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The effect of laser wavelength on postoperative pain score in the endovenous ablation of saphenous vein insufficiency

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PURPOSE
Endovenous laser ablation has replaced surgical methods in the treatment of saphenous insufficiency. The aims of this study were to compare the effectiveness of 1470- and 980-nm wavelength (WL) laser systems, to compare the postoperative complication rates, and to determine the effect of laser WL on postoperative pain scores.

MATERIALS AND METHODS
Between October 2010 and November 2011, 79 consecutive patients with saphenous vein insufficiency were examined. The patients who received the 980-nm treatment were defined as Group 1; 54 extremities of 47 patients were treated in this group. The patients who received the 1470-nm treatment were defined as Group 2; 36 extremities of 32 patients were treated in this group.

RESULTS
Early technical success was 100% in both groups. Both major and minor complications were seen in Group 2. The complications in Group 1 were mostly major; however, three minor complications were reported in this group. The complication rates of the two groups were not significantly different. There was no statistically significant difference between the pain scores of the two groups.

CONCLUSION
Early postoperative pain was the major factor that impaired quality of life. There was no relationship between the postoperative pain scores and laser WL or energy density. The laser WL did not affect technical success or occurrence of complications. Use of a suitable energy density resulted in complete occlusion in all patients with saphenous vein insufficiency.

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Lower extremity venous insufficiency is a very common medical condition that affects approximately 25% of females and 15% of males (1). Great saphenous vein reflux is the most common underlying cause of symptomatic varicose veins. Other causes are reflux in other truncal veins, such as the small saphenous vein, the anterior or posterior thigh circumflex vein, the Giacomini vein, and perforating veins. Treatment options for varicose veins include conservative management, minimally invasive procedures, and surgery.

In 1999, Salat (2) first reported the delivery of endoluminal laser energy with an 810-nm diode laser for the treatment of varicose veins. Early success with this device prompted development of other devices that supplied wavelengths (WLs) more specific to the hemoglobin chromophore (810-, 940-, and 980-nm devices) in an effort to achieve 100% saphenous vein closure (2–7). In contrast to these laser systems, the 1320- and 1470-nm WL laser systems affect interstitial water (8, 9). Goldman (6) introduced the 1320-nm WL, which better exploits water as the energy-absorbing molecule. Two comparative studies indicated that patients treated with water-specific laser WLs reported less postoperative pain, used less painkillers, and were less likely to have ecchymosis (8, 10).

There is increasing focus on reducing postoperative pain and bruising, while maintaining high saphenous vein ablation rates. Because the 1470-nm WL is absorbed by water at a level 40-times more than the 980-nm WL, the manufacturer hypothesized that it would more readily target the vein wall and more readily ablate veins at lower energy densities, with fewer side effects. The most common side effects seen with all laser types are bruising, localized pain, indurations, discomfort along the treated vein, and superficial phlebitis (11).

The aims of this study were: to compare the effectiveness of the 1470-nm and 980-nm WL laser systems, to compare the postoperative complication rates associated with these systems, and to determine the effect of laser WL on postoperative pain scores.

Materials and methods

Between October 2010 and November 2011, 79 consecutive patients who had saphenous vein insufficiency were studied. The patients were divided into two groups; those treated with the 980-nm WL laser system were defined as Group 1 and the patients treated with the 1470-nm WL laser system were defined as Group 2. In Group 1, 54 extremities of 47 patients (32 females, 15 males) were treated with the 980-nm WL laser system. The patients were 18–64 years of age (mean age, 42.03±11.81 years). In Group 2, 36 extremities of 32 patients (22 females, 10 males) were treated with the 1470-nm WL laser system. They were 25–76 years of age (mean age, 44.21±12.44 years).

All endovenous laser ablation (EVLA) procedures were performed under tumescent anesthesia in an outpatient setting. First, the patients were covered in a standard sterile fashion. The saphenous vein was then punctured (below the knee in all patients) using a 21 G needle under ultrasonography (US) guidance. A 0.018-inch guidewire was inserted into the saphenous vein, and a laser fiber was placed 1–2 cm distal to the saphenofemoral or saphenopopliteal junction. A tumescent anesthetic solution (15 cc 2% prilocaine, 10 cc 8.4% sodium bicarbonate, 0.5 mg adrenalin diluted in 500 cc physiological saline solution) was injected using a pump in 32 patients, and using a pressured blood sock in 47 patients.

The parameters of the laser system (Gigaa 980 nm, Vari-Lase Endovenous Laser System, Vascular Solutions Inc., Sycamore Court, Minneapolis, USA) for Group 1 were adjusted to 14 W, continuous mode. The fiber retrieval rate was 6–9 s, and a ~80–100 Joule (J)/cm energy density was delivered. For Group 2, the parameters for the laser system (VenaCure® 1470, AngioDynamics Inc., Latham, New York, USA) were 10 W, continuous mode. The fiber retrieval rate for this system was 4–6 s, and a ~40–60 J/cm energy density was delivered. The total laser energy amounts and ablated saphenous vein lengths were recorded for all patients. Foam scleroteraphy was applied concurrently with the EVLA procedure in 18 patients, and in a subsequent session in 24 patients.

All patients wore Class II (20–30 mmHg) compression stockings for one month. An analgesic and anti-inflammatory drug (diclofenac sodium 75 mg) was prescribed for one week. Patients were evaluated at one week, and one, three, and six months after the procedure. The efficacy of the treatment, side effects, adverse events, and recurrence were evaluated by clinical examination and Doppler US. Pain scores were recorded (Table 1) according to the visual pain scale. Erythema, localized cellulites, superficial thrombophlebitis, and localized hypoesthesia were accepted as minor complications.

The study protocol was approved by the local ethics committee, and informed consent was obtained from all patients.

Table 1. Pain score of extermities in Groups 1 and 2

Pain score	Group 1 (n=54)	Group 2 (n=36)
Median	2.5	2.0
Range	0–8	0–8

Table 2. Comparison of lenght and CEAP scores in Groups 1 and 2

	Group 1 (n=54)	Group 2 (n=36)	*P*[a]
Length (cm)	35.2±8.7	33.75±13.1	0.818
Complication	5.5%	0.0%	0.547
CEAP score	2.16±0.64	2.21±0.64	0.348

[a]Fisher's exact test.
CEAP, clinical-etiology-anatomic-pathophysiologic.
Data are given as mean±standard deviation or %.

Table 3. Comparison of age, pain scores, and energy density (J/cm) in Groups 1 and 2

	Group 1 (n=54)	Group 2 (n=36)	*P*[a]
Age (years)	42.03±11.81	44.21±12.44	0.445
Pain score	3.25±2.42	3.45±2.30	0.717
Energy density (J/cm)	101.82±15.63	52.39±7.02	< 0.001

[a]Student test for equality of variances.
Data are given as mean±standard deviation.

Statistical analysis

Continuous variables are expressed as mean±standard deviation or median (minimum-maximum) while categorical variables were expressed as frequency and percentage values. Power analysis was performed with a sample size test. The analysis indicated that a 20% change in the pain score was considered clinically important. For α=0.05 and β=0.20 values and 95% confidence bounds, the adequate subject count was calculated to be 29. According to this sample size, the statistical power was 0.958. Continuous variables were compared between groups by using Mann-Whitney test or independent samples t test. Relationship between continuous variables were investigated by using correlation analysis, and Pearson correlation coefficient was computed. Statistical analyses were performed using a computer software (Statistical Package for Social Sciences, version 13.0, SPSS Inc., Chicago, Illinois, USA). Significance level was set at $P < 0.05$.

Results

Early technical success was 100% for both groups. Three minor complications occurred in three Group 1 patients: one localized thrombophlebitis, and two below-the-knee localized hypoesthesia. However, the complication rates of the two groups were not significantly different. Also, the ablated vein lengths and CEAP scores (nonhomogen parameters) of the two groups were not significantly different (Table 2).

The homogen parameters (mean ages, gender, mean pain score values, mean energy density) of the two groups along with technical success, pain scores, and complication rates are shown in Table 3. The mean scores of Groups 1 and 2 were 3.25±2.42 and 3.45±2.30, respectively. There was no statistically significant difference between the pain scores of the two groups. The mean laser energy amount was 101.82±15.63 J/cm for Group 1, and 52.39±7.02 J/cm for Group 2. There were no statistically significant differences between the homogen parameters of the two groups, except for the mean laser energy amount per cm (Table 3).

Pearson correlation analysis showed no correlation between complications

Table 4. Comparison of different energy density levels in terms of pain score, complication rates, and technical success

	Energy density	
	≥66 J/cm (n=29 extremities)	≤65 J/cm (n=55 extremities)
Pain score	2.81±2.13[a]	3.54±2.41
Complications	0.0%	5.5%
Technical success	100%	100%

[a]P = 0.507, chi-square test.
Data are given as mean±standard deviation or %.

and ages, saphenous vein length, gender, or laser energy amount per cm.

When the patients were divided into two groups according to laser energy (≤65 J/cm for Group 1, and ≥66 J/cm for Group 2), the correlation analysis showed no statistically significant relationship between complication rates and technical success. Although the pain scores were higher in Group 2, the difference was not statistically significant (Table 4).

Discussion

EVLA and foam scleroteraphy have replaced surgical methods for the treatment of saphenous insufficiency (12–16). Tumescent anesthesia is one of the most important factors that affect the success of the EVLA procedure (16, 17). Bruising, tenderness, and pain are usually seen in the first one or two weeks after EVLA treatment. Anti-inflammatory drugs and compression stockings reduce these minor complications (18). The other important factor in EVLA treatment is the energy density (8, 10). Use of various amounts of energy has been suggested. Timperman et al. (19) reported that 80/cm^{-1} or greater should be applied for successful treatment. They emphasized that the higher amount is effective and safe for EVLA treatment. Theivacumar et al. (20) reported that the energy amount is the main parameter that affects treatment success, and that 60/cm^{-1} or greater should be used for successful treatment. In contrast, Kim et al. (21) reported 100% technical success using 35.16/cm^{-1} in 34 patients. In our study, the patients were treated using 103/cm^{-1} energy from a 980-nm WL laser system and 52 J cm^{-1} energy from a 1470-nm WL laser system. We achieved complete occlusion of the saphenous veins in all patients in both groups. Although the treatment success depends on the energy density, the energy density differs according to laser WL.

Postoperative pain during the first one or two weeks was the most important factor that affected the quality of life. Several articles report that the quality of life was higher and minor complications were less likely when 1470-nm WL laser systems were used instead of 980-nm WL laser systems. Doğancı and Demirkılıç (22) compared prospectively 30 patients who received 980-nm and 1470-nm laser treatments. They reported that the quality of life was higher and minor complication rate was lower in patients treated with the 1470-nm WL l aser systems. Almeida (17) reported lower postoperative pain scores, ecchymosis, and paresthesia in patients treated with the 1470-nm WL laser system. In our study, the mean postoperative score was 3.25±2.42 with the 980-nm WL laser system, and 3.45±2.30 with the 1470-nm WL laser system. A 20% (2-point) difference in the pain score is in our view clinically significant. Although pain scores were slightly lower with the 1470-nm WL laser system, there was no statistically significant difference between the two laser systems. Both major and minor complications were seen in Group 2 (1470-nm WL). The complications that arose in Group 1 (980-nm WL) were mostly major; however, three minor complications were reported. Overall, there was no statistically significant difference between the two laser systems regarding complications.

Pannier et al. (23) performed 100 EVLA procedures (108 vena safena magna, 26 vena safena parva) using 1470-nm WL laser treatment. They reported that the paresthesia rates increased significantly when 100/cm^{-1} or higher energy density was used. In our study, we saw paresthesia in two patients treated with the 980-nm WL; the mean laser energy densities in these patients were 98 and 110/cm^{-1}. However, we did not see paresthesia with use of the 1470-nm WL, despite use of higher energy amounts and below-the-knee puncture. Additionally, independent of the type of laser system used, the patients were divided into two groups according to laser energy per cm (≤65 J for Group 1, and ≥66 J for Group 2). Statistical analyses showed that there was no relationship between energy amount and complication rate. Thus, our results suggest that energy amount is not a unique determinant of either the occurrence of complications or postoperative pain. If a suitable energy density (100/cm^{-1} for 980-nm WL laser systems, and 50/cm^{-1} for 1470-nm WL laser systems) is delivered, then tumescent anesthesia quality and the pull-back rate of the laser fiber are the main factors affecting complication ratios and pain scores.

In conclusion, EVLA is an effective and safe procedure for the treatment of saphenous vein insufficiency. Early postoperative pain was the major factor that impaired quality of life. There was no relationship between postoperative pain scores, laser WL, or energy density. Additionally, laser WL did not affect the technical success or occurrence of complications. Use of a suitable energy density (100/cm^{-1} for 980-nm WL laser systems, and 50/cm^{-1} for 1470-nm WL laser systems) resulted in complete occlusion in all patients.

Conflict of interest disclosure

The authors declared no conflicts of interest.

References

1. Callam MJ. Epidemiology of varicose veins. Br J Surg 1994; 81:167–173. [CrossRef]
2. Salat BC. Tratamiento endoluminal de las varices con laser de diodo: Estudio preliminar. Rev Patol Vasc 1999; 5:35–46.
3. Min RJ, Khilnani N, Zimmet SE. Endovenous laser treatment of saphenous vein reflux: long-term results. J Vasc Interv Radiol 2003; 14:991–996. [CrossRef]
4. Goldman MP, Mauricio M, Rao J. Intravascular 1320-nm laser closure of the great saphenous vein: a 6- to 12-month follow-up study. Dermatol Surg 2004; 30:1380–1385. [CrossRef]

5. Proebstle TM, Lehr HA, Kargl A, et al. Endovenous treatment of the greater saphenous vein with a 940 nm diode laser: thrombotic occlusion after endoluminal thermal damage by laser generated steam bubbles. J Vasc Surg 2002; 35:729–736. [CrossRef]
6. Goldman MP. Intravascular lasers in the treatment of varicose veins. J Cosmetic Dermatol 2004; 3:162–166. [CrossRef]
7. Oh CK, Jung DS, Jang HS, Kwon KS. Endovenous laser surgery of the incompetent greater saphenous vein with a 980-nm diode laser. Dermatol Surg 2003; 29:1135–1140. [CrossRef]
8. Proebstle TM, Moehler T, Gül D, Herdemann S. Endovenous treatment of the great saphenous vein using a 1,320 nm Nd:YAG laser causes fewer side effects than using a 940 nm diode laser. Dermatol Surg 2005; 31:1678–1684. [CrossRef]
9. Mordon SR, Wassmer B, Zemmouri J. Mathematical modeling of endovenous laser treatment (ELT). Biomed Eng Online 2006; 5:26. [CrossRef]
10. Kabnick LS. Outcome of different endovenous laser wavelengths for great saphenous vein ablation. J Vasc Surg 2006; 43:88–93. [CrossRef]
11. Van Den Bos RR, Neumann M, De Roos KP, Nijsten T. Endovenous laser ablation-induced complications: review of the literature and new cases. Dermatol Surg 2009; 35:1206–1214. [CrossRef]
12. Brown K, Moore CJ. Update on the treatment of saphenous reflux: laser, RFA, or foam? Perspect Vasc Surg Endovasc Ther 2009; 21:226–231. [CrossRef]
13. Min RJ, Khilnani N. Endovenous laser treatment of saphenous vein reflux. Tech Vasc Interv Radiol 2003; 6:125–131. [CrossRef]
14. Yilmaz S, Ceken K, Alparslan A, Sindel T, Lüleci E. Endovenous laser ablation for saphenous vein insufficiency: immediate and shortterm results of our first 60 procedures. Diagn Interv Radiol 2007; 13:156–163.
15. Morrison N. Saphenous ablation: what are the choices, laser or RF energy. Semin Vasc Surg 2005; 18:15–18.
16. Almeida J, Mackay E, Javier J, Mauriello J, Raines J. Saphenous laser ablation at 1470 nm targets the vein wall, not blood. Vasc Endovasc Surg 2009; 43:467–472. [CrossRef]
17. Almeida JI. Endovenous ablation without anesthesia? Early experience with a new laser wavelength that is highly absorbable by water. Endovascular Today 2009; 8:28–31.
18. Oğuzkurt L. Endovenous laser ablation for the treatment of varicose veins. Diagn Interv Radiol 2012; 18:417–422.
19. Timperman PE, Sichlau M, Ryu RK. Greater energy delivery improves treatment success of endovenous laser treatment of incompetent saphenous veins. J Vasc Interv Radiol 2004; 15:1061–1063. [CrossRef]
20. Theivacumar NS, Dellagrammaticas D, Beale RJ, Mavor AI, Gough MJ. Factors influencing the effectiveness of endovenous laser ablation (EVLA) in the treatment of great saphenous vein reflux. Eur J Vasc Endovasc Surg 2008; 35:119–123. [CrossRef]
21. Kim HS, Nwankwo IJ, Hong K, McElgunn PS. Lower energy endovenous laser ablation of the great saphenous vein with 980 nm diode laser in continuous mode. Cardiovasc Intervent Radiol 2006; 29:64–69. [CrossRef]
22. Doğancı S, Demirkılıç U. Comparison of 980 nm laser and bare-tip fiber with 1470 nm laser and radial fiber in the treatment of great saphenous vein varicosities: a prospective randomised clinical trial. Eur J Vasc Endovasc Surg 2010; 40:254–259. [CrossRef]
23. Pannier F, Rabe E, Maurins U. First results with a new 1470-nm diode laser for endovenous ablation of incompetent saphenous veins. Phlebology 2009; 24:26–30. [CrossRef]