Delineating the durability outcome differences after saphenous ablation with laser versus radiofrequency

William J. Yoon, MD,[a] Max Dresher, MA,[b] Paul R. Crisostomo, MD,[a] Pegge M. Halandras, MD,[a] Carlos F. Bechara, MD,[a] *and* Bernadette Aulivola, MD,[a] *Maywood, Ill*

ABSTRACT

Objective: The mechanism of delivering thermal energy to the vein wall differs between endovenous laser ablation (EVLA) and radiofrequency ablation (RFA). Different mechanisms of ablation may have different effects on the durability of these procedures typically performed for saphenous vein insufficiency. Whether there is a difference in long-term durability outcomes between these two techniques remains uncertain. This study aimed to delineate the durability outcome differences in terms of recurrence rate and pattern.

Methods: A retrospective review identified 270 consecutive patients who underwent saphenous ablation using EVLA or RFA between July 2013 and October 2016. The primary end points were clinical symptom recurrence and anatomic recurrence of reflux.

Results: Overall, 343 limbs were included in the study; 246 limbs (183 patients) underwent EVLA and 97 limbs (87 patients) underwent RFA. The mean follow-up time was 112 days for EVLA (range, 2-1153 days) and 106 days for RFA (range, 3-735 days; $P = .786$). No significant differences were observed between the groups with respect to demographic data, Clinical, Etiological, Anatomical, Pathophysiological classification, or ratio of great saphenous vein to small saphenous vein treated. The mean time to recurrence of symptoms was 219 days longer with EVLA (n = 8; mean, 774 days; range, 187-1042 days) than RFA (n = 4; mean 555 days; range, 341-616 days). Kaplan-Meier estimates for 1- and 3-year freedom from clinical recurrence were 100% and 96% for EVLA and 97% and 93% for RFA, respectively. There was no difference between the two groups (log rank, $P = .0666$). In cases with recurrent reflux documented on duplex (four in the EVLA group and three in the RFA group), the thigh segment was the most frequently involved site (75% in EVLA, 67% in RFA). Same site recanalization was significantly less frequent in EVLA (0.82% in EVLA vs 2.06% in RFA; $P = .0388$). New areas of reflux developed at a similar rate between the groups, in 0.82% of EVLA limbs in the anterior accessory saphenous vein and the calf great saphenous vein, and in 1.03% of RFA limbs in the anterior accessory saphenous vein ($P = .8436$).

Conclusions: The results of our study suggest that the outcomes of EVLA and RFA performed for saphenous vein insufficiency may differ in the long term. The clinical recurrence rates are similar, but the anatomic recurrence patterns may differ, with more frequent treated site recurrence in the RFA group. (J Vasc Surg: Venous and Lym Dis 2019;7:486-92.)

Keywords: Venous ablation; Saphenous insufficiency; Radiofrequency ablation; Endovenous laser therapy

Endovenous thermal ablation is commonly used to treat symptomatic saphenous vein insufficiency.[1,2] Laser and radiofrequency have both been employed as thermal energy sources for ablation. Endovenous laser ablation (EVLA) and radiofrequency ablation (RFA), however, differ in their mode of action of delivering thermal energy to the vein wall. In EVLA, the laser energy is absorbed by blood components in the vein, producing steam bubbles at the tip of the laser fiber that are distributed along the entire inner vein wall, resulting in indirect homogenous thermal injury to the endothelium.[3] In contrast with EVLA, RFA requires direct contact of the endothelium with the catheter, causing heating of the vein wall in its whole circumference.[4]

This difference in the mechanism of action may affect the durability of these procedures differently. Yet, whether there is a difference in long-term durability outcomes between these two treatment modalities remains uncertain. This study aimed to delineate the durability outcome differences in terms of recurrence rate and pattern.

METHODS

We retrospectively reviewed the electronic medical records of all patients who underwent EVLA or RFA at a single institution from July 2013 to October 2016. Our

From the Division of Vascular Surgery and Endovascular Therapy, Loyola University Medical Center[a]; and the Loyola University Chicago Stritch School of Medicine.[b]

Author conflict of interest: none.

Presented at the Forty-first Annual Meeting of the Midwestern Vascular Surgical Society, Chicago, Ill, September 7-9, 2017.

Correspondence: Bernadette Aulivola, MD, Division of Vascular Surgery and Endovascular Therapy, Loyola University Medical Center, 2160 South First Ave, Maywood, IL 60153 (e-mail: baulivola@lumc.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X

Published by Elsevier Inc. on behalf of the Society for Vascular Surgery.

https://doi.org/10.1016/j.jvsv.2018.11.013

indications for treatment included symptomatic saphenous vein insufficiency, Clinical, Etiological, Anatomical, Pathophysiological (CEAP) Clinical (C) grade of 2 or greater, and demonstrated venous reflux with a duration of 0.5 seconds or greater on duplex ultrasound imaging. Criteria needed for symptoms included pain, swelling, stasis dermatitis, and stasis ulcer. Patient's cosmetic concern also constituted an indication for treatment. Treatment exclusion criteria consisted of (1) acute deep venous thrombosis (DVT) or previous DVT, (2) known thrombophilia, (3) concomitant severe peripheral artery disease, (4) active malignancy, (5) pregnancy, and (6) patient anatomy not amenable to the endothermal ablation catheter. Patients with previous surgical intervention or ablation on the same site were excluded from the study. There has been increasing data demonstrating successful endovenous thermal ablation of large (>1 cm) saphenous veins without complication[5-7]; therefore, we did not consider venous diameter as an exclusion criterion. Current use of anticoagulants was also not an exclusion criterion. A total of 270 consecutive patients were identified for inclusion in the study. The protocol and conduct of this retrospective study were reviewed and approved by our institutional review board. Informed consent was not required.

Two vascular surgeons performed all the clinical evaluations and endovenous thermal ablation procedures: one surgeon mainly performed EVLA and the other mainly RFA. The two interventionalists may have read the ultrasound images, because they are a part of the groups of physicians who interpret vascular ultrasound images in our Intersocietal Accreditation Commission accredited noninvasive vascular laboratory. Reflux was considered significant if reversal of flow was present for 0.5 seconds or more after compression and decompression of the distal vein segment in the standing position. The diameters of the great saphenous vein (GSV) were also measured at several locations, including the saphenofemoral junction (SFJ); the high, mid, and low thigh; and the high, mid, and low calf. The largest diameter was chosen to analyze. Disease severity was assessed using the "C" of the CEAP clinical classification.

Treatment of the GSV or small saphenous vein (SSV) was performed in symptomatic patients who failed an initial course of conservative therapy with leg elevation and compression. Treatment modality use was according to availability of the surgeon at the time and the surgeon's preference. All procedures were carried out under tumescent local anesthesia and based on the manufacturer's instructions for use. For RFA, a ClosureFast catheter (Medtronic, Dublin, Republic of Ireland) was used with patient supine for the GSV or prone for the SSV. The procedures were done by percutaneously placing a 7F sheath in the saphenous vein under ultrasound guidance. The catheter was then introduced and positioned with the end 2 to 3 cm from the SFJ or saphenopopliteal junction (SPJ). The tumescent solution was placed around the saphenous vein. A 7-cm segment of the vein was treated for a 20-second therapeutic cycle and was closed at 120°C. EVLA was performed with a straight-tip laser fiber connected to an 810-nm diode laser source that was set on 8W. After cannulation of the target vein, a laser fiber was positioned 2 cm distal to the SFJ or the SPJ under ultrasound guidance. Then, the vein was treated by withdrawing the laser fiber 1 cm in 5 seconds. The length of veins and the number of segments treated and the access points were left to the discretion of the treating surgeon.

According to the definition of a varicose vein by the American Venous Forum and the Society for Vascular Surgery, we used 3 mm as the size threshold (>3 mm).[1] Varicose veins were removed by stab phlebectomy. Concomitant phlebectomy was recommended in both groups, because studies have demonstrated that concomitant phlebectomy along with saphenous ablation decreased the need for secondary procedures. Staged phlebectomy was performed for persistent varicose veins as well as for new varicose veins that developed after saphenous ablation.[8] Perforated veins were treated based on the guidelines from the Society for Vascular Surgery/American Venous Forum that suggest treatment of pathologic perforating veins (those with an outward flow of >0.5 seconds duration, with a diameter of >3.5 mm, located beneath a healed or open venous ulcer), unless the deep veins are obstructed.[1] Successful ablation treatment was defined by the absence of flow/reflux on duplex ultrasound imaging on its whole length of the treated vein segment. After vein ablation treatment, patients were placed in a compressive

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective cohort study
- **Key Findings:** In a comparison of 246 limbs that underwent endovenous laser ablation (EVLA) and 97 limbs that underwent radiofrequency ablation (RFA) the 1- and 3-year freedoms from clinical recurrence were not different; 100% and 96% for EVLA and 97% and 93% for RFA ($P = .0666$); however, same site recanalization was less frequent with EVLA (0.82%) than with RF (2.06%; $P = .0388$).
- **Take Home Message:** This study suggests that the long-term outcomes may differ between EVLA and RFA, with more frequent treated site recurrence in the RFA group.

dressing (20-30 mm Hg) with localized pressure along the treated vein and postprocedural compression stockings for several weeks.

Our postprocedure follow-up protocol includes duplex ultrasound scanning within 1 week; then at 1, 6, and 12 months after ablation; and annually thereafter. At each follow-up visit, treated limbs were assessed clinically and by duplex ultrasound scanning. Follow-up periods were measured in days relative to the date when the treated limb was last assessed. During the follow-up period, patients were examined for evidence of recurrent or residual varicose veins, which was defined as the presence of any visible or palpable varicosities on the treated leg that had been noticed by the examining clinician. Clinical recurrence was defined as the presence of recurrent varicose veins on the treated limb that had been detected by the treating vascular surgeon. Recurrent varicose veins that developed later in untreated areas were accounted as new recurrent veins owing to disease progression. Recanalization (with or without reflux) was defined as the documentation of flow (open section >5 cm in length) in a previously treated vein. Duplex-detected recurrence was defined as reappearance of reflux in the treated limb. All recurrent varicosities were traced with duplex ultrasound imaging.

Patient demographics collected included age, gender, and race. Other covariates captured included the pretreatment baseline characteristics such as disease severity by CEAP classification scores, GSV diameter, SSV diameter and reflux duration. Treatment details recorded included anatomic location of vein ablated and adjunctive procedures such as phlebectomy. Posttreatment complications recorded included pulmonary embolism, DVT, endothermal heat-induced thrombosis as classified according to Sadek et al,[9] and neuropathy. Recurrence data recorded included date, anatomic site, and pattern of recurrence. The lower extremities of patients who underwent bilateral saphenous ablation were considered separately. The primary end points for the study were clinical recurrence and duplex-detected recurrence.

Descriptive statistics were used for the analysis. Continuous variables were described using standard summary statistics; categorical variables were described using frequencies and percentages. Group differences were determined using the Student *t*-test for continuous variables and χ^2 tests for categorical variables. Kaplan-Meier survival analysis was used to assess time to clinical recurrence. To calculate differences between the survival curves, the log-rank test was used. A *P* value of less than .05 was considered statistically significant.

RESULTS

Overall, 343 limbs were included in the study. Of these, 246 limbs in 183 patients underwent EVLA and 97 limbs in 87 patients underwent RFA. There were no significant differences between the groups with respect to age, gender, presenting CEAP scores, pretreatment reflux duration or target vein diameter. The mean follow-up time was 112 days for EVLA (range, 2-1153 days) and 106 days for RFA (range, 3-735 days; $P = .786$). Patient demographics and pretreatment clinical characteristics are shown in Table I.

Periprocedural details are provided in Table II. All of the patients in both treatment groups were treated for symptomatic venous insufficiency refractory to conservative management. There was no evidence of difference in the GSV ablated between the groups. SSV ablation was performed in 20 limbs with EVLA and 6 limbs with RFA ($P = .549$). When GSV ablation was performed, concurrent stab phlebectomy of varicose veins was performed more frequently in the RFA group (43.1% in EVLA vs 61.9% in RFA; $P = .002$). In cases where the SSVs demonstrated reflux and were causing clinical symptoms or were cosmetically significant, concurrent SSV ablation was performed (11.0% in EVLA vs 2.1% in RFA; $P = .008$). Target vein occlusion with cessation of reflux in the treated segment was achieved in all limbs in the EVLA group and in 99% of limbs in the RFA group at the completion of the procedure.

Adverse events associated with thermal venous ablation were minimal, as demonstrated in Table III. There was no significant difference between groups in the

Table I. Patient demographics and pretreatment clinical characteristics

	EVLA	RFA	*P* value
No. of limbs	246	97	
No. of patients	183	87	
Age, years (mean ± SD)	56.6 ± 12.4	59.8 ± 15.3	.052
Female, %	73.3	62.9	.086
Limbs in CEAP class, %			
C2	43.2	44.3	
C3	32.1	26.8	
C2 + C3	74.4	71.1	.538
C4	11.1	15.5	
C5	4.1	8.3	
C6	9.5	5.2	
C4 + C5 + C6	25.6	28.9	.538
GSV diameter, mm (mean ± SD)	6.58 ± 2.9	7.27 ± 3.4	.070
SSV diameter, mm (mean ± SD)	4.20 ± 0.9	3.60 ± 0.5	.214
Preoperative reflux duration, seconds (mean ± SD)	2.62 ± 1.4	2.83 ± 1.1	.209

CEAP, Clinical Etiologic Anatomic Pathophysiologic; *EVLA*, endovenous laser ablation; *GSV*, great saphenous vein; *RFA*, radiofrequency ablation; *SSV*, small saphenous vein.

Table II. Periprocedural details

	EVLA (n = 246)	RFA (n = 97)	*P* value
Primary vein ablated			
Thigh GSV only	190 (77.2)	83 (85.6)	.082
Calf GSV only	5 (2.03)	4 (4.12)	.279
SSV only	20 (8.13)	6 (6.19)	.549
Thigh GSV + calf GSV	4 (1.63)	2 (2.06)	.784
Thigh GSV + SSV	23 (9.34)	2 (2.06)	.019
Calf GSV + SSV	2 (0.81)	0	.374
Thigh GSV + Calf GSV + SSV	2 (0.81)	0	.374
Adjunctive procedure			
None	107 (43.5)	29 (29.9)	.566
Phlebectomy	106 (43.1)	60 (61.9)	.002
Accessory saphenous ablation	22 (8.9)	8 (8.3)	.837
Immediate technical success	246 (100)	96 (99.0)	.111
Length of proximal stump (cm)[a]	1.4 ± 1.1	1.2 ± 0.9	.081

EVLA, Endovenous laser ablation; *GSV*, great saphenous vein; *SSV*, small saphenous vein; *RFA*, radiofrequency ablation.
Values are presented as number (%) or mean ± standard deviation.
[a]Proximal saphenous vein stump length from the saphenofemoral junction or saphenopopliteal junction to the leading point of occlusion.

length of the patent proximal stump of the saphenous vein (from the SFJ or SPJ to the leading point of occlusion) after the procedure. Endothermal heat induced thrombosis class I and II were slightly more prevalent in the RFA group than the EVLA group, but this failed to reach statistical significance ($P = .121$ and $P = .197$, respectively). No progression of any thrombus to endothermal heat-induced thrombosis class I and II was observed at 4 weeks postoperatively. No cases of pulmonary embolism occurred. DVT during follow-up did not occur in our series. There were also no significant differences in neuropathy complications between groups with rate of saphenous neuropathy observed in 0.8% in the EVLA group and 2.1% in the RFA group and sural neuropathy observed in 0.8% of the EVLA group and 1.0% of the RFA group (Table III).

Table III. Adverse events associated with thermal venous ablation

	EVLA	RFA	*P* value
EHIT class			
I	5 (2.03)	5 (5.15)	.121
II	6 (2.43)	5 (5.15)	.197
III	0	0	–
IV	0	0	–
Pulmonary embolism	0	0	–
Neuropathy			
Sural	2 (0.8)	1 (1.0)	.845
Saphenous	2 (0.8)	2 (2.1)	.332

EHIT, Endothermal-heat induced thrombosis; *EVLA*, endovenous laser ablation; *RFA*, radiofrequency ablation.
Values are presented as number (%).

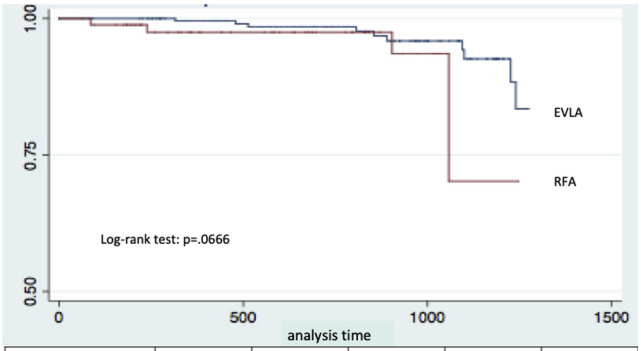
Of the 343 limbs that underwent endovenous thermal ablation, 12 were identified as having recurrent venous disease after a previous treatment. The mechanism of initial ablation was EVLA in eight limbs and RFA in four limbs. The mean time to recurrence of symptomatic varicose veins causing clinical symptoms, however, was 219 days longer with EVLA than RFA: 774 days for EVLA (range, 187-1042 days) versus 555 days for RFA (range, 341-616 days). Kaplan-Meier estimates for the 1- and 3- year freedom from clinical recurrence were 100% and 96% for EVLA and 97% and 93% for RFA, respectively ($P = .0666$; Fig).

Of the eight limbs with clinical recurrence after EVLA, two were found to have varicose veins in a previously untreated leg segment, whereas RFA-treated limbs had no instances of clinical recurrence at the previously untreated leg segment. The sites of clinical recurrence and veins ablated at the initial treatment are shown in Table IV.

Duplex-detected recurrence occurred more frequently after RFA (3.09%) compared with EVLA (1.63%), but this did not reach statistical significance ($P = .3893$). The duplex-detected patterns of recurrence included recanalization of the originally treated vein segment, new reflux in the originally treated vein remote to the site of initial ablation, and new reflux in an accessory truncal pathway. In the EVLA group, recanalization was observed in two veins and two new segments of reflux developed, one at the lateral accessory saphenous vein and the other at the calf GSV. Recanalization was also the most common cause of duplex-detected recurrence for RFA, noted in two of three patients with recurrence followed by the development of new reflux at the anterior accessory saphenous vein in one patient. Overall, the most common duplex-detected recurrence pattern was recanalization. Noticeably, recanalization at the treated site was significantly less frequent in EVLA compared with RFA (0.82% in EVLA vs 2.06% in RFA; $P = .0388$). Neovascularization with clinically visible recurrence was not identified. Duplex-detected recurrence rates and patterns are shown in Table V.

DISCUSSION

The primary goal in treating lower extremity varicose veins using thermal ablation is to obtain durable vein occlusion so as to avoid subsequent recurrence. Hence, understanding the differences in midterm recurrence rates and patterns of recurrence between EVLA and



Days	100	190	370	730	1090
EVLA, limbs at risk	235	235	209	147	62
RFA, limbs at risk	86	81	56	38	4

Fig. Freedom from clinical recurrence after endovenous laser ablation (*EVLA*) and radiofrequency ablation (*RFA*).

RFA is critical in selecting the most appropriate treatment modality.

The results of this study indicate no difference in the rate of clinical recurrence between the groups. For both groups, the recurrence rate is increased progressively with the duration of the follow-up period after the initial treatment. As depicted in the Fig, decreases in Kaplan-Meier estimates for freedom from clinical recurrence are seen at 3 years compared with those at 1 year after both EVLA and RFA. This finding is in agreement with the results of previous studies. In the randomized, controlled trial (RCT) conducted by Rasmussen et al,[10,11] the 1-year recurrence for RFA was 4.8% and 5.8% for EVLA; these rates were nearly tripled in their 3-year results in that RCT (RFA, 14.9%; EVLA, 20%). Of note, although the recurrence rates were similar, the mean time to recurrence of symptoms in the current study was 219 days longer with EVLA (mean, 774 days; range, 187-1042 days) than RFA (mean, 555 days; range, 341-616 days).

In addition, the topographical recurrence sites of varicose veins for EVLA differed from those for RFA. Recurrent varicose veins were more frequently observed at the calf level in the EVLA group compared with the RFA group despite concomitant treatment of the incompetent calf perforating veins at the time of initial treatment. However, the thigh segment was the most common recurrence site for the both groups. A significant proportion of recurrences at the calf level were also demonstrated in the two separate studies conducted by Rasmussen et al.[10,11]

The majority of our cases of recurrence occurred owing to recanalization of a segment of the previously treated vein. This development may be due to the fact that the majority of our patients underwent concomitant stab phlebectomy of varicose branch veins at the time of initial thermal ablation.[12] In contrast, in the Winokur study, new reflux in the anterior accessory saphenous vein or SSV was the most predominant recurrence pattern.[13]

As opposed to the findings of Rasmussens's RCT, in which no difference in recanalization between the RFA (7.0%) and EVLA (6.8%) was demonstrated,[11] this study showed a significant difference between the use of RFA and EVLA in recanalization, in that greater proportions of recanalization occurred when RFA was used as the energy source for the original ablation opposed to EVLA (0.82% in EVLA vs 2.06% in RFA; $P = .0388$). In the recent multicenter study, Recurrent Venous disease After Thermal Ablation (REVATA), Bush et al[14] assessed whether the use of radiofrequency as the mechanism for the original ablation led to greater frequencies of GSV recanalization. Their results showed that the mechanism used for the original ablation was found to be

Table IV. Clinical recurrence details

Treatment	Limb No.	Ablated vein	Recurrence site	Time to recurrence, days
EVLA	1	Thigh GSV	Thigh to calf	802
EVLA	2	Thigh GSV	Thigh to calf	1042
EVLA	3	Thigh GSV	Thigh to calf	665
EVLA	4	Thigh GSV	Calf to ankle	756
EVLA	5	Thigh GSV	Thigh	187
EVLA	6	Thigh GSV	Thigh	303
EVLA	7	Thigh GSV	Calf	328
EVLA	8	Thigh GSV	Thigh	215
RFA	9	Thigh GSV	Thigh to calf	341
RFA	10	Thigh GSV	Thigh	544
RFA	11	Thigh GSV	Thigh	616
RFA	12	Thigh GSV + calf GSV	Thigh to calf	428

EVLA, Endovenous laser ablation; *GSV*, great saphenous vein; *RFA*, radiofrequency ablation; *SSV*, small saphenous vein.

Table V. Duplex-detected recurrence rates and patterns

	EVLA	RFA	*P* value
Rate, %	1.63 (n = 4)	3.09 (n = 3)	.389
Recanalization			
Treated site recanalization, no.	2	2	
Recanalization, %	0.81 (n = 2)	2.06 (n = 2)	.039
New reflux			
Site	Lateral ASV Calf GSV	Anterior ASV	
New reflux, %	0.81 (n = 2)	1.03 (n = 1)	.844

ASV, Accessory saphenous vein; *EVLA*, endovenous laser ablation; *GSV*, great saphenous vein; *RFA*, radiofrequency ablation.

significantly related ($P < .001$), which were in agreement with our findings.

Our data found only one new reflux case (out of 246) in the untreated segment below the original ablation, which occurred after EVLA. This finding is compared favorably with the 14% found in the REVATA trial.[14] Our low rate may reflect the fact that the entire refluxing segment of saphenous vein was treated during the original ablation. The other causes of new refluxes we observed at the anterior ASV after EVLA as well as after RFA were indicative of disease progression. It is possible, as some investigators suggest, that once the GSV is ablated, flow is then directed to the ASV and resultant insufficiency occurs.[15]

In our study, the recurrence pattern after either method of thermal ablation did not involve neovascularization as observed in the previous studies.[14] One possible reason is that the ablated veins were left in situ, favoring recanalization by endothelial cells over neovascularization.[16,17]

The limitations of this study include the data gathering inherent to retrospective studies. The electronic medical records of patients who returned to our institution for evaluation of symptomatic veins were reviewed only. Thus, patients who had recurrences but sought treatment at other institution could not be included in the current study. This precluded the ability to determine a true percent recurrence. There was also no randomization of patients between EVLA and RFA. A statistically significant difference in phlebectomy performed between the groups may also be a source of potential bias in favor of EVLA. Another limitation is the lack of long-term follow-up data and variation in follow-up intervals to some extent. To adjust the variations in follow-up periods, we used Kaplan-Meier analysis method, but a longer follow-up period may have revealed more recurrence events. This study was further limited by the lack of formal outcome assessment such as the Venous Clinical Severity Score for uniform measurement of changes in patient symptoms post-thermal ablation.

CONCLUSIONS

The results of our study suggest that the outcomes of EVLA and RFA performed for saphenous vein insufficiency may differ in the long term. The clinical recurrence rates are similar, but the anatomic recurrence patterns may differ, with more frequent treated site recurrence in the RFA group.

AUTHOR CONTRIBUTIONS

Conception and design: WY, BA
Analysis and interpretation: WY, PC, PH, CB, BA
Data collection: WY, MD
Writing the article: WY, MD, PC, PH, CB, BA
Critical revision of the article: WY, BA
Final approval of the article: WY, MD, PC, PH, CB, BA
Statistical analysis: WY, MD
Obtained funding: Not applicable
Overall responsibility: BA

REFERENCES

1. Gloviczki P, Comerota AJ, Dalsing MC, Eklof BG, Gillespie DL, Gloviczi ML, et al. 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(Suppl):2S-48S.
2. O'Donnell TF, Balk EM, Dermody M, Tangney E, Iafrati MD. Recurrence of varicose veins after endovenous ablation of the great saphenous vein in randomized trials. J Vasc Surg Venous Lymphat Disord 2016;4:97-105.
3. Proebstle TM, Sandhofer M, Kargl A, Gul D, Rother W, Knop J, et al. Thermal damage of the inner vein wall during endovenous laser treatment: key role of energy absorption by intravascular blood. Dermatol Surg 2002;28:596-600.
4. Labropoulos N, Bhatti A, Leon L, Borge M, Rodriguez H, Kalman P. Neovascularization after great saphenous vein ablation. Eur J Vasc Endovasc Surg 2006;31:219-22.
5. Atasoy MM. Efficacy and safety of endovenous laser ablation in very large and tortuous great saphenous veins. J Vasc Interv Radiol 2015;26:1347-52.
6. Khilnani NM. Endovenous laser ablation can safely and successfully treat large-diameter saphenous veins: a posse ad esse (from possibility to actuality). J Vasc Interv Radiol 2015;26:1353-4.
7. Fernandez MC. Prospective study of safety and effectiveness in the use of radiofrequency ablation for incompetent great saphenous vein >12 mm. J Vasc Surg Venous Lymphat Disord 2017:1-7.
8. Carradice D, Mekako AI, Hatfield J, Chetter IC. Randomized clinical trial of concomitant or sequential phlebectomy after endovenous laser therapy for varicose veins. Br J Surg 2009;96:369-75.
9. Sadek M, Kabnick LS, Rockman CB, Berland TL, Zhou D, Chasin C, et al. Increasing ablation distance peripheral to the saphenofemoral junction may result in a diminished rate of endothermal heat-induced thrombosis. J Vasc Surg 2013;1:257-62.
10. Rasmussen LH, Lawaetz M, Bjoern L, Vennits B, Blemings A, Eklof B. Randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy, and surgical stripping for great saphenous veins. Br J Surg 2011;98:1079-87.
11. Rasmussen L, Lawaetz M, Serup J, Bjoern L, Vennits B, Blemings A, et al. Randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy, and surgical stripping for great saphenous varicose veins with 3-year follow-up. J Vasc Surg Venous Lymphat Disord 2013;1:349-56.
12. Rasmussen L, Lawaetz M, Bjoern L, Blemings A, Eklof B. Randomized clinical trial comparing endovenous laser ablation and stripping of the great saphenous vein with clinical and duplex outcome after 5 years. J Vasc Surg 2013;58:421-6.
13. Winokur RS, Khilnani NM, Min RJ. Recurrence patterns after endovenous laser treatment of saphenous vein reflux. Phlebology 2016;31:496-500.

14. Bush RG, Bush P, Flanagan I, Fritz R, Gueldner T, Koziarski J, et al. Factors associated with recurrence of varicose veins after thermal ablation: results of the recurrent veins after thermal ablation study. Sci World J 2014;2104:505843.
15. Garner JP, Heppell PSJ, Leopold PW. The lateral accessory saphenous vein — a common cause of recurrent varicose veins. Ann R Coll Surg Engl 2003;85:389-92.
16. Nelzen O, Fransson I. Varicose vein recurrence and patient satisfaction 10-14 years following combined superficial and perforator vein surgery: a prospective case study. Eur J Vasc Endovasc Surg 2013;46:372-7.
17. Nelzen O. Great uncertainty regarding treatment of varicose vein recurrence. Phlebologie 2014;43:13-8.

Submitted Jan 20, 2018; accepted Nov 20, 2018.