Evaluation of the Impact of Podiatrist Care in the Primary Prevention of Foot Problems in Diabetic Subjects

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OBJECTIVE — To evaluate the influence of podiatrist activities on the outpatient care of diabetic patients in terms of knowledge of diabetic foot care, self-care, and minor foot problems.

RESEARCH DESIGN AND METHODS — There were 733 patients, aged 10–79 years, identified from the national diabetes register. Patients without recent visits to a podiatrist and without an obvious need for foot care were randomized into a podiatric care group (education and primary prevention measures, $n = 267$) and a control group (written instructions only, $n = 263$). The patients were examined by an independent study podiatrist at baseline and after 1 year.

RESULTS — Patients in the podiatrist group had greater improvement in knowledge of diabetic foot care ($P = 0.004$) and self-care ($P < 0.001$) scores compared with control subjects. The prevalence of callosities in regions other than the calcaneal region decreased more ($P = 0.009$) in the podiatrist group (from 54.5 to 39.5%) than in the control group (from 51.3 to 48.2%), and the size of the callosities decreased more ($P < 0.001$) in the podiatrist group than in the control group. Reduction in the prevalence of callosities was associated with younger age (<50 years).

CONCLUSIONS — Education and primary preventive measures provided individually by a podiatrist result in significant improvements in knowledge and foot self-care scores and in improvements in the prevalence of some minor foot problems. Long-term studies are needed to evaluate whether the intervention of podiatrists starting at an early phase would lead to a reduction in major foot problems.

Minor foot problems are common in diabetic subjects (1–3), and there is general agreement that to avoid major complications like chronic ulcers and amputations, more attention has to be paid to proper patient education and special diabetic foot care teams. Most education programs for diabetic patients, however, include foot care as one topic among several other issues. Therefore, the importance of preventive foot care may remain obscure for many diabetic patients, especially those with diabetes of a short duration. There are also reports that older diabetic patients may lack adequate knowledge and skills to take care of their feet (4). Whereas there are several reports suggesting that amputation rates can be reduced by the implementation of foot clinics that concentrate on established foot lesions (5–8), patient education and primary prevention in the general outpatient setting (especially by podiatrists) have been less extensively studied. In Finland, podiatrists are not included in the staff of public outpatient health care systems, and only a relatively small number of diabetic patients have received foot care and education from private podiatrists. This situation gave us a special opportunity to evaluate, in a randomized trial, the effectiveness of the influence of podiatrist activities in the outpatient care of type 1 and type 2 diabetic patients identified from the national diabetes register. The main emphasis was laid on patients' knowledge of foot care, self-care habits, and the prevalence and severity of foot problems.

RESEARCH DESIGN AND METHODS

Patients

The formation of the baseline study population has been described in detail earlier (3). Briefly, it included 733 patients (369 males, 364 females) in the age range 10–79 years (~100 patients, 50 males and 50 females, in each 10-year age stratum), age 46.9 ± 19.1 (mean ± SD), who were living in the town of Turku or its vicinity. The patients were originally identified using the national drug imbursement register, which includes all patients receiving antidiabetic drug treatment in Finland. Of the 733 patients, 110 patients had visited a podiatrist within the 6 months before the baseline visit; they continued to receive treatment from their own private podiatrists during the subsequent year and were excluded from this study (Fig. 1). Of the remaining patients, 93 subjects had an obvious need for foot care, i.e., a major foot problem (previous amputation, present ulcer or infection) or a high risk for ulcer formation (intracutaneous hemorrhage, severe structural deformity, e.g., Charcot joint), and they all were referred to a podiatrist and not included in this report. The rest of the patients were randomly allocated to a podiatrist group ($n = 267$) and a control group ($n = 263$). The randomization was performed separately for males and females and separately for patients below and above 20 years of age. The baseline findings of the whole patient population have been published earlier (3). All patients alive 1 year later were invited to a follow-up examination. Of the original patients, 233 (87.3%) in the podiatrist group and 226 (85.9%) of the control subjects attended the follow-up examination. Before the follow-up, 12 patients (5 in the intervention group and 7 of the control

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Received for publication 7 February 1997 and accepted in revised form 27 August 1997.

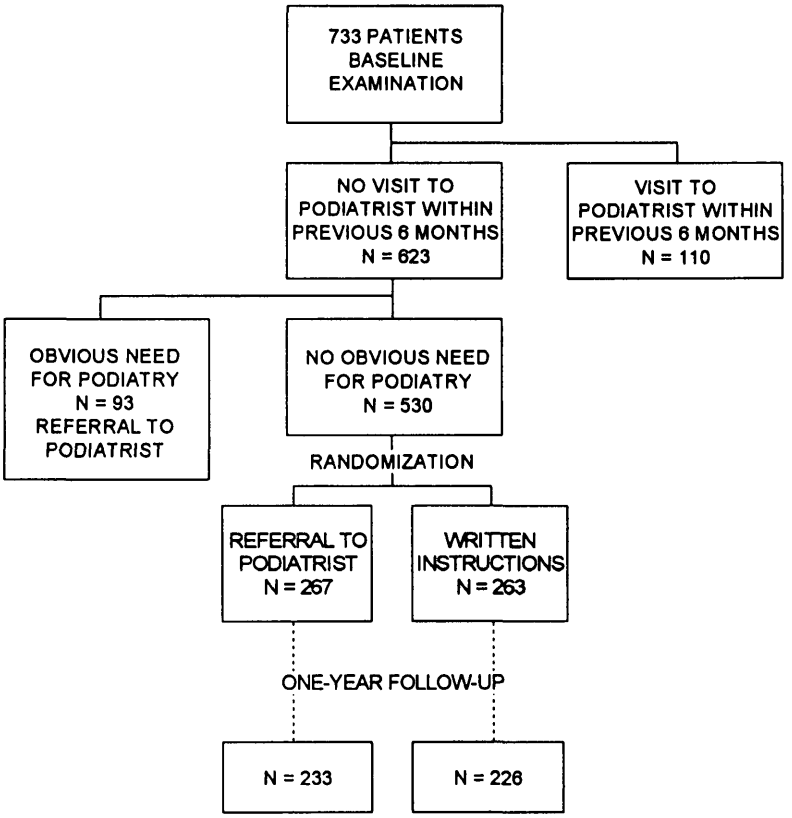

Figure 1—*Formation of the study groups*

subjects; mean age 67.7 years) had died, and thus 88.6% of the patients still alive attended the follow-up examination. Mean age of the attending patients was 43.9 years, and that of the nonattending patients was 44.1 years.

Methods

Education and foot care. Patients in the podiatrist group visited a podiatrist during the 12-month period after the baseline examination as many times as judged appropriate by the podiatrist. The first visit (~45 minutes) took place within 1 month after the baseline examination and focused mainly on education. Podiatric treatment was provided at the possible later visits (30–60 min each). Three independent podiatrists working outside the study center were responsible for this education and treatment. At the time of the study, education for podiatrists in Finland lasted 1.5–2.5 years, depending on whether they had a certificate from senior high school .

Education was given individually to every patient, taking into account each patient's age, occupation, earlier foot care habits, etc. Education included guidance concerning the use of proper footwear (socks, shoes), daily hygiene, cutting of toenails, use of emollient cream when necessary, avoidance of high-risk situations (e.g., exposure of the feet to hot environment, walking barefoot), and foot gymnastics. Preventive measures included gentle debridement of calluses, preparation of individual insoles, promotion of the use of emollient creams, treatment for ingrown toenails, guidance for foot gymnastics, etc. Foot gymnastics were aimed at increasing or maintaining muscle strength and joint mobility by regular training, e.g., walking on the heels and on the forefeet, flexing, extending, and spreading out the toes. The services of the podiatrists were free of charge to the patients. The patients in the control group received written instructions only.

Baseline and follow-up examinations. Information about patients' diabetes and its treatment, foot problems, self-care practices, and previous foot care were collected in structured interviews of a similar format at baseline and at 1-year follow-up. Both examinations were performed by one and the same specially trained podiatrist at the study center who was unaware of the results of the baseline study at the follow-up examination. Reproducibility of the clinical examination by the podiatrist was good (mean κ coefficient 0.72) as reported earlier (3).

Ischemic and neuropathic ulcers were combined in the analyses. Ingrowth of the toenails was graded into three categories according to the depth of ingrowth. The two more severe grades with or without possible inflammation and the mildest grade with inflammation or infection were considered significant ingrowth. Fungal infection of the nail was defined clinically as the presence of at least two of the following: thickening, brittleness, color change increasing from the tip to the base of the nail, and detachment from the nail bed by at least 25% of nail area. Abnormal foot or toe posture included splayed forefoot, hallux valgus formation (angle >15°), and claw toes. Hyperkeratotic changes included callosities in the calcaneal region and in other regions (usually under the metatarsal heads or under the digits) independent of their etiology, fissures in calcaneal region, interdigital and other corns, and verrucae.

Patient knowledge about foot care was tested with 19 questions about different foot care topics. All questions had three possible answer alternatives from which one or two were correct. All correct answers were counted as +1 point, all wrong answers as −1 point, and unknown as 0. The maximum score was 57. The self-care score was derived from seven questions concerning foot care habits. The total score (0–12) consisted of questions about hygiene (0–3), creaming (0–3), self-examination (0–3), and foot gymnastics (0–3).

Serum fructosamine concentration was measured at baseline and at 1-year follow-up by a colorimetric test using nitroblue tetrazolium (9).

Statistical analyses

The data were analyzed using the SAS Version 6 program package. Changes in continuous variables within a group and between groups during the 12-month follow-up period were tested with repeated measures analysis of variance using the GLM (general linear models) procedure. Categorical variables were tested with repeated measures analysis using the CATMOD (categorical modeling) procedure.

RESULTS — The mean number of visits to a podiatrist during the follow-up year was 4.7 (median 3) in patients randomized to podiatrist care and 0.4 (0) in patients randomized to the control group. The pro-

portion of patients using special insoles and other appliances increased in the podiatrist group, but tended to decrease in control subjects (Table 1).

Knowledge of foot care increased and self-care of feet improved in both patient groups, but significantly more in the podiatrist group than in control subjects (Table 1). For example, the proportion of patients who examined their feet every day increased from 21.9 to 34.3% in the podiatrist group and from 22.6 to 29.7% in the control subjects.

The prevalence of callosities both in calcaneal and other regions decreased significantly in the podiatrist group, but not in the control group (Table 2). The difference in change between the two groups in the prevalence of callosities in regions other than the calcaneal region was highly significant. The prevalence of corns decreased in the podiatrist group, but not in control subjects. The prevalence of ingrown toenails increased significantly in control subjects, but not in the podiatrist group. There were no significant changes in the prevalence of other nail disorders during the 1-year follow-up period. The prevalence of inability to spread out toes decreased in both groups, but the prevalence of inability to flex toes normally decreased only in the podiatrist group. The differences in change between the podiatrist group and the control subjects with respect to the prevalence of corns, ingrown toenails, and inability for normal toe movements were not significant. The diameter of the greatest callosity both in calcaneal and other regions decreased significantly only in the group randomized to podiatric care (Table 3). The difference in the change in diameter in regions other than the calcaneal region was significant between the groups. There were no significant differences between the baseline and 1-year follow-up examinations in either group with respect to the prevalence of other hyperkeratotic changes or any abnormality in foot or toe posture.

The change in the prevalence of noncalcaneal callosities was also calculated by subgrouping the patients according to baseline characteristics (Table 4). In these analyses, the patients of both groups were combined. The prevalence of noncalcaneal callosities decreased more in patients under 50 years of age as compared with older patients. Duration of diabetes, mode of treatment, or metabolic control was not associated with the decrease in the prevalence of callosities.

Table 1—*Knowledge of foot care, self-care habits, and use of special insoles*

	Podiatrist group	Control subjects	Difference in change between groups (*P*)*
n	233	226	—
Knowledge score			0.004
Baseline	26.7 ± 11.4	26.1 ± 11.8	—
12 months	32.1 ± 10.8	29.2 ± 12.6	—
P†	<0.001	<0.001	—
Self-care score			<0.001
Baseline	5.4 ± 2.8	5.3 ± 2.6	—
12 months	7.0 ± 3.2	6.0 ± 2.5	—
P†	<0.001	<0.001	—
Use of special insoles			<0.001
Baseline	3.9	5.8	—
12 months	16.4	3.1	—
P†	<0.001	0.081	—

Data are means ± SD or %. *Significance of interaction term (treatment group multiplied by baseline/follow-up); †significance of change within group.

Table 2—*Prevalence of podiatric findings*

	Podiatrist group	Control subjects	Difference in change between groups (*P*)*
n	233	226	—
Callosities in calcaneal region			0.14
Baseline	18.5	16.8	—
12 months	12.0	15.5	—
P†	0.003	0.62	—
Callosities in other regions			0.009
Baseline	54.5	51.3	—
12 months	39.5	48.2	—
P†	<0.001	0.33	—
Corns			0.16
Baseline	36.9	33.6	—
12 months	27.0	29.7	—
P†	0.001	0.16	—
Ingrown toenail			0.33
Baseline	19.3	23.0	—
12 months	24.0	31.4	—
P†	0.054	0.004	—
Other nail disorders			0.40
Baseline	37.3	44.3	—
12 months	34.3	44.7	—
P†	0.28	0.88	—
Inability to spread out toes			0.23
Baseline	50.6	53.1	—
12 months	39.1	46.5	—
P†	<0.001	0.034	—
Inability to flex toes			0.94
Baseline	23.2	29.7	—
12 months	18.0	24.8	—
P†	0.044	0.11	—

Data are %. *Significance of interaction term (treatment group multiplied by baseline/follow-up); †significance of change within group.

Table 3—*Diameter of greatest callosity*

	Podiatrist group	Control subjects	Difference in change between groups (*P*)*
Calcaneal region			0.065
n	49	55	—
Baseline	40.5 ± 30.8	30.6 ± 28.5	—
12 months	25.5 ± 28.8	28.3 ± 26.8	—
P†	0.001	0.65	—
Other regions			<0.001
n	141	138	—
Baseline	16.6 ± 10.2	15.2 ± 9.8	—
12 months	11.4 ± 10.3	14.4 ± 9.9	—
P†	<0.001	0.39	—

Data are means ± SD and are given in millimeters. Patients having no callosities in either examination were excluded. *Significance of interaction term (treatment group multiplied by baseline/follow-up); †significance of change within group.

The incidence of severe foot lesions during the 1-year follow-up period was low. There were no amputations in either group. Only one patient (in the podiatrist group) had a new ulcer at the 1-year follow-up. This low incidence was expected because patients who were estimated to be at a higher risk for major foot problems were all referred to podiatric care and excluded from this randomized study.

Serum fructosamine concentration was similar in the podiatric group and in the control subjects both at baseline (3.46 ± 0.67 vs. 3.41 ± 0.66 μmol/l) and at 1-year follow-up (3.38 ± 0.63 vs. 3.35 ± 0.69 μmol/l).

CONCLUSIONS — At the evaluation 1 year after the baseline examination, our study shows that education given to diabetic patients individually by a podiatrist significantly improves the patients' knowledge of foot problems and self-care practices when compared with education by written instructions alone. Because education was given within 1 month after the baseline examination, its beneficial effects seem to last for at least 11 months. However, we cannot exclude the possibility that at least some patients may have received repeated education by the podiatrist at later visits. Regarding improved self-care practices, our results are in accordance with those reported by Kruger and Guthrie (10), who demonstrated improvements in the care of toenails in a small group of NIDDM patients participating in a hands-on session on foot care when compared with patients participating in a lecture presentation only. However, individual education may not need to be mandatory to obtain favorable results: intensive group education of four weekly 1-h sessions, including practical training and cognitive motivational techniques, improved foot care routine compliance more than conventional education, which was one 1-h lecture (11). The follow-up time in the latter study was 6 months, and it included only 62 highly selected NIDDM patients. It is possible that reinforcement of information about foot care is as important as the method applied in foot-care education. In support of this theory, Litzelman et al. (12) showed that in NIDDM patients, an education program, which started with one session led by a nurse and a physician and was followed by telephone and postcard reminders for up to 3 months, resulted in a significant improvement in six out of twelve components of self foot-care behaviors compared with usual care. Further studies are needed to determine the optimum frequency of reminder actions needed to maintain the beneficial effects of education when >1 year has elapsed after the initial educational program.

Compared with previous studies, our patient population was large, comprising >500 patients at baseline. Unlike earlier studies, however, we included both IDDM and NIDDM patients, and we had similar numbers of patients in all 10-year age strata from 10 to 79 years. The patients had been identified from a national diabetes register, making the population representative of all diabetic patients needing drug treatment in Finland. However, inclusion of young age-groups means that there were many patients with a very low probability of major foot problems who therefore might have poor motivation for preventive measures, a variable that may have diluted the effects of education. On the other hand, their learning ability is probably better than that of patients in older age-groups.

The second objective of our study was to evaluate the effects of podiatric activities on the prevalence of minor foot problems. The main finding was that the number and the size of callosities decreased more in the podiatrist group than in the control subjects. This is most probably due to both the improved self foot-care behaviors and the preventive care, e.g., foot appliances such

Table 4—*Prevalence of noncalcaneal callosities at baseline and at 1-year follow-up by age, diabetes duration, mode of treatment, and metabolic control*

	n	Baseline	12 months	Difference in change (*P*)*
Age (years)				0.007
<50	266	60.2	45.9	—
≥50	193	43.0	40.9	—
Diabetes duration (years)				0.36
<10	227	52.0	44.9	—
≥10	232	53.9	42.7	—
Treatment				1.00
Diet or oral antidiabetic drugs	197	50.8	41.6	—
Insulin	262	54.6	45.4	—
Metabolic control†				0.43
Good	239	56.1	45.2	—
Poor	220	49.6	42.3	—

Data are %. *Significance of interaction term (grouping factor multiplied by baseline/follow-up); †stratified by mean fructosamine concentration (3.4 μmol/l) of all subjects. Patients from podiatrist and control groups are combined.

as insoles, provided by the podiatrist. Reduction of callosities may have important long-term consequences because this reduction results in a significant decrease in dynamic foot pressures in these areas (13). The incidence of major foot problems was very low overall, and there was no difference between the two experimental groups. This result was expected because we had, for ethical reasons, excluded those patients who obviously needed foot care from the population being randomized to intervention and control groups. Moreover, the follow-up time was only 1 year.

As far as we know, there are no previous randomized studies like ours evaluating the influence of podiatrist activities in preventing minor foot problems in the outpatient care of diabetic patients. There are, however, several studies suggesting that the intervention of multidisciplinary teams including a podiatrist can reduce the incidence of foot and lower-extremity amputations by ~50% (5–8). To prevent major problems, it is important to develop intervention strategies at an earlier phase because it is known that minor problems like callosities often precede major lesions (14). We observed that the decrease in the prevalence of callosities was associated with young age (<50 years). This may imply that the skin of younger patients responds better to measures alleviating extra pressure in the sole as compared with the skin of older patients.

In conclusion, education and primary preventive measures given individually by a podiatrist to diabetic patients without a great risk for severe foot lesions result in significant improvements in knowledge and foot self-care scores and in improvements in the prevalence of some minor foot problems. Long-term studies are needed to evaluate whether the activities of a podiatrist starting at an early phase lead to a reduction in major foot lesions in the long run.

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