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How to perform endovenous laser ablation of great saphenous veins?

Comment procéder à l'ablation par laser endoveineux des grandes veines saphènes ?

Pannier F.[1], Rabe E.[2]

Summary

The goal of endovenous laser ablation (EVLA) is the occlusion of the treated saphenous veins.

- Caused by the high temperatures at the tip of the fibre, vaporisation of the blood appears which can be seen in ultrasound as a so called steam bubble formation.
- With high wave lengths, absorption in the venous wall is much higher and direct damage and shrinkage of the venous wall appears more intensely.

Evidenced based indications for EVLA are the treatment of incompetent great and small saphenous veins. Absolute contraindications for EVLA are acute deep and superficial venous thrombosis.

Before EVLA complete duplex work-up of the venous system is mandatory. The complete procedure is controlled by duplex ultrasound including the position of the fibre in the sapheno-femoral junction.

EVLA can be performed in general or local aesthesia. Local aesthesia is usually performed as tumescent local anaesthesia.

Initial occlusion rates after the treatment are almost 100%. During 1 year follow-up, about 5% of reflux recurrences may occur. Severe complications like deep venous thrombosis are rare with a prevalence below 1%.

Résumé

Le but de l'ablation par laser endoveineux des varices (EVLA) est l'occlusion des veines saphènes traitées.

- Cette occlusion est causée par les températures élevées atteintes à l'extrémité de la fibre laser. La vaporisation du sang peut être visualisée à l'échographie sous la forme de bulles vaporisées.
- Avec des longueurs d'onde élevées, l'absorption thermique dans la paroi veineuse est beaucoup plus élevée, induisant des dommages directs de la paroi et un rétrécissement veineux plus intense.

Les indications de base de l'EVLA sont le traitement des incompétences des grandes et petites veines saphènes. Les contre-indications absolues sont les thromboses veineuses profondes et superficielles en phase aiguë.

Avant de procéder à une cure par EVLA, un bilan par écho-Doppler complet du système veineux est obligatoire. L'ensemble des procédures est pilotée par l'écho-Doppler, incluant le contrôle de la position de la fibre laser au niveau de la jonction saphéno-fémorale.

La procédure EVLA peut être effectuée sous anesthésie locale ou générale. L'anesthésie locale est généralement effectuée par tumescence.

Le taux d'occlusion initiale après le traitement est de presque 100 %. Pendant la première année de suivi, un taux de 5 % environ de récidive du reflux est observé. Les complications graves telles que la thrombose veineuse profonde sont rares avec une prévalence inférieure à 1 %.

1. Felizitas Pannier, Department of Dermatology, University of Cologne, Kerpener Straße 62, D50937 Cologne, Germany.
E-mail: info@dr-pannier.de
2. Eberhard Rabe, Department of Dermatology, University of Bonn, Bonn, Germany.
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The following parameters have to be considered in the planning of a ELVA session:

- Power (Watt): in most of the studies a power between 10 and 15 W has been used.
- Energy (Joule): power (Watt) × application time (sec.) = energy (J).
- Energy Density:
  - linear endovenous energy density (LEED) in J/cm;
  - endovenous fluence equivalent (EFE) in J/cm².
- Pullback modality: pulsed or continuous mode.

Keywords: endovenous laser ablation (EVLA), LEED, EFE, varicose veins, laser.

Les paramètres suivants doivent être pris en compte dans la planification d'une procédure ELVA :

- Puissance (Watt) : dans la plupart des études, une puissance comprise entre 10 et 15 W a été utilisée.
- Énergie (Joule) : puissance (Watt) × temps d'application (sec.) = énergie (J).
- Densité d'énergie :
  - la densité linéaire d'énergie endoveineuse (LEED) : en J/cm ;
  - l'équivalent en fluence endoveineuse J/cm (EFE) : en J/cm².
- Modalité : retrait en mode pulsé ou continu.

***Mots-clés :** ablation par laser endoveineux (EVLA), LEED, EFE, varices, laser.*

Introduction

In 1998, ***Boné*** reported the first endovenous treatment of great saphenous vein with laser light [1].

Since then, endovenous laser ablation of saphenous veins has become a standard procedure in the treatment of saphenous varicose veins [2].

During the last 10 years, several developments have improved the standard procedure.

In the beginning most of the treatments have been performed with diode-laser systems with a wave length between 810 and 980 nm.

The main absorption spectrum of these lasers is haemoglobin [3, 4, 5].

In the last years Diode lasers with a higher wavelength between 1320 and 1470 nm have been developed [6, 7].

The main absorption of these wavelengths appears in water, which makes them more specific for the venous wall.

In most of the cases the laser energy has been transmitted by a glass fibre-system, so called bare fibre. Bare fibres produce more perforation of the venous wall, more hematoma and post-treatment pain [8].

Therefore, new systems which avoid the contact of the fibre tip with the saphenous wall were developed.

Among these are the so-called **radial fibres**, which admit the laser light circumferentially around the fibre tip [9]. With these new fibre-systems perforation of the vein can be avoided and much lesser post-procedural pain and ecchymosis appears [10].

In the first years of endovenous laser treatment, low energy densities around 25 J/cm vein were used in many centres.

As recanalisation of the treated vein appeared in several cases, higher energy densities are now proposed and a minimum of 60-72 J/cm vein should be applied [11].

The goal of endovenous laser ablation is the occlusion of the treated saphenous veins [12], caused by the high temperatures at the tip of the fibre, vaporisation of the blood appears which can be seen in ultrasound as a so called *steam bubble formation*.

As a consequence, a heat-transmitted damage of the venous wall appears. This might have been the main effect of the lower wave lengths laser systems.

With high wave lengths absorption in the venous wall is much higher and direct damage and shrinkage of the venous wall appears more intensely.

This appears especially in laser systems with a wavelength around 1470 nm and with radial emitting fibre tips [13].

These mechanisms lead to shrinkage and occlusion of the saphenous vein. The long-term goal is the complete disappearance of the vein.

Power (Watt)

In most of the studies a power between 10 W and 15 W has been used.

There is some evidence that a high power with a short application time leads to more vaporisation and lower power with long application time to more coagulation effects [14]. Reports about a better occlusion rate with higher power seem to be due to different energy densities used in the different groups [15].

Energy (Joule)

The power in Watt, the pullback time of the laser fibre and the pulse duration are responsible for the applied energy in Joule (J).

[power (Watt) × application time (sec) = energy (J)]

Energy Density

Most important for the effectivity of endovenous laser ablation is the energy density in the treated vein [16].

Most of the studies use the **l**inear **e**ndovenous **e**nergy **d**ensity (LEED) in **J/cm** treated vein, or the **e**ndovenous **f**luence **e**quivalent (EFE) in **J/cm²**, which respects the diameter of the treated vein.

In the laser protocol the diameter of the treated vein and the length of the treated segment, the used power, the pulse duration and the pullback time must be documented.

- ***Proebstle*** was one of the first who showed dependency of the occlusion rate of the EFE [17, 18].
- ***Timperman*** could show that high energy density leads to better occlusion rates [19, 20]. He found a 100% occlusion rate when the LEED was higher than 60 J/cm independently of the vein diameter [21].

Pullback modality

The application of laser energy in the vein can be applied in a pulsed or continuous mode [22].

In a pulsed pullback mode, pulse duration and pulse density are important for the energy density.

In most of the centres, continuous pullback and application of energy is preferred.

Indications and contraindications

Evidenced based indications for endovenous laser ablation are the treatment of incompetent great and small saphenous veins [22, 23]**.**

- In smaller studies treatment of insufficient perforators or venous malformations has been published [24, 25].
- ***Theivacumar*** could demonstrate good results of endovenous laser ablation in the intrafascial part of the incompetent anterior accessory saphenous vein [26].

Absolute contraindications for endovenous laser ablation are:

– acute deep and superficial venous thrombosis and severe arterial occlusive disease as well as severe illness of the patient;
– tortuous veins or postphlebitic changes in the vein may hinder the propagation of the laser fibre in the vein.

In these cases an additional puncture can be used.

Combination with other methods

Endovenous laser treatment is mainly used to treat straight interfacial veins like the saphenous veins; additional treatment is needed for subcutaneous varicose veins like side branches and tributaries.

For this reason, endovenous laser treatment should be combined with percutaneous phlebectomy or foam sclerotherapy in the same session or at follow-up.

Diagnosis

Before indicating endovenous laser treatment complete diagnostic work-up of the venous system by **duplex-ultrasound is mandatory** [27].

This diagnostic work-up includes the deep venous system, the intrafascial and the subcutaneous veins.

The exact description if the vein, which will be treated, is intrafascial or subcutaneous is mandatory for planning the procedure.

Endovenous laser treatment is mainly used in insufficient intrafascial veins.

For this pre-treatment diagnosis but also for the handling of the laser treatment itself, which is completely performed under duplex control, high skills in duplex ultrasound are needed.

Anaesthesia

Endovenous laser ablation can be performed in general or local aesthesia.

Local aesthesia is usually performed as tumescent local anaesthesia.

The application of a higher volume of the tumescence solution around the vein inside the intrafascial space compresses the vein.

In addition the fluid works as an isolation of the surrounding tissue from the high temperature inside the vein.

For this reason in cases where general anaesthesia is used, physiological NaCl-solution is injected in the intrafascial space around the vein in addition.

Puncture and fibre positioning

The access to the vein is usually performed by puncture with a short catheter under duplex control at the distal point of insufficiency.

In many cases this is below the knee-region in case of GSV and Mid-calf in case of SSV.

When the vein cannot be punctured because of a spasm or other reasons a venosectio can be performed.

Using the Seldinger technique with an introducer sheath, the laser fibre is inserted under duplex control into the vein and forwarded towards the junction with the deep venous system.

A pilot light indicates the tip of the fibre, but it is not sufficient for the correct positioning of the fibre tip in the junction.

Duplex control of the intravenous position of the fibre is mandatory.

The fibre tip is positioned in most of the cases 1-2 cm below the junction with the femoral or the popliteal vein. This distance is documented by ultrasound.

After positioning of the fibre tip, the tumescent fluid is applied around the vein.

For intrafascial veins, the tumescence fluid should always be injected into this intrafascial space because only in this case it can produce compression of the vein itself.

Positioning of the tumescent aesthesia in the fatty tissue is less effective and should only be used if subcutaneous veins are treated.

After the injection of the tumescent fluid, the position of the fibre tip is controlled again by ultrasound.

Energy application and compression

The energy needed is calculated before starting the treatment according to the power used and eventually to the diameter of the vein.

When using 15 W, a pullback time of 5 sec/cm is needed to reach 75 J/cm.

During slow pullback of the activated laser fibre the effect can be visualized by duplex ultrasound and the steam bubble effect can be seen in the treated vein.

If applicable, insufficient tributaries are treated in addition by phlebectomy or foam sclerotherapy.

After application of the laser energy excentric compression by padding with cotton wool along the treated vein is applied. Concentric compression by bandages or a compression stocking is additionally applied and used for about 1-2 weeks.

Post-treatment control

To make sure that the vein is completely occluded and no severe side effects have occurred, the patient should be controlled clinically and by duplex ultrasound within 1 week after the procedure.

A follow-up visit within 6 months should be performed to see if additional treatments of side branches are necessary.

Results

Initial occlusion rates after the treatment are almost 100%.

During 1 year follow-up about 5% of reflux recurrences may occur [23].

These refluxes may occur in the region of the junction or along the treated vein, for instance in regions where insufficient side branches drain into the saphenous vein.

Most of these findings can easily be treated by foam sclerotherapy.

Severe complications like deep venous thrombosis are rare with a frequency below 1% [16].

A special case is endovenous heat induced thrombosis (EHIT) in the junction with the thrombus tip reaching from the saphenous vein into the deep venous system [28].

These findings are seen in ultrasound and are usually asymptomatic.

If diagnosed EHIT may be treated by low-molecular heparin for up to 3 weeks.

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