

# Role of Experimental Socks in the Care of the High-Risk Diabetic Foot

## A multicenter patient evaluation study

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**OBJECTIVE**— To assess the acceptability of specially designed socks to provide satisfactory pressure relief in the insensitive, high-risk, diabetic foot. We have conducted a longitudinal multicenter patient evaluation study to assess the acceptability of such hosiery in neuropathic diabetic patients.

**RESEARCH DESIGN AND METHODS**— A group of 86 neuropathic diabetic patients (69 males, 14 with type I diabetes) with a mean age of 63 yr (range 34–85 yr), and a diabetes duration of 16 yr (range 1–45 yr) participated in the study. Peripheral vascular disease was present in 28 (33%) patients, previous foot ulceration in 39 (44%) patients, and active ulceration was present in 11 (13%) patients. All patients were provided with three pairs of specially designed socks and 80 patients with extra-depth shoes. Evaluation and foot examination were performed at 3 and 6 mo.

**RESULTS**— Socks were worn for a mean of 6 days/wk (range 1–7 days/wk). Patient satisfaction evaluated at both visits was good or very good in 85%, average in 12%, and poor in 3% of patients. Ten ulcers healed during this period, and seven new ulcers occurred. Intention to continue wearing the socks, most or all of the time, was expressed by 84% of patients.

**CONCLUSIONS**— We conclude that the experimental socks have a high level of patient satisfaction when worn with suitable shoes, and may be an acceptable and inexpensive addition to existing methods of protecting the high-risk insensitive diabetic foot.

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TYPE I DIABETES, INSULIN-DEPENDENT DIABETES MELLITUS; PVD, PERIPHERAL VASCULAR DISEASE; VPT, VIBRATION PERCEPTION THRESHOLD.

High dynamic plantar foot pressures in diabetic neuropathic patients have been shown to be strongly predictive of subsequent plantar ulceration (1). It has been shown that specially designed socks with extra padding underneath the heel and forefoot are effective in reducing vertical pressures under the diabetic foot, during walking, by up to 30% (2), a property maintained over a 6-mo period (3). A further study showed these socks to be effective in the reduction of blisters in healthy long-distance runners (4), which suggests they may help reduce shearing forces experienced while the foot is shod. This trial was designed to assess the patient acceptability of such socks. We performed a 6-mo evaluation study of diabetic patients whose feet were assessed to be at high risk because of neuropathy.

### RESEARCH DESIGN AND

**METHODS**— A group of 86 diabetic patients (69 males, 14 with type I diabetes) with high-risk neuropathic feet were recruited from seven centers in the U.K. and U.S. Their mean age was 63 yr (range 34–85 yr) with a mean diabetes duration of 16 yr (range 1–45 yr).

A clinical examination was conducted at baseline. Neuropathy was assessed by measuring either VPT, using a biothesiometer (Biomedical Instruments, Newbury, OH) or cutaneous pressure perception threshold, using Semmes-Weinstein monofilaments (Gillis W. Long, Hansens Disease Center, Carville, LA) at the great toe. These are methods shown to be comparable in a previous study (5). The criteria for neuropathy were VPT greater than the age-matched normal range (6) or inability to perceive monofilament grade 4 (5). PVD was assessed according to the presence or absence of foot pulses and/or a history of claudication.

An initial assessment form was completed for each patient at the beginning of the study, and active or previous ulcer sites were noted. All patients re-

ceived advice regarding foot care, and 80 (93%) were provided with, or were already wearing, extra-depth shoes, fitted by a pedorthotist, to accommodate the thicker socks. The remaining 6 patients' shoes were assessed to be of an adequate width and depth for the socks.

Each patient was provided with three pairs of specially designed socks produced by the same manufacturer (Thor. Lo. Thotics RX Plus, Thor. Lo. Hosiery, Statesville, NC). The high-density padding covers the heel and forefoot with protective padding over the dorsum of the foot, particularly the toe area.

Patients completed satisfaction questionnaires at 3 and 6 mo, and their feet were reexamined by the participating physician. Participants were asked to note frequency of sock use and how they would evaluate them on a scale of 1 to 5 (very good to poor). They also were asked to list any benefits or problems with the socks and to compare them with their usual hosiery.

Results were analyzed using Minitab software (Minitab, State College, PA).

**RESULTS**— All patients, as would be expected from the selection criteria, presented with neuropathy, whereas PVD was present in 28 (33%). A total of 39 (44%) patients had a history of previous neuropathic foot ulceration. Further, 11 (13%) patients had active neuropathic ulcers at baseline (eight Wagner grade I, and three grade II), 10 of whom had healed by the end of the study. New ulcers developed, during the course of the study, in 7 patients (four grade I, three grade II, and one grade III), 5 of whom had a history of previous ulceration; 3 of these patients had worn shoes that did not accommodate the thicker padded socks, despite having been provided with, and advised to wear, extra-depth shoes. Two patients developed ulcers as a result of direct trauma, and one was caused by a burn. The remaining

patient developed an ulcer while wearing inappropriately fitting large socks.

During the course of the study, the socks were worn for a mean of 6 days/wk (range 1–7 days/wk). In the questionnaires, satisfaction scores remained constant at the 3- and 6-mo visits. Evaluation was very good/good in 73 (85%) patients, average in 10 (12%) patients, and poor in 3 (3%) patients. Intention to continue wearing the socks, all or most of the time, was expressed by 72 (84%) patients, 8 (9%) said they would wear them sometimes, with only 6 (7%) saying they would not continue to use them. Four patients who evaluated the socks highly during the initial 3 mo stopped wearing them in the summer months as they found it too hot.

Patients were invited for their comments at both visits. The most commonly recorded positive remarks were comfort (54 [63%] patients), protection (22 [26%] patients), and warmth (14 [16%] patients).

**CONCLUSIONS**— Despite the increasing awareness of the importance of foot care, foot problems still remain the most common reason for hospital admission among diabetic patients in the U.K. (7). It has been shown that up to 71% of foot ulcer patients had not considered themselves to have been previously at risk of foot problems (8).

Much has been written about the importance of correctly fitting footwear, although many diabetic patients still wear shoes that are too tight for them (9). In the U.K., as many as one in six pairs of National Health Surgical shoes are not worn (10). One of the advantages in providing the specialized, densely padded socks to the participants in this trial was that all their footwear was assessed and extra-depth shoes provided if necessary, thus reinforcing the importance of correctly fitting shoes, and increasing compliance.

A previous study by our group, using the same socks in patients with rheumatoid arthritis, showed a reduction

in painful symptoms while wearing the socks (11). The presence of neuropathy in all patients in this study prevented us from attempting to assess a measure of symptomatic relief. However, despite this, many patients made remarks about the comfort the socks provided, stating this was the reason they would continue to wear them.

In comparison with other methods of relieving pressure under high-risk diabetic feet, such as insoles, the socks are simple to apply, less expensive, and comparable in pressure reduction (12), with the added advantage of providing protection over the whole foot.

We conclude that the specially designed socks have a high level of patient satisfaction, but must be worn with shoes that accommodate the thicker padding. They are an acceptable and inexpensive addition to existing methods of protecting the high-risk diabetic foot and may be helpful in preventing foot ulcers and reducing the reoccurrence rate after successful treatment.

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