



The Contemporary Treatment of Varicose Veins (Strangle, Strip, Grill or Poison)

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"Varicose veins are the result of an improper selection of grandparents"

William Osler, 1848-1919

Venous disorders are usually not life- or limb-threatening conditions, but they affect millions of people on a daily basis, worsening their quality of life, and incur significant healthcare costs. Recent advances have made it possible to treat almost all affected patients with minimally invasive methods, resulting in little morbidity and a high expectation of success [1].

Varicose veins, the most common sign of chronic venous insufficiency, affect approximately a third of the population [2,3]. The venous system of the leg consists of three components: deep veins, superficial veins, and perforators communicating between the two systems. All three systems contain one-way valves and act in harmony, therefore dysfunction of one ultimately results in dysfunction of the other two. Venous return from the dependent lower extremities is achieved by active pumping of the calf muscles, assisted by competent valves preventing retrograde flow. Superficial venous insufficiency results from venous hypertension secondary to reflux (incompetent valves) and obstruction or failure of the leg muscle pump mechanism (alone or in combination) [4]. When the superficial veins are placed under high pressure they dilate and elongate to accommodate the increased blood volume. The tortuous appearance, termed varicose, is derived from the Greek term for "grape-like."

Many risk factors have been associated with the development of venous insufficiency, among which family history and female gender have shown the strongest correlation [5]. In addition to the condition's unaesthetic appearance, patients may complain of restless leg, heaviness and tiredness (which is relieved by sitting and leg elevation), swelling, pruritus and pain. Discomfort increases as the day progresses, in the summer, and for women

in the first days of the menstrual period. Importantly, reticular veins and telangiectasias may cause symptoms similar to those of gross tortuous varicose veins [6]. Some patients seek medical help to prevent future deterioration and, especially, due to the unfounded fear of gangrene and amputation. Without treatment 50% will develop eczema or dermatitis; less than 14% will develop superficial thrombophlebitis, bleeding or ulcer (ulcus cruris). In the past, superficial vein thrombosis was considered a benign condition, however 12–25% of affected patients may also develop a deep vein thrombosis.

The CEAP classification [7,8] defines the clinical class, etiology, anatomic distribution and the pathophysiology of venous insufficiency. The clinical class, with ascending severity, ranges from 0 (no signs) to 6 (active venous ulcer). Varicosities are the most frequent finding and are present in more than 80% of the patients. Skin changes are found in 25%, and 7–14% of patients have either healed or active ulcers [4,8]. Chronic venous insufficiency can be of primary, secondary or congenital origin. Approximately two-thirds of patients suffer from primary venous insufficiency confined to the superficial venous system [7-9]. Secondary insufficiency affects 18–28% of limbs with known etiology such as trauma or thrombosis, resulting in reflux [9]. Congenital insufficiency includes birth defects such as Klippel-Trenaunay syndrome and accounts for 1–3% of cases [10]. With regard to anatomic distribution, 90% of limbs show superficial vein insufficiency, compared to 30% of deep vein insufficiency and 20% of perforator vein insufficiency, alone or in combination [6,8]. Primary valve incompetence (reflux) may result from inborn vein wall weakness, leading to venous dilatation. This can occur at any site of the superficial or deep system. Mechanical forces, as in retroperitoneal fibrosis, neoplasm, pregnancy or lymph node enlargement, can lead to valvular "breakdown." In that case, the reflux develops a retrograde process starting at the saphenofemoral junction [10].

Recently, a clinical severity score was added to complement the CEAP system to better assess symptoms and future outcome of venous insufficiency [11]. The diagnosis of chronic venous insufficiency depends on: a) physical examination (which alone is insufficient and inaccurate), b) hand-held Doppler, and c) venous duplex scanning. Obstruction, if present, can be visualized as a non-compressible or partially compressible vein. It cannot be over-emphasized that the examination is subjective and strongly based on the operator's experience.

This review will discuss the modern treatment of varicose veins: namely, compression by elastic stockings, classical stripping surgery with phlebectomy, radiofrequency or endovenous laser ablation, and ultrasound-guided foam sclerotherapy. Treatments of the deep venous system are beyond the scope of this review.

Compression (“Strangle”)

Compression reduces the diameter of the veins, thereby increasing flow velocity and decreasing the risk of thrombosis. The fibrinolytic system is activated, lymphatic flow is improved, and filtration of fluids out of the intravascular space is reduced, thereby ameliorating skin changes and edema [12]. Moreover, compression reduces reflux and improves venous outflow, leading to a decrease in venous pressure both at rest and with ambulation. Compression is also anti-inflammatory, alleviating the pain and swelling. Some of these effects last after the compression is removed [13]. Incompetent valves become fibrotic with time and the damage is irreversible. Compression therapy, by the external support, constricts dilated veins and may restore competence to incompetent non-fibrotic valves [13].

Varicose veins can lead to severe morbidity and are not only a cosmetic problem. The traditional treatment options are compression or surgical removal of the varices and long saphenous vein.

There are different techniques of compression: bandages, hosiery (elastic stocking), and mechanical means (intermittent pneumatic). Only the first two are used for the treatment of varicose veins; the third one is used for the treatment of severe edema and ulcers. Elastic bandages, unless periodically and expertly rewrapped, maintain compression for only 6–8 hours while patients are ambulatory; they lose up to 50% of the initial compression even in recumbent patients at 24 hours [14]. Therefore, bandages as treatment should be discarded. All patients with varicose veins should use properly adjusted medical hosiery.

Compression therapy – although uncomfortable and difficult to wear, especially in hot climates – should always be offered as the first line of treatment for varicose veins. It is safe, relatively cheap and effective. The downside of this treatment is poor patient compliance. It may be the only possible treatment modality in certain patients, such as those with limited mobility, short

life expectancy, or those on continuous mandatory anticoagulant medication. In addition, compression should always be used as an adjunctive temporary treatment for all other types of treatment.

Surgery (“Strip”)

Surgery for varicose veins has three goals: a) elimination of varicosities (venous hypertension), b) good cosmetic results, and c) low morbidity and low recurrence of new varices [15].

Most surgical solutions are directed at the saphenous system, since in approximately 90% of limbs the venous insufficiency is confined to this system alone. The classic operation was described by Keller 100 ago [16]. The procedure included extensive dissection of the saphenofemoral junction and the whole length of the vein to cut all the tributaries. In 1906, Charles Mayo described removal of the greater saphenous vein by a special “ring vein-enucleator” [17]. This procedure allowed removal of parts of the saphenous vein without dissection of the tributaries that were torn off or avulsed.

Flush ligation alone at the saphenofemoral junction was practiced in the belief that the gravitational reflux is controlled and the vein is spared for future conduit for bypass surgery. Unfortunately, reflux continued and hydrostatic forces were not controlled [18]. A number of studies have confirmed that patients undergoing stripping of the greater saphenous vein tend to have fewer recurrences (25% vs. 43%, 2 years after surgery) and less re-operations than patients undergoing flush ligation alone [19,20]. Thus, simple proximal saphenous vein ligation should be done only in very specific cases. In nearly all patients, stripping of the saphenous vein is supplemented with stab avulsion of clusters of varices via mini-stab incisions (2–3 mm) by special phlebectomy hooks. These are done prior to stripping so that the leg can be elevated and wrapped in an elastic bandage immediately after stripping.

The long-term significant complication of the stripping operation from groin to ankle is sensory impairment due to saphenous nerve damage in up to 39%. Thus, many surgeons today prefer surgery only from the groin to the knee in order to minimize the risk of saphenous nerve injury. Other complications include hematoma, wound infection, lymph edema and scarring. DVT was encountered in up to 5% of the patients; 2% with clinical significance [21].

Other surgical procedures have been advocated by various authors. These include the conservative and hemodynamic method for insufficient veins on an ambulatory basis (known as CHIVA) in which only tributaries of the saphenous vein are flush ligated and divided in order to correct the reflux in the saphenous vein, external wrapping of the proximal GSV and trans-illuminated powered phlebectomy, but none have been proven superior to the classic operation and thus their use is quite limited.

Patients' satisfaction following surgery is hampered by a relatively long recovery period, absence from work and, especially, a high recurrence rate of varices (Duplex scanning revealed that

GSV = great saphenous vein

neovascularization in the groin was the most common cause of recurrence) [20]. Therefore, new minimal invasive treatment modalities were introduced.

Thermo-ablation: radiofrequency and laser (“Grill”)

Radiofrequency and endovenous laser heat the vein from inside, causing spasm with protein denaturation, irreversible shrinkage of the vein collagen, and intimal destruction. Contraction of the venous wall minimizes the likelihood of recanalization. Both methods use duplex guidance to locate the GSV and introduce the intraluminal catheter or fiber. The procedures are done under general, regional or tumescent local anesthesia: a large volume of a diluted solution of lidocaine and adrenaline in saline is infiltrated into the subcutaneous tissues and along the perivenous space. Tumescence achieves two goals: a thermal barrier around the vein to minimize damage to surrounding tissue and skin, and anesthesia (abolishing pain). Clusters of varices and smaller tributaries are dealt with, as in surgery, by stab avulsion or sclerotherapy.

Radiofrequency employs a bipolar generator and catheters with sheathable electrodes, which exchange electric polarity between the collapsible electrodes and a central ball tip. The GSV is accessed just above or below the knee level. The catheter tip is positioned (under duplex guidance) at the saphenofemoral junction while the patient is in reverse Trendelenburg position. Tumescent anesthesia is administered and the leg is wrapped from foot to thigh to exsanguinate the vein by compression. Vein wall temperature is maintained at 85°C by the generator. The catheter is then withdrawn along the length of the vein to be treated at 2.5–3 cm/min.

Endovenous laser treatment is basically similar to radiofrequency. A catheter is placed into the GSV, through which a laser fiber (usually 600 µm) is introduced and positioned at the saphenofemoral junction. Tumescent is administered and the fiber is slowly withdrawn while laser energy is continuously applied. The vein is closed from the junction to the access point. It takes around 10 minutes to treat a vein for a length of 30 cm. For smaller veins a lower energy level can be adjusted. Recently, these procedures were also employed for smaller veins such as accessory saphenous veins or even perforators [22]. The wavelength of 810, 940 or 980 nm is targeted at the hemoglobin. The newer energy applied at 1320 nm wavelength is not a blood absorption-dependent wavelength and is targeted at the water in the endothelial cells rather than at the hemoglobin in red blood cells. Also, it requires less heat, is confined to the vessel and does not perforate its wall. A 6 month follow-up study confirmed its safety and efficacy [23].

Both radiofrequency and endovenous laser appear to be safe and effective in the early and mid-term follow-up, with patients' satisfaction overwhelmingly better than after stripping. Early success rates for GSV ablation were in excess of 90%, comparable to, or better than the results following stripping [24-26]. A prospective randomized study directly comparing radiofrequency with stripping confirmed these earlier studies [27]. The recurrence

rate at 2 years with laser was merely 7%. Recently, Merchant and co-workers [28] presented a multicenter registry with 89% occlusion of the GSV and 86% reflux-free rates at 4 years. Incomplete ablation can be detected at any time following endovenous laser, and these veins can often be successfully treated with ultrasound-guided foam sclerotherapy [26,28].

Complications of these procedures include DVT in up to 1%, superficial vein thrombosis in up to 2.5%, and paresthesia in 2–16%. Leg edema, bruising, hematoma, pain and localized skin thermal injury occur in less than 1% of patients [23-28]. Pain and bruising were more common after endovenous laser than after radiofrequency.

Minimally invasive treatment options were recently introduced with excellent short-term results. These might replace surgery as the treatment of choice in the near future.

Ultrasound-guided foam sclerotherapy (“poison”)

Sclerotherapy has been used for the treatment of varicose veins for many years. In a randomized study [29], conventional sclerotherapy results were substantially worse when compared with surgery. Ultrasound-guided foam sclerotherapy must be considered a completely new treatment. Orbach [30], in 1944, demonstrated that shaking the sclerosant with air produced a material 4.5 times more effective than the same sclerosant alone, but the large bubbles were effective only for small veins. Fegan [31] emphasized the idea of treating an “empty vein” so that the sclerosant is not mixed and diluted by blood, thereby reducing its efficacy. Sclerosants became protein-bound and inactivated the GSV (even 20 mm in diameter) using polidocanol and sodium tetradecyl sulphate (in CO₂) injected as microfoam by USGS. Frullini and Cavezzi [34] and Tessari [35] describe easier ways to produce the foam. The most popular technique (that of Tessari) – due to its simplicity and low cost – utilizes two ordinary disposable syringes attached to a three-way stopcock. One syringe is filled with air and the other with sclerosant at a ratio of 3 to 1. The material is then passed back and forth through the stopcock. Optimal microfoam is produced after approximately 20 passages. This microfoam is more stable and has a higher concentration and larger volume. The foam tends to remain separate from the blood, displacing it, and filling the vein completely. The larger volume of foam (compared to the original volume of sclerosant) allows easier filling of the vein and longer exposure of the endothelium to a higher concentration of the drug. The reaction depends on the original concentration of the sclerosant and the duration of contact [36]. The liquid sclerosant is ineffective in veins with a diameter larger than 3 mm [36-40].

DVT = deep vein thrombosis

USGS = ultrasound-guided foam sclerotherapy

USGS allows for accurate treatment of saphenous veins, major trunks and reticular veins, regardless of their size, tortuosity or anatomic location. USGS can be used especially for recurrent varices following venous surgery. Unlike surgery, it is possible to treat *all* veins, simultaneously, in both legs, without anesthesia. Moreover, young fertile women who are expected to become pregnant again, as well as elderly patients, can still be treated [36-39]. The ultrasonic favorable reaction is immediate spasm and obliteration of the treated vein and, later, incompressibility and no flow. The clinical reaction is a hard cord with a slight tenderness and, later, disappearance of large bulging varices.

No randomized trial comparing foam sclerotherapy to classic stripping surgery has yet been published. A 10 year, prospective controlled randomized trial (VEDICO, 40) that included 800 patients examined different treatment modalities: liquid sclerotherapy (normal and high dose), multiple ligations, stab avulsions, foam sclerotherapy, and ligation followed by sclerotherapy. The study concluded that foam sclerotherapy was more efficacious than liquid sclerotherapy, and its results are comparable to those of surgery [36,40]. All published results have demonstrated immediate venous occlusion in 80% of patients and up to 95% occlusion after three injections [35-40]. Early and mid-term results revealed a recurrence rate of approximately 20% (after 3 years), with re-injections remaining as simple and efficacious as primary injections.

Contraindications for USGS include: allergy to the sclerosing agent, severe systemic disease, recent DVT, inability to walk, and severe arterial occlusive disease. Severe complications of USGS such as anaphylaxis are rare. Intra-arterial injection is theoretically reduced by ultrasonic guidance; however, it depends on the presence of arteriovenous shunts (in hereditary venous malformations or post-trauma) and the physician's technique and knowledge. Local tissue necrosis can occur by either extravasation or by a too high sclerosant concentration. DVT was reported in 3 per 1000 foam sessions (0.3% of sessions) and can be found in up to 2% of patients. Superficial vein thrombosis is observed in 10% of cases, but it is an excessive reaction rather than a real complication. Temporary visual disturbances and headaches were reported in up to 1%, mostly in patients suffering from migraine. Pigmentation usually disappears within a year following the treatment. Hematoma and pain of the treated veins are, again, an excessive reaction [36,37,39].

Conclusions

Similar to other fields in surgery, patients will be treated in the future by less invasive methods. Early results of radiofrequency, endovenous laser and USGS are encouraging. They enable patients a quicker recovery and return to daily normal activity, and they avoid postoperative scarring. The treatment should be tailored to the individual patient. The main issue, however, is durability. None of these obliterative procedures has yet been validated for long follow-up in the literature, but these methods were proven to be less aggressive and effective at mid-term. They must therefore be considered as still in the clinical validation stage, and as such only to be used by dedicated expert surgeons.

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