

REVIEW

Nerve Injuries and Varicose Vein Surgery

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Introduction

Varicose vein (VV) surgery remains one of the commonest surgical operations performed across Europe. In the UK, it is also the commonest single cause of medico-legal action against general and vascular surgeons.¹ Most of these actions appear to arise because patients have a poor understanding of the risks and benefits of intervention and are, therefore, surprised and aggrieved when the end-result (cosmetic improvement and/or symptom relief) is less satisfactory than they expected, or they suffer from unexpected complications. In the majority of cases, this situation arises because the surgeon has failed, either consciously or sub-consciously, to properly inform their patient of the risks and benefits. There are a number of reasons why this might happen including a lack of time and/or a wish not to cause unnecessary patient anxiety. The latter may be due to a genuine desire on the part of the surgeon not to alarm the patient or for fear that admitting to complications and occasional poor results may damage practice and livelihood. Another reason why surgeons may not be in a position to discuss their complication rates with their patients is ignorance. As most surgeons do not follow-up their VV patients, they usually lack valid personal audit data with regard to medium and long-term outcomes. This, together with a natural reluctance to publish anything other than excellent results, means that the true risks associated with VV surgery

are surprisingly poorly documented in the literature. Probably, the most honest account of the morbidity associated with VV surgery remains Corbett's personal series of almost a 1000 limbs in ~600 patients.² Although, in this large prospectively documented consecutive series, major morbidity and complications were extremely low, there was a significant incidence of minor morbidity (17% patients) and, in particular, neurological complications (11% patients).

In the UK, the commonest single cause of litigation following VV surgery is alleged injury to cutaneous sensory, specifically the saphenous and sural, nerves.¹ However, as discussed above the true incidence and, most importantly, natural history of such injuries are poorly described. This means that surgeons have limited information to pass on to their patients and that the questions most frequently posed to 'expert witnesses' in medico-legal cases are difficult to answer with authority. For example, does objective evidence of nerve injury constitute a 'breach of duty' or should nerve injury be regarded as unavoidable consequence of VV surgery that can occur even in the best of hands? What is the true incidence of nerve injury after VV surgery? Why should the majority of people with nerve injury remain relatively asymptomatic while a small minority develop a chronic dysaesthetic pain syndrome such as saphenous nerve neuritis? If nerve injury is apparent following VV surgery, what should the patient be told about its likely resolution or chronicity? Is specific treatment ever indicated; for example, nerve repair? What reasonable steps can the competent surgeon be expected to take in order to

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minimise the risk of nerve injury and can this risk ever be reduced to zero?

The aim of this review is critically to analyse the literature pertaining to nerve injury and VV surgery. Firstly, in order to provide answers to these and other important questions and, secondly, where answers are not forthcoming, to suggest ways in which these gaps in our knowledge might be filled.

Long saphenous surgery and the saphenous nerve

The standard operation for long saphenous vein (LSV) VV involves disconnection of the saphenofemoral junction (SFJ), stripping of the LSV to just below the knee and multiple stab avulsions (MSAs) according to preoperative marking.³ Several randomised, controlled trials have proved beyond reasonable doubt that failure to strip the LSV, at least to the level of the knee, is associated with an unacceptable incidence of recurrence⁴ and sub-optimal results in terms of health-related quality of life (HR-QoL) and haemodynamic improvement.⁵

Anatomy

The saphenous nerve (L3, 4) descends with the superficial femoral artery and pierces the roof of the lower quarter of the adductor canal where it comes to lie deep to sartorius (Fig. 1). Here it gives off an infrapatellar branch through that muscle to supply the skin medial to the knee and distal to the patellar. The main nerve pierces the deep fascia (fascia lata) just above the knee and appears in the superficial tissues at the level of the knee between sartorius and gracilis. At this point, the nerve lies deep and posterior to the LSV, separated from it by subcutaneous fat. Below this level the nerve gets progressively more superficial and anterior and eventually becomes juxtaposed to the LSV. This occurs at a variable point but most commonly about 2–3 cm below and medial to the tibial tuberosity where the LSV receives the anterior and posterior arch veins (the crow's foot) and the Boyd perforator. Below this level the nerve and its branches are often wrapped around the LSV and its tributaries making virtually impossible the removal of the latter without damaging the former. The nerve supplies branches to the skin of the medial surface of the calf and ends in the skin of the medial surface of the foot.

The typical area of sensory loss caused by damage to the saphenous nerve lies on the medial aspect of the calf, above the medial malleolus (Fig. 2). Smaller areas of patches of cutaneous numbness not within this area

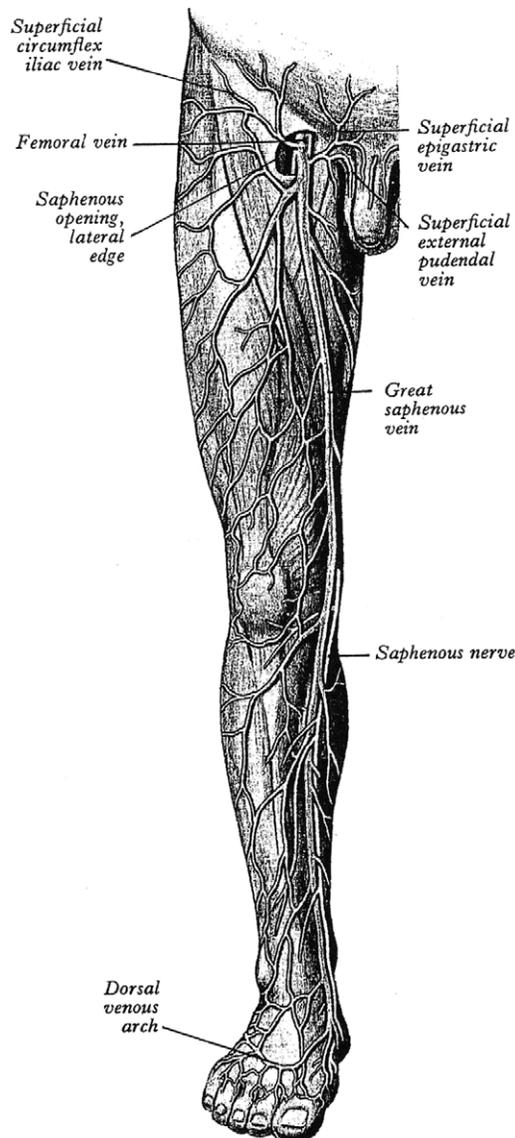


Fig. 1. The relationship of the saphenous nerve and long (great) saphenous vein in the lower limb. Reproduced with kind permission from Gray's Anatomy 38th Edition, Elsevier Science Ltd, 1995 Fig 10.176 p 1596.

are due to the interruption of minor cutaneous nerves and, as such, are not true saphenous nerve injuries. They occur usually as a consequence of MSAs and are probably unavoidable.

What is the incidence of saphenous nerve injury if the LSV is stripped to the ankle?

In the past, when standard practice was to strip the LSV from ankle to groin, up to 50% of patients suffered saphenous nerve injury on blind, objective testing.^{6,7}

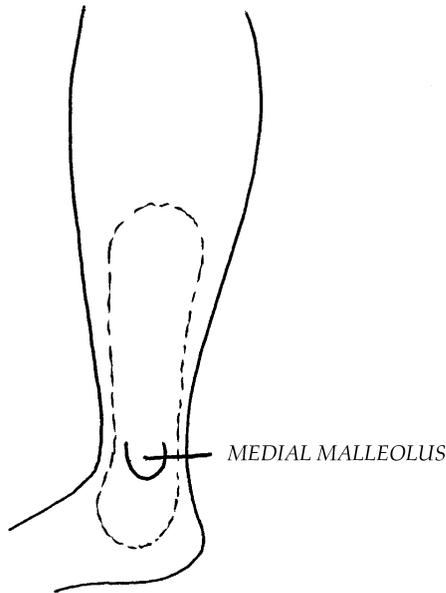


Fig. 2. Typical area of sensory loss with saphenous nerve injury.

Does the direction of stripping matter?

It has been suggested that stripping the LSV from groin to ankle, rather than from ankle to groin, would reduce the incidence of saphenous nerve injury. This is because the nerve often straddles the point where tributaries join the main LSV in an inverted 'V'⁶ (Fig. 3) so that, as the head of the stripper is drawn cranially,

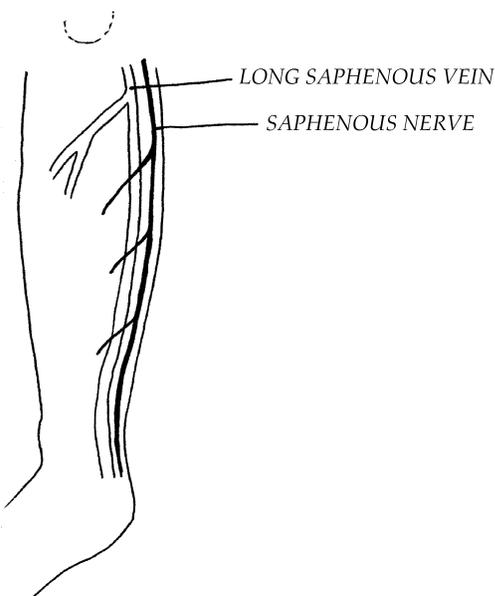


Fig. 3. Arrangement of the branches of the saphenous nerve straddling the LSV in the calf, leading to avulsion on cranial directed stripping of the LSV from the ankle.

the nerve is avulsed along with those tributaries. A number of studies appear to confirm this contention although incidence of sensory loss remains significant, varying from 4 to 23% on objective testing.^{6,8,9}

Is it necessary to strip the LSV?

Perhaps, because of concerns about nerve injury, as well as haematoma formation, a significant proportion of surgeons (up to 18% surveyed) chose not to strip LSV at all.³ However, there is now overwhelming evidence to show that failure to strip the LSV, at least to the level of the knee (please see below), is associated with an unacceptable rate of recurrence⁴ and a negative impact upon deep venous reflux and HR-QoL.⁵

Is stripping of the LSV to the knee associated with a lower incidence of saphenous nerve injury?

As the saphenous nerve normally only joins the LSV in the calf, and because the LSV in the calf is itself rarely varicose, stripping of the LSV to just below the knee has been viewed by many as the optimum balance of risks and benefits.³ In a randomised trial comparing partial (from groin to 4 cm below the level of the knee joint) with complete (groin to ankle) LSV stripping using the standard stripper, at 3 months the former was associated with a significantly lower (7% vs. 39%) incidence of saphenous nerve injury on blinded, independent assessment. As additional procedures, including short saphenous vein (SSV) surgery, perforating vein ligation and MSA were performed with similar frequency in both groups it was reasonably concluded that the improved results were due to the partial LSV stripping.¹⁰ In another randomised trial comparing LSV stripping to the knee with no stripping, the overall prevalence of saphenous nerve injury was 8% with no difference between groups. However, in this study, details of how the assessments were made and whether the assessor was blinded were not provided.¹¹ On the basis of these rather limited data, it is now standard UK practice to strip to the level of the knee joint.

Are there any disadvantages in only stripping the LSV to the knee?

It is not known whether stripping the LSV to the knee, as opposed to the ankle, is associated with a higher incidence of recurrent VV. However, a significant number of patients with VV do have significant reflux

in the below knee LSV and its major tributaries. Furthermore, there are data to suggest that failure to deal with such reflux leads to persistent incompetence in medial calf perforators, and a failure to correct deep reflux and overall venous haemodynamics.^{5,12} This is an area worthy of further study.

Can the incidence saphenous nerve injury be reduced still further?

Inversion stripping

Two early series suggested that the use of rigid (PIN) stripper¹³ could virtually eliminate the incidence of saphenous (and sural nerve injury) in the course of LSV (and SSV) inversion stripping.^{14,15} In a randomised trial, Durkin *et al.*¹⁶ reported that 1 week post-operatively there were three cases of saphenous nerve injury in 33 patients undergoing conventional, and one in 43 patients undergoing PIN, stripping to the knee (9.1% vs. 2.3%). However, the assessment methods are incompletely described and there was no longer-term follow-up. A further randomised trial reported a 13% incidence of saphenous nerve injury in the PIN group compared with 17% (not significant) in the conventional group.¹⁷ However, there are a number of factors that limit the interpretation of these data. For example, in patients stripped to the knee the incidence of saphenous nerve injury was 19% (conventional) and 6% (PIN), while the incidence in those patients stripped to the ankle was 11% (conventional) and 25% (PIN). Unfortunately, the numbers of patients are too small to ascribe any statistical or clinical significance to these apparent differences. It is also important to note that as the data were analysed on an 'intention to treat' basis, the PIN group includes patients in whom inversion stripping (especially to the ankle) had failed and there was recourse to the conventional method. A more recent randomised trial comparing conventional stripping with PIN stripping (68 patients in each group, primary VV only) found no cases of saphenous nerve injury in either group at 1 week follow-up.¹⁸ In summary, while inversion stripping may be an attractive technique and offer a number of theoretical advantages over conventional stripping, there are no compelling data to suggest that it reduces saphenous nerve injury and larger, more methodologically robust, trials would be required to answer this question definitively.

Sequential avulsion of the LSV

A randomised trial of comparing sequential avulsion ($n = 40$) with conventional stripping of the LSV to the knee ($n = 40$) found the former was associated with

significantly less pain at 1 week post-operatively. However, when assessed at 6 weeks, there were only three cases of minor sensory loss in the saphenous nerve distribution, two of which were in the conventional stripping group. Once again, how the assessments were made is unclear.¹⁹

Radio frequency ablation (VNUS)

In this technique, the LSV is occluded by heating the vessel wall to $\sim 85^\circ\text{C}$ using radiofrequency energy.²⁰ Registry data reported the presence of paraesthesia in 43/286 (15%) of limbs at 1 week, 21/233 (9.4%) at 6 months, 9/232 (3.9%) at 12 months and 8/142 (5.6%) at 2 years. When the LSV was ablated to the level of the knee, paraesthesia was recorded in 5/179 (2.8%) and 5/111 (4.5%) limbs at 12 and 24 months. This compares with 4/53 (7.5%) and 3/31 (9.7%), respectively when the LSV was ablated to the level of the ankle. However, these data were collected from 31 sites worldwide and the assessment methods were not specified.²¹ Other groups using the VNUS technique have reported: no paraesthesia in a series of 41 legs;²² a prevalence of 8.5% (12/140);²⁰ a prevalence of 33% (6/18) (inner thigh) in limbs treated for recurrent LSV reflux.²³ The assessment methods are not described in these series and how many represent true saphenous nerve injury is unclear. In summary, there is no evidence that VNUS significantly reduces the incidence of saphenous nerve injury. Indeed, given the means by which VNUS induces LSV obliteration, damage to the surrounding tissues, including nerves, seems intuitively to be at least as likely as with surgical stripping.

Endovenous laser therapy (EVLT)

EVLT uses pulsed light energy to obliterate the LSV. It has been suggested that the low penetration of this energy means EVLT is less likely than heat-based techniques to damage surrounding tissues. Proebstle *et al.*²⁴ treated 31 legs without any evidence of nerve injury. In a further series of 90 legs a single case of paraesthesia involving the medial calf was noted but had resolved at 6 weeks.²⁵ Once again, the assessment methods are not described.

Echo-guided foam sclerotherapy

A number of groups have reported a zero incidence of saphenous nerve injury with this technique.^{26,27} But, once again, the methods and rigour by which such injuries were sought is unclear.

If a patient complains of saphenous nerve injury after VV surgery what should they be told about the natural history and likely prognosis?

Given the apparent frequency of saphenous nerve injury and its medico-legal implication, it is surprising there are so few data on which to base an answer to this fundamental question. Jones et al.¹¹ reported an 8% prevalence (9/113 limbs) of saphenous nerve injury 2 years post-operatively. Unfortunately, as no early post-operative data were presented, it is not possible to draw any conclusion regarding the natural history. Common clinical experience suggests that in most patients the area of paraesthesia improves over time. However, there is no doubt that a small number of patients go on to develop an extremely troublesome dysthetic pain syndrome, sometimes called saphenous neuritis. Unfortunately, the incidence, aetiology, natural history, prevention and management of the condition are completely unknown. This is another area in urgent need of systematic study. Suffice to say, patients must be warned specifically of the small risk of this unpleasant complication.

Is specific treatment indicated for saphenous nerve injury?

It has been suggested that the detection of saphenous nerve injury in the early post-operative course should prompt referral to a plastic surgeon for consideration of nerve repair. To our knowledge, this view has no evidence base. Furthermore, this advice would seem to be quite inappropriate given the numbers of VV operations performed in Europe, the likelihood that at least 5–10% will develop some degree of nerve injury, and the fact that most patients do not appear to be unduly troubled. If one could identify, early on, the small proportion of patients who will go on to develop a saphenous neuritis then some form of intervention may be warranted but, as has been pointed out already, we are almost completely ignorant of this important complication.

Short saphenous surgery and the sural nerve

Anatomy of the sural nerve

The sural nerve (S1,2) arises from the tibial nerve in the popliteal fossa and then descends in the back of the leg to the posterior surface of the lateral malleolus (Fig. 4). At first it lies deep to the deep fascia on the lateral head of gastrocnemius and then comes to lie in the groove between the two heads of gastrocnemius lateral to the

SSV. In the middle third of the calf it is joined by the peroneal communicating branch of the common peroneal nerve and pierces the deep fascia to lie in the superficial tissues. The sural nerve may pierce the deep fascia with, below or (less commonly) above the SSV. Behind the lateral malleolus it turns forward along the lateral border of the foot and little toe. It supplies the skin of the lower half of the posterior surface of the leg, the lateral part of the dorsum of the foot, and the lateral side of the little toe. The sural nerve lies close and lateral to the SSV throughout its length and is at risk during dissection of the saphenopopliteal junction, stripping of the SSV, and MSAs of the SSV and its tributaries.

What is the incidence of sural nerve injury following SSV stripping?

Although, the evidence is by no means as strong as it is for the LSV, stripping the SSV should reduce recurrence rates by disconnecting the mid-calf perforator and communicating veins to the LSV system.²⁸ Yet, it is not part of standard practice, at least in the UK, largely because of concerns over injuring the closely applied sural nerve.³ This being the case, it is perhaps surprising to discover that there is, in fact, very little data in the literature to support this circumspection. There are a number of case reports describing sural nerve injury in the course of SSV surgery but, by definition, the authors obviously view them as rare events. Furthermore, these reports do not, for the most part, relate the injuries to the total case-load.^{29,30} The rest of the literature comprises small case series where operations for SSV and LSV are often analysed together and where the operative and assessment methodologies are often incompletely described. This makes any interpretation extremely difficult. Most recently, Rashid et al.³¹ reported on 59 patients undergoing operations for recurrent varices in the popliteal fossa and noted one case of sural nerve injury 6 weeks post-operatively.

Is partial stripping of the SSV safer?

A study comparing complete SSV stripping with stripping of only those segments found to be refluxing by venous duplex (selective stripping), found evidence of sural nerve injury in 21% (5/24 legs) and 0% (0/20 legs), respectively. However, the description of the operative techniques is extremely cursory and neurological examination was only performed in 80% of the complete and 75% of the selective group at an

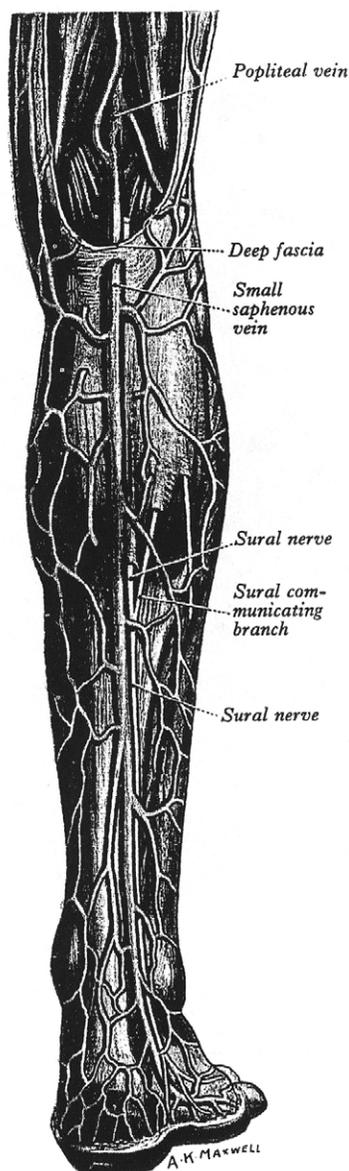


Fig. 4. The relationship of the sural nerve and short (small) saphenous vein in the lower limb. Reproduced with kind permission from Gray's Anatomy 38th Edition, Elsevier Science Ltd, 1995 Fig 10.177 p 1596.

average of 8.9 m post-operatively. It is also not clear if this was a blinded, independent assessment.³²

Is inversion stripping safer?

As with the LSV, PIN stripping may or may not reduce the incidence of sural nerve injury. Although two, early, uncontrolled, series reported a zero incidence^{13, 15} both were small and included no independent or objective neurological assessment.

Are sequential avulsions safer?

Many surgeons once they have confidently identified and divided the SSV in the popliteal fossa, bend up the knee so that a length of 5–10 cm SV can be drawn up into the wound from the calf and excised. Some also remove the SSV from the calf further down through separate incisions. In theory this should be safer as the vein can be cleared of any surrounding tissues under direct vision but there is no evidence that it is, in fact safer than 'blind' stripping. And, of course, as with the LSV it is much less cosmetically satisfactory.

Does pre-operative imaging of the popliteal fossa reduce the risk of sural nerve injury?

Anatomical variations are common in the popliteal fossa and sural nerve damage is inevitable if it is placed within the vein wall itself, a rare but documented occurrence.³⁰ In the enclosed space of the popliteal fossa other nerves, including the common peroneal² and tibial nerves are at risk of traction injury. While pre-operative marking may make surgery more precise and this may reduce the likelihood of nerve injury, in general, there is no evidence at present to support this contention.

Sural neuritis

A small number of patients with sural nerve injury go on to develop an extremely unpleasant chronic pain syndrome. However, we know even less about this condition than we do about saphenous nerve neuritis.

Multiple avulsions and other cutaneous nerves

MSAs are by their nature blind procedures and the cutaneous nerves, are therefore particularly at risk, including the saphenous and sural nerves. Interestingly, a randomised study comparing SF ligation alone to partial LSV stripping found more reports of numbness at 6 weeks in the 'ligation alone' group, and the sensory deficit in the saphenous nerve distribution persisted in 8% of patients at the 2 year follow up, with no difference between the groups.¹¹ Various areas of the leg are particularly at risk during MSA. The common peroneal nerve is at risk as it winds around the neck of the fibula, the tibial nerve and vessels behind the medial malleolus and the saphenous nerve in the medial calf.

Trans-illuminated powered phlebectomy

A recent article examined the safety and efficacy of powered phlebectomy with or without preceding saphenous procedures. Although, some of the treatment groups contained small numbers of patients, there was an overall incidence of ca. 23% neurological deficit for all combinations of treatment.³³ Clearly, further comparative data are required before any firm conclusion can be drawn about this new technique and cutaneous nerve injury.

Recurrent varicose veins

Intuitively, one would imagine that operations for recurrent VV are going to result in a higher incidence of nerve injuries. However, there are almost no data in the literature to confirm or refute this contention.² A study of recurrent VV surgery comparing complications after direct or indirect exposure of the SFJ found two cases of numbness in the direct group and three in the indirect group, but assessment methods are poorly described and which nerves were affected is uncertain.³⁴

Subfascial endoscopic perforator surgery (SEPS)

Jugenheimer *et al.*³⁵ reported an incidence of sural and saphenous nerve injury of 2 and 10%, respectively. In the North American Subfascial Endoscopic Perforator Surgery (NASEPS) registry mid-term report,³⁶ the incidence of saphenous nerve injury was 7% (10/146). A randomised trial of open compared to endoscopic division of perforating veins found two cases of nerve injury in the open approach group.³⁷ However, these data are difficult to interpret because SEPS is nearly always performed in conjunction with LSV and/or SSV surgery.

Use of tourniquet in VV surgery

It has been suggested that the use of a tourniquet might increase the incidence of nerve injury because of direct compression, ischaemia, or difficulty in distinguishing nerve and vascular structures in a bloodless field. In a randomised trial of no tourniquet versus the Lofquist cuff tourniquet, 3/50 patients had temporary saphenous nerve injury at 6 weeks, one of whom was in the tourniquet group.³⁸ A further comparative trial using the same tourniquet found no evidence of significant post-operative compli-

cations in either group. However, this was neither randomised nor case-matched and post-operative neurological complications were not objectively assessed.³⁹ In a series of 220 patients using a different tourniquet there was a 3% prevalence of saphenous nerve injury. However, these patients underwent saphenofemoral ligation and LSV stripping prior to placement of the tourniquet.⁴⁰

Discussion

Given the frequency with which VV surgery is performed, the apparent high incidence of nerve injuries, that (at least in the UK) VV surgery is the commonest single cause of litigation against general and vascular surgeons, and that knowledge clearly has a major impact upon practice, it is really quite surprising to discover that the literature on this important subject is so deficient. So, what is it safe to conclude?

1. Cutaneous nerve injury can and does occur even in the best of hands; its presence is not, therefore, indicative of substandard care or a 'breach of duty' *per se*.
2. Having said that, it is mandatory that patients are made aware of the frequency and possible long-term consequences of these complications.
3. With regard to the LSV, stripping to just below the level of the knee appears to afford the optimum balance between undertaking an effective and durable operation, while at the same time minimising the risk of saphenous nerve injury.
4. With regard to the SSV, the current reluctance to strip may be based upon an exaggerated perception of the risk of sural nerve injury; however, this is an area where further research is urgently required.
5. The evidence that inversion stripping is associated with a lower incidence of nerve injury than conventional stripping is not compelling, although the technique is attractive for other reasons.
6. With the exception of echo-guided foam sclerotherapy, none of the newer, minimally invasive, techniques appear to afford significant protection against cutaneous nerve injury.
7. The natural history of saphenous and sural nerve injury following VV surgery is unknown.

While the majority of patients undergoing VV surgery enjoy an excellent result,⁴¹ and major morbidity and mortality are rare, minor morbidity, particularly cutaneous nerve injury, remains a common problem. A thorough review of the literature has revealed just how much we do not know about this

important complication of VV and re-emphasised the need for further research.

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