VER
Vascular & Endovascular Review

Incidence of Sural Nerve Injury following Endovenous Laser Ablation of the Short Saphenous Vein: A Prospective Observational Study

Dr Rajesh G Patil[1], Dr Preksha Sharma[2], Dr Aditya Salian[3]

[1]Associate Professor, Department of General Surgery, Byl Nair Charitable Hospital, Mumbai.
[2]Senior Resident, Department of General Surgery, Byl Nair Charitable Hospital, Mumbai.
[3]Junior Resident, Department of General Surgery, Byl Nair Charitable Hospital, Mumbai.
Corresponding Author: Dr Rajesh G Patil

ABSTRACT

Background: Endovenous laser ablation (EVLA) is now the treatment of choice for symptomatic short saphenous vein (SSV) reflux, but the close anatomical relationship between the SSV and the sural nerve places the nerve at risk of thermal injury. Reported rates of post-operative paraesthesia vary widely, and the natural history of nerve recovery is poorly characterised in prospective cohorts. Materials and Methods: In this prospective observational study, 50 consecutive adult patients undergoing 1470-nm radial-fibre EVLA for symptomatic SSV reflux (with or without saphenopopliteal junction incompetence) at a tertiary-care teaching hospital were followed for 3 months. CEAP classification, vein diameter and delivered laser energy were recorded. Patients were assessed for numbness, tingling and burning pain along the sural nerve distribution at post-operative day (POD) 0, POD 1, 1 week, 1 month and 3 months; symptoms persisting beyond 1 month were further evaluated with nerve conduction studies (NCS). Associations between sural nerve injury and age, sex and CEAP subclass were analysed using Fisher's exact test. Results: Mean age was 45.7 ± 11.6 years (range 18–79) with a male predominance (72%). Mean SSV diameter was 3.66 ± 0.83 mm and mean energy delivered was 1171.4 ± 124.8 J. Sural nerve symptoms occurred in 5/50 patients (10%; 95% CI 4.3–21.4%), most commonly numbness (6%) and burning pain (4%) at POD 1 and 1 week. Symptoms resolved completely within 1 month in 4 of 5 patients; 1 patient (2%) had persistent injury confirmed on NCS at 3 months. No significant association was found between injury and age, sex, or CEAP classification (all $p>0.05$), though injury rates were numerically higher in C4 disease. Conclusion: EVLA of the SSV, performed with energy titration and generous ultrasound-guided tumescent anaesthesia, carries a modest and largely self-limiting risk of sural nerve injury, with the great majority of cases resolving within 1 month on conservative management.

KEYWORDS: Varicose veins; Endovenous laser ablation; Short saphenous vein; Sural nerve injury; CEAP classification; Nerve conduction study.

How to Cite: Dr Rajesh G Patil, Dr Preksha Sharma, Dr Aditya Salian, (2024) Incidence of Sural Nerve Injury following Endovenous Laser Ablation of the Short Saphenous Vein: A Prospective Observational Study, Vascular and Endovascular Review, Vol.7, No.2, 501-508

INTRODUCTION

Lower limb varicose veins are among the commonest vascular disorders, affecting up to 35% of women and 15% of men [1,2], and can substantially impair quality of life through cramping, itching, leg heaviness, pigmentation, and ulceration arising from chronic venous insufficiency and venous hypertension.

High ligation and stripping of the great saphenous vein (GSV) was, for decades, the standard treatment for axial reflux; evidence supporting an equivalent surgical strategy for the short saphenous vein (SSV) has always been comparatively weaker, and persistent or recurrent popliteal fossa reflux after saphenopopliteal disconnection has been reported in a substantial minority of patients [3]. Since the early 2000s, minimally invasive endovenous techniques — endovenous laser ablation (EVLA), radiofrequency ablation (RFA), mechanochemical ablation and ultrasound-guided foam sclerotherapy — have progressively replaced open surgery, reducing operative morbidity, cost and recovery time [4,5].

EVLA delivers thermal energy to the vein lumen via a laser fibre, damaging the endothelium and causing vein-wall spasm followed by fibrotic occlusion of the refluxing segment [6]. Randomised trials comparing EVLA with conventional surgery have consistently shown equivalent occlusion rates with less pain, bruising, and faster return to normal activity [7-9], and for the SSV specifically, EVLA is now regarded as more effective than surgery for saphenopopliteal junction and SSV reflux [10]. This efficacy, however, carries a specific anatomical hazard: the intimate relationship between the SSV and the sural nerve.

The sural nerve is typically formed, in the lower third of the leg, by the union of the medial sural cutaneous nerve (a branch of the tibial nerve) and the lateral sural cutaneous nerve (a branch of the common fibular nerve); the level of union is generally regarded as variable and may occur anywhere from the popliteal fossa to the ankle. From its point of formation, the nerve runs alongside the SSV along the posterior calf and past the lateral malleolus before terminating as the lateral dorsal cutaneous nerve of the foot. Because SSV ablation typically extends up to the saphenopopliteal junction, and the nerve lies in close proximity to the vein for much of its lower-third course, it is not possible to treat the vein without placing the sural nerve at some risk of thermal injury — a limitation shared with historical SSV stripping, after which sural nerve injury has been reported in up to 50% of patients [11].

Post-procedural sensory disturbance after EVLA is well recognised but inconsistently reported, with paraesthesia rates in the literature ranging from approximately 7% to 37% [12,13], and it remains unproven in many series whether these symptoms specifically reflect sural, as opposed to saphenous, nerve injury. Most such symptoms are believed to resolve within 6–8 weeks, but robust prospective data using objective electrophysiological confirmation are limited, particularly from South Asian, public-hospital populations where disease burden and treatment thresholds may differ from Western cohorts.

Nerve conduction studies (NCS), particularly the sensory nerve action potential (SNAP), provide an objective, side-to-side comparable measure of sural nerve integrity and can distinguish resolving paraesthesia from true persistent axonal injury [14,15]. Strategies proposed to mitigate nerve injury during SSV EVLA include reducing delivered energy in the lower third of the leg, use of tumescent anaesthesia to create a protective peri-venous fluid cushion, adjunctive foam sclerotherapy below the calf, and restricting the access/puncture site to no lower than mid-calf level, as recommended by current European guidelines — although even this does not eliminate risk entirely [16].

We undertook this prospective observational study to determine the incidence of clinically apparent and electrophysiologically confirmed sural nerve injury following EVLA of the SSV, and to examine whether injury risk varies by age, sex, or CEAP clinical class, in patients treated at our institution using a standardised low-energy, tumescence-based protocol.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted in the Department of General Surgery at a tertiary-care teaching hospital in a metropolitan city over a 1-year period, following approval from the institutional ethics committee.

Study population and sample size

All adult patients (>18 years, either sex) undergoing elective EVLA for symptomatic SSV reflux, with or without associated GSV or saphenopopliteal junction (SPJ) incompetence, were considered eligible. Inclusion required symptomatic SSV reflux with or without SPJ reflux, a lateral leg ulcer, vein diameter >3 mm, or perforator incompetence on duplex imaging, and/or SSV varicosity with an associated ulcer in the lower lateral third of the leg. Patients aged <18 or >80 years, and those with superficial thrombophlebitis, pregnancy, isolated varicosities, concomitant peripheral arterial disease, diabetes mellitus, peripheral neuropathy, sciatica, fibromyalgia, autoimmune/inflammatory arthritis, or a prior history of leg trauma were excluded, to avoid confounding sensory symptoms unrelated to the index procedure.

Departmental records identified 58 patients who underwent EVLA for SSV incompetence in the preceding 12 months. Using Slovin's formula ($n = N / [1 + N \cdot e^2]$, with population $N = 58$ and margin of error $e = 0.05$), the calculated minimum sample size was 50.7 (rounded to 50); 50 consecutive eligible patients were recruited by periodic sampling over the study period.

Pre-operative assessment

All patients underwent clinical examination — the Brodie–Trendelenburg test for saphenofemoral valve competence, the multiple-tourniquet test for perforator incompetence, and the modified Perthes' test to exclude deep venous thrombosis — together with duplex ultrasonography to confirm SSV reflux and measure vein diameter. Disease was classified according to the CEAP system. Written informed consent was obtained from all participants after they were provided a patient information sheet describing the procedure and its risks, including sural nerve injury.

Procedure

All procedures were performed under spinal anaesthesia with the patient prone for SSV access. Under real-time ultrasound guidance (performed by a second operator using a sterile probe cover), the SSV was cannulated — typically at the mid-calf or malleolar level — using a Seldinger technique, and a 1470-nm radial laser fibre was advanced to the saphenopopliteal junction. Tumescent local anaesthetic (with sodium bicarbonate added) was infiltrated circumferentially around the vein under ultrasound visualisation prior to ablation, both to provide anaesthesia and to create a peri-venous fluid cushion protecting adjacent structures — including the sural nerve — from thermal spread. In four thin patients with a superficially situated sural nerve and a thin subcutaneous SSV, tumescent infiltration was extended from the ankle to mid-leg specifically to protect the nerve. Energy delivery was titrated to vein diameter, with lower energy used in the distal third of the leg, where the nerve lies closest to the vein. Following ablation, patients were fitted with grade II compression stockings, given a single dose of intravenous antibiotic, along with anti-inflammatory and multivitamin supplementation, and discharged the same or next day.

Outcome assessment

Patients were assessed for numbness/hypoaesthesia, tingling, and burning pain along the sural nerve distribution (posterior and lateral aspect of the lower third of the leg around the lateral malleolus) at post-operative day (POD) 0, POD 1, 1 week, 1 month and 3 months. Symptom severity was recorded using a 10-point visual analogue scale to permit objective comparison. Patients with symptoms persisting beyond 1 month underwent nerve conduction studies (sural sensory nerve action potential, with contralateral side-to-side comparison) in the neuro-medicine department, to objectively confirm or exclude persistent axonal injury. Patients with confirmed nerve injury were managed with reassurance and a combination of pregabalin and methylcobalamin.

Statistical analysis

Data were entered in Microsoft Excel and analysed using standard statistical software. Continuous variables (age, vein diameter, energy delivered) are presented as mean ± standard deviation, median (interquartile range), and range. Categorical variables are presented as frequencies and percentages, with a 95% confidence interval calculated for the overall sural nerve injury rate using the Wilson score method. Associations between overall sural nerve injury and age group, sex, and CEAP subclass were tested using Fisher's exact test, given expected cell counts <5 in several strata; a two-sided $p<0.05$ was considered statistically significant.

RESULTS

Fifty patients undergoing EVLA for symptomatic SSV reflux were enrolled and completed 3 months of follow-up (Table 1). The cohort comprised 36 men and 14 women (male:female ratio 2.6:1; Figure 2), with a mean age of 45.7 ± 11.6 years (median 45, IQR 40–50.8; range 18–79); 42% of patients were aged 40–49 years (Figure 1). Mean SSV diameter, averaged over knee, mid-leg and ankle measurements, was 3.66 ± 0.83 mm, and mean laser energy delivered was 1171.4 ± 124.8 J.

Table 1: Baseline demographic and clinical characteristics of study patients (n = 50)

Variable	Value
Age (years) — mean ± SD	45.7 ± 11.6
Age (years) — median (IQR)	45 (40–50.8)
Age (years) — range	18–79
Sex — male, n (%)	36 (72%)
Sex — female, n (%)	14 (28%)
SSV diameter (mm) — mean ± SD	3.66 ± 0.83
SSV diameter (mm) — median (IQR)	3.45 (3.1–3.8)
Laser energy delivered (J) — mean ± SD	1171.4 ± 124.8
Laser energy delivered (J) — median (IQR)	1160 (1072.5–1250)

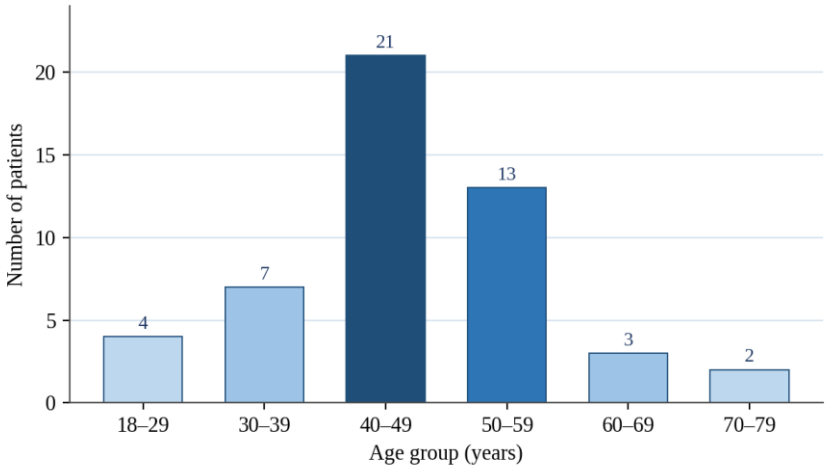

Figure 1: Age distribution of study patients (n = 50)

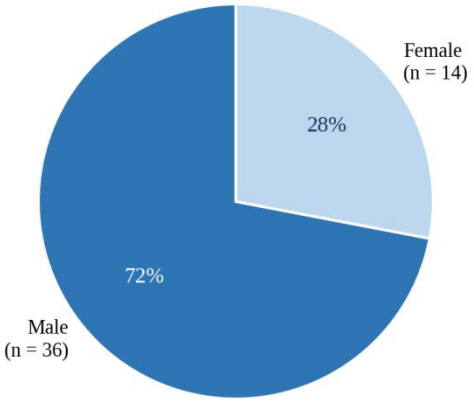

Figure 2: Sex distribution of study patients (n = 50)

By clinical (C) class, 21 patients (42%) were C2, 13 (26%) C3, 15 (30%) C4 and 1 (2%) C5. Aetiology was primary (Ep) in 47 (94%), congenital (Ec) in 2 (4%) and secondary (Es) in 1 (2%). Anatomically, superficial reflux alone (As) accounted for 33 patients (66%) and combined superficial–perforator involvement (As,p) for 17 (34%); all patients were classified Pr (reflux as the pathophysiological mechanism). The most frequent composite CEAP category was C2EpAsPr (30% of patients), followed by C3EpAsPr (16%) and C4EpAs,pPr (14%) (Table 2, Figures 3 and 4).

Table 2: CEAP classification of study patients (n = 50)

CEAP component	Number	Percentage
C2	21	42.0
C3	13	26.0
C4	15	30.0
C5	1	2.0
Ep (primary)	47	94.0
Ec (congenital)	2	4.0
Es (secondary)	1	2.0
As (superficial only)	33	66.0
As,p (superficial + perforator)	17	34.0
Pr (reflux)	50	100.0

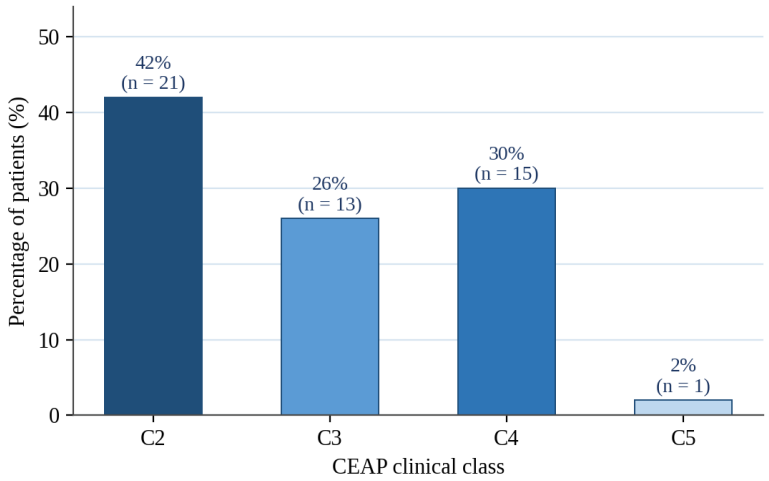

Figure 3: Distribution of study patients according to CEAP clinical (C) class

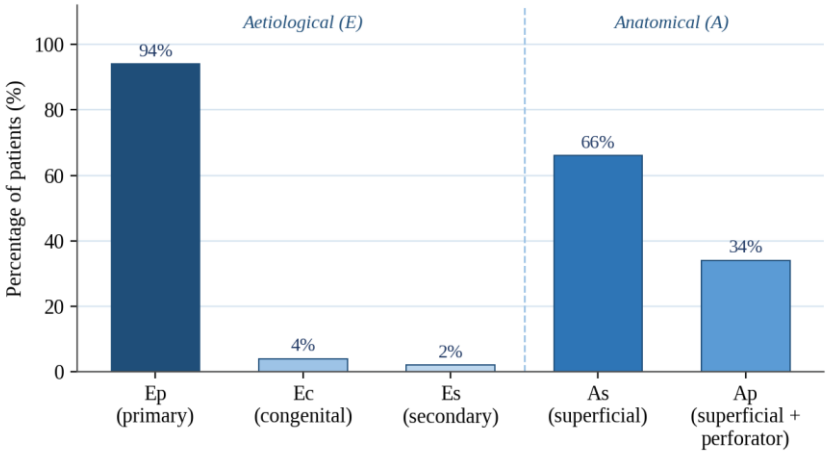

Figure 4: Distribution of study patients according to CEAP aetiological (E) and anatomical (A) classes

No patient had sensory symptoms immediately post-operatively (POD 0). By POD 1, 5 patients (10%) had developed new sensory symptoms along the sural nerve distribution — numbness in 3 (6%) and burning pain in 2 (4%) — a pattern that remained unchanged at 1 week. By 1 month, symptoms had resolved completely in 4 of these 5 patients; only 1 patient (2%) had persistent numbness at both 1 month and 3 months (Table 3, Figures 5 and 6). Overall, therefore, 5 of 50 patients (10%; 95% CI 4.3–21.4%) experienced sural nerve injury at some point during follow-up, while 45 (90%) remained entirely asymptomatic throughout.

The single patient with symptoms persisting beyond 1 month underwent nerve conduction studies, which confirmed a reduced sural sensory nerve action potential amplitude consistent with persistent axonal injury; the remaining 4 symptomatic patients achieved full spontaneous clinical resolution within 1 month and did not require electrophysiological testing.

Table 3: Distribution of sural nerve symptoms over the follow-up period (n = 50)

Time point	No symptoms, n (%)	Numbness, n (%)	Burning pain, n (%)
POD 0	50 (100%)	0 (0%)	0 (0%)
POD 1	45 (90%)	3 (6%)	2 (4%)
1 week	45 (90%)	3 (6%)	2 (4%)
1 month	49 (98%)	1 (2%)	0 (0%)
3 months	49 (98%)	1 (2%)	0 (0%)

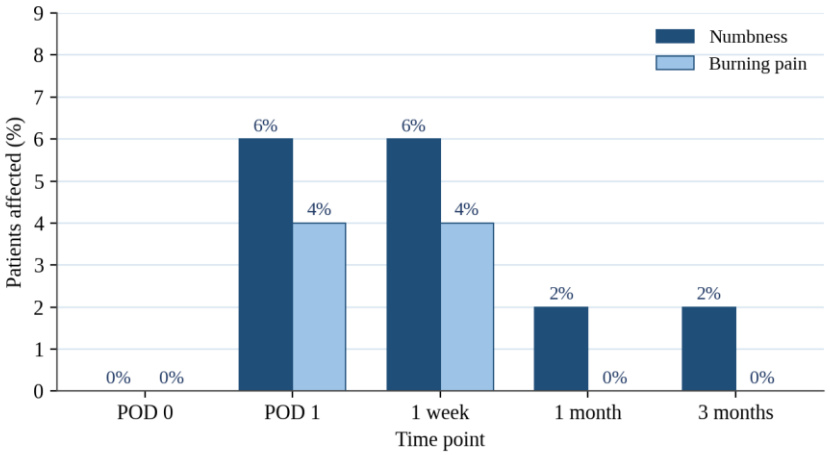

Figure 5: Sural nerve symptoms by type over the follow-up period (n = 50)

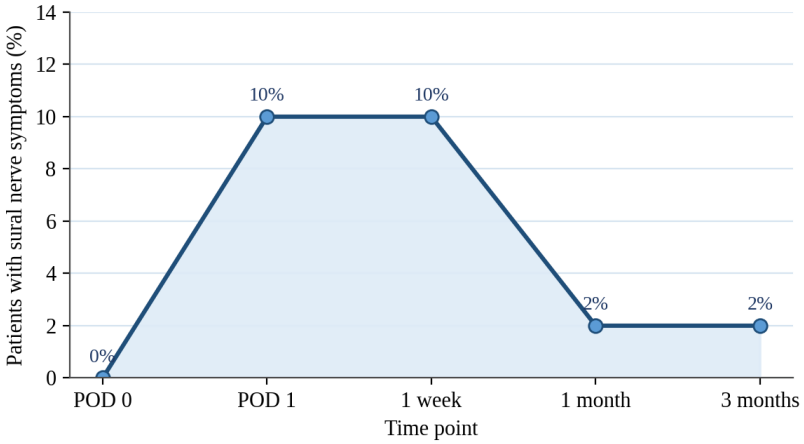

Figure 6: Overall proportion of patients with sural nerve symptoms over follow-up (n = 50)

Sural nerve injury showed no statistically significant association with age group, sex, or CEAP C, E, or A class (all p>0.05, Fisher's exact test; Table 4, Figures 7 and 8). Although none of these associations reached statistical significance — reflecting the small number of injury events — injury rates were numerically highest in C4 disease (26.7% vs 4.8% in C2) and in patients with combined superficial–perforator (As,p) involvement (17.6% vs 6.1% in As), both markers of more extensive disease typically requiring ablation of a longer or larger-calibre vein segment.

Table 4: Association between overall sural nerve injury and demographic/clinical variables

Variable	Sural nerve injury, n (%)	P value
Age 18–29 (n=4)	1 (25.0%)	1.000*
Age 30–39 (n=7)	1 (14.3%)	
Age 40–49 (n=21)	2 (9.5%)	
Age 50–59 (n=13)	0 (0%)	
Age 60–69 (n=3)	1 (33.3%)	

Variable	Sural nerve injury, n (%)	P value
Age 70–79 (n=2)	0 (0%)	
Female (n=14)	2 (14.3%)	0.611*
Male (n=36)	3 (8.3%)	
CEAP C2 (n=21)	1 (4.8%)	0.383*
CEAP C3 (n=13)	0 (0%)	
CEAP C4 (n=15)	4 (26.7%)	
CEAP C5 (n=1)	0 (0%)	
CEAP Ep (n=47)	5 (10.6%)	1.000*
CEAP Ec/Es (n=3)	0 (0%)	
CEAP As,p (n=17)	3 (17.6%)	0.320*
CEAP As (n=33)	2 (6.1%)	

**Fisher's exact test.*

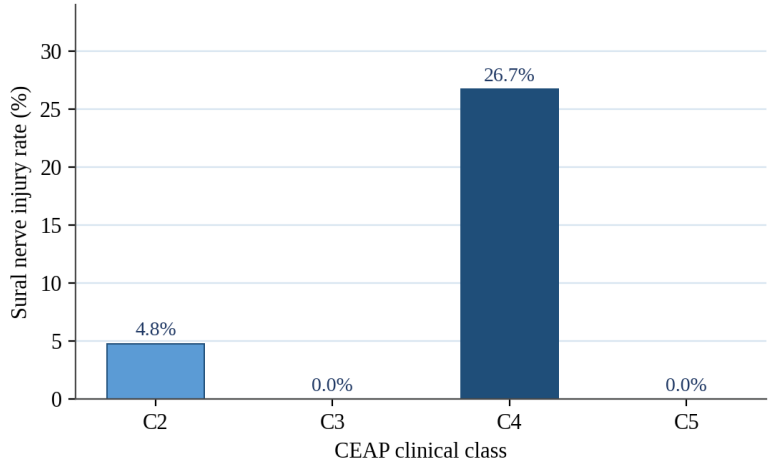

Figure 7: Sural nerve injury rate according to CEAP clinical (C) class

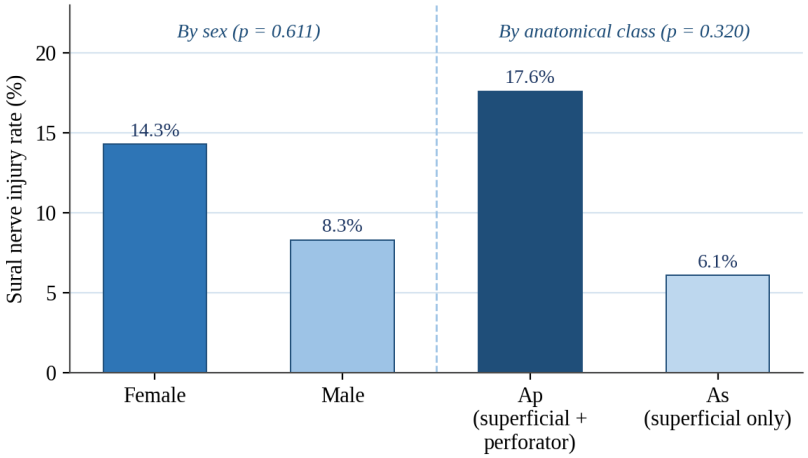

Figure 8: Sural nerve injury rate according to sex and CEAP anatomical (A) class

DISCUSSION

In this prospective cohort of 50 patients undergoing 1470-nm radial-fibre EVLA for SSV reflux, we found a 10% incidence of clinically detectable sural nerve injury, the great majority of which (4 of 5 cases, 80%) resolved spontaneously within 1 month. Only a single patient (2% of the overall cohort) had electrophysiologically confirmed persistent injury at 3 months. These findings sit within, and toward the favourable end of, the wide range of paraesthesia rates reported after SSV endovenous thermal ablation in the literature, historically quoted between 7% and 37% [12,13].

Several technical factors in our protocol likely contributed to this relatively low and predominantly transient injury rate. First, all procedures used a radial-fibre 1470-nm laser, which produces more homogeneous, lower-peak-temperature energy delivery to the vein wall than older bare-tip fibres, theoretically reducing lateral thermal spread to peri-venous structures [6,17]. Second, energy delivery was deliberately reduced in the lower third of the leg, where the sural nerve lies closest to the SSV, consistent with strategies proposed elsewhere to mitigate nerve injury [16]. Third, and in our view most important, circumferential tumescent anaesthesia was infiltrated around the vein under real-time ultrasound guidance in every case, generating a visible peri-venous fluid "halo" that both compresses the vein for more effective ablation and acts as a heat sink, absorbing lateral thermal energy before it reaches the nerve; the addition of sodium bicarbonate to the tumescent solution may also help buffer the acidic milieu generated by thermal tissue injury. The safety of this tumescent technique is well established, and in four thin patients with a superficially situated sural nerve we further extended tumescent infiltration from the ankle to mid-leg; none of these patients developed nerve injury.

Our overall injury rate of 10% compares favourably with several published series. Rasmussen et al., in a randomised comparison of EVLA versus high ligation and stripping for SSV reflux, reported neurological symptoms in their EVLA arm at a broadly comparable frequency, while historical stripping series have reported sural nerve injury rates as high as 50% [10,11]. Restricting the access/puncture site to no lower than mid-calf, as recommended in current European guidelines, has been shown to reduce but not eliminate nerve injury risk [16]; in our series, entry was at the lower calf or malleolar level in half of patients, yet the overall injury rate remained modest, suggesting that tumescent technique and energy titration may be at least as important as puncture-site selection in preventing injury — though our study was not designed or powered to formally compare these variables.

We found no statistically significant association between sural nerve injury and age, sex, or CEAP classification, consistent with the generally accepted view that thermal nerve injury after EVLA is a technique- and anatomy-dependent phenomenon rather than one strongly determined by patient demographic factors [13]. The numerically higher injury rate we observed in C4 disease (26.7% vs 4.8% in C2) is biologically plausible: more advanced chronic venous disease, particularly with skin changes, often requires ablation of a longer or larger-calibre vein segment and correspondingly higher cumulative energy delivery, which could increase the risk of thermal spread to the adjacent nerve. Given the small number of injury events (n=5) in our cohort, however, this observation should be regarded as hypothesis-generating rather than confirmatory, and larger, adequately powered studies are needed to establish whether CEAP class is a genuine independent risk factor.

The use of nerve conduction studies to objectively confirm persistent injury, rather than relying on clinical symptoms alone, is a strength of our study design and addresses a recognised limitation of much of the existing literature, where sensory symptoms after EVLA are frequently attributed to sural (or saphenous) nerve injury without electrophysiological confirmation [12,14,15]. In our single patient with injury confirmed on NCS, symptoms had already persisted beyond 1 month, supporting the use of a 1-month threshold to trigger formal electrophysiological evaluation in clinical practice, since the great majority of post-operative sensory symptoms resolve spontaneously before this point and do not require investigation. For patients with confirmed or clinically probable persistent nerve injury, we used pregabalin — a modulator of the alpha-2-delta subunit of voltage-gated calcium channels — together with methylcobalamin, which achieved symptomatic improvement, although prolonged pregabalin use carries recognised risks of sedation, dizziness, peripheral oedema and dry mouth that warrant appropriate counselling and, where possible, a time-limited course.

LIMITATIONS

This study has several limitations. The sample size, while adequately powered for descriptive incidence estimation, was too small to detect modest but potentially clinically relevant associations between injury and CEAP subclass or vein diameter, as reflected in the wide confidence interval around our overall incidence estimate (4.3–21.4%). Follow-up was limited to 3 months; late-onset or very slowly resolving symptoms beyond this window would not have been captured. NCS was performed only in the single patient with symptoms persisting beyond 1 month rather than in all symptomatic patients, meaning that the 4 patients judged to have resolved clinically were not electrophysiologically confirmed to have normal sural nerve conduction, and subclinical injury cannot be entirely excluded in this group. Finally, as a single-centre study from one public tertiary-care hospital using a standardised low-energy, tumescence-based protocol, our findings may not generalise directly to centres using different laser wavelengths, fibre types, or tumescent techniques.

CONCLUSION

EVLA of the short saphenous vein, using a 1470-nm radial fibre, energy titration reduced in the distal leg, and generous ultrasound-guided tumescent anaesthesia, is associated with a modest 10% incidence of sural nerve injury, the majority of which is transient and resolves within 1 month with conservative management alone. Only 2% of patients in our cohort had persistent, electrophysiologically confirmed injury at 3 months. Injury was not significantly associated with patient age, sex, or CEAP classification, although higher rates in more advanced (C4) disease merit further evaluation in larger cohorts. Given its well-established efficacy and the low, largely self-limiting rate of sural nerve complications demonstrated here, EVLA — with or without adjunctive foam sclerotherapy — can be considered a safe first-line approach for SSV incompetence, provided careful attention is paid to energy titration and tumescent technique in the distal leg.

DECLARATIONS

Ethics approval and consent to participate: This study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment.

Availability of data and materials: The de-identified dataset generated during the study is available from the corresponding author on reasonable request.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest: The authors declare that they have no conflict of interest.

Acknowledgements: The authors thank the Department of Neuro-medicine for performing nerve conduction studies.

REFERENCES

1. Kurz X, Lamping DL, Kahn SR, Baccaglini U, Zuccarelli F, Spreafico G, et al. Do varicose veins affect quality of life? Results of an international population-based study. J Vasc Surg. 2001;34:641-8.
2. Callam MJ. Epidemiology of varicose veins. Br J Surg. 1994;81:167-73.
3. Rashid HI, Ajeel A, Tyrrell MR. Persistent popliteal fossa reflux following saphenopopliteal disconnection. Br J Surg. 2002;89(6):748-51.
4. Navarro L, Min RJ, Bone C. Endovenous laser: a new minimally invasive method of treatment for varicose veins — preliminary observations using an 810 nm diode laser. Dermatol Surg. 2001;27:117-22.
5. Goldman MP, Amiry S. Closure of the greater saphenous vein with endoluminal radiofrequency thermal heating of the vein wall in combination with ambulatory phlebectomy: 50 patients with more than 6-month follow-up. Dermatol Surg. 2002;28:29-31.
6. Proebstle TM, Lehr HA, Kargl A, Espinola-Klein C, Rother W, Bethge S, et al. Endovenous treatment of the greater saphenous vein with a 940-nm diode laser: thrombotic occlusion after endoluminal thermal damage by laser-generated steam bubbles. J Vasc Surg. 2002;35:729-36.
7. Belcaro G, Nicolaides AN, Ricci A, Dugall M, Errichi BM, Vasdekis S, et al. Endovascular sclerotherapy, surgery and surgery plus sclerotherapy in superficial venous incompetence: a randomized, 10-year follow-up trial — final results. Angiology. 2000;51:529-34.
8. Darwood RJ, Theivacumar N, Dellagrammaticas D, Mavor AI, Gough MJ. Randomized clinical trial comparing endovenous laser ablation with surgery for the treatment of primary great saphenous varicose veins. Br J Surg. 2008;95(3):294-301.
9. Mekako AI, Hatfield J, Bryce J, Lee D, McCollum PT, Chetter I. A non-randomised controlled trial of endovenous laser therapy and surgery in the treatment of varicose veins. Ann Vasc Surg. 2006;20(4):451-7.
10. Rasmussen LH, Lawaetz M, Bjoern L, Vennits B, Blemings A, Eklof B. Randomized trial comparing endovenous laser ablation of the short saphenous vein with high ligation and stripping in patients with varicose veins: short-term results. J Vasc Surg. 2007;46(2):308-15.
11. Sam RC, Silverman SH, Bradbury AW. Nerve injuries and varicose vein surgery. Eur J Vasc Endovasc Surg. 2004;27:113-20.
12. Huang Y, Jiang M, Li W, et al. Endovenous laser treatment combined with a surgical strategy for treatment of venous insufficiency in lower extremity: a report of 208 cases. J Vasc Surg. 2005;42:494-501.
13. 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.
14. Tavee J. Nerve conduction studies: basic concepts. In: Levin KH, Chauvel P, editors. Handbook of Clinical Neurology, Vol 160. Amsterdam: Elsevier; 2019. p.217-24.
15. Kamble N, Shukla D, Bhat D. Peripheral nerve injuries: electrophysiology for the neurosurgeon. Neurol India. 2019;67:1419-22.
16. Sanioglu S, Yerebakan H, Ozgen A, Ozdemir HO, Sancar NK, Farsak MB. Mid-calf level as a puncture site is not safe enough for thermal ablation of the small saphenous vein. SAGE Open Med. 2017;5:2050312117731474.
17. Roggan A, Friebel M, Dorschel K, Hahn A, Muller G. Optical properties of circulating human blood in the wavelength range 400-2500 nm. J Biomed Opt. 1999;4:36-46.