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Effect of elastic compression stockings in patients with varicose veins and healthy controls measured by strain gauge plethysmography

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Background/aims: Oedema is one of the most frequent signs of chronic venous insufficiency and may be present at all stages of this disorder. The aim of this study was to compare the effects of four different types of elastic compression stockings on oedema prevention in patients with varicose veins.

Methods: An increase in foot volume after elevation of the leg was evaluated by strain gauge plethysmography in 20 limbs with varicose veins and 14 normal limbs, and the effects of four different compression stockings – 8, 14, 22 and 30–40 mmHg – were compared.

Results: All stockings significantly reduced the foot volume increase compared with the no stockings patient group and the normal group. There was no significant difference in the volume increase in the normal group for all four stockings, while there was a significantly smaller volume increase in the 22 mmHg stocking compared to the 14 mmHg stocking in the patient group. Between the 22 mmHg and 30–40 mmHg stockings or between the 14 mmHg and 8 mmHg stockings, there was no significant difference in the volume increase.

Conclusion: Elastic stockings, even with a pressure as low as 8 mmHg, can prevent oedema in patients with varicose veins, as well as in normal controls. However, the 22 mmHg and 30–40 mmHg stockings were better at preventing foot oedema in patients with varicose veins than those exerting less compression.

Key words: oedema prevention – plethysmography – varicose veins – elastic stockings – low compression class stockings

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COMPRESSION therapy is a major treatment option in chronic venous insufficiency. The beneficial haemodynamic effects of elastic compression stockings in chronic venous insufficiency have been demonstrated using ambulatory venous pressure measurements and various kinds of plethysmopraphy (1–5). However, although oedema is one of the most frequent signs of chronic venous insufficiency and may be present at all stages of the disease (6, 7), the effects of elastic compression stockings on oedema prevention are still largely unknown (8, 9). Recently, low compression class stockings have been used in preventing oedema of the leg in patients with venous disease, as well as in the general population (10, 11). However, little work has been done to demonstrate the effect of low compression class stockings on venous haemodynamics (11, 12). The aim of this study was to develop a method for evaluating oedema in a sitting position and to compare the effects of four different types of elastic compression stocking on oedema prevention in patients with varicose veins, and control subjects.

Subjects and Methods

Our study used 20 limbs of 14 female patients with primary varicose veins of the leg. The patients' median age was 53 years (range 44–62 years). During the first visit, patients were assessed clinically and by Doppler ultrasound, and those with secondary varicosities due to post-thrombotic syndrome were excluded from the study. In all limbs, sapheno-femoral incompetence was diagnosed with the Doppler ultrasound technique.

As a control, 14 limbs of 14 healthy female volunteers were also studied. Their mean age was 20 years with a range of 19–21 years.

Evaluation of oedema prevention was carried out using strain gauge plethysmography, with the subjects sitting on a 42-cm chair. The strain gauge was

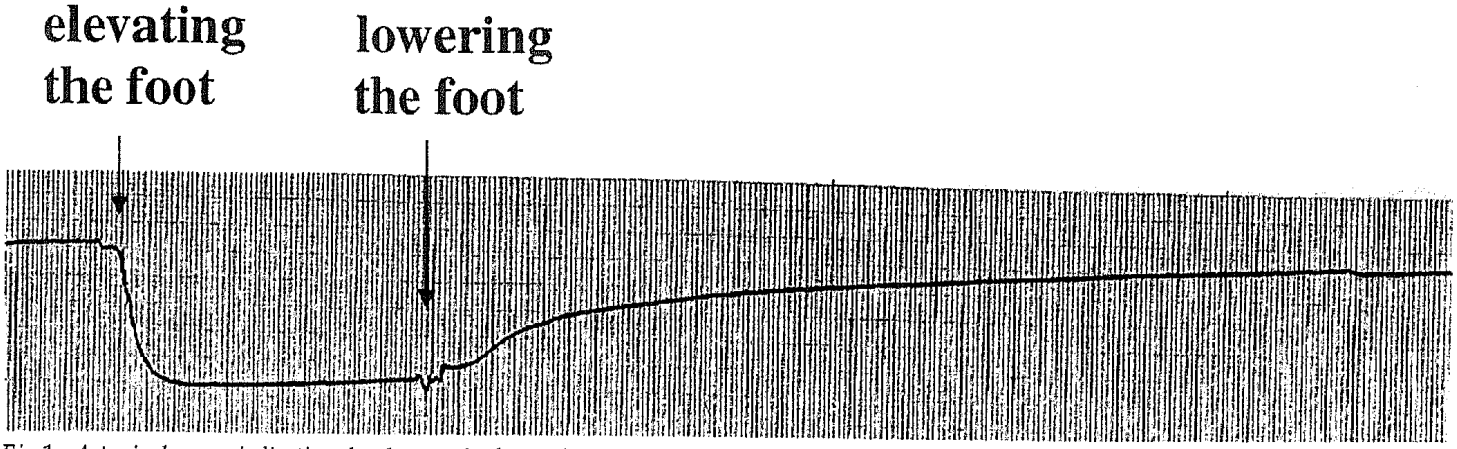

Fig.1. A typical curve indicating the changes in foot volume during elevation and lowering of the foot.

placed around the middle portion of the foot. After one minute rest, the leg was elevated to a height of 62 cm and the foot was rested against a foot support for one minute. The leg was then lowered gently to the floor. The increase in foot volume was recorded for three minutes (Fig.1). The curves obtained were analysed every 5s for the first minute, and then at one minute intervals after lowering the foot. The increase in foot volume was calculated from each volume increase divided by 1% calibration (mL/100mL).

The subjects were then instructed to wear knee-length graduated elastic stockings, and the plethysmographic examination was repeated with a strain gauge applied against the stocking. Four different strength stockings were compared in random order: 8 (Purela, Okamoto Co., Nara, Japan), 14 (Ansilk, Alcare Co., Tokyo, Japan), 22 (Slimwalk, Pippu Co., Oosaka, Japan) and 30–40mmHg (Sigvaris, Ganzoni & Cie AG., St. Gallen, Switzerland) at the ankle. The stockings were fitted to the individual subject, according to lower limb measurements, as recommended by the manufacturers.

Unpaired data were analysed using the Mann–Whitney *U*-test and paired data were analysed using Wilcoxon's rank test. A *P*-value of less than 0.05 was regarded as significant.

Results

Fig.2 shows the results of the foot volume increase without stockings in patients with varicose veins and normal controls. The patient group showed a significantly larger volume increase in the foot than the normal group 30s after lowering the foot.

In Fig.3, the results of measurements with stockings in the normal group are shown. All tests with stockings showed a significantly smaller volume increase in the foot than without stockings. There was no significant difference in the volume increase in the foot with any of the four stockings.

Fig.4 shows the results of measurements with stockings in the patient group. All tests with stockings showed a significantly smaller volume increase in the foot than without stockings. The 22mmHg stocking showed a significantly smaller volume increase in the foot than the 14mmHg stocking 25s after dropping the foot. Between the 22mmHg and 30–40mmHg stockings or between the 14mmHg and 8mmHg stockings, there was no significant difference in the volume increase.

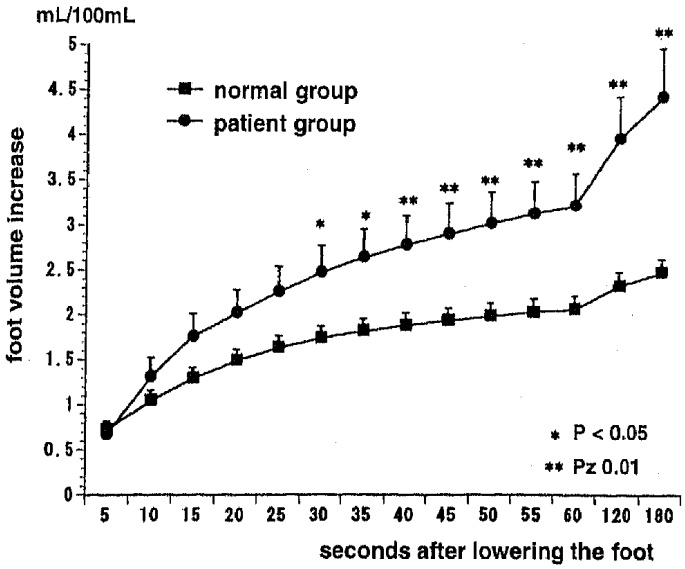

Fig.2. Results of foot volume increase without stockings in patients with varicose veins and normal controls (mean ±SEM).

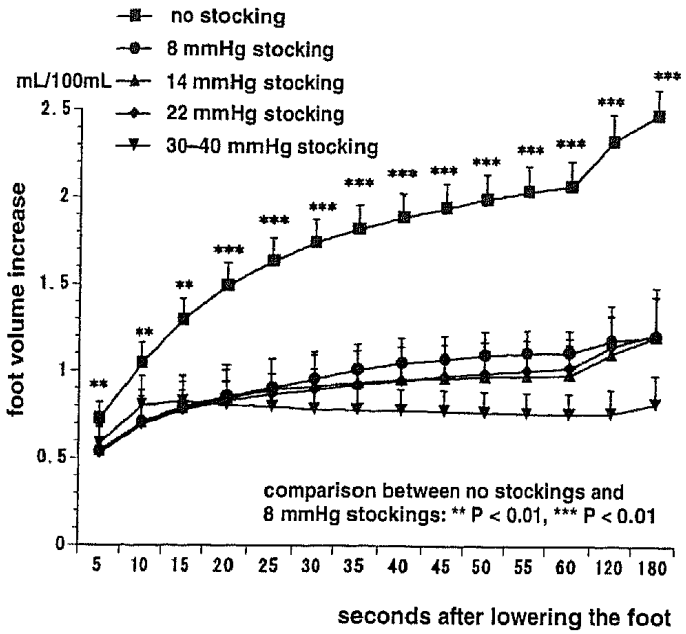

Fig. 3. Results of measurements with stockings in the normal group (mean ± SEM).

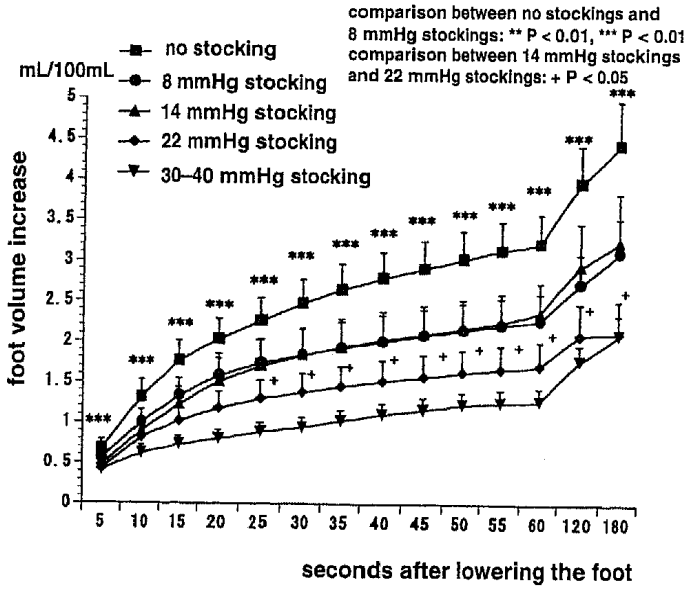

Fig. 4. Results of measurements with stockings in the patient group (mean ± SEM).

Discussion

Without stockings, patients with varicose veins showed a significantly larger volume increase in the foot than normal controls, indicating that oedema developed more easily in these patients due to venous reflux. The volume increase in the foot decreased significantly in patients with varicose veins with any stocking, as in the normal controls. These findings indicate that elastic stockings, with compression as low as 8 mmHg, can provide an effective oedema preventive effect in patients with varicose veins, as well as in normal controls, as suggested by other investigations (10, 11).

Of the four different strength stockings, there was no significant difference in the foot volume increase in normal controls, indicating that even low strength compression was sufficient in subjects without venous insufficiency to prevent foot oedema. However, in patients with varicose veins, the 22 mmHg stockings showed a significantly smaller foot volume increase than the 14 mmHg stockings. These findings indicate that the 22 mmHg and 30–40 mmHg stockings are better at preventing oedema of the foot in patients with varicose veins. This evidence is in agreement with other investigations in which different haemodynamic effects were obtained with the different compression pressures in patients with venous diseases (1, 3–5).

Oedema of the limbs usually develops after long-periods standing or sitting, due to an increase in hydrostatic pressure. The present investigation was carried out with the subjects sitting in a chair. Evaluation of oedema prevention in the sitting position is more physiological than that in the supine position (11). Although the present study showed the beneficial effects of elastic stockings on oedema prevention in the sitting position, the results may be different when the examination is made with subjects standing. However, in our preliminary study the measurements in the standing position without the subjects having to move their leg were difficult. Furthermore, development of foot oedema may be different due to factors such as occupation and the degree of venous insufficiency (6, 8, 10). Oedema of the limb may develop more easily in occupations involving periods of prolonged standing, and low compression class stockings may not always be effective in such cases. Further studies, including these factors, are necessary.

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