
Evaluation of Therapeutic Compression Stockings in the Treatment of Chronic Venous Insufficiency

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BACKGROUND. Chronic venous insufficiency (CVI) affects a significant portion of the world's population, causing substantial morbidity and medical expenditure. Its pathophysiology is based on venous hypertension in the lower extremities, with vascular compression therapy remaining the foundation of its medical management.

OBJECTIVE. To evaluate the effectiveness of therapeutic compression stockings in the treatment of lower extremity CVI.

METHODS. A group of 112 patients with CVI received graduated-compression stockings and rated the severity of their symptoms on a five-point scale before wearing the stockings,

and then again after 1 and 16 months of treatment. Patient complaints associated with stocking use and patient compliance rates were also recorded at 1 and 16 months.

RESULTS. A statistically significant improvement ($p < 0.001$) was reported in patient severity scores for lower extremity swelling, pain, skin discoloration, activity tolerance, depression and sleeping problems after 1 and 16 months of treatment with compression stockings.

CONCLUSION. Therapeutic graduated-compression stockings are an effective treatment for CVI of the lower extremities.

CHRONIC VENOUS INSUFFICIENCY (CVI) is a widespread and debilitating disease estimated to affect 10 to 15 million Americans, resulting in the loss of more than two million work-days annually.^{1,2} Its chronic nature incurs a large socioeconomic impact in many countries, including a direct annual contribution to health care spending estimated to be \$1.3 billion in Germany, \$354 million in Italy, and \$2.4 billion in France.³⁻¹⁰

The pathophysiologic basis of CVI is venous hypertension in the lower extremities where the calf-muscle pump acts as the natural safeguard against its development.¹¹ Physiologically, the calf-muscle pump works by contracting around the exterior of thin-walled veins in order to force the blood inside into motion.^{12,13} The pump cannot, however, determine the direction in which the blood will flow. This is achieved by the presence of one-way valves within the veins that allow the flow of blood only proximally out of the legs. Failure or incompetence of these valves leads to decreased calf-muscle pump efficiency and the eventual development of lower extremity venous hypertension.¹⁴ Varicose veins are the visible result of this process, and a vicious cycle can result in which in-

creasing venous distension promotes increasing valvular incompetence.¹⁵⁻¹⁷ Ultimately, the syndrome of CVI can develop with signs and symptoms that can vary from leg swelling and aching to skin hyperpigmentation, fibrosis, and open ulceration.¹⁸⁻²¹

The complexity of different clinical manifestations, etiologies, areas of anatomic involvement, and pathophysiology found in CVI patients highlighted the need for a classification system that could aid in unifying its diagnosis and treatment. Therefore, the CEAP classification system was developed for CVI during the 1994 American Venous Forum as follows: clinical manifestations (C), etiologic factors (E), anatomic distribution of involvement (A), and underlying pathophysiology (P).^{22,23} It is hoped that this or a similar system may eventually be established worldwide in order to facilitate the interinstitutional study of CVI and the scientific analysis of its management alternatives.

For centuries, compression therapy in various forms has remained the mainstay of treatment for patients with CVI.^{24,25} The purpose of this study was to assess, based on patient self-evaluation, the effectiveness of the therapeutic graduated-compression stocking in the treatment and management of chronic venous insufficiency.

Materials and Methods

After receiving institutional review board approval and obtaining informed consent from patients, a group of

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128 patients with CVI from the Glenbrook and Evanston Hospitals in Illinois, were eligible for admittance into the study. At the time of the initial interview, all patients were asked to disclose their medical history and prior treatments for CVI. Patients who were currently wearing compression stockings were excluded from the study (16 patients). Therefore, a total of 112 patients were admitted to the study, including 95 female and 17 male subjects, with a mean age of 46.8 years (range 27–85 years). Of the patients included in the study, 85% (95/112) had no prior CVI treatment or varicose vein surgery. Of those patients with prior CVI treatment, 10% (11/112) had prior venous sclerotherapy, and 5% (6/112) had undergone a previous varicose vein stripping procedure.

After the initial interview, patients underwent venous duplex scanning of their lower extremities in order to determine the anatomic distribution of involvement and underlying pathophysiology of their CVI. The results of the duplex scans were then combined with the clinical manifestations and etiologic factors involved in each case of CVI in order to categorize the patients into the CEAP classification system (Table 1).

At the start of the study, all patients were instructed to wear 30–40 mmHg compression stockings (MEDIVEN, MediUSA, Arlington Heights, IL) of varying lengths (36% thigh length, 17% mid-thigh length, 47% knee or calf length) for the duration of the study. The patients' stockings were replaced as needed in order to prevent the deterioration of the stockings during the study, and patients with unilateral lower ex-

trinity CVI were instructed to wear compression stockings only on the affected limb.

In order to objectively evaluate the degree of symptoms in each patient, a questionnaire with a five-point scale (1 = minimal problem, 5 = maximal problem) was used to quantify the symptoms of swelling, pain, skin discoloration, cosmetic problems, activity tolerance, depression, and sleep problems caused by the disease (Appendix A). The term "pain" was used to indicate leg discomfort while walking or standing for long periods of time, whereas "activity tolerance" was used to indicate the degree to which leg pain or tiredness affected a given patient's ability to walk or exercise. "Discoloration" was a term used to describe pigment changes in the skin due to long-term blood stasis. "Cosmetic problems" was used to indicate the overall appearance of the leg, including lipodermatosclerosis, visible varicosities, ulceration, or gross swelling of the limb. "Depression" was a term used to reflect the level to which a patient was upset about the appearance of his or her legs, and "sleep problems" was used to indicate the level to which nighttime leg cramping or aching interfered with a patient's usual sleep routine.

All of the symptoms were rated by the patients before wearing the stockings, and then again after 1 and 16 months of treatment. In the 1 and 16 month follow-up questionnaires, the patients were also asked to rate any new numbness, sweating, itching, or pain caused by wearing the stockings (Appendix B). Patient compliance was measured after each follow-up, and the final results were analyzed using the Wilcoxon Signed Rank test.

Table 1. CEAP Classification Results for All 112 Patients

	Percent of Patients
Clinical Classification	
No visible signs	6%
Telangiectasias	32%
Varicose veins	82%
Edema	52%
Pigmentation	44%
Healed ulcer	5%
Active ulcer	2%
Etiologic Classification	
Congenital	0%
Primary	85%
Secondary	15%
Anatomic Classification	
Superficial veins	92%
Deep veins	35%
Perforating veins	19%
Pathophysiologic Classification	
Reflux	98%
Obstructive	12%
Both	22%

Results

At 1 month, patients reported a significant reduction ($p < 0.001$) in their severity scores for swelling, pain, skin discoloration, depression, sleeping problems and cosmetic problems, with a significant increase in activity tolerance (Table 2). Regarding tolerance to the stockings, the mean severity score reported for each complaint category was 1.41 for numbness, 1.45 for sweating, 1.40 for itching, and 1.44 for new pain (Table 3). After one month of treatment, 92/112 (82%) of the patients reported that they were still wearing their compression stockings.

After 16 months of treatment, a further significant reduction ($p < 0.001$) was again noted between the 1 and 16 month severity scores for the symptoms of swelling, pain, skin discoloration, depression, sleeping problems, and cosmetic problems, with a significant increase in activity tolerance (Table 2). The mean severity score for each patient complaint decreased to 1.20 for numbness, 1.23 for sweating, 1.14 for itching, and 1.12 for new pain (Table 3). After 16 months for treatment,

Table 2. The Mean Value of Symptom Severity Scores Reported by Patients Initially, and after 1 and 16 Months of Treatment with Compression Stockings

	Initial	One Month*	16 Months**
Swelling	2.45 (1.25)	1.47 (0.83)	1.13 (0.51)
Pain	2.94 (1.29)	1.77 (1.09)	1.38 (0.69)
Discoloration	2.76 (1.29)	2.23 (1.22)	1.81 (0.99)
Cosmetic problems	3.03 (1.41)	2.50 (1.41)	1.98 (0.99)
Activity tolerance	2.33 (1.35)	1.71 (1.19)	1.38 (0.73)
Depression	1.72 (1.12)	1.42 (0.87)	1.29 (0.81)
Sleep problems	2.00 (1.25)	1.46 (0.99)	1.24 (0.63)

* $p < 0.001$ for comparison between initial and 1 month severity scores across all categories.

** $p < 0.001$ for comparison between 1 and 16 month severity scores across all categories.

Statistical analysis via the Wilcoxon Signed Rank Test.

Numbers in parentheses are SD.

78/112 (70%) of the patients reported that they were still wearing their compression stockings.

Discussion

Chronic venous insufficiency is a recalcitrant medical problem that afflicts millions of people around the world, causing substantial morbidity and medical expenditure.^{26,27} Since the pathophysiologic basis of CVI is venous hypertension in the lower extremities, compression therapy has remained the mainstay of treatment based on the understanding that it helps to relieve symptoms of CVI by improving venous function.^{28,29} In fact, external compression therapy has been used in the treatment of venous disease since the time of Hippocrates,³⁰ and in 1931 Wright showed its first successful use in the treatment of CVI.³¹ Since then, numerous different types of vascular compression therapy have been introduced, ranging from simple wraps with uniform compression to the modern day elastic stocking that provides graduated pressure from the distal to the proximal portion of the leg.³² This "graduated" compression stocking is believed to have the most effective design due to its ability to enhance calf-muscle pump function, and thereby increase venous blood flow proximally out of the legs.³³ In this study, the graduated-compression stocking proved to be effective in significantly reducing the symptoms of CVI over an extended period of time. In addition, by

Table 3. The Mean Severity Score of Patients' Complaints after 1 and 16 Months of Treatment with Compression Stockings

	1 Month	16 Months
Numbness	1.41 (1.20)	1.20 (0.92)
Sweating	1.45 (1.00)	1.23 (0.83)
Itchiness	1.40 (0.97)	1.14 (0.78)
New pain	1.44 (1.20)	1.12 (0.80)

comparing the CEAP classification results (Table 1) with the significant improvement in patient symptoms (Table 2), it is clear that compression therapy can be effective for the treatment of CVI across disease severity.

Another important dimension of CVI that must be mentioned is that it can considerably reduce the quality of life (QOL) of patients.³⁴ In fact, for many patients the pain and discomfort caused by venous disease can mean the loss of physical mobility, reduced work capacity, and impairment of social life.³⁵⁻³⁷ These dimensions are particularly relevant because they reflect the impact of the disease according to the patient's own perception. Therefore, it is unfortunate that most severity scales for venous disease are currently based exclusively on clinical pictures and lack data on the multidimensional impact of the disease.³⁸ In this study, however, it was possible to evaluate the severity of venous disease in terms of outcomes relevant to QOL issues through the use of a patient self-evaluation questionnaire. These types of questionnaires have already been shown to be effective and valid tools for measuring and quantifying QOL treatment outcomes.^{39,40} The use of the questionnaire in this study revealed that patients wearing compression stockings became less depressed about the appearance of their legs, began to sleep more routinely, and began to increase their daily activity levels. These results make it clear that therapy with compression stockings can improve the QOL of CVI patients. In fact, when patients were given the opportunity to comment on their follow-up evaluation forms, they repeatedly volunteered that compression stockings helped them to lead normal, active lives once again.

Historically, compression stockings have been associated with poor patient compliance due to complaints about their old-fashioned design and uncomfortable fit. However, patient compliance in wearing the stockings in this study was as high as 82% and 70% after 1 and 16 months of treatment respectively. In addition, the percentage of patient complaints decreased over the duration of the 16-month study period, possibly indicating patient adaptation to the fit and feel of the modern compression stocking (Table 3). In the future, patient compliance may be even higher than found in this study due to the increasing availability of stockings in various colors, styles, and lengths.⁴¹

Finally, in a medical world turning evermore towards preventive medical strategies, it should be mentioned that compression stockings are also effective in preventing the progression of CVI into its more severe states of manifestation. For example, lower extremity venous ulceration is a late manifestation of CVI, with an annual cost of treatment in the U.S. estimated to be more than one billion dollars.⁴² A great deal of this cost is due to the chronic, recurrent nature of the disease, and therefore it is important to know that 90%

of patients with venous ulcer formation have no ulcer recurrence while wearing compression stockings.⁴³

In conclusion, since compression stockings can significantly reduce the signs and symptoms of CVI and can improve the quality of life of patients, they are a valuable asset in any CVI treatment armamentarium.

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Appendix A. Chronic Venous Insufficiency Form 7.2A (To be filled out by the patient)

Please fill out this form as completely as possible. Evaluate your symptoms before therapy. (1 = minimal problem, 5 = major problem) (Circle one for each.)

	Right Leg					Left Leg				
1. Swelling of the Leg	1	2	3	4	5	1	2	3	4	5
2. Discomfort or Pain*	1	2	3	4	5	1	2	3	4	5
3. Discoloration of the Skin	1	2	3	4	5	1	2	3	4	5
4. Cosmetic Problems**	1	2	3	4	5	1	2	3	4	5
5. Decreased Activity Tolerance#	1	2	3	4	5	1	2	3	4	5
6. Depression***	1	2	3	4	5	1	2	3	4	5
7. Sleep Problems****	1	2	3	4	5	1	2	3	4	5

*Do you have pain or discomfort when walking or standing for long periods of time?

**Do you dislike the overall appearance of your leg?

#Do you have to curtail/stop walking/exercise as a result of pain or tiredness in your legs?

***Are you upset or sad about the appearance of your legs?

****Do you have problems sleeping due to nighttime leg cramping or aching?

Appendix B. Chronic Venous Insufficiency Form 7.2B (To be filled out by the patient)

One month follow-up of office patients

Please evaluate your symptoms after therapy. (1 = minimal problem, 5 = major problem) (Circle one for each.)

	Right Leg					Left Leg				
1. Swelling of the Leg	1	2	3	4	5	1	2	3	4	5
2. Discomfort or Pain*	1	2	3	4	5	1	2	3	4	5
3. Discoloration of the Skin	1	2	3	4	5	1	2	3	4	5
4. Cosmetic Problems**	1	2	3	4	5	1	2	3	4	5
5. Decreased Activity tolerance#	1	2	3	4	5	1	2	3	4	5
6. Depression***	1	2	3	4	5	1	2	3	4	5
7. Sleep Problems****	1	2	3	4	5	1	2	3	4	5

Please describe any problems you had with the stockings or compression devices using the same 1-5 rating system (Circle one for each.)

1. Numbness	1	2	3	4	5	1	2	3	4	5
2. Sweating	1	2	3	4	5	1	2	3	4	5
3. Itching	1	2	3	4	5	1	2	3	4	5
4. Pain	1	2	3	4	5	1	2	3	4	5

*Do you have pain or discomfort when walking or standing for long periods of time?

**Do you dislike the overall appearance of your leg?

#Do you have to curtail/stop walking/exercise as a result of pain or tiredness in your legs?

***Are you upset or sad about the appearance of your legs?

****Do you have problems sleeping due to nighttime leg cramping or aching?