Role of Interventional Radiologists in the Management of Lower Extremity Venous Insufficiency

Rulon L. Hardman, MD, PhD¹ Paul J. Rochon, MD, RPVI¹

¹Department of Radiology, University of Colorado, Anschutz Medical Campus, Aurora, Colorado

Address for correspondence Paul J. Rochon, MD, RPVI, Department of Radiology, University of Colorado, Anschutz Medical Campus, Aurora, CO (e-mail: Paul.Rochon@ucdenver.edu).

Semin Intervent Radiol 2013;30:388–393

Abstract

Keywords

- ▶ chronic venous insufficiency
- ▶ varicose veins
- ▶ endovascular laser ablation
- ▶ endovascular radiofrequency ablation
- ▶ sclerotherapy
- ▶ interventional radiology

Lower extremity venous insufficiency affects over half of all women. Interventional radiologists should be aware of the clinical evaluation of women with venous insufficiency and classification of disease. Endovascular therapies available for treatment of lower extremity venous insufficiency include: endovenous laser ablation, radiofrequency endovascular ablation, and sclerotherapy. The interventional radiologist should be versed on which therapy to select in each clinical presentation and the procedural techniques. The authors review the role of the interventional radiologist in managing this lower extremity venous disorder.

Objectives: Upon completion of this article, the reader will be able to discuss the clinical evaluation, classification, and treatment options for lower extremity venous insufficiency.

Accreditation: This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of Tufts University School of Medicine (TUSM) and Thieme Medical Publishers, New York. TUSM is accredited by the ACCME to provide continuing medical education for physicians.

Credit: Tufts University School of Medicine designates this journal-based CME activity for a maximum of **1 AMA PRA Category 1 Credit™**. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Lower extremity venous insufficiency is a common condition, with approximately 50 to 55% of women showing some stigmata of venous disease and approximately 20 to 25% of women having visible varicose veins.¹ Patients usually

present because of cosmetic consequences of venous insufficiency, such as telangiectasias (spider veins) and varicosities. The spectrum of venous insufficiency, however, can present with itching, pain, aching, lower extremity heaviness, muscle cramps, ankle swelling, discoloration, lipodermatosclerosis, and ulcerations. Veins affected by insufficiency may thrombose or bleed.

Treatment of venous insufficiency aims to treat both the cosmetic and symptomatic sequelae. Although many mechanisms have been suggested for the cause of venous insufficiency,² current clinical diagnosis is based on detecting reflux in the superficial lower extremity venous system, most commonly the great and small saphenous veins. Various treatment options are available for venous insufficiency. Historically, venous insufficiency was treated conservatively with graduated compressing stocking or invasively with surgical vein stripping. Current additional treatments include endovascular ablation with either laser or radiofrequency, and the injection of sclerosing agents into the vein—both of which fall within the scope of practice of interventional

radiology. Additional therapies for venous insufficiency include conservative hemodynamic cure for venous insufficiency (CHIVA) and ambulatory selective varix ablation (ASVAL).

This article focuses on the management of venous insufficiency patients as an interventional radiologist, from the initial presentation, clinical workup, treatment options, treatment, and follow-up.

Clinical Evaluation

History and Physical Exam

The management of primary venous insufficiency should begin with a clinical evaluation of each patient. Clinical history about the patient's symptoms should be elicited. Severity of disease, presentation of insufficiency (telangiectasias, skin changes, and ulcers), duration, and distribution are important in classifying the patient's insufficiency and directing management. History combined with ultrasound results leads to categorizing the patient's disease by the CEAP classification, further detailed below.

Patients with a family history of varicose veins have a much higher incidence of varicose veins.³ Age and gender are also important factors contributing to venous insufficiency. The Framingham Study showed a prevalence of varicose veins of 10% in women younger than 30 years and 77% in women older than 70 years.⁴ In addition, patient's weight and pregnancy affect the incidence of venous insufficiency. Laurikka et al showed a strong correlation between parity and the presence of varicose veins.⁵ Current pregnancy status is also important as most guidelines consider pregnancy and breast feeding relative contraindications to treatment, such as sclerotherapy.⁶ Additional pertinent history includes patient allergies, prior deep vein thrombosis, pulmonary embolism, and whether or not the patient has a known right to left shunt such as a patent foramen ovale (PFO).

Congenital syndromes that manifest with venous insufficiency include Klippel-Trenauney syndrome and Parkes-Weber syndrome. Klippel-Trenauney syndrome occurs both in men and women and is characterized by deep vein hypoplasia. Patients frequently have aberrant venous pathways such as sciatic veins or persistent embryonic veins. Parkes-Weber is a rare disorder that presents with lower extremity varices and arteriovenous malformations. Evaluation in patients with these syndromes should include magnetic resonance venography in addition to duplex ultrasound.⁷

The physical examination of patients with suspected venous insufficiency involves inspection and palpation of both the legs. Investigation for any asymmetry, edema, or other skin manifestations such as spider veins, varicose veins, pigment changes, or ulcerations is necessary. These skin changes represent subsets of the spectrum of minor to severe manifestations of chronic venous insufficiency (►Figs. 1–3).

When examining the lower extremities, attention should also be given to the pelvis to assess for any signs of iliac vein obstruction or pelvic vein insufficiency. Pedal pulses should be palpable as the lack of this may indicate arterial insufficiency, which is a contraindication for treatment. Any signs of cellulitis preclude any decision

Figure 1 Telangiectasias in venous insufficiency.

Figure 2 Varicose veins.

Figure 3 Lipodermatosclerosis.

for treatment. Documentation of the lower extremities in the medical record via drawings or photographs provides a baseline of venous disease and related factors.

Ultrasound Evaluation

Duplex ultrasound is the most useful tool for diagnosing venous insufficiency, and contributes to disease classification and treatment planning. Ultrasound evaluation is performed with a linear array 7.5 to 10 MHz probe, and patients are evaluated with both gray-scale and Doppler images.

The ultrasound evaluation in this patient population is more extensive when compared with the typical lower extremity examination for deep vein thrombosis; however, deep vein thrombosis must also be excluded, as the superficial system may provide an important venous drainage pathway in these patients. Venous evaluation for insufficiency should be performed with the patient standing, supporting their weight with the contralateral leg, or in reverse Trendelenburg. The standing position dilates the veins and allows evaluation of reflux. Standard evaluation for deep vein thrombosis should first be performed.

Reversed venous flow (reflux) is evaluated. The great saphenous vein and small saphenous veins are documented for the presence of reflux lasting more than 0.5 seconds (**Fig. 4**). Abnormal reflux in the deep veins is documented if lasting longer than 1.0 second. Perforating veins are considered abnormal if the diameter of the vein is greater than 3.5 mm and if there is reflux of flow for greater than 0.5 seconds.⁸

Ultrasound is also an important tool in guiding endovascular therapy as well as clinical follow-up. Evaluation after endovenous therapy should demonstrate an occluded saphenous

Figure 4 Duplex ultrasound of the great saphenous vein demonstrates reflux lasting 3 seconds (normal < 0.5 s) (arrows). Findings are diagnostic for venous insufficiency.

vein, thickened venous wall, and absent flow up to 5 cm from the saphenofemoral confluence.

CEAP Classification and Venous Clinical Severity Score

In an effort to standardize the comparison of treatments and description of venous insufficiency, the American Venous Forum published criteria for the classification of venous disease in 1994, summarized as CEAP classification.⁹ CEAP classification includes a description of clinical class (C) of disease based on objective signs, etiology (E) of insufficiency, anatomical (A) distribution, and underlying pathophysiology (P). (**Table 1**). The anatomic distribution is annotated by eighteen named venous segments (**Table 2**).

CEAP underwent revision in 2004 by a panel directed by the American Venous Forum.¹⁰ Using the original CEAP, the disease pattern listing all effected segments; using the revised CEAP, only the highest classification is reported.

In response to the CEAP system not depicting the spectrum of severity of venous disease, the American Venous Forum developed the Venous Clinical Severity Score (**Table 3**).¹¹ This scoring system should be complementary to the CEAP classification system.

Treatment Options

Several options exist to treat chronic lower extremity venous insufficiency. The common treatments include graduated compression stockings, surgical venous stripping, endovascular treatments, and sclerotherapy. The American College of Radiology has published recommendations and appropriateness criteria for the therapies in various clinical presentations.¹²

Compression Stockings

Graduated compression stockings are the first treatment for chronic venous insufficiency.¹³ Stockings are helpful in patients who cannot undergo surgical or ablative therapies, such as during pregnancy,^{12,14} and are also used after ablative and surgical treatments. The optimal duration of compression

Table 1 CEAP classification for chronic venous disease¹⁰

CEAP Classification	
Clinical Classification	
C0	No visible or palpable signs of disease
C1	Telangiectasias or reticular veins
C2	Varicose veins
C3	Edema
C4a	Pigmentation or eczema
C4b	Lipodermatosclerosis or atrophic blanche
C5	Healed venous ulcer
C6	Active venous ulcer
S	Symptomatic, including ache, pain, tightness, skin irritation, heaviness, muscle cramps, and other complaints attributable to venous dysfunction
A	Asymptomatic
Etiologic Classification	
Ec	Congenital
Ep	Primary
Es	Secondary (post-thrombotic)
En	No venous cause identified
Anatomic classification	
As	Superficial veins
Ap	Perforator veins
Ad	Deep veins
An	No venous location identified
Pathophysiologic	
Pr	Reflux
Po	Obstruction
Pr,o	Reflux and obstruction
Pn	No venous pathophysiology identifiable

stockings after therapy is unknown, but research suggests that durations over 1 week after therapy do not provide added benefits.¹⁵ Limitations of compression stockings are that there is poor long-term compliance with compression stockings, as they are difficult to use and uncomfortable. The Society for Vascular Surgery and American Venous Forum guidelines recommend against using compression stockings in patients who are candidates for other therapies.¹⁶

Surgical Venous Stripping

Historically, surgical intervention has been the treatment of choice for venous insufficiency. Current surgical treatment involves ligating the great saphenous vein at the groin and at the ankle and then removing the vein by inverting the vein using a stripping device.¹⁷ Surgical intervention has been reported by some studies to have lower long-term recurrence rates, but a meta-analysis by Pan et al showed no significant difference compared with endovenous ablation by 2- or 5-year follow-up.¹⁸ Surgical intervention tends to be reserved

Table 2 Eighteen named venous segments¹⁰

Named venous segments	
Superficial veins	
1	Telangiectasias or reticular veins
2	Great saphenous vein above knee
3	Great saphenous vein below knee
4	Small saphenous vein
5	Nonsaphenous veins
Deep veins	
6	Inferior vena cava
7	Common iliac vein
8	Internal iliac vein
9	External iliac vein
10	Pelvic: gonadal, broad ligament vein, other
11	Common femoral vein
12	Deep femoral vein
13	Femoral vein
14	Popliteal vein
15	Crural: anterior tibial, posterior tibial, peroneal veins
16	Muscular: gastrocnemial, soleal, other
Perforating	
17	Thigh
18	Calf

for patients with a large dilated and tortuous saphenous vein that is directly under the skin.¹⁹ Recent studies comparing endovascular treatments to surgical stripping have had difficulties recruiting patients to randomization as patients do not desire to be in the surgical arm.^{20,21}

Newer surgical managements include ambulatory phlebectomy and CHIVA. Ambulatory phlebectomy involves removal of varicose veins through small stab incision,¹⁹ whereas CHIVA involves identifying shunts between superficial and deep veins and ligating the shunt.²²

Injection Sclerotherapy

Sclerotherapy involves injecting a chemical that causes ablation of the venous lumen. It may be used to treat superficial, deep, or perforating lower extremity veins. Various sclerosing agents have been described, including osmotic agents, detergents, chemical agents, and erosive agents. The only US Food and Drug Administration (FDA) approved medications are sodium tetradecyl sulfate, sodium morrhuate, and ethanolamine oleate, all of which are detergent agents. Sclerosants work by causing irreversible damage to the venous wall by attacking lipids and cellular walls. Frequently, sclerotherapy is performed by mixing air or oxygen into the sclerosant, known as foam sclerotherapy. A commonly performed method of forming the foam is known as the Tessari method, by which the sclerosant is mixed with air using a three-way stopcock, using a 4:1 air-to-sclerosant ratio.^{23,24}

Table 3 Venous clinical severity score

Attribute	Absent = 0	Mild = 1	Moderate = 2	Severe = 3
Pain	None	Occasional, not restricting activity or requiring analgesics	Daily, moderate activity limitation, occasional analgesics	Daily, severe limiting activities or requiring regular use of analgesics
Varicose veins	None	Few, scattered branch varicose veins	Multiple: GSV varicose veins confined to calf or thigh	Extensive: Thigh and calf or GSV and LSV distribution
Venous edema	None	Evening ankle only	Afternoon edema, above ankle	Morning edema above ankle and requiring activity change
Skin pigmentation	None or focal, low intensity (tan)	Diffuse, but limited in area and old (brown)	Diffuse over most of gaiter distribution (lower ⅓) or recent pigmentation (purple)	Wider distribution (above lower ⅓) recent pigmentation
Inflammation	None	Mild cellulitis, limited to marginal area around ulcer	Moderate cellulitis, involves most of gaiter area (lower ⅔)	Severe cellulitis (lower ⅓ and above) or significant venous eczema
Induration	None	Focal, circum-malleolar	Medial or lateral, less than lower ⅓ of leg	Entire lower ⅓ of leg or more
Active ulcers, number	0	1	2	> 2
Active ulcer duration	None	< 3 mo	> 3 mo but < 1 y	Not healed ≥ 1 y
Active ulcer, size	None	< 2 cm diameter	2–6 cm diameter	> 6 cm diameter
Compressive therapy	Not used or not compliant	Intermittent use of stockings	Wears elastic stockings most days	Full compliance: stockings + elevation

Abbreviations: GSV, greater saphenous vein; LSV, lesser saphenous vein.

The targeted vein is usually identified by ultrasound and a small volume of sclerosant is injected into the vein. Consensus guidelines suggest using up to 10 mL of foam sclerosant per treatment session.^{6,25} Efficacy of sclerotherapy is reported as 85% success in closure of the treated vein. In one study, 82% of patients showed complete cosmetic improvement and 90% of patients showed some improvement in symptoms.²⁵ Complications occur in 1.2% of treated patients, with migraine-like headache, visual disturbances, and transient ischemic events (TIA) being the most concerning of the complications.²⁵ Patients with known PFO are more likely to have migraine headache or TIA, however, the risk is not great enough for society consensus statements to recommend screening for PFO.⁶ Other reported complications are deep vein thrombosis, pulmonary embolism, and thrombophlebitis.

Endovenous Ablation

Two forms of endovenous ablation are most commonly utilized, endovascular laser ablation (EVLA) and radiofrequency ablation (RFA). Ablation is performed by placing the selected ablation device into the saphenous vein, usually by ultrasound guidance. The ablative device causes endovascular heating, which damages the venous endothelium leading to fibrosis and thrombosis.

Both RFA and EVLA are performed in a similar manner. The patient is placed reverse Trendelenburg on a table and the leg is sterilely prepared. The vein of interest is accessed with a

micropuncture set and ultrasound guidance. The micropuncture is exchanged for a long vascular sheath. The ablation device is placed within a sheath, and tumescent anesthesia is applied across the area intended for treatment. The ablation fiber is withdrawn retrograde through the saphenous vein. Ablation is performed to approximately 2-cm distal (toward the foot) to the saphenofemoral or saphenopopliteal junction; the ablation device should never be used in the common femoral vein. The patient's leg is wrapped with compressive bandages or the patient is instructed to use 30 to 40 mm Hg compression stockings.¹⁹

A meta-analysis by Mundy et al demonstrated occlusion rates of the great saphenous vein in the 88 to 100% range after EVLA.²⁶ RFA ablative techniques have shown similar efficacy rates in randomized controlled trials.^{27,28} Common complications for ablative therapy include thrombophlebitis, skin burns, and pulmonary artery embolism, with complications occurring less than 5% of treatments.^{29–31} Benefits of endovascular treatment over surgery include: not needing to make an incision at the thigh and ankle; shorter hospital stays; quicker return to work times; less postprocedure pain; and similar long-term efficacy rates as surgery.^{31–34}

Summary

Interventional radiologists have the skills and training to aid women in the extremely common condition of venous

insufficiency. Various treatment tools are available, with an increasing role for endovascular therapies. Endovascular therapies have proven in randomized controlled trials to have equal long-term efficacy to surgical management. In addition, endovascular therapies have shown decreased pain, decreased hospital stays, and improved return-to-work times. It is important that interventional radiologists continue to provide comprehensive clinical care in the treatment of patients with lower extremity venous insufficiency.

Grants

No grant funding sponsored this research.

References

- Callam MJ. Epidemiology of varicose veins. *Br J Surg* 1994;81(2):167–173
- Lim CS, Davies AH. Pathogenesis of primary varicose veins. *Br J Surg* 2009;96(11):1231–1242
- Carpentier PH, Maricq HR, Biro C, Ponçot-Makinen CO, Franco A. Prevalence, risk factors, and clinical patterns of chronic venous disorders of lower limbs: a population-based study in France. *J Vasc Surg* 2004;40(4):650–659
- Brand FN, Dannenberg AL, Abbott RD, Kannel WB. The epidemiology of varicose veins: the Framingham Study. *Am J Prev Med* 1988;4(2):96–101
- Laurikka JO, Sisto T, Tarkka MR, Auvinen O, Hakama M. Risk indicators for varicose veins in forty- to sixty-year-olds in the Tampere varicose vein study. *World J Surg* 2002;26(6):648–651
- Rabe E, Breu F, Cavezzi A, et al; for the Guideline Group. European guidelines for sclerotherapy in chronic venous disorders. *Phlebology* 2013
- Gloviczki P, Driscoll DJ. Klippel-Trenaunay syndrome: current management. *Phlebology* 2007;22(6):291–298
- Min RJ, Khilnani NM, Golia P. Duplex ultrasound evaluation of lower extremity venous insufficiency. *J Vasc Interv Radiol* 2003;14(10):1233–1241
- Porter JM, Moneta GL; International Consensus Committee on Chronic Venous Disease. Reporting standards in venous disease: an update. *J Vasc Surg* 1995;21(4):635–645
- Eklöf B, Rutherford RB, Bergan JJ, et al; American Venous Forum International Ad Hoc Committee for Revision of the CEAP Classification. Revision of the CEAP classification for chronic venous disorders: consensus statement. *J Vasc Surg* 2004;40(6):1248–1252
- Rutherford RB, Padberg FT Jr, Comerota AJ, Kistner RL, Meissner MH, Moneta GL. Venous severity scoring: An adjunct to venous outcome assessment. *J Vasc Surg* 2000;31(6):1307–1312
- American College of Radiology. ACR Appropriateness Criteria: Radiological Management of Lower-Extremity Venous Insufficiency. Available at: <http://www.acr.org/~media/ACR/Documents/AppCriteria/Interventional/RadiologicManagementLowerExtremityVenousInsufficiency.pdf>. Accessed July 23, 2013
- Palfreyman SJ, Lochiel R, Michaels JA. A systematic review of compression therapy for venous leg ulcers. *Vasc Med* 1998;3(4):301–313
- Lohr JM, Bush RL. Venous disease in women: epidemiology, manifestations, and treatment. *J Vasc Surg* 2013;57(4, Suppl):375–455
- Huang TW, Chen SL, Bai CH, Wu CH, Tam KW. The optimal duration of compression therapy following varicose vein surgery: a meta-analysis of randomized controlled trials. *Eur J Vasc Endovasc Surg* 2013;45(4):397–402
- Gloviczki P, Gloviczki ML. Guidelines for the management of varicose veins. *Phlebology* 2012;27(Suppl 1):2–9
- Meissner MH, Gloviczki P, Bergan J, et al. Primary chronic venous disorders. *J Vasc Surg* 2007;46(6, Suppl S):54S–67S
- Pan Y, Zhao Z, Mei J, Shao M, Zhang J. Comparison of endovenous laser ablation and high ligation and stripping for varicose vein treatment: a meta-analysis. *Phlebology* 2013(e-pub ahead of print)
- Gloviczki P, Comerota AJ, Dalsing MC, et al; Society for Vascular Surgery; American Venous Forum. The care of patients with varicose veins and associated chronic venous diseases: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. *J Vasc Surg* 2011;53(5, Suppl):2S–48S
- Biemans AA, Kockaert M, Akkersdijk GP, et al. Comparing endovenous laser ablation, foam sclerotherapy, and conventional surgery for great saphenous varicose veins. *J Vasc Surg* 2013;58(3):727, e1
- Rasmussen LH, Lawaetz M, Bjoern L, Vennits B, Blemings A, Eklof B. Randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy and surgical stripping for great saphenous varicose veins. *Br J Surg* 2011;98(8):1079–1087
- Mowatt-Larssen E, Shortell C. CHIVA. *Semin Vasc Surg* 2010;23(2):118–122
- Cavezzi A, Tessari L. Foam sclerotherapy techniques: different gases and methods of preparation, catheter versus direct injection. *Phlebology* 2009;24(6):247–251
- Tessari L, Cavezzi A, Frullini A. Preliminary experience with a new sclerosing foam in the treatment of varicose veins. *Dermatol Surg* 2001;27(1):58–60
- Rathbun S, Norris A, Morrison N, et al. Performance of endovenous foam sclerotherapy in the USA for the treatment of venous disorders: ACP/SVM/AVF/SIR quality improvement guidelines. *Phlebology* 2013(e-pub ahead of print)
- Mundy L, Merlin TL, Fitridge RA, Hiller JE. Systematic review of endovenous laser treatment for varicose veins. *Br J Surg* 2005;92(10):1189–1194
- Merchant RF, Pichot O; Closure Study Group. Long-term outcomes of endovenous radiofrequency obliteration of saphenous reflux as a treatment for superficial venous insufficiency. *J Vasc Surg* 2005;42(3):502–509, discussion 509
- Nicolini P; Closure Group. Treatment of primary varicose veins by endovenous obliteration with the VNUS closure system: results of a prospective multicentre study. *Eur J Vasc Endovasc Surg* 2005;29(4):433–439
- Gibson KD, Ferris BL, Polissar N, Neradilek B, Pepper D. Endovenous laser treatment of the small [corrected] saphenous vein: efficacy and complications. *J Vasc Surg* 2007;45(4):795–801, discussion 801–803
- Lawrence PF, Chandra A, Wu M, et al. Classification of proximal endovenous closure levels and treatment algorithm. *J Vasc Surg* 2010;52(2):388–393
- van den Bos R, Arends L, Kockaert M, Neumann M, Nijsten T. Endovenous therapies of lower extremity varicosities: a meta-analysis. *J Vasc Surg* 2009;49(1):230–239
- Helmy ElKaffas K, ElKashef O, ElBaz W. Great saphenous vein radiofrequency ablation versus standard stripping in the management of primary varicose veins—a randomized clinical trial. *Angiology* 2011;62(1):49–54
- Pronk P, Gauw SA, Mooij MC, et al. Randomised controlled trial comparing sapheno-femoral ligation and stripping of the great saphenous vein with endovenous laser ablation (980 nm) using local tumescent anaesthesia: one year results. *Eur J Vasc Endovasc Surg* 2010;40(5):649–656
- Subramonia S, Lees T. Randomized clinical trial of radiofrequency ablation or conventional high ligation and stripping for great saphenous varicose veins. *Br J Surg* 2010;97(3):328–336