ORIGINAL ARTICLE

Are Foot Abnormalities More Common in Adults with Diabetes? A Cross-Sectional Study in Basrah, Iraq

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Abstract

Background: Altered foot biomechanics, limited joint mobility, and bony deformities with neuropathy, peripheral vascular disease, and infection have been associated with an increased risk of ulceration and amputation among patients with diabetes. The aim of our study was to estimate prevalence of foot abnormalities among Iraqis with diabetes and to see if they are more common than in a control population.

Methods: We structured the study as a comparative outpatient clinic study. The study population consisted of 100 patients with type 2 diabetes and 100 patients without diabetes as the control group. The study was conducted between January 2006 and August 2007. The patients and study control subjects were selected from the outpatient clinic at Al-Faiha Hospital in Basrah, southern Iraq. All were adults of at least 40 years of age.

Results: There were no differences between the two groups regarding sex, age, weight, qualifications, smoking status, marital status, or residency, but patients with diabetes had a higher body mass index and a higher socioeconomic status. No differences were found in the type of footwear worn or in occupation. Foot abnormalities associated with diabetes were prominent metatarsal heads, hammertoe, high medial arch, wasting, joint stiffness, amputation, fissures, nail changes, ulcer, and dermopathy on univariate analysis. With a multivariable model using logistic regression, only wasting (odds ratio [OR], 0.21; 95% confidence interval [CI], 2.16–11.33; p = 0.0002), ulcer (OR, 0.08; 95% CI, 1.12–134.59; p = 0.03), and dryness (OR, 0.11; 95% CI; 1.19–7.32; p = 0.01) remained significantly associated with diabetes.

Conclusion: We checked for 17 foot abnormalities associated with diabetes and found that 13—prominent metatarsal head, high medial arch, hammertoe, wasting, joint stiffness, amputation, fissures, nail changes, ulcers, blisters, dryness, sclerosis, and dermopathy—were statistically more frequent in study participants with diabetes than in control study subjects without diabetes. In a logistic regression model, only wasting, ulcer, and dryness remained strongly associated with diabetes. A larger study is needed to see the relationship of these abnormalities with footwear worn, duration of wearing footwear, occupation, duration of diabetes, and insulin use.

Introduction

Foot problems are common in patients with diabetes, often requiring prolonged and costly hospital stays and eventually leading to lower extremity amputation.[1]

Motor neuropathy affects the function of the intrinsic and extrinsic musculature of the foot, thus upsetting the delicate balance between flexors and extensors of the toes.[2] Atrophy of the small muscles responsible for metatarsophalangeal (MTP) plantar flexion is thought to lead to the development of hammertoes, claw toes, prominent metatarsal heads, and pes cavus.[3] Unfortunately, structural deformities are common sites of abnormally high pressure. Repetitive pressure at these sites can result in tissue breakdown and in calluses, and in the absence of protective sensation, continued activity can cause the calluses to thicken, hemorrhage underneath, and eventually ulcerate.[4,5]

Altered foot biomechanics, limited joint mobility,

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bony deformities with neuropathy, peripheral vascular disease, and infection have been associated with an increased risk of ulceration and amputation.[6,7] The critical triad most commonly seen in patients with diabetic foot ulcers is peripheral sensory neuropathy, deformity, and trauma. All of these risk factors are present in 65% of diabetic foot ulcers.[8]

Autonomic neuropathy is reflected by decreased sweating, loss of skin temperature regulation, and autosympathectomy. Anhydrosis results in xerotic skin and predisposes skin to fissures, cracks, and callus formation.[9]

Appropriate footwear is integral to ulcer prevention.[10] Prescription footwear and custom-fitted orthotics have been shown to prevent occurrence and recurrence of complications and increase patients' use of shoes outdoors. Clinical recommendations for people with diabetes include provision of special footwear to individuals with foot risk factors.[11]

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We found, in a previous study conducted in Basrah, Iraq, that structural foot abnormalities in patients with diabetes had the following incidences: prominent metatarsal heads in 36.2%, wasting in 11.5%, hammertoes in 10.9%, pes cavus in 5.4%, claw toes in 3.8%, and amputation in 2.1%. Skin changes included dryness of the skin in 17%, fissures in the skin in 14.7%, calluses in 14.2%, tinea pedis in 13.7%, foot ulcer in 13.7%, and nail changes in 7.1%.[12] Peripheral neuropathy and dermopathy were seen in 21.9% and 6%, respectively. Although it is widely assumed that these foot abnormalities are more common in patients with diabetes, a comparison of abnormalities in patients with diabetes versus abnormalities in study control subjects without diabetes has not been reported before.

In this study, we sought to estimate the prevalence of foot abnormalities among patients with diabetes and to determine whether they are more common than persons without diabetes.

Research Design and Methods

This was a comparative outpatient clinic study. The study population consisted of 100 patients with type 2 diabetes; 100 patients without diabetes served as the control group. The study was conducted between January 2006 and August 2007. Patients and study control subjects were selected from the outpatient clinic from Al-Faiha Hospital in Basrah, in southern Iraq. We included only adults aged 40 years and older; women were included only if they were not pregnant. Patients who were dieting, with or without drug therapy, to treat diabetes were considered diabetic.

For all patients, a medical history was taken, which included age, smoking status, job status, and education (years of school attended). Patients who were cigarette smokers were considered smokers, whereas those who had been smoke free for at least one year were considered nonsmokers. Socioeconomic status was calculated, and each patient was classified into low or intermediate socioeconomic status on the basis of the aggregate score of education level, occupation, and income.[13p25-6] Residency was divided into rural and urban according to patients' addresses.

Patients' footwear types were divided into sandals, sneakers, cut shoes (locally made shoes not related to foot conditions), shoes, and boots. The patients who used footwear were divided into two groups: those whose footwear use was >12 hours/day and those whose use was ≤12 hours/day.

Weight, height, and body mass index ([BMI] calculated according to the Quetelet formula: weight in kilograms divided by height in square meters) were determined for all patients.

Definitions

Each foot was evaluated and examined during the study by one of the two authors for the following abnormalities. If an abnormality was present in either foot, the individual was considered to have the abnormality.

Structural foot abnormalities were defined as follows:

- Prominent metatarsal heads were defined as "any palpable plantar prominences of the metatarsal site of the foot"
- High medial arch (pes cavus) was defined as "an abnormally high medial longitudinal arch, which extends between the first metatarsal head and the calcaneus"[5,14–17]
- Extension contracture at the MTP joint with flexion contracture at the proximal interphalangeal (PIP) joint was called hammertoe
- Hyperextension of the MTP and flexion of the PIP and distal interphalangeal joint was called claw toe[18]
- Wasting was defined as guttering between metatarsal heads[15]
- Joint stiffness was defined as any limitation of dorsiflexion of the forefoot or toes[19]
- Hallux valgus was defined as a lateral angulation of the first MTP joint of the great toe.[20]

Abnormalities of the skin of the foot were defined as follows:

- Callus was defined as any hyperkeratotic formation due to shear stresses, usually in proximity to a bony prominence
- Dryness was assessed objectively
- Fissures were defined as any skin break that did not fit the definition of foot ulcer
- Nails changes included any longitudinal ridging, fissuring, separations, loss, or thickening[5,14–16]
- Diabetic foot ulcer was defined as any full-thickness skin lesion distal to the ankle, excluding minor abrasions, fissures, or blisters
- Interdigital fungal infection (tinea pedis) was defined as any white, macerated skin in any web spaces.[21]

Statistical Analysis

All data were analyzed in 2007 by SPSS version 8.0 for Windows (SPSS Inc, Chicago, IL). Differences between the groups were tested by Student *t*-test in the case of continuous data and by χ^2 test or Fisher's exact test (low numbers) in the case of categoric data. Univariate analysis was performed to determine each foot abnormality's association with diabetes. Variables found associated with diabetes in univariate analyses were then entered into a multivariable model using logistic regression to determine the power of each foot abnormality for association with diabetes. A p value of <0.05 was considered statistically significant.

Results

Characteristics of patients with diabetes and of study control subjects are detailed in Table 1. Of patients

Table 1. Study participant characteristics

Characteristics		No. of participants with diabetes (%)	No. of participants without diabetes (%)	p value
Sex	Men	41 (41.0)	48 (48.0)	NS
	Women	59 (59.0)	52 (52.0)	
Age (years), mean ± SD		58.34 ± 10.61	56.02 ± 10.42	NS
Weight (kg), mean ± SD		69.83 ± 16.73	68.73 ± 12.15	NS
Body mass index		26.15 ± 6.16	25.14 ± 5.06	<0.001
Education (years)		3.28 ± 4.58	3.97 ± 5.10	NS
Smoker		19 (19.0)	20 (20.0)	NS
Duration of diabetes		3.96 ± 6.06	—	
Insulin use (any type, for any duration)		26 (26.0)	—	
Marital status	Married	100 (100.0)	98 (98.0)	NS
	Unmarried	0 (0.0)	2 (2.0)	
Residency	Urban	66 (66.0)	69 (69.0)	NS
	Rural	34 (34.0)	31 (31.0)	
Socioeconomic status	Intermediate	23 (23.0)	10 (10.0)	0.02
	Low	77 (77.0)	90 (90.0)	
Total sample		100	100	

NS = not significant; SD = standard deviation

Table 2. Type of footwear, duration of wearing, and occupation

		No. of participants with diabetes (%)	No. of participants without diabetes (%)	p value
Type of footwear	Sandals, sneakers	88 (88.0)	87 (87.0)	1.0
	Cut shoes, shoes, boots	12 (12.0)	13 (13.0)	
Duration of wearing	>12 hours	14 (14.0)	3 (3.0)	0.009
	≤12 hours	86 (86.0)	97 (97.0)	
Occupation	Worker	20 (20.0)	27 (27.0)	0.52
	Farmer	3 (3.0)	2 (2.0)	
	Housewife	56 (56.0)	47 (47.0)	
	Unemployed	21 (21.0)	24 (24.0)	

Table 3. Foot abnormalities among study participants

	No. of participants with diabetes (%)	No. of participants without diabetes (%)	p value
Structural abnormalities			
Prominent metatarsal head	57 (57.0)	36 (36.0)	0.004
High medial arch	14 (14.0)	3 (3.0)	0.009
Hammertoe	29 (29.0)	13 (13.0)	0.009
Claw toe	7 (7.0)	4 (4.0)	NS
Hallux valgus	16 (16.0)	13 (13.0)	NS
Wasting	66 (66.0)	23 (23.0)	<0.001
Joint stiffness	33 (33.0)	6 (6.0)	<0.001
Amputation	9 (9.0)	1 (1.0)	0.01
Skin changes			
Callus	75 (75.0)	66 (66.0)	NS
Fissures	90 (90.0)	76 (76.0)	0.01
Nail changes	76 (76.0)	52 (52.0)	0.001
Ulcers	27 (27.0)	1 (1.0)	<0.001
Tinea pedis	1 (1.0)	0 (0.0)	NS
Blisters	1 (1.0)	0 (0.0)	0.04
Dryness	1 (1.0)	0 (0.0)	<0.001
Sclerosis	1 (1.0)	0 (0.0)	<0.001
Dermopathy	38 (38.0)	3 (3.0)	<0.001

NS = no significance

Table 4. Multivariate association of foot abnormalities with diabetes

	B	Odds ratio (95% confidence interval)	p value
Constant	–29.5		NS
Structural abnormalities			
Prominent metatarsal head	–0.4	0.00 (0.25–1.44)	NS
High medial arch	1.3	0.06 (0.88–18.34)	NS
Hammertoe	0.0005	0.00 (0.38–2.59)	NS
Wasting	1.5	0.21 (2.16–11.33)	0.0002
Joint stiffness	1.06	0.07 (0.95–8.90)	NS
Amputee	2.1	0.03 (0.54–123.56)	NS
Skin changes			
Fissures	0.3	0.00 (0.48–4.31)	NS
Nail changes	0.7	0.05 (0.89–4.91)	NS
Ulcers	2.5	0.08 (1.12–134.59)	0.03
Blisters	4.7	0.00 (0.00–0.64 E+18)	NS
Dryness	1.0	0.11 (1.19–7.32)	0.01
Sclerosis	-0.08	0.00 (0.30–2.72)	NS
Dermopathy (shin spots)	1.5	0.09 (1.11–21.28)	0.03

NS = no significance

with diabetes, 41.0% were men and 59.0% were women versus 48.0% men and 52.0% women in the control group (p = 0.39). There was no difference between the groups in age, weight, education level, smoking status, marital status, or residency (urban vs rural). The BMI in the group with diabetes was 26.15 ± 6.16 kg/m^2 vs 25.14 ± 5.06 kg/m^2 for the control group (p < 0.001). The duration of diabetes was 3.96 ± 6.06 years. Of the group with diabetes, 26.0% were taking insulin. In the socioeconomic category, 90% of the control group was of low socioeconomic status, whereas 77% of the group with diabetes was of low socioeconomic status.

The type of the footwear worn and number of hours it was worn daily are detailed in Table 2. There was no difference between the two groups regarding the type of footwear worn, whether sandals, sneakers, shoes, or boots. Ninety-seven percent of the control group had worn footwear for ≤12 hours and 86% of the group with diabetes had done so (p = 0.009). There was no significant difference between the two groups regarding occupation (p = 0.52).

The distribution of structural foot abnormalities is detailed in Table 3. Prominent metatarsal heads (57.0% vs 36.0%; p = 0.004), high medial arch [pes cavus] 14.0% vs 3.3%; p = 0.009), and hammertoes (29.0% vs 13%; p = 0.009) occurred more often in the diabetes group than in the control group. Claw toes (7.0% vs 4.0%) and hallux valgus (16.0% vs 13.0%) were seen almost equally in both groups. Wasting was more common (66.0% vs 23.0%; p < 0.001) in the diabetic group than in the control group. Joint stiffness (33.0% vs 6.0%; p < 0.001) and amputation (9.0% vs 1.0%; p < 0.018) occurred more often in the diabetes group than in the control group.

There were no statistically significant differences between the two groups regarding callus rate (75.0% for the diabetes group vs 66.0% for the control group), but fissures (90.0% vs 76.0%) were more common in the diabetic group (p = 0.013). Nail changes (76.0% vs 52.0%), ulcers (27.0% vs 1.0%), and dermopathy (38.0% vs 3.0%) were far more common in the diabetes group (p < 0.001).

When the 13 foot abnormalities significantly associated with diabetes were entered simultaneously into a logistic regression model (Table 4), only wasting (odds ratio [OR], 0.21; 95% confidence interval [CI], 2.16–11.33; p = 0.0002), ulcer (OR, 0.08; 95% CI, 1.12–134.59; p = 0.03), and dryness (OR, 0.11; 95% CI, 1.19–7.32; p = 0.01) remained strongly associated with diabetes.

Discussion

To our knowledge, this was the first attempt to study the prevalence of foot abnormalities in detail among Iraqis with diabetes.

The BMI in the diabetes group of this study was higher than in the control group. This was confirmed in an earlier study in Iraq.[22]

No difference in the smoking rate was found between groups in this study; however, smoking is a known risk factor for diabetes foot ulcer.[23]

No difference was found between types of footwear worn or occupation in both groups, but more of those who had worn footwear ≤12 hours were in the control group than in the diabetes group. Though the aim of this study was not to show the relationship between footwear worn and duration of wearing footwear, occupation, and foot abnormalities, because studies have confirmed that inappropriate footwear is the most common source of trauma and cause of ulceration in patients with diabetes,[24] and Jayasinghe and coworkers[25] even found that walking barefoot is a risk factor for diabetic foot disease in Sri Lanka.

In western Washington State health care organizations, a survey of 400 diabetic patients found pes cavus in 19.5%, hallux valgus in 23.9%, and hammertoes/claw toes in 46.7%;[17] whereas in our study, pes cavus (high medial arch) was seen in 14.0%, hallux valgus in 16.0%, and hammertoes/claw toes in 36.0%. The prevalence of calluses in both groups in our study did not differ; however, there is a clear association between pathologic foot pressures as well as callus formation and the incidence of plantar ulcerations in other studies.[26,27]

Dryness was reported in this study in 1% of the diabetes group. Others have reported percentages ranging from 75% to 82.1%.[28] This discrepancy may be due to differences in the definition of dryness.

Conclusion

We gathered data on 17 foot abnormalities associated with diabetes and found that 13 were statistically more frequent than in study control subjects without diabetes: prominent metatarsal head, high medial arch, hammertoe, wasting, joint stiffness, amputation, fissures, nail changes, ulcers, blisters, dryness, sclerosis, and dermopathy. In a logistic regression model, only wasting, ulcers, and dryness remained strongly associated with diabetes. A larger study is needed to see the relationship of these abnormalities with the type of footwear used, daily duration of footwear use, occupation, duration of diabetes, and insulin use. ❖

Editor's Note

When this manuscript appeared in our mail box, we asked ourselves how and why it came to us. We asked the authors and they replied that they read the journal regularly online and that it is popular with a lot of doctors in Iraq. We were pleasantly surprised by the scope of our online readership and we are happy to publish this article.

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

Acknowledgments

We thank Lesley Pocock, Publisher and Managing Director, medi+WORLD International, World CME, for reviewing the manuscript.

Katharine O'Moore-Klopf of KOK Edit provided editorial assistance.

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Each Day's Work

As to your method of work, I have a single bit of advice, which I give with the earnest conviction of its paramount influence in any success which may have attended my efforts in life—Take no thought for the morrow. Live neither in the past nor in the future, but let each day's work absorb your entire energies, and satisfy your widest ambition.

— After Twenty-Five Years, *William Osler, MD, 1849-1919, American physician, pathologist, author, and historian*