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Assessment of the Outcome of Diabetic Foot Ulcers in Basrah, Southern Iraq: A Cohort Study

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Keywords
Basrah · Diabetic foot ulcers · Outcome

Abstract
Background: Diabetic foot ulcers are one of the most severe and costly complications of diabetes. Foot ulcers result from a combination of multiple causes including peripheral neuropathy and peripheral arterial disease. Patients with diabetic foot ulcers frequently require amputation of the lower limb. ***Objectives:*** The aim of this study was to assess the outcome of diabetic foot ulcers among Iraqi patients with diabetes and to examine the effect of some risk factors on healing of the ulcer. ***Methods:*** A cohort study was conducted on 100 patients from January to August 2017 at the Diabetic Foot Clinic, Alfayha Teaching Hospital, Basrah, Iraq. ***Results:*** A total of 100 patients with diabetic foot ulcers were included. The ulcers of 60% of the patients healed, whereas 8% persisted unhealed; 25% of the patients had a minor amputation, 5% had a major amputation, 1% had recurrent ulcers, and 1% died. The study showed statistically significant associations between diabetic foot ulcer healing and the following variables: patients' age, glycated HbA_{1c}, duration of diabetes, complications of diabetes like peripheral neuropathy, and ulcer size. ***Conclusions:*** Diabetic foot ulcer outcomes can be predicted by several factors, some of which are modifiable. Modification of the modifiable factors, such as better control of diabetes, treatment of peripheral neuropathy, and early management of ulcers, may improve the outcome and facilitate healing.

Introduction

Diabetes mellitus (DM) is a global epidemic, and diabetic foot ulcers (DFUs) are one of its most severe and costly complications and represent one of the most common causes of hospitalization of diabetic patients. DFUs are complex, chronic wounds which have a major long-term impact on patients' morbidity, mortality, and quality of life [1]. DFUs are relatively common. Once the protective layer of a skin is broken, deep tissues are exposed to a bacterial infection that progresses rapidly. Patients with DFUs frequently require amputation of the lower limbs, and in more than half of the cases, infection is the predominant factor. It has been reported that around 25% of people with diabetes will develop a DFU during their lifetime [2]. In addition, it has been estimated that every 20 s a lower limb is amputated due to diabetic complications [3]. In fact, every year 5% of the patients with

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Table 1. Basic characteristics of the participants

Characteristic	Subjects, *n*
Gender	
Male	51
Female	49
BMI	
Normal	39
Overweight	33
Obese	28
Type of DM	
Type 1	4
Type 2	96
Treatment of DM	
Oral antidiabetic	35
Insulin	36
Combined	27
No treatment	2
HbA_{1c}	
<7%	14
>7%	86
Infection (clinical)	
Present	45
Absent	55
Smoking	
Current smoker	15
Ex-smoker	40
Nonsmoker	45

BMI, body mass index; DM, diabetes mellitus.

diabetes develop foot ulcers, and 1% require amputation [4].

In most patients, peripheral neuropathy, peripheral arterial disease, or both play a central role in the development of foot ulcer [5]. A proper assessment of the outcome of foot ulcer requires inspection, palpation, and probing of the soft tissue wound on the feet on initial presentation and during follow-up [6]. In Iraq, there have been no previous studies to describe the outcome of DFUs.

The aim of this study was to assess the outcomes of DFUs in Iraqi patients with diabetes, classifying them into the following categories: healing, persisting unhealed, minor amputation, major amputation, recurrence, and death. Also, it aimed at examining the effects of some risk factors on ulcer healing, such as patient age, HbA_{1c}, duration of diabetes, complications of diabetes like peripheral neuropathy, and ulcer size. We hypothesized that the aforementioned risk factors would affect the DFU outcomes. This study presents the baseline data for further DFU studies in Iraq.

Subjects and Methods

This was a cohort study including patients who attended the Alfayha Diabetic Foot Clinic, Basrah, Iraq, from January to August 2017. All patients with diabetes aged 18–90 years and having DFUs were included. Those who had diabetic foot lesions other than ulcers or those who had no diabetes were excluded from the study. A total of 100 adult patients with DFUs were included in this study.

The demographic data and duration of diabetes were recorded. The diagnosis of peripheral neuropathy was based on clinical signs and symptoms, in addition to insensitivity of the foot to 10-g Semmes-Weinstein monofilament [7], loss of vibration perception tested by using a 128-Hz tuning fork on the medial malleolus and the dorsal aspect of the big toe [8], and the absence of ankle reflexes.

The diagnosis of ischemia in the foot was based on bedside examination, by looking for specific presenting signs and symptoms (dry, shiny, hairless skin on the affected limb; brittle nails; and skin which is cool to touch) with measurement of the ankle-brachial index. A result of 1–1.2 was considered normal. A result <0.9 was considered abnormal. A laboratory blood test for HbA_{1c} was ordered. HbA_{1c} was measured by BIO-RAD D-10 high-performance liquid chromatography. In addition, a clinical examination of the ulcer and measurement of its size were done. Clinical evidence of an infection according to the Infectious Disease Society of America (IDSA) was reported. After that, treatment was started with surgical debridement to remove all nonviable tissue. Follow-up was conducted weekly for 6 months and the outcomes were classified into one of the following six categories:

1. Healing, defined as a continuous viable epithelial covering over the entire, previously open wound [9]
2. Persisting unhealed, defined as incomplete re-epithelialization of the wound [9]
3. Minor amputation, defined as amputation restricted to the foot, not affecting walking ability (transmetatarsal, tarsometatarsal, or Lisfranc's amputation) [10]
4. Major amputation, defined as amputation performed above the level of the ankle [10]
5. Recurrence, defined as re-ulceration, most commonly occurring on the same foot [11]
6. Death

SPSS version 22 was used to perform the statistical analysis. The data are reported as counts and percentages, and the level of significance is set at $p < 0.05$. The χ^2 test and Fisher's exact test were used to test for correlations between variables. Multivariate analysis by logistic regression was applied to adjust for other variables when testing the effect of each risk factor on DFU outcome.

Results

A total of 100 patients were included in this study. Of them, 51 were male and 49 female. The mean age of the participants was 53.6 ± 9.6 years. Sixty-one percent of the participants were overweight or obese. The majority of them had type 2 diabetes. Two-thirds were on insulin, either combined with oral antidiabetic drugs or alone. Only

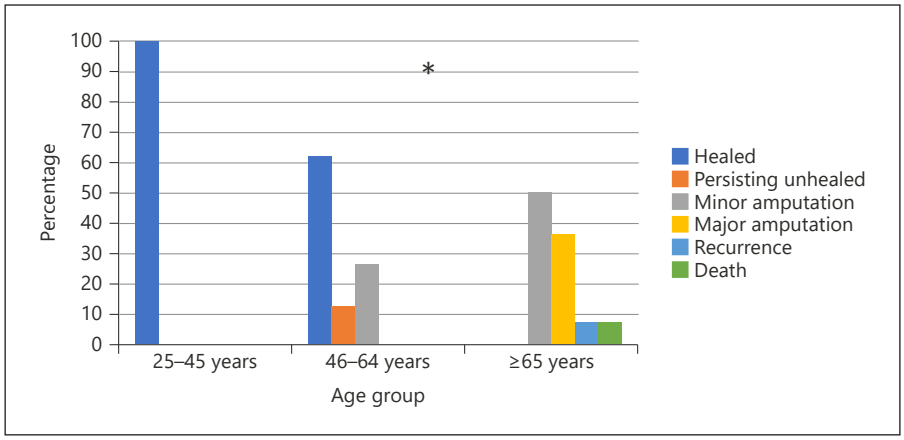

Fig. 1. Association between age and outcome of diabetic foot ulcers. * $p = 0.006$.

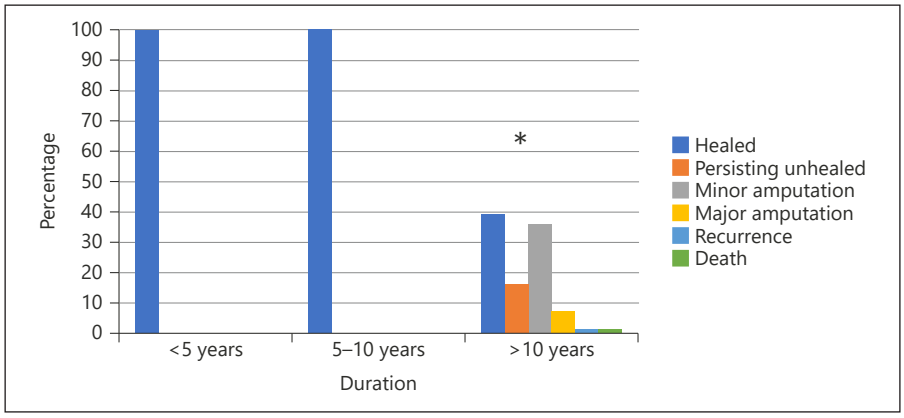

Fig. 2. Association between duration of diabetes mellitus and outcome of diabetic foot ulcers. * $p = 0.0001$.

14% of the studied population were smokers (Table 1). We classified the participants into three age groups: 25–45, 46–64, and ≥65 years.

The majority (62%) of the patients in the age group of 46–64 years were healed, while the age group ≥65 years had poor outcomes, with 50% of them undergoing a minor amputation, 36% undergoing a major amputation, 7% with recurrence, and 7% dead ($p = 0.006$), as shown in Figure 1.

Regarding the relation between duration of DM and DFU outcome, 39% of those with a duration of their DM of >10 years had healed, compared to 100% of those with a duration <10 years ($p = 0.0001$), as shown in Figure 2.

Regarding the relation between HbA_{1c} level and DFU outcome, those with HbA_{1c} <7% had a 100% healing rate, compared to those with HbA_{1c} >7%, of whom only 53.6% had healed ulcers ($p = 0.007$), as shown in Figure 3.

Regarding the association between peripheral neuropathy and DFU outcome, half of those with peripheral neuropathy had their ulcers healed, compared to all of those without ($p = 0.03$), as shown in Figure 4.

Finally, studying the association between ulcer size and DFU outcome revealed that 73% of those patients with an ulcer size >5 cm ended up with a minor amputation. In contrast, those with small ulcers (<1 cm in diameter) had a 100% healing rate ($p = 0.001$), as shown in Figure 5.

The percentage of healed ulcers according to each variable is summarized in Table 2. The univariate statistical significance was maintained after applying multiple logistic regression, as shown in Table 3.

Discussion and Conclusion

This study was conducted on 100 patients with DFUs attending the Alfayha Diabetic Foot Clinic. There was no gender difference, and the majority of the participants were in the middle age group. Most of the participants had type 2 DM, which is more common than type 1 DM. In addition, around two-thirds were on insulin, which may reflect the long duration of diabetes among the pa-

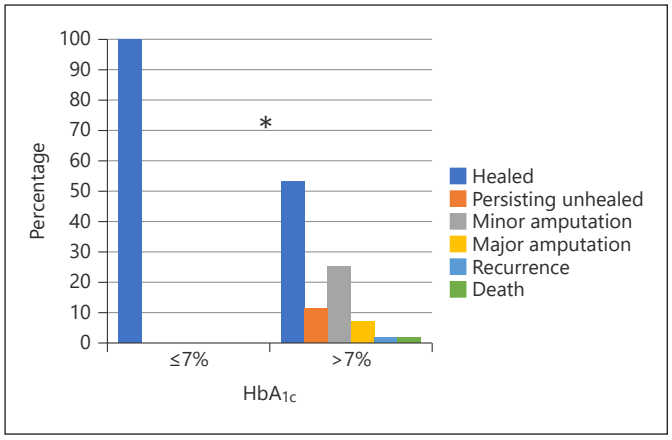

Fig. 3. Association between HbA_{1c} and outcome of diabetic foot ulcers. * $p = 0.007$.

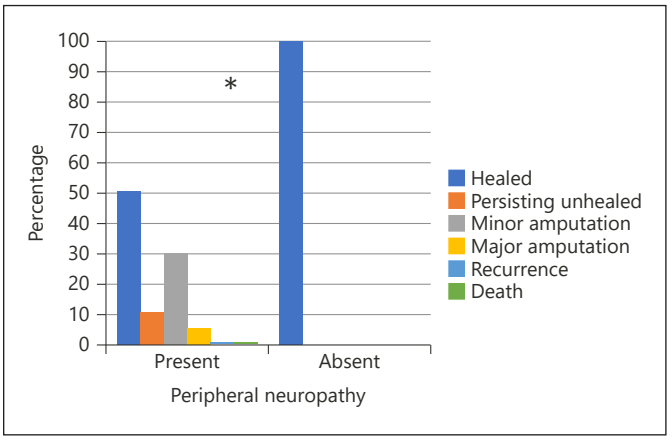

Fig. 4. Association between peripheral neuropathy and outcome of diabetic foot ulcers. * $p = 0.03$.

Table 2. Percentage of healed ulcers according to different variables

Risk factor	Groups	Healed DFUs, %	*p* value
Age	25–45 years	100	0.006
	46–64 years	62	
	≤65 years	0	
DM duration	<5 years	100	0.0001
	5–10 years	100	
	>10 years	39	
HbA_{1c}	≥7%	100	0.007
	>7%	53	
Peripheral neuropathy	Present	51	0.03
	Absent	100	
Ulcer size	<1 cm	100	0.001
	1–5 cm	48	
	>5 cm	0	

DFUs, diabetic foot ulcers; DM, diabetes mellitus.

Table 3. Multiple logistic regression model of the effect of risk factors on ulcer healing

Risk factor	Odds ratio	95% CI	*p* value
Age	1.00	0.99–1.00	0.15
Diabetes mellitus duration	0.91	0.79–1.05	0.20
HbA_{1c}	0.95	0.84–1.08	0.44
Peripheral neuropathy	1.11	0.87–1.41	0.41
Ulcer size	1.00	0.88–1.14	0.99

tients. The study shows that patients ≥65 years old have a poor outcome compared with other age groups; this finding is similar to what has been reported in the study by Katsilambros et al. [12], which revealed that the amputation rate increased with age, being 1.6% in the age group of 18–44 years, 3.4% in the age group of 45–64 years, and 3.6% in patients ≥65 years. As people become older, the wound healing process is impaired, due to many factors such as peripheral arterial disease, decreased defense mechanisms, and impaired immunity.

The longer the duration of DM, the higher the probability that DFUs end up with an outcome other than healing. The DFUs in all those with a duration of DM <10 years had healed. This is similar to the findings of two other studies, one from Saudi Arabia [13] and one from China [14]. Both microvascular and macrovascular complications of DM are directly related to the duration of the disease.

The study showed that those with poorly controlled DM, as reflected in an HbA_{1c} >7%, had a poor outcome with regard to DFUs. This is similar to the results of a study from India that showed a clear and significant relation between diabetic foot complications and the degree of glycemic control [15]. Poor glycemic control is the main risk factor for developing diabetic complications. Consequently, optimal control of plasma glucose will halt the progression of all complications including DFUs.

Peripheral neuropathy is one of the major risk factors for all foot complications. The study showed that all those who had no peripheral neuropathy achieved ulcer healing

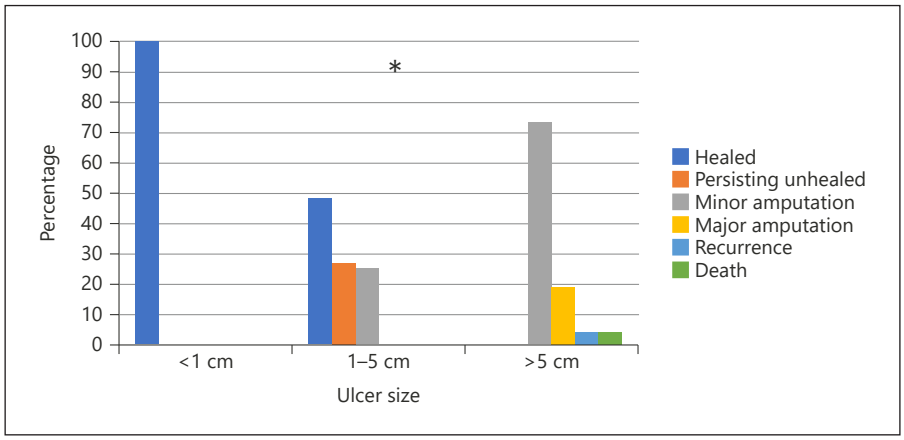

Fig. 5. Association between ulcer size and outcome of diabetic foot ulcers. * $p = 0.001$.

without complications. This strong association of peripheral neuropathy with diabetic foot complications has been also reported in a study from Saudi Arabia, where 33% of their diabetic patients were suffering from chronic nerve compression [16]. Peripheral neuropathy exposes the afflicted patient to repetitive trauma to the feet. In addition, it increases the duration of pressure over the area without the patient noticing it.

The size of the wound also plays a critical role in prognosis, and this study showed that those with DFUs >5 cm in diameter had poorer outcomes than those with smaller ulcers. These findings are similar to those of another study from the USA, which demonstrated that the risk factors or wound characteristics that are most dramatically associated with failure of wound healing are increased wound size and duration [17].

Optimal glycemic control, patients' education about the importance of foot care, and increasing the awareness of health care providers in order to diagnose DFUs in the early stages and to prevent the development of high-grade wounds are very important steps to reduce the burden of DFUs and their effect on the quality of life of people with DM.

Promotion of the role of primary health care providers in Iraq in screening for diabetic foot by using foot screening tools as well as patient education (advising them regarding diet and physical activity, foot hygiene, nail cutting, treatment of calluses, and appropriate footwear) are recommended. Early diagnosis and management of DFUs is crucial. Special care should be provided to those at risk of DFU complications, such as elderly people and those with poorly controlled or longer-lasting DM, larger ulcers, and peripheral neuropathy. The DFU outcome can be predicted from the age of the patient, duration of diabetes, glycemic control, ulcer size, and presence of complications such as peripheral neuropathy. Future, larger studies are required to further understand DFU outcomes in Iraq.

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Statement of Ethics

Written informed consent was obtained from each participant. Ethical approval was obtained from the Research Ethics Committee of the Basrah Health Directorate.

Disclosure Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All authors have directly participated in the planning, execution, and analysis of this study. All authors have critically reviewed and approved the final draft and are responsible for the content of the manuscript.

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