


Rehabilitation of patients with venous diseases of the lower limbs: State of the art

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Abstract

Background: To date, no document comprehensively focused on the complex issue of the rehabilitation of chronic venous diseases of the lower limbs.

Method: This article overviews and summarizes current strategies concerning venous rehabilitation of lower limbs.

Results: Venous rehabilitation is based on four main strategies: (1) lifestyle adaptations and occupational therapies; (2) physical therapies; (3) adapted physical activities; (4) psychological and social support. Rehabilitative protocols must be tailored to the specific needs of each patient, depending on the severity of chronic venous disease and on the location and pattern of venous lesion(s), but also on age, motor deficits, co-morbidities and psychosocial conditions.

Conclusions: Venous rehabilitation consists of non-pharmacologic and non-surgical interventions aiming at prevention of venous disease progression and complications, reduction of symptoms and improvement of quality of life. Well-designed clinical trials are required to evaluate the efficacy of the described rehabilitative protocols in influencing the evolution of venous disorders.

Keywords

Venous diseases, post-thrombotic syndrome, chronic venous insufficiency, chronic venous disease, calf muscle pump function

Introduction

Rehabilitation of patients with venous diseases of the lower limbs consists of all non-pharmacologic and non-surgical interventions aiming at prevention of venous disease progression and complications, reduction of symptoms, and improvement of quality of life (QoL).¹

With the exception of medical elastic compression stockings (MECS), physical therapies (PTs), and rehabilitative protocols are not or only partially mentioned in recent guidelines on chronic venous diseases (CVDs).² In turn, there is increasing evidence regarding the role of PTs in preventing disease progression and optimizing results of surgical and pharmacologic treatments.

This study aims to overview and summarize current strategies concerning rehabilitation of patients with venous diseases of the lower limbs.

Methods

To start the present study, a literature search was initially designed and conducted by A.C. in PubMed,

Embase, and the Cochrane Library between 1 January 1980 and 1 July 2017. Criteria for search and selection were the following headings and keywords: *Rehabilitation, Physical Therapy, Adapted Physical Activities, Sport, Hydrotherapy, Balneotherapy, Salus Per Aquam (SPA) and Venous Disease, Venous Insufficiency, Venous Ulcer, Varicose Veins, Post-Thrombotic Syndrome*. By reference checking and additional search by the Authors, other relevant literature was added.

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Unfortunately, studies available in literature largely focus only on patients with severe chronic venous insufficiency (CVI) (C5 and C6 legs, according to CEAP classification). Moreover, most studies are not corroborated by evidence-based analysis of results. For these reasons, all advices in the present document should be currently considered as “*best practice suggestions.*”

The need for a tailored rehabilitation approach

The rehabilitation approach must be tailored to the specific needs of each patient. In fact, it not only depends on the severity of CVD and on location and pattern of venous lesions but also on age, motor deficits, co-morbidities, and psychosocial conditions.

It is paramount to consider all co-morbidities potentially influencing venous return and to treat them whenever possible (obesity, cardiac or respiratory insufficiency, renal failure and metabolic disorders, neurologic, muscular or articular diseases and finally, cutaneous lesions). In particular, rehabilitative protocols must be designed taking into account the cardiorespiratory, skeletal, neuromuscular, and psychosocial limitations of each patient.

Obesity is the main comorbidity to be considered in patients with CVI.³ In fact, literature data show that CEAP clinical class is more advanced in obese than in non-obese patients with comparable severity of venous incompetence.³

Tools for rehabilitation

Rehabilitation of patients with CVD of the lower limbs is based on four main strategies: (1) lifestyle adaptations and occupational therapies; (2) PTs; (3) adapted physical activities (APAs); (4) psychosocial support (Table 1).

Lifestyle adaptations

All CVI patients should adapt their lifestyle according to the clinical severity of the disease.

The most frequent advice is to start wearing MECS during day time. The efficacy of MECS in chronic phases of venous diseases is unclear, due to the low quality of most of the studies.² The role of MECS in the prevention of post-thrombotic syndrome (PTS) is still debated.^{4,5} Nevertheless, MECS improve patients' symptoms⁶ and QoL.⁷ Moreover, there is a large body of evidence on the positive effect of MECS in promoting ulcer healing⁸ and preventing ulcer recurrence.⁹

In addition to MECS, other lifestyle changes may be advised, as listed in Table 2. These suggestions aim to improve the QoL by reducing venous stasis and related symptoms, but also possibly preventing complications and delaying disease progression.¹⁰ Even if only some of these advices are supported by evidence-based studies,¹¹ lifestyle changes and self-care strategies should be considered in all patients with venous disorders.

Table 1. Main strategies for the rehabilitation of patients with venous diseases.

Strategy	Recommended in	Objectives	Main tools
Lifestyle adaptations	All patients with venous disease	To reduce symptoms and improve the QoL. To possibly prevent complications, disease progression and recurrence	MECS Advices mentioned in Table 2
PTs	All patients showing impairment of the mechanisms facilitating venous return. All patients with comorbidities which negatively influence venous return	To obtain a persistent increase in efficacy of the mechanisms which facilitate venous return	Plantar correction Improve muscular efficiency Improve joints flexibility Gait reeducation Respiratory exercises Exercise mimetics Treatment of comorbidities
APAs and recreational sports	Poorly active patients, obese patients	To maintain and possibly improve the results of PT To possibly prevent complications, disease progression and recurrence	Supervised physical activity tele-rehabilitation (home activity) Hydrotherapy and SPA therapies
Psychological and/or social support	Patients with psychic and/or social problems	To obtain a better adherence to rehabilitative protocols (PT, APAs, elastic stockings, lifestyle advice) To improve the QoL	Increased measures of social interaction and support; psychotherapy

QoL: quality of life; MECS: medical elastic compression stockings; PTs: physical therapies; APAs: adapted physical activities; SPA: Salus Per Aquam.

Table 2. Main lifestyle changes and self-care for patients with venous disorders of the lower limbs.

- To walk frequently, especially during working days, preferably in the middle of the day or before/after work while always wearing MECS
- To rest with the legs elevated during breaks and whenever possible
- To raise the foot end of the bed 10–20 cm with blocks to obtain an angle of approximately 10°. This is not recommended for patients with cardiac or pulmonary failure, peripheral arterial disease and hiatal hernia
- To maintain skin moisture and prevent drying out and cracking of the skin
- To possibly use specially designed seats at work
- To take cold showers to counteract vasodilatation, especially in the warm season
- To wear appropriate clothing: loose clothes avoiding constrictions and favoring respiratory movements are to be preferred
- To wear comfortable shoes with low heels (<3 cm), supplied by insoles in case of foot dysmorphisms
- To avoid wearing high heels
- To avoid sunbathing
- To avoid sauna, hot thermal baths and mud baths

MECS: medical elastic compression stockings.

Table 3. The *vis a latere*: main venous pumps of the lower limb.

Site of pumping	Muscles	Movement	Compressed veins
Foot	Plantar muscles	Weight-bearing	Lateral plantar veins
Leg (lower half)	Anterior muscles	Dorsiflexion of the foot	Deep veins at the ankle and lower leg
Leg (anterior compartment)	Anterior muscles	Dorsiflexion of the foot	Deep veins of the antero-lateral compartment
Leg (posterior compartment)	Sural muscles	Plantar flexion of the foot	Sural veins
Popliteal fossa	Heads of the gastrocnemius	Contraction of the gastrocnemius	Popliteal vein (lower portion)
Anterior thigh	Sartorius	Flexion of the hip/extension of the knee	Femoral vein
	Quadriceps	Flexion of the hip/extension of the knee	Femoral vein
Posterior thigh	Hamstring	Flexion of the knee	Deep femoral vein
Buttock	Gluteal muscles	Extension of the hip	Gluteal veins

Note: Modified from Gardner and Fox. The return of blood to the heart.¹⁶

PTs in CVI patients

The aim of PTs is to obtain a persistent increase in the efficacy of the mechanisms facilitating venous return. Patients with severe CVI (C4–C6 legs, according to the CEAP classifications) or comorbidities influencing venous function, need to be considered for PTs.

The blood return from the lower limbs is guaranteed by three kinds of forces: (1) the *vis a tergo* (blood propulsion by residual capillary pressure), (2) the *vis a latere* (blood acceleration by muscular pumping), and finally, (3) the *vis a fronte* (thoraco-abdominal blood aspiration). PTs aim to increase the efficacy of all mechanisms involved in blood acceleration and aspiration.

Increasing the *vis a tergo*. The *vis a tergo* consists of the residual pressure of the blood at the end of the capillary bed. It was demonstrated that exercising enhances

microvascular endothelial function, resulting in increased venous flow,¹² even if exercises are performed with other parts of the body.^{13,14}

Accordingly, in order to increase the blood propulsion at the venular level, any kind of physical activity should be intensified and sedentary habits completely discouraged.

Increasing the *vis a latere*. The *vis a latere* consists of the blood acceleration due to the muscular contractions which squeeze intermuscular veins and intramuscular venous networks (muscular pumps). A coordinated chain of muscular pumps is sequentially activated during walking, respectively, the plantar, calf, thigh and gluteal pumps (Table 3).^{15,16}

In patients with severe CVI (C4–C6 classes), plantar loading, joint flexibility, and muscular efficiency are more impaired than in age-matched subjects. Hence, to increase the *vis a latere*, it may be necessary to

correct plantar abnormalities, to increase muscular efficiency, and joint mobility, as well as to optimize function and coordination of the different pumps.

The plantar pump. The role of the plantar pump in venous return is well established.^{17,18} It has been demonstrated that the hemodynamic effects of the plantar pump are quantitatively similar to those of the calf¹⁷ and that correction of plantar loading by insoles improves venous return and QoL with an efficiency that is almost equal to that provided by MECS.¹⁹ For all these reasons, the plantar loading must be routinely evaluated in all patients with CVI and possibly corrected.

Ankle rehabilitation. Mobility of the ankle joints is reduced in patients with CVI, in a greater proportion than in similarly aged subjects without venous disorders.^{20–22} The reduction of the ankle range-of-motion (aROM) correlates to the severity of the venous disease.²⁰ In limbs classified C4 and higher, this can be due to periostitis, calcification, and/or lipodermatosclerosis with subcutaneous and fascial fibrosis.²³

PT for ankle rehabilitation consists of passive and active movements of the ankle starting with non-weight-bearing exercises, moving to resistive exercises, and then weight-bearing activities.²⁴ Apart from these traditional physiotherapeutic treatments, ankle flexibility can also be enhanced by manual lymphatic drainage,²³ biomechanical stimulations,²⁵ and myofascial release.²⁶ Increasing aROM correlates to improvement of the calf pump efficiency.²⁷

The calf pump. The hemodynamic role of the calf pump in venous return is well established. In legs with severe venous disease, the calf pump is often dysfunctional and can lead to ulcer formation, delayed ulcer healing, and increased risk of ulcer recurrence.²⁶

Action of the calf pump: The mechanism of action of the calf pump is the alternate contraction of the extensor and flexor muscles of the leg during the gait. The contraction of the extensor muscles squeezes the deep veins of the lower leg (distal leg pump¹⁶) and of the anterolateral leg. The contraction of the flexor muscles squeezes the sinusoids of the sural veins and the deep veins of the posterior leg (upper leg pump¹⁶).

The efficacy of the calf pump depends on correct plantar loading, normal ankle mobility and, finally, muscular efficiency. Accordingly, besides static foot disorders and other skeletal anomalies, calf pump dysfunction may be related to abnormalities of muscle strength and endurance. Impaired muscular efficiency is due to age, disuse, and venous incompetence itself. In fact, the latter was recognized to possibly cause muscle atrophy^{28,29} and peripheral neuropathy.³⁰

Improving calf pump function: It has been clearly demonstrated that calf exercise regimens improve muscular endurance³¹ and may even restore proper function of the muscle pump with increased ejection fraction (EF) and reduced residual fraction (RF).³¹ Rehabilitation of the calf pump mainly consists of exercises of dorsal and plantar foot flexion with increasing load. These can be performed according to different protocols. Individually tailored physio-therapeutic exercises may include a mix of stretching the muscles and repeated contractions and relaxations. Besides improving EF and diminishing RF, these exercises also improve aROM.

Alternatively, calf pump efficiency can also be improved by exercise mimetics:

Foot movers: are specially designed training machines by which patients can exercise in a seated or a reclining position. The use of foot exercisers is included in most rehabilitation programs.^{32,33} However, no study evaluated the long-term adherence to the use of foot exercisers.

Artificial muscle activation: Rhythmic muscle activity can be achieved by transcutaneous muscle³⁴ or nerve stimulation.³⁵ The efficacy of these devices has been demonstrated to increase venous flow and prevent venous stasis,³⁶ especially if used in conjunction with MECS.³⁷

Intermittent pneumatic compression (IPC) was demonstrated to prevent deep vein thrombosis in subjects at risk, as well as to increase ulcer healing.³⁸ No data are available concerning the effectiveness of IPC in chronic phases of venous diseases. As an example, no benefit was seen to accrue if IPC was used as an adjuvant therapy to aid prevention of ulcer recurrence.³⁹ However, it was recently proposed to use intermittent compression devices or pneumatic compression sleeve units in patients with severe PTS whose symptoms are inadequately addressed with MECS alone.²

Gait re-education. A disturbed gait is typical for patients with severe CVI, especially for older ones.⁴⁰ Apart from other neuromuscular dysfunctions typical for patients with venous diseases of the lower limbs,^{28–30} a deficit in proprioception may be responsible for gait alterations.⁴¹ Gait re-education may significantly increase the efficacy of the plantar and leg pumps^{39,41} by promoting heel-to-toe gait pattern and discouraging the shuffling gait.

The goal of gait re-education is to regain the correct sequence of weight bearing on the calcaneus (emptying of the veins of the lower leg and of the anterior muscular compartment), weight bearing on the mid-foot

(emptying the plantar reservoir), and weight bearing on the anterior foot (emptying the veins of the calf).

The gait must be evaluated in all patients with venous disorders, and re-education can be prescribed in those showing abnormality of the physiologic sequence of foot, calf, and thigh motions during walking.⁴⁰

Once expelled from the leg, the blood is further propelled by the popliteal, thigh (anterior and posterior), and gluteal pumps¹⁷ (Table 3). Very few studies on venous rehabilitation considered the role of these pumps. Gait re-education contributes to improving the efficiency of these pumps and coordinating their sequential activation.

Increasing the vis a fronte. The *vis a fronte* consists of the thoraco-abdominal blood aspiration from the lower limbs. Valsalva described in 1710 the blood aspiration activated by respiratory variations of intra-thoracic pressure. Franklin and Janker⁴² described the blood aspiration from the inferior vena cava due to variation of the intrabdominal pressure as well as by spinal movements related to spine flexion-extension and rotation. Even if thoracoabdominal aspiration has been considered predominant over lower extremity muscle pumping in venous return,⁴³ few protocols on venous rehabilitation include the necessity of specific respiratory exercises.

Development and implementation of respiratory exercise protocols for improving the venous return should therefore be further investigated.

APAs

Patients with severe CVI are less mobile and physically active than age-matched counterparts and only about 30% of them perform exercises regularly.⁴⁴ In all these cases, programs of supervised exercises efficiently supplement daily physical activities.⁴⁵

APAs can also be indicated in patients who received PT to maintain (and possibly improve) the results of the treatment and to prevent recurrences.

The goal of APAs is to increase the strength of muscles and the mobility of joints involved in the above described pumping mechanisms. APAs consist of physical or sports activities adapted to the capabilities of each patient, his/her preference, and potential co-morbidities. APA protocols are currently based on daily intensification of any kind of physical activity, structured aerobic exercises, structured resistance exercises, and flexibility exercises.

APAs can be performed in different settings, depending upon clinical severity and co-morbidities. Outpatients may follow rehabilitative APAs under the supervision of caregivers in the hospital setting or

outside the hospital. APAs may be performed also at home.⁴⁵ In the latter case, online coaching and remote-control instruments (tele-rehabilitation) are now available to promote the adherence to therapeutic protocols.⁴⁵

Short- and long-term APA programs of rehabilitation (from one week to six months) demonstrated positive results in terms of calf muscle pump function and reduction of symptoms.⁴⁶

However, to date, no study established the effectiveness in preventing worsening and complications of CVI.^{46,47} Moreover, the adherence to physical activity programs is rather limited; in patients with venous ulceration, it appeared to be only about 40%.⁴⁴

Sports activities in patients with CVI. No evidence-based studies have been carried out on the positive or negative effects of sports in patients with CVI. Only anecdotal contributions are available.¹⁰ Appropriate sports are those which associate rhythmic movements of the muscles and joints of the lower limbs and deep breathing: walking, running, swimming, water aerobics, cross-country skiing (in contrast to downhill skiing), golf, and dancing.¹⁰

Inappropriate sports activities are those which involve increasing the intra-abdominal pressure (weightlifting), blockage of the ankle joint (downhill skiing), and rapid increase of the pressure of the blood column on venous valves (tennis, ball games). Violent sports are discouraged as well, due to the risks for leg trauma.¹⁰

Physicians often encourage sedentary patients to train regularly and even participate in sports competitions. However, an excessive practice of some sports (e.g. long-distance running and cycling) may be inappropriate in patients with venous diseases, if not supported with proper MECS. In addition, exaggerated sports activity might even induce varicose changes or enhance pre-existing ones.⁴⁸

It is still debated if “elastic sports stockings” are effective in increasing sports performance in healthy individuals. It seems that elastic stockings have a positive effect on muscle recovery associated to a greater comfort.⁴⁹ Even if no study has scientifically evaluated the protective role of elastic stockings in athletes with venous diseases of the lower limbs, the use of elastic stockings by venous patients also during sports activities may be included in lifestyle suggestions.

Hydrotherapy and SPA therapies. Hydrotherapy has a long tradition in Europe for the treatment of vein diseases.⁵⁰ Hydromassotherapy and vascular pathways are associated with immersion in sulfurous, sulfate, salsojoidic, salsobromojoidic waters. Specific exercises have been

designed to be performed in the water by patients with venous diseases of the lower limbs.⁵¹

The positive effects are related to specific properties of immersion in water due to hydrostatic pressure, osmotic pressure, and temperature (balneotherapy) and partly related to specific chemical properties of the water (crenotherapy).^{50,52–54}

The efficacy of hydrotherapy is based almost purely on empiricism. No study has scientifically demonstrated the biological effects of particular components of water on venous return.

SPA sessions are usually performed in thermal resorts which allow a comprehensive approach to venous diseases.⁵⁴ In fact, apart from hydrotherapy, in the SPA resorts, venous patients may undergo intensive PT and APA programs, diet, and social activities.⁵⁴

A few studies have evaluated the effects of combined therapies performed during thermal cures. These improve QoL as well as venous symptoms.^{50–54} No study has compared the effects of the same protocols performed during thermal cures or in other circumstances.

Psychosocial support

The relationships between venous disease and psychosocial factors have been evaluated only in subjects afflicted with severe CVI. It has been demonstrated that approximately one-third of patients with C5–C6 disease can be considered “at-risk” of depression.⁵⁵ Moreover, the presence of venous leg ulcers is significantly associated with being single, low self-efficacy levels,⁵⁵ and receiving poorer levels of social support.⁵⁶

Psychosocial measures are significantly associated with a reduced rate of ulcer recurrence.^{55,56} In addition to a direct effect on the immune system and normal healing processes, this can also be due to the impact on self-care and physical activities as well as to better adherence to compression therapy.^{57,58} The strong and statistically significant relationship between social support and recurrence highlights the necessity of increased measures of social interaction in patients with severe CVI.⁵⁵

Measures of psychologic support and social interaction may be necessary in selected patients with CVI, to influence the level of physical activity and self-management, thus allowing a greater adherence to treatments (especially to the use of MECS).^{57,59}

Discussion

This document is the first to present a comprehensive overview of all aspects of rehabilitation for patients with venous diseases of the lower limbs. An exact definition of “venous rehabilitation” is also reported.

Table 4. The “Decalogue” of venous rehabilitation: main diagnostic and therapeutic steps of venous rehabilitation.

To evaluate	To prescribe
- Body mass index	- Proper nutrition, APAs, sport activity
- Plantar load	- Plantar abnormalities correction
- Ankle ROM	- Specific PT protocols
- Muscle efficiency	- Specific PT protocols
- Gait analysis	- Gait re-education
- Respiratory dynamics	- Respiratory gymnastic
- Comorbidities	- Specific treatment, if possible
- Sport activity	- Appropriate sports, elastic stockings
- Sedentarism	- APAs, sports activities
- Psychosocial conditions	- Psychic, social, and occupational supports

ROM: range of motion; PT: physical therapy; APAs: adapted physical activities.

The main target of rehabilitation is to prevent disease progression and complications as well as to improve QoL. A holistic approach to venous patients seems indicated, not limited to medical or surgical interventions, but including any form of intervention which may enhance venous return. Venous rehabilitation implies improvement of daily lifestyle and self-care strategies including compression therapy, as well as the adherence to physical rehabilitative protocols.

It is not possible to propose a standard rehabilitative protocol with more details than those in Table 4. The main reason is that strategies should be individualized according to the severity of the disease, the location and pattern of venous lesion(s), age, motor disabilities, comorbidities, and psychosocial conditions of each patient. The second reason is related to the high costs of the rehabilitative protocols (especially PT, AFA, and SPA) and the marked geographic differences regarding their reimbursement and availability.

Beyond cost implications, the main cause of the poor adherence to rehabilitative protocols is the lack of information from caregivers.⁴⁴ This lack is probably due to the absence of any reference to rehabilitation in studies evaluating the outcome of medical or surgical procedures as well as in most guidelines.

It must be taken into the right account that the majority of studies on rehabilitation of patients with venous diseases of the lower limbs lack scientific evidence. In fact, many investigations demonstrated the efficacy of single rehabilitative tools (e.g. calf exercises) on single components of the venous return (e.g. calf pump) but failed to prove objective benefits in clinical terms (e.g. prevention of ulcer formation and recurrence, reduced rate of recurrent thrombosis,

or deterioration of PTS). The protocols developed so far need to be discussed and refined by further evidence-based investigations.⁶⁰ In particular, well-designed randomized controlled trials are required to evaluate the efficacy of the described rehabilitative protocols in influencing the long-term evolution of CVI. On the other hand, it seems desirable that studies evaluating the efficacy of any pharmacologic or surgical treatment consider the prescription and the adherence to rehabilitative protocols, in most cases limited to MECS.

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AC made a substantial contribution to the concept and design of the work, acquisition of data. AC, MdM, AtC, NM, GM drafted the article and revised it critically for important intellectual content. AC, MdM, AtC, NM, GM approved the version to be published. Each author has participated sufficiently in the work to take public responsibility for appropriate portions of the content.

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