

Multi-disciplinary Quality Improvement Guidelines for the Treatment of Lower Extremity Superficial Venous Insufficiency with Ambulatory Phlebectomy from the Society of Interventional Radiology, Cardiovascular Interventional Radiological Society of Europe, American College of Phlebology and Canadian Interventional Radiology Association



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Abbreviations: AP = ambulatory phlebectomy, CEAP = clinical status, etiology, anatomy, and pathophysiology [classification], CVD = chronic venous disease, DVT = deep vein thrombosis, EVTA = endovenous thermal ablation, GSV = great saphenous vein, SSV = small saphenous vein, VCSS = venous clinical severity score

PREAMBLE

LOWER extremity venous insufficiency is a heterogeneous medical condition whose

spectrum ranges from cosmetic abnormalities including spider telangiectasias to varicose veins with or without associated signs and symptoms including severe

edema, skin ulceration, and subsequent major disability. Venous hypertension caused by incompetent valves in the superficial veins is by far the most common cause of this condition. This document will review the appropriate means by which ambulatory phlebectomy (AP) is to be used to maximize the benefit for patients who undergo the procedure.

The membership of the Society of Interventional Radiology (SIR) Standards of Practice Committee represents experts in a broad spectrum of interventional procedures from both the private and academic sectors of medicine. Generally, Standards of Practice Committee members dedicate the vast majority of their professional time to performing interventional procedures; as such they represent a valid broad expert constituency of the subject matter under consideration for standards production. Representatives from the Cardiovascular and Interventional Radiology Society of Europe (CIRSE) and the American College of

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Phlebology broaden the expertise to include multispecialty and international experience.

Technical documents specifying the exact consensus and literature review methodologies as well as the institutional affiliations and professional credentials of the authors of this document are available upon request from SIR, 3975 Fair Ridge Dr., Suite 400 North, Fairfax, VA 22033.

METHODOLOGY

SIR produces its Standards of Practice documents using the following process. Standards documents of relevance and timeliness are conceptualized by the Standards of Practice Committee members. A recognized expert is identified to serve as the principal author for the standard. Additional authors may be assigned dependent upon the magnitude of the project.

An in-depth literature search is performed using electronic medical literature databases. Then a critical review of peer-reviewed articles is performed with regards to the study methodology, results, and conclusions. The qualitative weight of these articles is assembled into an evidence table, which is used to write the document such that it contains evidence-based data with respect to content, rates, and thresholds.

When the evidence of literature is weak, conflicting, or contradictory, consensus for the parameter is reached by a minimum of 12 Standards of Practice Committee members using a modified Delphi consensus method (Appendix A) (1,2). For purposes of these documents, consensus is defined as 80% Delphi participant agreement on a value or parameter.

The draft document is critically reviewed by the Standards of Practice Committee members, either by telephone conference calling or face-to-face meeting. The finalized draft from the Committee is sent to the SIR membership for further input/criticism during a 30-day comment period. These comments are discussed by the Standards of Practice Committee, and appropriate revisions made to create the finished standards document. Prior to its publication the document is endorsed by the SIR Executive Council.

The current guidelines are written to be used in quality improvement programs to assess AP for lower extremity

superficial venous insufficiency. The most important elements of care are (i) pretreatment evaluation and patient selection (ii), performance of the procedure, and (iii) postprocedure follow-up care. The outcome measures or indicators for these processes are indications, success rates, and complication rates. Although practicing physicians should strive to achieve perfect outcomes, in practice all physicians will fall short of ideal outcomes to a variable extent. Therefore, in addition to quality improvement case reviews conducted after individual procedural failures or complications, outcome measure thresholds should be used to assess treatment safety and efficacy in ongoing quality improvement programs. For the purpose of these guidelines, a threshold is a specific level of an indicator that, when reached or crossed, should prompt a review of departmental policies and procedures to determine causes and to implement changes, if necessary. Thresholds may vary from those listed here; for example, patient referral patterns and selection factors may dictate a different threshold value for a particular indicator at a particular institution. Therefore, setting universal thresholds is very difficult and each department is urged to adjust the thresholds as needed to higher or lower values to meet its specific quality improvement program situation.

INTRODUCTION

During the past decade the scope of treatments for lower-extremity venous insufficiency has undergone dramatic evolution and change. AP, microsurgical phlebectomy, office phlebectomy, ambulatory stab avulsion phlebectomy, and Muller' phlebectomy are all synonyms for an outpatient procedure by which dilated incompetent surface veins can be avulsed through multiple stab incisions. This technique was first described by Aulus Cornelius Celsus (25 BC to 45 AD) and reinvented by Robert Muller, a Swiss dermatologist, in the mid-1950s. This procedure has been performed for incompetent tributary branches of the great or small saphenous veins, perforators, reticular veins, veins supplying telangiectasias, facial veins, and foot veins (3–13). Small segments of veins are removed through minute skin incisions (1–3 mm) or needle puncture, with the goal of complete

and definitive eradication of the target vein with minimal damage to the skin (14–24).

Interventional physicians have become increasingly involved in the assessment and treatment of lower-extremity venous insufficiency with the advent of endovenous thermal ablation (EVTA) for the treatment of truncal vein incompetence (25). An important consideration in the treatment of truncal reflux is the appropriate treatment of the incompetent and dilated tributary and perforator veins where AP is a key adjunct in the treatment algorithm.

These guidelines are written to be used in quality improvement programs to assess AP. The most important processes of care are (i) patient selection, (ii) performing the procedure, and (iii) monitoring the patient. The outcome measures or indicators for these processes are indications, success rates, and complication rates. Outcome measures are assigned threshold levels.

DEFINITIONS

Although practicing physicians should strive to achieve perfect outcomes (eg, 100% success, 0% complications), in practice all physicians will fall short of this ideal to a variable extent. Thus indicator thresholds may be used to assess the efficacy of ongoing quality improvement programs. For the purposes of these guidelines, a threshold is a specific level of an indicator which should prompt a review. "Procedure thresholds" or "overall thresholds" reference a group of indicators for a procedure, eg, major complications. Individual complications may also be associated with complication-specific thresholds. When measures such as indications or success rates fall below a (minimum) threshold, or when complication rates exceed a (maximum) threshold, a review should be performed to determine causes and to implement changes, if necessary. Thresholds may vary from those listed here; for example, patient referral patterns and selection factors may dictate a different threshold value for a particular indicator at a particular institution. Thus, setting universal thresholds is very difficult and each department is urged to alter the thresholds as needed to higher or lower values, to meet its own quality improvement program needs.

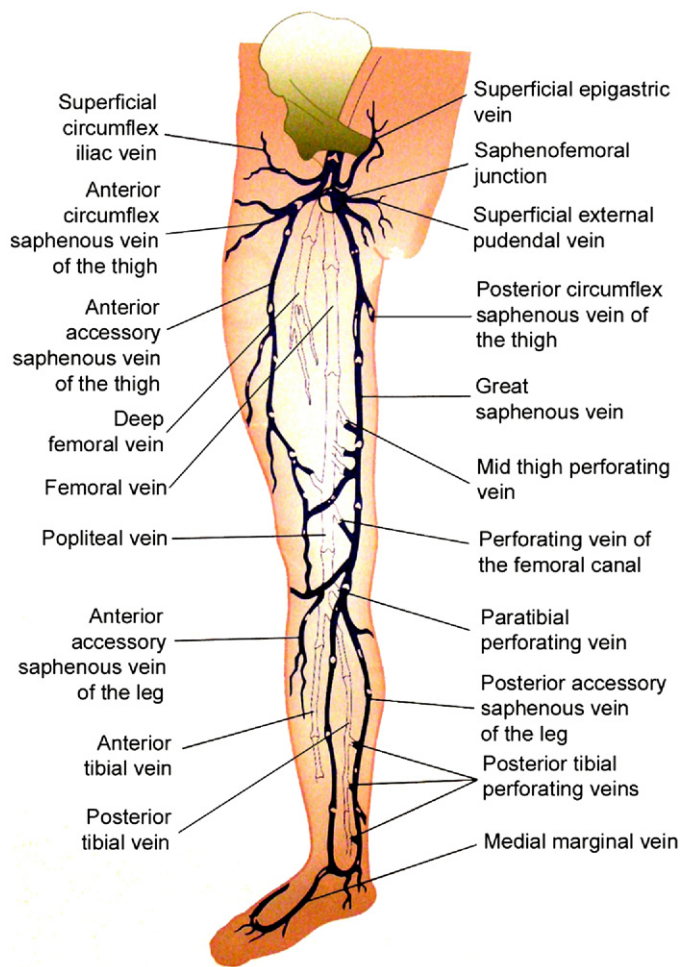


Figure. Superficial and deep venous system of the lower extremity.

Complications can be stratified on the basis of outcome. Major complications result in admission to a hospital for therapy (for outpatient procedures), an unplanned increase in the level of care, prolonged hospitalization, permanent adverse sequelae, or death. Minor complications result in no sequelae; they may require nominal therapy or a short hospital stay for observation (generally overnight).

Anatomy

Superficial veins.—The veins of the lower extremity that are superficial to the fascia surrounding the muscular compartment are considered the superficial veins. These include innumerable venous tributaries known as collecting veins as well as the great saphenous vein (GSV) and small saphenous vein (SSV) and their major named tributaries (Fig).

Deep veins.—The deep veins are those found deep to the muscular fascia. These include the tibial, peroneal, popliteal, femoral, and iliac veins.

GSV.—An important component of the superficial venous system, the GSV begins on the dorsum of the foot, and ascends along the medial aspect of the leg to ultimately drain into the femoral vein near the groin crease. This vein resides in a space deep to the superficial and superficial to the deep fascia. This location is known as the saphenous space. The word “great” replaces “greater” or “long” by international consensus (26,27).

SSV.—Another important superficial vein, the SSV begins on the lateral aspect of the foot and ascends up the midline of the calf. In as many as two thirds of cases it drains into the popliteal vein and in at least one third of cases it extends more cephalad. The SSV also resides in the saphenous

space. The word “small” replaces “lesser” or “short” by international consensus (26,27).

Anterior and posterior accessory GSVs.—The anterior and posterior accessory GSVs are located in the saphenous space and travel parallel and anterior or posterior to the GSV. The anterior accessory GSV is much more common.

Giacomini vein.—The Giacomini vein is an intersaphenous vein that is a communication between the GSV and SSV. It represents a form of SSV cephalad extension that connects the SSV with the posterior circumflex vein of the thigh, a posterior tributary of the proximal GSV.

Truncal veins.—The term “truncal veins” refers to the saphenous veins and their intrafascial straight primary tributaries.

Reticular vein.—The term “reticular vein” refers to collector veins connecting spider veins or skin capillary networks to the superficial venous system or to perforating veins. These veins may become enlarged and appear as “green” veins under the skin surface.

Spider vein.—The term “spider vein” refers to fine enlarged capillary networks on the skin surface having a spider-like appearance. Spider veins may be red or a blue color.

Disease Process

Venous reflux.—Veins contain valves that direct blood flow in one direction. Usually this is from the foot toward the heart and from the skin toward the muscles. When the valves fail, blood can flow retrogradely and such flow is defined as reflux. Clinically significant reflux in truncal veins lasts for greater than 0.5–1.0 seconds following release of compression on the muscular mass below the vein itself.

Venous obstruction.—Obstruction of venous segments will impede venous drainage and can lead to venous hypertension. Thrombosis is the most common cause of acute venous obstruction. Such thrombosis can lead to permanent occlusion or recanalization with or without valvular incompetence in that vascular segment.

Chronic venous disease.—Chronic venous disease (CVD) is the clinical entity that results from chronic venous hypertension (28). The overwhelming majority of patients with stigmata of venous hypertension have primary (or degenerative) disease of the vein wall with re-

sultant valvular dysfunction in the superficial veins, which leads to reflux (29). This subset of CVD is known as superficial venous insufficiency. Pathophysiologically significant reflux of the GSV or in one of its primary tributaries is present in 70%–80% of patients with chronic venous insufficiency. SSV reflux is found in 10%–20% and nonsaphenous superficial reflux is identified in 10%–15% of patients (30,31). Venous obstruction, deep vein reflux, muscular pump failure, and congenital anomalies are much less common causes. Venous obstruction is the most common of these other causes of CVD and is almost always the result of previous deep vein thrombosis (DVT). It is initially an obstructive disease but usually progresses to a combination of obstruction and superficial and deep venous reflux (32). Reflux or outflow vein obstruction lead to an increase in pressure in the superficial venous system. The veins themselves can dilate if unconstrained and the pressure causes stretching of receptors in the vein wall, which leads to discomfort to the patient. The pressure itself can adversely affect local tissues and metabolic processes leading to damage in the vein wall, the skin, and subcutaneous tissues.

Neovascularization.—Neovascularization describes the presence of multiple small tortuous connections between the saphenous stump or the femoral vein and a residual saphenous vein or one of its patent tributaries (new or dilated preexisting vessels outside the originally treated venous wall) that can occur following surgical ligation of the saphenofemoral junction or less commonly the saphenopopliteal junction. This is a very common pattern of recurrence following surgical ligation of the GSV and its tributary veins near the saphenofemoral junction and presents as a tangle of blood vessels in the vicinity of the saphenofemoral junction.

Clinical status, etiology, anatomy, and pathophysiology (CEAP) classification.—“CEAP” is an acronym for a descriptive classification system that summarizes the disease state in a given patient with lower-extremity venous insufficiency (29,33). The system describes the clinical status, etiology, anatomy, and pathophysiology of the problem. This clinical status scale is the most frequently used component in grading patients based on physical observations of disease severity (Table 1).

Venous clinical severity score (VCSS).—VCSS is an additional means of grading the spectrum of disease severity (34,35). The VCSS allows more detailed description of the severity of attributes of chronic venous insufficiency compared with the CEAP system. The VCSS is an important complement to CEAP in reporting clinical success of an intervention (Table 2).

TREATMENT METHODS

AP

Also known as microphlebectomy or stab phlebectomy, AP is a procedure by which varicose tributaries are removed with small hooks through 3–4-mm skin nicks using only local anesthesia.

EVTA

EVTA refers to the procedure by which thermal energy is endovenously delivered to the lumen of a vein with the goal of causing the veins to irreversibly occlude. It is usually employed to eliminate incompetent superficial truncal veins responsible for the manifestations of superficial venous insufficiency. The associated varicose tributary and reticular veins and telangiectasias are treated separately with adjunctive therapies including AP and compression sclerotherapy.

Sclerotherapy

Sclerotherapy is a procedure by which a medication is injected into a vein in order to irreversibly occlude it. This is usually done with a syringe and needle, although these medications can be injected with a catheter or intravenous cannula.

Duplex Ultrasound

Duplex ultrasound (US) is the most important imaging test to investigate patients with CVD. It uses grayscale imaging to visualize the venous anatomy and evaluate patency. Color and pulse-wave Doppler imaging is used to investigate direction and velocity of blood flow through the veins to identify reflux. Duplex US to evaluate CVD is much more complicated and time-consuming than to detect DVT, as it also involves the analysis of segmental competence of all the deep, superficial, and perforator veins.

Tumescent Anesthesia

The term “tumescent anesthesia” refers to the delivery of large volumes of dilute local anesthetic agent to create a large region of anesthesia. This form of delivery typically causes a localized swelling, leading to the use of the term “tumescent.” Popularized by plastic surgeons, this concept has been used in the treatment of veins by delivering the anesthetic solution perivenously.

Clinical Success

Clinical success is defined as an improvement in the clinical status of a patient as defined by one of the objective assessment instruments, such as the CEAP or VCSS classification, by at least one grade. In practice, most patients treated with AP will also be treated with adjunctive EVTA or compression sclerotherapy. It is generally believed that clinical success will be dependent on the thoroughness of the adjunctive procedures that are performed, as well as the success of AP.

COMPLICATIONS

Paresthesia and Dysesthesia

Paresthesia and dysesthesia describe the loss or aberration, respectively, of normal sensory perception. Injury to the saphenous or sural nerves adjacent to the GSV, SSV, or tributary veins can lead to these sensory disturbances.

Deep Vein Thrombophlebitis

Deep vein thrombophlebitis is thrombosis in the veins deep to the muscular fascia.

Superficial Thrombophlebitis

Superficial thrombophlebitis is thrombosis in veins superficial to the muscular fascia. The veins involved are usually the subcutaneous collecting veins, which are the tributaries of the saphenous veins. The GSV or SSV may or may not be thrombosed.

Arteriovenous Fistula

An arteriovenous fistula is an abnormal connection between an artery and a vein. Such a connection may be created

Table 1
CEAP Classification of CVD

Class	Description
Clinical classification	
C0	No visible or palpable signs of venous disease
C1	Telangiectasias or reticular veins
C2	Varicose veins, distinguished from reticular veins by a diameter ≥ 3 mm
C3	Edema
C4	Changes in skin and subcutaneous tissue
C4a	Eczema, pigmentation (and additionally corona phlebectasia)
C4b	Lipodermatosclerosis or atrophie blanche
C5	Healed venous ulcer
C6	Active venous ulcer
Symptom classification	
S	Symptomatic, including ache, pain, tightness, skin irritation, heaviness, and muscle cramps, and other complaints attributable to venous dysfunction
A	Asymptomatic
Etiologic classification	
Ec	Congenital
Ep	Primary
Es	Secondary (postthrombotic)
En	No venous cause identified
Anatomic classification	
As	Superficial veins
Ap	Perforator veins
Ad	Deep veins
An	No venous location identified
Pathophysiologic classification	
Pr	Reflux
Po	Obstruction
Pr,o	Reflux and obstruction
Pn	No venous pathophysiology identifiable
Level of investigation	
Level I	Office visit, with history and clinical examination, which may include use of a hand-held Doppler scanner
Level II	Noninvasive vascular laboratory testing, which now routinely includes duplex color scanning, with some plethysmographic method added as desired
Level III	Invasive investigations or more complex imaging studies, including ascending and descending venography, venous pressure measurements, CT, or MR imaging
Example	
A patient has painful swelling of the leg, and varicose veins, lipodermatosclerosis, and active ulceration. Duplex scanning on May 17, 2004, showed axial reflux of the great saphenous vein above and below the knee, incompetent calf perforator veins, and axial reflux in the femoral and popliteal veins. There are no signs of postthrombotic obstruction. Classification according to basic CEAP: C6,S, Ep,As,p,d, Pr (2004-05-17, L II)	

iatrogenically by a penetrating injury or as part of a primary vascular disease process.

Toxicity Related to Tumescent Anesthesia

Toxicity can develop from the use of large doses of lidocaine used for perivenous anesthesia. Close follow-up with monitoring and management of ancillary therapy is appropriate for the radiologist.

PHYSICIAN CREDENTIALING

Before treatment, all patients with CVD should undergo a thorough clinical

evaluation by a physician who is appropriately trained in the care of venous diseases. The body of knowledge required includes a thorough understanding of venous anatomy, physiology, pathophysiology, diagnosis, duplex US, and treatment options. The requisite knowledge and clinical experience can be acquired through training in Accreditation Council for Graduate Medical Education-recognized (or approved) postgraduate residency or fellowship programs. Knowledge and skills can also be acquired through continuing medical education and/or mentored clinical experience (11).

PRETREATMENT ASSESSMENT

Clinical evaluation of the patient before treatment in an outpatient setting provides the physician an opportunity to perform a focused venous history along with a relevant medical history, followed by focused venous physical examination and evaluation of the patient's venous system with Duplex US. Only after such an examination can the physician communicate the appropriate treatment options. Patients with duplex US-documented truncal incompetence have the option of selecting EVTA, surgical high ligation and/or stripping, or US-

Table 2
Venous Clinical Severity Score

Attribute	0 (Absent)	1 (Mild)	2 (Moderate)	3 (Severe)
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 SSV distribution
Venous edema	None	Evening ankle only	Afternoon edema, above ankle	Morning edema above ankle and requiring activity change, elevation
Skin pigmentation	None or focal, low intensity (tan)	Diffuse, but limited in area and old (brown)	Diffuse over most of gaiter distribution (lower one third) or recent pigmentation (purple)	Wider distribution (above lower one third) and recent pigmentation
Inflammation	None	Mild cellulitis, limited to marginal area around ulcer	Moderate cellulitis, involves most of gaiter area (lower 2/3)	Severe cellulitis (lower 1/3 and above) or significant venous eczema
Induration	None	Focal, circum malleolar (<5 cm)	Medial or lateral, less than lower third of leg	Entire lower third of leg or more
Number of active ulcers	0	1	2	>2
Active ulceration duration	None	<3 mo	>3 mo, <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 and elevation

guided sclerotherapy to initiate treatment. Patients also have the option of conservative treatment with graded medical compression stockings. Subsequently or concurrently the patient may undergo AP or sclerotherapy of the dilated tributary branches of the GSV or SSV.

Medical History

A complete medical history of the presenting venous problem, previous therapy and response, previous history of thrombosis, comorbidities, medications, allergies, and any pertinent family history should be obtained from the patient. Chronic venous insufficiency causes symptoms in many patients that can impact their quality of life. These symptoms are summarized in **Table 3**. All of these symptoms are worsened with prolonged standing or sitting, improve with movement, and are most noticeable at the end of the day. In long-standing cases, patients may develop skin changes in the form of eczema, corona phlebectasia, pigmentation, and lipodermatosclerosis, and in the

Table 3
Symptoms Associated with Chronic Venous Insufficiency

Aching
Throbbing
Heaviness
Fatigue
Pruritus
Night cramps
Restless legs
Generalized pain or discomfort
Leg swelling

worst cases may form ulcers. A family and coagulation history searching for evidence of a hypercoagulable state should also be obtained. Laboratory and further hematologic evaluation is strongly recommended for patients with a history suggestive of a hypercoagulable state.

Physical Examination

A complete physical examination of the patient below the level of the umbi-

licus should be performed. This should be performed in the standing position (except for nonambulatory patients) and should include the lower extremities as well as the lower pelvis in patients in whom iliac vein occlusion is possible. Visible vein abnormalities including telangiectasias, reticular veins, and varicose veins should be documented. Edema of the extremities should be documented and calf and ankle diameter measurements obtained in cases of questionable edema. Careful attention should be directed at the skin near the medial and lateral malleolus of the ankle, as this region is most vulnerable to the effects of chronic venous hypertension. Manifestations of CVD such as corona phlebectasia, eczema, lipodermatosclerosis, and ulceration should also be documented. It is suggested that a standardized means of clinically assessing the severity of the effects of the chronic venous hypertension, such as the CEAP scale, be used to document one's findings (**Table 1**) (29). In addition, it is strongly recommended that a written documentation of the history,

clinical and duplex US examination findings be created for each patient, including a discussion of the impression and clinical recommendations. Photographs of the visible findings are also helpful to document the severity and extent of the disease before treatment.

Duplex US

Duplex US is essential in all patients with CEAP classification of C2 or higher and in patients with clinical symptoms of leg pain, swelling, or night cramps to identify reflux and patency and to establish the pattern of disease. The technique of duplex US for CVD is different than for the evaluation of lower-extremity DVT. The goals, objectives, and technique of this examination have been reviewed in a consensus statement by the Union Internationale de Phlebologie, American College of Phlebology, and SIR in several recent publications (38–40). During this examination, it is important to evaluate the anatomy and the physiology of both the superficial and deep venous systems. A thorough knowledge of the anatomy of the superficial venous system and its common variants is necessary. Accurate use of the newly accepted nomenclature to describe these veins is essential for medical reporting (26,27,39). The aim of the duplex US is to define all of the incompetent pathways and their sources, which involve saphenous and nonsaphenous veins, perforating veins, and deep veins. The evaluation should also include an assessment of the patency of the deep venous system, including the femoral and popliteal vein.

The necessary equipment includes grayscale US and pulse-wave Doppler imaging equipment using frequencies of 7.5–10 Mhz, although higher and lower frequencies may be used depending on the patient's morphology. Color Doppler imaging is very useful and readily available as a package with most units including pulse-wave Doppler equipment. Duplex US should be performed in the standing position and the examiner should thoroughly evaluate the GSV, SSV, their named tributaries, and the deep veins for both reflux and ob-

struction. Venous reflux is diagnosed when there is reversal of flow from the expected physiologic direction for more than 0.5 seconds following a provocative maneuver to create physiologic flow. These maneuvers include calf or foot compression by the examiner, dorsiflexion by the patient, or a Valsalva maneuver to assess for competency of the saphenofemoral junction or saphenopopliteal junction. A standardized report should be created and used to describe the findings for each examination in each patient. The use of diagrams significantly enhances the future understanding and communication of important clinical findings.

Ancillary Imaging

In unique or isolated clinical situations, patients may require further imaging to characterize venous obstruction, reflux, or venous anomalies in the pelvis or lower extremity such as a conventional intravenous or endovascular catheter contrast venogram, or computed tomographic (CT) or magnetic resonance (MR) venogram. Rarely patients require a conventional catheter, CT, or MR arteriogram to evaluate for the possibility of an arteriovenous malformation. Following clinical and imaging evaluation, the patient's clinical state should be summarized as to the severity, cause, anatomic location, and pathophysiology using the CEAP classification system (Table 1) (29).

INDICATIONS AND CONTRAINDICATIONS FOR AP

Indications for AP

The indications for AP include asymptomatic varicose veins for cosmetic purposes, symptomatic varicose veins not responding to conservative treatment, and patients with complications of varicose veins such as superficial thrombophlebitis, recurrent thrombophlebitis, and bleeding (22,41,42). Varicose branch tributary veins close to the skin surface, such as major tributary branches of the GSV or SSV such as the anterior thigh circumflex vein, posterior thigh circumflex vein, or anterior accessory great saphenous vein, are good indications for AP. These veins may also be treated with sclerotherapy or EVTA

Table 4
Indications and Contraindications

Indications	
Asymptomatic varicose veins for cosmetic purposes	
Symptomatic varicose veins	
Complications of varicose veins	
Superficial thrombophlebitis	
Recurrent thrombophlebitis	
Bleeding	
Contraindications	
Absolute	
Infectious dermatitis or cellulitis in area to be treated	
Severe peripheral edema	
Seriously ill patients	
Patients not able to follow postoperative instructions	
Allergies to local anesthetics	
Relative	
Pregnant or nursing patients	
Obstructed deep venous system	
Liver dysfunction	
Severe uncorrectable coagulopathy or hypercoagulable states	
Inability to wear compression stockings	
Inability to ambulate	

if marked tortuosity is absent. The GSV and SSV are not appropriate veins for AP as they lie below the superficial fascia and are too deep for AP. Varicose groin pudendal veins and labial veins are also appropriate indications for AP. Incompetent dilated perforator veins close to the skin surface are also candidates for AP. Dilated reticular veins of the popliteal area, lateral thigh and leg, ankle, and dorsal venous network of the foot are less common indications for AP. Networks of thick blue spider veins may also be removed by AP. Body areas other than the lower extremity where AP may be used include dilated periorbital, temporal, or frontal facial venous networks, and dilated veins of the abdominal wall, arms, or the dorsum of the hands (44). However, it should be noted that removal of functional veins for purely aesthetic purposes is a subject of debate, and a practice avoided by some physicians in an effort to preserve functional veins. The AP technique may also be used for drug implant extraction or to perform vein biopsies (45,46). Patients, or their representatives, must be able to give informed consent and be in good health with normal cardiovascular and pulmonary status (Table 4).

Contraindications for AP

Absolute contraindications for AP include infectious dermatitis or cellulitis in the area to be treated, severe peripheral edema, lymphedema, serious illness, inability to follow postoperative instructions, and allergies to local anesthetic agents (22,41–43). Relative contraindications include patients who are pregnant or nursing, have a obstructed deep venous system (ie, relying on superficial venous system for venous drainage), liver dysfunction (ie, limiting metabolism of local anesthetic agent), severe uncorrectable coagulopathy or hypercoagulable states, inability to wear compression stocking secondary to inadequate arterial circulation, or hypersensitivity to compression stockings and inability to ambulate after the procedure (Table 4).

Treatment Guidelines for AP

Treatment of proximal to distal CVD is of critical importance for good patient outcomes and to limit recurrence and appearance of new veins. After a proper clinical evaluation, any GSV or SSV reflux must first be treated with EVTA, sclerotherapy, or high ligation and/or stripping. AP may be performed concurrently or after treatment of proximal venous disease.

AP may be performed in an outpatient office or hospital setting. The facility should be equipped with good lighting and resuscitation capabilities, including medications to treat allergic reactions and volume replacement agents in case of excessive blood loss. A procedure table capable of Trendelenburg position may be helpful in performing the procedure. The procedure is typically performed under local anesthesia and no premedication is usually given. Before starting the procedure, the patient is placed in a standing position, preferably on a platform for the comfort of the practitioner. Photographs can be taken of the area to be treated for documentation of the pretreatment appearance. In the standing position, the veins to be treated with AP can be marked out with a surgical pen or permanent marker. The marking should ideally be done by the physician performing the procedure.

The patient should then be placed in a supine or prone position on the

procedure table. With the patient in a recumbent position, there is typically contraction and change in position of the vein(s) to be treated. Transillumination can be used to again locate the vein to be treated. Once the vein to be treated is localized with light guidance, a second set of markings using a different color surgical pen or marker should be placed directly on the vein (47–53). The area to be treated should then be prepared in a sterile fashion. Tumescence anesthesia should then be instilled around the vein to permit vein extraction and limit patient discomfort. Tumescence mixtures with concentrations from 0.01% to 0.1% lidocaine may be used. The amount of local anesthetic agent used should follow the usual recommendations according to the patient's body weight. Up to 5 mg of lidocaine per kilogram of body weight can be administered. If epinephrine is added, up to 7 mg/kg of lidocaine can be administered. If the amount of local anesthesia to be used is more than the recommended maximum dose, then the procedure should be staged and divided into multiple sessions. The interval between sessions is at the discretion of the physician and patient. Epinephrine may be used for most procedures. The potential advantage of epinephrine is contraction of superficial veins possibly decreasing the amount of bleeding after AP. The potential risks associated with epinephrine include skin necrosis and tachycardia. If the patient's age is greater than 60 years, lidocaine without epinephrine may be used to prevent cardiac complications. Sodium bicarbonate may be used to buffer the tumescence solution and make the infiltration less painful (22,41,54–58).

Cutaneous microincisions are performed with an 18-gauge needle, number 11 blade grasped transversely with a needle holder, or ophthalmic scalpels. The size of the microincisions varies between 1 mm and 3 mm in length. A longer microincision leads to a more visible scar and a greater possibility of scar formation or pigmentation. In the thigh, lower leg, and foot, the microincisions may be performed vertically for a potentially better cosmetic result. Around the knee, the tension lines can be followed. The interval between the microincisions can vary from 1 cm to 5 cm, depending on size, length, and types of veins ex-

tracted. Most microincisions may be left alone without any sutures or tape placed on them. An alternative is to place gauze on the microincisions with a long stretch bandage on top. Tape or adhesive bandages applied on microincisions may lead to blistering, allergic dermatitis, or pigmentation. When the microincisions are longer than 3 mm, a single 6–0 nylon suture can be applied to obtain a better closure.

There are several types of hooks that have been exclusively designed for AP. The hooks differ in their sharpness and shape of the tip. Common hooks used include the Muller hooks and Ramalet hooks (3–8). There are many new generations of hooks being created. Commercial over-the-counter hooks are available for AP, but care must be used during use. Once the hook is introduced through the microincision, it should be rotated and moved in a perpendicular plane against the vein to be removed. If there is difficulty introducing the hook, a blunt dissector may be introduced through the microincision to free the perivenous adventitial tissues. Once the vein is hooked, it should be brought to the skin surface gently through the microincision and grasped with a mosquito clamp. With a gentle rotating motion, the vein should be loosened from the perivenous adventitial tissues and slowly avulsed. Very gentle traction should be applied with a mosquito clamp as the vein is removed. Traction on the mosquito clamp allows removal of the vein and also outlines the course of the vein. As the segment of vein becomes larger and longer with gentle traction, the mosquito clamp should be repositioned closer to the skin surface to decrease the tensile force on the vein. It is an option to divide the vein between the mosquito clamps. It is important to note that the mosquito clamp should never be introduced into the microincision. It is recommended that the tip of the mosquito clamp be pointed upward as it is either pulled or rolled over the vein in the same or in a counter direction while traction is applied. It is important that the physician try to remove the entire segment of the vein that has been marked. Retained segments of varicose veins will develop superficial thrombophlebitis, leading to induration and bruising and leaving hard, tender, or lumpy areas for prolonged periods of time. These areas will have a tendency

to leave dark pigmentation in the overlying skin. Hemostasis is achieved by intra- and postprocedural local compression.

AP in the ankle or foot region should be only performed after significant experience has been obtained in other areas in the lower extremity. Special care must be paid to these areas to avoid neurovascular injury. The hooking technique should be much more gentle and deliberate than in other areas in the lower extremity. The foot should be dorsiflexed to decrease tension of the anatomic structures. After the vein is hooked it should come out easily. If the patient experiences pain or removal of the vein requires a large amount of tension, it is a strong possibility that a different structure such as a nerve or tendon has been hooked. The hook should then be removed and reinserted and another attempt made. Aggressive insertion of the hook into the microincision and "hooking" of structures should be avoided to prevent complications. AP in the pretibial area must be performed with caution because the large number of lymphatic vessels located in this area. AP in the popliteal fossa should also be performed with great care as the skin behind the knee is quite thin and microincisions are easily enlarged by aggressive hooking. Any additional tissue extruded from microincision sites should be reinserted (59–65).

POSTTREATMENT CARE

After AP is completed, the leg treated should be cleaned. The application of antiseptic powder or solution should be avoided, as it may induce silicotic granulomas (66). Adequate dressing of the area treated is a critical step in the follow-up care. The microincisions should be covered with sterile gauze or absorbent (ie, nonadhesive) pads and then with a high elasticity (ie, long-stretch) bandage. This achieves compression across the treated area, preventing postprocedural hemorrhage, pain, and other complications. The bandage should be applied distally too proximally to cover the treated area (67,68). Tape or adhesive bandages should not be applied on the microincisions because of the risk of blistering, allergic dermati-

tis, or pigmentation. A class II closed-toe graduated compression stocking based on the site of treatment should be worn over the dressing to apply extra pressure and keep the dressings in place. The sterile gauze or absorbent pads should be removed between 2 to 7 days after the procedure based on the size and location of the veins that have been removed. The compression stocking should be left on for a period of 2–4 weeks depending on the amount of bruising after the gauze and institution treatment protocol, and until absorbent pads have been removed (18,22,41).

Patients should be instructed to walk around the office for a minimum of 30 minutes after the procedure, to ensure there is no postprocedural bleeding and that the dressings and stockings are comfortable and tolerable for the patient. After the initial ambulation, patients can be discharged. Patients should be instructed not to drive home as the tumescent anesthesia may have lingering effects on the motor nerves. Patients should be encouraged to ambulate as much as possible at home. More vigorous exercise is generally discouraged for the first week to avoid developing increased central venous pressure on the treated area. Long periods of immobility such as those that occur with air flights or long car rides soon after AP should be discouraged to minimize venous stasis and the risk of DVT. Pain control may be achieved using an over-the-counter medication such as ibuprofen or, if a large segment of vein has been removed, acetaminophen (300 mg) with codeine phosphate (30 mg) and caffeine (15 mg) may be prescribed.

Patients should return to the office after 4–7 days or as per institution protocol to have the dressings removed and the microincisions checked. After the dressings are removed, patients should continue to wear the compression stockings for a total of 2–4 weeks depending on the amount of bruising. Patients should return for further follow-up appointments at approximately 4–12 weeks. At each follow-up appointment, the microincisions should be checked for healing. Residual reticular veins or telangiectasias may be treated with sclerotherapy at the operator's discretion (7,22,41,60,62).

SUCCESS RATES

Clinical success, as described in the section on treatment methods, is defined as an improvement in the clinical status of a patient as defined by one of the objective assessment instruments, such as the CEAP or VCSS classification, by at least one grade. Setting an appropriate success rate threshold for AP is difficult. There are many variables that will affect the eventual success of the procedure. These include patient population, type of CVD treated, anatomical location of treatments, the experience of the physician, preprocedural assessment, and postprocedural care. There are no references in the literature suggesting appropriate thresholds. However, based on anecdotal evidence there is a success rate in the range of 75%–95% (58,70).

COMPLICATIONS

Complications secondary to AP may be classified as cutaneous, vascular, local anesthesia-related, or neurologic. Complications may be secondary to incorrect patient indications, postoperative dressings, or surgical technique. Many complications can be avoided as the operating physician's skill and experience develops. However, it should be noted that complications may still occur with perfect surgical technique. Major complications are very rare. The vast majority of complications are minor in nature as per the SIR classification of complications (Appendix B). The different types of complications secondary to AP are listed in Table 5 (4,5,18,20,21,23,24,54,57,70–74).

Cutaneous Complications

A number of different types of skin lesions may occur after AP. Most can be prevented by proper application of postoperative dressings. Blisters occur secondary to skin shearing (eg, with Steri-Strips or adhesive bandages) and may lead to postbullous hypopigmentation (transient or permanent) or transient hyperpigmentation. Blister formation may be prevented by avoiding the use of adhesive dressings and using gauze dressings with a short- or long-stretch bandage. Transient hyperpigmentation may result from hemosiderin

Table 5
Complications Seen after AP

Common	Rare
Cutaneous	
Transient pigmentation	Contact dermatitis
Skin blisters	Infection
	Keloids
	Tattooing with marking pen
	Foreign body (silicotic) granuloma
	Necrobiosis lipoidica
Vascular	
Hematomas	Postoperative hemorrhage
	Matting (neovascularity)
	Superficial phlebitis
	DVT
	Edema
	Lymphatic pseudocyst
Local anesthetic	Concomitant anesthesia of deeper nerves
Neurologic	Postoperative pain
	Carpotarsal syndrome
	Transitory or permanent sensory deficit
	Neuroma

staining (after hematoma resorption) and postinflammatory melanocytic hyperactivity. Hyperpigmentation most commonly fades in weeks to months without treatment. However, sun protection (ie, sunblock and skin coverings) and UV avoidance are critical to avoid melanogenesis in treatment areas. Contact dermatitis is very rare because of the new generation of hypoallergenic topical medications and dressings. Visible scarring after AP is rare and can be avoided with tiny incisions, minimizing skin trauma. Scarring tends to persist longer in the younger patient population, and they should be made aware of this before AP. Keloid formation is also very rare even in patients at risk, most likely secondary to the small size of the incisions. Hypertrophic scars are also unusual and mainly observed in the dorsum of the foot, where they fade very slowly. Tattooing with a marking pen is rare and can be prevented by avoiding performing incisions over areas marked with a marking pen. Skin necrosis is also very rare and has been reported after the use of 1% lidocaine with 1/100,000 epinephrine. Therefore it is recommended 1/400,000 epinephrine be used (56). Foreign body granulomas along the incision sites are no longer observed, with the elimination of postprocedural application of antiseptic powder (8,66,75).

Vascular Complications

The incidence of vascular complications is correlated with the size and type of treated vessels (more likely with perforator veins) and location of AP (more common in thigh and popliteal fold), or the patient's history (previous sclerotherapy, phlebitis, lipodermatosclerosis). Appropriate compression and dressing should reduce the incidence and hopefully avoid such complications.

Postprocedural bleeding from the microincision sites may occur when the patient stands up or after some minutes of walking after undergoing the procedure. This type of bleeding can be controlled by additional pressure with gauze pads and reinforcement of the pressure dressing. Therefore it is advisable to reassess the dressing after 30 minutes of ambulation. Postprocedural bleeding occurs more frequently with perforator avulsion and in patients with postthrombotic syndrome. Careful and prolonged compression of the incision after removal of perforator vein is recommended.

Diffuse postprocedural hematomas are frequently seen, depending on the fragility of the patient's skin and effectiveness of the compression. These are typically self-limited. Superficial thrombophlebitis of incompletely removed varicose veins or in the neigh-

boring vein may occur some days after AP. Conservative measures including compression or oral antiinflammatory drugs, or invasive therapy such as evacuation of the clots and AP of the inflamed vein followed by compression and ambulation, will help relieve the symptoms.

DVT has rarely been reported after AP. This would be considered a major complication per SIR criteria and treatment would include anticoagulation along with compression (18). Edema is most commonly the result of an incorrectly applied dressing and will resolve after one night without the compression bandage. Edema may persist for several months after AP of the foot or SSV, as a result of unrecognized lymphatic insufficiency (76). Lymphocele is a rare complication of AP of the ankle, pretibial or popliteal areas with rapid development of a soft, painless fluctuant nodule. This may be punctured and drained. Alternatively compression with circular massage may be helpful. Neovascularity or "matting" is a complication of AP, sclerotherapy, and surgical ligation and stripping. The cause is unknown, and the matting may resolve spontaneously or be treated with sclerotherapy after a 3-month interval.

Local Anesthetic Complications

Anaphylactic reactions to local anesthetic agents are very rare. Toxic reactions may occur after accidental intravascular injection or use of concentrated solutions or in individually sensitive patients. Infiltration of the local anesthetic agent must be stopped if signs such as malaise, tremor, or paresthesias occur. Rarely, tumescent anesthesia may penetrate more deeply, particularly in the popliteal fold area, leading to infiltration of motor fibers of the peroneal nerve and causing transient nerve palsies such as drop foot, which clears within several hours. It is important to test the mobility of the foot before the patient stands up.

Neurologic Complications

Neurologic symptoms may arise as a result of the compressive dressing application and can be relieved with removal and reapplication of the dressing. Intraprocedure manipulation of a nerve is very painful and may cause transient postprocedural paresthesias. If a patient describes pain on insertion of the AP

Table 6
Threshold and Suggested Complication Rates for AP

Complication	Reported (%)	Suggested (%)
Cutaneous		
Skin blisters	1–20	10
Transient pigmentation	1–18	15
Visible scars	3–5	7
Contact dermatitis	1–3	3
Infections	0.5–2	2
Keloids	0.5–1	1
Vascular		
Major hematomas	0.1–2.5	3
Postprocedural hemorrhage	0.3–4.3	4
Superficial thrombophlebitis	0.1–3	3
Neovascularity or matting	1.3–9.5	10
Lymphocele	0.1–2.5	3
Persistent edema	0.1–1.3	1.5
DVT	0.5	0.5
Neurologic		
Paresthesia	0.2–4.6	5
Transient nerve palsies	0–4	5

hook or upon exteriorization of “vein,” the structure should be released and the AP hook reinserted to prevent nerve damage. If nerve injuries are observed, they typically occur in AP of the SSV as the sural nerve may be damaged by the hook, leading to paresthesia, or transected with permanent complete sensory loss over a large cutaneous area.

Published rates for individual types of complications are highly dependent on patient selection and are based on series comprising several hundred patients, which is a volume larger than most individual practitioners are likely to treat. Generally, the complication-specific thresholds should be set higher than the complication-specific reported rates listed earlier. It is also recognized that a single complication can cause a rate to cross above a complication-specific threshold when the complication occurs within a small patient volume (eg, early in a quality improvement program). In **Table 6**, all values were supported by the weight of literature evidence and panel consensus.

CONCLUSION

AP is a safe, aesthetic, and effective procedure for the removal of varicose and reticular veins in the lower extremity that may be performed in either an outpatient freestanding or inpatient health setting. It is an important ancillary procedure for the interventional physician in the treatment of

CVD. Thorough training and careful technique are essential for producing optimal results and preventing complications.

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APPENDIX A: CONSENSUS METHODOLOGY

Reported complication-specific rates in some cases reflect the aggregate of major and minor complications. Thresholds are derived from critical evaluation of the literature, evaluation of empirical data from Standards of Practice Committee members’ practices, and, when available, the SIR HI-IQ System national database.

APPENDIX B: SOCIETY OF INTERVENTIONAL RADIOLOGY STANDARDS OF PRACTICE COMMITTEE CLASSIFICATION OF COMPLICATIONS BY OUTCOME

Minor Complications

- A. No therapy, no consequence
- B. Nominal therapy, no consequence; includes overnight admission (up to 23 hours) for observation only.

Major Complications

- C. Require therapy, minor hospitalization (> or = to 24 hrs, but <48 hours).
- D. Require major therapy, unplanned increase in level of care, prolonged hospitalization (>48 hours).
- E. Permanent adverse sequelae
- F. Death.

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