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Abstract

The lower limb venous system is responsible for the return of the blood from the leg toward the heart. Chronic venous disease occurs by a deficiency in the blood return due to structural or functional abnormalities of the veins of the lower limbs. Insufficient venous return leads to the accumulation of blood in the lower limbs and to varying degrees of venous hypertension, presenting a wide spectrum of clinical manifestations, ranging from simple telangiectasies and varicose veins to advanced forms. Chronic venous disease has a large prevalence in the world population and has significant impact on health services for high demand due to disease symptoms, activity limitation and aesthetic concern. Common symptoms are pain, cramps, heaviness, edema, and lower limb ulcer. The presence of tortuous and dilated veins must be noted, as well as telangiectasies, angiomatic formation, edema, and trophic skin alterations. CEAP classification has been proposed in order to standardize the scientific publications about varicose veins and therapeutic indications. Chronic venous disease treatment involves no interventionist actions to control symptoms and improve the quality of life with physical activity, compression therapy, phlebotropic agents, and interventional

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treatment such as sclerotherapy, transdermal laser, or surgery. Today, we have the minimally invasive methods as an alternative of surgery: endovenous ablation with laser or radiofrequency and foam sclerotherapy.

Introduction

The lower limb venous system is responsible for the return of the blood from foot, leg, and thigh toward the heart. There are three types of limb veins: superficial, deep, and perforating, which communicate the superficial veins to the deep veins [1]. They are all interconnected and the disorder present in one affects the others.

Chronic venous disease occurs by a deficiency in the blood return due to structural or functional abnormalities of the veins of the lower limbs. This is by: (1) obstruction of the venous flow (thrombosis or extrinsic compression), (2) reflux due to venous valvular incompetence that can be primary or secondary, or (3) deficiency in the calf muscle pump [2].

Insufficient venous return leads to the accumulation of blood in the lower limb and to several degrees of venous hypertension. Therefore, the chronic venous disease presents a wide spectrum of clinical manifestations, ranging from simple telangiectasias (spider veins), reticular veins (subdermal), varicose veins (subdermal and subcutaneous), and leg edema to advanced forms with hyperpigmentation of the skin, dermal sclerosis, and venous ulcers [3].

Varicose veins are tortuous, dilated, and elongated veins, with loss of valvular function and wall changes related to venous hypertension. They are subdermal and subcutaneous, most commonly in lower limbs [4]. There are no classical varicose veins in the deep system due to muscle fascial sheath that prevents the dilation and stretching of the veins. The varicose veins may be (1) primary, of unknown etiology that corresponds to most cases or (2) secondary, resulting from deep vein thrombosis, vascular malformation (like vein or valve agenesis), and congenital or acquired arteriovenous fistulas.

Epidemiology

Chronic venous disease has a large prevalence in the world population, with involvement of 25–33 % of women and 10–20 % of men in the adult population, with proportional increase related to age [5–7]. The prevalence is approximately 37.9 % in the general population. According to the Framingham study, the annual incidence of varicose veins is 2.6 % in women and 1.9 % in men, with a ratio of 2 women to 1 man affected [8]. Chronic venous disease has significant high demand on health services due to the symptoms, activity limitation, and aesthetic concern.

Pathophysiology

Chronic venous hypertension is responsible for the alterations found in chronic venous disease. When the patient lies down, the foot is at the same level as the heart so the blood flows without difficulties. However, it is necessary for the blood to

overcome gravity when the patient is standing. During physical activity, contractility of the calf muscles acts as a pump that ejects the blood back to the heart (calf pump). The venous valves close after the passage of the blood avoiding blood reflux directing the blood stream to the right side of the heart [9].

During standing or sitting, especially after long periods of time, there is no calf muscles action. Then, venous stasis occurs leading to increased intravenous pressure, which may damage the venous walls and valves [9].

Venous hypertension leads to extravasation of plasma and blood elements to the surrounding tissues, mainly for skin and subcutaneous tissue. Red blood cell is degraded in the interstitial space forming hemosiderin and causing skin hyperpigmentation. Considering the microcirculation, the hypertension generates inflammation of the subcutaneous tissue, lipodermatosclerosis, and leukocyte sequestration leading to cellular damage. Fibrin increase in the interstitial tissue hinders the diffusion of metabolites leading to less availability of essentials elements to healing and ulceration eventually [10]. Hemodynamic worsening translates into clinical worsening [11].

Natural History

Varicose veins of the lower limbs are the most frequent presentation of chronic venous insufficiency, affecting 75 % of the patients. Of these, 71 % have varicosities derived from the reflux of the great saphenous vein, making it the most affected vessel in the wide clinical spectrum of chronic venous insufficiency [12]. Primary varicose veins are associated with a normal deep venous system and progress less frequent to more advanced venous disease, when compared to secondary [13]. Some risk factors for its development are: family history for varicose veins, advanced age, obesity, high number of pregnancies, phlebitis, professional prolonged orthostatic position, smoking, physical inactivity, and poor fiber diet [2].

Advanced forms of chronic venous disease with venous dilatation, edema, and ulcers are associated with low mortality rates. However, they present with severe loss of quality of life due to discomfort, high rates of recurrence, and the long evolution, having bad prognosis: 50 % of the ulcers heal in 4 months, 20 % in 2 years, 8 % in 5 years and they have annual recurrence of 6–15 % [14–17].

Lower limbs varicose veins are estimated to affect about one-third of the world population [4]. However, only about 3–6 % of the people with varicose veins will develop stasis ulcers [18]. Therefore, usually the evolution of the majority of the chronic venous diseases are benign and most patients present purely aesthetic discomfort without major problems for health in general.

Varicose veins are a small risk factor for deep vein thrombosis. So, when it occurs, other risk factors of more importance such as venous stasis, malignancy, thrombophilia, trauma, or hormonal replacement should be considered [19].

Superficial thrombophlebitis is often linked to varicose veins complications. It leads to pain and local inflammation. It can occasionally cause deep vein thrombosis if it reaches to the deep venous system through a communicating vein [20].

Clinical Manifestations

The clinical manifestations of chronic venous disease encompass a large spectrum of venous disorder from simple telangiectasies and reticular veins to venous ulcers.

Patients refer symptoms such as lower limbs pain, heaviness, edema, cramps, burning, itching, or tingling in different intensity degrees [4]. Symptoms are more pronounced at the end of the day (after long periods of orthostatic position) and in hot weather, worsening in summertime. It gets better with horizontal decubitus and lower limb elevation.

Hormonal action also influences the manifestations, with larger number of complaints during the premenstrual period and in the presence of hormone replacement or oral contraceptives use.

In advanced cases occur skin alterations such as eczema, dermatitis, hyperpigmentation (secondary to hemosiderin deposition), lipodermatosclerosis, and blanche atrophie. It can also occur wounds (stasis ulcer) mainly in malleolar region, phlebitis, and occasional bleeding [21].

Classification

CEAP classification has been proposed in order to standardize the scientific publications regarding varicose veins and therapeutic indications and takes into account the knowledge about the pathophysiology of venous disease, diagnostic methods, and the different concepts of the meaning of chronic venous insufficiency. This classification is related to four criteria: clinical (C), etiological (E), anatomical (A), and pathophysiological (P) and was adopted worldwide, being the most used currently.

CEAP classification is shown in Table 14.1 [22]:

Table 14.1 Basic CEAP classification [22]

| |
|---|
| <i>Clinical classification (C): from 0 to 6</i> |
| C0 No visible sign of venous disease |
| C1 Telangiectasies or reticular veins |
| C2 Varicose veins |
| C3 Edema |
| C4 Changes in skin and subcutaneous tissue |
| 4a Pigmentation or eczema |
| 4b Lipodermatosclerosis or atrophie blanche |
| C5 Healed ulcer |
| C6 Active ulcer |
| S: symptomatic |
| A: asymptomatic |
| <i>Etiological classification (E)</i> |
| Ec Congenital |
| Ep Primary |
| Es Secondary (post-thrombotic syndrome, trauma) |
| En No venous cause identified |

(continued)

Table 14.1 (continued)

| | |
|--|--------------------------------------|
| <i>Anatomical classification (A)</i> | |
| As | Superficial veins |
| Ad | Deep veins |
| Ap | Perforator |
| An | No venous location identified |
| <i>Pathophysiological classification (P)</i> | |
| Pr | Reflux |
| Po | Obstruction, thrombosis |
| Pr,o | Reflux and obstruction |
| Pn | No venous pathophysiology identified |

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Table 14.2 Definitions about CEAP clinical (C) classification [22]

| | |
|----------------------------------|---|
| Corona phlebectatica | Fan-shaped pattern of numerous small intradermal veins on medial or lateral aspects of ankle foot |
| Telangiectasia | Confluence of dilated intradermal venules less than 1 mm in caliber. Synonyms include spider veins, hyphen webs, and thread veins |
| Reticular vein | Dilated bluish subdermal vein, usually 1 mm to less than 3 mm. Usually tortuous. Excludes normal visible veins in persons with thin, transparent skin. Synonyms include blue veins, subdermal varices, and venulectasies |
| Varicose vein | Subcutaneous dilated vein 3 mm in diameter or larger, measured in upright position. May involve saphenous veins, saphenous tributaries, or no saphenous superficial leg veins. Varicose veins are usually tortuous, but tubular saphenous veins with demonstrated reflux may be classified as varicose veins. Synonyms include varix, varices, and varicosities |
| Edema | Perceptible increase in volume of fluid in skin and subcutaneous tissue, characteristically indented with pressure. Venous edema usually occurs in ankle region, but may extend to leg and foot |
| Eczema | Erythematous dermatitis, which may progress to blistering, weeping, or scaling eruption of skin of leg. Usually seen in uncontrolled chronic venous disorder, but may reflect sensitization to local therapy |
| Pigmentation | Brownish darkening of skin, resulting from extravasated blood. Usually occurs in ankle region, but may extend to leg and foot |
| Atrophie Blanche (White atrophy) | Localized, often circular whitish and atrophic skin areas surrounded by dilated capillaries and sometimes hyperpigmentation. Should not to be confused with healed ulcer scars |
| Venous ulcer | Full-thickness defect of skin, most frequently in ankle region, that fails to heal spontaneously and is sustained by chronic venous disorder |

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For a better understanding of the various CEAP clinical classes (C), precise definitions of each were described as shown below in Table 14.2 [22].

The Figs. 14.1, 14.2, 14.3, 14.4, 14.5, and 14.6 represent CEAP clinical classification from C1 to C6 respectively.



Fig. 14.1 CEAP C1: Telangiectases and diffuse reticular veins



Fig. 14.2 CEAP C2: Varicose veins



Fig. 14.3 CEAP C3: Right lower limb edema associated with varicose veins



Fig. 14.4 CEAP C4: Hyperpigmentation and eczema



Fig. 14.5 CEAP C5: Healed ulcer in right medial malleolus



Fig. 14.6 CEAP C6: Granulated circumferential venous ulcer

Diagnosis

Chronic venous disease diagnosis is made by medical history and physical examination.

Common symptom is pain, reported by the patient as heaviness or cramps, being exacerbated by prolonged orthostatic position and relieved by lower limb elevation and bed rest [21].

The physician should also inquire about the period of evolution of the disease, the manner and intensity of progression, the influence of the weather, particularly in hot seasons, the use of estrogens and worsening in menstrual period, the number of pregnancies and the variations observed during this period and in puerperium, the occupation, as well as the posture at work, daily activities in general, with the estimated period of orthostatic, the frequency and type of physical exercises, the existence of varicose veins in the family.

At physical examination, the presence of tortuous and dilated veins must be noted, as well as telangiectasias, angiomatic formation, edema, and trophic skin alterations [21]. Lower limb pulses examination in patients with varicose veins is essential to exclude concomitant peripheral artery disease, which could change the treatment approach. Noninvasive tests like the lower limb venous duplex scan may be requested after the decision to make an intervention. They confirm the diagnosis and evaluate the etiology, whether primary or secondary, and the anatomy of the affected vessels. These tests will be better discussed in another chapter of this book.

Differential Diagnosis

Chronic venous disease manifestations can be confounded with other diseases.

Pain in the morning or just when the person takes the orthostatic position are probably not of venous origin; as well as pain at the lateral part of the thigh, which suggests nerve irritation. Pain at the knee joint, worsening after effort is typical of osteoarthritis and when located in inguinal region could be hip osteoarthritis, tendinitis, or nerve injury.

There are several systemic diseases that manifest with lower limb edema such as cardiac failure, nephrotic syndrome, liver disease, endocrine dysfunction, kidney failure, metastatic cancer, and autoimmune and inflammatory diseases. In addition, it could be considered as side effect of some medications such as calcium channel blockers, oral hypoglycemic agents, anti-inflammatory drugs, among others [21].

Deep vein thrombosis should be kept in mind if there is previous history of trauma, prolonged immobilization or major surgery. However, it should also be differentiate with: rupture of Baker's cyst, hematoma due to gastrocnemius muscle rupture, lymphedema, and erysipelas. In manifestations such as pigmentation and dermatosclerosis, the differential diagnosis should be made with dermatitis, myxedema, skin necrosis, and purpura [21].

Treatment

Clinical Treatment

Chronic venous disease initial treatment involves no interventionist action to control symptoms and improve the quality of life, as well as to prevent the development of secondary complications and disease progression. Lifestyle modifications, such as the practice of regular physical activity, intermittent elevation of the limb and weight loss should be encouraged. Compression therapy and occasionally pharmacotherapy could also be added as part of the clinical treatment.

If clinical treatment is insufficient, invasive treatment should be considered according to the anatomy and pathophysiology of the patient. Specific treatment is based on the disease's severity. Patients classified as CEAP C4 to C6 often require invasive treatment and early treatment of patients CEAP C3 could prevent disease progression to more advanced classes [23].

Compression Therapy

Compression therapy is an essential component in the treatment of patients with chronic venous disease. It promotes a graduated external compression of the leg to oppose the hydrostatic force of venous pressure that is main pathogenic factor of the disease. It also improves calf pump function, increasing the velocity of venous flow, with good effects on the microcirculation, improving the oxygenation of the skin and lymphatic circulation [23]. However, it is not efficient to prevent the disease progression [24].

External compression above 60 mmHg in patients in standing position causes the occlusion of limb vessels, which could harm the skin circulation. Therefore, this value is considered to be the safe upper limit for compression therapy [23].

Several compression methods are available: graduated compression stockings, Unna boot, elastic and nonelastic bandages, and intermittent pneumatic compression.

Graduated Compressive Stockings

Compressive stockings are designed to have the highest compressive pressure at the ankle. The compression progressively reduces from the ankle to one-third at the upper leg and a half at the thigh.

The socks are available in four scales: 15–20 mmHg, 20–30 mmHg (gentle compression), 30–40 mmHg (medium compression), 40–50 mmHg (high compression), and three lengths: 3/4 (below the knee), 7/8 (thigh), and pantyhose. Usually, the 3/4 stocking is sufficient to control the symptoms.

The appropriate stocking size is provided according to the patient's measures (thigh, calf, and ankle). Some obese patients or those with advanced chronic venous disease may require special size, and therefore it should be customized. The durability of the elastic stocking is 6–9 months, once the elasticity expires after that period [24].

Unna Boot

Unna boot is an artisanal preparation of a multilayer inelastic bandage for the lower limbs. The strips are impregnated with a paste consisting of zinc oxide,

glycerin, and gelatin. This bandaging allows movement of the ankle joint and the normal gait, helping the functioning of the calf muscle pump, preventing the occurrence of edema, improving the skin and subcutaneous microcirculation, which accelerates the healing of stasis ulcer [25]. Not every patient is well adapted to the Unna boot, and it has to be changed weekly by a health professional, which makes its use difficult for many patients. Furthermore, the Unna boot cannot be used in the presence of infection.

Elastic and Nonelastic Bandages

Compressive bandages are used in single or multiple layers for patients with advanced chronic venous disease. When applied, the pressure, the number of layers, the components, and the elastic properties of the material to be used should be considered. The bandage can be elastic and nonelastic. The main disadvantage of the nonelastic bandage is the loss of pressure when the limb loses its volume. Training in the bandage application is important once incorrect preparation can cause additional ulcers. The elastic bandage is easier to apply. It should be applied in order to have a higher pressure than the resting pressure. Drawbacks are some possible discomfort when using it and the possibility of ulcers, especially in bony prominences when adequate coverage is not applied [24].

Intermittent Pneumatic Compression

Pneumatic compression is a mechanical compression where an external force is applied by intermittent insufflation pneumatic boots. It can be used in the treatment of venous leg ulcers and lymphedema. The device is somewhat expensive, and therefore it may be a less accessible treatment for the general population [26].

Pharmacotherapy

Phlebotropic agents are drugs with venoactive properties, increasing venous tone and reducing capillary permeability. They have an anti-edema action by decreased capillary permeability, improved lymphatic drainage, venoconstriction, and anti-inflammatory action [27]. There are several classes of such drugs: flavonoids (γ -benzopyrones), coumarins (α -benzopyrones), saponosides (horse chestnut and extracts), among others. However, there is insufficient scientific evidence to prove their effectiveness in the treatment of chronic venous disease and stasis ulcer. It is suggested in present trials some efficacy in controlling edema and healing of venous ulcers, but further studies are still needed [28, 29]. Available trials in current literature must be interpreted cautiously since they are poorly reported and have an unclear risk of bias favoring the drugs [29].

Interventional Treatment

Sclerotherapy

Sclerotherapy is the injection of a chemical substance in the vein lumen, causing endothelial damage and consequently vein thrombosis and eventually fibrosis of the

vessel [30]. It can be used to treat veins with different calibers although it is normally used for telangiectasies and reticular veins treatment. There are several types of sclerosing agents, and they may be used in liquid form for the smaller veins and as foam for the larger ones. Sclerotherapy is used as a primary treatment or in conjunction with surgery to correct chronic venous disease [31].

Relative contraindications to sclerotherapy are: asthma, advanced diabetes complications, hypercoagulable state, leg edema, peripheral occlusive arterial disease, chronic renal failure. Absolute contraindications are: medicine allergy, cellulitis or other acute skin disease, acute respiratory disease, severe systemic disease, migratory phlebitis, acute superficial thrombophlebitis, pregnancy, hyperthyroidism, bedridden patients [32].

A common complication of sclerotherapy is skin hyperpigmentation by hemosiderin deposit. Such hyperpigmentation may be avoided by microthrombectomy in the thrombosed varicose vein to drain the clot causing less pain and inflammation by mini punctures [33]. Other complications are neoangiogenesis, injection pain, and itching after the procedure. Some rare complications include skin necrosis, thrombophlebitis, anaphylaxis, deep vein thrombosis, and pulmonary embolism.

Transdermal Laser and Intense Pulsed Light

Transdermal laser and intense pulsed light (IPL) are therapies that have arisen as a treatment option for spider veins and telangiectasies, in addition to sclerotherapy. They penetrate the skin to reach the vein to be treated without causing damage to it or to the surrounding tissues [34]. They are used for telangiectasies and reticular veins smaller than 3 mm [35, 36]. For each type of vein to be treated, it should be selected the wavelength, pulse duration, and beam diameter [37]. The action mechanism of these lasers is the light absorption by the hemoglobin. The absorbed light is converted into thermal energy which causes coagulation of the targeted vessel [38].

Indications for transdermal laser and intense pulsed light include smaller veins than a 30G needle, “matting” (vascular neof ormation), sclerosing resistant veins, and patients with needle phobia [39]. Contraindications are: pregnancy, hypertrophic scars or keloids, use of anticoagulants, tanned skin, and photosensitive diseases [38].

Complications are: transient rash, hyperpigmentation, hypopigmentation, “matting,” thrombosis, damage to the skin, skin burning, purpura, and local pain [38].

Surgical Treatment

Surgical treatment of lower limbs varicose veins is indicated in the presence of pain, aesthetic discomfort, or in the presence of disease complications such as superficial phlebitis, bleeding, lipodermatosclerosis, and ulcers (active or healed).

Traditional phlebectomy is invasive and painful. Today, we have the minimally invasive methods as an alternative: endovenous ablation with laser or radiofrequency and foam sclerotherapy. They offer the benefits of a faster recovery with less physical limitation, reduction of complications, and increased quality of life [40].

Surgical complications are: lesions in the femoral artery or vein, motor nerve and sensory nerve injury, deep vein thrombosis, infections, superficial phlebitis, and lymphedema.

Endovenous Ablation

Endovenous ablation uses thermal energy to obliterate the vein by laser or radiofrequency, leading to vessel thrombosis and eventually fibrosis. This technique is commonly used to the incompetent saphenous vein as an alternative to conventional stripping and to the tributaries as an alternative to conventional surgical phlebectomy [2]. The procedure is done guided by ultrasound under local or regional anesthesia in a procedure suite.

Complications such as paresthesia, rupture of the vein, superficial thrombophlebitis, deep venous thrombosis and pulmonary embolism, skin burn, infection, pigmentation, bruising, neovascularization, hemorrhage, and necrosis may occur although it is considered less invasive than conventional surgery [2].

Contraindications for the procedure includes: superficial or deep vein thrombosis, aneurysm, and ankle-brachial systolic pressure index lower than 0.9.

Radiofrequency Ablation

Radiofrequency ablation is a minimally invasive procedure that effectively treats venous reflux, with minimal discomfort to the patient and shorter recovery time, providing less time of work.

For its realization, it is used as catheter (“ClosureFAST”) [41] which has a bipolar 7 cm electrode at the tip, where the heat energy is dissipated. The catheter contact with the vein wall produces endothelium destruction and vein wall occlusion by collagen contraction and thrombus formation.

Endovenous Laser Ablation

Endovenous laser ablation has many similarities with radiofrequency, but there are some differences in the catheter and the ablation mechanism. The laser uses a fiber that dissipates thermal energy, generating heat and vapor bubbles that destroy the target vein endothelium. This creates an inflammatory reaction resulting in an effective thrombotic occlusion and eventually fibrosis.

Several wavelengths are used for endovenous laser: 810, 940, 980, 1064, 1319, 1320, and 1470 nm [42]. These wavelengths differ in the ability to absorb water and hemoglobin. Recent researches suggest that the various wavelengths are equally effective, but the greater length present with lower levels of pain and bruising.

Comparison Between the Methods

Ablation is compared to conventional surgery in effectiveness. However, in the conventional surgery group, more postoperative pain and bruising were observed. On the other hand, phlebitis and hyperpigmentation was higher in the thermal ablation

group [43]. Comparing laser and radiofrequency ablation, foam sclerotherapy and stripping for saphenous vein reflux treatment, the methods were similar in efficacy. However, the late results of foam sclerotherapy were more unfavorable, with higher rates of recanalization. Either in radiofrequency or in foam sclerotherapy method, the patient's recovery was faster compared to conventional surgery and laser [44].

Primary failure and disease recurrence comparing endovenous or radiofrequency laser ablation and conventional surgery had no significant statistical difference. However, intravenous ablation showed less bruising, lower rates of wound infection, less pain, and faster return to daily activities [45].

Patients with advanced CEAP class (C5 and C6) appear to have benefit from use of endovenous ablation. Radiofrequency and endolaser are preferably recommended to open surgery because they reduce convalescence and decrease morbidity and postoperative pain [2].

What the Generalist Can Do?

Inform the patient that the disease is benign. The practitioner should also recommend some physical activity, the use of gradient elastic stockings, and stimulate lifestyle modification and weight loss. Interventional treatment should be indicated in cases of pain or complications such as edema, lipodermatosclerosis, phlebitis, or ulcers.

When to Refer to the Expert?

The patient must be referred in cases of complications such as pain, edema, lipodermatosclerosis, phlebitis, and ulcers or if he wishes to be operated.

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