A short review of diagnosis and compression therapy of chronic venous insufficiency

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ABSTRACT

Introduction: Chronic venous insufficiency (CVI) is a venous disorder in the lower extremities associated with changes in the skin and subcutaneous tissue. Treatment with short-stretch compression bandages is highly recommended for advanced stages of CVI.

Methods: The compression systems Rosidal® Sys, Porelast®, Coban™, and Proguide™ were evaluated in 4 groups of mobile and active patients (n = 18) with CVI stage II or III. Sub-bandage pressures at point B1 were measured in the upright and supine positions 30 min and 12 h after the bandage was applied. Average pressures and values of the static stiffness index (SSI) were calculated for each group.

Results: The Porelast®, Rosidal® Sys and Coban™ systems had SSI values in excess of 10 mmHg, 30 min and 12 h after application. The corresponding values for Proguide™ were below 10 mmHg.

Conclusion: Porelast®, Rosidal® Sys and Coban™ are very stiff systems, whereas Proguide™ is more similar to long-stretch compression bandages with a lower degree of stiffness.

KEY WORDS

chronic venous insufficiency, compression therapy

Clinical picture and diagnosis

Chronic venous insufficiency (CVI) of the lower extremities is an important socioeconomic problem in developed societies because of its high prevalence, leading to altered quality of life, high treatment costs, and disability payments (1). Due to chronic damage to the venous pumping function, lesions of the skin and often of the subcutaneous tissues may occur (2). Genetic and environmental factors play important roles in the development of CVI (3). The influence of inheritance has not been fully explained, but it is known that, in 85% of persons with varicose veins, signs of CVI are also present in other family members (4).

Leg edema and skin changes develop as a consequence of elevated venous pressure that does not decline to normal levels during walking despite the action of the calf muscle pump. The most frequent cause is improperly functioning venous valves, resulting in a retrograde flow of blood (reflux). Less frequently, CVI develops as a result of proximal venous obstruction. Primary varicose veins arise due to inherent defects of

Table 1. Important differences between short- and long-stretch bandages.

Criterion	Long-stretch bandages	Short-stretch bandages
Extensibility	Over 100%	10% to 100%
Stiffness (SSI)	Under 10	Above 10
Sub-bandage pressures at rest	High	Low
Sub-bandage pressures during exercise	High	Very high
Application	Patient	Experienced person
Bandage can remain in place several days	No	Yes

venous walls and/or valves, whereas secondary varicose veins are mostly caused by deep venous thrombosis (DVT). Varicose veins develop mainly as a result of genetic anomalies of the venous system (1, 5). According to data in the literature, 20 to 38% of venous leg ulcers occur as a consequence of post-thrombotic syndrome following DVT (6, 7).

CVI is manifested clinically by leg edema, stasis dermatitis, hyperpigmentation of the skin, lipodermatosclerosis, atrophie blanche, and ulceration. Subjective symptoms of CVI include heavy, tired legs, cramps, and pain (8). Patients in Widmer's Stage II of CVI have varicose veins, hypostatic dermatitis, lipodermatosclerosis, and atrophie blanche. If ulceration is present or has healed, the patient is classified as Stage III. Early detection and treatment of CVI prevents deterioration, complications, and progression of the disease (9). In addition to a detailed history and clinical examination, continuous wave ultrasound (CW Doppler) is usually sufficient for detection of reflux at major junctions (saphenofemoral and saphenopopliteal). However, for accurate tracing of reflux and detection of all insufficient superficial and deep veins, duplex investigation combining Doppler flux-assessment with an ultrasound B-scan is necessary. Duplex examination has almost completely replaced plethysmography, which provides global quantitative functional assessment of the superficial and deep venous system. Phlebography is another investigation that can be used to localize reflux or obstruction, providing mainly morphological assessment of the disorder. It is rarely used today because of its invasive nature (10).

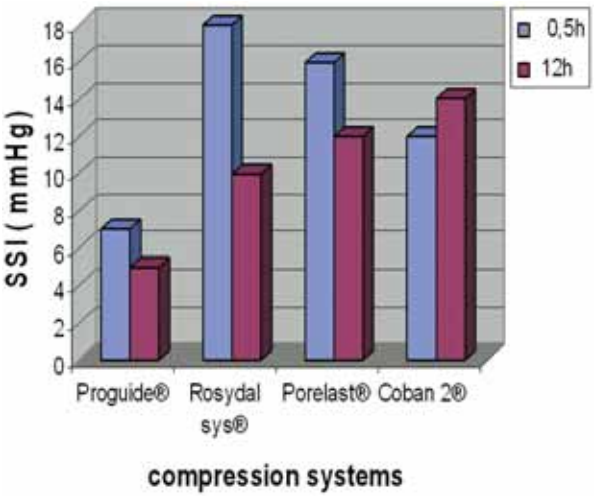

Figure 1. Static stiffness index (SSI) data for 4 compression systems 30 min and 12 h after application.

Compression therapy in CVI

Compression therapy and venotonic drugs are recommended at all stages of CVI (11). Considering the underlying venous pathology, sclerotherapy and phlebectomy may be used to treat incompetent subcutaneous or even truncal veins, laser therapy for telangiectasias, and endoluminal techniques (laser, radiofrequency ablation) or surgical stripping for incompetent saphenous veins (12).

If chronic venous insufficiency is not diagnosed and treated at an early stage, lesions of the skin and subcutaneous tissue progress, leading to stasis dermatitis, atrophie blanche, lipodermatosclerosis, and, finally, venous ulceration. In advanced stages of CVI, treatment with short-stretch compression bandages is highly recommended (13).

A distinction is made between short-stretch (extensibility 10% to 100%) and long-stretch (extensibility > 100%) compression materials according to the degree of extensibility (the bandage's ability to stretch when force is applied). Short-stretch materials generate very high sub-bandage pressures during exercise due to muscle contraction and the stiffness of the material, and maintain low pressures during rest due to their low elasticity. By contrast, long-stretch bandages exert moderately high pressures, which are almost the same at rest and during walking and are unaffected by changes in calf circumference, such as changes due to a decrease in edema (14). The differences between long-stretch and short-stretch elastic bandages are given in Table 1.

The force needed to stretch an elastic bandage to a certain length and produce a certain amount of pres-

sure depends on the strength of the material. The elasticity of the bandage is described as its ability to resume its original length when tension is reduced (15). Sub-bandage pressures depend on the tension of the bandage, the number of layers applied, and the curvature of the limb. The relationship between pressure and curvature is expressed by Laplace's law (16):

$$P \sim T / R$$

P = pressure under the bandage,
T = tension,
R = radius of the limb

The tension in a bandage is proportional to the force used when the bandage is applied. How long a bandage is able to sustain a particular degree of tension is determined by the strength of application and its elasticity, and this in turn is a function of the composition of the yarn and the production method (15).

Stiffness is a measure of how the pressures under the bandage change during walking. It can be clinically assessed using the static stiffness index (SSI), which is the difference in pressure between active standing and lying (17).

Static stiffness index (SSI) = [sub-bandage pressures (standing)] - [sub-bandage pressures (supine)]

Short-stretch bandages have greater stiffness than long-stretch bandages. Compression systems made up of multiple layers of long-stretch material are stiffer than single-layered long-stretch bandage because of the force of friction acting between the layers. Values are measured using pressure transducers positioned in the medial gaiter area; SSI values above 10 indicate a high level of stiffness (17, 18).

This study measured sub-bandage pressures and stiffness in 4 commonly used short-stretch bandages in order to select the bandage providing the most efficacious action in the treatment of advanced CVI.

Patients and methods

We retrospectively analyzed clinical data on 18 patients that were treated with four different compression systems from 2005 to 2006. They all had CVI stage II or III, and peripheral arterial occlusive disease was excluded. Before the start of sub-bandage pressure measurements, the patients were informed of the purpose of the measurements and gave their informed consent for the procedure.

Proguide™ (Smith-Nephew, UK), a two-component adhesive compression system, Rosidal® Sys (Lohmann & Rauscher, Germany), a short-stretch non-adhesive system, Porelast® (Lohmann & Rauscher, Germany), a short-stretch adhesive system, and the Coban™ 2-layer system (3M, USA), a two-component short-stretch adhesive system, were applied to 4 groups of patients: Group 1 (Proguide™): 1 male, 3 females, average age 65; Group 2 (Rosidal® Sys): 2 males, 2 females, average age 70; Group 3 (Porelast®): 2 males, 4 females, average age 75; and Group 4 (Coban™ 2-layer): 1 male, 3 females, average age 68. Sub-bandage pressures were measured with a Kikuhime measuring device (Medi-Trade, Soro, Denmark) that is used for clinical, non-invasive assessment of compression therapy (17). The dimension of the pressure transducer was 10 cm. The measurements were performed at point B1 (on the medial aspect of the leg, 12 cm above the ankle), 30 min and 12 h after bandage application in the upright and supine positions.

Results

Table 2 shows average sub-bandage pressures ±SD in the upright and supine positions 30 min and 12 h after bandage application. The mean pressure drop (%) is only a guide to the volume reduction of the limb. SSI values 30 min and 12 h after bandage application were calculated from the average pressures. These are shown in Figure 1.

Discussion

The goal of compression therapy is to influence different structures of the lower extremities. Dilatation of the superficial venous system associated with supra-fascial edema is treated by moderate-level pressures effectively produced by long-stretch compression systems. When edema extends below the fascia (i.e., lymphedema, phlebolymphedema), or lipodermatosclerosis is present, higher sub-bandage pressures are needed for effective treatment. Such pressures are generated by short-stretch compression systems, which are usually very stiff. Our measurements showed that Porelast®, Rosidal® Sys, and Coban™ are very stiff systems with SSI values above 10 mmHg throughout the evaluation period. The Proguide™ system was found to have lower stiffness, with SSI values below 10 mmHg (Figure 1). Measurements taken in a standing position 12 h after bandage application showed a smaller decline in pressure from the initial values for the Proguide™ and Coban™ systems compared to Porelast® and Rosidal® Sys. The slower decline in pressures under Proguide™ and Coban™ bandages can be explained by the greater elasticity of these materials compared to the other two systems. Among the high-stiffness systems, Rosidal® Sys showed the greatest decrease in sub-bandage pressures 12 h after application in the standing position. The advantage of this system is that the

Table 2. Average sub-bandage pressures with the standard deviations for all four compression systems 30 min and 12 h after application in the upright and supine positions, and mean pressure drop in 12 h.

	Proguide™*n* = 4	**Rosidal® Sys*n* = 4**	**Porelast®*n* = 6**	**Coban™*n* = 4**
Upright 0.5 h	38 ± 3.8 mmHg	54 ± 2.6 mmHg	54 ± 7.8 mmHg	51 ± 7.2 mmHg
Upright 12 h	29 ± 3.2 mmHg	22 ± 2.0 mmHg	35 ± 2.5 mmHg	39 ± 4.3 mmHg
Mean pressure drop %	29%	59%	35%	24%
Supine 0.5 h	31 ± 5.9 mmHg	36 ±4.4 mmHg	38 ± 2.1 mmHg	39 ± 7.9 mmHg
Supine 12 h	24 ± 2.5 mmHg	12 ± 2.3 mmHg	23 ± 1.2 mmHg	25 ± 7.5 mmHg
Mean pressure drop %	23%	67%	39%	36%

bandages may be used for 2 to 3 months and are suitable for repeated application, whereas the other three systems evaluated use disposable materials.

Mean pressure drop (%) can be a measure of the therapeutically intended volume reduction of the limb. In our study, the best therapeutically intended volume reduction of the limb was achieved using the Rosidal® Sys compressive system (Table 2).

Conclusion

Early detection and treatment of CVI is important for preventing disease progression and development of various complications. Compression therapy is needed at all stages of CVI. Short-stretch compression systems are suitable for advanced forms of disease associated with cutaneous changes and ulceration. Our observations in four compression systems over a period of 12 h following bandage application showed that the adhesive short-stretch systems Porelast® and Coban2™ and the non-adhesive short-stretch system Rosidal® Sys are very stiff, whereas the adhesive short-stretch system Proguide™ displayed a lower level of stiffness. The best volume reduction of the limb was achieved with the Rosidal® Sys compressive system.

Acknowledgements

The authors would like to thank Hugo Partsch, MD (Department of Dermatology, Medical University of Vienna, Austria) for his valuable suggestions during the preparation of the manuscript. The authors had no financial interest in this study.

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