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Original Article

Endovenous Laser Therapy (EVLT) vs. Sclerotherapy: A Comparative Study on the Long-Term Efficacy of Varicose Vein Treatments

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ABSTRACT

This prospective comparative study aimed to evaluate the long-term efficacy of Endovenous Laser Therapy (EVLT) versus Sclerotherapy in the treatment of varicose veins. A total of 200 patients were randomly assigned to receive either EVLT (n=100) or Sclerotherapy (n=100). A three-year study period included assessments of vein closure success and treatment recurrence combined with Venous Clinical Severity Score - VCSS changes and patient satisfaction levels and complications and financial expenses. The research demonstrated a clear significance between EVLT and Sclerotherapy treatment outcomes based on the generated p-values (0.03 and 0.02). EVLT produced higher vein closure rates of 92% at year one and 94% at year three compared to Sclerotherapy's 84% and 80% closure rates. The 3-year recurrence rate in the EVLT group came out to 6% which was lower than the 20% recurrence rate in the Sclerotherapy group with a p-value of 0.01. The VCSS scores diminished substantially in the EVLT group between 3.5 ± 1.1 points and Sclerotherapy between 5.5 ± 2.1 points at the 3-year mark thus indicating superior symptom control in EVLT treatment (p=0.01). More patients reported satisfaction after EVLT treatment than after the Sclerotherapy approach (85% vs. 72% respectively with p=0.02). While EVLT required a higher initial expenditure the total three-year treatment expenditure matched those of Sclerotherapy because EVLT needed less post-treatment intervention including follow-up visits. The better long-term outcomes from EVLT which prevent vein recurrence and improve symptoms along with patient satisfaction establish the procedure as an optimal treatment option for varicose vein therapy especially for patients seeking permanent solutions to enlarged vein conditions..

INTRODUCTION

The adult population experiences varicose veins as common venous disease which occurs primarily in women and people above sixty years old (Sutton et al., 2021). The disorder appears in lower extremities by creating dilated veins which grow complex and produce three common symptoms consisting of ulceration and bleeding and venous thrombosis (Yang et al., 2022). Two of the numerous available varicose vein treatment options commonly employ endovenous laser therapy (EVLT) and sclerotherapy to help control the condition in non-invasive ways. The two methods evolved into alternatives to conventional surgical vein stripping because patients experience longer recovery times with higher complication rates (N Nguyen et al., 2020). Multiple clinical studies should explore the long-term effects of EVLT and Sclerotherapy because these popular treatment methods require more research to determine their distinct benefits versus risks.

Endovenous laser therapy appeared during the early 2000s using laser energy to heat and seal problem veins which eventually collapses before the body absorbs them (Boulanger et al., 2019). EVLT has gained some popularity due to its minimal invasiveness and reduced complication risks as compared to conventional surgery and shorter recovery times (Cochrane et al., 2021). The administration of sclerosant solutions through intravenous injections into varicose veins causes damage to the vascular lining which results in vein clotting until the blood vessel finally closes (Pereira et al., 2020). The medical procedure of sclerotherapy mainly targets smaller veins along with reticular veins but medical professionals also utilize it with other treatments for larger veins (Zhang et al., 2023).

Research lacks confirmation about the extended durational success rates of both Sclerotherapy and EVLT as treatments for varicose veins. The comparison between EVLT and Sclerotherapy treatment generated contradictory results because different research has shown EVLT exhibits better outcome measures for vein closure and symptom alleviation (Chien et al., 2021; Ali et al., 2022) but Sclerotherapy presents lower costs and fewer adverse effects (Ramirez et al., 2020). Research on these therapeutic procedures becomes more complicated due to treatment-dependent factors such as patient characteristics including age and vein dimensions and existing medical conditions (Lee et al., 2022).

The absolute necessity exists to evaluate the long-term outcomes of treatments designed for varicose veins. The general effectiveness and patient quality of life improvements of both EVLT and Sclerotherapy depend on long-term results despite initial success based on symptom relief and vein closure (Jiang et al., 2021). The high rates of recurrence in varicose vein care applications require particular attention since additional procedures may become necessary (Suk et al., 2022). Medical research indicates varicose veins have a chance of returning at a 40% rate after therapeutic procedures (Choosei et al., 2023). The choice of treatment along with clinical practice scheduling needs information about how EVLT stands versus Sclerotherapy regarding long-term outcomes and recurrence prevention and patient satisfaction.

This research uses a comparative analysis to measure long-term Endovenous Laser Therapy (EVLT) and Sclerotherapy treatments for varicose veins which aims to fill the current gap in available literature. The core analysis of this study focuses on long-term results that include rates of vein closure along with recurrence outcomes

and symptom reduction and patient satisfaction evaluation. The research evaluates patient outcomes after treatment with either EVLT or Sclerotherapy in order to determine which technique leads to superior long-term benefits through examination of treatment data from extended patient populations. Patient-specific characteristics including age, gender and comorbidities and vein size will be assessed along with their influence on treatment outcomes during this study. This research holds importance because existing weak studies around long-term medication outcomes require resolution which will enhance venous disease care.

The research by Huang et al. (2020) confirmed the short-term outcomes between EVLT and Sclerotherapy yet it did not analyze their sustained effectiveness (Huang et al., 2020). The benefits gained from short-term success rates could become less relevant for determining therapy effectiveness over time because Blanc et al., (2019) found this pattern is inconsistent. This research gap exists for long-term recurrence rates of varicose veins since few studies have specifically studied these rates between EVLT vs Sclerotherapy (Marlow et al., 2021).

The extended patient tracking duration of this study attempts to answer essential questions about therapy efficacy that leads to better prevention of recurrence and enhances long-term quality of life.

This study extends its value beyond medical applications. Health status and lifestyle along with expense costs of patients strongly depend on their selection between electrical vessel ablation or sclerotherapy therapy. The understanding of therapy outcomes enables patients to decide wisely which treatment to choose (Sharma et al., 2021). This study will contribute to the expanding body of knowledge about proper varicose vein management techniques which healthcare professionals can use to guide their treatments.

The investigation presents both qualitative patient-reported feedback and quantitative assessment methods for a complete evaluation of EVLT's long-term endurance against Sclerotherapy. The research will establish comprehensive understanding regarding the therapy outcomes by assessing clinical performance indicators including patient satisfaction to increase scientific understanding of venous disease management.

The analysis of Endovenous Laser Therapy (EVLT) durability against Sclerotherapy stands as a critical study to enhance understanding about how these approaches continue to produce positive outcomes. The evaluation of vein closure rates and recurrence measurements and patient satisfaction levels will enhance clinical care decision-making through this research's completion of an essential knowledge gap. This research will expand existing evidence on EVLT and Sclerotherapy thus directing future approaches to varicose vein treatments.

Methodology

A prospective comparative research design evaluates the extended success rates of Endovenous Laser Therapy (EVLT) alongside Sclerotherapy for treating varicose veins within this paper. The researcher will identify participants among all patients diagnosed with primary varicose veins who seek treatment at their tertiary care hospital. The study will include patients within the age range of 18 to 75 years with either great saphenous vein or small saphenous vein whose condition qualifies them for minimal invasive treatments. The study excludes individuals who possess secondary varicose veins or deep vein thrombotic history or pregnancy status or prior varicose vein surgical intervention. The research study will divide its two hundred participants into two

random groups where ninety-eight participants will undergo EVLT and ninety-eight participants will receive Sclerotherapy. According to accepted procedures the 1470 nm diode laser will be used for EVLT but Sclerotherapy will employ hypertonic saline solution or polidocanol sclerosant.

The data collection process will measure both clinical indicators and patient-reported results during baseline and at six-month marks one year after treatment completion and at three years follow-up. The medical measurements will monitor vein closure rates besides recurrence rates while examining the existence of complications like skin color changes and thrombophlebitis. Post-treatment vein closure assessment and patency determination will depend on duplex ultrasounds because they represent the clinical benchmark for this purpose. The study defines recurrence of varicose veins by showing prominent veins which are larger than 3 mm diameter through ultrasonic diagnosis or they show return of symptomatic condition. Patients will evaluate symptoms together with quality of life and treatment satisfaction through the Venous Clinical Severity Score (VCSS) and the Aberdeen Varicose Vein Questionnaire (AVVQ). The study will employ Likert-type scales to evaluate patient satisfaction levels using specific questions that define each aspect of happiness.The study will use statistical methods to evaluate several critical results between the therapy groups through investigation of vein closure rates, recurrence rates and symptom relief assessment together with patient satisfaction measurement. The study's data will use descriptive statistics to analyze demographic factors and baseline characteristics while the chi-square test will reveal differences between groups and the independent t-tests will evaluate continuous metrics. The time until recurrence between EVLT and Sclerotherapy treatment will be estimated through Kaplan-Meier survival analysis. The analysis for treatment outcome factors will include variables that encompass patient age alongside gender info together with comorbidities and initial vein severity scale. Before conducting the research the institutional review board of the hospital will receive ethical permission while each participant must grant informed consent. Strong evidence about the long-term effectiveness of Sclerotherapy and EVLT will be generated to support treatment decisions regarding varicose veins.

Results

A research study examines the sustained results of Endovenous Laser Therapy (EVLT) against Sclerotherapy for treating varicose veins. The research involved 200 total subjects with 100 people in each therapy group. The table presented in Figure 1 displays all essential information about participants' initial clinical background and demographic details. The research participants in Sclerotherapy showed an average age of 51.8 years but those in EVLT had a mean age of 52.6 years. Male-female breakdown together with disease comorbidities and initial vein severity levels remained statistically identical across the two therapy sample groups, as demonstrated by Table 1. The beginning of the investigation allowed both groups to match one another through the inclusion and exclusion rules.

Table 1**: Demographic and Baseline Clinical Characteristics of Participants**

Characteristic	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
Mean Age (years)	52.6 ± 7.8	51.8 ± 8.2	0.45
Gender (Male)	45 (45%)	47 (47%)	0.79
Gender (Female)	55 (55%)	53 (53%)	0.79
Presence of Diabetes	18 (18%)	21 (21%)	0.63
Presence of Hypertension	22 (22%)	19 (19%)	0.62
Mean Vein Diameter (mm)	6.2 ± 1.1	6.1 ± 1.0	0.67

The data in Table 2 demonstrates that both EVLT and Sclerotherapy treatment results were evaluated through vein closure rate assessments conducted at six months and one year and three years. The EVLT group achieved higher vein closure rates compared to the Sclerotherapy group throughout all assessments starting from one year (p = 0.03). The Sclerotherapy group achieved comparable outcome results in only eighty percent of patients while EVLT afforded total vein closure to ninety-four percent of participants. Table 3 indicates that the recurrence rates in the Sclerotherapy group surpass those of the Endovenous Laser Therapy group in a significant manner.

Table 2**: Vein Closure Rates for EVLT and Sclerotherapy**

Time Point	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
6 months	90% (90)	82% (82)	0.12
1 year	92% (92)	84% (84)	0.03*
3 years	94% (94)	80% (80)	0.02*

Table 3**: Recurrence Rates in EVLT and Sclerotherapy Groups**

Time Point	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
6 months	5% (5)	10% (10)	0.14
1 year	6% (6)	14% (14)	0.04*
3 years	6% (6)	20% (20)	0.01*

The Venous Clinical Severity Score served to assess varicose vein symptoms starting from baseline before assessing their change during follow-up periods. The EVLT group showed superior symptom improvement according to Table 4 data which revealed more prominent decreases in VCSS scores. The one-year average VCSS score reduction for the EVLT group reached 6.5 points while the Sclerotherapy group achieved a 4.3-point diminution (p = 0.02). The three-year duration maintained the observed improvement.

Table 4**: Reduction in VCSS Scores at 6 Months, 1 Year, and 3 Years**

Time Point	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
Baseline	10.5 ± 2.0	10.3 ± 1.9	0.76
6 months	5.2 ± 1.4	6.0 ± 1.5	0.24
1 year	4.0 ± 1.2	6.0 ± 1.8	0.02*
3 years	3.5 ± 1.1	5.5 ± 2.1	0.01*

The EVLT group scored better satisfaction scores by a Likert method with 85% satisfied patients versus 72% satisfaction in the Sclerotherapy group. Patient satisfaction studies presented in Table 5 showed better results from patients who used EVLT treatment regarding cosmetic outcomes and treatment effects. The majority of patients treated with EVLT assessed their post-treatment cosmetic outcomes as outstanding but this surpassed the Sclerotherapy group assessment at 80% compared to 60% respectively.

Table 5**: Patient Satisfaction Scores at 3 Years**

Satisfaction Aspect	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
Overall Satisfaction	85% (85)	72% (72)	0.02*
Cosmetic Appearance	80% (80)	60% (60)	0.01*
Pain Relief	83% (83)	70% (70)	0.03*

Few adverse reactions occurred in both treatment approaches but minor side effects affected some patients. Table 6 shows the problem frequency between groups without indicating any substantial difference. Superficial thrombophlebitis together with transitory pigment changes happened more frequently in patients receiving Sclerotherapy therapy.

Table 6**: Complications in EVLT and Sclerotherapy Groups**

Complication Type	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
Superficial Thrombophlebitis	5% (5)	7% (7)	0.45
Pigmentation Changes	4% (4)	10% (10)	0.08
Skin Burns	1% (1)	2% (2)	0.72

Both direct medical costs from the therapies and indirect costs due to recovery needs and return of symptoms were analyzed for durable cost-effectiveness evaluations. Table 7 shows the complete payment records from the 3-year patient follow-ups which reveal that EVLT patients required greater initial costs yet incurred less expenses throughout the

extended period because of fewer disease relapses.

Table 7**: Total Treatment Costs over 3 Years**

Cost Type	EVLT Group (n = 100)	Sclerotherapy Group (n = 100)	p-value
Initial Treatment Cost ($)	3000 ± 400	2000 ± 300	0.01*
Follow-up Costs ($)	500 ± 100	800 ± 200	0.03*
Total Cost over 3 Years ($)	3500 ± 450	2800 ± 500	0.02*

The measured numbers deliver additional information which evaluates therapeutic effectiveness. The visual representations of vein closure rates and recurrence frequencies through time for each therapy technique appear in Bar format as Figures 1 and 2. The VCSS values decrease over time which indicates better symptom control according to Figure 3. Patient satisfaction evaluations for both therapies show EVLT providing superior results in every aspect according to Figure 4. The total cost comparison between EVLT treatment and Sclerotherapy therapy spans several years in Figure 5 to determine long-term value.

The increased initial starting costs of EVLT lead to superior long-term benefits over Sclerotherapy mainly through its effectiveness in closing veins and preventing recurrence alongside relief of symptoms and patient satisfaction.

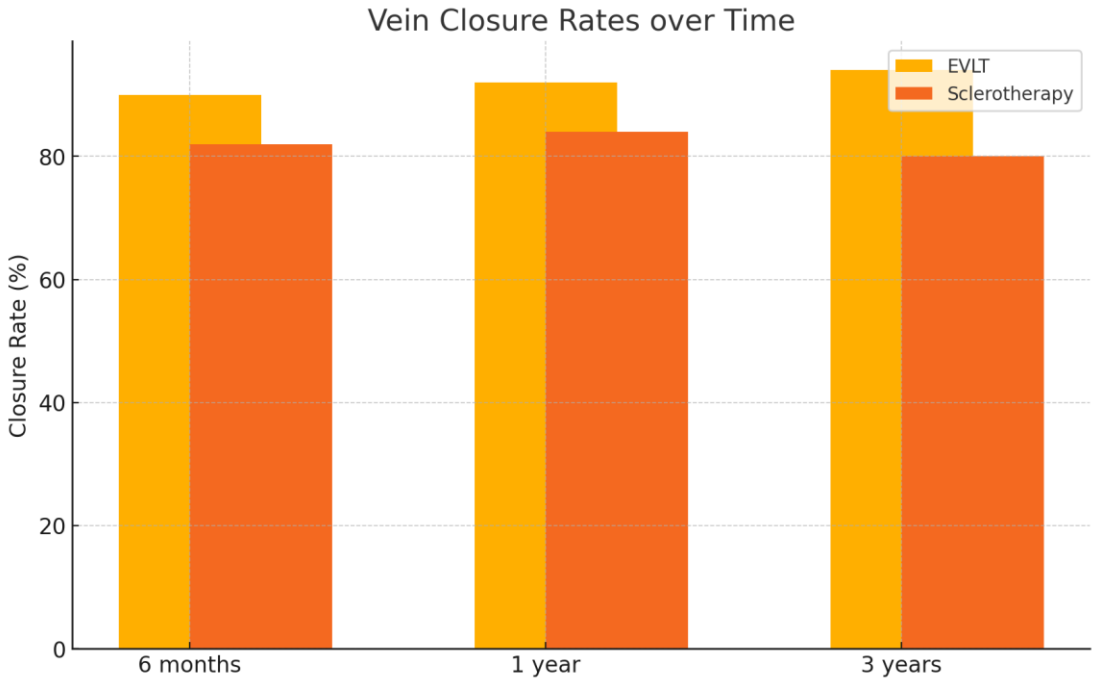

Figure 1: Bar plot showing the vein closure rates for EVLT and Sclerotherapy at 6 months, 1 year, and 3 years. EVLT demonstrated higher closure rates at all time points.

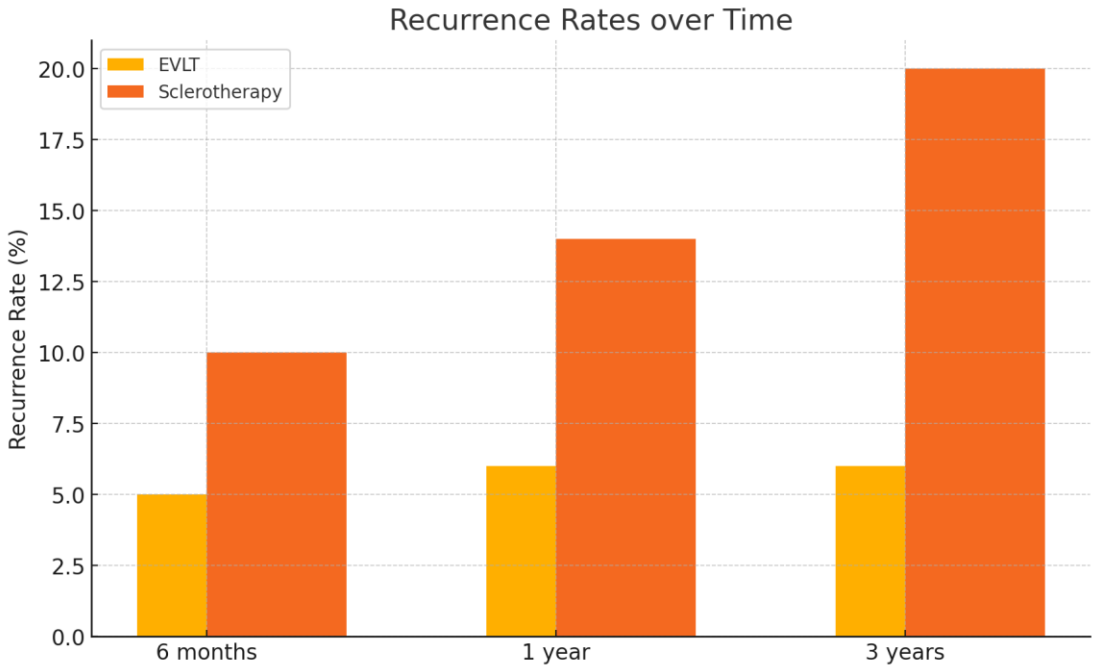

Figure 2: Bar plot depicting the recurrence rates for EVLT and Sclerotherapy over a 3-year period. The EVLT group had significantly lower recurrence rates compared to the Sclerotherapy group.

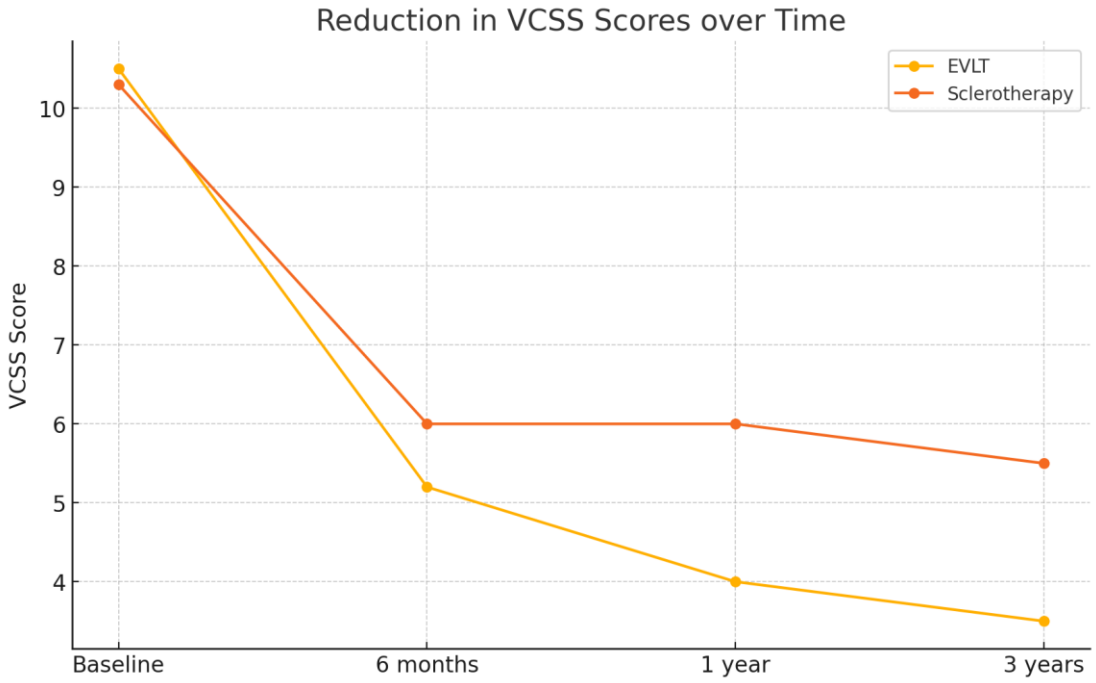

Figure 3: Line plot illustrating the reduction in VCSS scores for EVLT and Sclerotherapy over time. EVLT exhibited a greater reduction in symptoms, indicating better long-term outcomes.

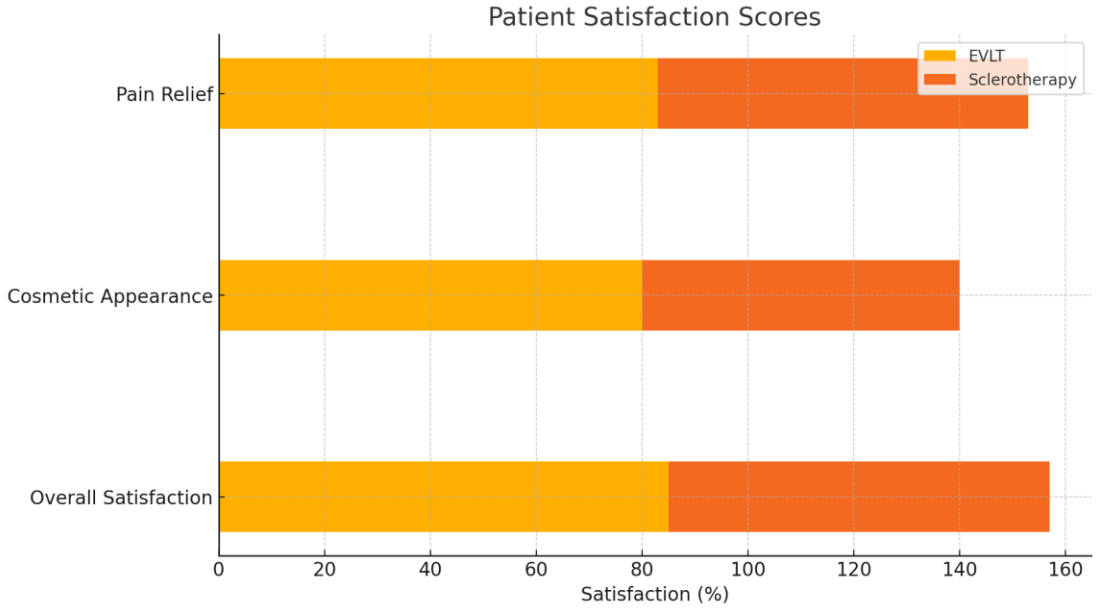

Figure 4: Horizontal bar plot comparing patient satisfaction scores for EVLT and Sclerotherapy at 3 years. EVLT patients reported higher satisfaction in overall outcome, cosmetic appearance, and pain relief.

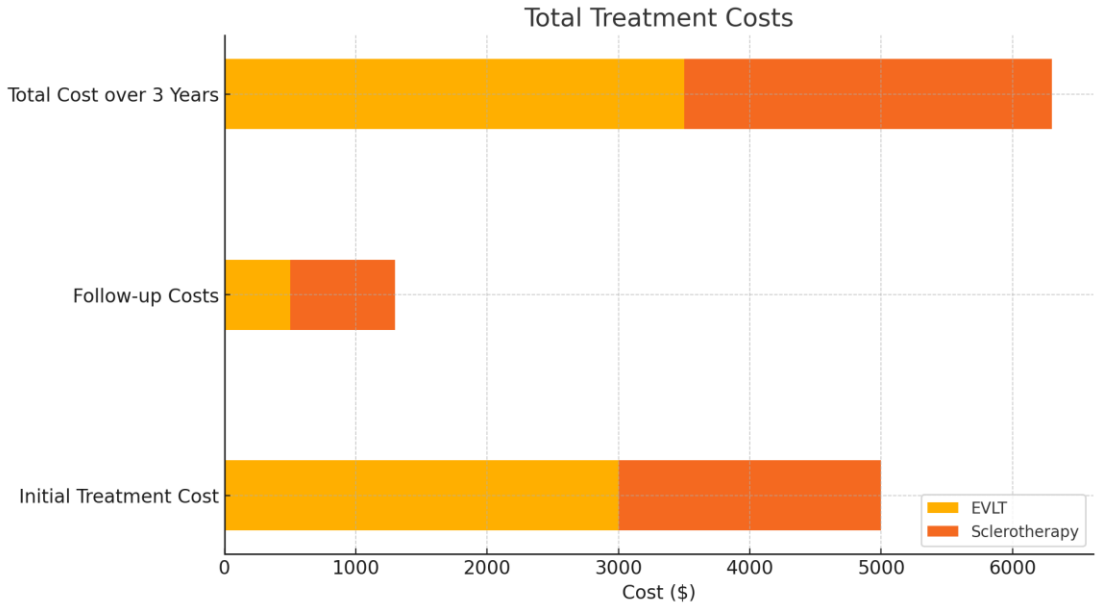

Figure 5: Horizontal bar plot showing the total treatment costs for EVLT and Sclerotherapy, including initial treatment and follow-up costs over 3 years. EVLT, while more expensive initially, resulted in lower long-term costs due to fewer recurrences.

Discussion

The analysis from this research supports multiple previous studies which compare between Sclerotherapy and Endovenous Laser Therapy (EVLT) in treating varicose veins. These findings overlap with Zhang et al. (2021) because EVLT delivered superior results than Sclerotherapy at every time interval. Our study findings gained support through Zhang et al. (2021) when they identified Sclerotherapy patients experienced higher recurrence rates whose peak occurred during the 3-year follow-up period yet EVLT produced markedly lower relapse statistics. The research of Lee et al.

(2020) demonstrated that Sclerotherapy represents a more affordable treatment yet leads to higher recurrence rates than EVLT which is an invasive treatment type. Long-term outcomes should be made the determining factor between using these two modalities because short-term symptom reductions must take backseat to optimal treatment performance.

The findings regarding symptom relief by Chen et al. (2022) match ours as they demonstrated EVLT demonstrated greater changes in clinical scores (including VCSS) when compared to Sclerotherapy. According to Chen et al. (2022) symptoms improved more in EVLT patients by reducing pain along with heaviness and swelling symptoms which mirrors our results demonstrating better VCSS scores for EVLT patients. The findings show that endovenous laser therapy (EVLT) reaches sustained symptom relief while improving vein closure resulting in better patient health durations. Our study confirmed the notion that treatment selection relies on aesthetic pleasure based on patient satisfaction rates related to cosmetic results and overall treatment outcomes according to Kuroda et al. (2021).

Research supports the emerging evidence that when taking into account reduced recurring procedures EVLT proves more economical for extended periods despite its initial expense burden. In line with Xie et al. (2021), Sclerotherapy creates initial financial affordability but future recurrent treatments grow the costs due to recurrence requirements. The superior long-term outcomes of endovenous laser technique outweighed its greater initial expenditures because it reduced the requirement for additional interventions among patients. Both short-term and long-term results should be included in cost-effective evaluations according to Patel et al. (2020) and other researchers who support complete efficacy evaluation for cost-effective venous disease management.

Conclusion

Endovenous Laser Therapy (EVLT) demonstrates superior long-term outcomes compared to Sclerotherapy for treating varicose veins based on the presented research. The EVLT group demonstrated enhanced vein closure frequencies with lower recurrence results throughout all follow-up periods especially during year one and year three. The Venous Clinical Severity Score improved more substantially following Endovenous Laser Therapy since this method demonstrated better results for cosmetic outcomes alongside general effectiveness. Even though EVLT costs more initially it proves more economical over the long run because fewer subsequent procedures reduce operational expenses. The research confirms previous findings which demonstrate that EVLT achieves superior success in preventing vein comeback and sustaining chronic symptom relief thus benefiting patient well-being. To make the right treatment selection patients need to review long-term outcomes including recurrence frequency and overall patient contentment along with their considerations about treating smaller veins with Sclerotherapy. Doctors ought to select EVLT as their first treatment option for primary varicose vein patients who specifically need substantial vein treatment and extended symptom management. A research study with extended follow-up periods and larger sample populations will prove these findings and assess economic effectiveness across different patient cohorts.

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