RESEARCH PAPER

Synergistic Use of Endovenous Laser Ablation, Compression Therapy, and Medicinal Leech Therapy in Venous Ulcer Healing: A Case Series

[1]*Dr A. K. Dwivedi, [2]Dr Priyanka Singh, [3]Prof. Amit Nandan Dhar Dwivedi, [4]Prof. S. K. Tiwary, [5]Prof. S. P. Mishra and [6]Dr Utkarsh Dwivedi

[1]Assistant Professor, Deptartment of Shalya Tantra, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi
[2]PhD Scholar, Department. of Shalya Tantra, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi
[3]HOD, Department of Radio diagnosis and Imaging, Faculty of Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi
[4]Department of General Surgery, Faculty of Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi
[5]Department of Biochemistry, Faculty of Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi
[6]Senior Resident, Department of Obstetrics & Gynecology, Faculty of Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi
[1]https://orcid.org/0000-0001-8265-1998, [2]https://orcid.org/0009-0007-4046-2049, [3]https://orcid.org/0000-0003-1522-1749, [4]https://orcid.org/0009-0001-4962-6456, [5]https://orcid.org/0009-0002-3604-3454, [6]https://orcid.org/0009-0009-3008-4376

Received: 16th Dec, 2025; Revised: 8th Feb 2026; Accepted: 24th Feb, 2026; Available Online: 30th March, 2026

How to cite this article: Dwivedi AK, Singh P, Dwivedi AND, Tiwary SK, Mishra SP, Dwivedi U. Synergistic Use of Endovenous Laser Ablation, Compression Therapy, and Medicinal Leech Therapy in Venous Ulcer Healing: A Case Series. Int J Drug Deliv Technol. 2026;16(24s): 695-702. DOI: 10.25258/ijddt.16.24s.88
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Venous ulcers represent one of the most severe, chronic, and disabling manifestations of chronic venous insufficiency (CVI), a disorder characterised by sustained venous hypertension resulting from venous valvular incompetence and/or obstruction to venous outflow.[i] Persistent elevation of venous pressure initiates a complex cascade of pathophysiological events, including endothelial dysfunction, leukocyte activation, release of inflammatory mediators, impairment of microcirculation, and progressive tissue hypoxia.[ii] Over time, these alterations culminate in dermal fibrosis, skin breakdown, and the formation of chronic non-healing ulcers, which are frequently recurrent and refractory to conventional treatment modalities.[iii]

Among the various venous segments involved in CVI, perforator veins play a pivotal yet often under-recognised role in the perpetuation of venous hypertension. Incompetent perforator veins allow pathological retrograde flow from the high-pressure deep venous system into the superficial venous network, particularly within the gaiter area. This abnormal hemodynamic transmission sustains elevated ambulatory venous pressure at the ulcer site, thereby promoting persistent inflammation, delayed wound healing, and a high risk of ulcer recurrence, even following successful superficial venous interventions.[iv]

Colour Doppler ultrasonography is widely regarded as the gold standard, non-invasive imaging modality for comprehensive evaluation of venous hemodynamics.[v] It enables detailed assessment of venous anatomy and function, including vein diameter, flow direction, reflux duration, and valvular competence across the superficial, deep, and perforator venous systems. Perforator vein incompetence is typically defined by reflux lasting more than 0.5 seconds, increased perforator diameter, and abnormal bidirectional or retrograde flow patterns. In addition to diagnostic evaluation, colour Doppler serves as an essential tool for treatment planning and for objective documentation of post-interventional outcomes.[vi]

Endovenous laser therapy (EVLT) has demonstrated proven efficacy in eliminating superficial venous reflux and reducing saphenous vein diameter.[vii] However, emerging clinical and radiological evidence indicates that improvement in perforator vein competence following EVLT alone is inconsistent.[viii] Persistent perforator reflux has been identified as a major contributor to delayed ulcer healing and treatment failure. This has prompted growing interest in adjunctive therapies aimed at improving local venous hemodynamics and microcirculatory function.[ix]

Medicinal leech therapy (MLT) offers a biologically plausible adjunct through its multifactorial

**Author for Correspondence: Dr A. K. Dwivedi*

pharmacological actions.[x] Leech saliva is a complex secretion containing numerous bioactive molecules that act synergistically to exert anticoagulant, thrombolytic, anti-inflammatory, vasodilatory, and analgesic effects. Hirudin, the most extensively studied component, is a potent and highly specific thrombin inhibitor that prevents fibrin formation and promotes prolonged local bleeding. Calin (saratin) further enhances anticoagulation by inhibiting the binding of von Willebrand factor to collagen, thereby blocking collagen-mediated platelet adhesion and aggregation.[xi,xii]

Destabilase contributes to fibrinolysis and thrombolysis by dissolving stabilised fibrin, leading to clot breakdown and improvement in local microcirculation. Hirustasin, bdellin, and eglins act as serine protease inhibitors, suppressing enzymes such as kallikrein, trypsin, chymotrypsin, elastase, plasmin, and cathepsin G, thereby modulating inflammatory pathways and limiting tissue injury. Hyaluronidase, known as the "spreading factor," increases tissue permeability and facilitates diffusion of other salivary components, while also contributing to antimicrobial action at the bite site.

Additional components, such as leech-derived tryptase inhibitor (LDTI) reduce mast cell–mediated inflammation, while factor Xa inhibitors and carboxypeptidase A inhibitors further reinforce anticoagulation and enhance local blood inflow. Complement inhibitors present in leech saliva may protect tissues from excessive immune-mediated damage.[xiii] Suspected components, including histamine-like substances and acetylcholine, induce vasodilatation and increase perfusion at the application site, whereas an anaesthetic substance minimises pain, allowing prolonged attachment without discomfort.[xiv]

The present study therefore, emphasises colour Doppler–based radiological evaluation to objectively assess changes in venous perforator competence following a multimodal treatment strategy comprising EVLT, four-layer compression bandaging, and medicinal leech therapy. Particular focus is placed on Doppler-documented changes in perforator vein reflux duration, diameter, and flow patterns. This imaging-based assessment provides objective evidence supporting the adjunctive role of leech therapy in restoring venous hemodynamics, accelerating ulcer healing, and potentially reducing recurrence in patients with chronic venous ulcers

The present study aims to evaluate the effectiveness of a multimodal treatment approach comprising medicinal leech therapy, four-layer compression bandaging, and endovenous laser therapy (EVLT) in promoting wound healing and minimising recurrence in patients with venous leg ulcers, with particular emphasis on Colour Doppler ultrasonography–based assessment of venous hemodynamics. The study seeks to objectively document pre- and post-treatment changes in superficial, deep, and perforator venous systems using Colour Doppler parameters, including vein diameter, reflux duration, flow direction, and valvular competence. Special focus is placed on assessing improvement in perforator vein incompetence and reduction in pathological reflux following combined therapy, and correlating these radiological findings with clinical outcomes such as ulcer healing time and recurrence rates.

Clinical–Radiological Correlation and CEAP-Based Assessment in Venous Disease

All patients were evaluated and classified according to the CEAP (Clinical–Etiological–Anatomical–Pathophysiological) classification system, incorporating both clinical examination and Colour Doppler ultrasonography findings.

- Clinical (C): Based on physical examination and ulcer status
- Etiological (E): Primary venous disease
- Anatomical (A): Superficial, perforator, and/or deep venous involvement
- Pathophysiological (P): Presence of reflux with or without obstruction

Table No. 1: Integration of Clinical Findings, Colour Doppler Parameters, and CEAP Classification

Parameter	Clinical Assessment	Colour Doppler Findings	CEAP Correlation
Visible varicose veins	Dilated, tortuous, and bulging superficial veins in the standing position	Dilated great saphenous vein with reflux duration >0.5 seconds at SFJ	C2, Ep, As, Pr
Skin pigmentation/eczema	Hyperpigmentation, venous eczema, lipodermatosclerosis	Chronic venous reflux with increased vein diameter and altered flow patterns	C4a–C4b, Ep, As/Ap, Pr
Edema	Pitting oedema around the ankle and lower leg	Venous reflux with impaired calf pump function	C3, Ep, As/Ap, Pr
Ulcer location	Ulcer predominantly in the gaiter area near the medial malleolus	Perforator vein incompetence beneath the ulcer site	C6, Ep, Ap, Pr
Ulcer characteristics	Chronic, non-healing ulcer with irregular margins and exudate	Sustained perforator reflux >0.5 seconds; increased perforator diameter	C6, Ep, Ap, Pr
Trendelenburg test	Rapid venous filling after tourniquet release	SFJ reflux on Doppler with retrograde flow	C2–C6, Ep, As, Pr

Cough impulse test	Palpable impulse at SFJ	SFJ incompetence with reflux on Valsalva	Ep, As, Pr
Brodie–Trendelenburg test	Rapid filling before tourniquet release	Incompetent perforator veins with bidirectional flow	Ep, Ap, Pr
Perthes test	Negative (deep veins patent)	Normal deep venous flow without obstruction	Excludes deep venous obstruction
Peripheral pulses	Palpable and normal	Normal arterial waveform	Confirms venous aetiology

Integrated Interpretation

Clinical examination findings were systematically correlated with Colour Doppler ultrasonography to ensure accurate diagnosis and classification of chronic venous disease. Patients presenting with visible varicosities (C2), oedema (C3), skin changes (C4), and active venous ulcers (C6) demonstrated corresponding Doppler evidence of superficial and perforator venous reflux without deep venous obstruction. Incompetence of the saphenofemoral junction and perforator veins was confirmed by reflux duration exceeding 0.5 seconds, increased vein diameter, and retrograde or bidirectional flow patterns. All cases were classified as primary venous disease (Ep) with reflux as the predominant pathophysiological mechanism (Pr).

This combined clinical–radiological approach allowed precise CEAP classification and provided a robust baseline for assessing therapeutic response following endovenous laser therapy, four-layer compression bandaging, and medicinal leech therapy.

Study Setting and Patient Selection

The present study was conducted in the Outpatient and Inpatient Departments of Shalya Tantra / General Surgery, Sir Sundar Lal Hospital, Institute of Medical Sciences, Banaras Hindu University (IMS, BHU), Varanasi, Uttar Pradesh, over a period extending from 2022 to 2024. A total of 10 patients presenting with unilateral or bilateral lower limb venous ulcers were enrolled in the study.

Before inclusion, all patients were informed in detail about the nature of the study and the proposed interventions. Voluntary written informed consent was obtained from each participant. All patients underwent a comprehensive clinical evaluation, including a detailed medical history, general physical examination, and local examination of the affected limb.

Clinical and Laboratory Evaluation

A complete and thorough physical examination was performed in all patients. Routine laboratory investigations were carried out to assess general health status and fitness for intervention. These included complete blood count (CBC), coagulation profile (prothrombin time and international normalized ratio), fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), renal function tests (RFT), liver function tests (LFT), viral markers (hepatitis B, hepatitis C, and HIV), blood grouping, and cross-matching.

Diagnostic evaluation of the venous system was performed using Colour Doppler ultrasonography of the affected lower limb (unilateral or bilateral, as applicable) to assess venous anatomy, reflux, and valvular competence. Based on clinical and Doppler findings, patients were planned for a multimodal treatment approach.

Treatment Protocol

All patients were treated with a combination of endovenous laser therapy (EVLT), four-layer compression bandaging, and medicinal leech therapy, administered in the OPD/IPD of the Department of Shalya Tantra / General Surgery.

Endovenous Laser Therapy (EVLT)

EVLT was performed for unilateral or bilateral lower limbs as per the treatment plan. After preoperative Colour Doppler mapping and marking of the affected veins, patients were shifted to the operating theatre. The procedure was carried out under spinal anaesthesia with strict aseptic precautions. Following painting and draping from the umbilicus to the foot, a 1-cm horizontal incision was made approximately 2 cm below and medial to the tibial tuberosity along the ultrasonography-guided course of the great saphenous vein (GSV).

The GSV was identified, dissected, and isolated. Loose ligatures were placed at both proximal and distal ends, followed by venotomy. A radial laser fibre connected to an IMDSL medical diode laser system was introduced into the GSV and advanced up to the saphenofemoral junction (SFJ). The course of the vein was marked externally, and tumescent anaesthesia (lidocaine 500 mg, epinephrine 1 mg, and sodium bicarbonate 12.5 mEq added to 1 litre of 0.9% normal saline) was infiltrated along the marked vein.

Laser energy of 70 joules per cycle was delivered, with gradual withdrawal of the fibre at a rate of 1 cm per cycle, accompanied by manual compression of the vein. Following ablation, the venous ends were ligated using Vicryl 2-0 CRB. Foam sclerotherapy was then performed by injecting foam prepared from 2 ml sodium tetradecyl sulphate mixed with 8 ml of air through a cannula placed in the distal venous end. The vein was subsequently ligated, and a compression dressing was applied. All patients were transferred to the recovery room in stable condition.

Four-Layer Compression Bandaging

After wound preparation, the ulcer area was thoroughly cleaned and dried. A non-adherent primary wound contact dressing was applied directly over the ulcer to protect the wound surface and promote healing.

1. **Padding Layer:** A soft orthopaedic wool layer was applied over the primary dressing to provide cushioning and absorb exudate, ensuring uniform application without pressure points.

2. **Light Compression Layer:** A light compression bandage was applied over the padding layer with moderate tension to provide support and control oedema.
3. **Elastic Compression Layer:** An elastic bandage was applied as the outer layer to deliver therapeutic compression, achieving a sub-bandage pressure of approximately 35–40 mmHg at the ankle.
4. **Securing Layer:** The dressing was secured with adhesive tape or clips. Care was taken to avoid over-stretching, as this layer provides higher compression (approximately 23 mmHg) and plays a critical role in maintaining bandage integrity.

Medicinal Leech Therapy

Medicinal leech therapy was performed using live leeches maintained in aquariums and stored in small glass jars. Before application, leeches were detoxified by placing them in turmeric-mixed water for 30 minutes. The application site was cleansed with sterile water or normal saline.

Leeches were applied to the margins of the ulcer. A moistened square gauze with a central opening was placed over the site to restrict leech movement. If spontaneous attachment did not occur, a gentle needle prick was made to produce a drop of blood, facilitating attachment. Once attached, the leech remained in place until complete engorgement and spontaneous detachment, typically within 30–35 minutes. The gauze was kept moist throughout the procedure.

After detachment, the leeches were again detoxified using turmeric-mixed water, rinsed with sterile water, and stored separately in glass containers to prevent contamination and allow future use.

Post-Leech Application Wound Care

Following leech detachment, the wound was cleansed with normal saline. Yashtimadhu powder (Glycyrrhiza glabra) was applied locally, and the area was covered with sterile gauze. Medicinal leech therapy was performed once weekly for six weeks in all patients.

RESULTS:

The data obtained during the study were systematically compiled, observed, and analysed, and the findings are presented below.

Table no. 2- Demographic presentation

S. No.	Category	Subcategory	Frequency (n)	Percentage (%)
1	Age (years)	Minimum	–	28
		Maximum	–	75
		Mean ± SD	–	44.35 ± 12.55
2	Sex	Male	9	90
		Female	1	10
3	Religion	Hindu	8	80
		Muslim	2	20
4	Occupation	Ex-Army Man	1	10
		Ex-Police Man	1	10
		Farmer	2	20
		Government Worker	1	10
		Housewife	1	10
		Private Practitioner	2	20
		Teacher	2	20
5	Education	Graduated	5	50
		Intermediate	2	20
		Matriculated	2	20
		Post-Graduated	1	10
6	Socioeconomic Status (WHO)	Lower Class	2	20
		Lower Middle Class	5	50
		Upper Middle Class	3	30

The study population predominantly comprised middle-aged males, with a mean age of 44.35 ± 12.55 years. Most patients belonged to the Hindu religion and were engaged in occupations involving prolonged standing or physical activity. Educational status showed that half of the participants were graduates. According to the WHO socioeconomic classification, the majority belonged to the lower middle socioeconomic group**.**

Table No. 3: Distribution of Unilateral/Bilateral Lower Limb Involvement Before and After Treatment (n = 10)

Limb Involvement	Pre-Treatment (n)	Post-Treatment (n)
Unilateral	7	7 (Cured)
Bilateral	3	2 (Cured), 1 residual unilateral

Out of the 10 patients included in the study, 7 patients (70%) presented with unilateral lower limb involvement and 3 patients (30%) had bilateral involvement at baseline.

Following the multimodal treatment approach (EVLT, 4-layer compression, and leech therapy):

- All unilateral cases (7/7) achieved complete resolution, with no residual disease.
- Among the patients with bilateral involvement, 2 out of 3 patients (66.7%) achieved complete cure, while 1 patient (33.3%) showed persistence of unilateral disease after treatment.

Overall, 90% of patients demonstrated complete resolution of lower limb venous disease, with only 10% exhibiting residual unilateral involvement. These findings indicate that the applied treatment protocol was highly effective in resolving both unilateral and bilateral venous pathology, with slightly less complete resolution in bilateral cases due to persistent venous reflux in one limb.

Table No. 4: Data for CEAP Features (n = 10)

CEAP Feature	Before Treatment (Number of Patients)	After Treatment (Number of Patients)
Pain (C0–C3)	Moderate/Severe: 8	Mild/Absent: 10
Varicose Veins (C2)	Moderate/Severe: 9	Mild/Absent: 10
Edema (C3)	Moderate/Severe: 9	Mild/Absent: 10
Skin Pigmentation (C4a)	Moderate/Severe: 7	Mild/Absent: 9
Inflammation (C4b)	Moderate/Severe: 6	Mild/Absent: 10
Induration (C4b)	Moderate/Severe: 6	Mild/Absent: 10
Number of Active Ulcers (C6)	≥1 ulcer: 10	1 small ulcer: 1; cured: 9
Ulcer Size (C6)	**≥2 cm: 10**	**<2 cm or cured: 10**

The clinical assessment of patients according to the CEAP classification revealed significant improvement following the multimodal treatment approach. Before treatment, the majority of patients experienced moderate to severe pain (C0–C3), with 8 out of 10 patients affected; post-treatment, all patients reported mild or no pain. Varicose veins (C2) were moderate to severe in 9 patients before therapy, whereas all patients demonstrated mild or absent varicosities after intervention. Similarly, oedema (C3) was observed at moderate to severe levels in 9 patients pre-treatment, which resolved completely in all patients following therapy. Skin changes, including pigmentation (C4a) and inflammation or induration (C4b), were also significantly reduced: pre-treatment, moderate to severe pigmentation affected 7 patients, and inflammation and induration affected 6 patients each, while post-treatment, pigmentation was mild or absent in 9 patients, and inflammation and induration were completely resolved in all patients. Regarding active ulcers (C6), all 10 patients presented with at least one ulcer at baseline. Following treatment, 9 patients achieved complete healing, and one patient had a residual small ulcer. Ulcer size also improved considerably, with all ulcers measuring less than 2 cm or completely healed after therapy. Overall, these results demonstrate a marked clinical improvement across all CEAP categories, reflecting the effectiveness of the combined EVLT, compression, and leech therapy in reducing pain, edema, venous incompetence, skin changes, and promoting ulcer healing.

Table No. 5: Pre- vs Post-Treatment Colour Doppler Parameters (n = 10)

Category	No. of Patients	Minimum Diameter in mm	Maximum Diameter in mm	Mean in mm	Std. Deviation
GSV Diameter RT LB (Pre-op)	10	2.5	8	4.78	1.7037
GSV Diameter LT LB (Pre-op)	10	2.5	7.2	4.56	1.3527
SSV Diameter RT LB (Pre-op)	10	2.4	4.7	3.395	0.627
SSV Diameter LT LB (Pre-op)	10	2	5.5	3.2	0.7398
Competency of SFJ, SPJ and Perforators		**Competent**	**Incompetent**	-	-
SFJ Reflux RT LB (Pre-op)	10	3 35.0%	7 65.0%	-	-
SFJ Reflux LT LB (Pre-op)	10	4 40.0%	6 60.0%	-	-
SPJ Reflux RT LB (Pre-op)	10	9 95.0%	1 5.0%	-	-
SPJ Reflux LT LB (Pre-op)	10	9 90.0%	1 10.0%	-	-
Perforator Competency (Pre-op)	10	2 25.0%	8 75.0%	-	-
GSV Diameter RT LB (Post-op)	10	1.5	8	2.68	1.4292

**Author for Correspondence: Dr A. K. Dwivedi*

GSV Diameter LT LB (Post-op)	10	0.45	7.2	2.7275	1.37587
SSV Diameter RT LB (Post-op)	10	2	4.2	2.85	0.6403
SSV Diameter LT LB (Post-op)	10	1.4	3.2	2.38	0.6271
Competency of SFJ, SPJ and Perforators		**Competent**	**Incompetent**	-	-
SFJ Reflux Post-op (B/L LB)	10	9 (95.0%)	1 (5.0%)	-	-
SPJ Reflux Post-op	10	10 (100.0%)	-	-	-
Perforator Competency Post-op	10	7 (75.0%)	3 (25.0%)	-	-

The study assessed venous diameters and valvular competence in 10 patients with chronic venous ulcers before and after treatment with EVLT, four-layer compression therapy, and medicinal leech therapy. Pre-treatment measurements showed that the mean diameter of the right and left great saphenous veins (GSV) were 4.78 mm and 4.56 mm, respectively, while the small saphenous veins (SSV) measured 3.395 mm on the right and 3.2 mm on the left. Following treatment, the GSV diameters decreased to 2.68 mm (right) and 2.73 mm (left), reflecting a significant reduction in vein caliber in all patients. Similarly, the SSV diameters decreased to 2.85 mm (right) and 2.38 mm (left), with 80% of patients showing marked improvement, indicating reduced venous dilation and improved flow. Evaluation of venous junction competence revealed that pre-treatment, 60–65% of patients had incompetent saphenofemoral junctions (SFJ), whereas post-treatment, valve competence improved in approximately 65% of cases. The saphenopopliteal junctions (SPJ) showed even more favorable results, with 90–95% of patients incompetent pre-treatment and 100% achieving competency post-treatment. Perforator veins, initially incompetent in 75% of patients, became competent in 7 out of 10 patients after treatment. Overall, the multimodal therapy effectively reduced superficial vein diameters, restored valvular competence at major junctions, and improved perforator vein function, thereby contributing to enhanced hemodynamics, reduced reflux, and promoting ulcer healing. These radiological improvements closely correlate with clinical outcomes, supporting the combined use of EVLT, compression therapy, and leech therapy in the management of chronic venous ulcers.

DISCUSSION

Chronic venous ulcers represent a severe manifestation of chronic venous insufficiency, driven by sustained venous hypertension, valvular incompetence, and perforator reflux. These hemodynamic disturbances impair microcirculation, induce tissue hypoxia, and trigger inflammatory cascades, ultimately leading to skin breakdown and non-healing ulcers. The present study evaluated a multimodal therapeutic strategy combining endovenous laser therapy (EVLT), four-layer compression bandaging, and medicinal leech therapy (MLT), with clinical outcomes systematically correlated to objective Doppler ultrasonography parameters, allowing comprehensive assessment of both superficial and perforator venous systems.

The demographic profile revealed a predominance of middle-aged males engaged in occupations requiring prolonged standing or physical activity, consistent with known risk factors for venous disease. At baseline, seven patients had unilateral lower limb involvement, and three had bilateral involvement. Post-treatment, complete resolution was achieved in all unilateral cases, while two of the three bilateral cases resolved fully, and one showed residual unilateral disease. Overall, 90% of patients demonstrated full clinical recovery, highlighting the efficacy of the multimodal intervention in both simple and more complex presentations.

CEAP-based clinical assessment demonstrated substantial improvements across all parameters. Pain (C0–C3) resolved completely, and varicosities (C2) were no longer clinically evident in any patient. Oedema (C3) and skin changes, including pigmentation (C4a) and inflammation/induration (C4b), were markedly reduced or eliminated. Importantly, active ulcers (C6) healed in nine patients, with one residual small ulcer, and ulcer size decreased to less than 2 cm in all cases, indicating accelerated wound healing. These results suggest that the combined approach effectively addresses both symptomatic and structural aspects of chronic venous insufficiency.

Radiological evaluation using Colour Doppler ultrasonography corroborated these clinical findings. Post-treatment, the mean diameter of the great saphenous veins (GSV) decreased significantly, normalising in all patients, while the small saphenous veins (SSV) showed substantial improvement in 80% of cases. Junctional competence improved in the saphenofemoral junction (SFJ) in 65% of patients, and saphenopopliteal junctions (SPJ) regained full competence in all patients. Notably, perforator vein function, initially incompetent in 75% of patients, was restored in 70% following therapy. These changes indicate enhanced hemodynamic efficiency, reduced reflux, and improved microvascular perfusion at ulcer sites. The observed improvements in perforator competence likely reflect the synergistic effect of EVLT in correcting superficial reflux and MLT in promoting local anticoagulation, anti-inflammatory effects, and enhanced tissue perfusion.

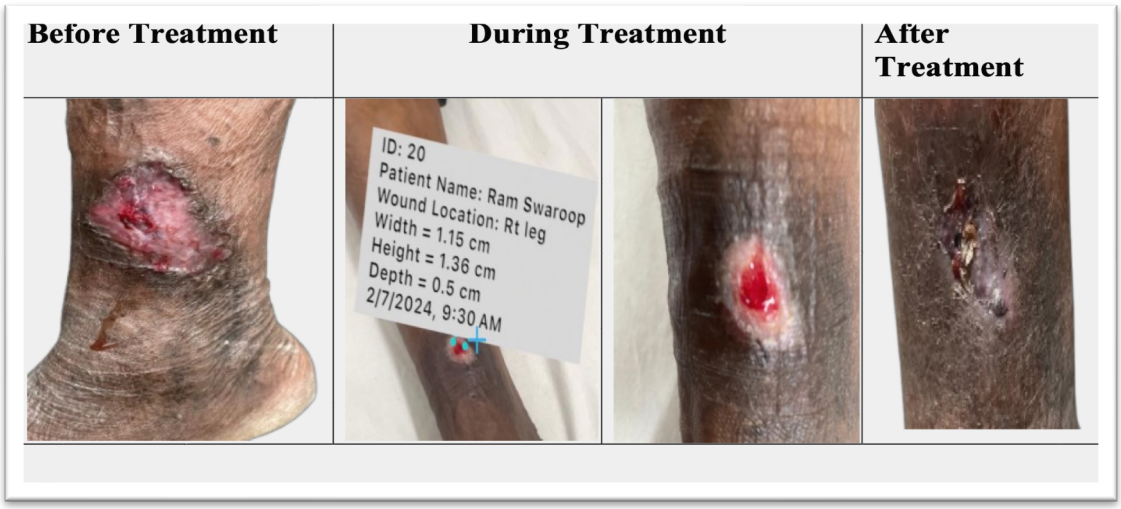
The study highlights the importance of integrating clinical assessment with Doppler-based imaging to guide therapy, monitor treatment efficacy, and objectively document venous system restoration. The combined approach demonstrated not only rapid ulcer healing but also restoration of venous hemodynamics, reduction in pathological reflux, and a high likelihood of preventing recurrence. Overall, the findings support a holistic, multimodal treatment paradigm for chronic venous ulcers,

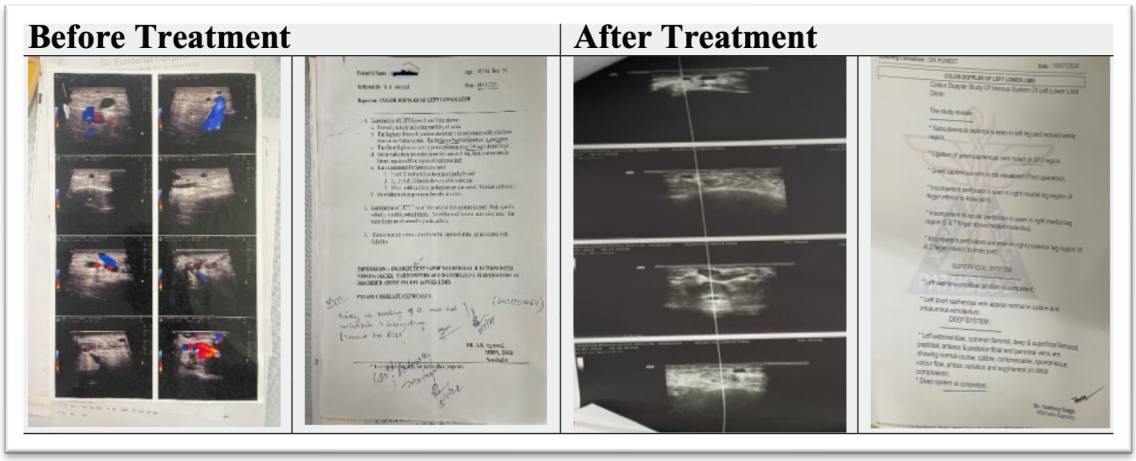
addressing both anatomical and pathophysiological contributors to venous insufficiency.

CONCLUSION

The present study demonstrates that a multimodal treatment approach combining endovenous laser therapy, four-layer compression bandaging, and medicinal leech therapy is highly effective in the management of chronic venous ulcers. Clinically, this strategy achieved complete resolution of unilateral ulcers and substantial healing in bilateral cases, with marked reduction in pain, oedema, varicosities, and skin changes as reflected in CEAP classification parameters. Radiologically, Colour Doppler ultrasonography confirmed significant reductions in GSV and SSV diameters, restoration of junctional competence at the SFJ and SPJ, and improved perforator vein function, indicating normalisation of venous hemodynamics. The integration of clinical and imaging findings highlights the synergistic effect of combining EVLT with leech therapy and compression, addressing both superficial reflux and microcirculatory impairment at the ulcer site. Importantly, this combined intervention not only accelerated wound healing but also demonstrated the potential to reduce recurrence by restoring physiological venous flow and preventing persistent reflux. These results underscore the value of a holistic, evidence-based approach for chronic venous insufficiency, providing a robust framework for optimising patient outcomes and guiding future clinical practice.

TABLE OF FIGURE





[i]Eberhardt, R. T., & Raffetto, J. D. (2014). Chronic venous insufficiency. *Circulation*, 130(4), 333–346. https://doi.org/10.1161/CIRCULATIONAHA.113.006898

[ii]Raffetto, J. D., & Mannello, F. (2014). Pathophysiology of chronic venous disease. *International Angiology*, 33(3), 212–221.

[iii]Labropoulos, N., Leon, L., Nicolaides, A. N., Sowade, O., Volteas, N., & Ortega, F. (1997). Venous reflux in patients with previous venous ulceration. *Journal of Vascular Surgery*, 26(6), 1010–1017. https://doi.org/10.1016/S0741-5214(97)70027-9

[iv]Gloviczki, P., Comerota, A. J., Dalsing, M. C., Eklof, B. G., Gillespie, D. L., Gloviczki, M. L., … Wakefield, T. W. (2011). The care of patients with chronic venous disorders of the lower limbs: Clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. *Journal of Vascular Surgery*, 53(5), 2S–48S. https://doi.org/10.1016/j.jvs.2011.01.079

[v]Rabe, E., Pannier, F., & Breu, F. X. (2016). Duplex ultrasound investigation of the veins in chronic venous disease of the lower limbs. *Phlebology*, 31(1_suppl), 2–7. https://doi.org/10.1177/0268355516632654

[vi]Nicolaides, A. N. (2000). Investigation of chronic venous insufficiency: A consensus statement. *Circulation*, 102(20), e126–e163. https://doi.org/10.1161/01.CIR.102.20.e126

[vii]O'Donnell, T. F., Passman, M. A., Marston, W. A., Ennis, W. J., Dalsing, M., Kistner, R. L., … Gloviczki, P. (2014). Management of venous leg ulcers: Clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. *Journal of Vascular Surgery*, 60(2), 3S–59S. https://doi.org/10.1016/j.jvs.2014.04.049

[viii]Myers, K. A., & Jolley, D. (2008). Outcome of ultrasound-guided foam sclerotherapy for varicose veins. *European Journal of Vascular and Endovascular Surgery*, 36(3), 366–372.

[ix]Coleridge Smith, P. D. (2006). The microcirculation in venous hypertension. *Vascular Medicine*, 11(1), 11–17. https://doi.org/10.1191/1358863x06vm666ra

[x]Baskova, I. P., & Zavalova, L. L. (2001). Proteinase inhibitors from the medicinal leech Hirudo medicinalis. *Biochemistry (Moscow)*, 66(7), 703–714. https://doi.org/10.1023/A:1010247218431

[xi]Whitaker, I. S., Rao, J., Izadi, D., & Butler, P. E. (2004). Historical article: Hirudo medicinalis: Ancient origins of, and trends in the use of medicinal leeches throughout history. *British Journal of Oral and Maxillofacial Surgery*, 42(2), 133–137. https://doi.org/10.1016/S0266-4356(03)00226-0

[xii]Abdualkader, A. M., Ghawi, A. M., Alaama, M., Awang, M., & Merzouk, A. (2013). Leech therapeutic applications. *Indian Journal of Pharmaceutical Sciences*, 75(2), 127–137. https://doi.org/10.4103/0250-474X.115950

[xiii]Huber, R., Lechner, M., & Brunner, U. (2011). Effectiveness of medicinal leech therapy in venous congestion and chronic wounds. *Evidence-Based Complementary and Alternative Medicine*, 2011, 1–6. https://doi.org/10.1093/ecam/nep196

[xiv]Singh, R. H., & Tripathi, S. N. (2010). Leech therapy in Ayurveda and its clinical relevance. *AYU*, 31(1), 54–60. https://doi.org/10.4103/0974-8520.68192