“ No limits with Lasers “

"NO LIMITS WITH LASERS" Laser ablation of varicose veins – are there limitations?

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Varicose veins are a frequently encountered medical condition. For almost 100 years, high ligation and stripping were the treatments of choice in order to remove the diseased vein directly. A new and different treatment option for varicose veins by using laser light for thermal occlusion was first carried out in 1999 by C. Bone Salat in Spain and revolutionized the therapy concept completely – and still is a continuous evolution. The technical evolution included a new design of the laser fiber tip with it changing from axial to radial radiation, realized a smaller diameter of the catheter device and transferred the wavelength from visible light into the deeper infrared spectrum. The target effect on the vein wall is defined by the level of absorption of the used wavelength: thermal induced collagen shrinkage leading to fibrotic sealing of the vein and followed by complete resorption. The ideal primary result is a tight echogenic closure.

> fig. 3

Looking back in history, laser development was made possible by the research of Max Planck (1900, light quanta) and Albert Einstein (1905, photo effect, 1917 stimulated emission). The laser technology is based on their basic research and findings.

I started my treatment of varicose veins with crossectomy/high ligation and stripping as an office setting procedure, used radiofrequency with different catheters (RFITT and VNUS) and laser devices with radial emitting fibers. I improved my way of treatment continuously after thousands of procedures – finally, in the EVLA technique. Especially by using direct puncture access, which is only possible with thin catheters. After continuous improvement and individual evolution by constantly tuning the parameter, I defined my personal principles of the endovenous laser treatment.

EXAMPLES (SONOGRAPHIC IMAGES)

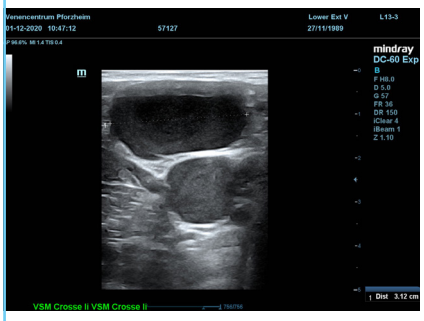

fig. 1 > GSV > 3 cm

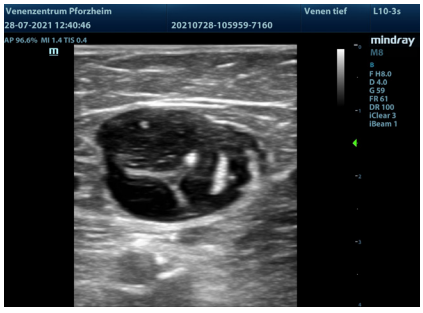

fig. 2 > External compression

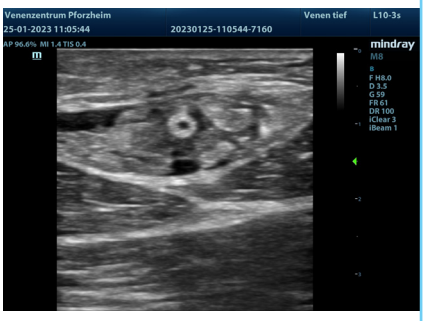

fig. 3 > Transmural denaturation

The question was, where are the limits to this method?

From a vascular surgeon´s perspective: Are there exclusion criteria for the EVLA procedure? Or are there cases left, which need to be treated with the conventional technique?

As for example very pronounced findings with or without severe dilatation of the great or small saphenous vein (> 3 cm) (> fig. 1) difficult recurrences after previous conventional or endovenous treatment (esp.: a short stump), very superficial or intracutaneous branches, perforators with critical skin such as dermatosis, or even the treatment of venous malformations?

The next question was, are there limitations at all?

In retrospect and with my experience after countless (> 5.000) endovenous interventions, I found the radial laser to be my technical instrument of choice.

In fact, there are several reasons for this.

Using laser devices means to consider the physical principles of laser light and absorption of photon transferred energy in tissue. To carry out the procedure, advanced technical equipment, especially a high-resolution ultrasound device is necessary. The importance of continuous ultrasonographic guidance during the whole procedure must be stressed. For larger vein diameters, external compression with the tumescent solution is important (> fig. 2). Two laser generators (one as back-up system) and different catheter types (different diameters) should be available in the armament of a high-volume center. Furthermore, anesthesia on demand for painless treatment might be helpful. With these prerequisites, the treatment of very pronounced findings, any dilatation in truncal veins, treatment of lateral branches, very superficial veins, and sequential treatments of accessory veins should be possible without restrictions. Tissue response obeys the laws of physics, what we observe is mainly a predictable and targeted transfer and absorption of energy.

The endovenous laser technology moved toward a higher wavelength into the deeper infrared spectrum (NIR). Water molecules absorb energy transferred from photons and are set into vibration, this process generates heat. Photons transport a defined amount of energy that is determined by their wavelength (> fig. 4).

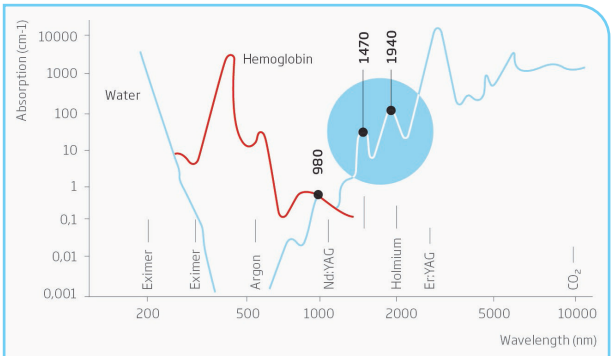

fig. 4 >
Absorption levels in water in relation to used wavelengths

Increasing the power (in watts) only increases the number of photons of the same size (with the same energy packet). The wavelength 1940 nm is easier absorbed by water, might protect the surrounding tissue better and may have less side effects compared to 1470 nm.

The applied LEED has to be adapted to the vein diameter, but vein wall thickness (VWT) should also be considered (after thrombophlebitis etc.). Above all, the use of the direct puncture technique and adequate laser fibers offers the possibility of treating GSV, SSV truncal reflux, simultaneous treatment of lateral branches, visible varicosity – whether subcutaneous or intracutaneous –, and recurrences. Furthermore, the whole treatment can be done at once. Thus, patients can be offered ideal results and a scar-free technique.

In retrospect, laser technology replaced the conventional surgical procedure and replaced it forever. Even interventions when taking plasmatic anticoagulants are possible without interrupting medication. That evolution transformed the today treatment for varicose veins at almost each clinical stage into an outpatient procedure.

Assessing the effectiveness of laser treatment is complicated by the presence of multiple variables including wavelength, type of pullback, thus energy delivered, type of fiber, use of tumescence, type of reflux and the individual variations and way of treatment. For a better understanding of tissue response and the results, I studied the physical basics of laser technology and quantum physics to improve my fine tuning. After many applications, continuous evolution and perfection of the set-up parameters, I began to be more and more fascinated by this technique, the results, based on photon transmitted energy, light absorption, the possibilities, development and progress of the laser technology.

The variation and modulation of physical parameters includes laser fluence (photon density, radiation over 2 rings, different outer diameter of fiber tip), the energy output in watts (number of photons), the pull-back speed (manual retraction due to pull back resistance) and the wavelength of used laser light. The application of enough tumescence and the importance of an almost bloodless vein during the ablation should be considered. All these factors will influence, might improve and determine energy absorption by the target chromophore water and thus the tissue effects. The understanding of the physical parameters and electromagnetic absorption will help to modify these parameters individually in order to improve its results. A skilled puncture technique is of particular importance. This offers an almost limitless procedure. Additive post ablative sclerotherapy of residual varicose veins as add on treatment in the early follow up is highly effective and of particular importance for prevention of recurrences.

CONCLUSION

In conclusion, minimal invasive therapy is strongly desirable in healthcare and treatment of varicose veins. As an office setting procedure, radial laser treatment comprises an undoubtedly cost-effective solution. It is a safe and very effective technique with very low postoperative pain, sooner return to normal activity and has better patient acceptance. Furthermore, patient benefit of predictable results in short term and long term. Innovative technologies have pushed the boundaries and set up new standards – conventional treatment is history.

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Dr. Weiler has worked since January 2005 in a private practice as vascular surgeon in Pforzheim. He has more than 25 years of experience in vascular surgery and phlebology and is qualified to educate and train in the field of phlebology. His specialty lies on endovenous therapy techniques.

He studied in Heidelberg, Germany, and in addition to his degree as a specialist in surgery and vascular surgery he gained the qualification in emergency medicine. Before focussing in vascular and endovascular surgery, Dr. Weiler worked in the department of Cardiovascular Surgery of the Robert-Bosch hospital in Stuttgart, Germany.

Dr. Weiler is a member of five national and international professional societies, for example he is a Member of the Board of the German Society for Phlebology (DGP) and there in the Working Group „Endovenous Therapies".

As a base for discussion, to underline the topic of the essay and to visualize the principles of treatment, I would like to add two cases.

Technical equipment: radial emitting fibers (different diameters), laser generator 1940 nm (1470 nm), a high-resolution ultrasound device, relaxed working atmosphere (good lighting conditions), pain-free patient.

Passion, knowledge of physics and individual creativity will guide you through. Workshops or training at centers is recommended. The availability of different catheter types (diameter) is important. Notice, that only thin fibers are ideal for direct puncture technique.

"ELEMENTARY PARTICLES (F.E. PHOTONS) ARE THE KIND IN WHICH ENERGY MUST BE TRANSFORMED IN ORDER TO BECOME MATTER." (Werner Heisenberg)

Planck's constant (h)	6,626 x 10-34 Js
Photon energy	E = h x f
Speed of light	299 792 458 m/s

CASE 1 > COMPLETE LASER ABLATION OF EPIFASCIAL TRIBUTARY

Before

After

DIAMETER OF GSV TRUNK > 3 CM (> FIG. 3)

Before

After

contact + imprint

contact

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