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REVIEW

Treatment Options for Primary Varicose Veins—A Review

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Introduction

Although varicose veins are common many remain asymptomatic and only a minority present for treatment. Nonetheless 40,000 National Health Service operations were performed in the UK in 2001[1] at an estimated cost of £20–£25 million (excluding non-hospital costs) thus consuming significant healthcare resources.[1]

The majority (60–70%[2]) of varicose vein patients have an incompetent sapheno-femoral junction (SFJ) and long saphenous vein (LSV) reflux. Although the pathogenesis of varicose veins is not fully understood,[3] abolition of reflux appears crucial for successful treatment. Thus standard treatment for varicose veins in the UK entails flush ligation of the SFJ, LSV stripping and stab avulsions of the varicosities.[4] Recently various novel techniques for the minimally invasive treatment of varicose veins have been developed. The potential impact of these will be considered and the evidence base for the treatment of varicose veins reviewed.

Epidemiology

In the Edinburgh Vein Study 32% of women and 40% of men, in a cohort of 1566 randomly selected subjects, had trunk varicosities.[5] Other studies, generally of less stringent methodology, have found the gender difference reversed with a prevalence of 20–25% in women and 10–15% in men.[6] In studies involving self-reporting, women tend to be over-represented, as they are more likely to present with varicose veins and more likely to undergo treatment.

The relationship between varicose veins and symptoms is controversial. Whilst it has been suggested that they might cause aching, heaviness, pruritis, and oedema; asymptomatic superficial venous reflux (duplex ultrasound) is present in up to 39% of the population.[7]

In the Edinburgh Vein Study lower limb symptoms were common irrespective of the presence of varicose veins, with 48% of all women complaining of aching legs. Pruritis was positively associated with the severity of varicosities in men and heaviness/tension, aching and itching correlated with their presence in women. However, the level of agreement between symptoms and trunk varices was too low to be of clinical value and the majority of lower limb symptoms have a non-venous cause.[8]

In another study Labropoulos *et al.* found that 70% of patients with LSV reflux complained of aching legs and this was more common with full-length LSV incompetence compared to above or below knee reflux alone. Ankle swelling was also more likely with a greater extent of reflux.[2]

A minority of patients with varicose veins develop complications including thrombophlebitis, varicose eczema, lipodermatosclerosis and ulceration. The true incidence of these is uncertain[3] but is estimated at around 5%.[9] In the past superficial thrombophlebitis (superficial vein thrombosis) was thought to be a benign condition. However, 12–25% of patients may also develop a DVT, either as extension of LSV thrombosis, or as non-contiguous thrombosis.[10–13,17]

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Although conventional management of superficial thrombophlebitis comprises compression, mobilisation and non-steroidal anti-inflammatory drugs, sapheno-femoral ligation or anticoagulation might be considered when proximal thrombi are identified by duplex scanning.[14–16,18] Recent papers have suggested that the treatment modality should depend on the site of thrombus (as identified with duplex scanning), with more proximal thrombi being treated with sapheno-femoral ligation or anticoagulation.[13,17] Most authors advise definitive surgical treatment of varicose veins (emergent or elective) to prevent recurrence (5–49%).[19]

What Might Constitute the Ideal Management for Varicose Veins?

The optimum management of varicose veins requires accurate identification of the source of superficial venous incompetence. Subsequent treatment, specifically tailored to abolish venous reflux, should relieve any symptoms attributable to superficial venous incompetence, prevent complications, improve cosmesis, be associated with a low morbidity, low recurrence rates, and if possible, a short recovery time. The cost-effectiveness of potential therapies should also be considered. These issues will be discussed for the treatment options described in Table 1.

Non-operative Therapy for Varicose Veins

Support hosiery

Compression hosiery improves both symptoms and venous haemodynamics among patients with varicose veins[20–23] and reduces oedema[24] with grade II compression (20–30 mmHg) conferring maximal relief.[24] However, benefit is restricted to the period during which the stocking is worn.[25] Compliance is variable and difficult to assess. It has been reported, however, that only 37–47% patients continue to wear them 1 year after DVT or for the long term prevention of venous ulceration.[26,27] Poor compliance has been attributed to both the cost of stockings,[26] and lack of patient education,[28] but may also be due to poor cosmesis. In general, grade II stockings are tolerated better than grade III stockings[29] and compliance also varies depending on the manufacturer.[20] A small non-blinded randomised controlled trial of compression stockings (class I and II) in pregnancy showed that the development of LSV reflux and symptoms were less common in the treated group ($p=0.047$) as compared to controls, but that there was no difference in development of varicose veins.[30] Compression therapy may also be facilitated with a variety of proprietary bandages although with the exception of Setopress® (half strength 30 mmHg; full strength 40 mmHg) the pressure exerted by these is uncertain and difficult to control.

Sclerotherapy

Sclerotherapy, which initiates a chemical thrombophlebitis, occlusion and subsequent vein fibrosis[31] was described by Chassaignac in 1855.[32] Although a variety of sclerosants have been employed (ferric chloride, hypertonic saline, polidocanol, iodine, glycerine),[32] sodium tetradecyl sulphate (STD) is most widely used for saphenous varicosities.[33]

Table 1. Treatment options for varicose veins

Compression hosiery	Below knee grade II (30–40 mmHg) compression stockings
Sclerotherapy	Direct injection of sclerosant into varicosities (outpatient); ultrasound guided LSV sclerotherapy (foam or liquid)
Minimally invasive	
Radiofrequency ablation (VNUS®)	Radiofrequency (thermal) ablation LSV ± phlebectomies or sclerotherapy: usually performed under general anaesthesia, day case or overnight in-patient stay
Endovenous laser treatment (EVLT®)	Laser (thermal) ablation LSV with pulsed diode laser ± delayed (6/52) sclerotherapy: local anaesthesia, out-patient ('Office') procedure
Surgical	
Sapheno-femoral ligation, LSV stripping and phlebectomies	Widely available, day case or overnight in-patient stay, general anaesthesia. Variations include length of vein stripped and method of stripping
Ambulatory conservative haemodynamic management (ACHM or CHIVA)	Identification of sites of deep to superficial reflux and elimination of these sites only, general anaesthesia, day case or overnight in-patient stay
Transilluminated powered phlebectomy (TIPP, TriVex®)	An alternative to phlebectomies using tumescent peri-venous infiltration and illumination to allow 'resection' of varicosities resulting in fewer incisions. Conventional surgery for reflux still required: general anaesthesia, day case or overnight in-patient stay
Endovenous diathermy	Endovenous diathermy: general anaesthesia, usually day case procedure
Cryosurgery	Endovenous cryoprobe: general anaesthesia, usually day case procedure

Recanalisation and high recurrence rates are common in patients with large veins or in patients who have sapheno-femoral or sapheno-popliteal incompetence.[34] Reported complications are few, however, tissue necrosis following dermal intra-arterial injection and haemosiderin deposition (skin staining) can occur.[31] Although sclerotherapy combined with sapheno-femoral ligation was temporarily popular in the 1960s and 70s as a less invasive alternative to conventional surgery it is now reserved for isolated varicosities without truncal reflux, or for residual varicosities after surgery.[35] Studies comparing SFJ ligation with sclerotherapy to SFJ ligation with LSV stripping found increased clinical recurrence and recurrent LSV reflux in the sclerotherapy group.[36,37]

More recently ultrasound directed LSV obliteration by sclerotherapy has been attempted in anticipation that long-term success might be superior to injection of the tributaries alone. Thus in 50 patients, using 3% liquid STD, Min reported 100% occlusion rates and high patient satisfaction at a mean of 8 months follow-up.[38]

It has been suggested that foam sclerotherapy, which allows a smaller quantity of sclerosant to cover a greater surface area and to displace blood from the LSV, might be both more effective and have fewer complications. LSV occlusion rates of 90% at 28 days and 81% at 3 years have been reported.[39,40] A non-randomised comparison of liquid and foam ultrasound-guided sclerotherapy of the LSV reported a higher occlusion rate (67 versus 17% at 1 year) and lower clinical recurrence rate (8.1 versus 25% at 1 year) with foam.[41] No complications were reported in this series. A further randomised trial comparing foam with liquid polidocanol to treat LSV incompetence (LSV <8 mm diameter) also showed that foam was more successful in abolishing LSV reflux on duplex ultrasound at 3 weeks (84% versus 40%).[42] Only minor complications were reported (5 cases of 'cutaneous inflammation' and one haematoma).

In a randomised trial comparing endovascular (liquid) sclerotherapy (EVS) or SFJ ligation alone with combined EVS and SFJ ligation, SFJ incompetence persisted in 19% of the EVS group compared to 0% in the other two groups at 10-year follow-up. However, distal LSV incompetence was present in 44% after EVS, 36% following SFJ ligation and 16% after combined treatment.[43] Similarly Bishop *et al.* reported a 57% incidence of SFJ reflux and a 75% incidence of LSV reflux at a mean follow-up of 27 months in 89 limbs treated with duplex guided sclerotherapy.[44] Thus, the long-term results for EVS alone appear disappointing.

Minimally Invasive Therapy for Varicose Veins

VNUS—radiofrequency ablation

Endovenous radiofrequency ablation (Closure system: VNUS Medical Technologies Inc., Sunnyvale, CA) of the LSV was described by Goldman in 2000.[45] It is usually performed under general or regional anaesthesia and is combined with phlebectomy, and sometimes sapheno-femoral ligation. It can also be performed using local anaesthesia and this may become more common given the apparent benefits of this when used in conjunction with endovenous laser therapy (see below).[45] At present there are no series describing the results for VNUS performed with this method of anaesthesia. The LSV is canulated at knee-level and a 5 or 8 French gauge catheter is advanced to the SFJ under ultrasound control and then slowly withdrawn. Heating of the vein and surrounding tissue results in endothelial denudation, collagen denaturation and acute vein constriction.[46] A multi-centre study found that 85% of LSV were obliterated at 2 years,[47] with other series reporting occlusion rates of 88–100% at up to 2 years follow-up.[47–50] The manufacturers guidelines state that the technique is suitable for non-tortuous LSV of <12 mm diameter and thus is applicable to 30–58% of patients.[48,49] Although there are anecdotal reports of its use in larger veins there is no published data to confirm this.

Manfrini *et al.* also compared VNUS with 'Restore',[50] a radiofrequency catheter designed to reduce the vein diameter and restore competence rather than ablate the vein. However, 'Restore' led to LSV occlusion in 16% of the patients and the overall results for 'Restore' were much worse than for VNUS 'Closure'.

There are two randomised-controlled trials comparing radiofrequency ablation with surgery.

Lurie *et al.*[51] reported the results of the EVOLVeS study, which was a multi-centre trial of 81 patients randomised to either radiofrequency ablation of the long saphenous vein or sapheno-femoral ligation, LSV stripping and phlebectomies.

LSV occlusion was achieved in 81% VNUS patients, with a slightly shorter treatment time then surgery (74 SD 10 min versus 89 SD 12 min). The recovery period (1.36 versus 6.65 days to work) was also quicker in the patients undergoing RF ablation. Although there were fewer overall complications in the VNUS patients, post-treatment paraesthesia rate was more common (16% compared to 6% in the surgical group, not significant).

Interpretation of the EVOLVeS data is difficult since

there were variations in both anaesthetic technique and the use of adjunctive procedures between centres, making the data on recovery and return to work more difficult to interpret. Furthermore, the study is of relatively small size and not powered to show significant differences between the techniques.

In a second, smaller trial Rautio randomised 28 patients to receive VNUS ablation or conventional surgery.[48] Both groups were treated under general anaesthetic and all patients underwent phlebectomies.

LSV occlusion was achieved in all patients, with a mean reduction in the VCSS (venous clinical severity score) of 5.1 (SD=1.5) in the VNUS ablation group and 4.4 (SD=1) in the surgical group. Post-operative pain scores were significantly lower for VNUS patients. There was no difference in the quality of life scores between the two groups following treatment.

Three (20%) thermal injuries occurred following VNUS group, with a similar proportion in both groups reporting post-treatment paraesthesia (2 (13%) VNUS group, 3 (23%) surgical group). Symptomatic thrombophlebitis occurred in 3/15 (20%) of the VNUS group. The medical costs of treating patients with VNUS were significantly higher.

The value of this study is compromised by its small size and the short-term follow (50 days).

Individual series reporting experience with VNUS suggest rather lower complication rates (saphenous neuritis (3–49%), skin burns (2–7%), haematoma and phlebitis).[47–50] Although deep vein thrombosis (DVT) has been reported in about 1% of VNUS patients (0.3% incidence of pulmonary embolus),[52] a recent study involving rigorous duplex examination 10 days post-procedure reported a 16% DVT rate.[53] In 11/12 patients this was due to extension of thrombus from the LSV. Although early thrombus resolution was noted following anticoagulation the authors recommend early duplex scans in all patients following VNUS.

Endovenous laser therapy

Endovenous laser techniques also offer the opportunity for minimally invasive treatment of varicose veins. An important potential advantage of EVLT® (810 nm-diode laser, Diomed Inc, Andover, MA) is that it is performed as an outpatient procedure under local anaesthesia. Although EVLT® at 10–14 W power has been used most widely, other laser modalities have been employed. For reasons outlined below the results for alternative laser treatments should be discussed separately. Under ultrasound control a laser fibre is inserted into the distal LSV and advanced to the SFJ. Peri-venous local anaesthetic (0.1–0.3% lignocaine) is infiltrated around the length of the LSV to provide analgesia, compress the vein to ensure vein wall apposition to the fibre, and to act as a heat sink to prevent thermal damage to local tissues. The latter may also allow the safe use of EVLT® in the treatment of sapheno-popliteal reflux.

The laser fibre is fired as it is withdrawn from the LSV at a rate of 3 mm/s with manual pressure further assisting vein wall apposition. A compression bandage or grade II elastic stocking is worn for a week following treatment and normal activity is resumed as soon as patients feel able. In our own pilot study 50% of patients returned to normal activity within 48 h of treatment (unpublished data). In contrast to VNUS, the LSV does not shrink immediately, but gradually reduces in size over several weeks until it is no longer visible on ultrasound after about 6 months, following a process of endothelial damage, focal coagulative necrosis, shrinkage and thrombotic occlusion of the vein.[54]

Observational studies report LSV closure rates of 94–99%[55] with an improvement in the appearance of superficial varicosities and relief of symptoms. For varicosities remaining after 6–12 weeks outpatient sclerotherapy is effective in the absence of LSV reflux.

A recent report by Min *et al.* describing almost 500 patients followed for up to 3 years[56] indicated LSV occlusion rates of 98% at 1 month and 93% at 2 years (n=121). No long saphenous veins regained patency after 2 years. The main complications were bruising (24%) and thrombophlebitis (5%) but there were no instances of DVT, burns or paraesthesia. A separate study reports one instance of temporary paraesthesia following EVLT®.[55]

The possibility that VNUS might be associated with a relatively high risk of DVT has been mentioned earlier. The absence of this complication following EVLT might reflect the shorter duration of treatment and thus the shorter time that a thrombogenic catheter is positioned close to the sapheno-femoral junction, or the much higher treatment temperatures, which vaporise the blood and presumably any thrombus. Alternatively it might be the occurrence of DVT has not been fully evaluated.

Other laser modalities including a 940 nm diode and a 1064 nm Nd:YAG laser may be associated with higher complication rates. For the latter temporary paraesthesia and thermal injury have been reported in 36 and 5% of patients, respectively.[57] This almost certainly reflects a much larger total laser dose (15, 250 J versus a median dose of 1456 J for EVLT® in our unpublished pilot study).

A potential criticism of minimally invasive

techniques that avoid SFJ ligation is that the LSV tributaries may remain patent and may promote recurrent reflux. However, Chandler *et al.* have suggested that avoiding surgical disruption of the SFJ may reduce neovascularisation and thus recurrence rates may be lower.[58] At present endovenous laser therapy shows considerable promise although long-term follow-up is awaited.

Surgical Treatment of Varicose Veins

The techniques involved in the surgical treatment of varicose veins will not be discussed in detail. Current surgical practice for varicose veins secondary to SFJ and LSV incompetence is SFJ ligation, including the LSV tributaries, LSV stripping to knee level or just beyond, and multiple phlebectomies.

Variations to the standard technique include the use of inversion strippers which are said to minimise bruising and soft tissue trauma[59] although a randomised controlled trial showed no difference in the extent of bruising or the incidence of paraesthesia at 1 week.[60] However, the exit wound was significantly smaller using the PIN inversion stripper (PIN, Credenhill Ltd, Derbyshire). As far as phlebectomies are concerned, cosmetic practice generally favours the use of vein hooks that allow removal of superficial varicosities through small stab incisions.[13]

Modifications of Standard Surgical Technique

Ambulatory conservative haemodynamic management (ACHM or CHIVA)

Conservative haemodynamic surgery for varicose veins (CHIVA) is described as a 'physiological surgery' technique, which involves identification (duplex ultrasound) and ligation of points of deep to superficial reflux rather than extensive, ablative surgery.[61] Communicating veins and saphenous veins are preserved and no phlebectomies are performed. Although haemodynamics improve and morbidity is low, recurrence rates may be as high as 35% at 3 years.[62] Nevertheless a non-randomised comparison with SFJ ligation, stripping and phlebectomies reported similar outcomes at 3 years except that cutaneous nerve damage was less common in the CHIVA group.[63] However, the methods of assessment were unclear and in view of the relative complexity of the technique and concerns about its effectiveness it has not been widely adopted.

Transilluminated powered phlebectomy ablation of varicosities (TriVex™)

Transilluminated powered phlebectomy (TriVex™ System Tumescent Cannula Illuminator, Smith and Nephew Endoscopy Division, Andover, MA) has been proposed as a quicker and more reliable method for varicose vein avulsion. Described in 2000,[64] an endoscopic dissector, with a rotating tubular blade and suction channel is used to resect the varicose veins with the aid of a transilluminator after hydro-dissection of the subcutaneous tissues. Spitz's initial experience[64] suggested a reduction in operative time and the number of incisions required, with fewer complications and improved cosmesis compared to historical controls. Although there have been no randomised trials comparing TriVex with conventional surgery, other studies confirm a reduction in the number of incisions but report increased cost, operative time, haematoma formation and possibly a higher incidence of paraesthesia in TriVex patients.[65–67] Despite this the technique may be useful in surgery for recurrent varicosities where peri-venous scar tissue and vein fragility may compromise the efficacy of conventional stab avulsions.

Subfascial endoscopic perforator ligation (SEPS) and the Linton procedure

The role of perforating veins in the aetiology of varicose veins is controversial. However, the size of perforating veins and percentage of incompetent perforating veins in the medial calf has been shown to correlate with the severity of chronic venous insufficiency (CEAP score)[14] across the spectrum of venous disease. The majority of the literature on perforator ligation (open or endoscopic) concerns patients with chronic venous insufficiency and venous ulceration[15] and the majority of vascular surgeons to not routinely ligate perforators in patients with uncomplicated varicose veins.[4] Indeed it has been shown that in such patients competence of the perforators is restored following abolition of LSV reflux.[68]

When perforator ligation is required for isolated perforator incompetence, endoscopic ligation is preferred to open surgery since it avoids problems with wound healing. However, if open surgery is undertaken, targeted incisions following ultrasound localisation of the perforators may also avoid the wound problems associated with the traditional Linton's procedure.

External valvular stents

The use of an external valvular stent (Venocuff™, Imthage Pty. Ltd, St Leonards, NSW, Australia) has been proposed by Lane as a more physiological solution to venous reflux which allows preservation of the LSV. He describes a large series of over 1500 patients, although outcome data is only available for a small proportion of these.[69] In 107 patients followed to 57 months, 90% has a competent SFJ, with a mean reduction in the proximal LSV diameter from 7.6 to 4.8 mm. Clinical recurrence rates were low. However, patients with LSV diameter >10–11 mm or with gross tortuosity or varicosities along the course of the LSV were excluded and therefore the technique was only found to be applicable on 34% patients. Patients preferred valvuloplasty as there was lower morbidity than with stripping. Complications were rare, with infection requiring cuff removal occurring in 0.3% cases. This technique may be suitable for patients with relatively minor varicose veins, although there are no comparative studies and its use has not been widespread.

Endovenous diathermy

Endovenous diathermy of the LSV was employed by some surgeons in the 1960–70s.[70] There is no evidence of any benefit over inversion stripping of the LSV and it carries the risk of thermal injury. A more recent study has suggested that it might be used to ablate incompetent tributaries with preservation of the LSV after sapheno-femoral ligation although no long-term follow-up was provided and most patients required additional sclerotherapy.[71]

Cryosurgery

The techniques of LSV cryostripping and cryosclerosis (where the vein is frozen *in situ* using liquid nitrogen) have been described as methods of treating LSV reflux in combination with sapheno-femoral ligation.[72] Recurrence rates for the former technique appear superior to those for cryosclerosis (4 versus >25% at 1 year).[72] Complications included haematoma formation, pigmentation (in up to 55% cryosclerosis patients), 'occasional nerve damage' and a single case of 'local necrosis' following cryosclerosis. It is unlikely that these techniques add anything to the current modalities available for varicose veins treatment.

Cost-effectiveness

There are no studies examining the cost-effectiveness of the different methods of treating varicose veins other than the cost-analysis in the study by Rautio comparing VNUS with surgery (described above). Logically, compression hosiery and sclerotherapy will result in the lowest cost but may be less successful than surgical treatments, either from the patients' perspective or in achieving long-term abolition of LSV reflux.

For the minimally invasive therapies the additional cost of catheters and a power source will increase the cost of treatment if this is performed in an operating theatre under general or regional anaesthesia since they will be additional to the costs of conventional surgery. However, when EVLT (and potentially VNUS) are performed as an outpatient 'office' procedure with follow-up sclerotherapy it is possible that these techniques may be more cost-effective than surgery.

Finally, whilst health-care providers are undoubtedly more focused on the direct costs of surgical instrumentation, the more rapid return to normal activity, including employment, reported following minimally invasive therapy for varicose veins should have a significant effect on the indirect costs of treatment.

Results of Surgery

Recovery

Unilateral varicose vein surgery is often performed as a day case procedure. Although this may also apply to bilateral surgery some surgeons suggest overnight stay or perform two separate day-case procedures. The latter increases treatment cost but is supported by the Royal College of Surgeons Guidelines (1992) which suggest that procedures likely to take >1 h generally require in-patient surgery.[73] Furthermore, up to 42% of patients may need overnight stay following planned day case surgery for bilateral varicose veins[74] and 88% of such patients prefer a single operation with overnight stay rather than staged surgery.[75]

A recent prospective study comparing recovery between unilateral and bilateral surgery found no difference in post-operative pain, analgesia use, post-operative stay, return to work and physical activity[67] although factors such as the type of employment or anaesthesia also influence when patients return to work.[76] Most patients require 2–3 weeks absence from

work after varicose vein surgery[67,76] and since most are either in employment or responsible for childcare, this is associated with considerable inconvenience and cost. It is a major disadvantage of conventional surgery.

Despite a period of relative immobility, analgesic usage after varicose vein surgery is relatively low with 42% patients requiring none,[77] and very low pain scores are reported after the first 48 h.[78]

Complications

Despite being a relatively minor procedure for a non-life-threatening condition varicose vein surgery is one of the commonest reasons for litigation, accounting for 17% of settled claims in general/vascular surgery, including the highest MDU settlement for these specialities between 1990 and 1998.[79] Furthermore, the NHS Litigation Authority (NHSLA) has paid almost £5.5 million in compensation to varicose vein patients since 1995.

Five to seven percent of cases suffer a cutaneous nerve injury, which is often temporary but can be permanent.[80] Most settled claims result from a failure to warn patients of this complication thus highlighting the importance of fully informed consent. More disabling nerve injuries may also occur with at least 12 cases of foot drop being recorded on the NHSLA database after sapheno-popliteal ligation. Ligation or injury to either the femoral vein or artery may also occur and are impossible to defend (Table 2).

Haematoma and wound infection are relatively common (up to 10%),[81] and although perhaps considered minor they delay return to work or normal activity. Thrombo-embolism is a potential risk following varicose vein surgery, but there is no firm evidence to suggest that this risk is greater than with comparable surgery, and the majority of vascular surgeons operate a selective policy on prophylactic heparin.[82] The quoted risk of pulmonary embolism is in the order of 0.2–0.5%.[83]

Recurrent varicose veins

Estimates of recurrence rates vary, depending on the length of follow-up, the definition of 'recurrence' and the primary method of treatment. These are summarised in Table 3. Thus recurrent reflux on duplex ultrasound is reported in 13–29% of patients following LSV stripping after 2–5 years[36,84,85] whilst Turton *et al.*[85] found new sites of reflux in 19% of patients 6 weeks post-operatively. By comparison 'clinical recurrence' is reported by 25–37% of patients after LSV stripping.[36,84,86] Nevertheless, several studies demonstrate that stripping reduces recurrence rates[36,84,86] although other techniques including closing the cribriform fascia by suture or PTFE patch are of unproven benefit.[87]

It must also be considered that recurrence may occur in some patients if pre-operative assessment has not excluded deep venous insufficiency. Whilst a pre-operative ultrasound scan is not mandatory it should certainly be performed when there is a history of a previous DVT. It is possible that the mechanism by which recurrence occurs will vary according to the initial treatment. Thus following SFJ ligation neovascularisation may be the commonest cause of recurrence, provided the initial surgery was performed effectively, whilst recanalisation may be more important following minimally invasive techniques. The latter may be more amenable to further treatment and might be associated with a differing risk of recurrence. Overall some 20% of operations are for recurrent varicose veins and these are associated with higher complication rates due to the technical difficulty of surgery.

Relief of symptoms

It is hard to quantify the placebo effect of surgery and impossible to design a double-blind randomised controlled trial comparing surgical with conservative treatment.

Early studies examining the efficacy of varicose vein surgery were thus limited to a comparison of pre and post-operative symptoms in individual patients. These studies indicated that surgery improved symptoms,[88] that sapheno-femoral ligation and LSV stripping was initially superior to high-tie and sclerotherapy in terms of cosmesis and persistent LSV reflux[37] and that patient satisfaction diminished from 86% patients at 1 year to 74% by 5 years.[89]

More recently scoring systems have been developed which allow a more accurate comparison between different treatment modalities. The CEAP score[90] and the venous clinical severity score (VCSS)[91] may be used by clinicians to assess the severity of venous disease based on clinical signs, anatomy, aetiology and pathology. The Aberdeen vein questionnaire, on the other hand, is a disease-specific quality of life questionnaire designed specifically for patients with varicose veins. It has been shown to have good validity and reliability.[92,93] When the latter was applied to 203 patients undergoing sapheno-femoral ligation, long saphenous vein stripping and multiple phlebectomies,

Table 2. Complication rates

Non-Surgical	
Compression hosiery	Care if peripheral vascular disease
Sclerotherapy[31,33]	Hyperpigmentation (10%)[31]
	Matting (<5%)
	Ulceration (0.2–0.9%)[31,33]
	DVT (0.02%)[31]
Ultrasound-guided sclerotherapy LSV	Transient visual disturbances (occasional)[107]
	Skin necrosis (occasional)[108]
	Cutaneous neuro-sensory loss (<1%)
	Phlebitis (incidence not known)
Minimally invasive	
Radiofrequency ablation (VNUS®)	Burn (2–7%)[47–50]
	Cutaneous neurosensory loss (4–20%)[47–49]
	Haematoma (<7%)[48]
	Bruising (about 50%)
	DVT (<1%)[109]
	Infection (<2%)[50]
	Phlebitis (3–20%)[48,50]
Endovenous laser treatment (EVLT®)	Haematoma—bruising very common
	Cutaneous neurosensory loss (<1%)[55]
	Hyperpigmentation (<4%)[110]
	Thrombophlebitis (<6%)[55,110]
	DVT—no reports
Surgery	
Sapheno-femoral ligation and stripping LSV to knee	Haematoma (<30%)[48]
	Cutaneous neurosensory loss (4–25%)[80,84,111]
	Wound infection (2–15%)[81,111]
	DVT (<2%)[52]
Transilluminated powered phlebectomy (TIPP, TriVex®)	Haematoma (5–12%)[67]
	Cutaneous neurosensory loss (5%)[66]
	Hyperpigmentation (<2.4%)[67]
Ambulatory conservative haemodynamic management (ACHM or CHIVA)	Few reported
Endovenous diathermy	Burn (1–2%)[70]
	Cutaneous neurosensory loss (<20%)[70]
	Also reports of common peroneal nerve injury
Cryosurgery	Haematoma (<30%)[72]
	Pigmentation (<55%)[72]
	Also reports of 'local necrosis' and local nerve damage[72]

a statistically significant improvement in the score was recorded at up to 2 years following surgery.[94]

General health-related quality of life has also been assessed using the short-form 36 questionnaire following varicose vein surgery. Although most studies show some improvement this does not always reach significance reflecting that generic quality of life measures are less sensitive than disease-specific tools.[93]

Although trials suggest that surgery improves both symptoms and quality of life for varicose veins patients none include a non-surgical control group.

Prevention of ulceration

Venous ulceration accounts for the majority of leg ulcers in the UK with a prevalence of 8–10 per 1000 of the population.[6] Although early reports suggested that ulcers only occurred in the presence of deep or perforator reflux, subsequent work, including Duplex studies, have shown that isolated superficial incompetence is responsible for this complication in 23–53% of sufferers.[95–97] Furthermore, modern DVT treatment may reduce the frequency of 'post-thrombotic' limb[98] thus increasing the proportion of ulcers that are secondary to superficial incompetence. Overall the commonest pattern of reflux is combined superficial, deep and perforating incompetence[95] although two recent studies suggest that treatment of the former may improve deep venous haemodynamics.[99,100]

To determine whether surgery prevents later ulceration would require a large study of patients with varicose veins randomised to surgery or observation with long-term follow-up. The logistic difficulties of such a trial (recruitment, loss to follow-up, duration of study, relatively small number of 'events') make this impractical.

Whilst it might be difficult to confirm a role for superficial venous surgery in preventing venous ulcers it is much easier to assess its effect on healing rates or on the risk of recurrent ulceration for surgery

Table 3. Recurrence rates for different treatments

	Duplex	Clinical	Re-treatment rates
Non-surgical			
Compression hosiery	N/A	N/A	N/A
Sclerotherapy	Not known	64% (3 years)[34] 90% (5 years)[112] 15% (6 years)[113]	22% (3 years)[114] 40% (5 years)[115]
Minimally invasive			
Ultrasound guided sclerotherapy LSV	24% (1 year)[116] 75% (2 years)[44] 18% (10 years)[43]	36% (2 years)[116]	Not known
Radiofrequency ablation (VNUS®)	10% (9 months)[117]	5% (6 months)[109] 3.8% (1 year)[49] 14% (2 years)[118]	Not known
Endovenous laser treatment (EVLT®)	1–2%(6 months)[55] <7% (3 years)[56]	Not known	Not known
Surgery			
Sapheno-femoral ligation and LSV stripping (to knee)	19% (6 weeks) and 15% (1 year)[85] 13% (2 years)[84] 29% (5 years)[36]	25% (2 years)[84] 37% (3 years)[86] 21% (5 years)[36]	6% (2 years)[84]
ACHM or CHIVA	35% (3 years)[62]	22% (3 years)[62]	Not known
Transilluminated powered phlebectomy	Not known	Not known	Not known
Endovenous diathermy	Not known	Not known	Not known
Cryosurgery	Not known	4% (1 year)[72]	Not known

performed once an ulcer has healed with compression therapy.

Two studies have examined the role of surgery in promoting ulcer healing. Scriven *et al.* assessed the benefit of SFJ ligation under local anaesthesia in 24 patients who had had ulcers for a median of 2 years and were unfit for general anaesthesia. In those with isolated saphenous reflux a significant improvement in ambulatory venous pressure (AVP) occurred and all ulcers healed at a median of 81 days without compression bandaging. For patients with both deep and superficial venous incompetence only 3 out of 9 ulcers healed after a median of 16.5 months despite compression bandaging after surgery. No data was given for recurrence rates.[101]

A further study has examined the impact of a specialised leg ulcer service on ulcer healing and recurrence. Following a venous duplex, surgery was offered to patients with superficial venous insufficiency. Of 39% with superficial incompetence alone healing rates were similar at 3 months (53%) for both operation and compression bandaging. However, recurrent ulcers were significantly more common (50 versus 9%) at 1 year in patients who declined surgery.[102]

In summary, there is fairly strong evidence to support a role for surgery in reducing ulcer recurrence among patients with superficial venous insufficiency. Whilst it may also enhance the chances of healing in some patients most pure venous ulcers respond to compression bandaging.[103]

Other complications

Surgery is generally advised for treatment or secondary prevention of other complications of varicose veins that are either less serious (e.g. phlebitis) or less frequent (e.g. bleeding) than ulceration in order to prevent further problems. However, there is no evidence to support the use of operation in the primary prevention of these events. Similarly there is no firm evidence that varicose veins alone are a risk factor for DVT[82] and thus simple reassurance should be all that is required for patients expressing these concerns.[104]

Cosmesis

Whilst a few patients seek treatment for varicose veins because they are unsightly, it may be the principal incentive for treatment in many who complain of other symptoms.[89] Furthermore, 55% of members of the Vascular Surgical Society of Great Britain and Ireland consider 'cosmetic varicose veins' an appropriate indication for venous surgery[4] although there is little objective data on the effect of surgery on this.

Although surgery is more invasive than sclerotherapy, a randomised trial comparing the two reported a better cosmetic result at 3 years in the surgical group. Interestingly, patients rated their cosmetic result more highly than their surgeons.[37]

It has been suggested that surgery performed with a tourniquet might improve the cosmetic result from

operation[105] although this is debated.[78] Careful surgery with small phlebectomy incisions is likely to be more important.

Other studies have examined patient satisfaction after surgery, which may be influenced by both improved cosmesis and symptom relief. Measures of satisfaction are difficult to employ and the techniques used in most studies are likely to have skewed results in a positive way.

Davies *et al.* sent a simple postal questionnaire to 456 patients up to ten years after surgery. Although 'overall' satisfaction was expressed by 79% of patients and more than two thirds reported a symptomatic improvement only 23% reported 'complete' satisfaction. Dissatisfaction was associated with being treated in NHS rather than independent hospitals and this might reflect the grade of operating surgeon.[106] Other studies quote satisfaction rates of 85–90% although it is not always clear how this was measured.[36] Finally, satisfaction may be higher following stripping as opposed to either sapheno-femoral ligation alone or sclerotherapy.[36]

Summary

Compression hosiery improves symptoms and haemodynamics and is useful in patients who are either unfit or decline more invasive therapy. Long-term efficacy is limited by poor compliance.

Sclerotherapy is effective in the absence of LSV reflux and is both cheap and relatively non-invasive. Ultrasound-guided long saphenous sclerotherapy seems to have disappointingly high recurrence rates compared to data from non-randomised studies of other endovenous techniques.

Although there are no placebo-controlled trials, surgical treatment for varicose veins seems to:

i. relieve symptoms and improve disease-related quality of life
ii. have a role in the secondary prevention of venous ulceration
iii. provide a cosmetic improvement which is almost certainly operator-dependent
iv. be associated with minor complications which are relatively common
v. be associated with major neurosensory or vascular complications which are very rare
vi. be associated with a definite but variable risk of recurrence.

Outcome data on the newer, less invasive interventions is generally less extensive than that for conventional surgery and is largely limited to small, non-randomised studies with limited follow-up. However, both radiofrequency and endovenous laser ablation of the LSV have been approved by the National Institute for Clinical Excellence (NICE) for routine clinical use in the UK. The clinical results for both techniques are similar although long-term follow-up is required. Whilst radiofrequency ablation it is usually performed under general anaesthetic and is limited to LSV of <12 mm diameter, endovenous laser treatment is performed under local anaesthetic and is equally effective for veins of >12 mm diameter. As a result, it offers potential benefits in terms of cost (disposables, staffing, work absence) and recovery time.

Of the other techniques reviewed CHIVA appears both complex and to have high recurrence rates, diathermy sclerosis and cryosurgery are associated with their own complications and confer no obvious advantage whilst transilluminated powered phlebectomy (TriVex™) seems to increase both operative time, cost, and haematoma development without major benefit in most patients. Although it might be useful in selected patients with skin changes and friable veins (particularly recurrences) NICE have indicated that there are still uncertainties regarding both efficacy and safety and it is therefore inappropriate for routine clinical use.

Conclusion

Currently sapheno-femoral ligation, long saphenous veins stripping and multiple stab avulsions remain the gold standard for treatment of varicose veins with sapheno-femoral incompetence and long saphenous vein reflux. However, in the quest for a less invasive treatment for this common yet non-life-threatening condition several alternatives are emerging. The most promising of these is endovenous treatment with either radiofrequency or laser ablation of the LSV. Their future role in the management of varicose veins will depend upon the balance of their obvious advantages against long-term recurrence rates. In an NHS increasingly focussed on patient choice, it may be the patient who makes the final decision.

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