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PERIPHERAL VASCULAR DISEASE (CJ COOPER AND R GUPTA, SECTION EDITORS)

Evaluation and Management of Chronic Venous Disease Using the Foundation of CEAP

Teresa L. Carman[1] · Ali Al-Omari[2]

Abstract

Purpose of the Review Venous disease is common. Depending on the population studied, the prevalence may be as high as 80%. Significant chronic venous disease with venous ulcers or trophic skin changes is reported to affect 1–10% of the population. A systematic assessment of the clinical findings associated with chronic venous disease will facilitate appropriate imaging. Based on imaging and assessment, patients with reflux or obstruction can be recommended proper medical and endovascular or surgical management.

Recent Findings Many types of endovascular management are available to treat reflux and eliminate varicose veins and tributaries. More recently adopted non-thermal non-tumescent techniques have been shown to be comparable with more widely performed laser or radiofrequency ablation techniques.

Summary A thorough clinical assessment, appropriate duplex ultrasound imaging, and use of advanced imaging when needed will allow clinicians to optimize therapy for patients with chronic venous disease based on the etiology, anatomy involved, and the pathophysiology.

Keywords Chronic venous disease · CEAP classification · Venous insufficiency · Venous therapy · Post-thrombotic syndrome

Introduction

Chronic venous disease (CVD) is a broad term applied to a spectrum of clinical disorders involving and impacting the venous system. CVD as previously defined is long-standing anatomic or functional changes within the venous system associated with clinical signs or symptoms that prompt investigation or care. Chronic venous insufficiency (CVI) is a term reserved for advanced venous disease associated with edema, trophic skin changes, or venous stasis ulceration [1•]. Given these definitions, one can imagine that the breadth of CVD is quite variable and spans from patients without visible signs but reported symptoms to active non-healing venous stasis ulcers [2]. CVD is generally non-life threatening and the symptoms are relatively nonspecific. Therefore, patients and physicians tend to overlook or under-recognize CVD. In addition, due to the heterogeneous clinical presentation and lack of a unifying terminology or classification system, early epidemiologic studies likely underestimated disease burden. In 1994, an international ad hoc committee from the American Venous Forum published a consensus statement outlining the CEAP classification system [2]. Designed to aid in scientific communication regarding disease severity and pathology, CEAP is a descriptive classification system that stands for clinical manifestation (C), etiology (E), anatomy (A), and pathophysiology (P). Recognizing additional opportunity for clarification, a revision was published in 2004 (Table 1) [3]. To foster the uniform use of terms and develop a scientific language for communication between venous experts, another multidisciplinary international faculty of experts developed the VEIN-TERMS consensus document [1•]. This consensus further solidified standards for discussing the clinical presentation, physiologic manifestations, and treatment for venous disease [1•]. Using the CEAP classification system and VEIN-

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✉ Teresa L. Carman
teresa.carman@uhhospitals.org

Ali Al-Omari
aliomari87@gmail.com

[1] University Hospitals Cleveland Medical Center, 11100 Euclid Ave, Mail stop LKS 3038, Cleveland, OH 44106, USA

[2] Northern Light Eastern Maine Medical Center, Bangor, ME, USA

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Table 1 CEAP classification scheme for chronic venous disease (CVD)

Clinical (C) classification
C0, no identifiable signs of venous disease
C1, intradermal telangiectasias (spider veins) or subdermal reticular veins
C2, subcutaneous varicose veins (≥ 3 mm)
C3, edema usually over the distal ankle and proximal foot
C4a, hyperpigmentation (hemosiderin staining) or venous eczema
C4b, lipodermatosclerosis or atrophie blanche
C5, healed venous stasis ulcer
C6, active venous stasis ulcer
Further noted as S—symptomatic (see text) or A—asymptomatic
Etiologic (E) classification
Ec, congenital including venous malformations, Klippel-Trenaunay and Parkes-Weber syndromes
Ep, primary disease
Es, secondary venous disease typically post-thrombotic
En, no identifiable etiology for the venous disease
Anatomic (A) classification
As, involving superficial veins (great or small saphenous or tributaries)
Ad, involving deep veins
Ap, perforator involvement
An, no venous anatomic changes identified
Pathophysiologic (P) classification
Pr, pathologic reflux (see text)
Po, obstruction either intrinsic or extrinsic
Pr,o, combined obstruction and reflux
Pn, no abnormal venous pathophysiology identified

Adapted from Meissner MH et al. *J Vasc Surg* 2007;46:54S–67S, with permission from Elsevier [14]

TERMs definitions allows practitioners to communicate and identify, evaluate, and plan management for patients with CVD in a common language [1•].

Epidemiology

CVD is common. From 1994 to 1998, the San Diego Population study evaluated more than 2200 multi-ethnic residents of San Diego, using clinical evaluation, duplex ultrasonography, and reported venous history including venous thromboembolism (VTE), surgery, or other intervention. The prevalence of venous disease in this population was 81%; 51.6% of people evaluated had spider veins, 23.3% varicose veins, and 6.2% advanced venous disease including edema, trophic skin changes, and active or healed ulcers [4]. Women were more likely to suffer from spider veins and varicose veins and men were more likely to have advanced venous disease. Disease prevalence increased with advancing age. Duplex ultrasound identified superficial functional disease in 19% of participants and deep venous functional disease in 9%. Similar to clinical disease, functional disease prevalence increased with advancing age. Women were more likely to have superficial disease and men more likely to have deep venous disease [4]. The Vein Consult Program demonstrated similar findings. In more than 99,000 patients from 23 countries in Asia, Eastern Europe, Latin America, and Western Europe, general practitioners identified CVD using the clinical classification from CEAP. From the total cohort, 69.9% were identified as having CVD. Prevalence was lowest in Asian patients (52%) and highest in Eastern European patients (70%). Significant disease with edema, trophic changes, or ulceration was identified in 19.8% of the Asian patients and 29.9% of Eastern European patients. The most important risk factor for CVD was a positive family history [5]. Few studies have evaluated the incidence of CVD. In the Bonn Vein study, the incidence of new varicose veins from initial evaluation to follow-up 6.6 years later was 13.7% and new CVI was 13% [6]. The Edinburg Vein Study, a population-based cohort study, enrolled 1566 individuals at baseline; 880 participated in a follow-up examination 13 years later. In 306 patients who were free of reflux at baseline evaluation, the incidence of new reflux was 12.7% and annual incidence 0.9% [7]. While the incidence of CVD may be estimated at 1–2% annually, disease progression is more common. From the Edinburgh Vein Study, 341 individuals with varicose veins or CVI at baseline, 193 (57.8%) demonstrated disease progression. While 31.9% of the 270 individuals with varicose veins at baseline progressed to CVI. A family history of venous disease, history of deep vein thrombosis, being overweight, and superficial venous reflux were associated with disease progression [8].

Clinical Presentation

Clinical evaluation focuses on signs and symptoms related to CVD. Unfortunately, the symptoms of CVD are nonspecific and may be difficult to associate solely to venous disease. Symptoms associated with CVD include heaviness of the legs, aching and throbbing, tiredness or fatigue of the legs, itching, tingling or burning, and nocturnal cramps or restlessness [9••]. Symptoms may increase throughout the day with prolonged dependency. Many patients find relief with elevation. Symptoms may also be exacerbated in the summer months and during a woman's menstrual cycle. From the Bonn vein study of 2624 individuals with CVD, 56.7% reported at least one symptom related to CVD. Symptom reporting was higher in women and increased with increasing age. From their analysis, there was a correlation between symptoms and worsening clinical severity [10]. This correlation has not been consistent. Van der Velden and colleagues using the VEINS-Sym and VEINS-QOL/Sym questionnaires demonstrated similar symptoms in non-venous diseases including knee and hip arthrosis, peripheral arterial disease, and spinal disc herniation [11], thus confirming the nonspecific nature of the lower extremity symptoms.

The clinical manifestations of CVD are described by "C" in CEAP. According to the CEAP classification scheme, clinical manifestations are based on increasing disease severity. The classification scheme goes from C0 through C6. Patients are

classified as **C0** when there is no discernable venous change. **C1** describes telangiectasias, intradermal vessels ≤ 1 mm also referred to as spider veins or reticular veins that are subdermal vessels 1–3 mm in diameter. Varicose veins are subcutaneous vessels ≥ 3 mm and are described by the classification **C2**. Patients with associated edema are classified as **C3**. Typical swelling is located over the ankle but may involve the leg or foot. Advanced skin changes or trophic changes involving the skin and subcutaneous tissues are category **C4**. C4 is further divided into **C4a** including hyperpigmentation or hemosiderin staining and venous eczema or stasis dermatitis. These changes can frequently be mistaken for cellulitis. **C4b** depicts the presence of lipodermatosclerosis or atrophie blanche. Lipodermatosclerosis is localized fibrosis and scarring of the skin and subcutaneous tissues–related inflammation, while atrophie blanche are areas of white atrophic skin with surrounding capillaries. These may be considered pre-ulcerative in some patients. Once a venous stasis ulcer heals, patients are classified as **C5**. **C6** describes the most severe skin finding—an active venous stasis ulcer (VSU) [3]—while CEAP does not describe symptoms associated with venous disease. The clinical classification may be described and depicted as symptomatic "S" or asymptomatic "A" (i.e., C2A).

The clinical classification is not a static determination. The initial classification should be recorded at the first visit. Patients may develop worsening disease and progression through the classification scheme with time. With the healing of an active VSU, the classification moves from C6 to C5—a reduction in classification. In addition, once the evaluation is complete, the underlying etiology is determined. Successful management can lead to an improvement of signs and symptoms with regression of disease classification.

Etiology

The "E" in CEAP denotes the etiology of the CVD. Etiology can be classified as congenital (C), primary (P), secondary (S), and no obvious venous cause (N) [3]. Venous malformations are one of the most common developmental anomalies. Congenital venous disease includes recognized clinical syndromes such as Klippel-Trenaunay or Parkes-Weber syndrome. While beyond the scope of this review, it is important to understand and recognize the presence of congenital vascular anomalies as the evaluation and management may be more complex than primary or secondary CVD [12, 13]. Primary CVD by definition is a venous disease without a secondary cause or identifiable mechanism of venous injury. There is no consensus on the etiology of primary CVD and varicose veins; in addition, the venous pathology responsible remains elusive. Primary varicose veins are more common in women and the prevalence increases with advancing age [14, 15]. Genetic and environmental risk factors contribute to primary varicose vein development. Additional risk factors include age, gender, pregnancy, obesity, and a family history of varicose veins. While a strong family history is often evident, a genetic component has yet to be identified [15]. The San Diego population study assessed risk factors for CVD. Using visible pathology, ultrasound, and a lifestyle and demographic questionnaire, they identified modifiable and nonmodifiable risk factors for CVD. Age, family history, and ligamentous laxity determined by flat feet or previous hernia surgery demonstrated the highest yet nonmodifiable correlation with moderate or severe venous disease. Modifiable risk factors including adiposity, smoking, and positional status, including hours spent standing or sitting, and parity were also associated with venous disease [16].

The most common cause of secondary CVD is associated with a history of deep or superficial venous thrombosis. Following DVT injury to the vessel lumen is common and may result in valve injury and reflux or luminal scarring causing obstruction [17]. Both obstruction and reflux are important pathophysiologic changes contributing to CVD and will be discussed under pathophysiology. Post-thrombotic syndrome (PTS) is the term applied to the clinical signs and symptoms of venous disease that follows an episode of deep vein thrombosis (DVT). PTS can be recognized in 20–50% of patients following DVT [18].

Anatomy

The leg veins are classified as deep veins, superficial veins, and perforator veins. Understanding venous anatomy and accurately identifying the venous segments is paramount to communicating venous disease. In 2002, the International Union of Phlebology published a consensus document to establish a common language regarding venous anatomy for the purpose of communication and publication [19]. This was further revised in 2005 and the terminology remains in effect today [20].

The deep veins lie within the deep compartment bounded by the muscular fascia and include the popliteal vein, femoral vein, common femoral vein, and iliac vein. The superficial veins including the great saphenous and small saphenous veins lie within the superficial compartment. This is bound by the muscular compartment and by the dermis. Perforating veins are the most numerous veins within the lower extremity and these perforate through the fascia and connect the deep and superficial veins. Perforating veins normally carry venous blood inward, from superficial to deep veins. However, in the setting of significant superficial venous reflux, the direction of flow can be reversed with venous blood flowing outward from deep to superficial veins. Perforators should be differentiated from communicating veins which connect veins within the same deep or superficial system [19]. It is well recognized that the venous anatomy can be quite variable. Any venous segment may be duplicated, anomalous, atretic, or absent. The

advanced CEAP scheme recognizes 18 named venous segments that can be further delineated within the deep, superficial, and perforating vein to better communicate the disease locality [3].

Pathophysiology

Normal venous function is designed to support cephalad venous return. Components of venous function include a calf muscle pump, intact venous valves, a cardiac pump, and a pressure gradient. Central to the production and clearance of the interstitial tissue fluid is the function of the vascular endothelium and the lymphatics [21]. Impairment or dysfunction of any component can result in clinical signs of CVD. There are 2 primary forces at work relative to venous return. Hydrostatic pressure related to the column of blood extending from the right atrium to the foot and hydrodynamic forces that work to return blood against gravity back to the right atrium. As we ambulate, the calf muscle contraction serves to eject blood from the sinusoids and veins of the legs. This lowers pressure in the leg and ejects blood upward against gravity. This cephalad propulsion is supported by intact, functional valves, and valve closure preventing retrograde flow. When the valves work as they are intended, they are referred to as competent valves. When functioning competently, the upright resting pressure at the ankle which can be as high as 90–100 mmHg is decreased to 20–30 mmHg with ambulation [21].

The pathophysiologic changes of CVI are related to underlying ambulatory venous hypertension. The "P" in CEAP denotes the pathophysiologic changes (venous reflux (R), obstruction (O), and combined reflux and obstruction (O)). In addition, there is a category "N." This is used when there is no discernable venous pathophysiology and neither reflux nor obstruction is identified [3]. Reflux is retrograde flow through a venous valve. Valvular incompetence or venous reflux may occur in any vein within the deep, superficial, or perforator systems. Valvular incompetency or the loss of valve integrity may occur as a primary process in the case of primary varicose veins or may be the result of vein injury as in post-thrombotic syndrome. The exact alterations within the vessel wall or the valve cusp that lead to primary valve changes resulting in incompetency and reflux are not well understood. Reflux through incompetent valves increases the hydrostatic pressure in the veins contributing to the clinical changes noted in CVD. Reflux may be axial, involving all the veins with continuous reflux from the groin to the ankle, or it may be segmental [1•]. Venous obstruction may also contribute to ambulatory venous hypertension. Obstruction may be intrinsic as in the case of webs, synechiae, or occlusion following DVT. Obstruction may also be extrinsic from compression of the vein as in the setting of a pelvic mass, retroperitoneal fibrosis, or non-thrombotic iliac vein (NIVL) compression [22]. The pathophysiology of CVD is generally attributed to either venous reflux (R) or obstruction (O) [3]. It is well recognized that patients may have both reflux and obstruction contributing to their symptoms and clinical manifestations. The combination of reflux and obstruction is most likely to occur in the setting of post-thrombotic syndrome. However, individuals with primary varicose veins may also have evidence of obstruction especially in patients with more advanced C4 or C6 disease [23].

"Pn" is included in the CEAP pathophysiology nomenclature for patients in whom there is no evidence of reflux nor obstruction. It is well recognized that even patients with advanced CVD may not demonstrate underlying venous changes [23]. Obesity-related CVD is increasingly recognized [24]. When associated with severe skin changes and secondary lymphedema, this syndrome has been given the moniker-phlebolymphedema [25]. Exogenous application of abdominal pressure demonstrated changes in venous diameter, peak and mean venous velocity, and venous flow volume. Venous changes were similar in obese patients with a body mass index (BMI) >30 kg/m^2 and normal weight volunteers with the application of 20 mmHg external abdominal pressure [26]. Similar ultrasound findings were demonstrated when normal weight and obese individuals were evaluated [27]. While the epidemiologic data demonstrates the impact of obesity on primary CVD, these physiologic findings lend understanding to the impact of obesity on venous function.

In addition to the valves within the deep, superficial, and perforating veins, microvalves within the small superficial veins have been shown to contribute to CVD [28, 29]. Microvascular reflux has been demonstrated to exist in the setting of great saphenous vein (GSV) competence. When microvalve reflux extends past the third generation of microvalves the impact on skin perfusion is most notable. In the setting of GSV, reflux microvalve incompetence seems to contribute to the progression of the skin changes associated with CVI [28]. Methods to adequately evaluate the small vessels and microvalve changes are lacking and further refinement of testing is required [29].

Evaluation

Systematic evaluation is required in CVD. A thorough history, physical examination, and supportive noninvasive testing will support the diagnosis and correct CEAP classification. Venous duplex ultrasound with reflux testing remains the mainstay of noninvasive imaging. Advanced imaging with computed tomography (CT), magnetic resonance imaging (MRI), and even venography may be required to fully delineate disease and plan intervention.

The history should include associated symptoms, symptom onset, exacerbating and relieving factors, and progression of disease. Attention to details related to pregnancy, menstrual cycle, environmental factors, occupational hazards, history of

VTE, and family history should be noted. The use of ankle-foot orthoses and ambulatory aides should be included. Exclusion of cardiac conditions, liver, renal, or endocrine disease that may contribute to signs and symptoms of CVD is essential. Edema is a frequent side-effect of many pharmaceuticals and a review of current medication and herbal drug use is crucial. Physical examination should be performed both at rest and standing. Evaluation should include lower extremity examination of the skin, identification of visible venous changes including telangiectasias, reticular veins, and varicose veins, as well as edema. The abdomen and flanks should be examined for sentinel veins that may be suggestive of a central obstructing process. A savvy practitioner should also ensure there is normal cardiac function without elevated jugular venous pressure, murmurs, or second heart sounds suggestive of elevated right heart pressures. Given the impact of the calf muscle pump on venous return, foot and ankle function as well as gait should be noted [22, 30].

There are several quality of life scores and clinical severity scores that may be used to help assess patients as well as outcomes of intervention. CEAP has been discussed [3]. The Venous Clinic Severity Score (VCSS), the Venous Segmental Disease Score (VSDS), and the Venous Disability Score (VDS) were conceived in 2000. The VCSS was updated in 2010 and is most widely used to assess clinical symptoms. This instrument uses patients reported symptoms and clinical findings to assign a severity score. The VSDS and VDS were designed to evaluate the anatomic and pathologic severity of venous disease and the impact of the disease on one's ability to work an 8-h day respectively [31]. The Villalta scale is typically used to assess severity and longitudinal impact of post-thrombotic syndrome. Using a 4-point scale, eleven different clinical signs and symptoms of venous disease are assessed. A cumulative score $\geq$ 5 points is considered consistent with post-thrombotic syndrome [31]. The Aberdeen Varicose Vein Questionnaire (AVVQ) was designed to be specific to varicose vein surgery patients. This is a patient-reported questionnaire to assess outcomes following uncomplicated varicose vein treatment [31]. Incorporation of these instruments and other measures of quality of life should be routine for the purposes of research and quality reporting.

Assessment of deep venous reflux can be done in the office using the Broden-Trendelenburg tourniquet test or with a hand-held Doppler, although these are not currently recommended in favor of a more thorough noninvasive evaluation typically done in the vascular laboratory [9••]. Both venous duplex imaging and venous air plethysmography (APG) can assess for reflux and obstruction. In addition, air plethysmography can be used to assess calf muscle function. However, few laboratories routinely perform APG.

Venous duplex imaging is the most common test to assess the anatomy and physiology of the venous system. The examination should ideally be performed with the patient standing. The protocol is systematic, employing B-mode, color Doppler, and pulse-wave Doppler both at rest and with provocative maneuvers including Valsalva and compression to elicit reflux and assess for obstruction. The protocol should be such that the superficial and deep veins from the groin to the ankle are assessed. DVT can be excluded and normal versus abnormal physiology can be identified [22, 30, 32••].

Normal veins are pliable and compressible. Following venous thromboembolism veins may demonstrate wall thickening [33]. Intraluminal echogenic changes and multiple flow channels are chronic changes that may also be seen following an episode of DVT. Normal flow within the veins is respirophasic. Reflux is identified as retrograde flow. Within the superficial system reflux time, > 0.5 s is considered significant, while in the deep veins reflux time, > 1.0 s is significant. Continuous flow, also called monophasic flow, in the antegrade direction, or a blunted response to distal compression, may suggest venous outflow obstruction. When indicated, imaging can extend into the pelvis and include the inferior vena cava and iliac veins, and in some patients, pelvic veins can be insonated and evaluated [32••]. However, most clinicians agree that pelvic imaging typically requires more advanced technologies [9••].

When abdominal or pelvic pathology is suspected, advanced imaging with MRI venography (MRV) or CT venography (CTV) allows for assessment of the anatomy. The choice of MRV or CTV should be made considering patient characteristics, the renal function threshold for contrast exposure, and local technical expertise. Communication with the imaging department regarding the need for venous phase imaging may be needed. Both techniques should adequately assess intraluminal obstruction and extrinsic compression. Subtle intraluminal changes such as webs may not be fully delineated [9••, 22, 30]. Catheter-based contrast venography utilizing pressure measurements and intravascular ultrasound (IVUS) may be warranted especially in patients with advanced venous disease, C4-C6. While more invasive, these modalities allow for intraluminal assessment and when combined with pressure measurement may provide the most definitive assessment of obstruction and allow for therapeutic intervention [22].

Treatment

Treatment for CVD includes medical management, endovenous therapy, and surgical procedures. Medical management starts with basic recommendations to mitigate symptoms and progression of disease. Given the impact of obesity on venous function, weight loss or maintaining an ideal body weight is a consideration for all patients [27]. Elevation at night can provide symptom relief [9••]. Skin care and wound care when required for VSU are frequently overlooked. Topical emollients should be recommended. The use of a topical low to intermediate potency steroid may be used to

manage stasis dermatitis. Venotonic drugs such as flavenoids and saponosides have been used more consistently in Europe than in the USA. Horse chestnut seed extract, a saponoside, is available as an over-the-counter supplement. The only Food and Drug Administration (FDA) approved agent for CVD is diosmiplex (Vasculera®). Diosmiplex is classified as a medical food. It contains purified diosmin, a micronized-purified flavenoid fraction (MPFF). Current guidelines suggest MPFF may be used as an adjunctive therapy in CVD [9••, 34].

Compression is a mainstay of medical therapy for CVD. Compression stockings should be recommended for management and while additional evaluation is being performed [9••]. The "strength" or tension of the compression should be matched to the disease state as well as patient characteristics. In general, patients with C0-C1 disease will usually have symptom improvement with a low grade 15–20 mmHg stocking. Patients with C2-C3 disease will likely benefit most from higher compression with 20–30 mmHg. Patients with the most severe disease C4-C6 will likely need 30–40 mmHg compression [17, 30]. Recommendations and adjustment to compression may be required for patients with associated peripheral arterial disease. Morbidly obese patients may require a higher grade of compression for symptomatic relief. In addition, compression should be tailored to what the user or their care provider can safely don and doff. Frail or elderly patients may not have sufficient hand strength or flexibility to don high-grade compression. VSU wound management can be quite complex. Basics of wound healing include maintaining a moist wound base, control of bioburden, and adequate compression therapy, usually multi-layered bandages, high-grade 30–40 mmHg graduated compression stockings, or multi-layered ulcer care compression [35].

Attaran and Chaar recently published an extensive review on compression therapy including a discussion on the mechanisms of action [36]. A recent consensus document reviewed the available evidence to support the use of compression in CVD [35]. Their recommendations include the following: the use of compression to alleviate symptoms in CVD (Grade 1B); use of compression to improve the quality of life and reduce VCSS scores in patients with CVD (Grade 1B); and compression to prevent and reduce edema associated with flights and occupational swelling in patients with CVD as well as for individuals at risk for leg swelling (Grade 1B). The use of compression to improve skin changes (Grade 1C) and lipodermatosclerosis (Grade 1B) in patients with CVD was also recommended. They did not find evidence to support the use of compression to prevent CVD progression [35].

Endovenous Therapy

Patients with CVD may not improve sufficiently with medical management alone. In addition, progression of disease is common and early management before significant skin changes or ulceration occurs is key. Symptomatic patients with documented reflux and/or obstruction may benefit from endovenous therapy to improve symptoms and limit progression. The goals of endovenous therapy are to ablate or eradicate pathologic veins, treat or prevent the complications related to CVD, improve the associated symptoms, improve venous function, improve the patient's quality of life, and provide a satisfactory cosmetic result [37]. When performed in patients with VSU, wound healing and increasing the ulcer-free interval are the goals of therapy [38]. There are several options for endovenous therapy to manage reflux. The goal of therapy in this setting is to create a chemical or heat-induced injury to the endothelium and incite a thrombo-inflammatory reaction that will end with fibrosis and obliteration of the refluxing vein. One method of treatment is sclerotherapy using a sclerosing agent such as hypertonic saline or a detergent such as sodium tetradecyl sulfate, polidocanol, or sodium morrhuate. Sclerotherapy can be used to treat across the spectrum of venous abnormalities from telangiectasias to vascular malformations to varicose veins with reflux. Patients with symptomatic C0 or C1 disease should be investigated for reflux and obstruction—although this association is uncommon. If there are associated symptoms of itching or burning, patients with C1 disease limited to telangiectasias or spider veins may benefit from injection sclerotherapy in addition to compression. In larger veins and varicosities, a sclerosant foam may be employed. Historically this was produced "off-label" in the office but there is now an FDA-approved proprietary sclerosant foam. Guidelines have been published regarding the safe and effective use of sclerotherapy across the spectrum of venous abnormalities from telangiectasias to vascular malformations to varicose veins with reflux [30, 37].

In addition to sclerotherapy, endovenous therapy now includes forms of thermal ablation as well as non-thermal non-tumescent (NTNT) ablation methods. Thermal methods of ablation include radio frequency ablation (RFA) and endovenous laser ablation (EVLA). These modalities have been used since the late 1990s. There is an abundance of data regarding the successful use, long-term results, and complications associated with the procedures. In general, they are comparable [39•, 40]. More recently, NTNT endovenous methods have been introduced into clinical practice. Because no heat is applied to the vein wall, no tumescent anesthesia is required. Mechanochemical endovenous ablation (MOCA) uses mechanical abrasion of the vein wall with a rotating wire while concomitantly injecting a sclerosant. The use of cyanoacrylate glue has also been approved as another NTNT method of venous closure. Both MOCA and cyanoacrylate glue have been compared with RFA and demonstrate similar rates of successful vein closure and improvement in severity scores. Complications of the thermal and NTNT methods of venous closure include phlebitis, ecchymosis, and pain. Extravascular injection of sclerosants can cause significant tissue injury and necrosis [39•, 40].

While noninvasive surgical management with phlebectomy of tributary veins may still play a role and while high-ligation and stripping may play a limited role in management, the days of routine vein stripping are no longer [9••].

While each procedure has risks and benefits, in competent, trained hands, all of these modalities are efficacious and safe with few absolute contraindications for the procedure. Ultimately the choice of therapy is dictated by the clinical presentation, practitioner and patient choice, and local availability since all practitioners may not have experience or access to all modalities. By convention, endovenous management should be reserved for patients with an active VSU or symptomatic patients who fail to improve despite appropriate medical management. Larger veins, > 5–7 mm, may be more appropriate for thermal ablation, foam sclerotherapy, and NTNT methods over sclerotherapy alone. There is some debate regarding the timing and management of patients with combined reflux and obstructing with most practitioners treating reflux first followed by outflow obstruction.

The management of venous obstructive disease should not be overlooked. Patients with obstructive disease, typically affecting the iliac veins, may benefit from more invasive therapies using catheter venography, intravascular ultrasound (IVUS), and venoplasty or stenting. The deep and superficial venous systems meet at the common femoral vein, so obstruction in the common femoral or iliac veins, or the IVC, can lead to advanced CVI. As previously mentioned, obstruction may related to intrinsic vein damage following deep vein thrombosis, extrinsic compression from anatomic structures or pelvic organs, or there may be a combination of pathologies as is typical in May-Thurner syndrome [22, 41]. Iliac vein lesions may present in 2 forms: non-thrombotic iliac veins lesions (NIVL) and iliac vein lesions associated with proximal DVT commonly referred to as May-Thurner syndrome [42]. Whether thrombotic or non-thrombotic, these lesions typically occur in the proximal left iliac vein where the right iliac artery crosses over creating compression. Imaging may demonstrate scarring, stenosis, and webs. In general, these lesions are best managed with endovenous stenting; however, the decision to proceed to stent placement should be individualized especially in young women of child-bearing age [42]. While there is no consensus on the management of chronic femoropopliteal disease, most practitioners agree that endovenous management of iliac and common femoral vein post-thrombotic obstruction has a role. In skilled hands, successful outcomes are promising. However, further studies are being designed to improve the care of complex post-thrombotic patients [41].

Conclusions

CVD is common. The prevalence increases with age. Given the aging population, this once under-recognized and under-appreciated clinical entity has gained more clinical attention. Using the CEAP classification system and understanding standardized venous terminology allows practitioners to better use the literature and communicate. While compression therapy is a mainstay for treatment, the availability and use of endovenous ablation techniques are expanding. The internal medicine and cardiovascular communities should strive to recognize the impact of this disease and embrace an understanding of the evaluation and management.

Compliance with Ethical Standards

Conflict of Interest Teresa L. Carman and Ali Al-Omari declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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