	980 nm	1320 nm
BMI < 25	410 limbs	130 limbs
BMI ≥ 25	95 limbs	38 limbs
Power (W)	12,25	8,1

***TABLEAU 5 :** Data of patients treated with 980 nm and 1320 nm lasers.*

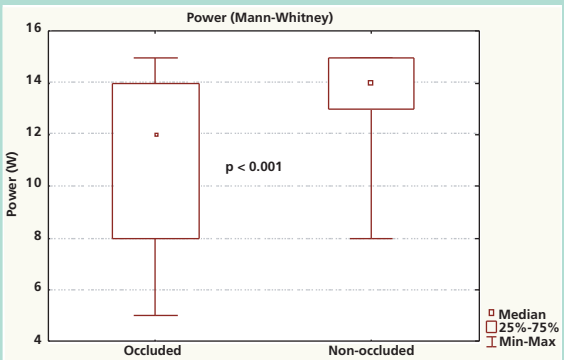

***FIGURE 4 :** Occlusion plotted against power (Mann-Whitney).*

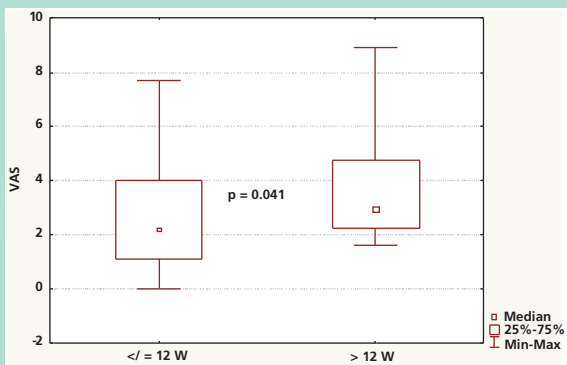

***FIGURE 5 :** Postprocedural pain evaluated by patient plotted against power.*

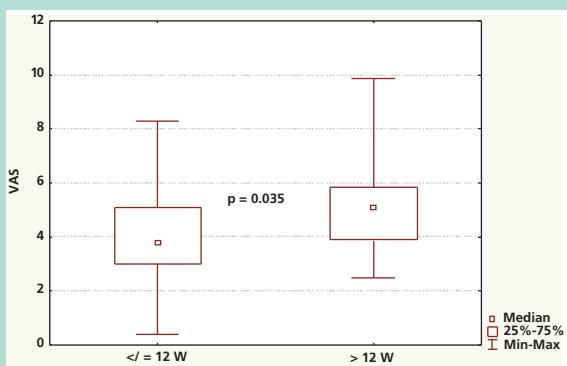

***FIGURE 6 :** Bruising evaluated by physician plotted against power.*

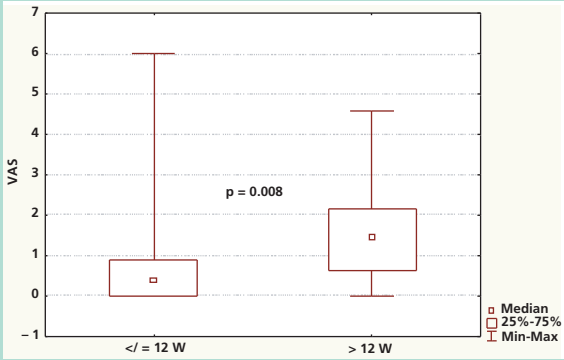

***FIGURE 7 :** Induration evaluated by physician plotted against power.*

• Immediate post-operative sequelae at D5 were significantly more favorable in lower power group (5 to 12 W) compared to 15 W group :

– pain (p = 0.041) : median [inter-quartile range] : 2.2 [1.1-4.0]) vs. 2.9 [2.25-4.75] **(Figure 5)** – bruising or hematoma (p = 0.035) : 3.8 [3.0-5.1] vs. 5.1 [3.9-5.85] **(Figure 6)** ;

– induration (p = 0.008) : 0.4 [0-0.9] vs. 1.45 [0.65-2.15] **(Figure 7)**.

• In both cohorts, no statistically significant difference was observed in terms of usual daily activities, sleep-related difficulties and prolonged standing position. The degree of phlebitis of GSV and eventual pain killer medication was same in both groups. QoL 1 month after procedure was also similar.

Discussion

• The amount of applied energy is of paramount importance during endovenous laser treatment. Undertreatment can result in a clinically unsatisfactory outcome, and overtreatment leads to adjacent tissue destruction without additional shrinkage and fibrosis of the targeted tissue. To establish the optimal parameters, it is necessary to determine the response of venous tissue to different thermal insults over different time periods. Furthermore, laser wavelength can also play an important role. One randomized and single-blinded study compared 810 nm and 980 nm diode lasers. Ecchymosis and superficial phlebitis was more often present when 810nm laser was used [15]. In order to minimize complications and side-effects, longer-wavelength lasers were developed [16].

• Some studies have recommended application of higher power (30 W) in order to administer high amount of laser energy to the venous wall [17, 18].

• In other studies [19, 20, 21], satisfactory outcome with low rate of complications and side effects was obtained by using quite low amounts of diode laser energy (35-39 J/cm) and power (11-12 W).

• **The results of our study showed that the clinical outcome does not improve by using higher laser power (15 W).** Moreover, using this power setting might amplify the deleterious effect of the thermal laser treatment without increasing the therapeutic effect. Higher power produces substantial carbonisation of the fiber tip with additional temperature elevation and possible wall perforation. Higher power can also result in desintegration of the fiber tip due to carbonisation process. The current study showed significantly higher rate of side-effects for 15 W power group compared to lower power groups.

• Not only the total amount of energy per centimeter of vein length (LEED) can influence the final result but also the energy deposition pattern. **We found that "slow" heating using a low or medium power (8 to 12 W) with slow pull-back speed of 0.2 to 2 mm/sec lead to the best outcome** with minimum complications.

Conclusions

Based on our observations, we recommend low or medium power settings (8 to 12 W) with slower pull-back speed of laser fibre to achieve sufficient energy per centimeter of the vein and the optimal clinical outcome with minimal side-effects. Theoretical danger of prolonged heating of surrounding tissues can be successfully managed with ultrasound guided tumescence.

References

1. Weiss R.A. Comparison of endovenous radiofrequency versus 810 nm diode laser occlusion of large veins in an animal model. Dermatol. Surg. 2002 Jan ; 28 (1) : 56-61.
2. Proebstle T.M., Lehr H.A., Kargl A., Espinola-Klein C., Rother W., Bethge S., Knop J. 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 Apr ; 35 (4) : 729-36.
3. Proebstle T.M., Sandhofer M., Kargl A., Gul D., Rother W., Knop J., Lehr H.A. Thermal damage of the inner vein wall during endovenous laser treatment: key role of energy absorption by intravascular blood. Dermatol. Surg. 2002 Jul ; 28 (7) : 596-600.
4. Zimmet S.E., Min R.J. Temperature changes in perivenous tissue during endovenous laser treatment in a swine model. J. Vasc. Interv. Radiol. 2003 Jul ; 14 (7) : 911-5.
5. Mordon S.R., Wassmer B., Zemmouri J. Mathematical modeling of endovenous laser treatment (ELT). Biomed. Eng. Online 2006 ; Apr 25, 5 : 26.
6. Schmedt C.G., Sroka R., Steckmeier S., Meissner O.A., Babaryka G., Hunger K., Ruppert V., Sadeghi-Azandaryani M., Steckmeier B.M. Investigation on Radiofrequency and Laser (980 nm) Effects after Endoluminal Treatment of Saphenous Vein Insufficiency in an Ex-vivo Model. Eur. J. Vasc. Endovasc. Surg. 2006 Sep ; 32 (3) : 318-25.
7. Timperman P.E., Sichlau M., Ryu R.K. Greater energy delivery improves treatment success of endovenous laser treatment of incompetent saphenous veins. J. Vasc. Interv. Radiol. 2004 Oct ; 15 (10) : 1061-3.
8. Proebstle T.M., Krummenauer F., Gul D., Knop J. Nonocclusion and early reopening of the great saphenous vein after endovenous laser treatment is fluence dependent. Dermatol. Surg. 2004 Feb ; 30 (2 Pt 1) : 174-8.
9. Timperman P.E. Prospective evaluation of higher energy great saphenous vein endovenous laser treatment. J. Vasc. Interv. Radiol. 2005 Jun ; 16 (6) : 791-4.
10. Min R.J., Khilnani N.M. Endovenous laser ablation of varicose veins. J. Cardiovasc. Surg. (Torino) 2005 Aug ; 46 (4) : 395-405.
11. Theivacumar N.S., Dellagrammaticas D., Beale R.J., Mavor A.I., Gough M.J. Factors influencing the effectiveness of endovenous laser ablation (EVLA) in the treatment of great saphenous vein reflux. Eur. J. Vasc. Endovasc. Surg. 2008 Jan ; 35 (1) : 119-23.
12. Kaspar S., Siller J., Cervinkova Z., Danek T. Standardisation of parameters during endovenous laser therapy of truncal varicose veins – experimental ex-vivo study. Eur. J. Vasc. Endovasc. Surg. 2007 Aug ; 34 (2) : 224-8.
13. Navarro L., Min R.J., Boné C. Endovenous laser: a new minimally invasive method of treatment for varicose veins-preliminary observations using an 810 nm diode laser. Dermatol. Surg. 2001 Feb ; 27 (2) : 117-22.
14. Launois R., Reboul-Marty J., Henry B. Construction and validation of a quality of life questionnaire in chronic lower limb venous insufficiency (CIVIQ). Qual. Life Res. 1996 Dec ; 5 (6) : 539-54.
15. Kabnick L.S. Outcome of different endovenous laser wavelengths for great saphenous vein ablation. J. Vasc. Surg. 2006 Jan ; 43 (1) : 88-93.
16. Goldman M.P., 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 Nov ; 30 (11) : 1380-5.
17. Proebstle T.M., Moehler T., Herdemann S. Reduced recanalization rates of the great saphenous vein after endovenous laser treatment with increased energy dosing: definition of a threshold for the endovenous fluence equivalent. J. Vasc. Surg. 2006 Oct ; 44 (4) : 834-9.
18. Proebstle T.M., 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 Dec ; 31 (12) : 1678-83.
19. Disselhoff B.C., der Kinderen D.J., Moll F.L. Is there recanalization of the great saphenous vein 2 years after endovenous laser treatment? J. Endovasc. Ther. 2005 Dec ; 12 (6) : 731-8.
20. Kim H.S., Nwankwo I.J., Hong K., McElgunn P.S. Lower energy endovenous laser ablation of the great saphenous vein with 980 nm diode laser in continuous mode. Cardiovasc. Intervent. Radiol. 2006 Jan-Feb ; 29 (1) : 64-9.
21. Kim H.S., Paxton B.E. Endovenous laser ablation of the great saphenous vein with a 980-nm diode laser in continuous mode: early treatment failures and successful repeat treatments. J. Vasc. Interv. Radiol. 2006 Sep ; 17 (9) : 1449-55.