Yeditepe Medical Journal 2010;(15): 309 - 316

LASER TREATMENT OF VARICOSE VEINS

Review Article

VARİKÖZ VENLERİN LAZER İLE TEDAVİSİ

Mehmet Umit Ergenoglu,

Yeditepe University, Department of Cardiovascular Surgery.

Ferdi Menda

Yeditepe University, Department of Anesthesiology and Reanimation.

Halit Yerebakan

Yeditepe University, Department of Cardiovascular Surgery.

Ergun Demirsoy

Yeditepe University, Department of Cardiovascular Surgery.

Corresponding Author:

Mehmet Umit Ergenoglu

Yeditepe University Hospital, Department of Cardiovascular Surgery
Devlet Yolu, Ankara Cad. No: 102/104, 34752, Kozyatagi, Kadikoy, Istanbul, Turkey
E-mail: mergenoglu@yeditepe.edu.tr

ABSTRACT

Venous insufficiency is one of the most common disorders seen in a vascular surgical practice. Incompetence of the Vena Saphena Magna is the most common cause of varicose veins. Until the past decade, truncal saphenous vein incompetence was most commonly treated with high ligation and stripping. Postoperatively patients often have significant discomfort and bruising, a desire to offer patients who have varicose veins a less painful treatment alternative to stripping, with a faster return to work and normal activities, led to development of endovenous thermal ablation techniques. Endovenous laser treatment is rapidly becoming a standard care in the treatment of varicose veins.

Key words: *Endovenous laser, laser ablation, laser coagulation.*

ÖZET

Venöz yetersizlik, vasküler cerrahi uygulamasında en sık karşılaşılan hastalıklardan birisidir. Vena Safena Magna yetersizliği variköz venlerin en sık nedenidir. 10 yıl öncesine kadar, safen ven yetersizliğinin tedavisinde yüksek ligasyon ve stripping en fazla kullanılan yöntem idi. Ancak, işlem sonrası yüksek oranda gözlenen rahatsızlık ve morarma, erken işe ve günlük aktivitelere dönme isteği endovenöz ablasyon tekniklerinin gelişmesine neden oldu. Buna bağlı olarak, endovenöz lazer tedavisi variköz venlerin tedavisinde hızla standart tedavide yerini aldı.

Anahtar Kelimeler :*Endovenöz lazer, lazer ablasyonu, lazer koagülasyonu.*

INTRODUCTION

The treatment of superficial venous disease has undergone a radical change since introduction of high ligation with or without stripping. The universal acceptance of venous duplex ultrasonography in the assessment of venous disease and the introduction of endovenous ablation have not only provided alternatives to standard and classic saphenous vein stripping but have also challenged the principles on which this traditional treatment was based. The classical treatment of varicose veins has historically been high ligation and stripping of the saphenous vein. Today, endovenous ablation techniques such as endovenous laser ablation (EVLA) and radiofrequency ablation have been adopted by many surgeons.

MECHANISM OF ACTION

EVLA for varicose veins was first used by Bone in 1999 and subsequently reported in large series by Navarro and Min (1, 2). The mechanism of action of EVLA involves thermal damage of the vein wall resulting in destruction of the intima by a process of selective photothermolysis and collagen denaturation of the media with fibrotic occlusion of the vein over time. Follow-up ultrasonography imaging of a successfully ablated vein shows a bright structure with no lumen.

Medical lasers which utilize light from the visible and infrared portions of the optical electromagnetic spectrum have four basic components; a medium, an optical cavity, an energy supply and delivery system of optical fibers or mirrors. Laser medium can be solids (ruby or Nd:YAG), gases (helium, argon, krypton, carbon dioxide), organic dyes (rhodamine 6G) or semiconductors (diode lasers). (3). Most commonly, the commercial lasers for EVLA are diode lasers (810, 940, 980nm) or Nd:YAG lasers (1064, 1320, 1470nm).

To simplify, endovenous lasers can be divided into two categories associated with the incorporated wavelengths: hemoglobin-specific laser wavelengths (HSLW, 810, 940, 980, 1064nm) and water-specific laser wavelengths (WSLW, 1319, 1320, 1470, 1500nm). Several manufacturers sell consoles that produce lasers and disposable laser catheters and sheaths. However, there is no evidence that particular laser wavelength affects the clinical outcome. (4, 5). In opposite to this, some studies have suggested that the choice of laser wavelength greatly impacts the results. (6).

Today, EVLA can be used for Vena Saphena Magna (VSM), Vena Saphena Parva (VSP), perforating vein (PV) and Giacomini (intersaphenous vein) insufficiencies. (7, 8).

The most important part for the ablation procedure is to identify all refluxed vein segments in order to prevent recurrence after ablation procedure. There are no specific or absolute general contraindications for endovenous ablation procedures. However, certain situations are clearly to be expected as unsuitable conditions for endovenous ablation. **Table I**, summarizes the contraindications of EVLA.

Patient Related Factors	Anatomical Factors
- Local anesthetic related issues o Allergy	- Tortuosity
- Peripheral artery disease	- Thrombophlebitis
- Deep vein insufficiency (relative)	- Previous therapies o Sclerotherapy o Phlebectomy
- Use of anticoagulation (relative)	
- Blood coagulation disorders	
- Pregnancy or breast feeding	
- Deep vein thrombosis	
- Large diameter of vein (relative)	

Table I *- Contraindications of EVLA (adapted from (9).*

In addition to primary truncal varicosities of saphenous vein system, accessory and perforator veins, recurrent truncal varicosities, Klippel-Trenaunay syndrome and congenital venous malformations have been treated successfully with EVLA. [10-14] Recently there is published article that isolated anterior accessory great saphenous vein can be treated successfully. (15).

TECHNIQUE

In comparison with traditional high ligation and stripping of the VSM, EVLA avoid accessing the groin. The procedure can be performed in the office, same day

admission center with mild sedation if needed, or in the operating room under regional or general anesthesia depending the planned concomitant procedures.

The target vein to be ablated is accessed with percutaneously (Seldinger technique) with an 18 or 21 gauge needle with the ultrasonography guidance. Venous entrée for EVLA requires micro-puncture system and sometimes a small stab incision is necessary. Small vein diameter, tortuosity, or venospasm may make access difficult and necessitate a more cephalad puncture for access. Reverse Trendelenburg position, use of sterile tourniquet proximally and sometimes the use of a small amount of topical nitro paste cream can help for easier vein access. (16). After access to the varicose vein is established, a .035-inch wire is passed through the needle into the vein and positioned 2 cm distal to the junction of the superficial and deep systems under ultrasonography guidance. Tortuous varicose veins, small diameter of vein, large branches, contain thrombotic or sclerotic segments made wire passing and advancing difficult. Re-introducing the wire, rotating the tip, changing the tip from U—shaped to straight, local message and finally small cut-down incision may be helpful. After wire is in place (femoral vein) and confirmed by ultrasonography, the needle removed and 2 to 3 mm stab incision over skin is made for ease manipulation of the introducer. A 5-French introducer sheath is advanced over the wire to the junction. Doppler ultrasonography guidance is mandatory for these maneuvers. Under ultrasonography, the echo dense tip of the sheath can be seen easily. For the VSM, the tip of the sheath is positioned below the superior epigastric vein or 2 to 3 cm distal to the SFJ to prevent possible thrombus propagation into the deep venous system. For the VSP, the tip of the sheath is positioned 2 to 3 cm below the VSP – popliteal vein junction. The laser fiber can be introduced in to the sheath and locked. The patient is now placed in Trendelenburg position and the vein is emptied by elevation. Sometimes, with skinny patients, the position of the laser tip can be confirmed using the red aiming beam which can be visible through the skin. Failure to observe this beam is a reliable indication of malpositioning.

Standard surgical preparation with aseptic techniques is essential in every aspect. The patient lies supine for VSM ablation and partial flexion and external rotation of the hip will help for vein access, especially the ones with posteriorly located. For VSP ablation, the patient is positioned in the prone position.

Locally applied tumescent anesthesia (TA) provides several advantages and should administer into the perivenous space adequately. It consist; epinephrine (5 ml), sodium bicarbonate (5 ml) and lidocaine %1 (35 ml) diluted in 500 ml saline. In most patients, 150 - 450 ml of TA solution is sufficient to anesthetize and compress the vein. In case of TA is not used, there is a high incidence of saphenous or sural nerve damage and skin burns. [17] The importance of adequate TA has been learned with increasing experience with these techniques.

Table II

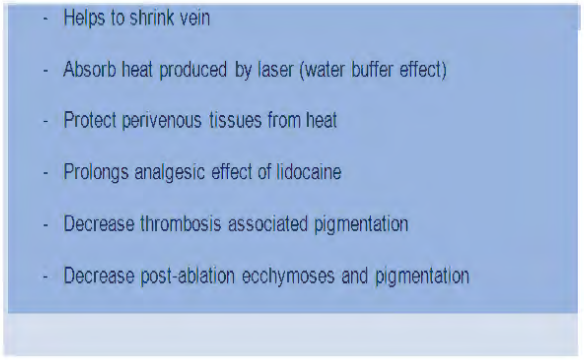

Table II **-** *Advantages of tumescent anesthesia solution.*

Shows the advantages of tumescent anesthesia solution for endovenous ablation. The TA solution which prepared and stored at $+4^0$C is administered with

22-gauge needle using either a 50 cc syringe or a Klein peristaltic infiltration pump (KPIP) set to 4 to 5 cc per second. KPIP can provide rapid delivery of cold solution, consistent infusion to the space with greater volume, which can help to protect surrounding structures. KPIP may also helps to prevent needle stick injury due to less puncture compared to the syringe systems. Compared to treating VSM system, it is required to use extra volume of TA when treating VSP system due to its particular anatomic specification.

The final position of the catheter is rechecked with ultrasonography and the vein is ablated in a retrograde fashion to just 2 cm above the puncture site.

EVLA is always used in continuous mode. But at the beginning of learning curve, it can be also used in pulsed mode. Pulsed mode was initially used in the early clinical experience with EVLA. However, concerns about locally overtreatment and perforations, as well as under treatment of skipped segments, continuous mode firing has evolved and accepted as preferred method of EVLA. Laser generator setting needs to be adjusted according to the mode chosen. In the pulsed mode; the total amount of administered energy depends on the distance between pulses, pulse duration and desired energy. During the continuous mode, the fiberoptic laser catheter is pulled back constantly; therefore the total energy delivered depends on pullback speed and wattage. This reduces treatment times, perforation and bruising. However, there is an article published recently which shows the result of randomized study, failed to confirm it. (18).Compared to continuous mode, pulsed mode has high risk vein perforation. Power settings can be between 10 – 15 watts according to the vein diameter and personal preference. But, it is important and mandatory to deliver 50 to 100 joules of energy per cm of vein treated and 60 to 70 joules of energy per cm is the ideal for vein obliteration. (19, 20). Withdrawal is often slower in the SFJ, resulting in increased energy delivery proximally. The laser energy dose is not the only determinant of successful ablation, still insufficient ablation may occur with high dose (95 joule/cm) of energy. (19).However, there has been no prospective randomized study comparing different regimens so far.

To ease of use, laser sheaths have centimeter marks and generators have digital readouts that show the total amount of joules of energy delivered in simultaneously. At the end of ablation procedure, laser system should be deactivated before the fiberoptic catheter is withdrawn from the skin. Doppler ultrasonography confirmation is essential to ensure patency of the common femoral and superficial epigastric veins.

The treated leg is then wrapped in gauze to absorb tumescence with an overlying elastic compression bandage. Patients should instruct to resume their normal activities right away with the exception of heavy lifting (more than 7 kg) during the first 2 weeks after the procedure. Elastic compression bandage is used for 2 days with non-steroid anti-inflammatory medications to prevent postoperative pain and swelling. After elastic compression bandage use, the patient is placed in a prescription compression hose with class II (30 – 40 mmHg) uses for 4 to 6 weeks period which can assist closure of the vein. However, incidence of DVT after endovenous ablation procedures appears low, some authors suggest and to use low molecular heparin to reduce the risk of thromboembolic complications and the others do not use in routinely. (21, 22). It is still on debate and there is no good evidence to support or disprove this management.

OUTCOME

EVLA has success rates up to 93 – 100% after 1 – 2 years as shown in **Table 3** and **4.** With the appropriate selection of

patients, EVLA can technically be carried out in more than 99% of patients.

Author	Number of veins treated	Wavelength(nm)	Complete Occlusion %	Follow-Up (Mean)
Min[22]	499	810	93.4	24 months
Nwaejike[24]	449	810	100	20 months
Proebstle[25]	282	940/1320	98	3 months
Zafarghandi[26]	77	980	97	6 months
Knipp[21]	460	810	95.9	12 months
Vuylsteke[27]	158	1500	93.3	6 months
Schwarz[28]	144	1470	100	3 months

Table III - *EVLA efficacy of VSM in selected articles.*

Author	Number of veins treated	Wavelength(nm)	Complete Occlusion %	Follow-Up (Mean)
Desmytree[29]	147	980	97	36 months
Huisman[30]	150	810	98	3 months
Kontothanassis[31]	226	810 and 980	98.7	16 months
Park[32]	96	980	57.29	36 months
Theivacumar[33]	39	940	100	6 months
Janne d'Othee[34]	67	810 and 980	100	39 months

Table IV - *EVLA efficacy of VSP in selected articles.*

However, lack of effectiveness and undesired side effects are also observed. [35] Results of published studies are very heterogeneous reporting recanalization rates up to 24%. (36) the connection between effective occlusion and sufficient endovenous applied laser energy (LEED) becomes obvious.

Systematic review of literature on EVLA showed that the most common side effects were ecchymoses and pain. Postoperative pain is rated as slight to moderate by most patients (81.5). The variations between published literatures depend on definition and the follow-up protocol. Bruising after EVLA is associated with administration of tumescent anesthesia and vein wall perforation caused by the laser. In a number of studies, the incidence of postoperative ecchymosis is reported in 60 – 80% of patients. (25, 36). **Table 5**.

Author	Number of Veins Treated	Wavelength (nm)	Skin Burns (%)	Ecchymoses Bruising (%)	Dysesthesia (%)	DVT (%)
Elmore[37]	516	810	0.4	NA	2.1	0
Agus[34]	1076	810, 980	0.2	39	0.8	0
Min[22]	499	810	0	24	0	0
Theivacumar[33]	644	810	NA	NA	1.1	0.2
Proebstle[25]	252	940	0	80	9	0

Table V - *Literature review for EVLA complication.*

Shows the brief literature review for EVLA complication. Skin burns and dysesthesia were %1, %2.1 in largest series respectively. The reported results vary considerably between studies in literature. The frequency and intensity of these side effects may be less for higher laser wavelengths and in continuous than pulsed mode. (4, 25).Some publications suggest that laser wavelength is the main factor related to the frequency and intensity of minor side effects such as ecchymoses and pain. (25).Pain is related to heating of the vein and the inflammatory reaction developed secondary to this. Degree of pain is much more variable than degree of ecchymoses between patients after EVLA. Most patients report pain as sensation of "pulling cord". Since pain has simple relation with perception, there is wide variation in analgesia requirement after EVLA. Mild dose of non-steroid anti-inflammatory drugs are recommended to reduce pain during this period for patients treated with EVLA. This period of time usually lasts a week and very few of patients (5% - 10%) require high dose of pain medication which results in work absence or functional impairment for 7 or 14 days. Pain is related with thermal injury. However, recently published histo-pathological study showed that acute thermal injury is limited to the intima and inner third of the media and no acute damage of perivascular nerve tissue was observed. (40).

The frequency of tenderness or discomfort over the treated vein segment

can be seen up to 33% of patients. (4).Prophylactic treatment with non-steroid anti-inflammatory for 3 – 5 days period may lessen the severity of symptoms.

It is difficult to establish the incidence of DVT after EVLA. Studies with early follow up showed no or few thromboembolic complications as showed in Table 5. However, there are several published articles in the literature support that extension of thrombus in to the femoral or popliteal vein. [19, 41, 42]. Possible reasons for the developing DVT are incorrect positioning of the laser tip, using general or epidural anesthesia instead of tumescent anesthesia which disallows patient to early ambulate after the procedure and finally preexistence of coagulation disorders. (43). It is not in routine use of the low molecular weight heparin (LMWH) before or after the ablation procedure. But in some literatures, the use of LMWH postoperatively is limited to the high risk patients such as history of thrombophlebitis or DVT. (44, 45).

Another rare complication is arteriovenous fistula after ablation procedure. In literature, recently; small numbers of cases of arteriovenous fistula after EVLA have been reported. [46-48] Because of the anatomic proximity of superficial sural artery and VSP, popliteal fossa is high risk anatomical location to develop arteriovenous fistula. Concomitant venous and arterial wall thermal injury or needle trauma during administration of tumescent anesthesia is another theory for explanation of this rare complication. Same reason as arteriovenous fistula, transient sural nerve injury following EVLA is high in the VSP group compared to saphenous nerve injury in the VSM group. Similarly, there is published literature of external iliac arteriovenous fistula after laser ablation of VSM. (49). However, fistula development in this particular anatomical region is a very rare condition.

There are occasional device related complications after EVLA have been reported in the literature. The damage of the laser fiber and guidewire retention is the device related published complications. Eventually, the fiberoptic catheter and guidewire are the vulnerable part of the EVLA system and the delivery of tumescent anesthesia may responsible from these complications. (50, 51).

In the literature classified as occasional complications, one case of septic thrombophlebitis (phlegmonous) after EVLA resulting surgical drainage and antibiotic treatment has been reported. (52).

As another group of rare complications, cutaneous nerve injury and hyperpigmentation in the line of the ablated vein segment after EVLA occur in 10 – 12% patients. (11). These complications are temporary and tend to improve with time. Using lower laser energies and sufficient tumescent anesthesia solution may provide enough protection from this complication. (17) .

CONCLUSION

Because most of the side effects are minor, major complications are rare; EVLA is a safe and minimally invasive procedure with excellent efficacy in the treatment of varicose veins. It offers patients a fast outpatient procedure with minimal downtime and discomfort. In combination with concomitant procedures such as microphlebectomy and foam sclerotherapy, excellent cosmetic and functional results can be achieved in most patients.

REFERENCES

1.*Min RJ, Zimmet SE, Isaacs MN, Forrestal MD. Endovenous laser treatment of the incompetent greater saphenous vein. J Vasc Interv Radiol. 2001 Oct;12(10):1167-71.*

2.Navarro L, Min RJ, Bone 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.

3.Fan CM, Rox-Anderson R. Endovenous laser ablation: mechanism of action. Phlebology. 2008;23(5):206-13.

4.Kabnick LS. Outcome of different endovenous laser wavelengths for great saphenous vein ablation. J Vasc Surg. 2006 Jan;43(1):88-93.

5.Proebstle TM, Lehr HA, Kargl A, Espinola-Klein C, Rother W, Bethge S, 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 Apr;35(4):729-36.

6.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 Nov;30(11):1380-5.

7.Uchino IJ. Endovenous laser closure of the perforating vein of the leg. Phlebology. 2007;22(2):80-2.

8.Theivacumar NS, Dellagrammaticas D, Mavor AI, Gough MJ. Endovenous laser ablation (EVLA) of great saphenous vein to abolish "paradoxical reflux" in the Giacomini vein: a short report. Eur J Vasc Endovasc Surg. 2007 Aug;34(2):229-31.

9.Darwood RJ, Gough MJ. Endovenous laser treatment for uncomplicated varicose veins. Phlebology. 2009;24 Suppl 1:50-61.

10.Proebstle TM, Gul D, Kargl A, Knop J. Endovenous laser treatment of the lesser saphenous vein with a 940-nm diode laser: early results. Dermatol Surg. 2003 Apr;29(4):357-61.

11.Proebstle TM, Herdemann S. Early results and feasibility of incompetent perforator vein ablation by endovenous laser treatment. Dermatol Surg. 2007 Feb;33(2):162-8.

12.Sidhu MK, Perkins JA, Shaw DW, Bittles MA, Andrews RT. Ultrasound-guided endovenous diode laser in the treatment of congenital venous malformations: preliminary experience. J Vasc Interv Radiol. 2005 Jun;16(6):879-84.

13.Anchala PR, Wickman C, Chen R, Faundeen T, Pearce W, Narducy L, et al. Endovenous Laser Ablation as a Treatment for Postsurgical Recurrent Saphenous Insufficiency. Cardiovasc Intervent Radiol. 2009 Dec 25.

14.van Groenendael L, van der Vliet JA, Flinkenflogel L, Roovers EA, van Sterkenburg SM, Reijnen MM. Treatment of recurrent varicose veins of the great saphenous vein by conventional surgery and endovenous laser ablation. J Vasc Surg. 2009 Nov;50(5):1106-13.

15.Theivacumar NS, Darwood RJ, Gough MJ. Endovenous laser ablation (EVLA) of the anterior accessory great saphenous vein (AAGSV): abolition of sapheno-femoral reflux with preservation of the great saphenous vein. Eur J Vasc Endovasc Surg. 2009 Apr;37(4):477-81.

16.Hogue RS, Schul MW, Dando CF, Erdman BE. The effect of nitroglycerin ointment on great saphenous vein targeted venous access site diameter with endovenous laser treatment. Phlebology. 2008;23(5):222-6.

17.Chang CJ, Chua JJ. Endovenous laser photocoagulation (EVLP) for varicose veins. Lasers Surg Med. 2002;31(4):257-62.

18.Darwood RJ, Theivacumar N, Dellagrammaticas D, Mavor AI, Gough MJ. Randomized clinical trial comparing endovenous laser ablation with surgery for the treatment of primary great saphenous varicose veins. Br J Surg. 2008 Mar;95(3):294-301.

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 Oct;15(10):1061-3.

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 Jan;35(1):119-23.

21.Knipp BS, Blackburn SA, Bloom JR, Fellows E, Laforge W, Pfeifer JR, et al. Endovenous laser ablation: venous outcomes and thrombotic complications are independent of the presence of deep venous insufficiency. J Vasc Surg. 2008 Dec;48(6):1538-45.

22.Pannier F, Rabe E. Mid-term results following endovenous laser ablation (EVLA) of saphenous veins with a 980 nm diode laser. Int Angiol. 2008 Dec;27(6):475-81.

23.Min RJ, Khilnani N, Zimmet SE. Endovenous laser treatment of saphenous vein reflux: long-term results. J Vasc Interv Radiol. 2003 Aug;14(8):991-6.

24. Nwaejike N, Srodon PD, Kyriakides C. 5-years of endovenous laser ablation (EVLA) for the treatment of varicose veins--a prospective study. Int J Surg. 2009 Aug;7(4):347-9.

25.Proebstle TM, Moehler T, Gul 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; discussion 83-4.

26.Zafarghandi MR, Akhlaghpour S, Mohammadi H, Abbasi A. Endovenous laser ablation (EVLA) in patients with varicose great saphenous vein (GSV) and incompetent saphenofemoral junction (SFJ): an ambulatory single center experience. Vasc Endovascular Surg. 2009 Apr-May;43(2):178-84.

27.Vuylsteke ME, Vandekerckhove PJ, De Bo T, Moons P, Mordon S. Use of a New Endovenous Laser Device: Results of the 1,500 nm Laser. Ann Vasc Surg. 2009 Sep 10.

28.Schwarz T, von Hodenberg E, Furtwangler C, Rastan A, Zeller T, Neumann FJ. Endovenous laser ablation of varicose veins with the 1470-nm diode laser. J Vasc Surg. 2010 Jun;51(6):1474-8.

29.Desmyttere J, Grard C, Stalnikiewicz G, Wassmer B, Mordon S. Endovenous Laser Ablation (980nm) of the Small Saphenous Vein in a Series of 147 Limbs with a 3-Year Follow-up. Eur J Vasc Endovasc Surg. 2009 Oct 14.

30.Huisman LC, Bruins RM, van den Berg M, Hissink RJ. Endovenous laser ablation of the small saphenous vein: prospective analysis of 150 patients, a cohort study. Eur J Vasc Endovasc Surg. 2009 Aug;38(2):199-202.

31.Kontothanassis D, Di Mitri R, Ferrari Ruffino S, Zambrini E, Camporese G, Gerard JL, et al. Endovenous laser treatment of the small saphenous vein. J Vasc Surg. 2009 Apr;49(4):973-9 e1.

32.Park SW, Hwang JJ, Yun IJ, Lee SA, Kim JS, Chang SH, et al. Endovenous laser ablation of the incompetent small saphenous vein with a 980-nm diode laser: our experience with 3 years follow-up. Eur J Vasc Endovasc Surg. 2008 Dec;36(6):738-42
.
33.Theivacumar NS, Beale RJ, Mavor AI, Gough MJ. Initial experience in endovenous laser ablation (EVLA) of varicose veins due to small saphenous vein reflux. Eur J Vasc Endovasc Surg. 2007 May;33(5):614-8.

34.Janne d'Othee B, Walker TG, Kalva SP, Ganguli S, Davison B. Endovenous Laser Ablation of the Small Saphenous Vein Sparing the Saphenopopliteal Junction. Cardiovasc Intervent Radiol. 2010 Jan 20.

35.Luebke T, Brunkwall J. Systematic review and meta-analysis of endovenous radiofrequency obliteration, endovenous laser therapy, and foam sclerotherapy for primary varicosis. J Cardiovasc Surg (Torino). 2008 Apr;49(2):213-33.

36.Sharif MA, Soong CV, Lau LL, Corvan R, Lee B, Hannon RJ. Endovenous laser treatment for long saphenous vein incompetence. Br J Surg. 2006 Jul;93(7):831-5.

37.Elmore FA, Lackey D. Effectiveness of endovenous laser treatment in eliminating superficial venous reflux. Phlebology. 2008;23(1):21-31.

38.Agus GB, Mancini S, Magi G. The first 1000 cases of Italian Endovenous-laser Working Group (IEWG). Rationale, and long-term outcomes for the 1999-2003 period. Int Angiol. 2006 Jun;25(2):209-15.

39.Proebstle TM, 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.

40.der Kinderen DJ, Disselhoff BC, Koten JW, de Bruin PC, Seldenrijk CA, Moll FL. Histopathologic Studies of the Below-the-Knee Great Saphenous Vein after Endovenous Laser Ablation. Dermatol Surg. 2009 Sep 1.

41.Puggioni A, Kalra M, Carmo M, Mozes G, Gloviczki P. Endovenous laser therapy and radiofrequency ablation of the great saphenous vein: analysis of early efficacy and complications. J Vasc Surg. 2005 Sep;42(3):488-93.

42.Viarengo LM, Poterio-Filho J, Poterio GM, Menezes FH, Meirelles GV. Endovenous laser treatment for varicose veins in patients with active ulcers: measurement of intravenous and perivenous temperatures during the procedure. Dermatol Surg. 2007 Oct;33(10):1234-42; discussion 41-2.

43.Goldman MP, Weiss RA. To the editor: Re: Endovascular laser procedures and deep vein thrombosis. Dermatol Surg. 2005 May;31(5):610.

44.Gale SS, Dosick SM, Seiwert AJ, Comerota AJ. Regarding "Deep venous thrombosis after radiofrequency ablation of greater saphenous vein". J Vasc Surg. 2005 Feb;41(2):374; author reply

45. Subramonia S, Lees T. Regarding "Deep vein thrombosis after radiofrequency ablation of greater saphenous vein: A word of caution". J Vasc Surg. 2005 May;41(5):915-6; author reply 6.

46.Theivacumar NS, Gough MJ. Arterio-venous fistula following endovenous laser ablation for varicose veins. Eur J Vasc Endovasc Surg. 2009 Aug;38(2):234-6.

47.Timperman PE. Arteriovenous fistula after endovenous laser treatment of the short saphenous vein. J Vasc Interv Radiol. 2004 Jun;15(6):625-7.
48. Vaz C, Matos A, Oliveira J, Nogueira C, Almeida R, Mendonca M. Iatrogenic arteriovenous fistula following endovenous laser therapy of the short saphenous vein. Ann Vasc Surg. 2009 May-Jun;23(3):412 e15-7.

49.Ziporin SJ, Ifune CK, MacConmara MP, Geraghty PJ, Choi ET. A case of external iliac arteriovenous fistula and high-output cardiac failure after endovenous laser treatment of great saphenous vein. J Vasc Surg. 2010 Mar;51(3):715-9.

50.Holdstock JM, Marsh P, Whiteley MS, Price BA. It is possible to cause damage to a laser fibre during delivery of tumescent anaesthesia for endovenous laser ablation (EVLA). Eur J Vasc Endovasc Surg. 2008 Oct;36(4):473-6.

51.Scurr JRH, Martin J, How TV, Gambardella I, Brennan JA. Retained Laser Fibre Following Endovenous Laser Ablation. European Journal of Vascular and Endovascular Surgery. [doi: DOI: 10.1016/j.ejvs.2006.11.017]. 2007;33(3):377-.

52.Dunst KM, Huemer GM, Wayand W, Shamiyeh A. Diffuse phlegmonous phlebitis after endovenous laser treatment of the greater saphenous vein. J Vasc Surg. 2006 May;43(5):1056-8.