Subfascial endoscopic perforator surgery: a review

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Approximately 1–2% of the UK population suffers from venous ulcers. Incompetent perforator leg veins are thought to be a major contributory factor. Subfascial endoscopic perforator surgery treats incompetent perforators in a minimally invasive fashion with significant improvement in wound healing and reduction in ulcer recurrence rates.

Chronic venous insufficiency (CVI) is a well-recognized cause of morbidity in the Western world. Approximately 0.5% of the UK population are estimated to have CVI (Boyd et al, 1952) with 1–2% of the population affected by venous ulceration at some stage of their lives (Frank et al, 1992). In the USA more than 2.5 million of the population have CVI, and at least 500 000 have venous ulcers at some point in their lives (Mozes et al, 1996).

In 1938, Linton described subfascial dissection and ligation of perforating veins of the calf. The operation was later modified but was nevertheless plagued with wound complications and prolonged hospitalization. Such poor results reduced the popularity of this procedure (Cockett and Jones, 1953).

The idea of approaching perforator veins from a remote site led doctors to attempt subfascial vein avulsion using shearing instruments. In the mid 1980s, Hauer and Fisher explored the idea of endoscopic perforator vein surgery. The North American Subfascial Endoscopic Perforator (NASEP) registry was formed in 1993, in 17 institutions in the US and Canada, to evaluate the results of endoscopic intervention for CVI and venous ulcers. Its other purpose was to assess early and late outcomes of such an intervention.

The anatomy and pathophysiology of perforator veins is poorly understood. However, no review article on subfascial endoscopic perforator surgery (SEPS) would be complete without a brief mention of the anatomy, physiology and pathology of the venous system of the lower limb. The description below is vital to the understanding of SEPS.

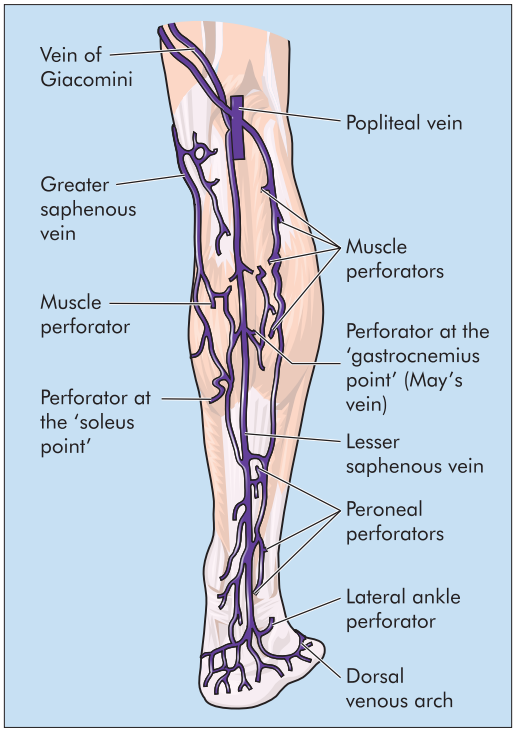
ANATOMY

Linton (1938)'s original description used the term 'communicating veins' to describe the main venous trunks. These connect the superficial system with the deep venous system, which drains the gastrocnemius and soleus muscles. The term 'communicating' was replaced by 'perforator' and is now reserved for venous tributaries that connect veins within the same system, i.e. veins within the superficial system or within the deep system.

Perforator veins are divided into anterior, medial and lateral groups (*Figures 1* and *2*):

- Anterior perforators located on the anterolateral surface of the lower leg connect the long and short saphenous systems to the anterior tibial veins

Figure 1. Perforating veins of the posterior leg.



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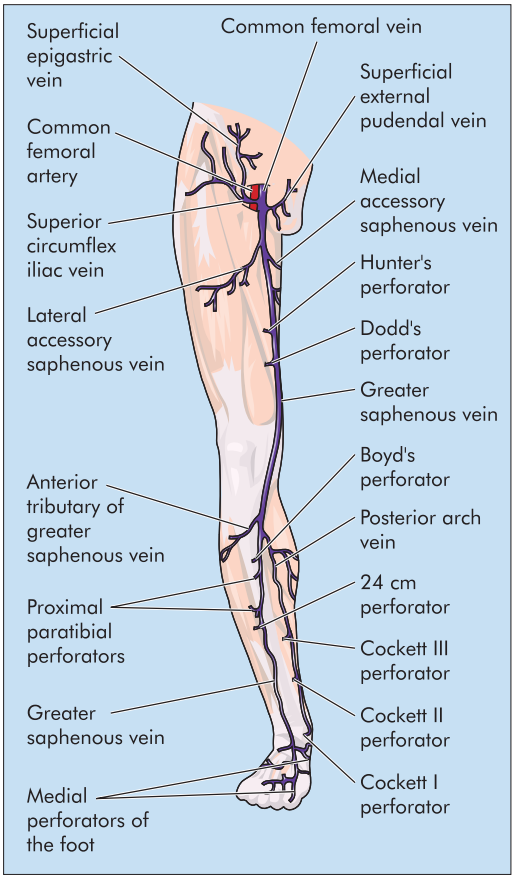
- Medial perforators mainly connect the superficial system to the posterior tibial veins; at least five groups of medial perforators were described by Mozes et al (1996), defined by the distance from the lower edge of the medial malleolus. These are the Cockett II perforator located 7–9 cm from the lower edge of the medial malleolus, Cockett III perforator located 10–12 cm from the lower edge of medial malleolus and three groups of paratibial perforators in the proximal leg found 18–22 cm, 23–27 cm and 28–32 cm from the medial malleolus
- Lateral perforators comprise popliteal and peroneal perforators and are situated on the posterolateral surface of the lower leg.

Other investigators have described medial perforators such as the Cockett I and the Boyd's perforator (O'Donnell, 1992). The Cockett I is a retromalleolar group of perforator veins, whereas the Boyd's perforator is located at the level of tibial tuberosity about 10 cm below the knee joint. Other perforators such as the Hunterian and Dodd's perforators are located in the thigh. Approximately 80% of incompetent perforator veins involves the medial group, 15% the lateral group and 5% the anterior group.

Figure 2. Perforating veins of the medial leg.



PATHOPHYSIOLOGY

Under normal physiological conditions the intact valves of the perforator veins and their oblique course through muscle and fascia protects the skin and subcutaneous tissue from systolic pressures of 150–300 mmHg generated by the calf muscle pump. Perforator vein incompetence will thus allow reverse flow from deep to superficial veins, giving rise to chronic ambulatory venous hypertension, which leads to venous ulceration.

Different theories have been hypothesized to explain this chain of events. The most current of these is the 'white cell trapping theory' (Moyses et al, 1987). According to this theory the skin changes of CVI are related to the sequestration of white blood cells in the skin, secondary to venous hypertension. Activated white cells accumulate in the dilated venules, which present a large surface area of endothelium. The trapped cells release free radicals, proteolytic enzymes and chemotactic factors, which attract more white cells. These metabolites and enzymes activate the coagulation and complement cascades thus increasing the permeability of the capillaries allowing large molecules to pass into pericapillary space. This results in localized damage to the tissues along with occlusion of the capillaries with leukocytes and platelet clumps, leading to ischaemia and ulceration.

The causes of perforator vein incompetence remains far from clear. Long-standing saphenous incompetence, local trauma and minor undetected calf vein thrombosis are thought to be some of the contributing factors. In 1988, four classes of CVI were described by the Ad Hoc Committee for Reporting Standards of the Society of Vascular Surgery and the North American Chapter of the International Cardiovascular Society, later modified in 1995 (Porter and Montea, 1995) (*Tables 1* and *2*).

PERFORATOR VEIN SURGERY

It is well recognized that dysfunction of superficial, perforator or deep venous systems, either alone or in combination, leads to skin changes and ulceration. However, the most important aetiological factor is thought to be the malfunction of perforator veins (Hauer et al, 1988; Labropoulos et al, 1995). A clear association between missed or recurrent perforators and ulcer recurrence has been demonstrated. Studies have also shown that normal competent perforator veins may enlarge in the presence of superficial reflux, thereby becoming incompetent (Labropoulos et al, 1995).

The open subfascial perforator vein interruption originally described by Linton was fraught with wound complications, mainly because the inci-

sions go through skin which is already compromised by eczematous changes and hardened subcutaneous tissue. Delayed wound healing, wound infections, deep vein thrombosis, flap necrosis and prolonged hospitalization have all been reported, with the incidence of wound infections reported as high as 58% (Puts and Gruwez, 1993).

ENDOSCOPIC PERFORATOR VEIN SURGERY

Operative technique

The limb is exsanguinated with an Esmarque bandage and a thigh tourniquet is inflated to 300 mmHg to provide a bloodless field. Two or three endoscopic ports (a 10 mm and two 5 mm) are placed in the subfascial space in the calf, through two small incisions made remote from the area of ulceration. A space maker balloon is inflated in the subfascial space to improve access and carbon dioxide is insuffulated to facilitate dissection. The incompetent perforator veins are clipped and divided with endoscopic scissors or an ultrasound coagulator. All medial perforator veins in the superficial and deep posterior compartment are divided.

To establish the efficacy of SEPS over the open procedures and medical conservative therapy, this procedure needs to show better results than open procedures in terms of fewer wound complications, better ulcer healing rates and a decreased rate of ulcer recurrence. Many of the trials regarding SEPS have tackled more than one of these issues; however, this article attempts to present them in sections for convenient reading.

Reported ulcer healing rates and recurrent ulceration with SEPS: The North American Registry published their preliminary results in 1997 (Gloviczki et al, 1997): SEPS was performed in 155 limbs, and after a mean follow-up period of 5.5 months ulcers healed in 88% of cases. The recurrence rate was reported at about 3%. When compared with the optimal medical management alone, the rate of healing was four times greater following SEPS. There were no deaths nor clinically detected thromboembolism in this series, and wound complications were minimal (6%) as compared to open techniques. However, this report was non-randomized and many of the patients also used compression stockings, questioning the efficacy of SEPS alone.

Iafrati et al (1997) reported a complete ulcer healing rate of 57% at a mean of 14 weeks, although numbers were small (18 procedures in 15 patients); six patients had concomitant long saphenous vein ligation as well as stripping. The authors concluded that although the operating room cost of SEPS was higher than the open procedure ($2570 *vs* $1883) this would probably be offset by shortened length of stay and decreased number of wound complications. The ulcer recurrence rate published by Bergan et al (1996) was as low as 10–20%, this being a marked improvement on rates of 22–69% at 1 year after conservative management.

In a randomized controlled trial Pierik et al (1997) compared SEPS with modified open Linton's procedure. They concluded that the ulcer healing was similar in both groups, although morbidity was lower in patients having SEPS. The preliminary report by Gloviczki et al (1996) described 11 limbs in nine patients having SEPS. With a mean follow-up period of 9.7 months, the ulcer healed or did not recur in seven limbs, in three limbs the ulceration improved and in one it was unchanged. Olivencia (2000) carried out a literature survey of 428 active ulcer treatments with SEPS. He reported that 79% of the active ulcers healed in 2.3 months with a range of 21 days to 5.4 months, and 6.5% of the active ulcers did not heal. Lacroix et al (1998) did a ret-

TABLE 1.
Classification of chronic venous insuffiency (CVI) by clinical severity

Class	Type of CVI	Signs and symptoms
0	Asymptomatic	Nil
I	Mild	Mild to moderate swelling, mild discomfort, local or generalized dilatation of subcutaneous veins
II	Moderate	Hyper-pigmentation, moderate brawny oedema, subcutaneous fibrosis
III	Severe	Chronic distal leg pain with ulcerative or pre-ulcerative skin changes, eczematoid changes, and/or severe oedema

TABLE 2.
Revised classification of chronic venous insuffiency

Class	Definition
C	Clinical signs (grade 0–6), supplemented by 'A' for asymptomatic and 'S' for symptomatic presentation
	0 no visible or palpable signs of venous disease
	1 telangiectases or reticular veins
	2 varicose veins
	3 oedema
	4 skin changes ascribed to venous disease (e.g. pigmentation, venous eczema, lipodermatosclerosis)
	5 skin changes as defined above + healed ulceration
	6 skin changes as defined above + active ulceration
E	Aetiological classification (congenital, primary, secondary)
A	Anatomical distribution (superficial, deep, or perforator, alone or in combination)
P	Pathophysiological dysfunction (reflux or obstruction, alone or in combination)

rospective comparison between three groups: patients having open surgery, patients with SEPS using a mediastinoscope and patients with SEPS using a laparoscope. They found no difference between ulcer healing and recurrence rates between the groups.

Wound complications and postoperative morbidity: Hauer (1988) was the first to introduce an endoscopic technique for division of perforator veins. Performing SEPS (called endoscopic subfascial dissection of perforating veins; ESDP) on 318 patients (462 legs), he reported a 78–93% good to very good result depending on the clinical parameter applied after a 14-month follow-up period. A later report by the same group claims the virtual eradication of wound complications using SEPS (Hauer et al, 1999).

In one study (Jugenheimer and Junginger, 1992) 72 patients (103 legs) underwent the SEPS procedure, SEPS being performed in combination with conventional long saphenous ligation in 97 legs. Postoperative delayed wound healing was seen in only three legs, with subcutaneous haematoma in six. After a mean follow-up interval of 2 years, regression in changes associated with grade I and II CVI (class 4–5 CEAP: clinical sign, aetiology, anatomy, pathophysiology) was seen in patients who fell into this category preoperatively. Of 17 active ulcers 16 healed completely (grade III CVI/class 6 CEAP).

Baron et al (2001) suggested that if the SEPS procedure is incorporated into an overall treatment plan for patients with CVI, it produces active healing with a minimum of postoperative complications. Their experience was based on 45 SEPS procedures with a healing rate of 90% at 9 weeks: no new ulcers developed at a mean follow up of 44 weeks. When SEPS was performed as an outpatient procedure on 19 limbs, with 15 patients having concomitant long saphenous vein stripping, the mean time to healing was 30.5 days. Minor postoperative complications occurred in only four limbs, and no ulcer recurrence was seen after a mean follow-up period of 8.6 months.

Limitation of SEPS: Rhodes et al (1998) studied 57 SEPS procedures carried out on 48 patients to identify risk factors associated with poor ulcer healing and recurrent ulceration after SEPS. In this study, SEPS was unable to prevent new or recurrent ulceration in 9% of cases. The authors concluded that venous outflow obstruction (post-thrombotic limbs), multilevel deep venous reflux and ulcer size >2 cm were all associated with ulcer recurrence and delayed healing. Tibial nerve damage after SEPS is a possible complication with the patient complaining of numbness in the sole of the foot in the distribution of the nerve.

Role of concomitant saphenous vein surgery with SEPS: A lot of interest has been shown in concomitant saphenous vein surgery and SEPS, which has shown better results than SEPS alone. Stuart et al (1998) concluded that in patients with coexistent deep venous reflux, saphenous vein surgery should be combined with SEPS to correct the pathological outward flow. A study by Darke and Penfold (1992) recruited 213 patients with venous ulceration. The authors demonstrated that nearly 40% of venous ulcers can be ascribed to a combination of incompetence of saphenous and ankle perforating veins. They also showed that medium-term healing can be achieved in at least 90% of ulcers by saphenous ligation alone. It has been emphasized that SEPS should be used in conjunction with immediate postoperative compression therapy for best results.

In 1999, the NASEP registry published midterm results of SEPS on the cohort of patients from their previous study (Gloviczki et al, 1999). During a mean follow-up of 24 months signs and symptoms of CVI improved significantly in most patients as measured by their clinical scores. Cumulative ulcer healing was 88% by 1 year and 95% by 2 years; ulcer recurrence rate at 1 year was 16% and at 2 years was 28%. Two interesting conclusions were drawn from this trial: first, when SEPS was performed concomitantly with ablation of superficial reflux with conventional surgery, a significant improvement in ulcer healing rate was seen as compared to SEPS alone. Second, ulcer healing time, recurrence of ulceration and new ulcer formation rate were higher in patients with post-phlebitic limbs and evidence of residual deep venous occlusion compared to patients with primary incompetence only. In this post-thrombotic group, 84% of ulcers healed at a median time of 54 days. This is important, because these same ulcers failed to heal in 101 patients (69%) before surgery, in spite of an estimated 75% good to excellent compliance with non-operative measures.

INDICATIONS FOR SEPS

SEPS is still looked upon with a great degree of scepticism by its critics, however, proponents suggest the following as possible indications for SEPS:

- Advanced class CEAP class 4 or 5 (class II CVI) as denoted by hyperpigmentation, eczematous skin changes and liposclerosis of subcutaneous fat
- CEAP class 6 (class III CVI), as signified by frank ulceration.

It must be borne in mind, however, that there are no randomized controlled trials to back these up.

Contraindications include associated chronic arterial occlusive disease, infected ulcer, morbid obesity and non-ambulatory or high-risk patients.

CONCLUDING REMARKS

SEPS remains a procedure in evolution, there being no large randomized controlled trials establishing the efficacy of this technique. The NASEP registry has addressed many of the contentious issues regarding SEPS. The contribution of pure perforator incompetence to the genesis of CVI is not clearly understood, superficial and deep venous incompetence invariably playing a part. NASEP emphasized the importance of superficial venous ligation along with SEPS in the treatment of CVI and venous ulceration, a view endorsed by others. Patients with post-phlebitic limbs do not respond well to SEPS, remaining vulnerable to recurrent ulceration. However, even this group showed an improvement in clinical score, and recurrent ulcers were seldom multiple and always less than 2 cm in size.

SEPS has also been widely compared with conservative measures for treatment of CVI and venous ulceration. However, conservative measures have reported initial treatment failure and recurrence rates of between 54 and 69% in 1–3 years of follow up. SEPS has shown a definite marked improvement in wound complications and recovery rates.

SEPS in conjugation with saphenous vein surgery appears to provide definite advantages over both conventional open surgery and conservative management in patients with clinically significant CVI. There is a need for randomized controlled trials to establish the efficacy of this procedure over best medical management and treatment with or without concomitant saphenous vein surgery. **HM**

Conflict of interest: none.

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KEY POINTS

- Chronic venous insufficiency (CVI) is a major cause of morbidity in the Western world, with 1–2% of the UK population being affected by venous ulceration at some stage of their lives.
- Perforator vein incompetence is thought to be a major factor in the chain of events leading to CVI. Open surgery for perforator vein interruption carries a high incidence of wound complications.
- Subfascial endoscopic perforator surgery (SEPS) has significantly reduced the incidence of wound complications when compared with open surgery. The rate of ulcer recurrence has also fallen considerably at 1–3-year follow up.
- SEPS has demonstrated better results when combined with conventional superficial venous surgery for class 4–6 CVI. However, patients with previous deep vein thrombosis have shown no significant improvement with SEPS as compared with other techniques.
- To date no large randomized controlled trials have been conducted to establish the true efficacy of this technique.