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IS VARICOSE VEIN TREATMENT FAILURE IN INDIA LINKED TO INADEQUATE TREATMENT OF SIGNIFICANT TRIBUTARIES LACK OF PATIENT COMPLIANCE OR RECURRENCE DUE TO DEEP VEIN ISSUES?

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ABSTRACT

Failure in varicose vein treatment, encompassing laser procedures, including improper procedure execution, improper patient selection, insufficient energy delivery (inadequate vein wall heating), technical errors, inadequate vein emptying (the presence of blood in the vein) and the use of wavelengths other than 1470nm and most importantly unattending the significant tributaries can contribute to treatment failure and the possibility of recanalization. Varicose vein treatment can fail due to several reasons, ie, the development of new varicose veins, and inadequate initial treatment, choosing the wrong treatment method for the specific type and most importantly unaddressing the significant tributaries can lead to failure. Even with successful treatment, the underlying condition of CVI can cause existing varicose veins to worsen or new ones to form. Modern techniques like catheter-based methods, foam sclerotherapy, or phlebectomy have improved the success rate. EVLA (Endovenous Laser ablation) treatment for varicose veins can be highly effective, but failures can occur due to various factors related to the initial treatment, the underlying condition of CVI and individual predispositions. EVLA is the most cost-effective therapeutic option, with RFA (Radio Frequency Ablation) being next to EVLAS for treating patients with varicose veins. EVLA or RFA is recommended as a first-line treatment for varicose veins. It has substituted the high ligation of the saphenofemoral junctional reflux and stripping of varicose veins.

INTRODUCTION

Varicose veins are characterized by superficial, tortuous, and dilated veins (greater than or equal to three millimeters in diameter), involving the saphenous veins, saphenous tributaries, or non-saphenous superficial leg veins. Age and family history are considered important risk factors. (1)

Varicose veins are considered a common clinical manifestation of chronic venous disease.(2)

Varicose veins of the lower extremity that are developed because of chronic venous insufficiency (CVI) are a common health problem (3)

Varicose veins may either be asymptomatic or cause serious symptoms. Varicose veins of the lower extremity may lead to pain, itching, burning sensation, tingling & numbness, night cramps, subcutaneous oedema, as well as skin changes and venous ulcers in chronic cases. Varicose veins of the lower extremity also limit the daily activities of individuals and cause loss of time and workforce (4)

In the past, surgery was the primary treatment for superficial venous insufficiency and varicose veins. Nowadays, vein stripping is not performed routinely and is supplemented by an endovenous laser ablation (EVLA) of varicose veins secondary to saphenofemoral junction (SFJ) insufficiency (5)

Recently, EVLA, radiofrequency ablation (RFA), and foam sclerotherapy are being used as alternatives to surgery in the treatment of superficial venous insufficiency (6)

Varicose veins are tortuous/twisted, dilated (>3.0mm in diameter) & elongated veins when a patient is in standing status. A prevalence of >15% noted in the general population (7). Serious conditions such as deep venous thrombosis (DVT) and pulmonary embolism may occur if untreated (8,9)

Patients with varicose veins can be treated with conservative or surgical options based on the clinical conditions and patient preferences (10,11)

In the recent decade, there has been a dramatic change in the recommendations for managing symptomatic varicose veins due to the rise of minimally invasive endovascular techniques (12,13)

Sclerotherapy is a less invasive percutaneous approach of administering sclerosants into the target veins (14). Sclerotherapy is recommended to treat significant tributaries and varicosities (15)

Endovenous thermal ablation (EVLA or RFA) is recommended as a first-line treatment and has substituted the surgical procedure to occlude the veins through heat energy for symptomatic varicose veins(16,17)

EVLA and RFA (EVLA being far superior to RFA) seem to be the safe, effective & efficient modalities in terms of occlusion rate, time to return to normal activity, and lacking complications such as thrombophlebitis, hematoma, and recanalization(18,19)

EVLA is an office-based treatment for varicose veins performed under local anesthesia. The main advantages are the preservation of the saphenous vein, no pain, less bruising,

no nerve damage, and no recurrence compared to stripping saphenectomy (20).

FACTORS CONTRIBUTING TO TREATMENT FAILURE:

1. TECHNICAL ERRORS/ISSUES:

(a) Inadequate Vein Wall Heating:
Improper laser fiber contact can lead to incomplete vein wall closure, resulting in recanalization.

(b) Incorrect laser parameters:
Using an inappropriate wattage, pulse duration, or pullback speed can also result in insufficient heating and vein closure.

(c) Low Laser Energy (Insufficient Energy Delivery):
Insufficient laser energy to properly heat and seal the vein can lead to incomplete or partial closure, allowing blood flow to return and the vein to reopen. The required energy for vein shrinkage is often cited to be above 70 J/cm. When the energy given is low, there is a high probability of reopening or non-occlusion of the vein. Vein shrinkage seems to fail without proper energy factors.

(d) Rapid Fiber Withdrawal:
Rapid fiber withdrawal, improper laser fiber contact with the vein wall or incorrect pullback speed can lead to inadequate heating of the vein wall and subsequent failure. Wattage - Administering high wattage for a short time has a vaporizing effect and low wattage for a longer time has a coagulating effect.

(e) Insufficient Vein Emptying:
Not properly emptying the vein before treatment can affect the effectiveness of the laser energy. Part of the laser energy may be absorbed by blood (Absorption by Hemoglobin), reducing the amount that reaches the vein wall.

(f) Wavelength and Blood Absorption:
When using wavelengths other than 1470nm, part of the laser energy is absorbed by hemoglobin in the blood, reducing the energy delivered to the vein wall and potentially increasing the risk of recanalization.

The 1470-nanometer (nm) wavelength is significant in laser ablation due to its unique interaction with water, the primary chromophore in biological tissues. 1470nm lasers are highly absorbed by water, which is a major component of vein walls. This increased absorption leads to more localized and effective heating, concentrating the laser's energy on the target issue.

This wavelength facilitates more localized and effective thermal damage in the vein wall compared to other wavelengths, which is crucial for treatments like Endovenous laser ablation (EVLA) of varicose veins, leading to better treatment outcomes, such as vein closure.

(g) Lower Linear Endovenous Energy Density (LEED):
When used with a 1470 nm laser, lower LEED (the energy delivered per centimeter of vein) can be used to achieve effective ablation with reduced adverse effects. This is because the laser's energy is more effectively absorbed and converted into heat within the vein wall, minimizing the need for high-intensity energy.

(h) Reduced Pain and Bruising:
The localized energy delivery and the 1470 nm laser contribute to reduced postoperative pain, bruising, and other adverse effects compared to other wavelengths.

PATIENT FACTORS:
(a) Individual patient factors, such as age & family history, can also influence treatment success.

(b) Large vein diameters (e.g., >0.8 cm) may be more challenging to treat successfully, potentially requiring alternative approaches or repeat treatments.

(c) Improper patient selection: For example, EVLA might not be the best choice for patients with very large or complex varicose vein networks and massive obesity.

(d) Underlying deep vein thrombosis (DVT): If DVT is present, EVLA may not be effective, as the blood clot can interfere with the laser's ability to seal the vein. If the laser energy is absorbed by hemoglobin, a thrombotic process can occur, increasing the risk of vein reopening.

(e) Presence of other diseased veins (tributaries): If significant/diseased tributaries with venous insufficiency are present, they should be adequately addressed. Otherwise it leads to treatment failure/recurrence.

(f) Inadequate Pre-Treatment Assessment: If the affected veins are not correctly mapped, the treatment may fail.

(g) Post–Treatment Care: Failure to follow post-treatment instructions, such as wearing compression stockings, can also contribute to treatment failure.

(h) Addressing Underlying Venous Insufficiency: Treating the underlying cause of varicose veins, such as venous valve malfunction (valvular incompetence), can help prevent recurrence.

UNCORRECTED SIGNIFICANT TRIBUTARIES/FEEDER VEINS:
This is the major issue for failure. Treatment of only the main vein (like the Great/Short saphenous vein) without addressing the significant tributaries/larger feeder veins can lead to recurrence. To minimize the risk of recurrence, many surgeons now perform concomitant laser ablation of significant tributaries during EVLA. The decision to ablate tributaries often depends on the individual patient's anatomy, the location and size of the veins, and the surgeon's judgment. In summary, while EVLA is generally effective, the presence of numerous or significant untreated tributaries can increase the risk of recurrence and treatment failure. By addressing these tributaries during the procedure, surgeons can improve the overall success rate and reduce the likelihood of long-term complications.

Here's a more detailed breakdown for addressing issues of Tributaries:

(I) Limitations of the Laser Technology:

(IA) Inability to reach smaller tributaries:
Laser fibers used in endovenous laser ablation (EVLA) may not be able to effectively reach and treat very small or tortuous (curved) tributaries.

(IB) Inadequate energy delivery:
If the laser energy is not sufficient to coagulate the tributary vein wall, the vein may not close properly, leading to continued reflux (backward flow of blood) and recurrence.

(IC) Technical challenges: Treating tributaries can be technically challenging, especially when they are located in difficult-to-reach areas or are connected to the main vein at acute angles.

(II) Factors Related to the Tributaries Themselves:

(IIA) Size and diameter:
Larger tributaries may require more energy and a longer treatment time than smaller ones, and may be more prone to recurrence if not adequately treated.

(IIB) Anatomy and branching pattern:
The complex branching patterns of tributaries can make it difficult to ensure that all branches are treated effectively.

(IIC) Presence of multiple tributaries:
In some cases, multiple significant tributaries may be present, requiring multiple treatment sessions or more advanced techniques.

OTHER POTENTIAL CAUSES:
(a) Recanalization/Reopening of the treated vein: Even if the initial treatment appears successful, the vein may recanalize later, especially within the first few months, or even years after the procedure.

(b) Failure to address underlying venous reflux: If the underlying cause of the varicose veins (e.g., reflux in the deep veins) is not addressed, the varicose veins may reappear or worsen over time.

(c) Infection or other complications: In rare cases, infection, nerve damage, or blood clots after EVLA can lead to treatment failure.

(d) Misdiagnosis or Failure to Identify Underlying Issues: If the problematic veins are not accurately mapped or identified or if underlying issues like deep vein disease are not addressed, treatment may fail.

(e) Rupturing of the Vein: The vein can reopen, especially within the first 3 months after treatment.

(f) Blood Flow Diversion: If tributaries remain open or are not completely ablated, they can allow blood flow to bypass the treated vein, preventing proper healing and leading to continued reflux (backward flow).

HOW TO ADDRESS THE PROBLEMS AND PREVENT THE RECURRENCE OR FAILURE OF LASER TREATMENT:
Pre-Treatment Assessment:
(A) Patient History: Gather information about the patient's medical history, including any previous treatments or underlying conditions that may affect the treatment outcome.

(B) Skin Type Assessment: Determine the patient's Fitzpatrick skin type to assess the risk of complications and adjust laser settings accordingly.

(C) Individualized Treatment Plan: Develop a tailored treatment plan based on the patient's specific anatomy, skin type, and the extent of the vascular issue.

(D) Detailed Mapping: Conduct a thorough examination, potentially using ultrasound imaging, to identify all significant tributary veins feeding into the main vein (this is very important part of the successful treatment) or targeted area. To prevent laser treatment failure due to missed significant tributaries, a thorough pre-treatment assessment is crucial. This includes identifying all potential vessels contributing to the condition, using appropriate imaging techniques like ultrasound, and ensuring the optimized laser settings for each vessel size and location etc. as mentioned below:

Treatment Optimization:
(A) Appropriate Laser Selection: Choose the right laser wavelength and energy settings for the target vessels, considering their size and depth.

(B) Precise Targeting: Use techniques like tumescent anesthesia and microcatheters to accurately target the vessels and minimize damage to surrounding tissue.

(C) Cooling Devices: Employ cooling systems during the procedure to protect the surrounding skin and reduce discomfort.

(D) Targeted treatment: Techniques like ultrasound-guided sclerotherapy or phlebectomy (surgical removal) of tributaries may be needed in addition to EVLA to address the significant branches.

(E) Multiple Treatment Sessions: For extensive or complex cases, multiple treatment sessions may be necessary to address all tributaries effectively (this is most important).

Post-treatment Care:
(A) Compression Therapy: Use compression stockings to support the treated area and promote healing.

(B) Avoid Sun Exposure: Protect the treated area from sun exposure to prevent pigmentation changes.

(C) Follow-up Appointments: Schedule regular follow-up appointments to monitor progress and address any potential complications.

(D) Patient Follow-up:
Providing patients with clear instructions on post-treatment care and scheduling follow-up appointments can improve outcomes.

Addressing Complications:
(A)Early Intervention: Address any complications, such as inflammation or hyperpigmentation, promptly to minimize long-term damage.

(B)Patient Education: Patients need to understand the importance of post-treatment care and follow-up appointments to ensure long-term success. Ensure patients are well-informed about potential side effects and the importance of post-treatment care.

By carefully addressing these issues, clinicians can significantly improve the success rate of laser treatments and minimize the risk of recurrence due to missed tributaries.

Among all the causes mentioned above, the commonest cause in our clinical experience is the failure to address the significant tributaries. Failure to address significant tributaries during laser treatment for varicose veins can lead to recurrence or persistent symptoms. This occurs when only the main treated vein(GSV/SSV) is ablated, leaving the significant tributaries unaddressed. This leads to continuous reflux flow, causing new varicose veins to form. Addressing these tributaries during the laser treatment can improve outcomes and reduce the likelihood of recurrence.

Therefore, a comprehensive approach to varicose vein treatment may involve addressing both the main saphenous vein and its tributaries.

Several factors can influence the success of treatment, including the number and size of tributaries, the skill of the surgeon, and the type of modality used.

CONCLUSION
Varicose veins need careful assessment by trained endovascular surgeons, especially with ultrasound experience, to evaluate the severity, root cause, and status of deep veins before deciding about the newer modality of laser treatment. Foam sclerotherapy and ligation (FSL) are feasible, safe, and easy to perform under local anaesthesia for outpatients with varicose veins. Ultrasound-guided sclerotherapy combined with sapheno-femoral ligation was less expensive, involved a shorter treatment time, and resulted in more rapid recovery compared to sapheno-femoral ligation, saphenous stripping, and phlebectomies.EVLA is the most cost-effective therapeutic option, with RFA being next to EVLA for the treatment of patients with varicose veins. Endovenous thermal ablation (EVLA or RFA) is recommended as a first-line treatment for

varicose veins and has substituted the high ligation of saphenofemoral junctional reflux and stripping of varicose veins. EVLA is the most cost-effective therapeutic option, with RFA being next to EVLA for the treatment of patients with varicose veins.

REFERENCES

1. Abou-ElWafa HS, El-Metwaly AAM, El-Gilany AH. Lower Limb Varicose Veins among Nurses: A Single Center Cross-Sectional Study in Mansoura, Egypt. Indian J Occup Environ Med. 2020 Sep-Dec;24(3):172-177. [PMC free article] [PubMed]
2. Hamdan A. Management of varicose veins and venous insufficiency. JAMA. 2012 Dec 26;308(24):2612-2
3. Evans CJ, Fowkes FG, Ruckley CV, et al. Prevalence of varicose veins and chronic venous insufficiency in men and women in the general population: Edinburgh Vein Study. J Epidemiol Community Health 1999;53:149 53
4. Nael R, Rathbun S. Treatment of varicose veins. Curr Treat Options Cardiovasc Med 2009;11:91 103
5. Meissner MH, Gloviczki P, Bergan J, et al. Primary chronic venous disorders. J Vasc Surg 2007;46:54 67
6. Brasic N, Lopresti D, McSwain H. Endovenous laser ablation and sclerotherapy for treatment of varicose veins. Semin Cutan Med Surg 2008;27:264–75
7. Medical Advisory Secretariat. Endovascular radiofrequency ablation for varicose veins: an evidence-based analysis. Ont Health Technol Assess Ser.. 2011;11:1 93.
8. Raetz J, Wilson M, Collins K. Varicose Veins: Diagnosis and Treatment. Am Fam Physician. 2019;99:682–688.
9. Lin F, Zhang S, Sun Y, Ren S, Liu P. The management of varicose veins. Int Surg. 2015;100:185 189. doi: 10.9738/INTSURG-D-14-00084.1.
10. Li X, Yang B, Li X, Ren S. Prospective Comparison of Effect of Ligation and Foam Sclerotherapy with Foam Sclerotherapy Alone for Varicose Veins. Ann Vasc Surg. 2018;49:75–79. doi: 10.1016/j.avsg.2018.01.004.
11. Sun Y, Li X, Chen Z, Ren S. Feasibility and safety of foam sclerotherapy followed by multiple subcutaneous interrupted ligation under local anaesthesia for outpatients with varicose veins. Int J Surg. 2017;42:49 53. doi: 10.1016/j.ijsu.2017.04.023.
12. Li X, Fan L, Ren S, Li X. Outcomes of Foam Sclerotherapy plus Ligation vs Foam Sclerotherapy Alone for Venous Ulcers in Lower Extremities. Ann Vasc Surg. 2017;45:160–165. doi: 10.1016/j.avsg.2017.06.055.
13. Liu P, Ren S, Yang Y, Liu J, Ye Z, Lin F. Intravenous catheter-guided laser ablation: a novel alternative for branch varicose veins. Int Surg. 2011;96:331 336. doi: 10.9738/cc44.1
14. Lawson JA, Gauw SA, van Vlijmen CJ, Pronk P, Gaastra MTW, Tangelder MJ, Mooij MC. Prospective comparative cohort study evaluating incompetent great saphenous vein closure using radiofrequency-powered segmental ablation or 1470-nm endovenous laser ablation with radial-tip fibers (Varico 2 study) J Vasc Surg Venous Lymphat Disord. 2018;6:31 40.
15. Gloviczki P, Comerota AJ, Dalsing MC, Eklof BG, Gillespie DL, Gloviczki ML, Lohr JM, McLafferty RB, Meissner MH, Murad MH, Padberg FT, Pappas PJ, Passman MA, Raffetto JD, Vasquez MA, Wakefield TW Society for Vascular Surgery; American Venous Forum. The care of patients with varicose veins and associated chronic venous diseases: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. J Vasc Surg. 2011;53:2S–48
16. Kabnick LS, Sadek M, Bjarnason H, Coleman DM, Dillavou ED, Hingorani AP, Lal BK, Lawrence PF, Malgor R, Puggioni A. Classification and treatment of endothermal heat-induced thrombosis: Recommendations from the American Venous Forum and the Society for Vascular Surgery This Practice Guidelines document has been co-published in Phlebology and Journal of Vascular Surgery: Venous and Lymphatic Disorders The publications are identical except for minor stylistic and spelling differences in keeping with each journal's style. The contribution has been published under a Attribution-Non Commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0), (https://creativecommons.org/Licenses/by-nc-nd/4.0/), Phlebology. 2021;36:8–25. doi: 10.1177/0268355520953759.
17. Mohammadi Tofigh A, Tahmasebi H, Zebarjadi J. Comparing the Success Rate and Side Effects of Endovenous Laser Ablation and Radiofrequency Ablation to Treat Varicose Veins in the Lower Limbs: A Randomized Clinical Trial. J Lasers Med Sci. 2020;11:S43–S48. doi: 10.34172/jlms.2020.S7.
18. He G, Zheng C, Yu MA, Zhang H. Comparison of ultrasound-guided endovenous laser ablation and radiofrequency for the varicose veins treatment: An updated meta-analysis. Int J Surg. 2017;39:267–275. doi: 10.1016/j.ijsu.2017.01.080.
19. Izzo L, Pugliese F, Pieretti G, Izzo S, Izzo P, Florio G, Del Papa M, Messineo D. High ligation of sapheno-femoral junction and thermal ablation for lower limb primary varicosity in day hospital setting. Ann Ital Chir. 2020;91:61 64.
20. Faccini FP, Ermini S, Franceschi C. CHIVA to treat saphenous vein insufficiency in chronic venous disease: characteristics and results. J Vasc Bras. 2019;18:e20180099. doi: 10.1590/1677-5449.009918