

Endovenous ablation versus open surgery for varicose veins

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Open and endovenous surgery of varicose veins are excellent ways of treating varicosis. However, there are great differences in how the techniques are performed. No matter which procedure is carried out, certain standards should be observed. The state of the art of open venous surgery with radical crossectomy is well-known, but unfortunately is still

not always performed correctly. The state of the art of endovenous surgery has not yet been sufficiently documented, but should be based on open surgery techniques. This work describes in detail what are (or should be) the standards of both methods today. A definition of recurrence applicable to both techniques is established.

Key Words: Varicose veins, crossectomy, radio frequency, vein surgery, recurrence.

INTRODUCTION

Venous diseases are among the commonest clinical pictures in the western world. The guidelines of the German Society of Phlebology and NICE both recommend early treatment of the epifascial venous system, by operation or intervention, in order to counter the possible complications and sequelae of chronic venous insufficiency insofar as possible. These may include skin alterations, venous leg ulcer, deep vein thrombosis and pulmonary embolism [1,2].

According to careful estimates, over 350,000 interventions in the epifascial venous system are carried out in Germany each year. Approximately one third of the operations require hospitalisation, but the majority are ambulatory, and this proportion is tending to rise. Crossectomy and stripping of incompetent vein segments used to be the methods of choice for the treatment of varicose saphenous veins, however in recent years new, minimally invasive endovenous methods have gained ground.

Despite all the innovations in treatment, stripping remains an important element in the treatment of varicose veins and-if carried out correctly-is preferable to endovenous procedures in some cases. In very superficially coursing saphenous veins in particular, an invaginating stripping procedure can produce a better cosmetic result.

For more than 30 years, the Gold standard for Stripping Operations has included:

- preoperative duplex ultrasound vein mapping and marking of the incision (especially important in operations on the small saphenous vein, since a wide variety of configurations of the confluence may be encountered),
- crossectomy and stripping of the saphenous vein, with invagination from proximal to distal as far as the distal reflux source (maximum),
- no stripping of the whole saphenous vein from the medial or lateral malleolus from distal to proximal,
- flat ligation of the saphenofemoral junction (SFJ) with non-absorbable sutures and ligation of all the tributaries with confluence in the region of the SFJ (including those joining the femoral vein),
- flat ligation is not always possible in crossectomy of the saphenopopliteal junction (SPJ), nor is it essential; however it is always desirable if possible.

Conditions for carrying out surgical and endovenous procedures

An essential first condition for the procedures is safe use of the duplex ultrasound equipment by a qualified operator. Both types of procedure should only be carried out by a doctor with well-grounded phlebological knowledge, who can investigate the medical history of the patient, carry out diagnosis, and is competent in the various forms of treatment, as well as other associated treatments which may become necessary.

Indications and contra-indications

The indications for endovenous treatment are basically the classic indications for venous surgery, i.e. principally incompetence of the great or small saphenous vein (GSV and SSV), as well as the accessory veins (anterior, posterior and superficial accessory saphenous veins), long stretches of (straight-coursing) tributaries, recurrent varices, and in some cases incompetent perforating veins. Recurrent varices with a very short stump and varicose SSVs with atypical, winding confluence should not be treated using endoluminal methods, except by designated endoluminal experts who are competent in the full range of endoluminal treatment options (radio-laser, radio frequency, steam, MOCA, vein closure products).

All the above-mentioned forms of varicosis can also be operated using classic open vein surgery techniques.

Most contra-indications apply to invasive techniques-with one exception: patients who are taking anticoagulants can be treated with endovenous procedures without suspending the anticoagulant treatment. Endovenous treatment is also often possible with multi-morbid patients in whom surgery is contra-indicated. If the GSV lies close under the skin in a thin patient, a more cosmetically satisfactory result can often be achieved by removing the vein by surgery rather than applying heat treatment, to avoid unsightly skin shrinking or pigmentation.

Anesthesia

Most endovenous procedures require tumescent local anaesthesia (TLA). TLA must only be injected para- and perivasally under strict ultrasound control, to reduce the risk of haematoma and paraesthesia [3]. Parallel dosing with analgesics by a qualified anaesthetist may be beneficial for the patient. Surgical crossectomy can also be carried out under TLA. However, additional analgesics at least, or even general or spinal

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anaesthesia, are often recommended in expressive findings or bilateral interventions.

Complementary treatment

Endovenous and surgical procedures are generally sufficient for the treatment of varicose saphenous veins. However, unfortunately most patients with incompetent saphenous veins also suffer from associated varicose tributaries.

To complement the endovenous or surgical treatment therefore, mini-phlebectomy and/or sclerotherapy of varicose tributaries is generally carried out in the same session. There is currently no consensus as to whether additional surgical ligation of the SFJ/SPJ improves the result of endovenous treatment. Disselhoff [4] sees no significant improvement in the outcome, whereas in the large randomised multicentre study by Flessenkämper et al. [5], the group treated with crosssection and laser treatment presented the best outcomes.

Compression treatment

Compression therapy for at least 1 week appears to be reasonable after endovenous therapy, however no data are available to support this. Many patients like to wear a compression stocking for 2 to 3 weeks after the treatment, since a mini-phlebotomy is often carried out in combination with the endovenous intervention and compression promotes faster abatement of postoperative discomfort. Use of a compression stocking for at least 2 to 3 weeks is therefore also recommended after surgical procedures.

Anticoagulation

There are no safe data as to whether and for how long thrombosis prophylaxis should be administered after surgical or endovenous intervention. If thrombosis prophylaxis is prescribed, the recommended medication is low-molecular heparin, following the guidelines.

Complications in surgical procedures

Complications after open vein surgery are rare. The largest multicentre study to assess crosssection and stripping, commissioned by the German Society of Phlebology, included 1090 operated legs. The complications identified prospectively in this study, the largest of its kind in the world, are listed in **Table 1**. The relatively high infection rate of over 2% does not refer to infections of the groin incision but to inflammation of peripheral stab incisions after phlebectomy. Further data from generally much smaller retrospective studies or record data can be found in Papapostolou et al. [6].

Table 1: Complications in surgical procedures [31]

Complications	%
Deep (leg) vein thrombosis (DVT)	0.093
Infections (superficial)	2.15
Groin haematoma	0.56
Sensitive nerve damage	3.17
Seroma	1.4
Phlebitis of remaining parts of the GSV	0.18

Complications after endovenous procedures

Complications after endovenous procedures are very rare, however they may be very serious, and the patient should sign an informed consent for the side effects of endovenous therapy. The commonest side effects are haematoma and ecchymosis, the latter especially caused by incorrect

infiltration of TLA with vein perforation, or the use of Bare Fibre laser or short laser wavelengths (810-940-980 nm). Hyperpigmentation along the course of the treated vein occurs less frequently. There may also be revascularisation within six months [7].

Bleeding and wound infection are rare, since no large incision should be needed (no crosssection, and vena sectio should be avoided insofar as possible). Deep vein thrombosis after treatment is very rare [8]; however the danger exists of the development of an appositional thrombus in the deep vein [9]: a post-ablative superficial thrombus extension is observed in around 1% of patients in the postoperative phase after endovenous treatment. In cases of EHIT I, no medication is necessary but a check-up should be carried out within 2 weeks after surgery. In cases of EHIT II-IV, anticoagulation treatment should be prescribed and a check-up should be carried out within 2 weeks after surgery. As a rule the appositional thrombus will be eliminated within 2 to 4 weeks. Duplex ultrasound examinations should be continued until the thrombus has disappeared completely.

Distribution of endovenous heat-induced thrombosis (EHIT) by endovenous treatment:

- EHIT I: Extension of the thrombus to the deep vein
- EHIT II: Extension into the deep vein with constriction of the lumen ≤ 50%
- EHIT III: Constriction of the deep vein lumen >50%
- EHIT IV: Complete occlusion of the deep vein

Nerve lesions, another complication, are uncommon and often reversible [7]. The patient should be warned of the possible occurrence of a fuzzy feeling in the area of the operated vein. The danger of a nerve lesion increases the further distal in the leg the endovenous treatment is applied [10]. As a phlebectomy is necessary in many cases after both open surgery and endoluminal thermoablative procedures, superficial dysaesthesia occurs after a small percentage of both treatments.

Patients must also be warned of the possibility of skin burns. These occur most frequently after steam treatment, particularly when applied to tributaries, if the skin is not properly protected or steam penetrates the tissue paravasally.

Occasionally patients report vein discomfort in the treated area a few days after an endovenous intervention. This occurs particularly after treatment of very superficial, large-lumen veins. Non-steroidal anti-inflammatory drugs are the most suitable means of controlling pain. In exceptional cases a stab incision can provide a solution where there is thrombus formation.

Other possible complications are:

- (aggravated) lymphoedema,
- matting,
- pathological (keloid) scar formation,
- injury of deeper vessels during the intervention.

Open surgery or endovenous technique?

State of the art of classic vein surgery: Crosssection has a long history in the German-speaking world. From W. Hach's overview "Medical history of crosssection" [11] we learn that the first crosssection was described by Karewski [12]. Unfortunately, in retrospect it is impossible to say with any certainty whether the operations described by Karewski in 1901, and subsequently by Navarro and Moro [7] in 1910, were true crosssections according to all the criteria of the modern sense of the term. In the guidelines of the German Society of Phlebology [13], crosssection is defined as flat ligation of the saphenofemoral junction with ligation of all the tributaries whose confluence is in the SFJ region. The same criteria were established by Hach and Mumme [14] in their standard work on phlebology "Vein Surgery".

Accurate, correct crosssection of the SFJ following the above definition is always technically possible. As long ago as 1989, Waldemann and Hartmann [15] indicated that exposure of a greater length of the femoral vein, allowing ligation directly at the confluence of the tributaries, further

reduces the risk of recurrence in the SFJ. Such situations are observed intra-operatively in 30-50% of cases [16-19].

Figure 1 presents a very plastic example of an intra-operative finding of this kind. A varicose condition resulting from such a particular anatomical situation can never be treated so correctly with the endoluminal method as is shown in this intra-operative photograph. **Figure 2** shows a correct SFJ crosssectomy, whereas **Figure 3** shows an incorrect procedure. This intra-operative finding is a striking demonstration of the fact that even the boldest endoluminal approach cannot treat the tributaries which join the femoral vein in isolation by heat occlusion of the GSV; such a procedure implies at the very least a higher potential risk of recurrence.

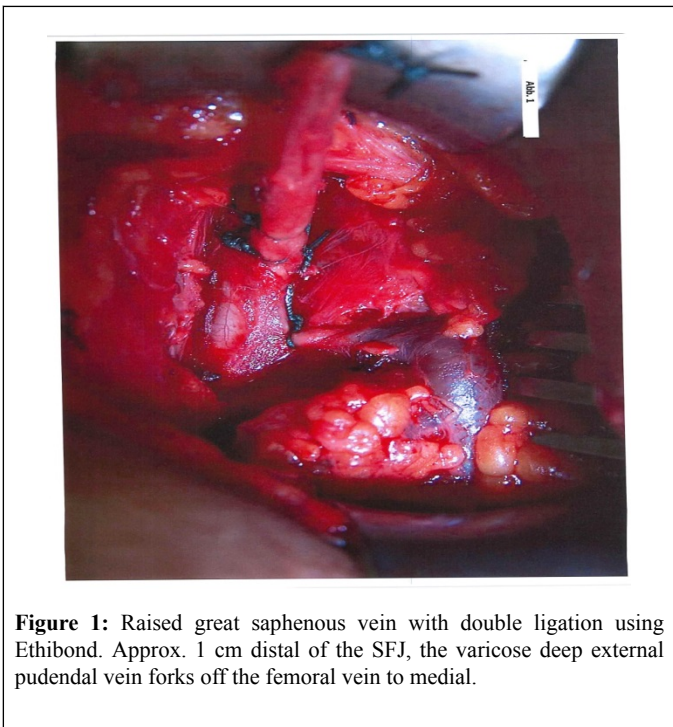


Figure 1: Raised great saphenous vein with double ligation using Ethibond. Approx. 1 cm distal of the SFJ, the varicose deep external pudendal vein forks off the femoral vein to medial.

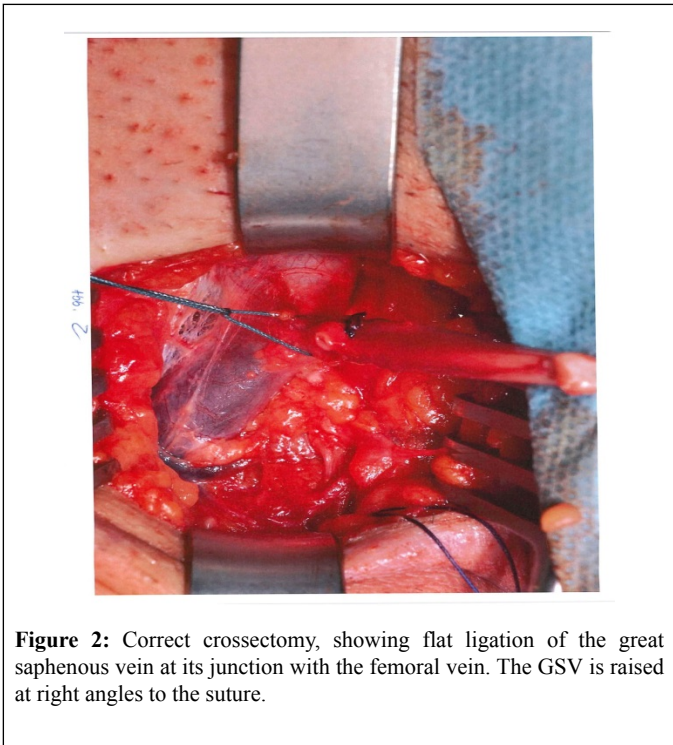


Figure 2: Correct crosssectomy, showing flat ligation of the great saphenous vein at its junction with the femoral vein. The GSV is raised at right angles to the suture.

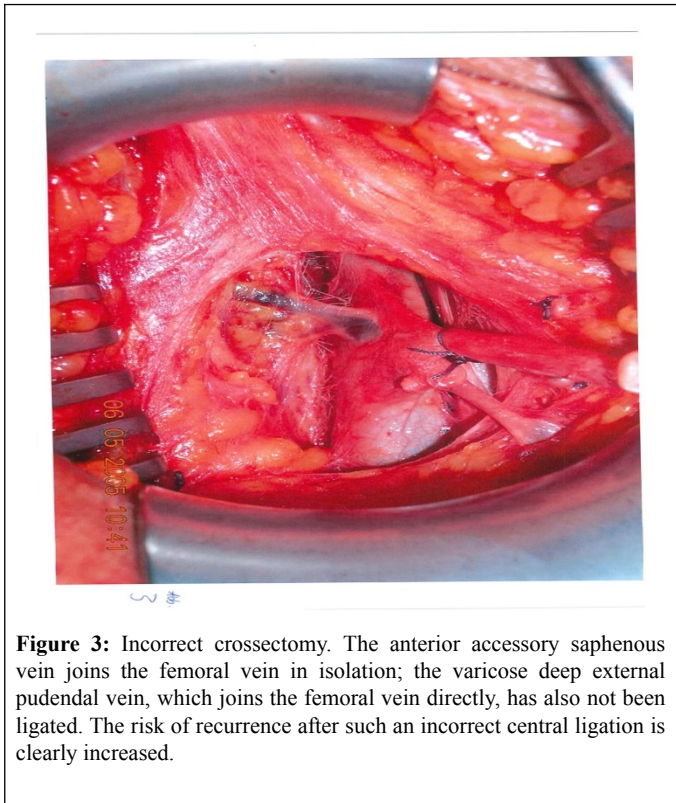


Figure 3: Incorrect crosssectomy. The anterior accessory saphenous vein joins the femoral vein in isolation; the varicose deep external pudendal vein, which joins the femoral vein directly, has also not been ligated. The risk of recurrence after such an incorrect central ligation is clearly increased.

Recurrences in the SFJ after a correctly executed crosssectomy are rarely found in duplex ultrasound examinations. Rafi [20], in a long-term retrospective study using ultrasound monitoring, found around 2% of recurrences in the SFJ after 20 years out of a population of 830 cases. The German multicentre study, which was designed according to the correct criteria for crosssectomy stated above to evaluate the validity of the crosssectomy and stripping technique (Lavacross study), included 1090 operated legs. After 5 years, clinically significant recurrences of reflux in the groin were found in only 1.42% of cases, confirming the findings reported by Rafi [30].

The Lavacross study, designed by Mumme [21], is the largest investigation carried out in the world to evaluate the validity of crosssectomy and stripping. It drew on information from 11 vein surgery centres in Germany. **Table 2** shows clearly higher recurrence rates in studies carried out in other countries. The very good results reported by Rass come from the centre led by Norbert Frings, one of the 11 centres included in the Lavacross study. What are the possible reasons for the poor outcomes reported by the other authors listed in **Table 2**.

Table 2: Duplex ultrasound findings of recurrent (30)

Author	Neoreflux found in duplex	Postop time
Disselhoff [7]	12%	(1 yr)
Darwood [5]	8.30%	(1 yr)
Pronk [34]	9%	(1 yr)
Carradice [4]	15%	(1 yr)
Rass [39]	1.30%	(2 yrs)

Yr : Year

In the English-language literature, the concepts of "high ligation", "flush ligation" or "saphenofemoral ligation" are used for crosssectomies. These concepts suggest that they are analogous with flat ligation of the GSV at the exact level of the femoral vein, as recommended in the guidelines of the German Society of Phlebology. In 2012, in an analysis of highly

recognised professional journals, Stenger and Hartmann [22] found that saphenous vein stumps of around 5 mm were being left after "high/flush ligation" [23-25]. The terms "high", "flush" or "saphenofemoral ligation" therefore by no means always fulfil the criteria for a clean crossotomy, even though these works were published in very high-impact journals.

The work of Disselhoff et al. [26] may be cited as an example in this context. The results describe 5% incompetent saphenous stumps and 10% incompetent anterior and posterior accessory veins six months after "flush ligation". After crossotomy techniques of this kind, reflux rates of 49% in duplex ultrasound after 5 years are not surprising.

In Germany too there is a quality problem in classic vein surgery

But in Germany too we can find similarly poor results, as Mumme showed in his German groin recurrence study [15,27,28]. In a 7-centre study in Germany, follow-up operations using a previously agreed technique were carried out on 458 legs which presented clinically relevant groin recurrence.

A saphenous stump left after the first operation, i.e. an error in technique, was present in 72.8% of all the cases. So it is not only in the Anglo-Saxon world but in Germany too that there is a quality problem in classic vein surgery. One possible approach to solve this state of affairs might be the introduction of a minimum number of operations per operating surgeon, as is required in the quality standards for hip and knee replacement operations.

SSV Surgery

Every surgical intervention in the SSV must be preceded by careful duplex diagnosis, which the operating surgeon must analyse. SSV surgery is demanding and requires great surgical experience [29]. Hach and Mumme describe SPJ crossotomy as ablation of the SSV immediately at its confluence with the popliteal vein, with ligation of the muscle veins if necessary. Such a technically demanding operation requires the patient to be lying face-down. Careful preoperative diagnosis by duplex ultrasound is essential, since unlike the SFJ, very wide variations are found in the confluence configuration of the SPJ [30].

Careful preoperative diagnosis by duplex ultrasound is essential

Not only does the height of the SPJ vary considerably, but the anatomy immediately surrounding the junction is sometimes very bizarre. Apart from the classic acute-angled confluence of the SSV into the popliteal vein approx. 3-4 cm above the popliteal crease (approx. 50% according to Stenger), very twisted confluence anomalies are sometimes found, with the confluence itself resembling a siphon or double siphon **Figure 4**. The proximity of the two motor nerves in the popliteal hollow makes SSV surgery interesting and stressful. Heat damage after endoluminal treatment and nerve lesions after open surgery are described [31]. However, this risk should not lead to the situation described by Winterborn et al. 2008 [32], that 11.5% of vein surgeons in Great Britain and Ireland discourage their patients from SSV surgery for that reason.

Based on personal experience of around 6,000 surgical interventions in the SSV, the following procedure is recommended for anatomical difficulties: firstly direct identification of the popliteal vein, as in SSV recurrence [29]; and secondly, because the tibial nerve generally courses on the upper side of the deep vein, exposure of a long segment and displacement of the motor nerve, e.g. with a vessel-loop or Langenbeck hook, and retrograde identification of the SPJ applying a flat double ligation with non-absorbable suture. In some anatomical situations, however, flat ligation of the SSV at the popliteal vein cannot be carried out without risk. In such cases the recommended procedure is open surgery of the SSV: flat SPJ crossotomy is desirable but not the only solution [33].

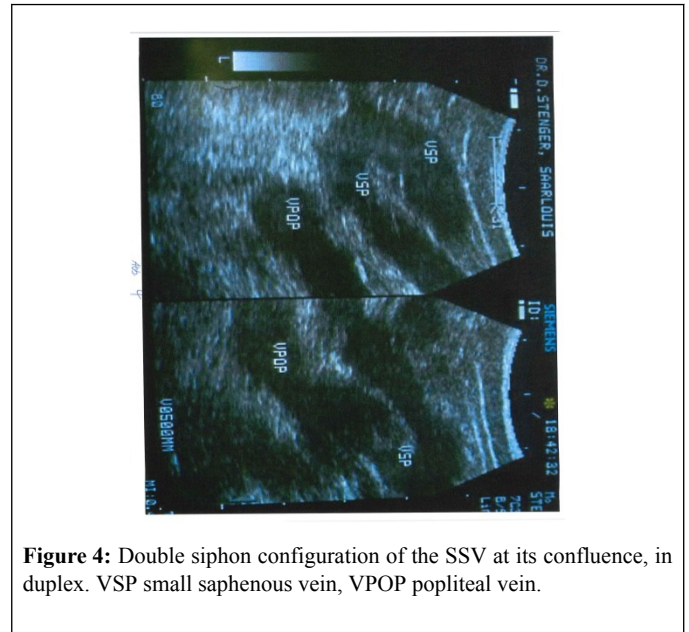


Figure 4: Double siphon configuration of the SSV at its confluence, in duplex. VSP small saphenous vein, VPOP popliteal vein.

As the meta-analysis of Boersma et al. [34] confirms, there is a lack of data on SSV surgery: only 4 RCTs have been carried out. The definition of recurrence refers to the obliterated small saphenous vein or to recurrent varicosis in the operated leg reported in the study. The correct approach would be to carry out a comparative study of the SPJ recurrences found in both groups by duplex ultrasound.

Winterborn et al. [35] give an exemplary account of the woeful plight of classic SSV surgery. Winterborn asked 379 vein surgeons in Great Britain and Ireland about the procedure that they used for SSV surgery. Only about 50% of the respondents carried out preoperative duplex diagnosis of the SPJ; 20% of surgeons did not operate with the patient face-down; 13% applied an immediately subfascial ligation; 76% applied a deeper ligation wherever they could (?); and only 10% carried out an SSV crossotomy under the criteria of an exactly flat saphenopopliteal ligation. Only 15% of the vein surgeons stripped the SSV, the majority simply carried out a resection of the proximal segment.

Recurrence of varicosis

A recurrent varicose vein in either the SFJ or SPJ region should normally be treated by open surgery. In 3 out of 4 cases, recurrence in the SFJ can be attributed to a technical error in the first operation, i.e. leaving a saphenous stump [15,28,36]. The operative procedure for SFJ recurrence is simple. The possible approaches are described in Hach and Mumme [29].

A few authors close the Fossa ovalis with a patch, i.e. a barrier operation [37]. Others carry out a complete resection of the stump after clamping it with a Satinsky clamp and close the defect with continuous suturing of the femoral vein [38]. The decisive factor is exactly flat ligation with non-absorbable suture.

Recurrence surgery of the SSV is an exacting intervention. In their standard work, Hach and Mumme describe the operational technique in detail as Prepopliteal Preparation. Carrying out a preparation through the old scar is not recommended due to the risk of lesions to the motor nerves. Unlike recurrence in the SFJ, some cases of recurrence in the SPJ are not anatomically linked with the first operation. In these cases the height of the vein confluence varies by 3-5 cm between the first and second interventions. In our opinion, this occurs because the first intervention is carried out on the SSV, but the second or recurrence intervention is on a lateral perforating vein in the popliteal hollow, or vice versa. However these are very rare individual cases. Overall, a recurrence intervention in both the SFJ and SPJ regions is considerably easier after endoluminal initial treatment than if open surgery was used in the first procedure.

Endovenous treatment procedures

The first endovenous catheter treatments of saphenous veins were carried out in 1998—first in Switzerland and shortly afterwards in Germany—using the VNUS Closure Plus[®] radio frequency catheter (Medtronic, Dublin, Ireland); the first treatment in USA was carried out in 1999 [10,39]. In the same year the first endovenous laser treatment was carried out in Europe with a diode laser [34,40]; this technique was authorised in USA in 2002. Since then the "triumphal march" of endovenous procedures has been unstoppable. In 2008, endovenous treatments constituted 80% of vein treatments carried out in USA. In Germany too, endovenous procedures are being used increasingly, although compensation for the ambulatory treatment of patients under legally required medical insurance plans using this method is not yet authorised by the Federal Joint Committee [10]. The percentage of endovenous treatments in USA is now over 80%, whereas in Germany over 80% of treatments are (still) carried out using open surgery. The reason for this is the difference in compensation structures, since in Germany to this day endovenous procedures are recognised by only a few health insurance companies. Increasing numbers of special agreements are being reached with the health funds involved, although unfortunately only a few of them are accepting such agreements to date. In Germany, endovenous procedures are not recognised by all health insurance companies.

Initial problems and side effects of endovenous procedures arose from slow energy delivery to the vein wall in the VNUS Closure Plus[®] radio frequency procedure, and the occasionally excessive energy delivered by laser. This led to long treatment times with VNUS Closure Plus[®] procedures and sometimes painful side effects with large areas of ecchymosis after laser treatment, and as a result these procedures were not initially preferred over stripping. However these problems were eliminated by the new and more sophisticated radio frequency machines and lasers with higher wavelengths (1320, 1470, 1550 and now also 1920 nm). Furthermore, new laser fibres have been developed with radial **Figure 5** and spherical laser energy radiation.

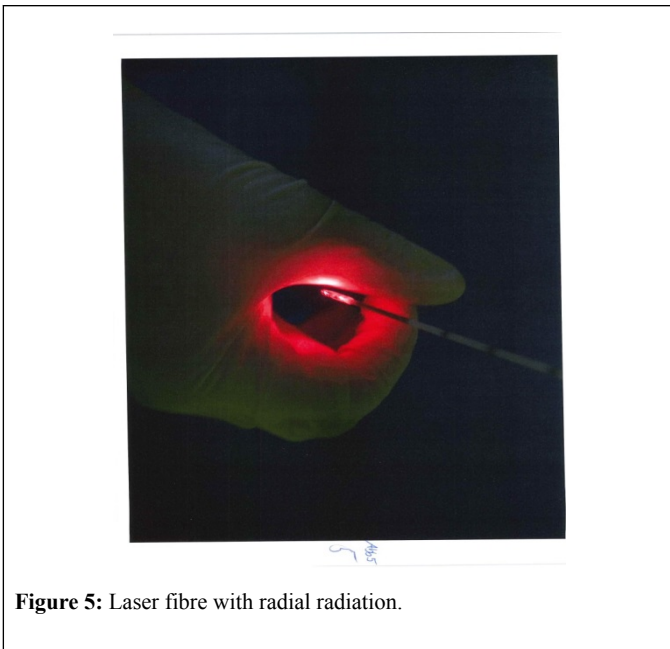


Figure 5: Laser fibre with radial radiation.

In this way the risks of punctual overheating and perforations of the vein wall, which exist with Bare Fibre laser, are excluded insofar as possible [41].

Post-thrombotic alterations to saphenous veins may make passage of the laser or radio-wave probe difficult or even impossible. Endoluminal procedures are not always possible in anomalous formations of the SPJ, where the course of the confluence is sometimes very twisted with configurations resembling a siphon or double siphon.

Endovenous procedures may be divided into two groups:

- thermal treatments, which use heat to degrade and so occlude the vein, and
- non-thermal procedures which close the vein by a chemical process.

Thermal treatments include

- Radio frequency procedures,
- Laser procedures, and
- Steam procedures.

The radio frequency procedures most commonly used in Germany are: ClosureFast, in which the vein is heated by segments to 120°; and radio frequency induced thermal therapy (RFITT) in which the vein is heated to 60-100°.

In laser treatments, the current trend is towards wavelengths with absorption in the water region (1300 nm and higher). In this procedure, laser probes with radial radiation are preferred, since they offer homogeneous degradation of the vein. The temperature reached is in the range of approx. 120-140°.

In the steam procedure, steam at 120° is produced in a generator and projected across an angle of 180° from the catheter tip. The advantage of this procedure however is not in the treatment of saphenous veins, but in the fact that it can also be used to close winding tributaries.

Non-thermal treatments include

- Mechanochemical ablation,
- Vein gluing procedures, and
- more generally duplex-controlled foam sclerotherapy of the saphenous veins.

In the ClariVein[®] [13] procedure (mechanochemical ablation), the vein is closed by a combination of mechanical effects (the catheter tip rotates, causing slight, painless degradation of the vein intima) and chemical effects (sclerotherapy liquid is sprayed into the vein from below the catheter tip).

In the VenaSeal procedure the vein is closed by a special vein glue (monocyanocrylate).

Foam sclerotherapy allows the vein to be closed by direct puncture or using a catheter.

The advantage of endovenous procedures is that no incision is needed in the knee or groin area, meaning that the patient can usually resume his/her normal physical activities on the following day (including sports).

State of the art of endovenous procedures

Execution: In all endovenous procedures, access to the diseased vein is at the distal reflux source. During thermal procedures care must be taken not to damage any nerves coursing nearby, and in cases where such dangers exist access may not necessarily be through the distal reflux source. For precise descriptions of the execution of the individual procedures, including tips and tricks, see also K. Hartmann et al. [42]. Very good anatomical knowledge (gained for example by open vein surgery) help in the execution of endovenous procedures.

Great saphenous vein treatment

The suppliers both of endoluminal laser systems and of radio frequency equipment recommend positioning the thermo-active probe tip 15-20 mm distal of the SFJ/SPJ. Such a procedure always results in a saphenous stump being left postoperatively, with a resulting increase in the risk of recurrence. It is therefore not surprising that the recurrence rates encountered in duplex ultrasound 5 years postoperative after endoluminal procedures are higher than after crossectomy and stripping of the GSV, with similar outcomes in terms of perioperative quality of life and morbidity [8,10,38,40].

K. Hartmann [5] is therefore right to state that nowadays endovenous crossectomy should be preferred insofar as possible, i.e. the GSV must be treated right up to its confluence with the femoral vein. Treatment is

particularly successful with radio frequency equipment and the new laser fibres with radial radiation (Figure 6a). The operating surgeon must have very good knowledge of ultrasound and very extensive experience. The endoluminal doctor's experience in open vein surgery is also helpful. Tributaries which flow into deep veins in the SFJ region should be treated thermally in the same session, especially the anterior accessory saphenous vein which is otherwise a frequent source of postoperative recurrence. This can be done without problems by an endoluminal procedure if the course of the anterior accessory vein runs straight. Flat closure of the epifascial vein together with the femoral vein is often possible intraoperatively, however after a few months the epigastric vein is once more visible in ultrasound and open. There is then an opening a few millimetres long in the SFJ, however it is not refluxive. The confluence of the epigastric vein lies in this short open segment of the great saphenous vein (Figures 6b and 6c).

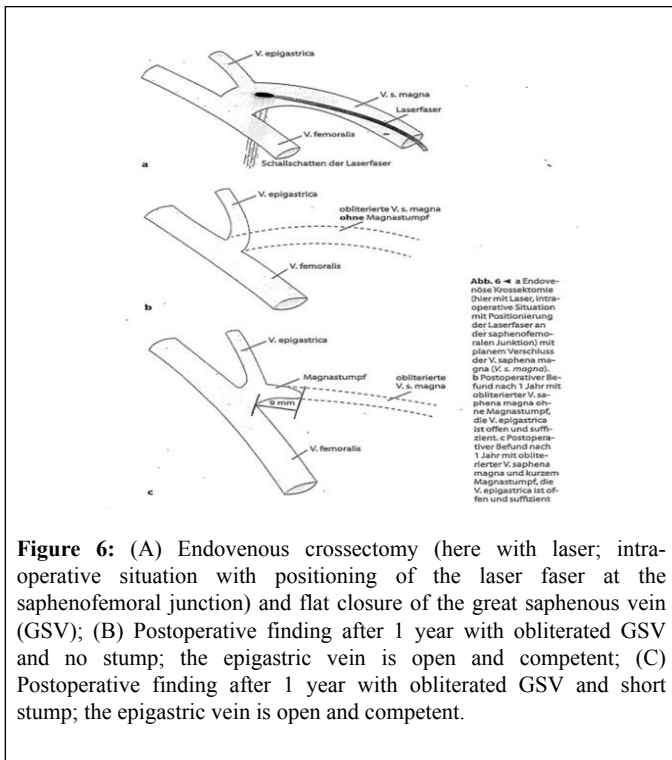


Figure 6: (A) Endovenous crosssectomy (here with laser; intraoperative situation with positioning of the laser faser at the saphenofemoral junction) and flat closure of the great saphenous vein (GSV); (B) Postoperative finding after 1 year with obliterated GSV and no stump; the epigastric vein is open and competent; (C) Postoperative finding after 1 year with obliterated GSV and short stump; the epigastric vein is open and competent.

The GSV must be treated right up to its confluence with the femoral vein

The most important difference from surgical crosssectomy is that in endovenous crosssectomy the SFJ and the epigastric vein remain open (or open again postoperatively). All the other veins which join in the SFJ region and flow into the femoral vein through the GSV must also be closed, either at once or in a second step with a further puncture (anterior, and if appropriate posterior, accessory saphenous veins). This procedure may correctly be described as an endovenous crosssectomy. Tributaries which flow directly into the femoral vein in the SFJ region remain open. However it is still not clear whether these very small tributaries have a significant influence on recurrence rates (larger veins can be treated endovenously at the same time if necessary).

The authors already have almost 10 years' experience with the new endothermal radio frequency and laser (1470 nm) equipment among their own patients, and no differences have been found in the number of SFJ recurrences as compared with classic surgery, with a single exception: initially the anterior accessory saphenous vein was not treated at the same time and many recurrences through this vein were recorded. Since treatment of this vein also has been included as a matter of routine (insofar as possible), recurrence rates fallen back to the same level.

Small saphenous vein treatment

The procedure for treating the SSV is rather different. In this case a stump of approx. 1 cm from the popliteal vein should be left to avoid nerve damage. Experience shows that the remaining stump becomes obliterated postoperatively (so long as no muscle veins join further distal), leaving a flat closure as the final result. The authors further recommend that the SSV should be treated under TLA without additional anaesthesia, so that the patient can advise of any discomfort during the intervention (e.g. tingling in the heel, lateral edge of the foot, etc., which indicates the proximity of a nerve).

Anatomical anomalies in the course of the SSV near the SPJ, which are not infrequently encountered, cannot always be satisfactorily treated endoluminally by laser or radio frequency procedures. In such cases a flat crosssectomy of the SPJ is the ideal.

Treatment of recurrent varicosis

The more experience the operating surgeon has in endovenous techniques, the earlier he/she will be able to correct recurrence in the SFJ/SPJ (Infobox 2). This assumes the presence of a straight stump approx. 10 mm long, which can be closed endoluminally. With a very short stump this will only work using radial laser technique.

Definition of recurrence in surgical and endovenous procedures:

- Recurrence is defined as reflux in the treated SFJ/SPJ which is visible in duplex ultrasound, whether or not a saphenous stump has been left.
- Refluxive recanalisation of some stretches after an endovenous procedure or a remaining saphenous trunk after a surgical procedure will be described as saphenous recurrence with or without SFJ/SPJ recurrence.

A short saphenous stump only a few millimetres long, with winding, recurrent varicose veins flowing out of it, should be treated with the correct type of crosssectomy appropriate to the diameter/size of the recurrent vein.

Non-thermal procedures are particularly suitable for treating perforating veins in the lower leg, as well as the whole length of the SSV if necessary.

It is beyond the scope of this work to discuss in more detail the different procedures applicable to these special forms; the authors refer the reader to the book of K. Hartmann et al. [18] cited above.

Different procedures for surgical and endovenous crosssectomy

We have learnt from surgical crosssectomies that a flat, radical crosssectomy produces the lowest recurrence rates. The same holds good for endovenous techniques: here too a short stump means fewer recurrences. Thus the manufacturers' recommendations to leave a distance of 2 cm and more from the SFJ/SPJ are not correct. We find the trend in the USA of leaving a stump of over 5 cm incomprehensible, and we do not recommend it. The positioning of the endovenous catheter in the saphenofemoral junction requires very great experience with duplex ultrasound, since heat damage to the femoral vein resulting from incorrect positioning of the probe (a matter of millimetres) may cause severe complications.

On the other hand, the need for a correctly executed crosssectomy in vein surgery is called into question by endoluminal techniques. All endoluminal techniques leave an unobliterated saphenous stump (as short as possible [$<5\text{mm}$]), or at least the junction of the epigastric vein remains in place (Figures 6b and 6c). In classic vein surgery a stump of this kind is considered a technical error and a principal cause of recurrence, which must be corrected in a second operation [4,29]. The definition of recurrence also differs between the two techniques discussed here—open surgery vs. endoluminal.

A short stump means fewer recurrences

Colleagues who operate with endoluminal procedures talk of occlusion rates in the heat-treated segments of the saphenous vein or, in cases of recurrence, of recanalisation of the initially treated saphenous vein. In classic open surgery the saphenous vein is removed (stripped). Recurrence is defined as reflux detected by duplex ultrasound with or without a stump in the operated groin region. This is comparing apples with pears. The definition of recurrence developed for classic vein surgery must also be applicable to all endovenous procedures. So far this is not occurring in the literature. Comparison of the recurrence rates of different techniques is only possible when the same definition is used for both types.

The definition of recurrence in the SSV is similar for surgical and endovenous treatments: Post-interventional reflux detected by duplex ultrasound in the popliteal hollow region (not infrequently through a popliteal perforating vein) is treated as recurrence.

Recanalisation of the treated saphenous vein with complete or intermittent refluxive stretches after endovenous procedures must be defined as treatment failures. This is equally true of open surgery, when the surgeon carrying out stripping of the GSV diverts to a tributary and a refluxive remnant of GSV is left in place.

Why are there two different approaches to SFJ/SPJ treatment?

One approach is surgical, in which all the tributaries with confluence in the SFJ region are ablated; the other is endovenous, in which all the branches of the SFJ are treated, but the epigastric vein is left in place.

Using the surgical approach, a remaining saphenous stump is more frequently associated with recurrence; for this reason radical crosssection is the method of choice. After endovenous treatment, a longer GSV stump (>10 mm) has tended to produce more recurrences among the authors' patients; here again, therefore, the recommendation is to make the ablation as flat as possible and treat the anterior accessory saphenous vein in the same session. The producers' recommendation to position the probe 15-20 mm distal of the SFJ region must be revised.

However the epigastric vein is left open. Why then does recurrence not occur more frequently? In the authors' view this can be explained by the fact that the whole of the GSV in the SFJ region is closed initially by thermal treatment of the vein down to its junction with the femoral vein. Although the GSV frequently recanalises in this region as far as the epigastric vein, its terminal valve remains closed, or is so severely damaged by shrinkage of the vein confluence that no recurrence occurs.

Which treatment-surgical or endovenous?

Finally the question arises when to use open surgery and when to use an endoluminal technique.

Nowadays all vein surgery interventions should be carried out in specialised centres. A vein centre will offer all surgical and endoluminal techniques-ideally, the doctors will be able to use both procedures. Patients should be honestly advised and sign an informed consent. The advantages and disadvantages of each procedure should be fully explained. Which technique is selected, and why, must be discussed in detail with the patient. An important aspect is that no patient who is covered by a legally required health insurance company which does not cover endoluminal operations should be obliged to pay for treatment.

As described above, open surgery offers certain advantages (e.g. very superficial varicose veins, winding veins, convolutions in the SPJ region), while endovenous surgery offers others (e.g. young or very old patients, multi-morbid patients and those receiving anticoagulant treatment). In the long run, however, the availability of a range of treatments is good for patients. Today the best procedure can be selected for each patient and his or her varicose veins.

The patient receives the best possible treatment in a vein centre

Finally the authors would like to stress that both types of procedure, surgical and endovenous (if properly executed) offer an excellent chance of curing the patient's varicosis.

The authors are worried by institutions which single-mindedly use the endoluminal approach in every case, and also by surgery or vein surgery departments which still regularly leave saphenous stumps in place.

CONCLUSION

- Both types of procedure, surgical and endovenous (if properly executed), offer excellent chances of curing the patient's varicosis.
- The availability of a range of treatments is good for patients. Today the best procedure can be selected for each patient and his or her varicose veins.

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