Review of Chronic Venous Insufficiency

From vein stripping to endovenous ablation, a look at the various techniques available for treatment.

BY OLUSEGUN O. OSINBOWALE, MD, AND YUNG-WEI CHI, DO

Chronic venous insufficiency (CVI) is a disorder affecting 25% to 30% of women and approximately 15% of men in Western society.[1] Varicose veins are the most recognized manifestation of CVI, affecting approximately one out of five adults.[2] The first written reference to varicose veins is the Egyptian Ebers papyrus, dated 1550 BC.[3,4] Patients with venous insufficiency may present with a number of signs and symptoms (Table 1). The size of varicose veins does not directly correlate with the degree of venous hypertension.[5] Saphenofemoral or saphenopopliteal reflux occurs in 85% of patients with varicose veins as a result of valvular incompetence. These incompetent superficial veins are important targets for the management of CVI.[6] Other patients may have a congenital absence of competent valves.[7] Hippocrates was the first to note the association between varicose veins and ulceration.[3] A number of multinational studies have estimated that 1% of the adult population are affected by venous ulceration at some time in their lives.[8]

PATHOPHYSIOLOGY OF VENOUS INSUFFICIENCY

All theories of venous ulceration (edema, valvular incompetence, calf muscle pump dysfunction, white cell trapping, fibrin cuffing, presence of arteriovenous malformations and abnormal capillaries) implicate increased venous pressure and damage to the microcirculation.[3] The driving force for fluid filtration is capillary hydrostatic pressure (Pc). Under supine conditions, Pc is approximately 25 mm Hg. Upon standing, changes in Starling forces cause a sharp Pc increase to quadruple the supine value. If no compensatory mechanisms come into play, fluid filtration increases, and edema rapidly develops.

The increase in Pc while standing is normally offset by two physiologic mechanisms: the postural vasoconstriction (venoarterial) reflex and the functional calf muscle pump, which are impaired in the presence of CVI. Under normal circumstances, these mechanisms help maintain a low capillary hydrostatic pressure while standing and walking.[9,10] In severe CVI, these mechanisms are impaired, and perforator vein valves are often incompetent. In calf muscle pump failure, blood from the deep venous system does not siphon effectively, and deep vein pressures may be transmitted to the superficial system and cause an increase in filtration pressure, which leads to edema. Solute delivery to the skin and transvascular exchange are then compromised. Macromolecular exchange is altered, demonstrated by extravasation of plasma proteins, fibrin, and endothelial gaps large enough for erythrocytes to pass through. These alterations may lead to increased lymphatic burden and secondary lymphedema.[9] Venous insufficiency in obese individuals may be exacerbated by lymphatic overload, causing further damage dermally and subdermally.[11]

DIAGNOSIS

Venous duplex ultrasonography is a safe, noninvasive, and cost-effective method of determining reflux in the superficial, deep, and perforating venous systems. The examination uses a high-resolution duplex ultrasound machine with pulsed and color Doppler, typically with a 5- to 7.5-MHz transducer probe.[12] Venous duplex is

TABLE 1. SIGNS AND SYMPTOMS OF CHRONIC VENOUS INSUFFICIENCY

Signs	Symptoms
Varicose veins	Leg pain
Telangiectasias	Itching
Edema	Paresthesias
Hyperpigmentation	Cellulitis
Eczema	Leg ulcer
Lipodermatosclerosis	Variceal bleeding
	Superficial thrombophlebitis

invaluable in documenting venous reflux, defined as retrograde flow lasting for > 0.5 seconds, and other underlying venous pathology such as thrombophlebitis. An example of venous reflux is shown in Figure 1. Ultrasound studies have demonstrated incompetent valves with retrograde blood flow in many limbs where varicose veins are not clinically apparent.[13] Furthermore, 40% of limbs with venous ulceration may not have visible varicose veins.[5] The CEAP classification (Clinical picture, Etiology, Anatomic distribution, and Pathophysiology) and VSS (Venous Severity Score) are widely accepted tools for grading and monitoring a range of CVI manifestations.[14,15] A number of therapeutic approaches have been used in the management of CVI, each with relative strengths and weaknesses.

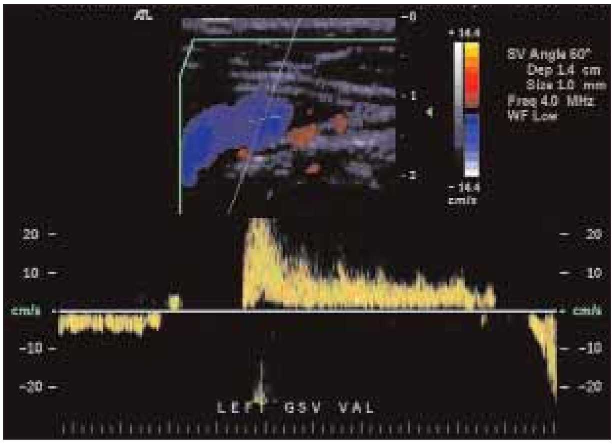

Figure 1. GSV reflux on duplex imaging.

CONSERVATIVE MANAGEMENT

Horse chestnut seed extract (HCSE) has been shown in vitro to inhibit the activity of elastase and hyaluronidase, both involved in the enzymatic degradation of proteoglycan, which constitutes part of the capillary endothelium. Placebo-controlled randomized trials suggest a decrease in lower leg volume and a reduction in leg circumference at the calf and ankle with the use of HCSE. Although safe and effective for symptomatic venous insufficiency, HCSE may be associated with pruritus, nausea, headache, and dizziness.[16]

Bandaging for varicose veins has been a mode of treatment since the time of Hippocrates.[13] Graduated compression stockings (GCS) combined with an exercise regimen have been shown to control reflux and improve calf muscle pump function in the setting of CVI.[17] Compliance with GCS is a significant clinical limitation due to difficulty wearing or tolerating compression from the garments. GCS do not address the cosmetic concerns of individuals with CVI. Identifying patients with surgically treatable venous incompetence remains an essential component of CVI management.[12,13]

The REACTIV trial involved 1,009 CVI subjects and prospectively demonstrated significant improvement in health care–related quality of life when managed with surgery or sclerotherapy compared to conservative management.[1] Common strategies to address saphenous vein reflux include high ligation and stripping, stab avulsions, transilluminated powered phlebectomy, subfascial endoscopic perforator surgery, endovenous ablation, and foam sclerotherapy.

INVASIVE STRATEGIES

High ligation has the theoretical advantage of preserving the GSV for later use as a conduit for arterial or coronary bypass procedures. Unfortunately, high ligation without saphenous vein stripping fails to eliminate axial reflux in most patients and is commonly associated with recurrent varicose veins.[6,12] Dissection of the saphenofemoral junction can be associated with persistent lymphatic leak, prolonged wound healing, and wound infection. Varicose vein surgery is associated with convalescence of up to 4 weeks.[4] Saphenous nerve deficits may occur in 40% to 58% of patients who had stripping to the ankle level, although the associated paresthesias decrease over time and are unlikely to be lifestyle-limiting.[12]

Vein stripping and ligation have become less favorable with the clinical recognition and histological confirmation of neovascularization after the procedure. Varicose veins may recur in 20% to 60% of patients within 10 years and in up to 70% beyond 10 years.[4,5,18] The presence of incompetent perforators in patients with advanced CVI is an indication for perforator ligation. Introduction of subfascial endoscopic perforator vein surgery using endoscopic instruments to interrupt incompetent perforators through small ports has contributed to the abandonment of open perforator ligation.[6] Transilluminated power phlebectomy has similar efficacy to conventional vein stripping; however, postoperative hematoma and femoral nerve injury remain a concern without a significant difference in postoperative pain and cosmetic satisfaction compared to vein stripping.[6,12]

MINIMALLY INVASIVE STRATEGIES

Sclerotherapy

Given the complications of invasive strategies, sclerotherapy emerged as an attractive alternative for treatment of mild-to-moderate CVI. Liquid or foam sclerotherapy treats varicose veins by causing chemical-mediated endoluminal obliteration and vessel involution. Ultrasound-guided foam sclerotherapy has been

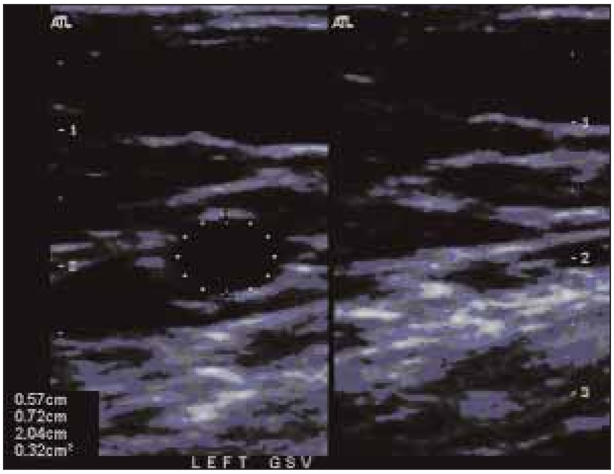

Figure 2. Patent GSV visualized above the knee, pre- and postcompression.

used to address saphenous vein reflux as well as to treat varicose tributaries. Minor complications of sclerotherapy include pigmentation and superficial thrombophlebitis. More serious complications can include cutaneous ulceration, anaphylaxis, and intra-arterial injection.[12]

Up to 65% of patients treated by sclerotherapy alone may develop recurrent varicose veins within 5 years, particularly in the setting of saphenous reflux.[5,19] In a single-center prospective series of 332 patients treated with sclerotherapy for venous insufficiency, 5.4% of patients experienced adverse effects lasting fewer than 30 minutes including dry cough, ocular migraine, true migraine, other visual disturbances, chest tightness, panic attack, paresthesias, and myoclonus. Two patients developed cutaneous necrosis. Deep venous thrombosis (DVT) without pulmonary emboli occurred in 1.8%.[20] Successful sclerotherapy often requires multiple treatments. Patient satisfaction may be similar within the first year of sclerotherapy and surgery for CVI; however, meta-analysis of trials with follow-up of at least 3 years suggests greater longitudinal benefit with surgery.[1] Currently, there are many chemical agents available for sclerotherapy; however, only sodium tetradecyl sulfate is approved by the Food and Drug Administration.

Endovenous Ablation

Endovenous radiofrequency ablation (RFA) and endovenous laser treatment (EVLT) are minimally invasive methods to treat incompetent saphenous veins and have largely supplanted more invasive vein treatments. The short- and midterm results for vein occlusion with first-generation RFA (ClosurePlus [Vnus Medical Technologies, San Jose, CA]) are approximately 90% after 5 years and approximately 95% for EVLT after 2 years.[2] Endovenous ablation for the treatment of saphenous vein reflux and CVI has been approved in the United States since 1999. RFA uses a radiofrequency generator and specialized catheter to heat the vein wall. The net effect is maximal venous contraction due to vessel spasm and collagen shrinkage.[19] EVLT is thought to cause venous occlusion and eventual involution either by the generation of steam bubbles from heated venous blood or by direct thermal wall damage from the laser.[21]

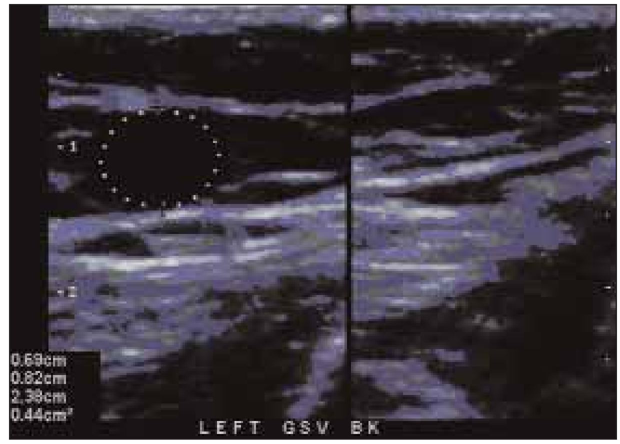

Figure 3. Patent dilated GSV visualized below the knee, pre- and postcompression.

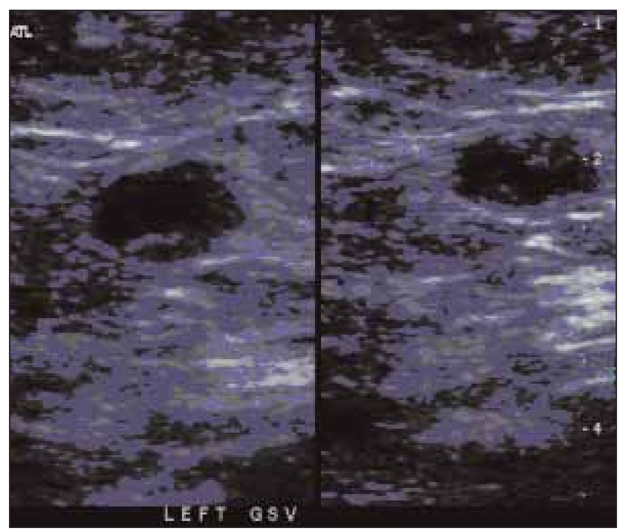

Figure 4. Noncompressible GSV with scar formation after vein ablation.

The general technique is similar for either modality. Veins treated with endovenous ablation should ideally be free of severe tortuosity or thrombus and without aneurysm. Using ultrasound guidance, access is gained to the great saphenous vein (GSV) or lesser saphenous vein via the Seldinger technique. The tip of the thermal apparatus is positioned at least 1 cm from the saphenofemoral or saphenopopliteal junction.[12,21] Tumescent anesthesia fluid (eg, 1% lidocaine and 1:100.000 epinephrine) is dispensed along the course of the target vein with at least 1-cm distance from the overlying skin to provide pain relief and reduce the risk of thermal injury. Tumescent anesthesia also contributes to vein spasm, which helps to eliminate blood flow within the treated vein. Once device positioning and anesthesia are performed, the energy source is activated, and the laser fiber is pulled back at a slow, steady rate. A pullback rate of 2 to 3 mm per second is advocated for EVLT.[21] A pullback speed that is too fast will be ineffective. The ClosureFast catheter uses segmental ablation technology to heat a 7-cm segment of vein for 20 seconds at a time. More thermal energy is applied within the first 10 cm from the saphenofemoral junction, either via slower initial pullback speed or dual-thermal activations, in order to maximize closure rates. The GSV is usually treated to the proximal calf or knee crease. Bandaging or use of a 30-to 40-mm Hg stocking follows vein treatment, and a venous duplex ultrasound within 72 hours is recommended to confirm vein closure and evaluate for postprocedural DVT.[1,12,21] Typical duplex images of a GSV before and after endovenous ablation are shown in Figures 1 through 4. Endovenous ablation does not require hospitalization and can be performed in an office setting.[6] Relative contraindications include coagulopathy, liver dysfunction limiting local anesthetic use, immobility, pregnancy, and breast-feeding.[21]

Both endovenous ablation modalities have been shown to reduce CVI symptoms in the majority of eligible patients. Whereas ClosurePlus heated the vein wall up to 85ºC and required a gradual pullback, the next-generation ClosureFast catheter, launched in 2007, heats the vein wall up to 120ºC in contiguous 7-cm segments at 20 seconds per segment. ClosureFast offers shorter ablation time and improved vein closure rates—up from 92% to 96% to 100% within the first 6 months—compared to ClosurePlus.[22,23] Skin paresthesia is the most common adverse effect after RFA, affecting 3% to 19% of patients within the first week and improving to 1% to 6% within 24 months. DVT rates range from 1% to 2%.[12] In a review series of EVLT with 810-, 940-, and 980-nm-wavelength lasers, which heat up to much higher temperatures than RF catheters, consistent GSV closure rates of 90% to 100% were observed. Pulmonary embolism, an extremely rare complication of DVT after endovenous therapy, had reported incidences below 0.05%.[21]

The EVOLVeS study prospectively evaluated 85 CVI patients randomized to RFA or stripping and ligation (surgery). Rates of procedure-related complications, patient recuperation, and quality-of-life outcomes were assessed. The immediate GSV closure rate was 95% with RFA versus 100% with surgery. There was significantly less postprocedural pain and less time to return to routine daily activities and work with RFA within 3 weeks of the procedure.[24] Forty-five patients were re-examined at 1 year, and 65 were re-examined 2 years after treatment. Follow-up visits included clinical examination with CEAP classification and calculation of venous clinical severity score (VCSS), ultrasound examination, and a quality-of-life questionnaire. Neovascularization was found in one RFA case and in four surgical cases. There was a statistically nonsignificant trend toward lower rates of recurrent varicose veins at combined 1- and 2-year follow-up: 14% for RFA and 21% for surgery. Improved quality-of-life scores persisted through the 2-year observations in the RFA group compared to the surgical group.[25]

> "Endovenous ablation for the treatment of saphenous vein reflux and CVI has been approved in the United States since 1999."

Meta-analysis of eight studies published between 1994 and 2007 revealed significant reductions in tenderness and ecchymosis at 1 week and significantly fewer hematomas at 72 hours, 1 week, and 3 weeks with RFA versus surgery. There was no significant difference between RFA and surgery in immediate or complete GSV occlusion, incomplete GSV closure, freedom from reflux, recurrent varicose veins, recanalization, or neovascularization. Quality-of-life results significantly favoring RFA over surgery included return to normal activity and return to work.[18]

Although both RFA and EVLT allow vein ablation with low rates of DVT and pulmonary embolism, EVLT has been associated with greater postprocedural pain.[19,21] This may be due in part to the direct relationship between amount of laser energy and achievement of vein closure.[2] In a prospective, randomized, single-blinded multicenter study, RFA and EVLT were directly compared. RFA was associated with improved recovery and quality-of-life parameters compared with 980-nm EVLT of the GSV. All scores referable to pain, ecchymosis, and tenderness were statistically lower in the RFA group at 48 hours, 1 week, and 2 weeks. There were no major complications with either modality.[26]

Relative effects of different laser wavelengths have been prospectively evaluated. One blinded, randomized investigation compared the effects of 810- and 980-nm diode lasers in treatment of saphenous venous insufficiency in 60 limbs with 12 months follow-up. The 810-nm wavelength is specific for hemoglobin absorption, whereas the 980-nm wavelength is specific for hemoglobin and water. One week after the procedure, patients in the 980-nm group showed significantly less bruising at the procedure site than the patients in the 810-nm group. Pain and varicose vein rating were significantly lower in the 980-nm-treated patients at 4 months versus the 810-nm group. Itching was significantly less 3 weeks after the procedure for the 810-nm group compared with the 980-nm group, but this difference was not maintained at the 4-month visit. There was no major complication with either laser wavelength.[27]

Attention has recently been focused on the utility and efficacy of high-wavelength/water-specific wavelength lasers (1,320–1,470 nm) in management of CVI. It has been suggested that higher wavelengths may be efficacious in ablating incompetent saphenous veins, using less energy while minimizing procedural pain compared to conventional EVLT.[28] Further study is required to confirm this assertion. Although endovenous therapy is most often used in downstream management of CVI, it has a recognized role in prevention of venous insufficiency.[29]

CONCLUSION

CVI is a clinical disease with a wide spectrum of causes and manifestations. It carries a high potential for morbidity if left unaddressed. The roles of prevention and conservative management of CVI are often suppressed by delayed diagnosis or presentation. Traditionally widespread use of high vein ligation and stripping has given way to less-invasive ultrasound-guided thermal techniques such as endovenous laser and radiofrequency ablation, with high rates of improvement in quality of life. Future management goals include improving vein closure rates while decreasing adverse effects related to treatment. ■

Olusegun O. Osinbowale, MD, is Associate Director of Vascular Medicine Fellowship, Department of Cardiology, Division of Vascular Medicine, Ochsner Clinic Foundation, in New Orleans, Louisiana. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Osinbowale may be reached at (504) 842-4168; oosinbowale@ochsner.org.

Yung-Wei Chi, DO, is Head of Vascular Medicine and Director of Vascular Lab, Department of Cardiology, Division of Vascular Medicine, Ochsner Clinic Foundation, in New Orleans, Louisiana. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Chi may be reached at (504) 842-4168; ychi@ochsner.org.

1. Michaels JA, Campbell WB, Brazier JE, et al. Randomised clinical trial, observational study and assessment of cost-effectiveness of the treatment of varicose veins (REACTIV trial). Health Technol Assess. 2006;10:1-196, iii-iv.
2. Pannier F, Rabe E. Endovenous laser therapy and radiofrequency ablation of saphenous varicose veins. J Cardiovasc Surg (Torino). 2006;47:3-8.
3. Shami SK, Shields DA, Scurr JH, Smith PD. Leg ulceration in venous disease. Postgrad Med J. 1992;68:779-785.
4. Winterborn RJ, Earnshaw JJ. Crossectomy and great saphenous vein stripping. J Cardiovasc Surg (Torino). 2006;47:19-33.
5. London NJ, Nash R. ABC of arterial and venous disease. BMJ. 2000;320:1391-4.
6. Puggioni A, Kalra M, Gloviczki P. Superficial vein surgery and SEPS for chronic venous insufficiency. Semin Vasc Surg. 2005;18:41-48.
7. Hopkins NF, Wolfe JH. ABC of vascular diseases. Deep venous insufficiency and occlusion. BMJ. 1992;304:107-110.
8. Cheatle TR, Scurr JH, Smith PD. Drug treatment of chronic venous insufficiency and venous ulceration: a review. J R Soc Med. 1991;84:354-358.
9. McDonagh PF. The microvascular pathophysiology of chronic venous insufficiency. Yale J Biol Med. 1993;66:27-36.
10. Rathbun S, Heath PJ, Whitsett T. Images in vascular medicine. The venoarterial reflex. Vasc Med. 2008;13:315-316.
11. Poirier P, Giles TD, Bray GA, et al. Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss. Arterioscler Thromb Vasc Biol. 2006;26:968-976.
12. Teruya TH, Ballard JL. New approaches for the treatment of varicose veins. Surg Clin North Am. 2004;84:1397-1417.
13. Scott HJ, McMullin GM, Coleridge Smith PD, et al. Venous disease: investigation and treatment, fact or fiction? Ann R Coll Surg Engl. 1990;72:188-192.
14. Classification and grading of chronic venous disease in the lower limbs. A consensus statement. Ad Hoc Committee, American Venous Forum. J Cardiovasc Surg (Torino). 1997;38:437-441.
15. Vasquez MA, Munschauer CE. Venous Clinical Severity Score and quality-of-life assessment tools: application to vein practice. Phlebology. 2008;23:259-275.
16. Pittler MH, Ernst E. Horse-chestnut seed extract for chronic venous insufficiency. A criteria-based systematic review. Arch Dermatol. 1998;134:1356-1360.
17. Zajkowski PJ, Proctor MC, Wakefield TW, et al. Compression stockings and venous function. Arch Surg. 2002;137:1064-1068.
18. Luebke T, Gawenda M, Heckenkamp J, Brunkwall J. Meta-analysis of endovenous radiofrequency obliteration of the great saphenous vein in primary varicosis. J Endovasc Ther. 2008;15:213-223.
19. Bergan JJ, Kumins NH, Owens EL, et al. Surgical and endovascular treatment of lower extremity venous insufficiency. J Vasc Interv Radiol. 2002;13:563-568.
20. Bergan J, Pascarella L, Mekenas L. Venous disorders: treatment with sclerosant foam. J Cardiovasc Surg (Torino). 2006;47:9-18.
21. Kalra M, Gloviczki P. Fifteen years ago laser was supposed to open arteries, now it is supposed to close veins: what is the reality behind the tool? Perspect Vasc Surg Endovasc Ther. 2006;18:3-8.
22. Roth SM. Roth SM. Endovenous radiofrequency ablation of superficial and perforator veins. Surg Clin North Am. 2007 ;87:1267-84.
23. Dietzek AM. Endovenous radiofrequency ablation for the treatment of varicose veins. Vascular. 2007;15:255-61.
24. Lurie F, Creton D, Eklof B, et al. Prospective randomized study of endovenous radiofrequency obliteration (closure procedure) versus ligation and stripping in a selected patient population (EVOLVeS Study). J Vasc Surg. 2003;38:207-214.
25. Lurie F, Creton D, Eklof B, et al. Prospective randomised study of endovenous radiofrequency obliteration (closure) versus ligation and vein stripping (EVOLVeS): two-year follow-up. Eur J Vasc Endovasc Surg. 2005;29:67-73.
26. Almeida JI, Kaufman J, Gockeritz O, et al. Radiofrequency endovenous ClosureFAST versus laser ablation for the treatment of great saphenous reflux: a multicenter, single-blinded, randomized study (RECOVERY study). J Vasc Interv Radiol. 2009;20:752-759.
27. Kabnick LS. Outcome of different endovenous laser wavelengths for great saphenous vein ablation. J Vasc Surg. 2006;43:88-93.
28. Almeida JI. Endovenous Ablation Without Anesthesia? Early experience with a new laser wavelength that is highly absorbable by water. Endovasc Today. 2009;4: 28-30.
29. Augustinos P, Ouriel K. Invasive approaches to treatment of venous thromboembolism. Circulation. 2004;110:I27-34.