



Ultrasound-Guided Foam Sclerotherapy for the Treatment of Chronic Venous Ulceration: A Preliminary Study

K.A.L. Darvall^{a,b,*}, G.R. Bate^a, D.J. Adam^a, S.H. Silverman^b,
A.W. Bradbury^a

^a Birmingham University, Department of Vascular Surgery, Heart of England NHS Trust, Birmingham, UK

^b Department of Vascular Surgery, City Hospital, Birmingham, UK

Submitted 20 January 2009; accepted 26 May 2009

KEYWORDS

Sclerotherapy;
Varicose ulcer;
Varicose veins

Abstract Objectives: When compared to compression therapy alone, surgical correction of superficial venous reflux (SVR) reduces recurrence but does not appear to increase healing of chronic venous ulceration (CVU). The role of ultrasound-guided foam sclerotherapy (UGFS) of SVR as part of the treatment of CVU remains uncertain. The aim of this study is to describe CVU healing and recurrence rates after UGFS and to relate these outcomes to patterns of pre- and post-intervention venous reflux.

Methods: A prospective study of 27 consecutive patients (28 legs) of median age 69 (interquartile range 54–79) years undergoing UGFS for SVR in addition to compression for treatment of CVU of median duration 12 (IQR 6–23) months. Prior to and 1, 6, and 12 months after treatment patients underwent clinical and duplex assessment.

Results: 8 limbs (29%) had deep and superficial venous reflux, and 20 limbs had SVR alone. There was a history of DVT in 4 limbs, and 4 patients were on warfarin. No limbs had significant arterial disease and all received post-UGFS compression. Median volume of (3% STD) foam used was 8 (range 2–14) ml. 1, 3 and 6 months after UGFS, 22 (79%), 27 (96%) and 27 (96%) CVU had healed. At 12 months, 25 ulcers remained healed, 2 ulcers had recurred; one patient had died from carcinomatosis.

Discussion: Following UGFS as an adjunct to compression, 96% of CVU healed within 3 months and only 2 healed ulcers (7%) had recurred at 12 months. UGFS appears to be an attractive minimally-invasive alternative to surgery to treat SVR in patients with CVU, especially the elderly and frail.

© 2009 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.

* Corresponding author. Dr. K.A.L. Darvall, Birmingham University, Department of Vascular Surgery, Flat 5 Netherwood House, Solihull Hospital, Lode Lane, Solihull, West Midlands B91 2JL, UK. Tel./fax: +44 0121 424 5086.

E-mail address: katydarvall@btinternet.com (K.A.L. Darvall).

Introduction

Approximately 1% of Europeans will develop chronic venous ulceration (CVU) during their life time; the point prevalence of open ulceration is estimated at 0.1%. CVU has a significant adverse impact on health-related quality of life (HRQL) and the condition consumes significant health care resources.^{1–3} The treatment of CVU remains controversial and outcomes are often disappointing, especially in the presence of (post-thrombotic) deep venous reflux (DVR). However, a recent randomised controlled trial (ESCHAR) comparing compression alone with compression plus superficial venous surgery in patients with superficial venous reflux (SVR) and CVU found that, although there appeared to be no difference in healing rates, recurrence rates were significantly lower in the surgery group.⁴ Healing rates were 65% at 6 months and approached 80% at 12 months; recurrence rates were 34% in the compression alone group and 15% in the surgery and compression group at a median follow-up of 14 months.⁴

Two groups have published data to suggest that ultrasound-guided foam sclerotherapy (UGFS) of SVR in patients with CVU may be an effective and attractive alternative to surgery in this often elderly and frail population.^{5,6} However, one study was retrospective, the other reported only 6 week follow-up, and neither study included duplex follow-up to assess residual or recurrent reflux and its relationship with ulcer healing.

The aim of this study, therefore, was prospectively to describe the rate of CVU healing and recurrence during the 12 months following UGFS of SVR, and also to assess the relationship between healing, recurrence and the pattern and severity of post-intervention venous reflux as determined by serial duplex ultrasound.

Methods

Local ethics committee approval and written informed consent were obtained. Consecutive patients undergoing UGFS in addition to compression as part of their treatment for open (CEAP clinical grade 6)⁷ CVU were enrolled between June 2005 and June 2007. All patients were NHS patients referred to the Heart of England NHS Foundation Trust by their general practitioners. All patients were assessed in a Consultant-led NHS outpatient clinic (AB, DA) where an ulcer history was taken, ankle-brachial pressure index (ABPI) was measured and a venous duplex scan was performed (AB, GB) to determine sites of venous reflux. Patients without SVR, those with an ABPI <0.8, those refusing to undergo UGFS, and those in whom the ulcer had healed prior to UGFS treatment were excluded. Patients were put on the waiting list for UGFS (approximately 4–6 weeks) and the ulcerated limb was placed into multilayer compression bandaging, Profore or Proguide (Smith and Nephew, Hull, UK) delivering 40 mmHg at the ankle while awaiting treatment.

UGFS treatment

UGFS was performed by one of the authors (AB, DA) on an outpatient basis in a treatment room. All treatments took

less than 30 min. Immediately prior to treatment patients underwent repeat venous duplex scanning (GB) and the incompetent saphenous trunks and superficial varices were marked on the skin. The patient then reclined in the supine (GSV) or prone (SSV) position and the saphenous trunk was cannulated with a peripheral intravenous catheter (Optiva™, Medex Medical Ltd, Rossendale, UK) under direct ultrasound guidance. 18–22 g cannulae (green, pink or blue) were used according to the size and depth of the target vein. 1–4 cannulae were inserted according to the extent of reflux. Once all cannulae were secured the limb was held in an elevated position for injection of the foam. Prior to injection all cannulae were flushed with normal saline to ensure no movement had occurred during the changes in limb position. Sclerosant foam was prepared by modified Tessari's method using two, 2 ml syringes (Tessari described using one 2 ml and one 5 ml syringe) connected by a 3-way tap and a 5-micron filter (B Braun Medical, Sheffield, UK) and comprised 0.5 ml 3% sodium tetradecyl sulphate (Fibrovein®, STD Pharmaceuticals Ltd, Hereford, UK) and 2 ml air. Foam was injected in 2 ml aliquots (to a maximum of 14 ml) and its distribution and resultant venous spasm observed by duplex imaging. At least 30 s were allowed to pass between injecting each aliquot of foam. After each injection patients were asked to dorsiflex and plantar-flex their ankle several times to clear any foam that might have entered the deep venous system. When all the trunk and tributary veins and the varices were in spasm and fully occluded with foam the cannulae were removed and compression was applied with the limb still held in the elevated position. A roll of Velband® (Johnson and Johnson Medical, Ascot, Berkshire, UK) was applied directly along the line of the previously marked saphenous trunk and superficial varices, and retained on the thigh using Peha-haft® cohesive bandage (Hartmann, Germany). Below-knee multilayer compression bandaging was applied as previously, and a thigh-length class II compression stocking (with the foot/lower leg portion removed) was applied over the top (Medi, Hereford, UK – produces 23–32 mmHg at the ankle). The thigh bandaging was left in place for 7–10 days when the patient was reviewed in clinic, at which time the bandaging was removed and the class II stocking worn (along with the below-knee multilayer compression bandaging) for a further 3 weeks. Compression bandaging was changed as necessary according to the amount of exudate.

Pre-treatment duplex and clinical assessment

All duplex examinations were performed in a standard manner by one of the authors (GB). Patients were examined standing with their weight on the contralateral limb and the leg to be examined slightly bent with the heel on the floor to relax the calf muscle while maintaining stability, with a Sonosite Micromaxx® (Sonosite Ltd, Hitchin, Herts, UK) fitted with a 10 MHz transducer. The following venous segments were insonated: proximal and distal superficial femoral vein; above and below-knee popliteal vein; saphenofemoral and saphenopopliteal junctions, the whole length of the GSV and the SSV. All veins were assessed for patency and compressibility. Reflux was induced with

a manual calf squeeze and was defined as reverse flow of greater than 0.5 s. Incompetent perforating veins were not specifically sought.

Outcome measures and follow-up

The chosen outcome measures were ulcer healing and complete occlusion of, and abolition of reflux in, the treated saphenous trunks on venous duplex. All patients were seen at 7–10 days and 1, 6 and 12 months after treatment in a dedicated research clinic by the Vascular Specialist Nurse (GB) and a Venous Research Fellow (KD, surgical trainee) where their legs were examined and a duplex scan was repeated. At the first visit the bandages were removed and a duplex was performed to look specifically for DVT; patients were also asked whether they had had any complications following their treatment. Patients were specifically asked about visual disturbance, headache, and skin and possible nerve problems in the treated leg.

Ulcer healing was defined as complete re-epithelialisation of the leg, and ulcer recurrence as any loss of skin continuity below the knee. All treated limbs underwent repeat venous duplex examination at each follow-up visit as per the pre-treatment duplex. In addition, occlusion of the treated saphenous trunk was determined by a lack of compressibility and the absence of any flow. Complete occlusion was defined as occlusion in the entire length of the treated GSV or SSV. Recanalisation was defined as the presence of flow in either an antegrade or retrograde direction in a previously occluded segment. Patients with residual or recurrent saphenous truncal reflux were offered further treatment by repeating foam sclerotherapy with 3% STD (Fibrovein[®]) as outlined above. After ulcer healing was achieved patients wore below-knee class II stockings (Medi, Hereford, UK) and patients were advised to wear these during the day.

Results

Twenty-seven patients (28 limbs) of median age 69 (interquartile range [IQR] 54–79) years with open CVU of primary aetiology (CEAP C6, E_p) were treated between June 2005 and June 2007. Demographic data, ulcer history, and pre-UGFS duplex findings are shown in Table 1. ABPI was normal (>0.9) in all limbs. SVR alone (A_s) was present in 20 limbs and 8 limbs had mixed SVR and DVR (A_{SD}); all limbs had reflux (P_R) rather than obstruction. 4 patients had a previous history of DVT; this was multiple in two patients and they consequently were on lifelong warfarin, one with a target INR of 4.5, the other 3.5. Two other patients were on warfarin for atrial fibrillation with target INR of 2–3. Median ulcer duration (IQR) was 12 (6–23) months. There were no symptomatic DVTs in any of the treated limbs, neither was there evidence of DVT on duplex at 7–10 days or 1, 6 or 12 month follow-up. There were no episodes of visual disturbance or other neurological symptoms, no cutaneous ulceration at cannulation sites, or paraesthesia.

At 1 and 6 months after treatment with a median (range) of 8 ml (2–14 ml) foam 22 ulcers (79%) and 27 ulcers (96%) respectively had healed completely (Table 2, Fig. 1).

Although the patients were not seen personally by the investigators at hospital between 1 and 6 months, all were reported by community carers to have healed their ulcers within 3 months of treatment. One patient whose ulcer had not healed at 1 month died soon after from carcinoma and was, therefore, excluded from further analysis. At 12 months, 25 ulcers (93%) remained healed and two ulcers had recurred (7%). Both patients who had recurrence at 12 months had stopped wearing their compression stockings, and both also had DVR prior to (and after) treatment.

Total occlusion of all treated veins at 1 month was observed in 22 of 28 limbs (Table 2, Fig. 1). Two patients had had unsuccessful treatment: one refused further treatment (patient 19) and the other had repeat UGFS although the ulcer was already healed (patient 18). Three patients had residual below-knee GSV reflux only with an occluded GSV in the thigh (patients 2, 9 and 20). All of these patients' ulcers had healed by 1 month and only one wanted further treatment (patient 9) for residual visible varicose veins (VV). The remaining one patient (patient 11) only had occlusion of her proximal GSV after the first treatment with many remaining VV and distal reflux. Her previously almost circumferential ulcer however was much improved and she did not want further injections.

At 6 month follow-up 22 of 27 limbs (patient 19 lost to follow-up) had total occlusion of all treated veins. Patients 2 and 20 still had residual below-knee GSV reflux and patient 11 still only had occlusion of the proximal GSV. The remaining two patients had had recanalisation of their below-knee GSV with recurrent reflux (patients 23 and 26). In both patients the ulcers remain healed and they only had a few VV so no further treatment was wanted.

At 12 months, 19 of 27 limbs had total occlusion of all treated veins. The situation for patients 2 and 20 (residual below-knee GSV reflux) and patients 23 and 26 (recurrent below-knee reflux) remained unchanged. Patients 3, 4 and 15 had recanalisation of the majority of their GSV with recurrent reflux at 12 months follow-up. However, their ulcers remained healed and they had few visible VV and remained asymptomatic, so they elected to have no further treatment at this stage. Finally, patient 11 had a recurrence of her ulcer between 6 and 12 months and continued to have distal reflux and many VV amenable to treatment with UGFS. However, the ulcers are intermittent and her symptoms are much improved so she continues to decline further treatment.

Discussion

The main findings of the present study are that following UGFS combined with compression, 27 of 28 (96%) CVU healed within 3 months, and at 12 months only 2 ulcers had recurred.

The outcomes reported here after UGFS plus compression appear to be superior to those reported from other studies where only compression has been used and no attempt has been made to eradicate SVR (healing 68–83% at 6 months, recurrence 26–28% at 12 months).^{8–10}

The importance of eradicating SVR was clearly demonstrated in the ESCHAR study which was a randomised

Table 1 Pre-treatment data.

Patient	Demographics		Ulcer characteristics			Refluxing segments on duplex ^a		
	Gender	Age	Site	Duration	Compression ^b	DV	GSV	SSV
1	F	87	Lateral	10y	+	+	–	+
2	M	86	Medial	12m	+	+	+	–
3	F	67	Medial	6m	–	–	+	–
4	M	22	Medial	2y	–	–	+	–
5	M	58	Medial	9m	–	–	+	–
6	F	53	Medial	9m	+	–	+	–
7	F	74	Lateral	4m	+	–	+	–
8	F	56	Medial	9y	+	–	+	–
9	M	79	Medial	4y	–	–	+	–
10	F	70	Medial	6m	–	+	–	+
11	F	56	Medial	4y	+	+	+	–
12	F	89	Medial	3m	–	–	+	–
13	M	68	Medial	12m	+	+	+	–
14	M	62	Medial	12m	–	–	+	–
15	F	55	Lateral	2y	+	–	+	–
16	F	80	Lateral	12m	+	–	+	–
17	M	52	Medial	6m	–	–	+	–
18	F	38	Medial	7m	–	–	+	–
19	M	86	Medial	40y	+	–	+	–
20	M	49	Lateral	12m	–	–	+	–
21	M	79	Medial	20m	–	–	+	–
22	F	75	Lateral	4m	–	+	+	–
23	F	81	Medial	8m	–	–	+	–
24	M	51	Medial	12m	+	–	+	–
25	M	70	Medial	12m	+	+	+	–
26	F	79	Medial	3m	–	+	+	+
27-R	F	54	Lateral	12m	–	–	+	–
27-L	F	54	Lateral	12m	–	–	+	–

^a + = Reflux present; – = no reflux. DV = deep veins (superficial femoral and or popliteal vein); GSV = great saphenous vein; SSV = small saphenous vein.

^b + = Compression bandaging used to treat current ulcer; – = no compression tried.

controlled trial of 500 patients comparing ulcer healing and recurrence rates after treatment with compression bandaging alone, and compression combined with superficial venous surgery.⁴ Healing rates at 6 months were 65% in both groups, and approached 80% by 12 months.⁴ Recurrence rates, however, were significantly lower in patients undergoing surgery, 15% vs. 34% at a median follow-up of 14 months (range 10–23 months).⁴ Longer term follow-up from the same study found ulcer healing rates at three years of 89% in the compression group and 93% in the compression and surgery group ($P = 0.73$, log rank test); and ulcer recurrence rates at 4 years of 56% in the compression group and 31% for the compression and surgery group ($P < 0.01$).¹¹

The CVU outcomes reported here after UGFS appear to be at least as good as those reported after surgery in the ESCHAR study ($n = 216$), although the numbers in the studies are very different. This suggests that UGFS may be an attractive alternative to surgery in this group of patients who are often elderly, frail and refuse (or are refused) operative intervention; further supporting this is the lack of side-effects found in this clinical series and the successful treatment of 4 patients anticoagulated with warfarin. Two

other groups have thus far looked at the effect of UGFS on CVU healing and have also reported promising results.

In 2004, Cabrera et al. reported a retrospective study of 116 consecutive patients with 151 ulcers of median duration (range) 62 (1–480) months treated over a 10-year period with 0.27% to 1% polidocanol CO₂ microfoam. Almost 30% of their patients had deep venous reflux and 20 had undergone previous surgery (unspecified). Unlike the present study where only 2 of the 28 treated limbs required two sessions of UGFS, their patients underwent repeated treatment sessions (median 3.6, range 1–17) until all identifiable SVR was eliminated. At 6 months, Cabrera reported an 86% healing rate (96/116) with a median time to healing of 2.7 months (8 weeks); 7 patients were never healed, one patient was lost to follow-up and there were recurrences in 10 patients. These outcomes are very similar to those reported here. In a multivariate analysis they found that both long ulcer duration and the presence of DVR were adverse prognostic factors; the latter appears to be the case in the present series too. Beyond 6 months, follow-up rates in the Spanish study were really too low to undertake proper analysis of longer term healing and

Table 2 Treatment and follow-up data.

Patient	Treatment data		Ulcers completely healed at follow-up ^a			All treated venous segments occluded on follow-up duplex scan ^b		
	No. of cannulae	Volume of foam (ml)	1m	6m	12m	1m	6m	12m
1	1	2	+	+	+	+	+	+
2	1	12	+	+	+	-	-	-
3	1	8	+	+	+	+	+	-
4	2	12	+	+	+	+	+	-
5	1	8	+	+	+	+	+	+
6	2	10	+	+	+	+	+	+
7	3	8	-	+	+	+	+	+
8	2	12	-	+	+	+	+	+
9	2	8	+	+	+	-	+	+
10	2	8	+	+	+	+	+	+
11	2	8	-	+	-	-	-	-
12	1	8	+	+	+	+	+	+
13	2	10	+	+	+	+	+	+
14	2	10	+	+	+	+	+	+
15	1	8	+	+	+	+	+	-
16	2	8	+	+	+	+	+	+
17	1	8	-	+	+	+	+	+
18	2	10	+	+	+	-	+	+
19	1	4	-			-		
20	1	8	+	+	+	-	-	-
21	2	12	-	+	+	+	+	+
22	1	3	+	+	-	+	+	+
23	1	8	+	+	+	+	-	-
24	3	10	+	+	+	+	+	+
25	2	8	+	+	+	+	+	+
26	4	14	+	+	+	+	-	-
27-R	2	10	+	+	+	+	+	+
27-L	1	6	+	+	+	+	+	+

^a + = Completely healed; - = not healed; left blank = lost to follow-up (died).

^b + = All treated venous segments occluded and no residual reflux; - = some reflux present; left blank = lost to follow-up (died).

recurrence rates; and repeated post-intervention duplex scans to assess the success of their treatment were not undertaken. However, the authors reasonably concluded on the basis of their short term results that microfoam treatment of ulcers was promising and worthy of further study.^{5,12}

In 2006, Bergan et al. reported their experience of 50 limbs with active CVU. 22 were treated with compression bandaging alone, 13 failed compression therapy and went on to have UGFS, and a further 15 were treated promptly with UGFS.⁶ Polidocanol foam was used in strengths of 1–3%, and the usual volume used was 8 ml. At 6 weeks follow-up they found complete ulcer healing in 45% of the compression only group, and 100% of the patients who had had UGFS.⁶ The same authors suggest that this observed increased efficacy of UGFS over superficial venous surgery in CVU healing could be due to the fact that the foamed sclerosant can act directly on the microcirculation (the end point of venous hypertension), rather than indirectly by superficial venous stripping.¹³

Also, GSV stripping is usually carried out to knee level only due to the risk of damage to the saphenous nerve

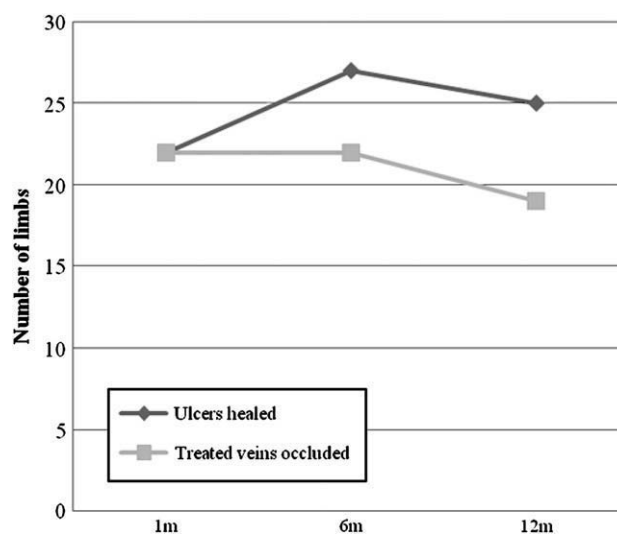


Figure 1 Ulcer healing rates and treated vein occlusion rates after ultrasound-guided foam sclerotherapy.

below the knee,¹⁴ with nearly one-third of patients having reflux in the distal GSV at follow-up in one study.¹⁵ Kulkarni et al., however, concluded that residual reflux after saphenous surgery is not the most important predictor of venous ulcer recurrence, although the hazard ratio of developing ulcer recurrence by 3 years was 2.5 in those with residual below-knee GSV reflux, this did not reach statistical significance.¹⁶ Neither the Spanish nor the US groups considered the effect of technically “successful” treatment (i.e. occlusion of all treated veins on duplex) on ulcer healing and recurrence. In the current study, of the 3 patients who still had residual reflux in the thigh GSV at 1 month, only one ulcer had healed. 5 limbs have had some recurrence of reflux by 12 months but in none of these limbs have the ulcers recurred. It will be interesting to see whether these patients go on to develop recurrent ulceration and hence whether it would be useful to treat these asymptomatic “recurrences” to prevent this. Of the 2 patients with recurrent ulceration, both have deep venous reflux and one continued to have significant superficial reflux also.

The small number of patients is an inherent weakness in the study, but as a preliminary study it demonstrates the potential of UGFS as an adjunct to healing CVU. The results must be interpreted with caution due to the fact that only 12 of 28 limbs had been treated by compression prior to assessment for treatment. This is slightly offset by the observation that none of the ulcers healed in the interval between placement on the waiting list for treatment and attending for UGFS (usually 4–6 weeks), during which time all limbs were treated with multilayer graduated compression bandaging. Another obvious limitation is that this study is not a randomised controlled trial. Although the authors (DA, AB) offer all patients a choice between surgery and UGFS as appropriate, in our practice patients rarely choose a surgical option. The striking differences we have observed between the outcomes following UGFS and surgery have removed our ‘grey area of clinical equipoise’ and we therefore feel it inappropriate for us to randomise patients between the two treatments. Even if we did wish to do that type of study, it is clear that the great majority of our patients would simply refuse randomisation. In these particular patients, this problem of recruitment and suitability for treatment has been demonstrated in the published RCTs.¹⁷

In summary, our preliminary data add further weight to the suggestion that eradication of SVR by means of UGFS improves CVU outcomes when compared to compression alone. In this regard, UGFS appears to be at least as effective as surgery as a means of dealing with SVR and does, therefore, appear the more attractive option in this elderly patient population. As is probably to be expected, patients with DVR do not respond as well to treatment with UGFS but this is also true of surgery and compression alone. Furthermore, the novel follow-up duplex data presented here does suggest long-term healing following UGFS probably requires careful follow-up and, if required, further sessions of UGFS to make sure that SVR remains completely eradicated. Encouraged by these promising early results the authors have embarked upon a larger study to look at the role of UGFS in the treatment of CVU in greater depth.

Conflict of Interest/Funding

None.

References

- 1 Darvall KAL, Bradbury AW. The management of venous ulceration. In: Earnshaw JJ, Murie JA, eds. *The evidence for vascular surgery*. 2nd edn., vol. 24. Shropshire: tfm Publishing Ltd; 2007. p. 207–15.
- 2 Phillips T, Stanton B, Provan A, Lew R. A study of the impact of leg ulcers on quality of life: financial, social and psychological implications. *J Am Acad Dermatol* 1994;**31**:49–53.
- 3 Sharp B, Davies AH. Quality of life in patients with venous ulcers. In: Davies AH, Lees TA, Lane IF, eds. *Venous disease simplified*, vol. 3. Shropshire: tfm Publishing Ltd; 2006. p. 33–44.
- 4 Barwell JR, Davies CE, Deacon J, Harvey K, Minor J, Sassano A, et al. Comparison of surgery and compression with compression alone in chronic venous ulceration (ESCHAR study): randomised controlled trial. *Lancet* 2004;**363**:1854–9.
- 5 Cabrera J, Redondo P, Becerra A, Garrido C, Cabrera Jr J, Garcia-Olmedo MA, et al. Ultrasound-guided injection of polydocanol microfoam in the management of venous leg ulcers. *Arch Dermatol* 2004;**140**:667–73.
- 6 Bergan J, Pascarella L, Mekenas L. Venous disorders: treatment with sclerosant foam. *J Cardiovasc Surg* 2006;**47**:9–18.
- 7 Eklof B, Rutherford RB, Bergan JJ, Carpentier PH, Glociczki P, Kistner RL, et al. American Venous Forum International Ad Hoc Committee for the Revision of the CEAP Classification. Revision of the CEAP classification for chronic venous disorders: consensus statement. *J Vasc Surg* 2004;**40**:1248–52.
- 8 Ghauri ASK, Taylor M, Deacon JE, Whyman MR, Earnshaw JJ, Heather BP, et al. Influence of a specialized leg ulcer service on management and outcome. *Br J Surg* 2000;**87**:1048–56.
- 9 Bello M, Scriven M, Hartshorne T, Bell PR, Naylor AR, London NJ. Role of superficial venous surgery in the treatment of venous ulceration. *Br J Surg* 1999;**86**:755–9.
- 10 Barwell JR, Taylor M, Deacon J, Ghauri AS, Wakely C, Phillips LK, et al. Surgical correction of isolated superficial venous reflux reduces long-term recurrence rate in chronic venous leg ulcers. *Eur J Vasc Endovasc Surg* 2000;**20**:363–8.
- 11 Gohel MS, Barwell JR, Taylor M, Chant T, Foy C, Earnshaw JJ, et al. Long term results of compression therapy alone versus compression plus surgery in chronic venous ulceration (ESCHAR): randomised controlled trial. *BMJ* 2007;**335**:83–8.
- 12 Cabrera J, Cabrera Jr J, Garcia-Olmedo MA. Sclerosants in microfoam: a new approach in angiology. *Int Angiol* 2001;**20**:322–9.
- 13 Pascarella L, Bergan JJ, Mekenas LV. Severe chronic venous insufficiency treated by foamed sclerosant. *Ann Vasc Surg* 2006;**20**:83–91.
- 14 Morrison C, Dalsing MC. Signs and symptoms of saphenous nerve injury after greater saphenous vein stripping: prevalence, severity, and relevance for modern practice. *J Vasc Surg* 2003;**38**:886–90.
- 15 Dwerryhouse S, Davies B, Harradine K, Earnshaw JJ. Stripping the long saphenous vein reduces the rate of reoperation for recurrent varicose veins: five-year results of a randomized trial. *J Vasc Surg* 1999;**29**:589–92.
- 16 Kulkarni SR, Barwell JR, Gohel MS, Bulbulia RA, Whyman MR, Poskitt KR. Residual venous reflux after superficial venous surgery does not predict ulcer recurrence. *Eur J Vasc Endovasc Surg* 2007;**34**:107–11.
- 17 Howard DPJ, Howard A, Kothari A, Wales L, Guest M, Davies AH. The role of superficial venous surgery in the management of venous ulcers: a systematic review. *Eur J Vasc Endovasc Surg* 2008;**36**:458–65.