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# Techniques For Saphenous Ablation, How To Choose Your Strategy

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## Abstract

With the enormous amount of treatment techniques available for saphenous ablation, it can be difficult to choose the best strategy. Not only are there different techniques like surgical and endovenous, thermal and non-thermal, and tumescent and non-tumescent, there is also the option to stage treatment, or to perform them in a single combined session. Fortunately, the recent European Society for Vascular Surgery (ESVS) practical guidelines on the treatment of chronic venous disease, provides flowcharts to guide physicians. For the great and small saphenous vein, as well as the anterior accessory saphenous vein, endovenous thermal ablation is the first-choice treatment. However, in some cases, a non-thermal non-tumescent technique may be preferred, or even high ligation and stripping if endovenous options are not available. This review gives an overview of the different techniques, compares them and discusses considerations when deciding on treatment strategies.

## Keywords

Saphenous ablation, superficial venous reflux, chronic venous disease.

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A lot has changed since Abu Al-Qasim Khalaf Ibn Al-Abbas Al-Zahrawi (936-1013 AD), also known as Abulcasis, described phlebological techniques including stripping. Three American surgeons Dr Keller (1905), Dr Mayo (1906) and Dr Babcock (1907), codified stripping techniques and in 1956, a Swiss dermatologist Dr Muller, started the phlebectomy by serial incisions which he performed as an office procedure under local anesthesia. [1] For a very long period of time, invasive treatments were the only option for varicose veins, until, in the 21st century, percutaneous thermal ablation techniques became commercially available.

And while the global prevalence of chronic venous insufficiency gradually increased [2], so did the choice of treatment techniques. Nowadays, we can choose between surgical and endovenous techniques, thermal or non-thermal, with or without the use of tumescent anesthesia, simultaneously performing a phlebectomy or adding foam sclerotherapy with or without the use of a catheter.

For the (young) phlebologist, it may seem like a jungle out there and it is understandable to question which techniques should be chosen for which patient and how to take into account costs as well. The recent European Society for Vascular Surgery (ESVS) practical guidelines on the treatment of chronic venous disease [3] and two large systematic reviews [4, 5] guide physicians treating patients with chronic venous disease (CVD).

This review describes in detail the available techniques for saphenous ablation, compares them and discusses considerations when deciding on treatment strategies.

## Patient selection

In this review we chose as a starting point a patient with symptoms and or signs related to chronic venous insufficiency, with on duplex ultrasound (DUS) confirmed reflux of one of the saphenous trunks (Figure 1); the great saphenous vein (GSV), the small saphenous vein (SSV), or the anterior accessory saphenous vein (AASV). A patient can have concomitant insufficient tributaries.

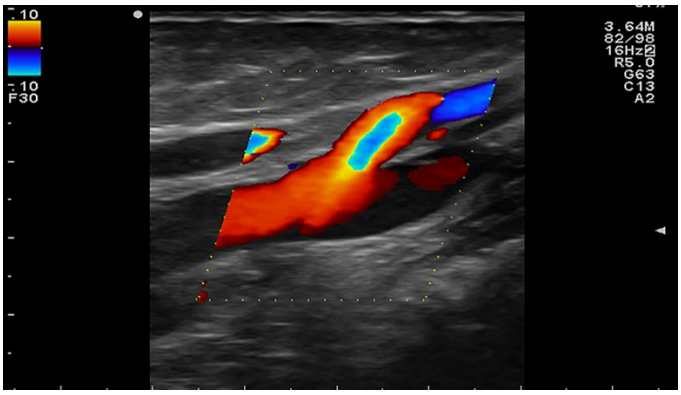


**Figure 1:** reflux at the sapheno-popliteal junction on duplex ultrasound. Yellow asterix is popliteal vein, yellow arrow points to reversed flow in the small saphenous vein

Symptoms can be diverse and are not always specific for venous disease, such as a heavy feeling of the leg or cramps. Signs are often described using the C from the Clinical, Etiological, Anatomical, Pathophysiological (CEAP) classification.[6]

## TYPES OF TECHNIQUES

## ENDOVENOUS LASER ABLATION (EVLA)

### Procedure

The procedure is performed under tumescent anaesthesia (TA) with DUS guidance (Figure 2). Tumescent anaesthesia not only protects the surrounding tissues from the heat, it also induces venous compression and spasm increasing the effectiveness of the procedure. Using a pump for injection makes TA easier to administrate. Patient is in supine position for treatment of the GSV (Figure 3a) and in prone position for the SSV.

Under DUS guidance (Figure 3b), the GSV or SSV is punctured and through the Seldinger technique, an introducer sheath inserted. Next, the laser fiber is put in and positioned distal to the sapheno-femoral (SFJ) or sapheno-popliteal junction (SPJ). Then TA is injected around the saphenous trunk and the laser ablation is performed. The GSV is usually punctured at the lowest point of reflux, but not lower than mid lower leg because of the vicinity of the saphenous nerve around the ankle.[3]

The SSV should not be punctured lower than mid-calf because of a higher chance to nerve damage at the distal calve. The AASV typically runs extrafascially after 10-20 cm below the junction. If it runs straight, it can be punctured lower, but ample TA should be administered in the subcutaneous part in order to prevent subcutaneous or skin burns.

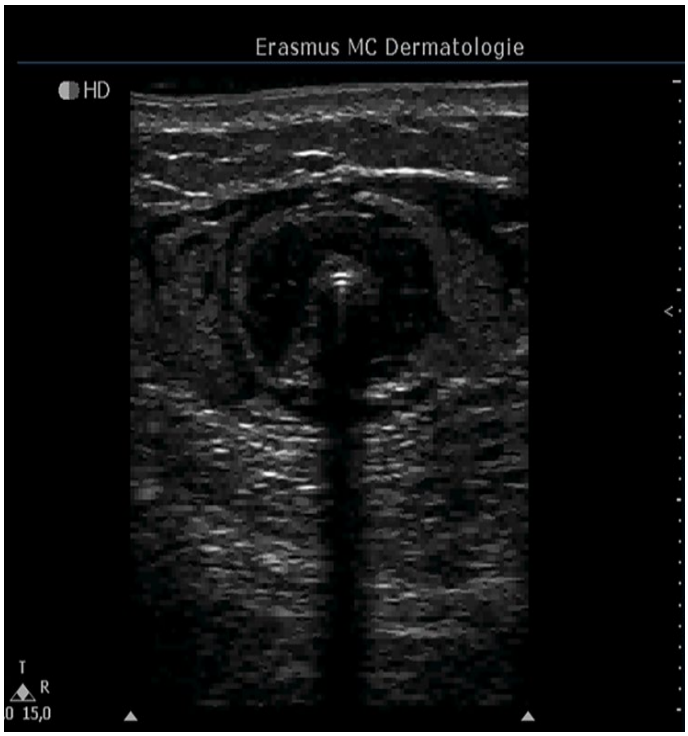


**Figure 2:** duplex ultrasound image showing the catheter (yellow arrow) surrounded by tumescent anaesthesia (within blue circle)

(a)

(b)

**Figure 3:** set-up for a patient being prepared for endovenous ablation of the great saphenous vein, a: clear the groin by pulling the underwear up with a gauze (the saphenopopliteal junction is located at the groin and should be accessible for duplex ultrasound (DUS)), b: DUS guided puncture

Laser ablation is not a standardized procedure, fiber tip designs, laser wavelength and Power may differ. It is generally accepted that delivering at least approximately 50 J/cm vein is sufficient to close the vein, although < 50J/cm showed similar closure rates.[7] Pullback speed is then dependent on the set Power. Noticeable, lower post-operative pain was found in patients treated with higher wavelengths and/or radial fibers[8-10], while closure rates were equally good between laser with higher or lower wavelengths.[8, 9]

### Effectiveness

EVLA is effective and safe. In a meta-analysis of 611 legs, the occlusion rate after 5 years was still almost 90%,[11] although in another study including 232 patients who underwent different endovenous saphenous ablation treatments, the 100% successful occlusion within the first days after EVLA, lowered to 70.1% after 5 years.[12]

EVLA also improves clinical outcome and quality of life. Pooled data showed a weighted mean improvement of 2.46 (95% CI 2.24–2.67) of the Venous Clinical Severity Score (VCSS) before and after treatment and significant better scores in both the Aberdeen Varicose Vein Questionnaire (AVVQ) and Chronic Venous Insufficiency Quality of Life Questionnaire (CIVIQ).[11] Deep venous complication rate was only 1.3% in a very large meta-analysis of 16.398 patients.[13]

### Recurrence

Another meta-analysis found that after EVLA, 36.6% varicose vein (VV) recurrences occurred during follow-up. One of the included studies in this meta-analysis reported that 12% of these recurrences occurred within 6 months after the procedure.[14] Recurrent reflux at the SFJ after EVLA is around 22%.[11] Clinically relevant recurrent VVs are less frequent (5.3%). Neovascularisation seemed to be the highest recurrence type, followed by recanalization and a refluxing AASV in one study[15], while recanalization was the main cause found in a review of several RCTs.[16] Obesity, reflux to below the knee, a bigger vein diameter and higher pre-intervention clinical class (C4-C6) increased the risk of recurrence, while a pre-operative competent terminal valve protected against recurrence.[15]

### Flush EVLA

A high recurrence rate in the AASV after EVLA of even 23.5% has been reported in another study that had a long follow-up (range 4 months to 9.2 years). The younger the patient, the more likely reflux at the groin developed.[17]

In order to prevent this, the flush EVLA (fEVLA) has been proposed in which the fibre tip is positioned exactly at the SFJ. Using a radial fiber, this technique was found to be successful (94.1% technical success), and safe (thrombotic complication rate 1.6%).[18] One RCT compared flush EVLA with standard EVLA (starting two cm distally of the SFJ) in 146 patients. At day 900 they found significant less reflux at the stump (3.6% in flush EVLA group compared with 22.2% in standard EVLA, $p<0.05$) and less reflux in the AASV in the flush EVLA group, however, this was not significant (7.1% vs 17.46%, $p=0.09$). [19]

## RADIOFREQUENCY ABLATION (RFA)

### Procedure

This procedure is also performed under TA with DUS guidance. Access to the target vein is similar to EVLA using the Seldinger technique. During activation of the RFA catheter, manual compression at the segment that is being treated, can increase contact of the vessel wall and the catheter with the aim to enhance obliteration. The most frequently used RFA system is the radiofrequency segmental thermal ablation, which sequentially heats vein segments of 7 cm (or 3 cm) at a temperature of 120 °C. It is advised to pull back 6.5 cm with the 7 cm catheter, to create small overlaps in treated segments. Puncture site is similar to EVLA. It should be noted that the 7-cm segment is not ideal for shorter segments to treat (e.g., short segment of SSV); instead, the shorter catheter can be used.

Other radiofrequency technologies are also available, such as radiofrequency induced thermal therapy (RFITT) and endovenous radiofrequency (EVRF®). One RCT found that complete GSV closure was significantly better after RFA and RFITT compared with EVRF, while quality of life and pain scores did not differ between the 3 groups.[20]

### Effectiveness and complications

Occlusion rates 5 years after RFA are high (85-95%) with significant improvement in VCSS and AVVQ scores from 12 to 60 months after treatment.[12, 21] The most important pattern of recurrence was disease progression at the groin with reflux in the AASV; after 5 years, 15% had symptomatic AASV reflux.[12, 21]

In a large retrospective study of 1297 patients treated with RFA, 5-year GSV recanalization rate was 17.5%. During follow-up QOL measured with SF-36 and AVVQ questionnaires was better for non-recurrent versus recurrent patients. This difference could not be measured using the VCSS.[22] CEAP classes C4 and 5, preoperative GSV diameter >6 mm and history of smoking were found to be independent predictors of recanalization.[23]

Postoperative complications after RFA were found to be low: deep vein thrombosis (0.39%), superficial vein thrombosis (0.91%), paresthesia (1.73%), and ecchymosis (4.26%).[22]

## OTHER THERMAL ABLATION TECHNIQUES

Endovenous steam ablation (EVSA) and endovenous microwave ablation (EVMA) are two alternative thermal ablation techniques. They are not reimbursed in most countries. Endovenous steam ablation works with the use of a catheter, which is advanced under DUS guidance. Pressurized superheated steam is pumped into the vein after TA, ultimately occluding the vein through thermal damage to the wall.

Due to lower temperatures used with EVSA, fewer thermal injuries and reduced post-operative pain have been reported and since the catheter is flexible, EVSA can treat more tortuous vessels and perforator veins as well.[24] Occlusion rates are above 90% after 1 year, but no long-term outcomes are available.[24, 25]

Endovenous microwave ablation is performed with a small microwave wire using a pulse mode and withdrawing the wire through the vein. Like with all other thermal ablation techniques, TA and DUS are necessary. Superficial VVs and perforators can be ablated with a short microwave needle. Not much studies are reported for EVMA. High occlusion rates, improvement in QOL and low complication rates have been described in Chinese patients.[26, 27]

## CYANOACRYLATE (CAC) ABLATION

### Procedure

Cyanoacrylates are synthetic glues that rapidly polymerize on contact with blood. Once delivered into the vein via a hand-held gun, CAC achieves immediate occlusion through fibrotic degradation of the vein via a granulomatous foreign body and inflammatory vein wall reaction. Under DUS guidance, a 5F introducer sheath/catheter is advanced to the SFJ and

positioned 5.0 cm caudal to the SFJ.

Using DUS to compress the proximal GSV, two injections of approximately 0.10 mL cyanoacrylate are given 1 cm apart at this location, followed by a 3-minute period of local compression, and then repeated injections and 30-second ultrasound probe and hand compression sequences until the entire length of the target vein segment is treated. There is no dose limit, which means that multiple saphenous veins could be treated in one session.

## Effectiveness

High closure rates of 88.5% 3 years post-procedure have been found in a multicenter European prospective trial[28] and an occlusion rate of 93.6 % was found after 5 years in the VeClose RCT.[29] The VCSS and QOL measures improved significantly after CAC, pain during the intervention was low and recovery time short.[30]

## Complications

Although complication rates seem low after CAC, some patients develop an erythematous dermal itching reaction within the first few weeks after GSV closure, usually in the overlying skin. This reaction is different from the typical phlebitis that can occur after saphenous ablation. Hypersensitivity reactions were reported in a review to be quite low (6.3%) after CAC treatment, of which the majority was mild.[31] However, in a recent study from Korea, hypersensitivity was much higher (27.6%).

Of the 24 patients who developed this reaction, 15 required oral antihistamine agents, and additional steroids were prescribed for the other nine. Mainly, the lesions were limited to the skin overlying the treated saphenous vein, but generalized skin allergic lesions were also noted. Intradermal steroid injections along the treated vein were even necessary in 3 patients.[32] Suprafascial saphenous veins with a depth <1 cm from the skin and saphenous vein diameter of ≥8 mm have been identified as risk factors in 1 study.[33]

## ULTRASOUND GUIDED FOAM SCLEROTHERAPY (UGFS)

The most commonly used sclerosing agents are Polidocanol (POL) and Sodium Tetradecyl Sulphate (STS), which can both be used in foam or liquid form. Foam is about 4 times more effective than liquid sclerotherapy because of the increased contact with the vein wall and a higher degree of vein spasm.[34]

Treatment of incompetent saphenous trunks with UGFS is less effective than EVLA, RFA and surgery.[5] Still UGFS may be considered when a swift treatment of the saphenous vein is preferred (e.g. in old or immobile patients, or patients who are not able to lay down for a longer time on an operating table). UGFS is especially useful for tortuous veins (neovascularization) when it is impossible to introduce a catheter or when wires cannot be advanced due to trabeculation after previous procedures or thrombosis (Figure 4).

Importantly, it should preferably be used for saphenous veins with small diameters as recurrent reflux was found to be higher in case of mid-thigh GSV diameter > 6 mm (62.6%) compared with a diameter < 6 mm (42%).[35] Ideally, multiple injection sites are used to improve outcome; one should start at the most proximal part and subsequently puncture more distally on the leg.

(a)


(b)

**Figure 4:** ultrasound guided foam sclerotherapy, a: in this case we used a butterfly needle, notice the backflow of blood, b: foam is being injected and is visible on duplex ultrasound

Alternatively, foam can be administered through a long intravenous catheter under DUS, with or without TA to reduce the vein caliber. This was found to increase occlusion rates (82.4%) compared with standard UGFS (62.9%, p < .001) at 3-year follow-up.[36]

## MECHANOCHEMICAL ABLATION (MOCA)

MOCA is another non-tumescent alternative that works by a combination of mechanical injury (the vein wall is touched by a rotating propeller tip) and liquid sclerotherapy. At least two devices are currently available. The first abrades the intima with the tip of a catheter's rotating wire. The liquid form of STS or POL are used most often, which limits the total dose that can be applied. The other device causes vein wall damage through a catheter with

sharp hooks at the tip, while chemical ablation is performed simultaneously by injecting a foam sclerosant. Similar to steam and CAC, it is not reimbursed in most countries.

## HIGH LIGATION AND STRIPPING

Before the invention of endovenous saphenous ablation techniques, refluxing saphenous trunks were all treated with high ligation with or without stripping. This technique is performed through an incision in the groin or popliteal fossa. Then the SFJ (groin) or SPJ (popliteal fossa) is exposed. All tributaries that drain into the common femoral vein or popliteal vein are ligated. Next, the GSV is stripped and pulled out of the leg (Figure 5). The lowest point of stripping is just below the knee to prevent damage of the saphenous nerve. Stripping of the SSV is less often performed out of fear to damage the sural nerve, although the rate of SPJ incompetence at one year was significantly lower in patients who underwent stripping (9 of 67, 13%) compared with ligation only (37 of 115, 32%, $p < .01$).[37]

**Figure 5:** stripping of the great saphenous vein

Incomplete strips can be avoided with a pre-operative DUS. Tributaries and focal dilatations may 'trap' the stripper and can already be identified and marked. By using TA, high ligation and stripping can nowadays be performed without the need for general or locoregional anesthesia

## COMPARING DIFFERENT TECHNIQUES

A large systematic review and meta-analysis has been performed of 72 RCTs to compare different techniques for GSV ablation. Regarding anatomical failure (incomplete stripping or GSV non-occlusion *with or without* reflux) endothermal techniques had the same failure rate as open surgery, except for EVLA which showed higher failures rates at long-term follow-up with a RR of 1.87 (1.14 to 3.07).[4]

The updated Cochrane review showed similar results, however found that technical success was better after EVLA up to five years (OR 2.31, 95% CI 1.27 to 4.23) compared with open surgery, with no difference at five years and beyond. They defined technical success as complete anatomical obliteration or *absence* of reflux on DUS.[5] The difference in definition of success may explain the different findings.

MOCA had higher anatomical failure rates than RFA (RR 2.77, 1.38 to 5.53), while CAC performed better at short-term follow-up (RR 0.56, 0.34 to 0.93) than RFA or EVLA. UGFS had a higher risk of anatomical failure and reintervention than open surgery.[4] Clinical recurrence rates were not significantly different between all comparisons. Following EVLA, significantly lower neovascularization rates occurred compared with open surgery at early, mid-term and long-term follow-up. RFA showed the same results as EVLA, however, these were not significant.

Venous thromboembolism was not significantly different for any comparison. EVLA, RFA and UGFS were significantly less likely to be associated with wound infection than open surgery. In addition, EVLA, RFA and UGFS had a significantly lower risk of haematoma than open surgery. Paraesthesia was significantly reduced following EVLA and UGFS compared with open surgery.

Paraesthesia was also significantly lower for non-tumescent non-thermal treatments relative to endothermal ablation. Furthermore, superficial thrombophlebitis was significantly greater in RFA and UGFS treatments compared with open surgery. A network meta-analysis of postoperative pain showed that CAC was ranked top in lowering postoperative pain, followed by MOCA, RFA, UGFS, EVLA and open surgery.[4]

## TREATMENT STRATEGIES

The ESVS 2022 clinical practice guidelines on the management of chronic venous disease, has included useful flowcharts to help guide physicians through the different superficial reflux treatment options.[3] Included are three flowcharts that address treatment of saphenous truncal ablation; one for the GSV, one for the SSV and one for the AASV. For the GSV and SSV endovenous thermal ablation (EVLA or RFA) is recommended as the first-choice treatment (level A evidence). For the AASV, EVLA also comes first in the flowchart, but with a less strong recommendation (should be considered) with a lower level of evidence (C).[3] In addition, for treatment of the GSV, the ESVS guidelines recommend that CAC should be considered if a non-thermal non-tumescent technique is preferred, and high ligation and stripping if endovenous options are not available.[3] For the SSV, CAC, MOCA and UGFS (only if diameter is <6mm) should be considered as treatment options. For the AASV, so far there is only evidence to recommend that UGFS should be considered (if the diameter is <6mm).[3] To further help facilitate choosing a strategy, Table 1 gives an overview of all techniques comparing different qualities like multiple treatment indications, non-tumescent, price, (postoperative) pain, paraesthesia and thrombophlebitis, together with the effectiveness[38].

**Table 1**

| Technique | Multiple treatment indications | Non-tumescent | Effective | Price | Postoperative pain: low-high | Paraesthesie | Thromboflebitis |
|---|---|---|---|---|---|---|---|
| EVLA | - | - | +++ | Low | 5 | + | + |
| RFA | - | - | +++ | Medium | 3 | + | + |
| CAC | - | + | +++ | Very High | 1 | - | + |
| UGFS >6mm | + | + | - | Very Low | 4 | - | + |
| UGFS <6mm | + | + | + | Very Low | 4 | - | + |
| CDFS | + | + | ++ | Low | 4 | - | + |
| MOCA | - | + | ++ | High | 2 | - | + |
| HLS 1 | - | - | +++ | Low | 6 | + | - |
| HLS 2 | - | - | +++ | Very high | 6 | + | - |

EVLA; endovenous laser ablation, RFA; radiofrequent ablation, CAC; Cyanoacrylate, UGFS; ultrasound guided foam sclerotherapy, MOCA; mechanochemical ablation, HLS 1; high ligation and stripping - outpatient, using tumescent anesthesia, HLS 2; high ligation and stripping - operating room, general/regional anesthesia

## STEPS AND CONSIDERATIONS WHEN CONSIDERING TREATMENT

First of all, only patients with symptoms and/or signs of CVD should be considered for treatment. The sole finding of truncal insufficiency on DUS in an otherwise asymptomatic patient should not be a trigger to immediately ablate the saphenous trunk. Also, keep in mind that conservative treatment with compression stockings can be an excellent treatment as well. Evenly important is promoting a healthy lifestyle. Advising your patient to lose weight (if applicable) and exercise is just as much part of the treatment. In adjunction, when it comes to choose a treatment technique for saphenous ablation, shared decision making is key. Explain to your patient the pros and cons of the possible strategies to fully get informed consent. Next, it is important, *prior* to intervention, to identify with DUS if deep venous reflux and/or obstruction is present. In case of obstruction, the superficial veins may act as collaterals which should then be preserved. In case of deep reflux, treatment of the superficial system may be less effective. [3]

Let's assume we have a patient with signs or symptoms, truncal reflux (either GSV, SSV or AASV), without any deep venous abnormalities. Endovenous thermal ablation is first choice treatment. However, in some cases, a non-thermal non-tumescent technique may be preferred, or even high ligation and stripping if endovenous options are not available[39]. That does not mean, you need to be able to offer all techniques possible. It is all in the details and you only learn these techniques fully by performing them often. Ideally, this also means that you are able to perform DUS yourself. By doing so, you can pick up every important detail before you start the procedure like tortuous parts, trabeculations, intra- or extrafascial course of the vein, distance to the skin, perforating veins and the exact length (including starting and ending point) of the vein segment that is refluxing. These findings may let you decide to choose another strategy than thermal ablation. In case of trabeculation or tortuosity of the vein, catheter directed techniques will not always be possible and UGFS may offer a great solution. In case of extra-fascial course of the vein, or a small distance to the skin, there is a higher chance of skin damage when a thermal technique is used. Patients with an extreme fear of needles might be a lot less anxious when a non-tumescent technique is used and elderly patients who cannot lay down too long benefit from a technique with a short duration. In case you are unable to offer a certain technique you deem best for your patient, refer them to a colleague.

High ligation and stripping may be the only option in countries without reimbursement for endovenous techniques. It is hard to justify it however when these techniques are fully covered. Even though HLS is very effective, it has an increased risk of haematoma, paraesthesia, wound infection and postoperative pain compared with endovenous techniques. It should therefore be reserved only for very specific patients with for example a large aneurysm close to the junction, and ideally should be performed under TA instead of under general anaesthesia.

Whether to treat concomitant tributaries simultaneously or not remains a matter of debate. Some advocate to treat the trunk in combination with UGFS or phlebectomies of the side branches. Others treat the trunk first, and only treat tributaries if they are still symptomatic when patients come for follow-up. Some patients get severe complaints of superficial thrombosis of the tributaries when only the trunk is ablated. Another approach, based on the theory that varicose veins can have an ascending origin, is to treat (large) tributaries first.

In a selection of patients, the refluxing trunk returns to normal after treatment of the refluxing tributaries.[40] Until we have more information on the characteristics of patients and their varicose veins that would benefit from a staged strategy, practitioners should make this decision based on their experience, practical considerations and wishes of the patient. In case

of C5 (healed ulcer) or C6 (an active ulcer), treatment should be more 'aggressive' by combining treatment options, and more promptly, in order to accelerate ulcer healing and prevent recurrence, even in the presence of deep venous reflux.[41, 42]

Obese patients, patients on anticoagulation, elderly patients and children, or patients with superficial reflux as part of a vascular malformation (solely or part of a syndrome like Klippel Trenaunay), do not fall into the same flowcharts as 'uncomplicated' patients. For them, a patient tailored treatment should be discussed, preferably in a multidisciplinary team. [3] Last, in an era where healthcare costs keep increasing, it is also important to look at financial aspects of the different treatments (Table 1).

If outcomes are comparable at long-term follow-up, it is hard to justify more expensive procedures in all patients. Individually however, there may be valid reasons to choose the procedure with the lowest amount of post-operative pain in order to go back to work quickly.

## CONCLUSION

Although it is promising to see so many techniques being developed to treat patients with superficial venous insufficiency, it can be difficult to choose the best treatment strategy. Fortunately, reviews and guidelines have provided clear data on effectiveness of the different techniques, complication risks and user friendliness (both for the physician and the patient).

With this information, it should become more easy to select the best fitting strategy for every patient through the process of shared decision making. Long-term follow-up data for truncal ablation techniques, cost-effectiveness studies, as well as studies on patient related outcome measures and staged versus concomitant strategies are necessary to keep improving patient care.

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