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Healing and Recurrence Rates Following Ultrasound-guided Foam Sclerotherapy of Superficial Venous Reflux in Patients with Chronic Venous Ulceration

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KEYWORDS

Ultrasound-guided foam sclerotherapy;
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Abstract *Objectives:* To determine healing and recurrence rates following ultrasound-guided foam sclerotherapy (UGFS) of superficial venous reflux (SVR) in patients with healed (clinical, etiologic, anatomic and pathophysiologic (CEAP) classification, C5) and open (C6) chronic venous ulceration (CVU).

Methods: Between 1 March 2005 and 31 December 2009, 130 consecutive patients (132 limbs, 49 CEAP C5, 83 C6) of median age 70 (interquartile range (IQR) 56–76) years underwent UGFS as part of their treatment for CVU.

Results: The median (IQR) follow-up time was 16 (12–32) months. One C6 patient moved abroad 1 week after UGFS and was lost to follow-up. Healing was observed in 67/82 (82%) remaining C6 patients at a median (IQR) of 1 (1–2) month following their first UGFS treatment. In 49 limbs originally treated for C5 disease, and in 67 limbs treated for C6 that healed following UGFS, there were five recurrent ulcers during the follow-up period, giving a 4.9% Kaplan–Meier estimate of recurrence at 2 years. In legs treated for C6 and C5 disease, the median (IQR) ulcer-free periods were 22 (IQR 9–32) and 14 (IQR 8–36) months, respectively.

Discussion: Healing rates following UGFS for CVU are comparable to those reported after surgery but recurrence may be lower. UGFS is a safe, clinically effective and, thus, highly attractive minimally invasive alternative to surgery in patients with C5 and C6 disease.

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Chronic venous ulceration (CVU) affects 1% of the adult European population with 0.1% having an open ulcer at any one time.^{1,2} CVU adversely impacts health-related quality of life (HRQL) and imposes a considerable burden on health-care resources.^{3–6} CVU results from the effects upon the dermal microcirculation of ambulatory venous hypertension (AVH) which, in turn, results from superficial (SVR) and deep venous reflux (DVR).^{7–9} In 2007, the Effect of Surgery and Compression on Healing and Recurrence (ESCHAR) trial showed that while compression plus superficial venous surgery (SVS) for SVR did not appear to increase healing rates, it did significantly reduce CVU recurrence rates when compared with compression alone.^{10–12} While minimally invasive methods such as radiofrequency (RFA) and endovascular laser ablation (EVLA) and ultrasound-guided foam sclerotherapy (UGFS) have increasingly come to replace SVS as the preferred treatment for uncomplicated varicose veins (C2/3 disease), outcome data on patients with C4–6 disease remains limited.^{13–21} With respect to UGFS for CVU, the number of patients studied thus far has been very small and the follow-up short.^{22–26} The aim of the current study is to report CVU healing and recurrence rates following UGFS.

Methods

Patients

Ethics approval was obtained for this study and patients gave informed written consent for their inclusion in this work. This was a study of consecutive UK National Health Service (NHS) patients undergoing UGFS as part of their treatment for CVU (C5/C6 disease) between 1 March 2005 and 31 December 2009.

In clinic, the venous aetiology of the ulceration was confirmed by means of history, clinical examination, duplex ultrasound scanning (DUS) and measurement of ankle–brachial pressure index (ABPI) in all patients supported by blood tests, histopathology and other specialist investigations, as required. All patients with confirmed C5/C6 disease in association with significant (>0.5 s) superficial truncal reflux on DUS have been offered UGFS in addition to compression, provided they do not have an ABPI < 0.8 or post-thrombotic DVR and/or obstruction on DUS.²⁷ In this study, the diameters of the superficial veins to be treated were not routinely measured or recorded. This is because we have found such measurements to be associated with significant inter- and intra-observer variability, reflecting both true measurement error and physiological variation. Furthermore, we do not exclude patients from UGFS on the basis of superficial veins size alone.

Data have been prospectively gathered and entered into a computerised database for analysis. While awaiting UGFS, patients were treated with either a multilayer elastic bandaging system (usually over a non-adherent dressing) or with knee-length graduated compression (usually RAL class II (Reichsausschuss für Leiferbedingungen)) stockings as appropriate, dependent on size of ulcer, degree of exudate and patients' ability to don and doff stockings.

UGFS treatment

Our methods have been described in detail elsewhere.^{20,21,25} However, briefly, prior to treatment, varices and truncal

veins were marked using DUS. Patients were positioned in a semi-recumbent position for great or anterior accessory saphenous vein (GSV, AASV) or prone for short saphenous vein (SSV) treatment. Veins were cannulated with one to four 18G, 20G or 22G cannulae (Optiva 2, Smith's Medical, Watford, UK) under DUS using local anaesthetic. Tumescence anaesthesia was not used. Air (2 ml) and 3% or 1% sodium tetradecyl sulphate (STS) (0.5 ml) (Fibrovein®; STD Pharmaceuticals, Hereford, UK) were oscillated between two 2-ml syringes connected by a 5- μ filter (B Braun Medical, Sheffield, UK). Inter-fascial trunks and major tributaries were treated with 3%, and extrafascial veins usually with 1% or 0.5% STS foam. Foam was injected in 2-ml aliquots (maximum 14 ml) and its progress and venous spasm monitored by DUS. There was a minimum interval of 30 s and patients dorsi- and plantar-flexed their ankles between each injection. Cannulae were removed and with the limb still in elevation, a roll of orthopaedic wool (Velband – Johnson and Johnson Medical, Ascot Berkshire, UK) was applied directly along the treated veins and retained using Pehahaft cohesive bandage (Hartmann, Germany). A thigh-length class II compression stocking (Credelast®; Credenhill, Ilkeston, UK) was applied and left in place for 5–10 days until the patient was reviewed in clinic. Bandaging was then removed and the stocking worn until the next follow-up at 1 month. In patients with significant ulcer exudate, to allow dressing changes, the full-length stocking was cutoff just below the knee and a multilayer, graduated, elastic bandaging system (usually worn over a non-adherent dressing) applied up the level of the tibial tuberosity. Patients were advised to wear below-knee European (RAL) class II stockings during the day after ulcer healing. All patients were provided with 24/7 contact telephone numbers in case of any concerns.

Outcome measures and follow-up

Patients were reviewed at 5–10 days; 1 month, 6 months, 12 months; and then, annually. At follow-up, patients were asked about side effects including visual disturbance, headaches and thrombophlebitis. Legs and ulcers were examined and a DUS was performed to look for deep vein thrombosis (DVT) and to assess the extent of superficial occlusion or recanalisation. Superficial venous occlusion of the treated veins was determined by a lack of compressibility and the absence of any flow. Recanalisation was defined as the presence of flow in either an antegrade or retrograde direction in a previously occluded segment. Patients identified on DUS follow-up surveillance as having residual, recurrent or new saphenous truncal reflux were offered further UGFS. Ulcer healing was defined as complete re-epithelialisation of the leg (for more than 2 weeks), and ulcer recurrence as any loss of skin continuity.

Statistical analysis

Comparisons of continuous non-parametric data were made by the Mann–Whitney-*U* test and a *p* value of <0.05 was considered significant. Ulcer healing and recurrence following UGFS were estimated using Kaplan–Meier survival analysis. Time to healing was calculated from the date of first UGFS treatment session for patients treated for open

ulcers (CEAP C6). Time to recurrence was calculated from the date of healing for patients treated for open ulcers and from the date of first UGFS session for those treated for healed ulcers (CEAP C5). Patients who died or were lost to follow-up were censored. All analyses were carried out using Statistical Package for Social Sciences (SPSS) Statistics version 18.0 for Windows.

Results

Between 1 March 2005 and 31 December 2009, 130 consecutive patients (132 limbs, 49 C5 and 83 C6) of median age 70 (interquartile range (IQR) 56–76) years underwent UGFS at a median (IQR) of 6 (2–12) weeks after being first seen in clinic. At referral, 96 limbs had primary SVR, 32 had recurrent (after previous surgery in the same leg and saphenous territory) and four had both primary and recurrent SVR. DVR was present in 19 limbs. Peripheral pulses were palpable in 125 limbs. Where pulses were not palpable, ABPIs were >0.8 in all cases. Three patients had previous arterial interventions: two popliteal angioplasty and one femoral–popliteal bypass. There was a history of DVT in 13 patients; this was multiple in three patients (Table 1). In 67 C6 legs where the data were prospectively recorded, the median (IQR) ulcer duration was 8 (3–12) months and in 40 C6 legs where the data were prospectively recorded, the median (IQR) ulcer diameter was 3 (1–5) cm.

Table 1 Characteristics of treated patients and limbs.

Characteristics	All limbs (<i>n</i> = 132)		Total (%)
	C5 (<i>n</i> = 49)	C6 (<i>n</i> = 83)	
Gender			
Male	28	37	65 (49)
Female	21	46	67 (51)
Previous DVT	8	5	13 (10)
Pre-treatment duplex findings			
Primary SVR	31	65	96 (73)
Recurrent SVR	16	16	32 (24)
Primary and recurrent SVR	2	2	4 (3)
DVR	7	12	19 (14)
Side			
Right	21	40	61 (46)
Left	28	43	71 (54)
Refluxing segments on duplex			
GSV primary	25	55	80 (54)
GSV recurrent	15	21	36 (24)
SSV primary	8	10	18 (12)
SSV recurrent	4	1	5 (3)
AASV primary	3	4	7 (5)
AASV recurrent	3	0	3 (2)

CEAP 5 = healed ulcer; CEAP 6 = open ulcer; DVT = deep vein thrombosis; SVR = superficial venous reflux; DVR = deep venous reflux; GSV = great saphenous vein; SSV = short saphenous vein; AASV = anterior accessory vein. Recurrent means at least one previous operation in that saphenous distribution in that leg.

In 95 limbs where the data were collected prospectively, the median (IQR) volume of foam used was 8 ml (10–12 ml). One C6 patient left the country 1 week after uneventful UGFS and was excluded from further analysis.

No immediate, medium and long-term complications were reported. Specifically, there was no DVT (clinically or on DUS) or pulmonary embolism (PE), visual disturbance or any neurological side effects. There were seven unrelated deaths at 4, 12, 21, 26, 34, 44 and 46 months after treatment; all had been treated for C6 disease. The patient, who died at 4 months, did so from congestive cardiac failure and was a 64-year-old male, who received UGFS for left-sided recurrent GSV reflux in association with C6 disease. No post-UGFS complications were reported and the ulcer healed by 1 month after UGFS.

In 120 legs, all SVRs were successfully eradicated following a single session of UGFS and remained so during follow-up. 12 limbs underwent a second UGFS session. In two patients, this was because the first treatment had not completely eradicated all SVR. One ulcer was already healed prior to the second treatment and the other healed within 2 months of the second session. 10 patients were treated for recurrent (recanalisation) or new (not present at first UGFS treatment) reflux during follow-up. Of these, six had been treated for C6 disease (five had healed prior to the second UGFS treatment and one remained unhealed) and four patients were treated for C5 disease, which remained healed at the time of the second UGFS treatment. One limb, originally treated for an open ulcer, underwent a third UGFS treatment session 3 years after the second session for recurrent venous reflux.

The median (IQR) follow-up for C6 legs was 16 (12–32) months. Healing was observed in 67/82 (82%) C6 patients at a median (IQR) of 1 (1–2) month following their first UGFS treatment (Fig. 1). The median (IQR) duration of ulcer prior to treatment in the non-healed and healed groups was 24 (11–48) and 6.5 (5–12) months, respectively ($p = 0.001$). In 49 limbs originally treated for C5 disease and 67 limbs originally treated for C6 disease, and those healed following UGFS, 5/116 (4.3%) ulcers recurred at 4.5, 4.5, 5, 24 and 33 months during a median (IQR) follow-up of 15 (12–35) months. In the Kaplan–Meier analysis, the estimated cumulative proportion remaining healed at 2 years is 95.1% (Fig. 2).

Of the five recurrent ulcers, four had originally been treated for C6 and one for C5 disease. Three (all originally C6) ulcers recurred within 5 months and were associated with discontinued use of compression stockings. Two had DVR and one had some recanalisation on duplex. The other two ulcers recurred at 24 (C5) and 33 (C6) months after UGFS. Neither patient had DVR, but did have partial recanalisation. In legs treated for C6 and C5 disease, the median (IQR) ulcer-free periods were 22 (IQR 9–32) and 14 (IQR 8–36) months, respectively.

Discussion

The main finding of this prospective study of 132 limbs affected by CEAP C5 or C6 disease is that when combined with compression, eradication of SVR by means of UGFS leads to an 81% healing rate at 6 months and 5% recurrence

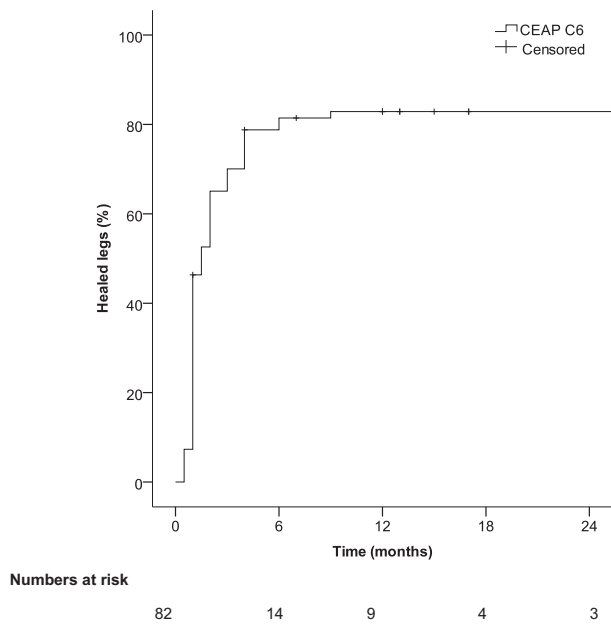


Figure 1 Kaplan–Meier analysis of ulcer healing in 82 limbs treated with UGFS for C6 disease.

rate at 2 years. This recurrence rate appears to be better than that achieved with compression alone (typically 26–28% at 12 months, 40% at 2 years and 56% at 4 years in the ESCHAR trial) and following SVS combined with compression (~20% at 2 years and 31% at 4 years in the ESCHAR trial).^{10–12,28–36} Patients with CVU are often old and frail and hence, poor candidates for surgery and general anaesthesia; making incisions through diseased skin is also problematic. It seems reasonable, therefore, to suggest that, where possible, such patients should be treated by minimally invasive alternatives.^{37,38} To our knowledge, there are five published reports on outcomes following UGFS for patients with CVU, although all the

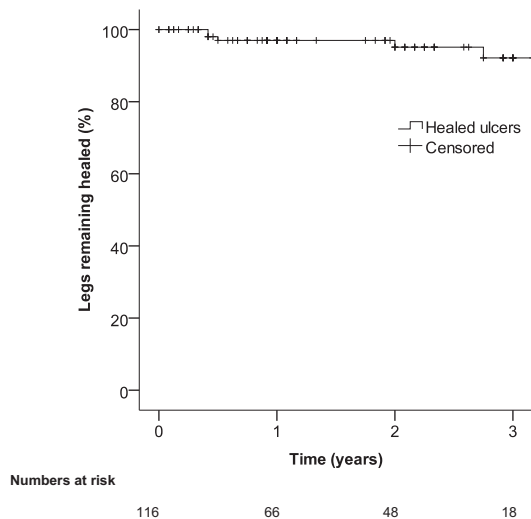


Figure 2 Kaplan–Meier analysis of ulcer recurrence 49 limbs originally treated for C5 disease and 67 limbs treated for C6 that healed after UGFS.

studies are small in size and present only short-term results.^{25,36,39–41} In our pilot study of 27 patients (28 limbs), we reported that UGFS combined with compression resulted in a healing rate of 96% at 6 months and that only two ulcers (7.1%) had recurred at 12 months.²⁵ Cabrera et al. reported similar outcomes in a retrospective study of 116 patients (151 ulcers). At 6 months, complete healing was seen in 83% of the patients, with median time to healing of 2.7 months. Seven patients never healed; one patient was lost to follow-up; and 10 patients (8.6%) had recurred ulcers; the 24-month recurrence rate was 6.3%.²⁶ Bergan et al. described their experience in 50 limbs with CEAP C6 disease treated with compression alone ($n = 22$), compression followed by UGFS when compression alone failed ($n = 13$) and UGFS plus compression ($n = 15$). At 6 weeks, 10 (46%) limbs had healed in the compression alone group compared with all the ulcers in the other two groups.⁴⁰ In a study of nine patients with 13 CVUs treated with UGFS, Hertzman reported healing in two ulcers and improvements in another nine at 2 weeks.⁴¹ O’ Hare and Earnshaw randomised 22 patients to four-layer compression bandages alone (control) and 18 patients to compression plus UGFS. At 24 weeks, 17/20 in the control group and 12/13 patients in the UGFS group had healed.³⁹

In the current study, only 15/82 C6 legs remained unhealed at the time of analysis. Three had DVR on DUS prior to UGFS. The mean duration of ulcer prior to UGFS was significantly longer in the non-healed ulcers. This supports the findings of several other groups and, once again, shows how important it is that all patients with leg ulcers are referred for specialist assessment and treatment as soon as possible.^{26,42} The number of recurrent ulcers in the present study is too small to allow for an analysis of predictive factor.

At the time most of these patients underwent UGFS, we were not specifically identifying and treating perforator disease. We are currently conducting studies in that area. However, we note (anecdotally at this stage) that perforators in the vicinity of the ulcer are often occluded following UGFS.

The majority of the C6 patients were already being treated with compression in primary care at the time of referral and yet had failed to heal. After assessment in clinic, all patients were treated with compression therapy (graduated elastic bandaging or stockings) while awaiting UGFS. Without a randomised controlled trial (RCT) of compression versus compression plus UGFS, it would not be possible to know what proportion of the benefit observed in this is due to compression and what proportion is due to eradication of SVR by means of UGFS. However, given that the ESCHAR trial and other non-randomised studies have provided clear evidence of benefit from the surgical or endovenous eradication of SVR, it is questionable whether a RCT without an intervention arm would be considered ethical. Even if it were, we would not be in equipoise and we doubt whether many (any) of our patients would accept randomisation once they had been informed of the available data as part of the consent process.

The question then remains as to whether UGFS is equally, more or less effective than surgery in the treatment of SVR in association with C5/C6 disease. Once again, a large RCT would be required. However, given that we and

many other groups have shown UGFS to be associated with a dramatic reduction in morbidity when compared with surgery (even in young patients with C2/3 disease), we do not think it would be appropriate to randomise these elderly, often frail, patients in such a trial (and we are sure that the great majority would not accept randomisation).

A trial of foam versus another endovenous technique (RFA, endovascular laser treatment (EVLT)) would be possible but we think it is unnecessary. Many of the patients in this study would have been unsuitable for catheter-based techniques and most would have required adjuvant techniques (foam, phlebectomy). Among the endovenous options, UGFS is uniquely versatile and able to eradicate, in a single session in over 90% of patients, all truncal reflux, as well as reflux in the local veins that 'feed' the ulcer under the surrounding damaged skin. UGFS is also very inexpensive to deliver and, in terms of cost-effectiveness, offers the best value for money.

Chronic venous insufficiency manifested by C5 and C6 disease is a chronic relapsing condition that requires life-long medical care (compression), intervention to eradicate SVR and regular surveillance (with DUS) to allow re-treatment of recurrent or new reflux.

The surgical paradigm that the treatment of C5/6 disease comprises a single 'high tie and stripping' operation (often delayed until the ulcer has healed) followed by compression stockings and discharge from follow-up is no longer appropriate. Rather, on the basis of present and other published data, we strongly believe that it is in our patients' best interests to eradicate all SVR by means of UGFS as soon as possible after the ulcer appears and then offer further UGFS, which, unlike 'redo' surgery is simple, safe and effective, as and when recurrent or new SVR develops.⁴³

Conflict of Interest

None.

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References

- 1 Darvall KAL, Bradbury AW. The management of venous ulceration. In: Earnshaw JJ, Murie JA, editors. *The evidence for vascular surgery*. 2nd ed., vol. 24. Shropshire: TFM Publishing Ltd; 2007. p. 207–15.
- 2 Margolis DJ, Bilker W, Santanna J, Baumgarten M. Venous leg ulcer: incidence and prevalence in the elderly. *J Am Acad Dermatol* 2002;**46**:381–6.
- 3 Kurz X, Kahn SR, Abenhaim L, Clement D, Norgren L, Baccaglini U, et al. Chronic venous disorders of the leg: epidemiology, outcomes, diagnosis and management. Summary of an evidence-based report of the VEINES task force. Venous Insufficiency Epidemiologic and Economic Studies. *Int Angiol* 1999;**18**:83–102.
- 4 Office of Health Economics. *Chronic venous disease of the leg*. London, England: Office of Health Economics; 1992. pp. 24–33. Report 108.
- 5 Ruckley CV. Socioeconomic impact of chronic venous insufficiency and leg ulcers. *Angiology* 1997;**48**(1):67–9.
- 6 Phillips T, Stanton B, Provan A, Lew R. A study of the impact of leg ulcers on quality of life: financial, social, and psychologic implications. *J Am Acad Dermatol* 1994;**31**(1):49–53.
- 7 Bradbury AW, Brittenden J, Allan PL, Ruckley CV. Comparison of venous reflux in the affected and non-affected leg in patients with unilateral venous ulceration. *Br J Surg* 1996;**83**:513–5.
- 8 Welkie JF, Comeraota AJ, Kerr RP, Katz ML, Jayheimer EC, Brigham RA. The haemodynamics of venous ulceration. *Ann Vasc Surg* 1992;**6**:1–4.
- 9 Venous disease. In: Phillip D, Coleridge-Smith PD, Ruckley CV, Fowkes FGR, Bradbury AW, editors. *How does a leg ulcerate?* Springer-Verlag; 1999. p. 51–68.
- 10 O'Meara S, Cullum NA, Nelson EA. Compression for venous leg ulcers. *Cochrane Database Syst Rev* 2009;**21**(1):CD000265.
- 11 Partsch H, Flour M, Coleridge Smith P International Compression Club. Indications for compression therapy in venous and lymphatic disease consensus based on experimental data and scientific evidence. Under the auspices of the IUP. *Int Angiol* 2008;**27**:193–219.
- 12 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**(7610):83.
- 13 Nijsten T, van den Bos RR, Goldman MP, Kockaert MA, Proebstle TM, Rabe E, et al. Minimally invasive techniques in the treatment of saphenous varicose veins. *J Am Acad Dermatol* 2009;**60**(1):110–9.
- 14 van den Bos R, Arends L, Kockaert M, Neumann M, Nijsten T. Endovenous therapies of lower extremity varicosities: a meta-analysis. *J Vasc Surg* 2009;**49**(1):230–9.
- 15 Leopardi D, Hoggan BL, Fitridge RA, Woodruff PW, Maddern GJ. Systematic review of treatments for varicose veins. *Ann Vasc Surg* 2009;**23**(2):264–76.
- 16 Breu FX, Guggenbichler S. European consensus meeting on foam sclerotherapy, April, 4–6, 2003, Tegernsee, Germany. *Dermatol Surg* 2004;**30**(5):709–17.
- 17 Coleridge Smith P. Foam and liquid sclerotherapy for varicose veins. *Phlebology* 2009;**24**(Suppl. 1):62–72.
- 18 Figueiredo M, Araújo S, Barros Jr N, Miranda Jr F. Results of surgical treatment compared with ultrasound-guided foam sclerotherapy in patients with varicose veins: a prospective randomised study. *Eur J Vasc Endovasc Surg* 2009;**38**(6):758–63.
- 19 Jia X, Mowatt G, Burr JM, Cassar K, Cook J, Fraser C. Systematic review of foam sclerotherapy for varicose veins. *Br J Surg* 2007;**94**:925–36.
- 20 Darvall KA, Bate GR, Silverman SH, Adam DJ, Bradbury AW. Medium-term results of ultrasound-guided foam sclerotherapy for small saphenous varicose veins. *Br J Surg* 2009;**96**(11):1268–73.
- 21 Darvall KA, Bate GR, Sam RC, Adam DJ, Silverman SH, Bradbury AW. Patients' expectations before and satisfaction after ultrasound guided foam sclerotherapy for varicose veins. *Eur J Vasc Endovasc Surg* 2009;**38**(5):642–7.
- 22 Wright D, P Gobin J, W Bradbury A, Coleridge-Smith P, Spoelstra H, Berridge D, et al. Varisolve® polidocanol microfoam compared with surgery or sclerotherapy in the management of varicose veins in the presence of trunk vein incompetence: European randomized controlled trial. *Phlebology* 2006;**21**:180–90.
- 23 Coleridge Smith PC. Chronic venous disease treated by ultrasound guided foam sclerotherapy. *Eur J Vasc Endovasc Surg* 2006;**32**(5):577–83.

- 24 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.
- 25 Darvall KA, Bate GR, Adam DJ, Silverman SH, Bradbury AW. Ultrasound-guided foam sclerotherapy for the treatment of chronic venous ulceration: a preliminary study. *Eur J Vasc Endovasc Surg* 2009;**38**(6):764–9.
- 26 Cabrera J, Redondo P, Becerra A, Garrido C, Cabrera Jr J, García-Olmedo MA, et al. Ultrasound-guided injection of polydocanol microfoam in the management of venous leg ulcers. *Arch Dermatol* 2004;**140**(6):667–73.
- 27 Eklof B, Rutherford RB, Bergan JJ, Carpentier PH, Gloviczki 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.
- 28 Ghauri AS, Taylor MC, 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.
- 29 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.
- 30 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.
- 31 Franks P, Oldroyd M, Dickson D, Sharp E, Moffatt C. Risk factors for leg ulcer recurrence: a randomised trial of two types of compression stocking. *Age Ageing* 1995;**24**:440–94.
- 32 Nelson EA, Harper DR, Prescott RJ, Gibson B, Brown D, Ruckley CV. Prevention of recurrence of venous ulceration: randomized controlled trial of class 2 and class 3 elastic compression. *J Vasc Surg* 2006;**44**(4):803–8.
- 33 Moffatt C, Kommala D, Dourdin N, Choe Y. Venous leg ulcers: patient concordance with compression therapy and its impact on healing and prevention of recurrence. *Int Wound J* 2009;**6**(5):386–93.
- 34 van Gent WB, Hop WC, van Praag MC, Mackaay AJ, de Boer EM, Wittens CH. Conservative versus surgical treatment of venous leg ulcers: a prospective randomised multicenter trial. *J Vasc Surg* 2006;**44**:563–71.
- 35 Iafrafi MD, Pare GJ, O'Donnell TF, Estes J. Is the nihilistic approach to surgical reduction of superficial and perforator vein incompetence for venous ulcer justified? *J Vasc Surg* 2002;**36**:1167–74.
- 36 Gloviczki P, Bergan JJ, Rhodes JM, Canton LG, Harmsen S, Ilstrup DM. The North American Study Group. Mid-term results of endoscopic perforator vein interruption for chronic venous insufficiency: lessons learned from the North American sub-fascial endoscopic perforator surgery registry. *J Vasc Surg* 1999;**29**:489–502.
- 37 Viarengo LM, Potério-Filho J, Potério GM, Menezes FH, Meirelles GV. Endovenous laser treatment for varicose veins in patients with active ulcers: measurement of intravenous and perivenous temperatures during the procedure. *Dermatol Surg* 2007;**33**:1234–42.
- 38 Sharif MA, Lau LL, Lee B, Hannon RJ, Soong CV. Role of endovenous laser treatment in the management of chronic venous insufficiency. *Ann Vasc Surg* 2007;**21**:551–5.
- 39 O'Hare JL, Earnshaw JJ. Randomised clinical trial of foam sclerotherapy for patients with a venous leg ulcer. *Eur J Vasc Endovasc Surg* 2010;**3a**(4):495–9.
- 40 Bergan J, Pascarrella L, Mekenas L. Venous disorders: treatment with sclerosant foam. *J Cardiovasc Surg (Torino)* 2006;**47**(1):9–18.
- 41 Hertzman PA, Owens R. Rapid healing of chronic venous ulcers following ultrasound-guided foam sclerotherapy. *Phlebology* 2007;**22**(1):34–9.
- 42 Gohel MS, Taylor M, Earnshaw JJ, Heather BP, Poskitt KR, Whyman MR. Risk factors for delayed healing and recurrence of chronic venous leg ulcers: an analysis of 1324 legs. *Eur J Vasc Endovasc Surg* 2005;**29**:74–7.
- 43 Bradbury AW, Bate GR, Pang K, Darvall KA, Adam DJ. Ultrasound-guided foam sclerotherapy is a safe and clinically effective treatment for superficial venous reflux. *J Vasc Surg*; 2010. Jul 15 [Epub ahead of print].