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Ultrasound assisted great saphenous vein ligation and division: an office procedure

Stefano Ricci, Leo Moro, Raffaele Antonelli Incalzi

Centro di Flebologia, Area di Geriatria, Università Campus Bio Medico, Roma, Italy

Abstract

The aim of this proof of concept study is to describe an ultrasound (US) assisted simplified surgical procedure for pre-terminal great saphenous vein (GSV) high ligation/division avoiding groin dissection and tributary interruption, in an office setting, in association to varices phlebectomy and saphenous vein foam occlusion treatment. *Inclusion criteria:* primary GSV reflux due to terminal valve, vein diameter >6 mm. By ultrasonography in standing position, the point GSV passing over the adductor longus muscle (about 3 cm from the junction) is identified. This E (*easy*) point, relatively superficial, free from tributaries and other structures, allows an easy grasping and extraction of the GSV vein through a 3 mm stab incision provided an ultrasonography assistance. The vein is divided/ligated about 2 cm distal from the ostium, the distal stump is cannulated and foam is injected on the distal segment from the E-point incision in a retrograde fashion, varices are avulsed by phlebectomy. Twenty procedures in 18 patients (venous clinical severity score: mean 3.15 - GSV diameter: mean 7.34) were performed, all the cases without inconveniences, with a duration not exceeding 10 min in addition to the phlebectomy procedure time. No complications as hemorrhage, infection, nerve lesion, lymphatic leak or thrombosis have been registered. At one month the residual saphenous stump length was in average 2.16 cm with complete closure of GSV in all. Three patients have been controlled at 6 months showing GSV complete closure. The procedure described is a simple office US assisted method for GSV ligation-division, leaving the 2 last cm of the saphenofemoral junction. It could be associated to most of the procedures in use with limited additional time and resources required.

Introduction

Several methods are in use for achieving great saphenous vein (GSV) exclusion [high ligation, high ligation + stripping, endovascular heat occlusion-laser/radio frequency (RF), chemical occlusion-sclerotherapy, glue occlusion-cyanoacrylate, steam occlusion, and others] in varicose veins treatment. Laser and RF, in particular, have achieved efficient GSV stem occlusion at 1 year (91%-95%)[1] and even at 5 years long term follow up (73-86%),[2,3] with sparing of the proximal part (2-3 cm) of the GSV. Indeed, leaving this part patent and drained through the sapheno-femoral junction (SFJ) allows the saphenous tributaries to maintain their physiological drainage. In fact recurrence after surgery is frequently associated to groin neovascularisation which is possibly triggered by tributaries dissection/ligation,[4] one of the proposed pathophysiological mechanisms. Avoiding both groin dissection and tributary interruption could explain the lower incidence of groin reflux recurrence referred by endovascular procedures,[5,6] but confirmatory long term randomized studies are still lacking.

Furthermore, there is some evidence[7] that a detailed ultrasound (US) SFJ investigation could avoid the need of dissection in almost the half of cases, while for the remaining ones a minimally invasive approach like the proposed one could lead to a decrease in the recurrence rate.

This view is at variance with the traditional belief that the junction need to be fully dissected and all the tributaries interrupted.[8,9]

Isolated GSV surgical high interruption, as an alternative to traditional saphenectomy can be useful in several selected conditions (summarized in Table 1). While treating varicose disease in an office setting, we conceived an US assisted simplified surgical procedure for high ligating/dividing the GSV, avoiding tributary interruption. This proof of concept study summarizes our initial experience with this method. It provides technical details of the method, the solutions we found to overcome some difficulties and the main indications.

Materials and Methods

Patients

Eighteen patients underwent 20 GSV pre-terminal interruptions (PTI) from October 2013 to April 2014 [12 female, 6 male; mean-age: 46 (from 28 to 70); mean-body mass index: 24.23 (from 16.6 to 31.8]. Selection and exclusion criteria are reported in Table 2.

Candidates were selected from the patients scheduled for primary varicose vein treatment in our dedicated office based surgical activity (Ambulatorio Flebologico, Area di Geriatria, Campus Bio-Medico, Roma, Italy).

All patients were $C2sEpAsPr_{2,3,5}$ of the clinical class of CEAP (Clinical-Etiology-Anatomic-Pathophysiologic) classification,[10] symptomatic and with evident and extended bulging varicosities with a GSV stem >6 mm (reflux cutoff value ≥1 s). In two cases the procedure was bilateral. Written informed consent was obtained from every patient.

Methods

In our practice varicose disease is treated by office based stab avulsion phlebectomy of varicosities, associated to US assisted foam sclerotherapy (4- 6 mL, 3% polidocanol 1:4 of air - Tessari method[11]) of the saphenous stem when the SFJ is incompetent, provided that GSV diameter, measured - avoiding isolated dilatations - at 15 cm below the junction, exceeds 6 mm.[12-14] For GSV ≤6 mm only the varicosities avulsion is made. Indeed, GSV treatment likely is not indicated due to possible residual efficiency of ostial/femoral valves.[7,15] In the planning phase, the GSV is initially studied in standing position by echography during the preoperative veins marking phase. The vein is followed distally, starting from the junction, and the point passing over the adductor longus muscle (about 3 cm from the junction) is identified (Figure 1A).

This site, that we call the *easy* (E) point, the GSV stem is relatively free from other structures contact (collateral branches, lymph nodes, deep veins and arteries, nerves), lies over a muscular plane and is only covered by a thick, highly echogenic superficial fascia (Figure 1B). The overlying skin is marked at this point. Then, all the veins to be avulsed are marked on the skin and the patient is prepared for the procedure. Local infiltration anesthesia (mepivacain 0.4% solution prepared with

Correspondence: Stefano Ricci, Corso Trieste 123, 00198 Roma, Italy.
Tel.: +39.327.5405566.
E-mail: varicci@tiscali.it

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bicarbonate 1.4%[16] is done over the markings but is made only superficially at the groin marked site to avoid hiding of the GSV by the subcutaneous infiltration. After varicosities phlebectomy is completed, US assistance is prepared at the groin using a probe sterile covering and sterile gel; a 3 mm transversal incision is made at marked site; by blunt dissection of the superficial subcutaneous tissue, a mosquito forceps is progressively advanced till the fascia layer over the GSV, observed in a transverse section. The fascia is repeatedly grasped by the forceps, possibly pulled out of the incision and sectioned to achieve a true opening of the structure: this will facilitate the vein's extraction. A right angle tiny forceps (Figure 2) is then advanced in the deeper space between the GSV and the adductor longus muscle and passed below the vein, under direct echo-visualization. Further anesthetic is then injected to obtain complete painless procedure, pushing the infiltration both towards the groin and over the distal part of the vein. (This will allow pulling the vein out in both directions). The GSV is then gently extracted from the skin incision (Figure 3A), freed from residual connective adhesions, sectioned between two forceps. The distal lower end is cannulated (Jelco Optiva® 2, I.V. Catheters, 20G; Smiths Medicals, St. Paul, MN, USA) and foam (4-6 mL) injected, until foam comes out of the distal phlebectomy stab incisions (for this reason performed previously), and ligated. The proximal upper end is gently pulled out and transfixed with 3/0 Vycril suture without occluding the tributaries. Few drops of sclerosing agent are dripped in the residual part of the ligated stumps to eliminate all the endothelium remnants. The two ends are actively repositioned under the fascia layer, to avoid adhesions to the skin. The incision edges are approached by a steri-strip. A compressive adhesive bandage is applied on the entire limb starting from the groin, to be worn for a week. Patients are invited to walk immediately and actively during the following hours; no anticoagulation prophylaxis is prescribed unless in presence of hyper coagulation status.

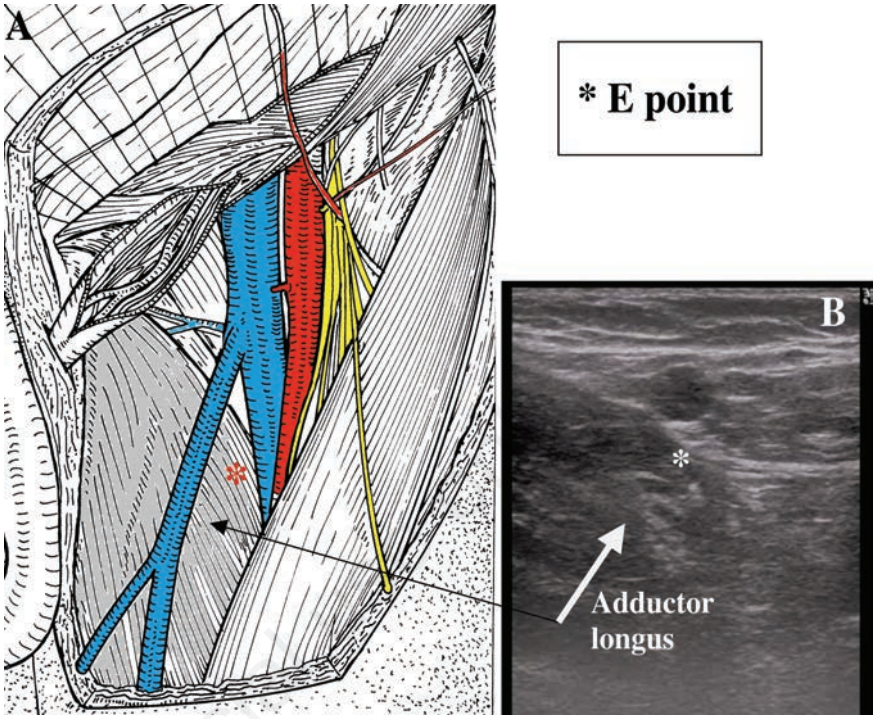

Figure 1. A) About three cm far from the ostium the great saphenous vein (GSV) lies over the adductor longus muscle, in a point (E point *) free from collateral branches, lymph nodes, nerves, deep veins and arteries (*modified from: Bardeleben KH, Haeckel E. Atlas of applied (topographical) human anatomy for students and practitioners. New York, NY: Rebman Company; 1906).* B) At the E point (*) the GSV lies over the muscle plane and is covered by a well visible superficial fascial plane.

Table 1. Indications of sapheno-femoral junction isolated interruption.

Traditional saphenectomy not suitable (patient aged, co-morbidity, ulcers)
To obtain a more efficient sclerotherapy of the saphenous stem
When sclerotherapy has failed or is contra-indicated (PFO + neurologic symptoms, thrombophylia, allergy, non acceptance)
When a saphenous conservative method is preferred (CHIVA)
Ascending GSV thrombosis needing to be arrested or avoided
SFJ interruption associated to endovascular treatments

PFO, patent foramen ovale; CHIVA, conservative hemodynamic correction of venous insufficiency; GSV, great saphenous vein; SFJ, sapheno-femoral junction.

Table 2. Inclusion and exclusion criteria.

Inclusion criteria
Primary GSV reflux due to terminal valve incompetence (Valsalva and compression/release positive over the junction, reflux >1 s, in standing position)
Vein diameter >6 mm measured at 15 cm distal from the groin
Length of the incompetence >30 cm (continuous, non interrupted)
Competent junction tributaries
Exclusion criteria
Clinical state not suitable for office surgery
Depth of GSV (skin-vein US distance) >3 cm
Previous GSV sclerotherapy

GSV, great saphenous vein; US, ultrasound.

Clinical and Duplex monitoring for these first cases are scheduled at 7 and 30 days, and then at 6 and 12 months.

Results

Twenty cases in 18 patients have so far been operated. The mean venous clinical severity score[17] was 3.15 [from 1 to 5; standard deviation (SD): 1.04]. The mean-diameter of GSV at 15 cm distal from the groin was 7.34 mm (6-10.5 mm; SD: 1.12). The duration of the specific procedure, as part of a phlebectomy session (lasting in average 45 min), has never exceeded 10 min. In no case the procedure has been interrupted. No complications as hemorrhage, infection, nerve lesion, lymphatic leak or thrombosis have been registered; one patient presented an asymptomatic edema around the groin incision lasting 15 days, treated by compression and antibiotics. Incision healing resulted very satisfactory (Figure 3B). In one case skin retraction at the scar was registered, in treatment with massaging.

All the patients have been clinically and US controlled at 7 days and 30 days. At one month the residual saphenous stump length was in average 2.16 cm (1.18-3; SD: 0.52) with complete closure of GSV in all. In all the cases the stump was patent without reflux. Eight patients have been controlled at 6 months showing GSV complete closure; one case presents at Valsalva a stump filling due to a pelvic reflux (Table 3) feeding the stump through a pudendal vein (not to a reflux from the ostium).

Discussion

This proof of concept study suggests that the proposed GSV PTI is easy to be performed and safe. It lends support to the current propensity to spare the last 2 cm of the GSV, to allow SFJ tributaries physiological drainage. It is effective at short term when associated to foam sclerotherapy, due to the wash out effect elim-

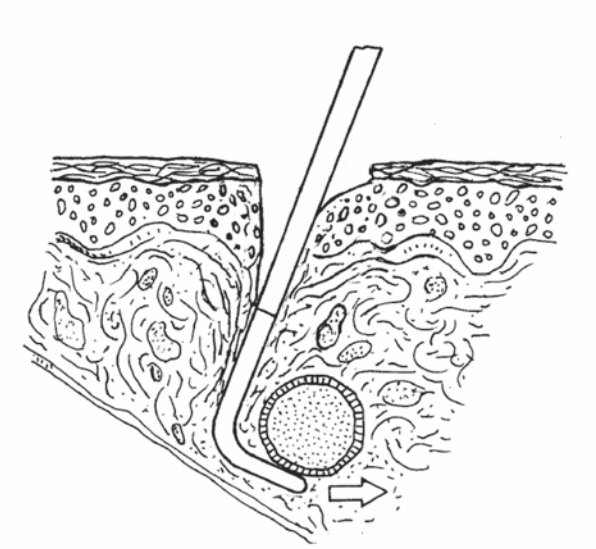

Figure 2. Through a fascia opening a right angle tiny forceps is advanced in the deeper space between the great saphenous vein and the adductor longus muscle and passed below the vein, under direct echo-visualization.

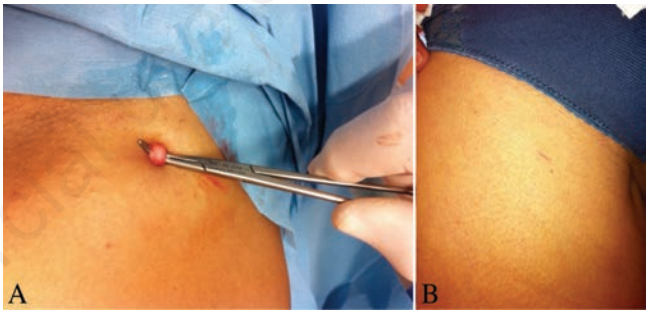

Figure 3. A) The great saphenous vein extracted from the skin incision will be divided and ligated. B) At one month the incision healing is usually very satisfactory.

Table 3. Demographic, clinical characteristics and results of participants.

Demographic and clinical characteristics	
All procedures, no.	20
Patients, no.	18
Gender, no. (% women)	12 (66.6)
Age mean	46 (28-70)
BMI mean; DS	24.23; 3.99
GSV vein diameter at 15 cm distal from the groin mean (DS); mm	7.34 (6-10.5); 1.12
VCSS mean; DS	3.15 (1-5); 1.04
Results	
Saphenous stump length mean (DS); cm	2.16 (1.18-3); 0.52
Patent stumps, no.	20
Reflux by Valsalva maneuver, no.	0
Results at 6 months (8 controls)	
Saphenous stump length mean (DS); cm	1.65 (1-2.5); 0.52
Patent stumps, no.	8
Reflux by Valsalva maneuver, no.	1 (pudendal)

BMI, body mass index; SD, standard deviation; GSV, great saphenous vein; VCSS, venous clinical severity score.

ination. Longer outcome evaluation will need considering possible bias due to the state of the related superficial vein network (possible recurrence, perforators hemodynamic, phlebectomy outcome).

Indeed, traditional flash to femoral vein high ligation has been universally considered as the gold standard operation to achieve GSV interruption.[18] However, suspect is rising that junction recanalisation due to neo-vascularisation could be secondary to junction wide dissection[19] and tributary interruption.[5] Indeed, several Authors performing saphenectomies without junction dissection reported favorable outcome, with apparently better results compared to traditional junction dissection.[20-22] Endovascular venous closure treatments meanwhile show that GSV closure leaving the junction's last 1-2 cm open to allow tributaries physiological drainage is associated with limited recurrence rates.[1,23-26]

Although GSV high ligation seems to be unnecessary when associated to modern procedures, still GSV interruption could be useful in some specific clinical and anatomical situations other than traditional GSV stripping (Table 1).

However, traditional groin dissection is a *true* surgical procedure, even when performed in local anesthesia, requiring surgical skill and a protected, dedicated setting. For this reason a simple technique of GSV interruption like the one we suggest could fit all described situations, but with a limited cost, limited surgical experience required, good efficacy and safety. This technique being *pre-terminal*, *i.e.* sparing the junction tributaries and avoiding dissection, it could create lesser stimuli to neo-vascularisation, provided that the neovascularization reaction theory will be definitively confirmed.[5,6] The residual 2-3 cm long saphenous stamp does not substantially differ from that left in place by the endovascular techniques.

About 15 % of the saphenous stems treated by sclerotherapy may recanalise at 1 year follow up,[27] up to about 50% at 5 years,[1] requiring further foam sclerotherapy. Trying to avoid recanalisation we began to perform pre terminal GSV ligation/division during the same phlebectomy/sclerotherapy session to obtain a more complete and durable foam sclerosis. Our 6 months control shows no recanalization, but the numbers are limited and long-term patency needs to be evaluated.

Our GSV PTI takes inspiration from the Dortu's experience dating back to 1993[28] followed by Fays-Bouchon in 1995[29] and recently resumed by others[20,21,30] suggesting a stab avulsion method of the saphenous stem with preterminal junction ligation. The GSV at the groin was found by pulling the distal GSV progressively extracted and feeling the saphenous stem under the skin[28] or a stripper previously introduced in a distal approach.[29] In our experience, the modern habit of US observation revealed that the GSV becomes more superficial at 2-3 cm from the SFJ, when passing over the Adductor longus muscle. In that site, the E point, the vein has its medial side in contact with the muscular fascia, while its lateral side is free from any other *dangerous* structure, allowing an *easy* blunt dissection guided by US imaging. Interestingly, this part of the GSV is usually free from tributaries and is easily pulled out for 1-2 cm due to its elasticity.

Two recently published papers[31,32] describe a GSV interruption technique by passing a tread below the GSV by US assistance, as a complement of endovenous laser ablation, with the purpose of avoiding risk of thrombosis and recurrence keeping the thermal energy away from the saphenofemoral junction. These authors simply apply a tread to close the vein in association to the Laser treatment.

The method that we suggest, at the opposite, allows GSV interruption, possible vein resection, vein cannulation for foam or endovenous ablation. Furthermore, a better visualization of the vein is accomplished avoiding the risk of femoral vein involvement.[32]

Finally, GSV PTI could perfectly fit the office based CHIVA (conservative hemodynamic correction of venous insufficiency) protocol[33] or similar[34] where the GSV interruption is done in the perspective of GSV stem sparing strategy. Compared to the other GSV interruption options (laser, RF, steam, glue) the PTI technique seems simpler, cheaper (no technology is needed) and, in particular, more precise in terms of anatomical positioning.

Attention should be drawn to assess the competence of the junction tributaries (particularly the anterior accessory SV) destined to drain in the residual GSV part. In case of one or more tributary incompetence, a reflux of the SFJ would be maintained active by the reverse flow in the same tributary, with possible fast recurrence. At the opposite, reflux absence in the residual stump is assured by the tributary valve competence. Finally, attention to the Giacomini vein (GV) hemodynamic should always be deserved, avoiding GSV proximal interruption when GV is the prevalent drainage of the small saphenous vein.

Limitations

Some limitations of the described method should be underlined: obese patients may be particularly cumbersome, especially if groin anatomy is unfavorable (deep skin creases); previous sclerotherapy may cause fibrous adhesions and GSV fragility; GSV diameter dilatation or aneurysm at the E Point may suggest more traditional surgical techniques. Finally, a good US experience is needed in the preoperative and operative phase.

Some technical points also will need to be analyzed in the future studies: should we shorten the proximal/distal stump surgically in order to make the neovascularization less probable? Should we do a simple ligature/titanium clip positioning on the GSV?

Conclusions

GSV PTI is a simple office surgical technique allowing a GSV ligation-division leaving the 2 last cm of the SFJ, possible thanks to US assistance. It could be associated to most of the procedures in use, if definite pre-terminal GSV interruption is wished, with limited additional time and resources required. However, only a long-term follow up will definitively prove its efficacy.

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