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Correlation between Uncontrolled Type 2 Diabetes Mellitus and Diabetic Foot Ulcer-A Cross Sectional Hospital Based Study

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ABSTRACT

Background: The most common result of uncontrolled diabetes mellitus is diabetic foot ulcers (DFU), and extensive study has been done on the relationship between DFU and diabetes-related variables such as FBS, RBS, and glycosylated hemoglobin (HbA1c).

Methods: During the study period, 150 individuals with a diagnosis of diabetic foot were enrolled in this cross-sectional study. The HbA1c values were determined by drawing blood samples. Wagner categorization grading was carried out following the diabetic foot ulcer examination. Age, gender, length of DM, and other foot ulcer risk variables were also reported as demographics.

Results: The majority of the patients (46.7%) had very poor glycemic control (HbA1c level >10). The majority of the patients (43.5%) were 45-60 years old and predominantly male. The majority of the patients were overweight. Higher BMI was significantly associated with diabetic foot ulcers ($p<0.05$). Longer duration of DM, history of smoking and peripheral neuropathy were significantly associated with the DFU. Mostly, patients with grades 4 and 5 were found to have HbA1c >8%. However, patients with grades 1-3 had HbA1c<8%. The correlation of HbA1c with DFU showed a statistically significant linear relationship with $p < 0.05$.

Conclusion: The longer duration of DM, increased HbA1c, and diabetic neuropathy are the common risk factors of diabetic foot. We have also established a positive association between uncontrolled diabetes and diabetic foot ulcers.

Key-words: Diabetic foot ulcers, uncontrolled DM, HbA1c, type 2 diabetes mellitus, Wagner classification

INTRODUCTION

Diabetic foot infections present a major obstacle to the treatment of diabetes mellitus, sometimes resulting in serious complications and adverse results. Comprehending the risk factors linked to these infections is crucial for executing efficacious preventive measures and delivering prompt, suitable therapy [1].

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Lesions that may develop in the foot of a diabetic patient are referred to as diabetic foot ulcers (DFUs). Its neuropathic etiopathogenic basis is persistent hyperglycemia, which induces ulcers in the foot due to previous trauma, whether or not PVD is present. This issue is the primary cause of non-traumatic lower limb amputation and is one of the most dangerous consequences of diabetes [2]. One of the most frequent reasons diabetic people are sent to hospitals is diabetic foot ulcers (DFUs).

DFUs are intricate, persistent wounds that significantly affect a patient's morbidity, death, and quality of life over the long run [3]. DFUs are comparatively common; once the skin's protective barrier is breached, a bacterial infection that spreads quickly reaches deep tissues. Lower limb amputation is a common procedure for

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patients with DFUs, and infection is the main cause of these cases in over half of them. It has been estimated that approximately 25% of people with diabetes will experience a DFU at some point in their lives [4]. Diabetic foot infections arise from a multifaceted interplay of risk factors, encompassing patient-specific, foot-specific, and systemic variables [5]. Elevated glycated hemoglobin levels are known to be a reliable indicator of the severity of diabetes mellitus.

The most frequent risk factors for developing diabetic foot ulcers are having diabetes for a longer period and having poor glycemic control [6]. Our healthcare system is severely strained both financially and medically by diabetic foot (DF). More than any other diabetic complication, foot ulcers are the leading cause of hospitalization for patients with diabetes and also represent around 20% of total healthcare expenses. Because an infected neuropathic foot frequently leads to amputation, the great majority of these cases are likely avoidable [7]. Twenty percentages of infections result in amputation, and over half of all foot ulcers become infected and necessitate hospitalization [8].

Within two years of a major amputation, 50% of patients will have their other limb amputated. Compared to people with diabetes alone, those with a history of DF ulcers had a greater ten-year mortality rate. The clinical profile of diabetic foot varies across India and is influenced by factors such as going barefoot or wearing inappropriate footwear, being illiterate, believing in complementary and alternative medicine, and primary care physicians' lack of experience treating diabetic foot patients [9]. Foot ulcers are avoidable, and the incidence of amputations can be decreased with comparatively easy therapies. Routine foot assessments are severely lacking despite an apparent increase in the awareness of diabetic foot care. A high clinical emphasis should be placed on the early diagnosis of the foot at risk to prevent the development of foot ulcers [10].

MATERIALS AND METHODS

Study design- This was a cross-sectional observational hospital-based study conducted in the Department of Surgery at a tertiary care hospital in India.

Study subjects- All patients with foot ulcers and diabetes mellitus who were admitted to the Department of Surgery during the study period were enrolled.

Inclusion Criteria

- Patients age > 18 years of age with both gender
- All diabetic patients with foot ulcers
- Patients who provided consent for the study

Exclusion Criteria

- Patients age < 18 years of age
- Patient incidental ulcers, having inflammatory or infectious diseases, Charcot foot and traumatic amputations
- Gestational diabetic and seriously ill patients
- Patients who have not provided consent for the study

Diabetic foot ulcers were identified in individuals with diabetes, who had non-traumatic skin sores on their feet that extended beyond the malleoli. After a thorough examination, diabetic feet were ranked from 1 to 5 using the Wagner classification system. Wagner grade 1 denotes superficial ulceration, grade 2 denotes an ulcer that extends to tendons or joints, grade 3 denotes an ulcer that affects deeper tissues and bones, resulting in osteomyelitis or the formation of an abscess, grade 4 denotes forefoot gangrene, and grade 5 denotes whole foot gangrene.

Data collection and analyses- Every patient had a thorough sociodemographic assessment, had their diabetes for the entire term, had a baseline clinical examination with information about any ulcers, and had their palpable pulses evaluated. All study participants will undergo random blood glucose and glycosylated hemoglobin (HbA1c) testing as part of the laboratory investigations.

Statistical analysis- Version 22 of the Statistical Package for Social Sciences (SPSS) program was used to examine the data. Following stratification, frequency and percentages were determined from categorical variables, and the Chi-square test was used. Less than 0.05 was the threshold for statistical significance.

Ethical consideration- Approval for this study was obtained from the relevant ethical committee, ensuring that all research procedures adhered to ethical standards and guidelines for protecting participants' rights and confidentiality.

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RESULTS

A total of 150 patients with diabetic foot ulcers were enrolled and analysed in this study. The majority of the patients (46.7%) had very poor glycemic control (HbA1c level >10), 32% had poor glycemic control (HbA1c 8.1-10), 11.3% had fair glycemic control (HbA1c 7.1-8) and 8% had good glycemic control (HbA1c ≤7). Higher HbA1c level a was significantly associated with the DFU.

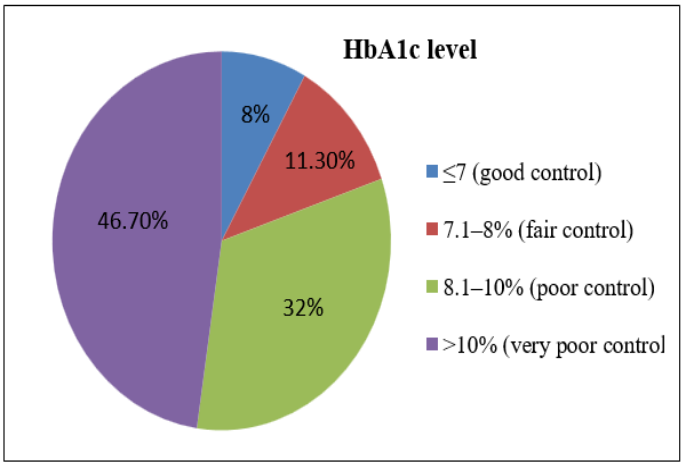

Fig. 1: Distribution of study subjects according to the HbA1c level

The majority of the patients (43.5%) were 45-60 years old, predominantly males (57.3%). Most of them (66.7%) reside in urban areas and half of them belong to the middle socio-economic class. Age, gender, residential and socio-economic status did not statistically differ between controlled and uncontrolled blood sugar levels (p>0.05). The majority of the patients were overweight. Higher BMI was significantly associated with diabetic foot ulcers (p<0.05) (Table 1).

Table 1: Socio-demographic characteristics of the DFU participants

Variables		Controlled DM (HbA1c ≤7)	Uncontrolled DM (HbA1c >7)	p-value
Age group in years	18-30	1 (8.3%)	8 (5.8%)	0.98
	31-45	3 (25%)	38 (27.5%)	
	45-60	5 (41.7%)	60 (43.5%)	
	>60	3 (25%)	32 (23.2%)	
Gender	Male	8 (66.7%)	79 (57.3%)	0.52
	Female	4 (33.3%)	59 (42.7%)	
Residence	Rural	3 (25%)	46 (33.3%)	0.55
	Urban	9 (75%)	92 (66.7%)	
BMI (Kg/m^2)	Normal	6 (50%)	30 (21.7%)	0.04
	Overweight	5 (41.7%)	60 (43.5%)	
	Obese	1 (8.3%)	48 (34.7%)	
Socio-economic class	Lower	1 (8.3%)	25 (18.1%)	0.67
	Middle	6 (50%)	65 (47.2%)	
	Upper	5 (41.7%)	48 (34.7%)	

Among the distribution of predisposing factors for DFU, longer duration of DM, history of smoking and peripheral neuropathy were common predisposing factors significantly associated with the prognosis of DFU, whereas diabetic nephropathy, vasculopathy, size of ulcer and presence of gangrene were not significant statistically (Table 2).

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Table 2: Comparison of Risk factors among controlled and uncontrolled DM with foot ulcer

Variables		Controlled DM (HbA1c ≤7)	Uncontrolled DM (HbA1c >7)	p-value
Duration of diabetes	< 5 years	2 (16.7%)	43 (31.2%)	0.04
	5-10 years	4 (33.3%)	36 (26.1%)	
	>10 years	6 (50%)	59 (42.7%)	
History of smoking	Yes	3 (25%)	76 (55.1%)	0.04
	No	9 (75%)	62 (44.9%)	
Diabetic Nephropathy	Present	2 (16.7%)	33 (23.9%)	0.56
	Absent	10 (83.3%)	105 (76.1%)	
Diabetic Vasculopathy	Present	3 (25%)	40 (28.9%)	0.76
	Absent	9 (75%)	98 (71.2%)	
Diabetic Neuropathy	Present	4 (33.3%)	92 (66.7%)	0.02
	Absent	8 (66.7%)	46 (33.3%)	
Ulcer Size	< 1 cm	6 (50%)	57 (41.3%)	0.73
	1-5 cm	5 (41.7%)	59 (42.7%)	
	> 5 cm	1 (8.3%)	22 (15.9%)	
Presence of gangrene	Yes	1 (8.3%)	23 (16.7%)	0.45
	No	11 (91.7%)	115 (83.3%)	

Most patients with grades 4 and 5 had HbA1c values more than 8%. HbA1c was less than 8% among patients in grades 1-3, nevertheless. HbA1c and the Wagner classification exhibited a statistically significant linear connection ($p < 0.001$) in correlation. Table 3 displays these results.

Table 3: Correlation of HbA1c level with ulcer grading (Wagner classification)

Ulcer grading	HbA1c ≤7	HbA1c 7.1-8	HbA1c 8.1-10	HbA1c >10
Grade 1	4 (33.3%)	1 (5.8%)	2 (4.2%)	1 (1.4%)
Grade 2	4 (33.3%)	2 (11.7%)	7 (14.6%)	8 (10.9%)
Grade 3	3 (25%)	4 (23.5%)	10 (20.8%)	14 (19.2%)
Grade 4	1 (8.3%)	8 (47.1%)	17 (35.4%)	20 (27.4%)
Grade 5	0 (00%)	2 (11.7%)	12 (25%)	30 (41.1%)

DISCUSSION

One of the most frequent reasons for hospital admissions in India is diabetic foot lesions, which are brought on by a variety of socio-cultural habits such as going barefoot, a lack of facilities for diabetic treatment, low levels of education, unfavorable socioeconomic circumstances, and poor glycemic control.

In our study, the majority of the DFU participants were in the 45-60-year age group, a similar finding observed by Bund *et al.* [11] and Alrashed *et al.* [12]. It may be because Diabetes Mellitus type II is classically seen in that particular age group.

The results of research by Abuhay *et al.* [13] and Fesseha *et al.* [14] are like the male preponderance found in the current study. Males are more likely than females to acquire diabetic foot infections due to higher foot pressure, less joint mobility, and an increased prevalence of neuropathy.

According to a study by Lavery *et al.* [15], patients in lower socioeconomic groups had a higher incidence of diabetic foot infections due to poor hygiene, a lack of knowledge about the nature of the illness, and a lack of care; however, our observation does not support this. The present study reported that the majority of the patients

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had HbA1c levels of more than 8 (poor glycemic control), our results comparable with the Farooque *et al.* [16]. Higher BMI was significantly associated with diabetic foot ulcers in this study, in agreement with Janmohammadi *et al.* [17] among subjects who developed DFU.

In our results, the common predisposing factors associated with DFU were longer duration of DM, smoking habit and presence of peripheral neuropathy. Our finding was similar to the many other researchers: Yin *et al.* [18], and Ravinthar *et al.* [19]. Smoking affects the small blood vessels and slows down wound healing.

We have observed that the severity of DFU was significantly correlated with the HbA1c level. Ulcer grading 4 & 5 were higher in Higher HbA1c levels>8, a consistent finding reported by Din *et al.* [20] and Sachar *et al.* [21]. Diabetic foot ulcers were more common in uncontrolled diabetes mellitus than in the controlled diabetes seen in this study by Casadei *et al.* [22] and Ojing Komut *et al.* [23].

The results of this study show that individuals with uncontrolled blood sugar had a lower success rate while treating DFU. Therefore, the degree of glycemic control influences both the likelihood of developing DFU and the effectiveness of its therapy. These results are consistent with those of Prakash *et al.* [24] and Abdissa *et al.* [25]. Overall diabetes duration, BMI, HbA1c level and diabetic neuropathy are constantly associated with DFU in the present research. Our results correlate with Almobarak *et al.* [26].

CONCLUSIONS

The most common factors linked to the DFU are smoking habit, diabetic neuropathy, longer duration of DM, and elevated HbA1c levels. A linear correlation exists between HbA1c and the Wagner grade of diabetic foot. Since tight glycemic control lessens neuropathy and vascular consequences of diabetes, it is crucial to prevent diabetic foot and its related complications through improved HbA1c management and awareness of correct foot care

CONTRIBUTION OF AUTHORS

Research concept-Savita Aharwal, Santosh Kumar
Research design- Savita Aharwal, Santosh Kumar
Supervision- Savita Aharwal, Santosh Kumar
Materials- Savita Aharwal, Santosh Kumar
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Article editing- Savita Aharwal, Santosh Kumar
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