

原 著

Difference of foot manifestations between young, adult, and bedridden elderly with diabetes : a cross-sectional observational study

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Key words

foot manifestation, diabetes, diabetic foot

Abstract

Aim : The purpose of this study was to investigate the differences of foot manifestations between young, adult, and bedridden elderly patients with diabetes.

Methods : Three groups of diabetic patients were recruited into a between subjects, cross-sectional study. The presence and frequency of foot manifestations were estimated by the inspection of foot in 17 young patients (young group), 22 adult patients (adult group), and 44 bedridden elderly patients (bedridden elderly group). The medical history was taken from medical records.

Results : In the young group, no ulceration was found. Regarding foot manifestation with non-ulcerative pathology, 64.7% of young patients had dry skin; 35.2%, erythema; 17.6%, callus; and 17.6%, deformation. In the adult group, 4.5% had ulcers; 86.3%, dry skin; 22.7%, callus; 22.7%, corns; 13.6%, deformation; 4.5%, erythema, and 4.5%, hematoma. In the bedridden elderly group, 2.3% had ulceration; 88.6%, dry skin; 43.2%, deformation; 6.8%, erythema; and 2.3%, hematoma. Dry skin was located on the heels in the young and adult groups, but on the dorsum pedis in the bedridden elderly group.

Conclusions : The foot manifestations of each group differed. Therefore preventive care for the diabetic foot should take into consideration aging and mobility. As the prevalence of dry skin was high in all groups, more effective moisturizing care for diabetic patients should be developed.

INTRODUCTION

Diabetic foot involves infection, ulceration and /or destruction of deep tissues associated with neurological abnormalities and various degrees of peripheral vascular disease in the lower limb (based upon the World Health Organization definition)¹⁾. Especially, foot ulcers are the most common complications of diabetes²⁻³⁾. Diabetic foot ulcers are associated with impaired physical and mental function that impact an individual's quality of life⁴⁻⁶⁾, and are the source of major suffering and medical cost^{7, 8)}.

Two-thirds of diabetic foot ulcers eventually heal⁹⁻¹¹⁾, however, up to 28% of patients with foot ulcers may result in some form of amputation¹²⁾, and a diabetic foot ulcer is preceded to at least 85% of lower extremity amputations¹³⁾. Someone loses its leg in the world because of diabetes in every 30 seconds¹⁴⁾. In turn, amputations have been associated with an increased risk of recurrent ulceration^{15, 16)}.

To prevent the diabetic foot ulcers, it is important to identify the early foot manifestations of diabetes. In patients with diabetes, apparently minor manifestations influenced by aging or lifestyle can lead to ulceration and provide an entry point for rapidly ascending infection.

Comparisons of foot manifestations in patients with diabetes and those without diabetes, in those with type 1 diabetes and those with type 2 diabetes, and in patients of various age with diabetes have been reported¹⁷⁻¹⁹⁾. These studies showed that patients with diabetes had some characteristics of foot manifestations, and that these might be influenced by aging and type of diabetes. However, patterns of diabetic foot manifestations in young and adult patients and those in bedridden elderly patients are not known, meaning that it is unclear whether we should implement standardized preventive care for diabetic foot for all patients with diabetes. The purpose of this study was to investigate the difference of the foot manifestations in young, adult, and bedridden elderly patients with di-

abetes.

PATIENTS AND METHODS

1. Study Design

A cross-sectional observational study was carried out between September 2002 and October 2003.

2. Patients

All patients diagnosed with diabetes mellitus were eligible for inclusion. The young group was recruited from outpatients of a pediatric diabetes clinic of a university hospital in Ishikawa, Japan, and the adult group from outpatients and inpatients of an adult diabetes clinic of a same university hospital. The bedridden elderly group was recruited from inpatients of a geriatrics hospital in Ishikawa, Japan. The diagnosis of diabetes was verified for all patients using the criteria set forth by the Japan Diabetes Society.

In all groups, those who had undergone any type of lower limb amputation were excluded. Other exclusion criteria were the difficulty in walking and preschool age for the young group, difficulty in walking and age less than 20 years for the adult group, and ability to ambulate for the bedridden elderly group.

3. Methods

1) Foot manifestations

After 15 minutes' bed rest, one researcher inspected and photographed both feet. Detailed sketches of these photos were per-

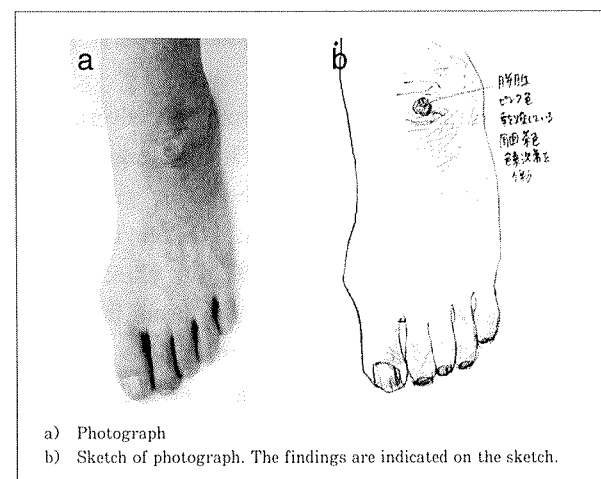


Fig. 1. Example of a sketch of a photograph

Table 1. Definitions of manifestations

Foot manifestation	Definition
Ulcer	A defect in which the epidermis and at least the upper (papillary) dermis has been removed ¹⁾
Dry Skin	Skin characterized by dull color (usually gray/white), rough texture, and a number of elevated ridges ¹⁾
Callus	Localized hyperplasia of the stratum corneum due to pressure or friction ²⁾
Corn	Hardening and thickening of the stratum corneum of the skin of the toes, caused by friction and pressure from poorly fitting shoes or hose ²⁾
Deformation	A type of structural defect characterized by the abnormal form or position of a body part, caused by a nondisruptive mechanical force ²⁾
Erythema	Blanchable reddening of skin or mucous membrane due to dilatation of arteries and veins in the papillary and reticular dermis ¹⁾
Hematoma	Localized collection of blood, usually clotted in the tissue, usually due to a break in the wall of a blood vessel ²⁾

- 1) Based upon Wolff K, Goldsmith LA, Katz SI, et al.: Fitzpatrick's Dermatology in General Medicine (7th Edition), McGraw-Hill, New York, 2008
 2) Based upon Block AMW, Borer WZ, Bruce BB et al.: Dorland's Illustrated Medical Dictionary (31st Edition), Saunders, Philadelphia, 2007

formed by the same researcher, and foot manifestations were ascertained by a wound, ostomy and continence nurse (Figure 1). Table 1 shows the definition of each manifestation^{20, 21)}.

2) Characteristics of patients

Age, gender, type of diabetes, duration of diabetes, therapy, and HbA1c were verified from hospital records. Neuropathy was evaluated by the 10-gram monofilament test, performed by one researcher who was trained according to the practical guidelines based upon the International Consensus and Practical Guidelines on the Management and the Prevention of the Diabetic Foot²²⁾. However, the 10-gram monofilament test was not performed in the bedridden elderly group because of cognitive dysfunction. Angiopathy was evaluated by ankle brachial pressure index (ABI), measured by one trained researcher.

4. Analysis

To compare each foot manifestation, descriptive statistics were used. Continuous values were represented by means and standard deviations (SD). The prevalence of foot manifestations was calculated as follows:

Prevalence of foot manifestations (%) =

$$\frac{\text{number of patients with foot manifestations}}{\text{total number of patients}} \times 100$$

SPSS 16.0J was used for all descriptive statistical analysis.

5. Ethical considerations

This research conformed to the ethical guidelines for clinical research specified by the Japan Ministry of Health, Labor and Welfare. A researcher provided the oral and written descriptions of the study to patients, and the informed consent was obtained. In case of difficulty in communicating, consent was obtained from the patient's family. All patients had the opportunity to withdraw their participation at any time.

RESULTS

1. Characteristics of participants

The young group contained 17 patients; the adult group, 22 patients; and the bedridden elderly group, 44 patients. Table 2 shows the characteristics of the 3 groups. Mean (\pm SD) age was 21.3 ± 6.2 , 56.0 ± 15.2 , and 81.9 ± 6.3 years, and mean (\pm SD) duration of diabetes was 13.5 ± 7.3 , 12.1 ± 9.7 , and 21.5 ± 14.9

Table 2. Characteristics of the 3 Groups

	<i>n</i> (%), Mean ± SD		
	Young <i>n</i> =17	Adult <i>n</i> =22	Bedridden elderly <i>n</i> =44
Age (yr)	21.3 ± 6.2	56.0 ± 15.2	81.9 ± 6.3
Gender			
Male	3 (17.6)	9 (40.9)	12 (27.3)
Female	14 (82.4)	13 (59.1)	32 (72.7)
Type of DM			
Type 1	17 (100.0)	7 (31.8)	0 (0.0)
Type 2	0 (0.0)	15 (68.2)	44 (100.0)
Duration of DM (yr)	13.5 ± 7.3	12.1 ± 9.7	21.5 ± 14.9 ^a
Therapy			
Insulin	11 (64.7)	13 (59.0)	14 (31.8)
Insulin + oral medication	6 (35.3)	3 (13.6)	0 (0.0)
Oral medication	0 (0.0)	6 (27.4)	5 (11.4)
Diet	0 (0.0)	0 (0.0)	25 (56.8)
HbA1c (%)	6.9 ± 1.6	7.8 ± 1.1	5.9 ± 1.1 ^b
Abnormal 10-gram monofilament test	0 (0.0)	2 (9.0)	—
Ankle Brachial Pressure Index	0.9 ± 0.1	0.9 ± 0.1	0.8 ± 0.2 ^c

^aDM: diabetes mellitus a) *n*=10 b) *n*=19 c) *n*=39

Table 3. Prevalence of foot manifestations

	<i>n</i> (%)		
	Young <i>n</i> =17	Adult <i>n</i> =22	Bedridden elderly <i>n</i> =44
Diabetic foot features	0 (0.0)	1 (4.5)	1 (2.3)
Ulcer	0 (0.0)	1 (4.5)	1 (2.3)
Non-ulcerative pathology	12 (70.6)	22 (100.0)	41 (93.1)
Dry skin	11 (64.7)	19 (86.3)	39 (88.6)
Erythema	6 (35.2)	1 (4.5)	3 (6.8)
Callus	3 (17.6)	5 (22.7)	0 (0.0)
Deformation	3 (17.6)	3 (13.6)	19 (43.2)
Corn	0 (0.0)	5 (22.7)	0 (0.0)
Hematoma	0 (0.0)	1 (4.5)	1 (2.3)

years, in young, adults, bedridden elderly group, respectively. All patients in the young group had type 1 diabetes. On the other hand, 15/22 (68.2%) and 44/44 (100%) had type 2 diabetes in the adult and bedridden elderly groups, respectively.

2. Foot manifestations

1) Prevalence of foot manifestations

Foot ulcers were found in 0% of the young group, 1/22 (4.5%) of the adult group, and 1/44 (2.3%) of the bedridden elderly group. Foot manifestations with non-ulcerative pathology were found in 12/17 (70.6%) of the young group, 22/22 (100%) of the adult group and 41/44 (93.1%) of the bedridden elderly group (Table 3). Among the foot manifesta-

tions with non-ulcerative pathology, the most prevalent one was dry skin in all groups, affecting 11/17 (64.7%), 19/22 (86.3%), and 39/44 (88.6%), in the young, adult, and bedridden elderly groups, respectively. However, the other following foot manifestations differed in its frequency in each group. In the young group, the next most common foot manifestations were erythema (6/17, 35.2%), callus (3/17, 17.6%), and deformation (3/17, 17.6%). In the adult group, they were callus (5/22, 22.7%), corns (5/22, 22.7%), deformation (3/22, 13.6%), erythema (1/22, 4.5%), and hematoma (1/22, 4.5%). In the bedridden elderly group, they were deformation (19/44, 43.2%), erythema (3/44, 6.8%), and hematoma

(1/44, 2.3%).

2) Location of foot manifestations

Table 4 shows the location of foot manifestations. Ulcers were found on the heel and external malleolus in the adult group and on the heel in the bedridden elderly group. Dry skin occurred on the heel in the young and adult groups and on the dorsum of the feet in the bedridden elderly group. Deformation was found at the 1st metatarsophalangeal joint in the young and adult groups and at the 1st metatarsophalangeal joint and toes in the bedridden elderly group.

DISCUSSION

To the best of our knowledge, this is the first analysis that the differences of foot manifestations between young, adult, and bedridden elderly diabetic patients have been investigated. In the young group, no ulcers were found. The most prevalent foot disorder in all groups was dry skin, and this was lo-

cated on the heels in the young group and the adult group. On the other hand, dry skin was located on the dorsum of the foot in the bedridden elderly group. We will discuss the foot manifestations of each group, the influence of aging (by comparing the young and adult groups), and the influence of walking (by comparing the young and adult groups with the bedridden group).

1. Foot manifestations of each group

In the young group, none of the patients had ulcers. Moreover, the foot manifestations might not have been caused by diabetes mellitus because none of the patients in this group had an abnormal 10-gram monofilament test.

In the adult group, 4.5% had ulcers and all had the foot manifestations with non-ulcerative pathology. 9.0% had neuropathy. Therefore, some foot manifestations might have been caused by diabetes mellitus and these may have developed into ulcers. In the pre-

Table 4. Main locations of foot manifestations

Foot manifestations	Location						
	Young (n=34)		Adult (n=44)		Bedridden elderly (n=88)		
Diabetic Foot Features	Ulcer		Heel	1	Heel	1	
			Lateral malleolus	1			
Non- Ulcerative Pathology	Dry Skin	Heel	21	Heel	35	Proximal dorsum	44
		Lateral plantar region	7			Lateral aspect of dorsum	42
		Lateral aspect of dorsum	7			Middle of dorsum	40
	Erythema					Medial aspect of dorsum	33
						Anterior surface of ankle	31
		Dorsum of 5th toe	4	Dorsum of 4th toe	2	Lateral face of dorsum	1
		Dorsum of hallux	2	Dorsum of 5th toe	2	Medial malleolus	1
	Callus					Lateral malleolus	1
						Lateral aspect of 5th MTP joint*	1
	Deformation						
Corn							
Hematoma							

*MTP joint: Metatarsophalangeal joint

sent study, the prevalence of ulcers (4.5%) was higher than that found in a previous study (2.0%) due to small sample size²³⁾.

The prevalence of dry skin was higher than that found in previous studies^{17, 18)}. This difference might be related to the definition of dry skin and to the original observation method of using detailed sketches in this analysis. In Romano and colleagues' study, the dermatological examinations were always performed by same two well-trained physicians¹⁸⁾. However, the definition of dry skin (xerosis) was unclear. In Borssen and colleagues' study, the clinical examination was performed by a diabetes clinic chiropodist¹⁷⁾. That study defined dry skin (dry feet) as "the patient/ subject gave a history of loss of foot perspiration that was confirmed on examination".

To the best of our knowledge, the present study is the first research to investigate the foot manifestations in bedridden patients with diabetes. We found that 2.3% had the ulceration and 93.1% had the foot manifestations with non-ulcerative pathology in the bedridden group, and that ABI was low in this group. Okuwa and colleagues showed that low ABI was a risk factor for lower-extremity pressure ulcers in bedridden elderly patients²⁴⁾, hence ischemia may have been a contributing factor to foot manifestations in the present bedridden patients with diabetes.

2. Influence of the aging: the young group vs. the adult group

Dry skin, callus, deformation, and erythema were found in both groups. Furthermore, locations of these foot manifestations were similar. On the other hand, ulcers, corns, and hematomas were found only in the adult group. Corns are caused by friction and pressure from poorly fitting shoes or hose²¹⁾. Our results might suggest that preventive care for the diabetic foot should take into account aging and lifestyle. However, the relationship between corns and lifestyle was unclear in this study.

Ulcers and hematomas may be caused by

neuropathy in diabetic patients. However, the relationship between foot manifestations and neuropathy was not considered in our study because of small sample size and the fact that patients had relatively well-controlled glycemia.

3. Influence of bedridden status: the young and adult groups vs. the bedridden elderly group

Calluses and corns were found in the young and adult groups but not in the bedridden elderly group. These lesions are caused by pressure or friction from day-to-day activities, for example walking for many hours, wear poorly fitting shoes, and sitting on the heels with the back straight. These activities are specific to ambulatory people.

Ulceration, dry skin, deformation, erythema, and hematoma were found in adults and in the bedridden elderly. However, location of dry skin, deformation, and erythema in the bedridden elderly differed from that in the younger patients. Dry skin was located on the heels in the young and adult groups, but on the dorsum of the feet in the bedridden elderly group. Mechanical shear or friction forces, for example, caused by walking, induce hyperkeratinization, and dry skin develops more easily on areas of thickened skin with hyperkeratinization such as the heel²⁵⁾. In addition, dry skin on the dorsum of the feet might be caused by poor blood flow in the bedridden elderly group, as ABI was low in this group.

In the young and adult groups, deformation was located at the medial aspect of the 1st metatarsophalangeal joint. However, in the bedridden elderly group, deformation was not only located at the medial aspect of the 1st metatarsophalangeal joint but at the toes. That might be caused by contracture.

Erythema was located on the toes in the young and adult groups but was found at other regions in the bedridden elderly group. These differences were coming from the differences in the region which pressure and friction were existed between both groups.

Pressure and friction in the young and adult groups is caused by shoes, and in the bedridden elderly group the mattress induces pressure and friction.

4. Preventive care for the diabetic foot

Moisturizing is important because of the high prevalence of dry skin in all groups. In the adult group, as some patients had neuropathy, the identification of high-risk patients is important. Additionally, an education regarding well-fitting shoes is needed to prevent corns. In the bedridden elderly group, the prevention of contracture and injury at bony prominences is important.

Our detailed observation with sketches allowed us to identify more foot manifestations with non-ulcerative pathology than previous studies. We believe that such detailed observation by healthcare professionals might allow the early identification of the foot manifestations with non-ulcerative pathology and increase the effectiveness of preventive care for the diabetic foot.

5. Limitations and future issues

The relationship of the foot manifestations with foot care or education was unclear, as we did not investigate in the present study. As small and region-specific population samples were observed, a larger sample size incorporating different regions is needed. In addition, the effectiveness of prevention care, specifically moisturizing care, for the diabetic foot that takes into account aging and mobility should be evaluated.

CONCLUSION

The foot manifestations of young, adult, and bedridden elderly patients differed. In young patients, no ulceration was found; the most frequent foot manifestations with non-ulcerative pathology were dry skin, which was located on the heels. In the adult group, 4.5% had ulcers, and the most frequent non-ulcerative foot manifestation was dry skin, which was located on the heels. In the bedridden elderly, 2.3% had ulceration, and the most frequent non-ulcerative foot manifesta-

tion was dry skin, located on the dorsum of the feet. Therefore, the preventive care for the diabetic foot should take into consideration age and mobility. As prevalence of dry skin was high in all groups, the more effective moisturizing care for diabetic patients should be developed.

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小児及び成人、寝たきり高齢の糖尿病患者における 足の所見に関する研究：横断的観察研究

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キーワード

足病変，糖尿病，糖尿病足病変

要 旨

目的：小児、成人、寝たきり高齢の糖尿病患者における足の所見を調査する。

方法：3群の糖尿病患者を対象とした横断研究であった。足の所見の種類と保有率は小児群17名、成人群22名、寝たきり高齢群44名の調査より算出した。病歴は診療録より情報収集した。

結果：小児群では潰瘍の保有はなく、非潰瘍性病変は、乾燥64.7%、紅斑35.2%、胼胝17.6%、変形17.6%であった。成人群では潰瘍4.5%、乾燥86.3%、胼胝22.7%、鶏眼22.7%。変形13.6%、紅斑4.5%、血腫4.5%であった。高齢寝たきり群では潰瘍2.3%、乾燥88.6%、変形43.2%、紅斑6.8%、血腫2.3%であった。乾燥は小児群と成人群では踵、寝たきり高齢群では足背側に保有していた。

結論：各群で足の所見は異なっていたことより、糖尿病足病変の予防ケアには年齢や可動性を考慮すべきである。全ての群において乾燥の保有率が高かったため、糖尿病患者に対する効果的な保湿ケアを開発する必要がある。