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RESEARCH ARTICLE

Short Term outcome of Endovenous Laser Ablation for Management of Varicose Vein: A Prospective Observational Study

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Abstract

Introduction: Chronic venous insufficiency (CVI)leads to significant impairment in quality of life with substantially lower perceived health. Endovenous laser ablation (EVLA) is a minimally invasive alternative to surgery, with fewer complications and quicker recovery. This study evaluates the short-term efficacy and safety of EVLA and identifies factors associated with recurrence in a North Indian population.

Material and Method: A prospective observational study was conducted on 85 limbs from 60 patients with symptomatic varicose veins (CEAP ≥ C2) from May 2023 to Nov 2024. All underwent pre- procedural clinical and duplex ultrasound evaluation. EVLA was performed using 1470 nm LASER, with radial fiber. Follow-up was done at 1 and 3 months, with post- procedural clinical and duplex ultrasound evaluation. Outcomes were assessed using CEAP clinical class, Revised Venous Clinical Severity Score (RVCSS), Aberdeen Varicose Vein Questionnaire (AVVQ), and USG findings.

Observation and Result: Significant improvements were observed in clinical severity and quality of life scores at 3 months. Mean CEAP C score decreased from 3.60 to 1.88 ($p < 0.001$), mean RVCSS decreased from 8.02 to 4.26 ($p < 0.001$) and mean AVVQ decreased from 38.13 to 11.51 ($p < 0.001$). Recanalization was noted in 7.1% of limbs. Residual venous ulcers persisted in 5.9%, and pigmentation in 29.4% of the limbs. Higher BMI, greater pre-EVLA vein diameter, and lower LEED were associated with recurrence. Paresthesia occurred in 12.9% of the limbs, significantly associated with higher LEED. No cases of DVT were reported.

Conclusion: EVLA significantly improves clinical severity and quality of life in patients with CVI. The recurrence rate of 7.1% is within the lower range reported in literature. Risk factors for recurrence include high BMI and large vein diameter. Optimizing LEED and ensuring adherence to post-procedural care, including compression therapy, are essential for better outcomes.

Keywords: EVLA, Varicose Veins, LEED, CEAP, RVCSS, AVVQ, Recanalization.

1. Introduction

Chronic venous insufficiency leads to significant impairment in quality of life (QOL),with patients reporting substantially lower perceived health compared to general population. [1] Treatment options include conservative management using Compression Stockings, Surgery in form of high ligation and stripping, Foam Sclerotherapy and Endo-

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venousablation [Light amplification by stimulated emission of radiation (LASER), Radiofrequency, Mechano-chemical, and Cyanoacrylate Glue ablation].

Endo-venous LASER ablation (EVLA) delivers thermal energy to vessel wall, which results in contraction of collagen and subsequent fibrosis, leading to obliteration of lumen. EVLA has demonstrated comparable efficacy to other modalities, with fewer complications, lower morbidity, and faster recovery, with earlier return to normal activity. [2]

Several wavelengths have been used in earlier published studies including 810nm, 940nm, 980nm, 1064nm, 1320nm and 1470nm. Shorter wavelengths such as 810nm primarily target hemoglobin, resulting in thrombosis formation. This is followed by activation of thrombolytic system, which increases the risk of recanalization. Therefore, longer wavelengths are preferred as they target the vessel wall, and not blood. The energy delivered is described in terms of Linear Endovenous Energy Density (LEED) : energy delivered per cm of target vein in Joules/centimeter. There is a direct correlation between the LEED and the efficacy of ablation.

LEED > 80J/cm leads to better outcome and lesser side effects. [3] In a study by Sadek M et al, average LEED of 107J/cm showed 100% occlusion rate; however there was an increased occurrence of paresthesia, as compared to LEED of <100J/cm. [4] Therefore, target LEED of 80-100 J/cm is optimal for maximizing efficacy, while minimizing complications.

Reported recurrence rates of varicose veins post EVLA vary widely in published literature. O'Donnell et al, showed in their systematic review and meta-analysis that an overall recurrence rate of 22% can be achieved after EVLA, with no difference compared to high ligation and stripping surgical procedure. [5] Disselh off BCVM et al, reported recurrence rate of 19.6% [6], while Rasmussen L et al, reported recurrence rate of 6.8% [2], highlighting the variability in outcomes across studies.

Although recurrence is frequently reported in published literature, the underlying risk factors contributing to it have not been clearly elucidated to date. Erben Y et al, conducted a multi-center study on EVLA, and found that long-term failure rate was more common in [7]:

a) male patients,

b) those receiving anticoagulation therapy, and

c) females with GSV diameter exceeding 7mm.

Higher body mass index may also affects short and long term recanalization rate. [8]

EVLA is a safe procedure with low rates of complications, which include skin burns, superficial thrombophlebitis, ecchymosis, paraesthesia due to nerve injury, and deep vein thrombosis. These complications can be reduced by using adequate quantities of cold tumescent anesthesia, which creates buffer between the vein and surrounding structures.

There have been few studies on the efficacy and safety of EVLA in North India, and on the causes and risk factors associated with recurrence of varicose veins post EVLA. Rathod J et al, conducted a study in Nagpur, Maharashtra (Central India) and reported occlusion rate of 98.61%, recurrence rate of 2.78%, on follow up of 1 year post EVLA, using 1470nm LASER ablation system. [9]

In our study, we assessed the short term (3 month) outcome, and safety of EVLA in a tertiary care center in North India. We also evaluated the rate of recurrence of varicose vein,and associated symptoms post EVLA, and tried to identify the factors that increased the risk of recurrence.

2. Material and Method

2.1 Study Design and Setting

This was a hospital based, prospective observational study,conducted in Department of Diagnostic and Interventional Radiology, in collaboration with Department of Surgery, at a Tertiary care Referral center, over a period of 18 months (May 2023 – November 2024).Patients were enrolled after due approval from Institute's Research and Ethics Committee.

2.2 Inclusion Criteria

Patients aged ≥18 years with symptomatic varicose veins (CEAP class C2 or higher), and sonographic evidence of SFJ/SPJ incompetence (reflux >0.5 seconds).

2.3 Exclusion Criteria

Patients were excluded if :

a) they had a history of deep venous thrombosis (DVT),

b) prior ablative or surgical intervention,

c) uncorrected coagulopathy,

d) allergy to local anaesthetics, or

e) were not suitable for EVLA due to vein anatomy or technical difficulty.

EVLA was performed in 85 limbs from 60 consecutive patients. Two patients were excluded from study, one due to prior DVT, and other due to prior EVLA.

2.4 Pre-Procedure Clinical and Ultrasonography Evaluation

Before EVLA procedure, detailed clinical history was obtained from each patient with special emphasis on type of occupation (standing job which involved standing for more than 4 hours per day, or sitting job which involved standing for less than 4 hours per day), presence of symptoms of chronic venous in sufficiency, any past and/or present history of hypertension (recorded blood pressure of ≥ 130/85 mmHg, or known case of hypertension on anti-hyper tensive medication), diabetes mellitus (elevated fasting blood sugar levels (>126mg/dl), elevated HbA1c (>6.5%), or on antidiabetic medications), history of smoking, and family history of similar venous disease.

Anthropometric measurements included weight, height and body mass index. Clinical Severity was assessed using CEAP classification, and Revised Venous Clinical Severity Score (RVCSS), while QOL was evaluated with Aberdeen Varicose Vein Questionnaire (AVVQ). Duplex ultrasonography included assessment ofSFJ/SPJ incompetence (reflux lasting for more than 0.5seconds), GSV calibre was measured at/just below SFJ, SSV calibre was measured at/just below SPJ, presence of any incompetent perforator (perforator vein>3mm or showing reflux), and varicosity (dilated and tortuous superficial veins >3mm). (Figure 1) Presence of anatomical variants like anterior accessory saphenous vein, and vein of Giacomini was also documented.

2.5 EVLA

EVLA was performed usingLasotronix diode LASER : 1470nm/15W, with radial fiber.Adequate amount of tumescent anesthesia (mixture of 15 ml lignocaine and 15ml soda bicarbonate in 500ml normal saline) was injected along length of vein (GSV/SSV). Segmental pull back technique was used for EVLA. Incompetent perforators were ablated where technically feasible, with bare fiber.

80 (94.1%) limbs underwent ablation of GSV. 58 (68.2%) limbs underwent ablation of SSV. 70 (82.4%) limbs underwent ablation of incompetent perforator using bare fiber. Mean (SD) LEED (J/cm) was 58.03 (8.33). LEED (J/cm) ranged from 39.23 - 79.55.

2.6 Follow Up Protocol

Patients were followed up at 1 and 3months post EVLA. Detailed clinical workup was done for assessment of complications, including pain, paresthesia, burn, bruising, and DVT; and for recurrence. Clinical category of CEAP score and revised VCCS score were recorded again, and QOL was assessed using AVVQ. Duplex ultrasonography was performed again to assess status of ablated vessel, whether thrombosed or patent, and to look for any incompetent perforator, varicosity or other complication. (Figure 1)

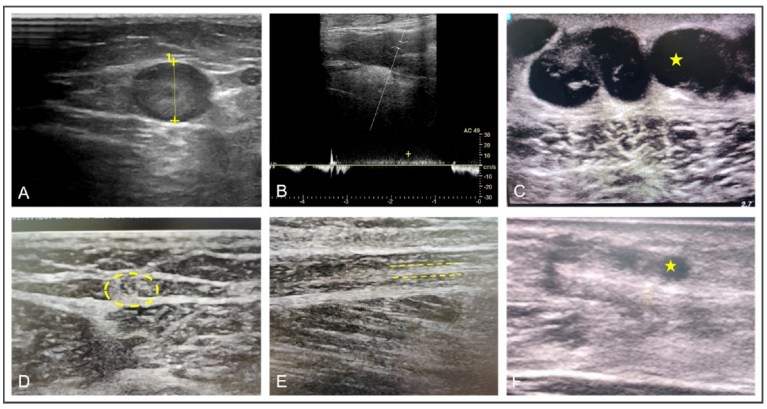

Figure 1. *Pre-EVLA ultrasonography images (A, B, C) showing dilated great saphenous vein (GSV) (yellow cursors) (A); reflux at sapheno-femoral junction lasting for more than 0.5secs (yellow cross) (B); and dilated tortuous superficial varicosities (yellow star) (C). 3 months post-EVLA ultrasonography images (D, E, F) demonstrating thrombosed GSV with echogenic contents (yellow dashed circle) (D); linear echogenic cord-like structure – thrombosed GSV (yellow dashed lines) (E); and thrombosed varicosities with echogenic contents within (yellow star) (F).*

2.7 Ethical Approval

All procedures performed were in accordance with ethical standards of Institutional and/or National Research Committee, and with 1964 Helsinki Declaration, and its later Amendments. Study proposal was first presented to Institutional Ethical Committee, and approval was obtained.

2.8 Statistical Analysis

Data was coded and recorded in MS Excel, and analyzed using SPSS v23 (IBM Corp.). Descriptive

Statistics were described in form of Mean/Standard Deviation and median/IQR for Continuous variable, and frequency and percentage for Categorical variable. Normality for Continuous data was checked using Shapiro-Wilk Test.

Group comparison for two independent group with Non-normally Continuously Distributed data was done using Wilcoxon-Mann-Whitney U Test. Friedman test was used for Paired analysis of Continuous Variables across Time. Chi-squared test or Fisher's Exact test was used for group comparisons for Categorical Data. Linear correlation between two non-normally distributed Continuous Variable was assessed using Spearman's correlation. Kruskal–Wallis test was used for Non-parametric comparison of a Continuous variable across more than two independent groups. Statistical significance was kept at $p < 0.05$.

3. Observation and Result

85 legs from 60 patients underwent EVLA, with ablation of GSV in 80 limbs and of SSV in 58 limbs.

3.1 Improvement in Clinical Grading (Figure 2)

Mean CEAP clinical class (C score) decreased from 3.60 pre-EVLA to 1.88 at 3 months post EVLA. Mean percent change in CEAP C score at 3 months was -56.80 ± 46.68.Mean RVCSS decreased from 8.02 pre-EVLA to 4.26 at 3 month follow-up. Mean percent reduction in RVCSS 3 months post EVLA was -41.02 ± 21.61.

3.2 Improvements in QOL(Figure 2)

Mean AVVQ improved from 38.13 pre-EVLA to 11.51 at 3 months. Mean percentage reduction in AVVQ after 3 months was -71.04 ± 20.03, indicating a substantial improvement in patient-reported QOL.

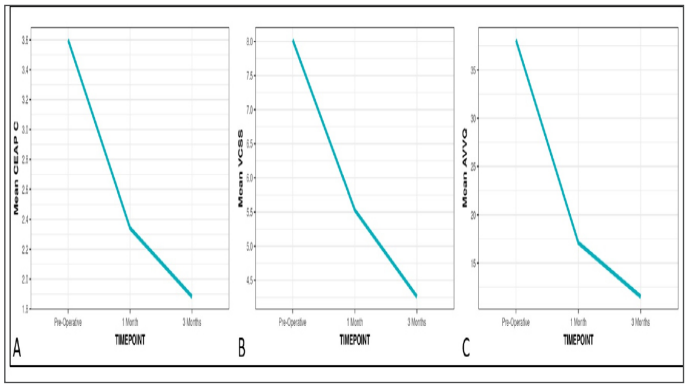

Figure 2. *Change in Clinical Severity Scores – CEAP Clinical class (A) and Revised Venous Clinical Severity Score (B); and in patient reported quality QOL, Aberdeen varicose vein questionnaire (C) at 1month and 3months after EVLA.*

Table 1. *Patient Demographic Characteristics.*

Demographics	Mean ± SD || Median (IQR) || Min-Max OR N (%)
Age (Years)	42.75 ± 14.97 || 43.50 (29.75-51.25) || 18.00 - 83.00
Gender	
Male	49 (81.7%)
Female	11 (18.3%)
Occupation	
Sitting	23 (38.3%)
Standing	37 (61.7%)
Family History (Yes)	5 (8.3%)
Obstetric History	
Prime Gravida	1 (9.1%)
Multi Gravida	10 (90.9%)
HTN (Yes)	10 (16.7%)
DM (Yes)	11 (18.3%)
Smoker (Yes)	15 (25.0%)
Height (cm)	168.52 ± 5.23 || 168.00 (165.00-170.00) || 159.00 - 188.00
Weight (kg)	72.53 ± 8.22 || 71.50 (67.00-76.00) || 57.00 - 104.00
BMI (kg/m²)	25.53 ± 2.56 || 25.15 (23.81-26.86) || 21.30 - 35.99

3.3 Ultrasonography Findings – Post-Evla (Table 2)

87.1% of limbs showed thrombosed great saphenous vein 3 months after EVLA. 7.1%of the limbs showed recanalization of GSV. 67.1% of limbs had thrombosed small saphenous vein 3 months after EVLA.2.4%of limbs showed recanalization of SSV.

Table 2. *Clinical and Ultrasonographic characteristics of limbs pre-EVLA.*

Ultrasound findings	Mean ± SD || Median (IQR) || Min-Max OR N (%)
SFJ Incompetence (Yes)	80 (94.1%)
GSV diameter (mm)	5.73 ± 1.57 || 5.5 (4.9-6.2) || 3 - 12
SPJ Incompetence (Yes)	58 (68.2%)
SSV diameter (mm)	3.77 ± 1.15 || 3.7 (3-4.5) || 1.9 - 6.8
Perforators (Yes)	68 (80.0%)
Varicosities (Yes)	82 (96.5%)
Anterior accessory saphenous vein (Yes)	4 (4.7%)
Vein of Giacomini (Yes)	3 (3.5%)
CEAP C Score (Pre-EVLA)	3.60 ± 1.35 || 4 (2-4) || 2 - 6
RVCCS (Pre-EVLA)	8.02 ± 4.31 || 7 (5-9) || 3 - 22
AVVQ (Pre-EVLA)	38.13 ± 15.59 || 35.71 (26.74-44.64) || 7.14 – 76.79

3.4 Procedure-Related Side Effects

Paresthesia was seen in 11 (12.9%) of limbs after end of 3months. Median LEED was higher in patients who developed paresthesia (65.62 J/cm), as compared to those who didn't developed paresthesia (56.90 J/cm).In 7 (8.2%) of limbs,there was persistent residual pain at puncture site,requiring intermittent analgesic use. Skin burns and ecchymosis were seen in 2 limbs (2.4%). No patient developed DVT post EVLA.

3.5 Residual Ulcer

At 3 months, residual venous ulcer were seen in 5 limbs (5.9%), accounting for 38.5% of limbs with active ulcers at baseline. 61.5% of active ulcers had healed by the 3-month follow-up.

3.6 Recurrence and Recanalization

92.9% of the limbs had no recurrence clinically, or recanalization of vein on USG. 5.9% of limbs (5 limbs)had recurrent symptoms, with recanalization of vein on USG. In 1 limb (1.2%), there was partial recanalization of vein on USG, without any clinical symptoms.

3.7 Demographics and Disease Burden (Figure3)

Pre-procedure GSV and SSV diameter showed statistically significant positive correlationwith CEAP C score, RVCSS, and AVVQ.Median GSV diameter was significantly higher in limbs with SFJ incompetence, versus competent SFJ.Similarly, median SSV diameter was higher in limbs with SPJ incompetence, compared to those without reflux, or with high-riding SSV.

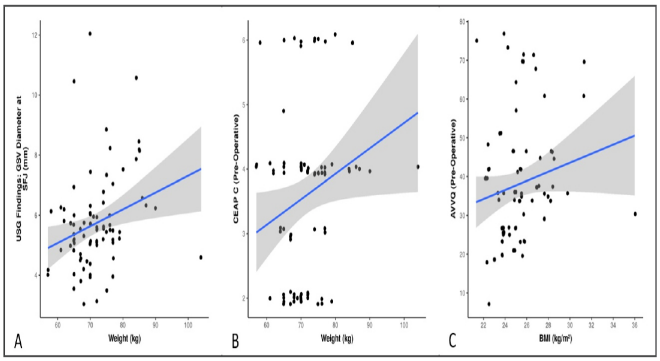

Figure 3. *Scatterplots showing positive correlation between pre-EVLA GSV diameter (mm) and weight (kg) (A), CEAP Clinical class and weight (kg) (B) and Aberdeen varicose vein questionnaire and BMI (kg/m²) (C). Individual points represent individual cases. Blue trendline represents the general trend of correlation between the two variables. Shaded grey area represents the 95% confidence interval of this trendline.*

Patient weight and BMI showed moderate positive correlation with GSV diameter, and clinical scores (CEAP C and RVCSS).BMI also showed a weak positive correlation with AVVQ score.Patients with

standing occupation (>4 hours/day) had higher median CEAP C scores, RVCSS, and AVVQ score, compared to those with sitting job.

3.8 Factors Associated with Recanalization

Limbs with GSV recanalization at 3 months had higher pre-procedure GSV diameter, and elevated baseline CEAP C and RVCSS score. Statistically significant difference in BMI was observed across groups,with and without recanalization/recurrence — with median BMI being higher in group with clinical recurrence.

4. Discussion

85 legs from 60patients underwent EVLA.Ablation was tailored to anatomical site of reflux (GSV and/or SSV), with adjunctive perforator ablation as and when required. EVLA demonstrated a high success rate, with marked improvement in clinical severity scores and patient-reported QOL.

4.1 Primary Outcome

At 3 months, there was significant decrease in disease burden (CEAP C score and RVCS score) and improvement in QOL (AVVQ). Residual pigmentation and prescribed compression stockings contributed to incomplete normalization of these scores, with extended follow-up likely to show further improvement as pigmentation resolves on long follow up.

Recurrence rate was 7.1%, with five cases showing both clinical recurrence and ultrasonographic recanalization, and one case showing asymptomatic partial recanalization.

Our observed recurrence rate of 7.1% falls within the lower end of the spectrum reported in literature, with rates ranging from 2.78% to 22% [2,5,6,9-11], with caveat that our study had a shorter duration of follow up of only 3months. Studies with longer follow up typically report higher recurrence rate [5].

4.2 Analysis of Recurrence

Patients with recanalization had a significantly higher mean BMI, consistent with prior studies linking obesity to increased recurrence after EVLA [12,13]. While preoperative GSV diameter was also significantly greater in limbs which showed recanalization, reverse was not observed—larger GSV diameter alone doesn't predict recanalization. This indicates that increased vein diameter may not be an independent risk factor for recurrence, and reflects overall disease severity rather than causality, which predisposes to both vein dilation and treatment failure.

Mean LEED in this study was 58.03 J/cm, below the commonly recommended 80–100 J/cm range. While patients with recanalization had lower LEED, the difference was not statistically significant. Prior studies, such as the one by Park JA et al, have shown acceptable outcomes with LEED values in 50–80 J/cm range, reinforcing that while energy dosage is a contributing factor, but it is not exclusive factor responsible for recurrence [14].

Recurrence rate in EVLA is highly dependent on operator skill, adherence to procedural protocols and adequate use of tumescent anesthesia. Anatomical variants like anterior accessory saphenous vein and vein of Giacomini can serve as alternative reflux pathway, or become source of recurrence, if not identified and treated. Patient compliance with post-operative care is also a key determinant of long-term success, a critical contributor of which is adherence to post-procedure compression therapy. Early use of compression stockings post-ablation is associated with reduction in postoperative pain [15]. Patient education, appropriate sizing, and compliance monitoring are necessary to optimize outcome.

Residual venous ulcers (C6) were present in 5.9% of total limbs at 3 months, with a healing rate of 61.5%, consistent with study done by Marston WA et al, who reported 57% resolution by 3 months [16]. These patients had no significant association with recanalization or pre-EVLA vein diameter, suggesting that ulcer healing depends on broader pathophysiologic control of disease. Proper wound care with adequate use of compression therapy can improve ulcer resolution rate.

Out of 36 patients with C4 disease, 61.1% had persistent pigmentation at 3 months. Pigment resolution is known to be slow, and can take a long time for complete resolution. Nonetheless, none of these patients showed worsening, with consistent decrease in area of pigmentation indicating stable disease control.

4.3 Secondary Outcomes and Analysis

No case of DVT was reported in our study. Minor complications included paresthesia, puncture site pain, and ecchymosis/burns. Paresthesia was associated with higher LEED (mean 65.62 J/cm vs. 56.90 J/cm). Although still within the safe range, this reinforces the need for careful titration of energy and effective tumescent anesthesia (adequate quantity and optimal temperature) to prevent nerve-related complications.

4.4 Demographic Trends and Risk Stratification

Patients in our study were predominantly middle-aged men, 81.7% men versus 18.3% female, with mean age of 42.75 years, which forms the bulk of working population. Studies have suggested that reticular vein, telengiectasia and varicose vein (C1-C2) are more common in women, with progression to more severe disease occurring at similar rates in both genders [17,18].

Patients also often present late in course of disease in our population (mean C score in our study was C4), at which time the prevalence shifts towards male predominance. Majority of patients (61.7%) were involved in jobs requiring prolonged standing. These patients had higher CEAP, RVCSS, and AVVQ scores, though standing was not significantly associated with GSV diameter. This suggests that occupational exposure exacerbates symptoms independently of structural vein change.

Higher BMI and weight were associated with increased vein diameter, worse clinical scores, and higher recurrence rates. These findings are consistent with previous studies linking obesity to more severe venous insufficiency [19], and poorer procedural outcome, both in mechanochemical [12]and thermal ablation [13].

Limitations

While our study provides insights into short-term outcome of EVLA, certain limitations should be acknowledged. Follow-up duration was limited to three months, which restricted the ability to assess long-term outcomes such as neovascularization, delayed recanalization, or ulcer recurrence. As a single-arm observational study, the efficacy of EVLA was not compared with other treatment modalities such as radiofrequency ablation, foam sclerotherapy, or cyanoacrylate glue ablation. Additionally, the single-center design may limit the generalizability of findings to other populations.Also, patient compliance with post-procedural advice (particularly the use of compression stockings and early ambulation) was not objectively monitored, which can influence outcome variability.

Future Directions

Future research should focus on long-term follow-up studies to evaluate the durability of EVLA outcomes, particularly in relation to delayed recanalization, ulcer recurrence, and neovascularization. Comparative trials involving other modalities—such as mechanochemical ablation (MOCA), foam sclerotherapy, and cyanoacrylate glue ablation—are needed in Indian context to assess relative efficacy, cost-effectiveness, and patient satisfaction. Development of stratified treatment protocols based on BMI and vein diameter may help tailor therapy, and improve outcome. Digital tools such as mobile applications or wearable devices may improve post-procedural compliance, by monitoring compression stocking use, and ambulation.

5. Conclusion

EVLA demonstrated excellent short-term clinical efficacy with statistically significant improvement in:

- CEAP Clinical Score (from 3.60 to 1.88),
- Revised VCSS (from 8.02 to 4.26), and
- AVVQ score (from 38.13 to 11.51),

there by indicating marked improvement in both Clinical Severity and patient QOL. Over all recurrence rate was 7.1%, which is at lower end of reported range in literature (2.78%–22%).

Patients with recurrence had lower mean LEED, while those without recurrence had higher LEED. Recanalization was also associated with higher weight and BMI. Patients with higher GSV/SSV diameters had significantly worse AVVQ, CEAP, and RVCSS scores.Higher BMI was significantly associated with higher disease severity scores (RVCSS, CEAP, AVVQ), as well as increased vein diameter.Occupations requiring prolonged standing were also significantly associated with higher clinical severity scores. Residual pigmentation and ulceration persisted in some cases, though trends indicated improvement, suggesting need for longer follow-up.

Conflict of Interest

The authors do not have any conflict of interest to declare.

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