Original article

Prospective five-year study of ultrasound-guided foam sclerotherapy in the treatment of great saphenous vein reflux

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Abstract

***Objectives*:** The purpose of this study was to determine the long-term efficacy, safety and rate of recurrence for varicose veins associated with great saphenous vein (GSV) reflux treated with ultrasound-guided foam sclerotherapy (UGFS).

***Methods*:** A five-year prospective study was performed, recording the effect on the GSV and saphenofemoral junction (SFJ) diameters, and reflux in the superficial venous system over time. UGFS was the sole treatment modality used in all cases, and repeat UGFS was performed where indicated following serial annual ultrasound.

***Results*:** No serious adverse outcomes were observed – specifically no thromboembolism, arterial injection, anaphylaxis or nerve damage. There was a 4% clinical recurrence rate after five years, with 100% patient acceptance of success. Serial annual duplex ultrasound demonstrated a significant reduction in GSV and SFJ diameters, maintained over time. There was ultrasound recurrence in 27% at 12 months, and in 64% at five years, including any incompetent trunkal or tributary reflux even 1 mm in diameter being recorded. Thirty percent had pure ultrasound recurrence, 17% new vessel reflux and 17% combined new and recurrent vessels on ultrasound. Of all, 16.5% required repeat UGFS treatment between 12 and 24 months, but less than 10% in subsequent years. The safety and clinical efficacy of UGFS for all clinical, aetiological, anatomical and pathological elements classes of GSV reflux was excellent.

***Conclusion*:** The popularity of this outpatient technique with patients reflects ease of treatment, lower cost, lack of downtime and elimination of venous signs and symptoms. Patients accept that UGFS can be repeated readily if required for recurrence in this common chronic condition. The subclinical ultrasound evidence of recanalization or new vein incompetence needs to be considered in this light.

Keywords: foam sclerotherapy; UGFS; great saphenous vein reflux; varicose veins; prospective study

Introduction

Ultrasound guided foam sclerotherapy (UGFS) is an established non-surgical outpatient method for treating varicose leg veins, first reported in 1989.[1] Few published prospective studies demonstrate the efficacy and safety of this technique.[2,3] UGFS is often reported with a non-uniform technique, which needs to be clearly defined for a meaningful comparison of results.

UGFS is minimally invasive and has become a popular method of treatment of varicose veins associated with great saphenous reflux with a very low record of adverse events.[4–13] Ideally, the refluxing veins are obliterated and reduced to a fibrous cord.

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The purpose of this study was to determine the efficacy, safety and rate of recurrence for varicose veins associated with great saphenous vein (GSV) reflux treated exclusively with UGFS prospectively over a five-year period.

Methods

Consecutive patients attending a private clinic for the treatment of symptomatic varicose veins were studied prospectively for five years. Patients were assessed clinically by a physician experienced in the management of venous disease, and patients were classified according to the clinical, aetiological, anatomical and pathological elements (CEAP) classification system.[14,15] They underwent routine colour duplex ultrasound mapping to confirm great saphenous reflux and to assess the extent of the venous disease.[16–18] This was performed prior to treatment by an independent vascular radiology service using a Phillips ATL HDI 3500 machine and a range of broadband probes (linear array CL10-5, L7-4, L12-5; curved array C5-2).

All patients who attended the first 12-month follow-up assessment ultrasound were included in the study. No patients were considered unsuitable for treatment. The Tessari microbubble method of UGFS sclerotherapy was used.[10] Sodium tetradecyl sulphate (STS; Fibrovein™, STD Pharmaceuticals, Hereford, UK) was mixed via a three-way tap (BD Connecta™ Plus 3) and two 3 mL BD Luer-Lock disposable syringes. A 1:3 sclerosant to room air ratio was used without filters, with approximately 20 rapid exchanges. Turbulent flow via an eccentrically placed three-way tap switch produced visible homogeneous microbubble foam. The microfoam was stable for 1–2 minutes, remixing if reducing to froth. The patient was placed supine, tilted laterally approximately 20° onto the hip to expose the inner thigh and groin. Patient posture and position was adjusted as required to allow ready ultrasound visualization of the vein to be treated. This enabled exact needle placement within the vein lumen. With GSV trunks over 10 mm diameter, the limb was elevated to reduce venous filling prior to UGFS.

Under ultrasound visual control, a 2.5–3.8 cm 25 gauge BD needle was introduced at intervals into the incompetent venous lumen selected for treatment. Transverse views were used to ensure rapid and accurate venous access, greatly reducing the slice thickness artefact commonly observed when viewing small targets in their long axis. Venous blood was aspirated into the syringe hub, and fresh foam was slowly injected with gentle pressure. With partially obstructed veins, little or no aspirate may be evident with subsequent UGFS treatments. Injectates of 0.25–2 mL of foam were introduced, carefully observing the intraluminal distribution. If foam was observed to pass into deep leg veins, that injection was terminated. The vein was massaged with the ultrasound probe or manually to encourage venous spasm. The saphenofemoral junction (SFJ) was protected by manual compression using the ulnar border of the patient's own hand during high trunkal injections, to prevent proximal flow.

The great saphenous trunk was treated proximally to distally, prior to the treatment of tributaries on the same treatment session. Incompetent perforators were injected indirectly, introducing foam into the adjacent superficial vein and carefully massaging it towards the perforator, using the ultrasound probe. This method reduces the risk of inadvertent arterial injection. Thumb pressure sensitivity controlled the pressure of injection. Patients were monitored for pulse, blood pressure, venous waveform and digital pulse oximetry (Omicrom FT, RGB Medical Devices, Madrid, Spain).

GSV trunks and larger tributaries were additionally compressed afterwards with a shaped foam pad for three days. Class 2 graduated compression stockings were applied immediately post-treatment while supine, and were worn for two weeks. Immediate ambulation was standard. Daily exercise for a minimum of 30 minutes was encouraged while in compression. Long-haul air flights of over four hours duration and heavy straining were avoided for 30 days. Cohesive compression bandages were occasionally used externally over the compression hose for extensive tributaries or trunkal veins over 10 mm in diameter. One resistant case required tumescent perivenous compression with Klein formula tumescent fluid (0.08% lignocaine – 0.084% sodium bicarbonate – adrenaline 1:1,000,000) at the SFJ and along the upper GSV to achieve closure.[19]

UGFS treatment was performed weekly until ultrasound demonstrated closure of all refluxing axial varicosities and tributaries. Further UGFS treatment was performed on ultrasound evidence of channel formation (recanalization) in the treated segments. This was recorded in the first 12-month treatment series as 'Year 1'. Adverse outcomes were recorded as a percentage of limbs treated. Follow-up routine surveillance duplex ultrasound was performed at one week, three months, six months and annually for five years, when patient symptoms and clinical venous signs were recorded. Any visible or palpable varicose veins or venous symptoms were documented. Any venous channels including incompetent

tributaries detected on ultrasound were recorded as 'recurrent' in this study. New incompetent veins were those not present on the initial duplex pretreatment assessment, and were usually not visible or palpable. Further UGFS treatments were performed where any recurrence or new incompetence was demonstrated on ultrasound in subsequent years. Diameters of vessels and incompetent channels were recorded in millimetres. Normal GSV diameters were 3.5–4.5 mm. Veins were noted to be:

- Closed;
- Open and competent (no reflux);
- Open and incompetent (ultrasound recurrence);
- New incompetence (new varicose veins);
- Combined (ultrasound recurrence and new varicose veins).

Closed fibrosed vessels were recorded at their maximum external diameter. Recanalized channels were noted at their maximum internal diameter. Even those less than 2 mm in diameter were included as 'recurrent'.

Patients completed a questionnaire assessment at each annual follow-up ultrasound visit, to self-grade changes in venous symptoms and cosmesis; to quantify pain; to determine whether they would have preferred surgery as an alternate treatment; if they would recommend UGFS to a friend for treatment; whether they would have UGFS repeated in future if indicated; and if they rated UGFS as a successful treatment.

Results

In 146 patients with CEAP 1-6 GSV reflux, 203 limbs were studied (Table 1). Subjects ranged in age from 25 to 85 years. Mean and median age was 57 years. Sixty-six percent were women and 34% were men. Thirty percent had postsurgical recurrent varicosities prior to UGFS treatment, which has a lesser associated procedure cost than surgery (or endothermal ablation methods) as well as less time off work. No presenting cases were declined treatment.

Table 1 Anatomical CEAP classification of cases studied ($n = 203$)

C 0	No visible or palpable signs of venous insufficiency	0%
C 1	Telangiectasias and/or reticular varicosities	1.5%
C 2	Varicose veins (VVs)	45%
C 3	VVs with leg oedema, or corona phlebectatica	11%
C 4	Venous eczema, pigmentation, lipodermatosclerosis, atrophie blanche	38%
C 5	Healed varicose ulcers	1.5%
C 6	Active venous ulceration	3%

CEAP, clinical, aetiological, anatomical and pathological elements

Table 2 Number of UGFS further treatments per year

	Number of treatments	Average	% Repeat UGFS	*N*
Year 1	1–9	2.53	0	203
Year 2	1–7	2.0	16.5	188
Year 3	1–6	2.04	8.2	121
Year 4	1–6	2.43	6.7	75
Year 5	1–2	1.5	8.8	34

UGFS, ultrasound-guided foam sclerotherapy

An average total volume of 7.3 mL foam (equivalent to 1.7 mL of 3% STS solution) was injected to achieve venous closure in the first 12 months (range 0.5–22 mL, median 6.5 mL, average 2.53 treatments). The number of treatments did not correlate to vein size ($P = 0.000247$). The number of repeat UGFS treatments performed annually is shown in Table 2. In the first year, 43% required additional UGFS treatment between six weeks and six months, and 23% between six months and twelve months. Symptoms such as aching limb pain and cramps usually resolved on the day of treatment. Leg swelling of venous origin reduced more slowly as interstitial oedema resolved. The skin changes of chronic venous insufficiency improved.

Complications

Adverse outcomes were infrequent with no serious complications reported. Any erythema was meticulously reported as superficial thrombophlebitis (STP) (10.3% in year 1; 4% in year 2). Other adverse effects reported or observed included

Table 3 Rates of recurrence

	Year 1 $n = 167$ (%)	Year 2 $n = 108$ (%)	Year 3 $n = 72$ (%)	Year 4 $n = 32$ (%)	Year 5 $n = 23$ (%)
Clinical recurrence					
No venous symptoms	84	89	76	88	74
Minimal venous symptoms	16	11	18	12	22
Significant venous symptoms	0	0	6	0	4
Ultrasound recurrence					
Venous closure	60	56	51	56	35
Any US recurrences	29	28	25	31	30
New varicose veins	4	8	8	0	17
Combined new/recurrent	7	7	15	13	17

Table 4 Overall recurrent GSV diameters ($n = 196$)

Average diameters (mm)	$n = 196$ Initial	$n = 48$ Year 1	$n = 30$ Year 2	$n = 18$ Year 3	$n = 10$ Year 4	$n = 17$ Year 5
Minimum GSV	2	0.5	0.5	0.6	0.6	0.8
Maximum GSV	22	7	5	6	6	6
Median GSV	5	2	2	2	2	2
Mean GSV	5.61	2.88	1.95	2.16	2.26	2.38
Persistent reflux <2 mm channel	0	42%	73%	56%	50%	42%
Persistent reflux >2 mm channel	0	58%	27%	44%	50%	57%

GSV, great saphenous vein

pain (3%), persistent swelling (2%), matting and staining (3.9%), transient migrainous scotomata (1%) and transient tongue of thrombus in the common femoral vein (1%). There was no incidence of anaphylaxis, fatality, stroke, sepsis, arterial injection, nerve damage, hypertrichosis, deep vein thrombosis or pulmonary embolism.

Recurrence

The clinical and ultrasound recurrence rates are shown in Table 3. The clinical recurrence rate stated reflects those with significant venous symptoms such as visible or palpable varices, aching, oedema or venous skin changes.

Serial GSV diameters are displayed in Table 4. Ultrasound-derived diameters of the GSV were persistently markedly reduced. Fully fibrosed trunkal vessel diameters (venous closure) measured 1.5–2.5 mm on ultrasound. A subgroup ($n = 41$), all of whom attended every annual follow-up for three years, demonstrated a similar significant reduction for all CEAP classes in GSV and SFJ diameters as the entire study group over five years (Tables 5 and 6). Forty-two percent of the ultrasound recurrent cases were less than 2 mm in diameter. The reduction in GSV size (average 4.38 mm at 5 years) was highly significant ($P = 0.00002$).

The SFJ showed a similar persistent highly significant reduction in diameter, averaging 3.067 mm at five years ($P = 0.0034$) (Table 6). This was independent of prior surgical intervention, with similar results for native SFJs and the subgroup that attended all possible follow-up visits (Tables 7 and 8). Fifty-six percent were closed or competent (Table 9), including native GSVs and those with post-surgical (non-native) neovascularization.

At five years, clinical recurrence was 4%; ultrasound recurrence was 30%, with 17% new vein formation, and 17% combined new and recurrent veins (Table 10). However, all patients reported that their treatment was successful, and that they would recommend it to a friend, would have it repeated if required, had improved cosmesis and much improved venous symptoms, and preferred UGFS to surgery as a treatment option.

Table 5 Subgroup GSV average diameters ($n = 41$)

	Pre-treatment diameter (mm)	Year 1	Year 2	Year 3
CEAP 2	4.5	2.1	1.8	1.8
CEAP 3	4.0	1.8	1.8	2.6
CEAP 4	6.3	2.4	1.9	2.7
CEAP 5	6.0	3.0	3.0	1.6
CEAP 6	3.5	2.0	2.3	1.6

GSV, great saphenous vein; CEAP, clinical, aetiological, anatomical and pathological elements

Discussion

All sizes of GSVs over all CEAP classes were shown to be safely and effectively treated. Primary or recurrent refluxing GSVs can be closed with UGFS, with high levels of patient satisfaction. We observed that recurrent varicose veins can present with multiple patterns of reflux, and the anatomy is often widely variant.[20–23] The data are mainly weighted for CEAP 2–4 classes, representing a wide range of presenting venous patients.

As reported in other studies with UGFS, chronic venous insufficiency and associated skin changes were relieved, and deep venous incompetence was often eliminated where associated superficial venous reflux was the key.[24]

Neovascularization characteristically seen after flush saphenous ligation[25] is not seen after UGFS.

Table 6 Average of all SFJ diameters ($n = 175$)

SFJ diameters in mm	Initial	Year 1	Year 2	Year 3	Year 4	Year 5
Minimum	1	1	0.5	1	1	1.7
Maximum	16	11	11	12	11	9
Median	8	5.9	5.6	6	7	5.25
Mean	8.07	5.2	5	5.4	6.4	5.12

SFJ, saphenofemoral junction

Table 7 Average native SFJ diameters (no previous surgery) ($n = 132$)

SFJ diameters (Native) in mm	Initial	Year 1	Year 2	Year 3	Year 4	Year 5
Minimum	5	2	2	2	2	2
Maximum	16	11	11	12	11	9
Median	9.0	6.0	6.0	6.0	7.3	6.3
Mean SFJ	9.1	6.1	5.9	6.2	7.4	5.9

SFJ, saphenofemoral junction

Postsurgical groin neovascularization was readily treated by massaging foam proximally after immediately distal UGFS.

Patients enjoyed an immediate return to activity, avoiding the cost of time off work. The technique of UGFS was well accepted by all patients, who felt strongly that UGFS was effective in treating their varicose veins, would recommend it to a friend, and would have UGFS repeated in the future if required. A statistically significant reduction in the diameter of the GSV was demonstrated in all cases of GSV reflux, sustained over the five-year period.

Acute STP was not uncommon (10.3%) in the post-treatment period, reflecting the aggressive treatment approach to complete closure of all branch varicosities and any demonstrated venous channels. The nil venous thrombosis rate compares very favourably with other methods of treatment of saphenous reflux and with postsurgical rates of these complications.[26] No other serious complications were seen, specifically no pulmonary embolism, arterial injection, sepsis,[27] nerve injury[28] or fatalities. A case of visual scotomata lasting for 20 minutes occurred with no sequelae.[29]

Table 8 Subgroup SFJ diameters over time ($n = 35$)

	Initial diameter (mm)	Year 1	Year 2	Year 3
CEAP 2	4.6	3.3	3.4	2.9
CEAP 3	7.0	4.5	5.3	6.1
CEAP 4	8.1	4.9	4.9	4.4
CEAP 5	11.0	9.0	8.0	8.0

SFJ, saphenofemoral junction; CEAP, clinical, aetiological, anatomical and pathological elements

Table 9 Status of the saphenofemoral junction (SFJ) ($n = 175$)

	Year 1 $n = 120$ (%)	Year 2 $n = 78$ (%)	Year 3 $n = 55$ (%)	Year 4 $n = 28$ (%)	Year 5 $n = 18$ (%)
SFJ closed	26	29	25	36	28
SFJ open and competent	33	34	35	21	28
SFJ open and incompetent	41	37	40	43	44
% efficacy	59	63	60	57	56

Table 10 Ultrasound and clinical recurrence rates (see Table 3)

	Clinical recurrence (significant symptoms) (%)	Ultrasound recurrence (on duplex US criteria)	
		Recurrences (%)	New varices (%)
Year 1	0	29	4
Year 2	0	28	8
Year 3	5	25	8
Year 4	0	31	0
Year 5	4	30	17

All patients reported excellent resolution of venous symptoms after five years, despite demonstrable ultrasound recurrence. Further UGFS treatment in subsequent years maintained control of this recurrent disease when required (Table 2). These results compare favourably with a recently published UGFS study.[30]

Conclusion

Ultrasound-guided microfoam sclerotherapy has been demonstrated to be an extremely safe, effective and popular office treatment suitable for the management of varicose veins associated with GSV reflux in this five-year prospective study. New and recurrent veins may arise over time observed on ultrasound surveillance. They can be readily retreated with UGFS as required.

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