Physical Therapy Improves Venous Haemodynamics in Cases of Primary Varicosity: Results of a controlled study

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Summary
Physical factors are known to influence haemodynamics in the veins of the lower extremities. In a controlled randomized study we investigated the effects of combined physical therapy on varicose veins.
Over a 24-wk period a treatment group consisting of 12 persons exercised under the activation by means of externally applied compression and cold temperature stimuli (i.e. thermosteresis). They also exercised once a day without supervision for 15 min. During the same period a control group of 12 persons underwent the same measurements but no treatment. At baseline and in wk 24 the following measurements were made under standardized conditions: venous capacity (ml/100 ml of tissue) using a strain gauge plethysmograph (Periquant 3800®, Gutman Eurasburg, FRG); and refilling time of subcutaneous veins emptied by activation of the ankle joint pump using a photoplethysmograph (Cardiopluse Analyzer®, Fritac Zurich).
In the treatment group venous capacity decreased by an average of 16% from 4.9±0.3 (sd) ml/100 ml tissue to 4.1±0.4 (p < 0.005, U-test) while in the control group it remained practically unchanged at 4.8±0.4 vs. 5.0±0.3. Venous refilling time in the lower extremities also increased in the treatment group, half refilling rising from 7.8±1.0 to 11.3±0.9 sec (p < 0.001) and total refilling time from 17.1±1.4 to 25.7±2.1 (p < 0.001); these parameters remained virtually unchanged in the control group, with half refilling time dropping slightly from 7.7±1.1 to 7.1±1.3 and total refilling time from 18.3±1.7 to 16.3±1.9.
Patient self-rating scores obtained using a standardized questionnaire administered at baseline and at the end of wk 24 improved in the treatment group only.
The combined physical therapy was thus shown to be of long-term therapeutic value. They improved venous function and reduced patients’ symptoms. Our findings indicate that for the further development of this combined treatment regimen it would be useful to identify the individual factors contributing to its efficacy and evaluate them separately.

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INTRODUCTION
The long term treatment of varicose veins, a widespread disorder, remains an unsolved problem (7, 21). As drug treatment has not proved effective, physical therapy would appear to be a rational alternative (3,5,18). Venous haemodynamics are influenced by external pressure, ambient temperature and the activity of muscles and joints (16,17,19). Although compression promotes venous return, it also impairs heat dissipation and muscular function in the compressed area, which in turn have a negative effect on venous function (8). Thermosteresis by means of repeated cold stimuli has shown to lead to improved function in uncontrolled studies. Controlled tests, however, have found no significant effects (4,6,18). Long-term benefits have been claimed for programs of activating exercises, but until now no controlled studies have been carried out(11,20).

For this reason we investigated the effects of a program of combined physical therapy consisting of exercises, external compression and brief cold stimuli. The aim of our study was to determine the potential long-term effects of such therapy on venous circulation in the legs and on patient’s symptoms.

MATERIALS AND METHODS
PATIENTS
Patients suffering from manifest varicose veins in both lower extremities with increased venous capacity, as determined by strain-gauge-plethysmography (SGP), and reduced venous filling time, as determined by photo-plethysmography (PPG), were recruited to this study. Exclusion criteria were concomitant heart or arterial disease, orthopaedic disorders of the lower extremities or vasoactive medication. During the recruitment phase an external diagnosis was made using standard phlebologic methods.

In all, 24 patients (17 women and 7 men) aged 31 to 71 (mean 54.7, sd±3.2) yr were enrolled. After receiving detailed information about test procedures, they were randomized into two groups. For the purpose of the study these two groups formed matched pairs, corresponding to one another in all relevant measurement parameters.

During the study there was one dropout from the control group who declined to submit to further control measurements.

MEASUREMENTS
The patients became accustomed to the measurement procedures during preliminary examinations. All measurements were carried out in a controlled environment (room
temperature 23°C, relative humidity 65% and air flow < 0.1 m/sec.

Following an acclimatization phase of 15 minutes two measurements each of cutaneous venous emptying and refilling, following 10 dorsiflexions of the foot performed over a period of 15 sec, were made at intervals of five minutes (1,9,14). Half refilling time and total refilling time were determined. For each patient the maximum arc of dorsiflexion was recorded and used as the basis for both measurements (i.e., each patient was required to describe the same arc during dorsiflexion for the control measurement at the end of the study period). The sensors of the Cardiopulse Analyser® (Fritac; Zurich, Switzerland) were applied 10 cm proximal to the medial malleolus of the tibia on both legs.

After a 15 minute rest period, two measurements each of venous capacity and maximum venous outflow were made at intervals of 5 min using a strain-gauge-plethysmograph (Periquant 3800®, Gutmann Eurasburg, FRG). The compression cuff was applied to the distal thigh and the mercury strain gauge at the greatest circumference of the calf (2,9). During this procedure patients lay supine with the lower extremities elevated 25 and the knees slightly flexed. Cuff pressure was increased over 20 sec to 40 mm Hg and held at this level for 60 sec. It was then further increased to 60 and finally to 80 mm Hg and held at each level for 60 sec. After a total of 200 sec the cuff was instantaneously deflated. Venous capacity (ml/100 ml tissue) was recorded continuously and the data printed out at the end of the procedure.

The standardized measurement procedure was carried out at baseline and at the end of week 24. Both sets of measurements were performed at the same time of day. The minimum time interval between the last supervised exercise session and the final measurement session was 4 days; the patients were instructed not to perform their unsupervised exercises and not to wear compression stockings either on the measurement day nor the day before.

PHYSICAL THERAPY

The treatment group exercised twice a week under the direction of a therapist for 60 min., the first 20 min of which took place in an exercise bath (water level 135 cm: hydrostatic pressure 100 mm Hg; water temperature 34°C ). Immediately following the bath patients’ lower legs were doused for 30 sec with copious cold water. This procedure was followed by 25 min of floor exercises in an exercise room. The exercises were designed to improve breathing and the efficiency of muscle and joint pumps. During exercise patients wore Varisma® compression stockings (Viso Medical, Sulzburg, FRG) exerting a pressure of 30 mm Hg and offering favourable thermal properties (obtained by cotton coating of the central elastic threads). The exercises were performed mainly with patients lying on mats and for part of the time with their legs elevated.

In addition, patients exercised once a day on their own for 15 min wearing compression stockings, which were otherwise not worn. The patients’ symptoms were recorded at
baseline and at the end of week 24 by means of a standardized questionnaire (Fig. 3).

STATISTICS
The results are presented as arithmetic means plus standard deviations (SD). Statistical significance was determined using a non-parametric, two-sample test for unpaired data (Mann-Whitney U-test).

RESULTS
Mean venous capacity in the treatment group (n = 24 extremities) was reduced by an average of 0.8ml (16%) from 4.9±0.3 to 4.1±0.4ml/100 ml of tissue (p<0.005). It remained unchanged in the control group, with an average increase of 0.2 ml (n = 22 extremities; Fig. 1).
Half and total venous refilling times as measured by photo-plethysmography after activation of the ankle joint pump increased only in the treatment group. Half refilling time increased from an average of 7.8±1.0 to 11.3±0.9 sec (p<0.001) in the treatment group. In the control group these values remained unchanged, with half refilling times of 7.7±1.1 and 7.1±1.3 sec, respectively (Fig. 2). Average total refilling time, which was comparable in both groups at baseline, also increased in the treatment group by an average of 51% from 17.0±1.4 to 25.7±2.1 sec (p<0.001). However, it showed no change in the control group, remaining steady at 18.3±1.7 sec (baseline) and 16.3±1.9 sec at week 24 (Fig. 2b).

Reduction of symptoms was reported only by patients in the treatment group. Those in the control group reported no change (Fig. 3).

DISCUSSION
Venous disorders are widespread in Central Europe, affecting between 10 and 15% of the total population, and much remains to be done to improve treatment (11,12,13,21). Physical therapy offers a rational and eminently suitable option in the treatment of these conditions as it relies on methods which are known to influence the function of both healthy and diseased veins (5,7).

In uncontrolled studies repeated cold stimuli (Kneipp therapy) have been shown to be effective in the treatment of venous insufficiency. In controlled studies, however, their beneficial effects were only partly confirmed (4,6,18). This may be due to the fact that cold stimuli influence the function of the superficial veins only, not that of the deep veins.

External compression increases venous flow and improves valve function. At the same time, however, it impedes heat dissipation and inhibits the action of the lower leg muscles. Special exercises can compensate for these negative effects and promote venous
Fig. 1 Venous capacity (ml/100 ml tissue) of treatment and control groups, based on increase in lower leg volume during venous occlusion (stepwise external subdiastolic and supravenous application of pressure over 200 seconds) at baseline and week 24.

Fig. 2b Venous refilling time (sec) after emptying of the subcutaneous veins through activation of the ankle joint pump (maximum of 10 evenly timed dorsiflexions) under standardized conditions.

Fig. 2 Half venous refilling time (sec) after emptying of the subcutaneous veins through activation of the ankle joint pump (maximum of 10 evenly timed dorsiflexions) under standardized conditions.
return. To date, however, there is no conclusive evidence that exercise alone, without additional external compression, is effective in the long term (11,16,20). On the other hand, it has been shown that serial exercises in thermoneutral water can reduce excessive venous capacity (10).

Our aim was to combine a number of active and passive physical therapy interventions of known benefit and investigate the effectiveness of this regimen in a controlled study. As patient compliance was an important factor, it was necessary to develop a varied program. For this reason we decided not use bicycle ergometers, although they offered the scientific advantage of standardization, because they were not acceptable to the patients. Patient compliance during treatment was found to be very good, probably due to the perceived reduction in symptoms. The control group, on the other hand, could only be motivated to cooperate for the 24 weeks test through repeated reminders and reimbursement of expenses.

We investigated venous function in a non-invasive manner, using established phebologic evaluation methods and standardized measurement procedures in order to obtain valid results (1,9,16). We found that the combination of physical therapy methods brought about long term improvement in venous function in patients with varicose veins. Further optimization of this treatment option will depend on targeted, more efficient use of the various treatment components. However, this must take patient compliance into account, since this will continue to be a key factor in the success of any therapy.

BIBLIOGRAPHY


2) Beinder E, Keller J: Das Stauungs-und Abfluβ

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