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Original Research Article

A comparative study of endovenous laser ablation and radiofrequency ablation in the management of varicose veins

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ABSTRACT

Background: Endovenous thermal ablation techniques, including endovenous laser ablation (EVLA) and radiofrequency ablation (RFA), have largely replaced conventional surgery for varicose veins. This study compares the short-term efficacy and complication profile of EVLA and RFA.
Methods: A retrospective analysis of 127 patients with symptomatic varicose veins treated between January 2019 and March 2024 was conducted. Patients were grouped into RFA (n=49) and EVLA (n=78) cohorts. Outcome measures included procedure time, pain scores (6 hrs, 1 day, 10 days), time to return to activity, and complications.
Results: The mean procedure duration was 1.31±0.42 hours in the RFA group and 1.23±0.41 hours in the EVLA group (p=0.321). Pain scores at 6 hours post-procedure were higher in the RFA group (3.65±0.78) compared to the EVLA group (3.38±0.69), though the difference was not statistically significant (p=0.051). Patients in the EVLA group returned to normal activity significantly earlier (2.26±0.52 days) than those in the RFA group (2.69±0.55 days), with a highly significant difference (p<0.001). Minor complications were comparable in both groups; however, two cases of tip breakage occurred in the EVLA group.
Conclusions: Both RFA and EVLA are effective and safe, but EVLA offers quicker recovery. Long-term comparative studies are warranted.

Keywords: Varicose veins, Endovenous laser ablation, Radiofrequency ablation, Minimally invasive surgery, Postoperative pain, Recovery, Complications

INTRODUCTION

Varicose veins are a common clinical condition affecting approximately 20-30% of the adult population, resulting from chronic venous insufficiency due to valvular incompetence.[1,2] Symptoms may range from cosmetic concerns to significant discomfort, edema, skin changes, and venous ulceration. The management of varicose veins has evolved significantly, with endovenous ablation techniques becoming the preferred first-line intervention over traditional surgical ligation and stripping.[3]

Endovenous thermal ablation modalities, including RFA and EVLA, have shown excellent efficacy in achieving saphenous vein closure, symptom resolution, and patient satisfaction.[4,5] RFA involves the use of radiofrequency energy delivered via a catheter that causes collagen contraction and vein wall fibrosis. In contrast, EVLA utilizes laser energy to photocoagulate the vein endothelium, leading to irreversible closure of the treated segment.[6]

The choice between EVLA and RFA is often guided by institutional availability, cost considerations, and surgeon preference. However, comparative data remain varied regarding postoperative pain, recovery, complications, and long-term durability.[7,8] Some studies suggest RFA may be associated with less postoperative pain due to more uniform thermal delivery, while others find EVLA associated with faster recovery and higher vein occlusion rates.[9,10]

Additionally, newer generations of 1470 nm diode lasers used in EVLA have been designed to minimize perivenous injury, potentially reducing pain and bruising compared to earlier 810-980 nm lasers.[11] Still, controversy persists over the superiority of one modality over the other, particularly regarding short-term recovery metrics such as pain scores, return to activity, and minor complications.[12-14]

In this context, the present study retrospectively evaluates and compares the short-term efficacy and safety profile of RFA and EVLA in the treatment of lower limb varicose veins at a tertiary care center in South India, with specific focus on pain scores, procedure time, early mobilization, and postoperative complications.

METHODS

Study design and population

This retrospective comparative study included a total of 127 patients diagnosed with symptomatic varicose veins who underwent treatment at the tertiary care center between January 2019 and March 2024. The patients were divided into two groups based on the treatment modality: Group A comprised 78 patients who underwent EVLA, while group B included 49 patients treated with RFA.

Inclusion and exclusion criteria

Inclusion criteria for the study were adults aged over 18 years with clinical-etiological-anatomical-pathophysiological (CEAP) classification ranging from C2 to C5. Patients were eligible if they had undergone either RFA or EVLA and had complete follow-up data available.

Patients were excluded from the study if they had undergone previous surgery for varicose veins, had a history of deep vein thrombosis (DVT) or significant peripheral arterial disease, or had incomplete or missing medical records.

Procedure and medications

All procedures were performed under ultrasound guidance using standard tumescent anesthesia techniques. No thromboprophylaxis was administered to any of the patients. Postoperatively, all patients received oral non-steroidal anti-inflammatory drugs (NSAIDs) for three days to manage pain and inflammation.

Outcome measures

The primary parameters assessed included the duration of the procedure, postoperative pain scores at 6 hours, 1 day, and 10 days using the numeric rating scale (NRS), and the time to return to normal activity, which was documented as the time of hospital discharge. Secondary outcomes included the evaluation of complications during the follow-up period, such as thrombophlebitis, ecchymosis, and tip breakage of the ablation catheter or fiber.

Statistical analysis

Data were analyzed using SPSS v26.0. Continuous variables were compared using the independent t-test, categorical data with chi-square test. A $p<0.05$ was considered significant.

RESULTS

A total of 127 patients were included in the study, with 78 undergoing EVLA and 49 undergoing the RFA (Table 1).

The mean procedure duration was slightly longer in the RFA group (1.31±0.42 hours) compared to the EVLA group (1.23±0.41 hours); however, this difference was not statistically significant (p=0.321).

Pain scores assessed using the NRS at 6 hours post-procedure were higher in the RFA group (3.65±0.78) than in the EVLA group (3.38±0.69), but the difference was not statistically significant (p=0.051). Pain scores at 1 day and 10 days post-procedure were similar between the two groups (Figure 1).

While procedure duration and pain scores showed no statistically significant difference between groups, a statistically significant difference was observed in the time taken to return to normal activity, with patients in the EVLA group resuming activity earlier (2.26±0.52 days) compared to those in the RFA group (2.69±0.55 days) ($p<0.001$) (Table 2).

The overall rate of minor complications, including thrombophlebitis and ecchymosis, was comparable between the two groups as shown in Table 3. Notably, two instances of tip breakage occurred in the EVLA group, while no such complications occurred in the RFA group. No cases of deep vein thrombosis, infection, or nerve injury were observed in either group.

Table 1: Demographics and baseline characteristics.

EVLA	EVLA, N (%)	EVLA, N (%)	EVLA
Mean age (in years)	48.22±12.68	50.88±14.96	0.2857
Male	27 (55.1)	42 (53.8)	—
Female	22 (44.9)	36 (46.2)	—

Table 2: Procedure and pain outcomes.

Parameters	RFA	EVLA	P value
Procedure duration (hours)	1.31±0.42	1.23±0.41	0.321
Pain score (6 hours)	3.65±0.78	3.38±0.69	0.051
Pain score (1 day)	1.18±0.60	1.14±0.35	0.654
Pain score (10 days)	0.06±0.24	0.08±0.27	0.734
Return to activity (days)	2.69±0.55	2.26±0.52	<0.001

Table 3: Complications associated with RFA and EVLA.

Complications	RFA, (n=49)	EVLA, (n=78)
Thrombophlebitis	3	2
Ecchymosis	3	2
Tip breakage	0	2

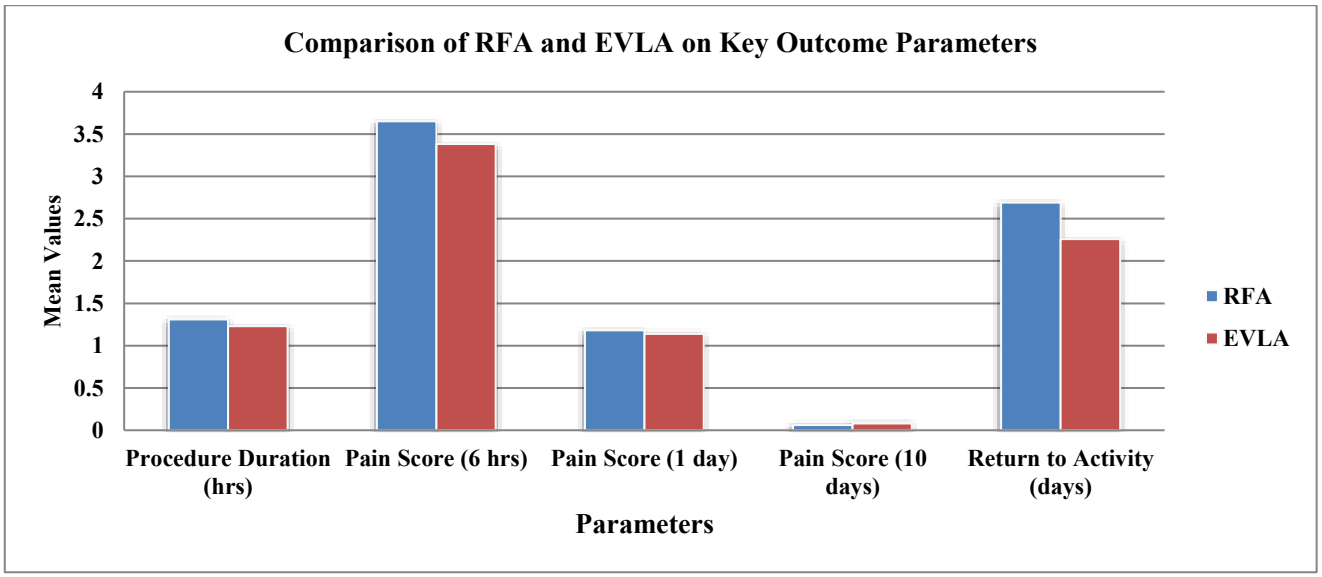

Figure 1: Mean values of three key short-term outcome parameters in patients undergoing RFA and EVLA for varicose veins: (1) procedure duration (hours), (2) pain scores at 6 hours post-procedure (NRS), and (3) time to return to normal activity (days).

DISCUSSION

This study demonstrates that both RFA and EVLA are effective in the short-term management of varicose veins, showing no significant difference in procedure duration or pain scores at 1 and 10 days post-procedure. However, patients treated with EVLA showed significantly earlier return to activity, highlighting a potential advantage of diode laser therapy in terms of early functional recovery.

The comparable procedure durations (RFA: 1.31 hrs vs. EVLA: 1.23 hrs) support findings from previous studies that reported similar operative times across both modalities.[10,15] This reinforces the feasibility of both techniques in outpatient settings, requiring limited theatre time and resources.

With regard to pain scores, although not statistically significant, the higher scores observed at 6 hours in the RFA group (p=0.051) could reflect differences in thermal energy delivery. EVLA (particularly with 1470 nm radial fibers) has been associated with better pain control due to reduced perivenous tissue damage, as supported by recent trials.[11,16] However, other studies report the opposite or no difference, possibly due to variability in tumescent anesthesia techniques, energy dosimetry, and patient pain thresholds.[7,17]

One of the most notable findings in our study was the significantly shorter time to return to activity in the EVLA group (2.26 vs. 2.69 days, p<0.001). This aligns with observations made in recent prospective cohorts, which attribute faster recovery post-EVLA to reduced postoperative inflammation and ecchymosis.[13,18]

In terms of complications, both techniques were associated with low rates of adverse events. Minor complications such as thrombophlebitis and ecchymosis were nearly equal. However, two cases of tip breakage were noted in the EVLA group. This event, while rare,

has been documented in literature and may be related to fiber fragility or over-manipulation in tortuous venous anatomy.[19] Importantly, no serious complications such as deep vein thrombosis, infection, or nerve injury were encountered, supporting the safety of both procedures.[20]

A major strength of this study is the use of real-world clinical data from a diverse patient population treated under uniform protocols. However, limitations include its retrospective nature, lack of long-term follow-up, and absence of objective radiological outcomes such as duplex-confirmed vein closure or recurrence rates.

Future studies should aim for prospective design, incorporate duplex ultrasonography, and evaluate patient-reported quality-of-life scores, in addition to cost analysis and cosmetic satisfaction. A randomized trial design would help validate the findings and guide clinical decision-making on modality selection.

CONCLUSION

Both EVLA and RFA are effective and safe modalities for the treatment of varicose veins. While outcomes such as pain and complications are similar, EVLA offers an advantage in early return to activity. It may be the preferred option where rapid recovery is prioritized.

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