rates of about 4%[8] or establish superiority over continuous pullback. No tissue thermometry was performed, the inter-pulse interval was not timed systematically, and the minimum interval required to prevent cumulative heating remains undefined, so the thermal rationale remains hypothetical. Paresthesia was ascertained from symptoms and bedside examination, not nerve conduction studies, so subclinical changes would not have been detected—although published data show poor concordance between conduction measures and symptoms.[15] Follow-up was limited to 1 month. Long-term follow-up is needed to confirm these results.

CONCLUSIONS

The segmental point obliteration technique (SPOT)—intermittent, point-by-point delivery with inter-spot cooling—was associated with complete occlusion and no paresthesia in this initial experience with nerve-sparing below-knee GSV ablation. These preliminary results support comparison with continuous pullback in larger, controlled studies.

Funding: None.

Disclosures: None.

REFERENCES

1. Gloviczki P, Lawrence PF, Wasan SM, Meissner MH, Almeida J, Brown KR, et al. The 2022 Society for Vascular Surgery, American Venous Forum, and American Vein and Lymphatic Society clinical practice guidelines for the management of varicose veins of the lower extremities. Part I. J Vasc Surg Venous Lymphat Disord. 2023;11(2):231-261.e6.

2. De Maeseneer MG, Kakkos SK, Aherne T, Baekgaard N, Black S, Blomgren L, 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(2):184-267.

3. Theivacumar NS, Dellagrammaticas D, Mavor AI, Gough MJ. Endovenous laser ablation: does standard above-knee great saphenous vein ablation provide optimum results in patients with both above- and below-knee reflux? A randomized controlled trial. J Vasc Surg. 2008;48(1):173-8.

4. Theivacumar NS, Darwood RJ, Dellagrammaticas D, Mavor AI, Gough MJ. The clinical significance of below-knee great saphenous vein reflux following endovenous laser ablation of above-knee great saphenous vein. Phlebology. 2009;24(1):17-20.

5. Sussman MS, Ryon EL, Bahga A, Almeida S, Almeida JI. A systematic review of the treatment of residual below the knee venous reflux after endovenous thermal ablation of the great saphenous vein. J Vasc Surg Venous Lymphat Disord. 2022;10(1):233-240.

6. Vaddavalli VV, Sen I, Shuja F, Colglazier J, Rasmussen T, DeMartino R, et al. Going the distance: endovenous ablation of the entire refluxing great saphenous is associated with lower mid-term symptomatic recurrence [abstract]. J Vasc Surg Venous Lymphat Disord. 2024;12(3):101764.

7. Veverková L, Jedlicka V, Vlcek P, Kalac J. The anatomical relationship between the saphenous nerve and the great saphenous vein. Phlebology. 2011;26(3):114-8.

8. Gifford SM, Kalra M, Gloviczki P, Duncan AA, Oderich GS, Fleming MD, et al. Reflux in the below-knee great saphenous vein can be safely treated with endovenous ablation. J Vasc Surg Venous Lymphat Disord. 2014;2(4):397-402.

9. Zhang Y, Lin X, Wang Z, Li W, Wang Y, Bian J, et al. Surgical outcomes of above-knee versus full-length endovenous laser ablation for great saphenous vein varicose veins. J Vasc Surg Venous Lymphat Disord. 2026;14(1):102342.

10. Nielsen AG, Croucher AA, Muschamp SD, Losty E, Worthington T, Kiely MJ, et al. Linear endovenous energy density (LEED) should always be quoted with the power used in endovenous thermal ablation - results from an in-vitro porcine liver model study. Phlebology. 2023;38(3):172-180.

11. Bontinis V, Bontinis A, Koutsoumpelis A, Chorti A, Rafailidis V, Giannopoulos A, et al. A network meta-analysis on the efficacy and safety of thermal and nonthermal endovenous ablation treatments. J Vasc Surg Venous Lymphat Disord. 2023;11(4):854-865.e5.

12. Utoh J, Tsukamoto Y. Prevention of saphenous nerve injury after below-knee laser ablation of incompetent great saphenous veins: a trial of two-step ablation and an early result. Phlebology. 2023;38(7):484-485.

13. Massaki AB, Kiripolsky MG, Detwiler SP, Goldman MP. Endoluminal laser delivery mode and wavelength effects on varicose veins in an ex vivo model. Lasers Surg Med. 2013;45(2):123-9.

14. Creton D, Pichot O, Sessa C, Proebstle TM; ClosureFast Europe Group. Radiofrequency-powered segmental thermal obliteration carried out with the ClosureFast procedure: results at

1 year. Ann Vasc Surg. 2010;24(3):360-6.

15. Yilmaz S, Delikan O, Aksoy E. Saphenous nerve injury after endovenous laser ablation of incompetent greater saphenous vein: An electroneuromyography study. Phlebology. 2016;31(2):106-10.

Table I. Patient, vein, and procedural characteristics (13 patients, 19 limbs)

Variable	Value
Age, years, mean ± SD (range)	58 ± 20 (31–87)
Female, n (%)	7 (53.8)
Bilateral treatment, n (%)	6 (46.2)
CEAP class, n limbs (C3 / C4 / C6)	8 / 7 / 4
Above-knee GSV diameter, mm, mean ± SD	5.3 ± 0.9
Below-knee GSV diameter, mm, mean ± SD	3.1 ± 0.5
Below-knee GSV depth from skin, mm, mean ± SD	4.3 ± 1.3
Total GSV treated length, cm, mean ± SD (range)	59.5 ± 10.2 (30–75)
Below-knee (SPOT) segment length, cm, mean ± SD	21.2 ± 3.2
Radial fiber, 400-µm / 600-µm, n limbs	6 / 13
Above-knee power, W	6–7
Below-knee (SPOT) power, W	6
Below-knee (SPOT) LEED, J/cm	48–60
Concomitant phlebectomy, n (%)	10 (76.9)

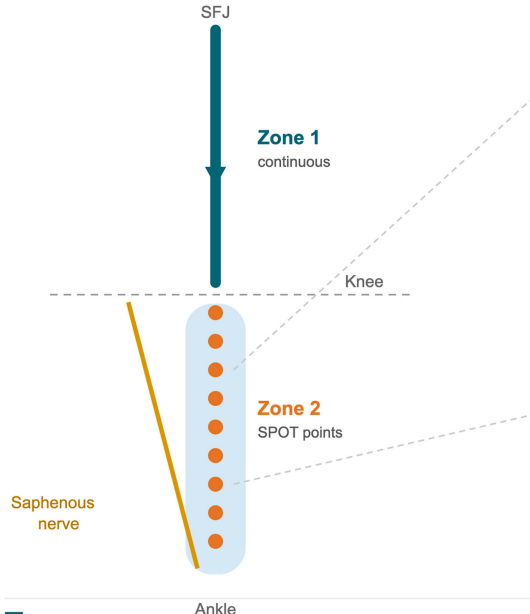
CEAP, Clinical-Etiology-Anatomy-Pathophysiology; GSV, great saphenous vein; LEED, linear endovenous energy density; SD, standard deviation; SPOT, segmental point obliteration technique.

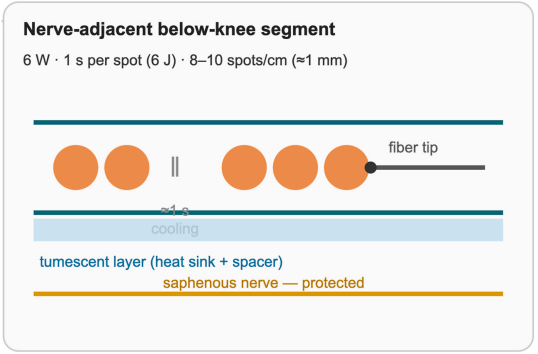
Table II. Outcomes and adverse events (19 limbs)

Outcome	Value
Paresthesia at 1 week, n/N (%)	0/19 (0)
Paresthesia at 1 month, n/N (%)	0/19 (0); 95% CI, 0–17.6
Complete occlusion at 1 month, n/N (%)	19/19 (100); 95% CI, 82.4–100
Deep vein thrombosis, n (%)	0 (0)
Endovenous heat-induced thrombosis, n (%)	0 (0)
Skin burn, n (%)	0 (0)
Wound infection, n (%)	0 (0)

CI, confidence interval (Clopper-Pearson exact).

Two-zone protocol for below-knee GSV ablation





Zone 1 (above-knee): continuous pullback · 6–7 W · LEED 60–70 J/cm

Zone 2 (below-knee, SPOT): intermittent points · 6 W · 1 s/spot · 8–10/cm · LEED 48–60 J/cm · inter-spot cooling

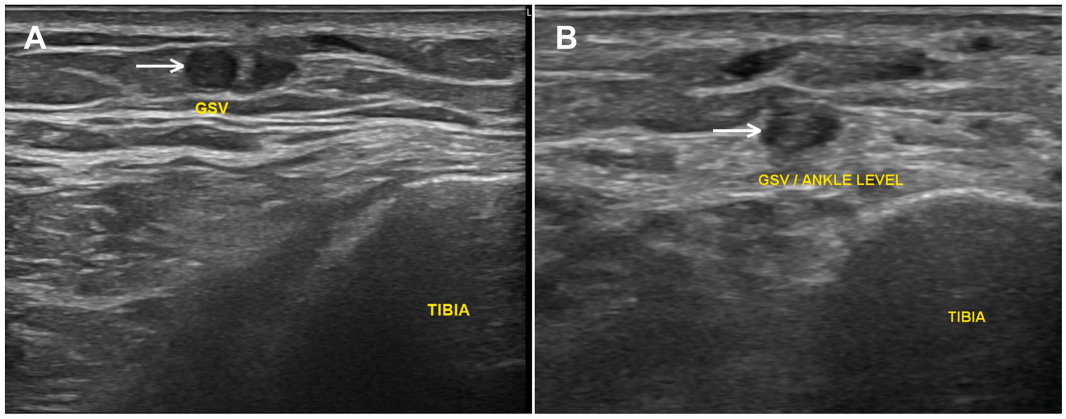

A
GSV
TIBIA
B
GSV / ANKLE LEVEL
TIBIA

FIGURE LEGENDS

Fig 1. Schematic of the two-zone protocol for below-knee great saphenous vein ablation: continuous pullback in the above-knee segment (Zone 1) and the segmental point obliteration technique (SPOT) in the nerve-adjacent below-knee segment (Zone 2), with a magnified inset of SPOT delivery. Parameters and structures are labeled on the figure. LEED, linear endovenous energy density; SFJ, saphenofemoral junction; SPOT, segmental point obliteration technique.

Fig 2. B-mode duplex ultrasound of the below-knee great saphenous vein (GSV) at the distal tibia/ankle level in a representative patient. (A) Before treatment, the patent vein appears as a round anechoic lumen (arrow); (B) at 1 month after SPOT, the vein is occluded, with loss of the anechoic lumen (arrow). GSV, great saphenous vein; SPOT, segmental point obliteration technique.