Journal of
Vascular Surgery
Venous and Lymphatic Disorders™

Current state of the treatment of perforating veins

Ellen D. Dillavou, MD,[a] Michael Harlander-Locke, MPH,[b] Nicos Labropoulos, MD,[c] Steven Elias, MD,[d] and **Kathleen J. Ozsvath, MD,[e]** *Pittsburgh, Pa; Los Angeles, Calif; and Stony Brook, New York, and Albany, NY*

Perforating veins may play a role in the development of chronic venous insufficiency and ulceration. There is renewed interest in minimally invasive treatments vs historic surgical options. Current indications for treatment, technical success, and evidence for clinical efficacy are summarized. Existing recommendations include perforator closure in Clinical, Etiology, Anatomy, and Pathophysiology class 5 or class 6 disease through percutaneous thermal ablation, subfascial endoscopic perforator surgery, open surgery, or sclerotherapy. Closure rates for percutaneous thermal ablation are reported as 60% to 80% initially. More recanalization and de novo perforator formation have been reported than after thermal saphenous closure. Ultrasound-guided foam sclerotherapy has shown promise in perforator closure and wound healing, but with variable success rates. Regardless of method used, successful closure of perforators appears predictive of wound healing with minimal morbidity. However, the power and design of all studies supporting this are far from robust, and more work is needed. (J Vasc Surg: Venous and Lym Dis 2015;■:1-5.)

Chronic venous insufficiency (CVI) is prevalent worldwide. Both deep and superficial venous reflux can cause CVI and ulceration, which is a risk for infection, pain, disability, and, rarely, carcinoma. Compression has historically been the primary therapy, but treatment of underlying venous disease to relieve venous hypertension appears to improve wound healing and to decrease recurrence.

Benefits of saphenous ablation have been well demonstrated; however, evidence for treatment of incompetent perforating veins is less clear. In 2010, the Pacific Vascular Symposium announced a Call to Action to reduce recalcitrant venous ulcers by 50% during the next 10 years. Clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum (2014) recommend treatment of perforating veins with reflux >500 ms and a vein diameter >3.5 mm located near healed or active venous ulcers (Clinical, Etiology, Anatomy, and Pathophysiology [CEAP] class 5 and class 6).[1] In contrast, these guidelines recommend *against* perforator treatment in CEAP class 1 and class 2 patients. The value of perforator treatment in CEAP class 3 and class 4 disease remains unclear.[1] Subfascial endoscopic perforator surgery (SEPS), open perforator surgery, sclerotherapy, and thermal ablation have all been used for perforator closure. This evidence summary reviews current methods and results of perforator treatment. A MEDLINE search of all peer-reviewed papers evaluating the treatment of perforator veins was compiled and reviewed. Clinical practice guidelines for the treatment of perforating veins of the Society for Vascular Surgery and the American Venous Forum were reviewed as well. These were chosen with emphasis on minimally invasive techniques with sonographic and clinical follow-up.

From the Division of Vascular Surgery, UPMC Hospitals, Pittsburgh[a]; the Division of Vascular Surgery, University of California, Los Angeles[b]; the Division of Vascular Surgery, Stony Brook University Medical Center, Stony Brook[c]; the Division of Vascular Surgery, New York-Presbyterian/Columbia University Medical Center, New York[d]; and the Division of Vascular Surgery, Albany Medical College/Albany Medical Center Hospital, Albany.[e]

Author conflict of interest: none.

Reprint requests: Ellen D. Dillavou, MD, FACS, RPVI, Director of Venous Services, UPP Division of Vascular Surgery, UPMC Vein Center, Ste 5414, 300 Halket St, Pittsburgh, Pa 15213 (e-mail: dilled@upmc.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.
2213-333X

http://dx.doi.org/10.1016/j.jvsv.2015.03.009

ANATOMY AND PHYSIOLOGY

Lower extremity venous anatomy consists of deep, muscular, perforator, and superficial veins. Perforating veins connect the superficial and deep systems and are a part of normal anatomy.[2,3] Updated nomenclature is based on anatomic location and distance from the foot.[4]

Perforating veins demonstrate bidirectional flow in the calf as the muscles contract and relax to equalize the pressure between the deep and superficial systems. With venous insufficiency, blood pools in the limb, creating venous hypertension that leads to lipodermatosclerosis, skin discoloration, venous claudication, and ulceration.[5] Treatment of pathologic flow dynamics reduces venous hypertension.

TECHNIQUES OF PERFORATOR CLOSURE

Subfascial perforator interruption and SEPS. In 1938, Linton described perforating veins of the leg and their relationship to venous ulcer. He detailed techniques to resect these with the medial fascia in the leg. This is now of historical interest because of significant morbidity[3] but illustrated the value of perforator closure in CVI. Perforator transection with SEPS established a less morbid, lower risk intervention[6-9] as the endoscope was used to visualize and to divide perforators. Despite some success, SEPS has been unsuccessful in some patients with chronic pain and recurrent ulceration, who ultimately required amputation.[10]

Table I. Randomized controlled trials examining the impact of perforator treatment

Study author	*No.*	*Comparison*	*Perforator surgery technique*	*Follow-up, months*	*Ulcer healing, %*		*Ulcer recurrence, %*	
					Control	*Active*	*Control*	*Active*
Nelzén[11] (2011)	75 patients	GSV vs GSV + perforators	SEPS	12	83	80		
van Gent[8] (2006)	170/200	Compression vs GSV + perforators	SEPS	29	73	83	23	22

GSV, Great saphenous vein; *SEPS,* subfascial endoscopic perforator surgery.
A MEDLINE search using the keywords *vein perforator surgery*, *perforator obliteration*, *perforator ablation*, *endovenous perforator ablation*, *subfascial endoscopic perforator surgery*, and *perforator ligation* yielded a total of 109 publications, excluding case reports or case series that contained only one patient with perforator treatment. Of the 109 studies in which radiofrequency, laser, foam sclerotherapy, or subfascial endoscopic perforator surgery was used for perforator treatment, two were randomized controlled trials that were published between January 1, 2004, and January 1, 2014.
All percentages have been rounded to the nearest percentile.

Of the five randomized controlled trials examining the role of SEPS in ulcer healing and recurrence, two have been conducted in the last 10 years (Table I). Several randomized controlled trials performed before 2004 showed similar results, but improved ulcer recurrence rates were associated with the addition of incompetent perforator surgery. The main limitation of the prospective randomized trials to date (excluding Nelzén and Fransson[11]) is that they combine great saphenous vein (GSV) treatment with perforator treatment, clouding the impact of perforator ablation. In the Effect of Surgery and Compression on Healing and Recurrence (ESCHAR) trial,[12] only six patients in the compression plus surgery cohort (3%) underwent calf perforator surgery only. The Nelzén trial examined GSV treatment vs GSV treatment plus SEPS. The results indicated no significant differences but were limited to a single institution and small numbers.

Extrapolation from SEPS data led to ablation and sclerotherapy of perforating veins to treat chronic venous ulceration with less invasive technology. Closure of perforators is well described (Table II), and Table III summarizes recent work in relation to ulcer healing. No randomized trial has shown benefit from treating perforator veins, so treatment of CEAP class 5 and class 6 patients is based on extrapolated data.

Foam sclerotherapy. Ultrasound-guided foam sclerotherapy (UGFS) was initially reported in 1992 to be helpful and safe in treating patients with perforator incompetence.[29] This is an off-label use of the Food and Drug Administration-approved sclerosants polidocanol and sodium tetradecyl sulfate. Concentrations of 1% to 3% of polidocanol or sodium tetradecyl sulfate can be agitated with air or carbon dioxide to create foam that is injected under ultrasound guidance. Some of these concentrations are available only as compounded products. Risks of any sclerotherapy include pigment changes, ulceration at the site of injection, arterial injection, deep venous thrombosis (DVT), and allergy. Because of low cost, ease of use, and tolerance by the patient, UGFS is widely performed. Benefit may come from both closure of the perforating vein and thrombosis of the network of varicosities surrounding ulcers or symptomatic areas.[13,28] In CEAP class 6 patients, a perforator occlusion rate of 54% with a 3% calf vein DVT has been reported. The same study found thrombosis of incompetent perforators to be the only predictor of ulcer healing.[13] UGFS may also prove to be useful in maintenance of healing, with one report demonstrating ulcer recurrence rates of 4.7% and 28% at 1 year and 5 years, comparing favorably with reports of up to >50% recurrence at 3 years with compression alone.[28,30]

Thermal ablation. Thermal ablation, or percutaneous ablation of perforators (PAPs), is appropriate for large perforators (>3.5 mm) in CEAP class 5 and class 6 patients. Few complications are reported, but they include calf vein DVT, hematoma, and nerve damage.[14,15,18,26]

Radiofrequency ablation (RFA). RFA has been used for saphenous closure for more than a decade and was recently adapted with a specific catheter for perforator closure (Covidien, Mansfield, Mass). A stiff catheter with a distal heating device, mounted on a stylet, directly punctures the perforator. The catheter is advanced to the fascia, and once it is introduced into the perforator vein, tumescent solution is injected into the perivenous space. The catheter alone can also be introduced over a 0.035-inch wire and advanced until it is adjacent to the deep veins. The catheter is activated, and the vein is treated for 30 seconds in four quadrants. This is repeated every 2 to 5 mm for the length of the perforator.

Endovenous laser ablation (EVLA). EVLA, like RFA, has been widely used to treat superficial venous insufficiency. Many laser wavelengths have been used for PAPs, the most common being 810 nm, 980 nm, and 1470 nm.[31] The 1470-nm laser fiber is introduced into the perforator through a 21-gauge needle without additional need for a sheath. Energy (50 joules/5 mm) is delivered through the fiber tip to treat the length of the perforator. Several studies have shown that EVLA PAPs is safe and feasible.[16,32,33]

TECHNICAL CHALLENGES

Closure of pathologic perforating veins is technically challenging compared with ablation of saphenous veins, regardless of technique. Whereas saphenous thermal ablation thrombosis has been reported to be 96% to 98%, perforator closure ranges from 59% to 90%, even in centers of excellence. Closure rates can be enhanced with repeated