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Original research

THE EFFECTIVENESS OF ENDOVENOUS LASER ABLATION VERSUS RADIO - FREQUENCY ABLATION IN THE TREATMENT OF VENOUS INSUFFICIENCY OF THE LOWER EXTREMITIES

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ABSTRACT

Objectives: *To compare the improvement in symptoms and effectiveness in eliminating reflux of chronic venous insufficiency (CVI) patients between two endovascular intervention methods: Endovenous Laser Ablation (EVLA) and Radio - Frequency Ablation (RFA) in patients with venous insufficiency of the lower limbs.*

Methods: *This retrospective longitudinal descriptive study aimed to assess the recovery of symptoms and reflux in the veins using the Mean Venous Clinical Severity Score (VCSS) and vascular echography between the two intervention methods.*

Results: *From January 2023 to January 2024, 129 patients underwent venous intervention at the Thoracic and Vascular Department of the University Medical Center in Ho Chi Minh City. Fifty - five patients underwent RFA, and the remaining 74 were treated with EVLA. The study included 44 male patients (34.1%) and 85 female patients (65.9%), with an average age of 55.8 years. All patients reported significant symptom improvement, though minor residual symptoms may have been underreported due to self-reported assessments. Multivariate regression analysis indicated that exercise habits and EVLA treatment independently contributed to symptom improvement, with p-values of 0.00001 and 0.03, respectively. Further subgroup analysis indicated that male patients and those with regular exercise habits experienced slightly faster symptom resolution.*

Conclusion: *EVLA should be prioritized in the treatment of venous ablation for CVI patients indicated for intervention. Structured exercise programs should be actively recommended to optimize recovery and long-term outcomes.*

Keywords: *Chronic Venous Insufficiency, Endovenous Laser Ablation, Endovenous Radio-Frequency Ablation.*

I. INTRODUCTION

Chronic venous insufficiency (CVI) of the lower limbs is a common condition, particularly in women with various risk factors. This condition leads to numerous symptoms and sequelae that negatively affect the patient's quality of life if left untreated. According to a report by Vu Thanh Binh et al., 100% of patients with CVI experience calf pain, with nearly 85% reporting heaviness in their legs while walking, and others suffering from leg pain [1]. The number of people with CVI is increasing worldwide, making complete treatment a significant challenge despite the advent of new methods. Therefore, selecting optimal treatment remains a subject of ongoing research.

Current guidelines recommend high-temperature ablation techniques such as Endovenous Laser Ablation (EVLA) and Radio - Frequency Ablation (RFA) due to their effectiveness in eliminating reflux at the saphenous - femoral junction [2].

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Recent studies have suggested that EVLA may offer superior symptom improvement and occlusion rates compared to RFA, making it an increasingly preferred option in clinical practice [3], [4].

However, the treatment that achieves the most favorable outcomes has not been thoroughly evaluated at the University Medical Center Ho Chi Minh City, especially in the current era where EVLA is becoming widely popular. Additionally, exercise habits have been recognized as a significant factor influencing symptom resolution and overall recovery following venous ablation procedures [5]. This study aims to determine the effectiveness of EVLA compared to RFA in eliminating reflux. Furthermore, we assess whether exercise habits independently contribute to improved patient outcomes following venous ablation treatment.

II. MATERIALS AND METHODS

2.1. Study design

This is a retrospective longitudinal descriptive study of patients with CVI of the lower limbs. Patients were divided into two treatment groups: one undergoing EVLA using a 1470 nm wavelength (EVLA Group) and the other undergoing RFA using the ClosureFAST catheter (RFA Group) at the Thoracic and Vascular Department of the University Medical Center in Ho Chi Minh City from January 2023 to January 2024.

Inclusion criteria: Patients with venous reflux > 500ms and great saphenous vein (GSV) diameter ≥ 5mm at the saphenous - femoral junction in a standing position [6].

Exclusion criteria: Patients with combined surgical removal of varicose veins at the saphenous-femoral junction.

Ablation Procedure: EVLA was performed using a 1470 nm wavelength laser at 5 W, 30 J/cm, while RFA was conducted with the ClosureFAST catheter using segmental ablation at 120°C, applying higher energy at the saphenofemoral junction to enhance closure rates.

Outcome Assessments: Patients were assessed for clinical symptoms, procedural complications, and the recovery of symptoms and reflux in the veins using vascular echography and the Venous clinical severity score (VCSS) [7]. The VCSS offers a standardized and objective measure of venous disease severity and its impact on patients' quality of life. It encompasses 10 parameters, including pain, varicose veins, venous edema, skin hyperpigmentation, inflammation, induration, number, duration, and size of ulcers, and compliance with compression therapy. Each parameter is graded from zero to three (None = 0, Mild = 1, Moderate = 2, Severe = 3). This evaluative scoring system aids in assessing chronic venous disease severity, disease progression, and treatment outcomes in patients.

Evaluations were conducted immediately after the intervention (T0) and during follow-up at 1 week (T1), 1 month (4 weeks, T4), and 4 months (16 weeks, T16) post-intervention. Figure 1 provides a summary of the research process.

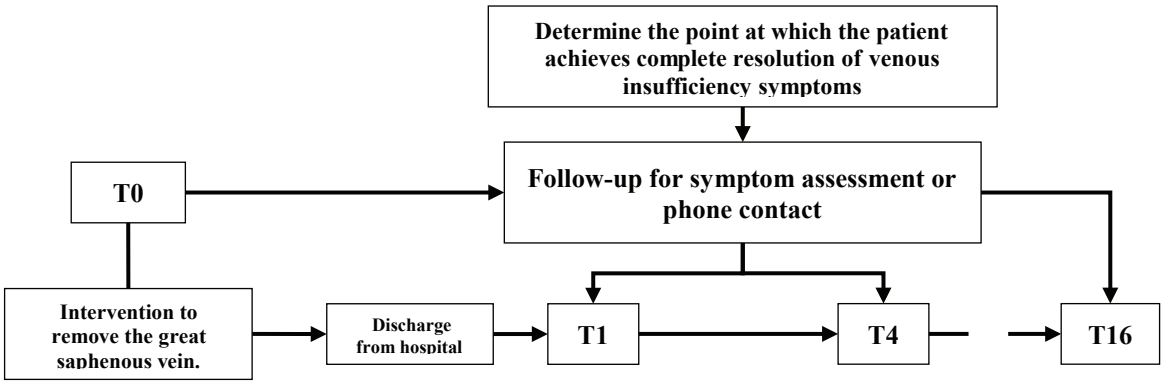

Figure 1: Summary of the research process conducted in this study

2.2. Data Collection and Analysis

Data were presented as n (%) for categorical variables, Mean ± SD for proportional data, and Median [IQR] for non-proportional data. The Kaplan - Meier curve method was executed to evaluate symptom improvement effectiveness based

on VCSS criteria. Univariate and multivariate Cox regression analyses were performed to determine factors affecting symptom improvement in lower limb varicose veins after procedures.

Data was processed and analyzed using R statistical software version 2.15.0.

III. RESULTS

129 cases of CVI lower limb were treated with GSV ablation using EVLA or RFA at the University Medical Center Ho Chi Minh City. Figure 2 shows the rate of EVLA and RFA treatment (Figure 2). General characteristics are listed in Table 1).

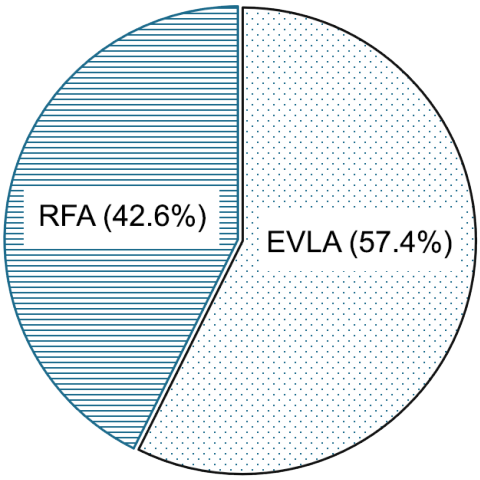

Figure 2: Rate of EVLA and RFA treatment (EVLA: Endovenous Laser Ablation; RFA: radio-frequency ablation)

Table 1: General Characteristics of the study population

Characteristic	Value
Male	44 (34.1%)
Age	55.8 ± 12.3
Multiparous	5 (5.9%) *
Exercise Habit	35 (27.1%)
Smoking	32 (24.8%)
reflux on echography > 500ms	129 (100%)
Symptom Presentation	
VCSS-0	0 (0%)
VCSS-1	98 (75.9%)
VCSS-2	31 (24.1%)

*: *Percentage calculated based on the total female population.*
VCSS: Mean Venous Clinical Severity Score

No major complications, such as skin burns, bleeding, infections, deep vein thrombosis, saphenous nerve damage, or arterial damage, were observed during or after the procedure. The average diameter of the GSV pre- and post-procedure is as follows (Table 2):

Table 2: Average Diameter of the GSV pre- and post-procedure

Average Diameter of the GSV (mm)	EVLA-group	RFA-group
Pre-procedure	6.8 ± 1.2	6.5 ± 0.8
After 1 Month	2.7 ± 0.5	2.8 ± 0.4
After 4 Months	2.2 ± 0.6	2.3 ± 0.7

GSV: Great saphenous vein

After 1 and 4 months, all patients underwent vascular echography (Table 3). At 1 month, 92 patients (71.4%) showed complete vein occlusion with no reflux. The remaining 30 patients (23.2%) still had blood flow within the vein but showed a significant reduction in vein diameter and no reflux. Seven patients (5.4%) exhibited residual reflux at 1 month, but no cases of reflux were recorded after 4 months. Both interventions showed 100% elimination of reflux in 4 months.

Table 3: Echography Results of the GSV After Intervention

Characteristics of the GSV post-procedure	1-Month		4-Month	
	EVLA-group	RFA-group	EVLA-group	RFA-group
Complete Occlusion	54 (73%)	38 (69%)	73 (98.7%)	53 (96.35%)
Residual Flow*	16 (21.6%)	14 (25.5%)	1 (1.3%)	2 (3.65%)
Residual Reflux*	4 (5.4%)	3 (5.5%)	0 (0%)	0 (0%)
Total	74 (100%)	55 (100%)	74 (100%)	55 (100%)

**: For patients with interventions on both limbs, residual flow or reflux was recorded if either limb exhibited these conditions. EVLA: Endovenous Laser Ablation; GSV: Great saphenous vein; RFA: radio-frequency ablation*

The symptom improvement effectiveness was evaluated by Kaplan-Meier curve based on VCSS criteria (Figure 3). After a 4-month follow-up period, all patients reported significant symptom improvement; however, minor residual symptoms may have been underreported due to self-reported assessments. No periprocedural or postprocedural complications were recorded in either treatment group.

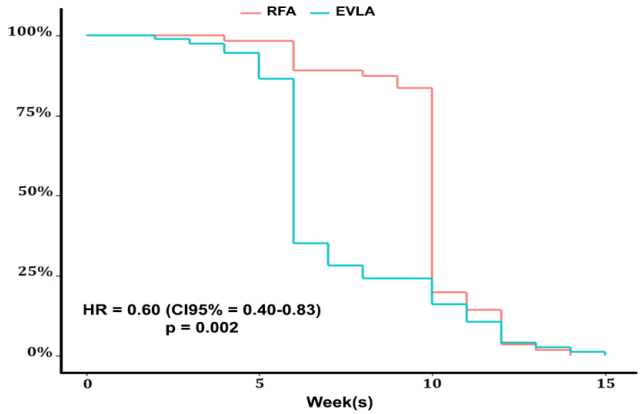

Figure 3: Kaplan - Meier symptom improvement effectiveness

Univariate regression analysis was conducted to identify factors affecting symptom improvement outcomes (Table 4). The factors identified included male gender, age ≥ 50, BMI ≥ 23 kg/m², exercise habits, smoking, and EVLA treatment. These factors were subsequently included in a multivariate regression model to evaluate their independent associations. The results indicated that exercise habits and EVLA treatment independently contributed to symptom improvement, with p-values of 0.00001 and 0.03, respectively.

Table 4: Multivariate Cox Regression Analysis Determining Factors affecting symptom improvement

Variable	HR	CI95%	p-value
Male Gender	0.88	0.57-2.23	0.72
Age ≥ 50	1.14	0.77-1.71	0.48
BMI ≥ 23 kg/m²	1.27	0.87-1.86	0.21
Exercise Habit	0.17	0.10-0.30	0.00001
Smoking	1.53	0.31-1.34	0.25
EVLA treatment	0.66	0.45-0.85	0.03

BMI: Body mass Index; EVLA: Endovenous Laser Ablation

IV. DISCUSSION

4.1. General Characteristics

Our findings indicate that two-thirds of the patients are female, and a few have a history of giving birth to three or more children. Most of the patients are elderly, with an average age of over 55. The data show that women are twice as likely to develop venous insufficiency compared to men. Additionally, in women, multiple childbirths further increase the risk of the disease. However, the rate of women with many children is low, as most women do not have more than two children, thus reducing the incidence of the disease in this group. This aligns with the international report by Aslam et al. on factors contributing to CVI of the lower limbs [8]. The author also mentioned risks associated with smoking habits, lack of exercise, and sedentary occupations. All of our patients were currently or previously engaged in jobs that involved prolonged sitting or standing, or frequent repetitive movements with little leg activity, combined with a lack of exercise (only a little over one-third of the patients exercised), and most of the men were heavy smokers (32 out of 44 men, with no women smoking).

4.2. Comparison of EVLA and RFA

When comparing the effectiveness of EVLA and RFA, Bozoglan et al. found that EVLA treatment was superior to RFA in many aspects [3]. The authors selected a sample of 60 patients with lower limb venous insufficiency who had varicose veins in both legs, treating one leg with EVLA and the other with RFA. This approach demonstrated that EVLA was more effective than RFA in improving symptoms post-treatment. Specifically, it reduced postprocedural complications such as skin bruising and leg swelling and promoted faster recovery. If complications did occur, most resolved within two weeks. No cases of paresthesia, deep vein thrombosis, or pulmonary embolism were reported post-intervention.

Another study conducted with a very large sample size to investigate the time to symptom improvement after EVLA showed significant improvement within 2 weeks conducted by Mallick et al [9]. There was a reduction in leg pain and swelling, and in some cases, leg ulcers healed. A small percentage (< 1%) developed new leg ulcers, and this rate remained < 2% after one year of follow-up.

In our study, all showed complete symptom improvement within 4 months, with no severe postprocedural complications, and most improved after 10 weeks. The average symptom improvement time for patients treated with EVLA was 8 weeks, and even earlier if the patient had no risk factors. Conversely, this time could be longer in patients with ≥ 1 risk factors, but all eventually improved completely. Similarly, patients treated with RFA also experienced symptom reduction, mostly after 10 weeks of treatment. Overall, patients treated with RFA took longer to recover from symptoms compared to those treated with EVLA, and this difference was statistically significant. Although EVLA was effective in symptom improvement and vein occlusion, El Kilic et al. reported higher complication rates, more postprocedural pain, and longer recovery times compared to RFA [10]. Long-term data also showed higher occlusion rates for RFA at 3 and 5 years, suggesting better durability. Thus, patient selection and long-term outcomes should be considered when choosing between EVLA and RFA [10].

4.3. Follow-up outcome

During follow-up, no cases showed symptoms after 4 months (VCSS 0), and most patients could resume normal activities soon after treatment. This was confirmed using the Kaplan-Meier symptom improvement effectiveness analysis, which showed that after a follow-up period, 100% of patients experienced complete symptom improvement, with no periprocedural or postprocedural complications recorded. This result is consistent with Bozoglan's conclusion that most patients recover from CVI symptoms within 8 weeks of treatment [3]. However, recovery time can be significantly shorter if patients have a habit of exercising before and after treatment. As with other interventions, early postprocedural movement is recommended for all patients, and those with a prior exercise habit tend to resume activity earlier. This significantly accelerates the healing process and symptom improvement. Therefore, in addition to choosing the intervention method, exercise also has a positive impact on disease improvement.

Furthermore, Jiang et al. recently reviewed data compiled from 29 studies [11]. The author compared

the short-term and long-term effectiveness of thermal ablation of the GSV, focusing on postprocedural occlusion rates and complications such as phlebitis and thrombosis. This report highlighted that RFA had fewer postprocedural complications compared to EVLA. The author also noted a limitation in the study did not evaluate other post-procedure aspects such as quality of life, symptom improvement according to VCSS, and recovery time [11].

For both methods, post-procedure GSV size was significantly reduced as recorded on echography, coinciding with clinical symptom improvement. Thirty patients (23.2%) still had blood flow within the vein but no reflux one month after treatment, possibly due to the use of low energy during ablation. However, at 4 months post-procedure, only 3 patients (4.95%) still had blood flow within the GSV without reflux. This rate was low, and all patients showed clear clinical improvement at this time. Residual venous reflux persisted in seven patients (5.4%) at 1-month post-procedure but was absent after 4 months of follow-up. There was no correlation between this condition and the size of the GSV or pre-procedure clinical symptoms. High-energy vein interventions can reduce the rate of residual blood flow within the vein but may also lead to local complications such as bruising along the vein path or vascular perforation causing bleeding. Although a small percentage still had blood flow within the GSV, there was no reflux, and these patients all showed significant symptom improvement. Bendix et al. also reported symptom improvement and reduced complications after endovenous interventions regardless of the initial size of the GSV [12]. They found that patients with larger veins pre-procedure had a faster rate of improvement, with most patients experiencing a reduction in vein diameter to less than 2mm after the procedure.

Furthermore, aside from the treatment method, our univariate regression analysis using the Cox method indicated that exercise habits independently contributed to symptom improvement. This finding underscores the critical importance of patient education regarding postprocedural care. Encouraging patients to adopt and maintain regular exercise routines can significantly enhance recovery and improve long-term outcomes. Interestingly, whether pre-existing exercise habits influenced the choice of EVLA or RFA remains uncertain. More active patients may have been more inclined toward a particular procedure based on physician recommendations or personal preferences. Investigating this relationship further could provide valuable insights into personalized treatment approaches. Therefore, healthcare providers should emphasize the role of physical activity and provide clear guidance on appropriate exercises and activity levels following the procedure. This comprehensive approach not only supports the effectiveness of the medical intervention but also empowers patients to take an active role in their recovery process.

This study has some limitations, including its retrospective design and single-center setting, which may introduce selection bias. The follow-up period was limited to 4 months, preventing long-term outcome assessment. Additionally, patient allocation to EVLA or RFA was not randomized, potentially influencing results. Future multi-center, randomized studies with longer follow-up are needed to confirm these findings.

V. CONCLUSION

Both EVLA and RFA achieved a very high rate of complete occlusion of the GSV after 4 months. However, the EVLA method resulted in symptom improvement in 6 weeks compared to 10 weeks for RFA, and the occlusion rate was also higher at 98.7% compared to 96.35% for RFA. Additionally, exercising or maintaining an exercise routine can help reduce the time required for symptom improvement in patients undergoing endovenous ablation.

Abbreviations

BMI: Body mass index
CVI: Chronic venous insufficiency
EVLA: Endovenous laser Ablation
GSV: Great saphenous vein
RFA: radio-frequency ablation
VCSS: Venous clinical severity score

Competing Interests

The authors declare no competing interests related to this study.

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