Reviews in Vascular Medicine 4-5 (2016) 1–8

Contents lists available at ScienceDirect

Reviews in Vascular Medicine

journal homepage: www.elsevier.com/locate/rvm

# A comparison of thermal and non-thermal ablation

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ARTICLE INFO

*Article history:*
Received 30 August 2015
Accepted 16 February 2016

*Keywords:*
Varicose veins
Thermal Ablation
Non-thermal Ablation

ABSTRACT

Varicose vein disease is common and has an adverse effect on patients. Treatment of the condition has been demonstrated to improve patients' physical well-being and quality of life. Surgical treatment has for a long time been the 'gold standard' method until the launch of endovenous thermal ablation towards end of the twentieth century. Indeed, being less invasive and offering the possibility of day-case local anaesthetic procedures, they have gradually become the mainstay of contemporary varicose vein treatment. Vein ablation using steam and microwave are new additions to thermal methods, but there is currently insufficient evidence as to their effectiveness and place in the management of varicose veins. The superiority of thermal ablation is now being challenged by endovenous non-thermal methods. Foam sclerotherapy, until recently the only endovenous non-thermal technique available, has been joined by mechanochemical ablation and cyanoacrylate glue as viable alternatives to thermal ablation. It is believed that these new non-thermal methods will be able to offer additional benefits to patients. This review of thermal and non-thermal ablation techniques assesses their respective merit in the management of varicose veins.



**Contents**



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http://dx.doi.org/10.1016/j.rvm.2016.02.001
2212-0211/

## 1. Introduction

Approximately one third of the population is afflicted with varicose vein disease [1]. Along with affecting the quality of life of patients, it also causes physical symptoms such as achiness, swelling and itching, with further worsening of the condition leading to skin changes and ulcerations [2–7]. Treating varicose veins does, however, abolish these symptoms and improve the quality of life of patients [8–10]. Traditionally, this was accomplished surgically, by ligation of an incompetent saphenofemoral or saphenopopliteal junction (SFJ or SPJ) along with stripping of the refluxing truncal vein.

Minimally invasive methods to treat varicose veins were introduced towards the end of the twentieth century and these have dramatically changed how varicose veins are managed. Indeed, these thermal techniques (TT), radiofrequency ablation (RFA) and endovenous laser treatment (EVLT), have enabled procedures to be carried out as day-cases, often in an office-based setting. The past few years has seen the introduction of non-thermal, non-tumescent (NTNT) methods of vein ablation, which are aimed at avoiding the unpleasant effects of thermal treatments.

Both these thermal and non-thermal ablation techniques are looked at in this review.

## 2. Thermal technique (TT)

Present in the arsenal of the Vascular surgeon for more than a decade, endothermal techniques (radiofrequency ablation (RFA) and endovenous laser treatment (EVLT)) have transformed the way varicose veins are managed. They involve the transmission of heat energy, either from a laser diode or radiofrequency catheter, to the vein wall. Over time, they have transformed the contemporary management of varicose veins, so that both the American Venous Forum (AVF) (USA) and the National Institute of Clinical Excellence (NICE) (UK) have recommended endovenous thermal ablation as first line treatment of varicose veins [11,12].

### 2.1. Radiofrequency ablation

Radiofrequency ablation (RFA) involves transmitting heat energy directly from an active electrode to the vein wall endothelium at a frequency ranging from 200 to 3000 kHz [13]. The electrode heats a narrow rim of tissue ( $< 1$ mm) in direct contact with it, while conduction ensures heat transfer to the deeper tissues. Collagen contraction of the vein wall or thermocoagulation of the vein wall ensues [13]. In one of the first clinical trial using this new technique, Goldman (2000) treated 10 patients (12 limbs) with great saphenous vein (GSV) incompetence using a Closure® catheter (VNUS Technologies, Sunnyvale, CA, USA). After infiltrating tumescent fluid around the vein and exteriorising it using a Muller phlebectomy hook, he inserted a 5 or 8 Fr RFA catheter device to within 1–2 cm from the sapheno-femoral junction (SFJ). He then applied pressure manually in the groin area and the RFA generator was activated. Once the catheter had reached 85 °C for 30 s, the catheter was pulled back at a rate of 3.5 cm/min [13]. At 3 and 6 months, all patients had ablated GSVs and resolution of all their pre-operative symptoms [13].

Segmental ablation using RF was the next stage in the evolution of the technique and Proebstle et al. [14] reported the first clinical study using this device. The catheter (ClosureFast, VNUS Medical Technologies Inc., San Jose, CA, USA) made it possible to treat truncal veins in segments at a temperature of 120 °C during 20-s treatment cycles rather than the pullback method utilised by Goldman (2000) [13,14]. The trial included 194 patients (252 limbs) and patients had a mean age of 50.5 years [14]. Once access was achieved, a 7-cm segmental heating catheter was inserted and positioned between 1–2 cm below the SFJ. Tumescent fluid was then injected. The purpose of this fluid is to reduce the diameter of the vein being treated, control treatment-related pain and protect surrounding structures from heat damage [14]. Close to the SFJ, two 20-s cycles were applied, while further distally, each subsequent segments were treated with one cycle only. An occlusion rate of 99.6% at the 6 months follow-up was achieved, based on a Kaplan–Meier method [14].

The same group conducted a multicentre trial at 8 different sites in Germany and France [15]. Two hundred and twenty-five patients with refluxing GSVs (295 in total) were recruited and treated with RFA as above. They were followed up at different time points over 5 years, with 80.0 percent of them having a duplex ultrasound scan at final follow-up. Based on a Kaplan–Meier method once again, an occlusion rate of 91.9% and a rate of absence of reflux was 94.9% at 5 years was demonstrated [15]. The Venous Clinical Severity Score (VCSS), used to assess the clinical morbidity, at 5 years showed a significant improvement from baseline (from 3.9 to 1.3; $p < 0.001$).

When RFA was compared to high ligation and stripping, as in the prospective randomised trial of endovenous radiofrequency obliteration versus ligation and vein stripping (EVOLVeS), non-significant differences in occlusion and recurrence rates were found at 2 years [16]. This study, which enroled 85 well-matched patients, may not have been adequately powered to be able to show a difference though. However, the time to return to normal activities in the study was significantly less in those receiving RFA compared to surgery (1.15 days versus 3.89 days; $p = 0.02$) as was the global quality of life (QoL) score ($p < 0.005$) [16,17].

### 2.2. Endovenous laser treatment (EVLT)

Endovenous laser ablation was introduced towards the turn of the century with Navarro et al. describing the first clinical trial [18]. The study recruited 33 patients (44 GSV) having SFJ reflux with GSV incompetence. The pre-marked GSV was cannulated followed by insertion of a bare-tipped laser fibre. The laser fibre tip was positioned 1–2 cm below the SFJ and tumescent local anaesthetic (lidocaine 0.5% without adrenaline) was instilled. Trendelenburg positioning and manual finger pressure was used to empty the vein. The ablative procedure consisted of laser energy delivered at a wavelength of 810 nm along the GSV while the laser fibre was being slowly pulled back in 3-5mm increments. Post-intervention, compression stockings were applied and the patients were followed for up to 14 months (mean follow-up of 4.2 months). All treated GSV segments were found to be occluded (100%) [18]. The technique appeared safe, was well-tolerated and shown to be very effective in the short term.

The efficacy of EVLT was confirmed in a second study conducted by Proebstle et al. [19]. Using a similar technique as Navarro et al. [18], with a slight variation (a 940 nm laser was used instead), they treated 26 patients (31 limbs) with GSV incompetence. The mean age was 57 years and most of the patients were females. One patient had an incomplete occlusion giving a complete occlusion rate of 97% up to 28 days after treatment [19]. Common complications encountered were pain and ecchymosis, though these were not as serious as those usually seen in those having surgical treatment. One patient consented to have conventional surgery, with EVLT administered immediately following ligation of the SFJ, but before the stripping part of the procedure. Macroscopic examination of the wall of the treated demonstrated reddening, carbonisation and even perforation at the sites where the laser fibre tip was nearest to the wall during laser energy delivery. Gross vein wall destruction due to direct impact of the