Original Research

RISK FACTORS ASSOCIATED WITH DIABETIC FOOT ULCERS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT

Introduction: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia, which leads to long-term microvascular and macrovascular complications. Among these, diabetic foot ulcer (DFU) is one of the most debilitating complications, significantly contributing to morbidity, reduced quality of life, prolonged hospital stay, and non-traumatic lower limb amputations. DFU develops due to a combination of peripheral neuropathy, peripheral arterial disease, and minor foot trauma, often aggravated by poor glycemic control and inadequate foot care practices. Identification of modifiable and non-modifiable risk factors is essential for early prevention and effective management. This study aims to evaluate the risk factors associated with diabetic foot ulcers in patients with Type 2 Diabetes Mellitus.

Aims: To identify and analyze the risk factors associated with the development of diabetic foot ulcers in patients with Type 2 Diabetes Mellitus.

Materials and methods: This was a hospital-based observational study conducted in the Department of Medicine, Malti Multispecialty Hospital and Medical College, Turkhed, Taluka Murtizapur, District Akola, Maharashtra, India, over a period of one year. The study population comprised patients diagnosed with Type 2 Diabetes Mellitus attending both outpatient and inpatient departments. A total sample size of 100 patients was included in the study to evaluate the risk factors associated with diabetic foot ulcers among these patients.

Results: The present study included a total of 100 patients with Type 2 Diabetes Mellitus, of whom 40 patients had peripheral arterial disease (PAD) and 60 patients did not have PAD. The analysis showed a significant association between PAD and diabetic foot ulcer (DFU). Among the 40 patients with PAD, 25 patients (62.5%) developed DFU, while 15 patients (37.5%) did not develop DFU. In contrast, among the 60 patients without PAD, 15 patients (25.0%) developed DFU and 45 patients (75.0%) remained free of ulcers. Statistical analysis revealed that the association between PAD and DFU was significant ($p = 0.003$) .

Conclusion: Diabetic foot ulcer in Type 2 Diabetes Mellitus is a multifactorial complication influenced by both modifiable and non-modifiable risk factors. Early identification of high-risk patients through regular screening for neuropathy and vascular disease, along with strict glycemic control and patient education on foot care, can significantly reduce the incidence of diabetic foot ulcers. A multidisciplinary approach is essential for effective prevention and management, ultimately reducing the burden of disability and amputation.

Keywords: Type 2 Diabetes Mellitus, Diabetic Foot Ulcer, Risk Factors, Peripheral Neuropathy, Peripheral Arterial Disease, Glycemic Control, Amputation, Foot Care.

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INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a rapidly growing global health problem and is associated with a wide spectrum of chronic complications affecting multiple organ systems. Among these complications, diabetic foot ulcer (DFU) is one of the most serious and disabling conditions, contributing significantly to morbidity, mortality, and healthcare burden worldwide. It is estimated that nearly 15–25% of patients with diabetes will develop a foot ulcer at some point in their lifetime,

making it a major public health concern [1,2]. DFU is also a leading cause of non-traumatic lower limb amputations, which are associated with poor prognosis and reduced quality of life.

The development of diabetic foot ulcer is multifactorial, involving a complex interplay between peripheral neuropathy, peripheral arterial disease (PAD), immunological dysfunction, and mechanical stress on the foot. Peripheral neuropathy is considered the most important predisposing factor, as it leads to loss of protective sensation, resulting in unrecognized minor trauma, pressure injuries, and repeated tissue damage [3]. Motor neuropathy may also contribute to foot deformities such as claw toes and Charcot arthropathy, further increasing plantar pressure points. Autonomic neuropathy leads to decreased sweating and dry skin, which predisposes to fissures and infections [4].

Peripheral arterial disease is another crucial factor in the pathogenesis of DFU. Reduced blood flow due to atherosclerotic changes impairs oxygen and nutrient delivery to tissues, leading to delayed wound healing and increased risk of gangrene. When neuropathy and ischemia coexist, the risk of ulceration and amputation increases exponentially [5]. In addition, hyperglycemia plays a central role by impairing immune function, reducing leukocyte activity, and promoting chronic inflammation, thereby increasing susceptibility to infections and poor wound healing [6].

Several modifiable and non-modifiable risk factors have been identified in the development of DFU. Non-modifiable factors include increasing age, male gender, longer duration of diabetes, and genetic predisposition. Modifiable risk factors include poor glycemic control, smoking, obesity, inappropriate footwear, and inadequate foot care practices [7]. Patients with a previous history of foot ulceration or amputation are at particularly high risk of recurrence, highlighting the chronic and recurrent nature of the condition [8].

Socioeconomic factors also play an important role in the development and outcome of diabetic foot ulcers. Poor awareness regarding foot hygiene, limited access to healthcare facilities, and delayed presentation to medical care significantly contribute to disease severity at the time of diagnosis. In developing countries, these issues are further compounded by lack of structured diabetic foot screening programs and multidisciplinary care systems [9].

The burden of diabetic foot ulcer extends beyond physical disability, as it also has psychological, social, and economic consequences. Patients often experience reduced mobility, loss of independence, depression, and financial strain due to prolonged treatment and repeated hospital admissions. Healthcare systems also face increased costs associated with wound care, surgical interventions, and amputations [10].

The aim of this study is to identify the risk factors associated with diabetic foot ulcers in patients with Type 2 Diabetes Mellitus. The objective is to evaluate the role of factors such as duration of diabetes, glycemic control, peripheral neuropathy, peripheral arterial disease, smoking, obesity, previous foot ulcer, and foot care practices in the development of diabetic foot ulcers. The study also aims to highlight the importance of early detection, regular foot examination, and patient education in preventing complications and reducing the risk of ulcer formation and lower limb amputation.

MATERIALS AND METHODS

Study Design: This was a hospital-based observational study.

Study Place: Department of Medicine, Malti Multispecialty Hospital and Medical College, Turkhed, Taluka Murtizapur, District Akola, Maharashtra, India.

Study Duration: The study was carried out over a period of 1 year.

Study Population: Patients diagnosed with Type 2 Diabetes Mellitus attending outpatient and inpatient departments were included in the study population.

Sample Size: A total of 100 patients with Type 2 Diabetes Mellitus

Study Variables:

- Neuropathy Status
- PAD Status
- Smoking Status
- Glycemic Control
- Previous Ulcer History

Inclusion Criteria:

Patients aged ≥18 years diagnosed with Type 2 Diabetes Mellitus. Patients willing to participate and giving informed consent. Both patients with and without diabetic foot ulcers were included for comparison.

Exclusion Criteria:

Patients with Type 1 Diabetes Mellitus. Patients with traumatic foot ulcers or non-diabetic foot ulcers. Patients with severe systemic illness or unwilling to participate in the study. Patients with incomplete clinical data were also excluded.

Statistical Analysis:

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. A chi-squared test ($\chi 2$ test) was any statistical hypothesis test wherein the sampling distribution of

the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate.

Explicit expressions that can be used to carry out various t-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a t-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test.

Once a t value is determined, a p-value can be found using a table of values from Student's t-distribution .If the calculated p-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favour of the alternative hypothesis.

P-value ≤ 0.05 was considered for statistically significant

RESULT

Table 1: Association between Peripheral Neuropathy and DFU

Neuropathy Status	DFU Present n (%)	DFU Absent n (%)	Total
Present	30 (60.0%)	20 (40.0%)	50
Absent	10 (20.0%)	40 (80.0%)	50
Total	40	60	100
p-value	0.001		

Table 2: Association between Peripheral Arterial Disease (PAD) and DFU

PAD Status	DFU Present n (%)	DFU Absent n (%)	Total
Present	25 (62.5%)	15 (37.5%)	40
Absent	15 (25.0%)	45 (75.0%)	60
Total	40	60	100
p-value	0.003		

Table 3: Association between Smoking and DFU

Smoking Status	DFU Present n (%)	DFU Absent n (%)	Total
Smokers	18 (60.0%)	12 (40.0%)	30
Non-Smokers	22 (31.4%)	48 (68.6%)	70
Total	40	60	100
p-value	0.02		

Table 4: Glycemic Control (HbA1c) and DFU

Glycemic Control	DFU Present n (%)	DFU Absent n (%)	Total
Poor Control	35 (58.3%)	25 (41.7%)	60
Good Control	5 (12.5%)	35 (87.5%)	40
Total	40	60	100
p-value	<0.001		

Table 5: Previous Foot Ulcer History and DFU

Previous Ulcer History	DFU Present n (%)	DFU Absent n (%)	Total
Present	20 (66.7%)	10 (33.3%)	30
Absent	20 (28.6%)	50 (71.4%)	70
Total	40	60	100
p-value	0.005		

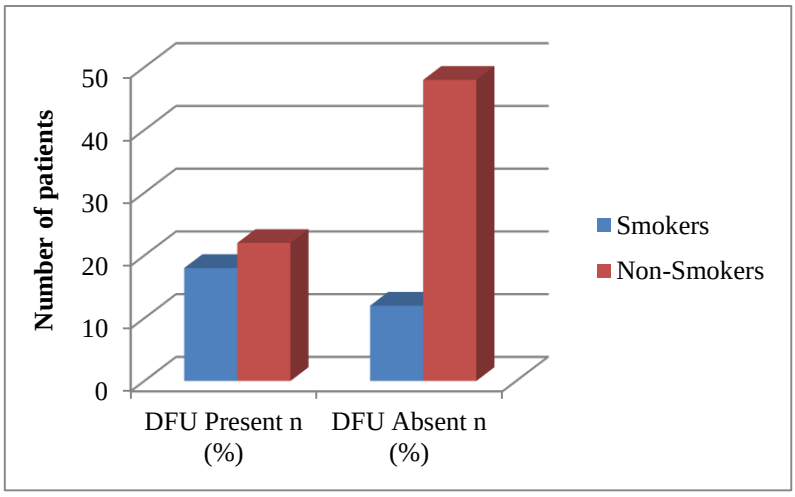

Figure 1: Association between Smoking and DFU

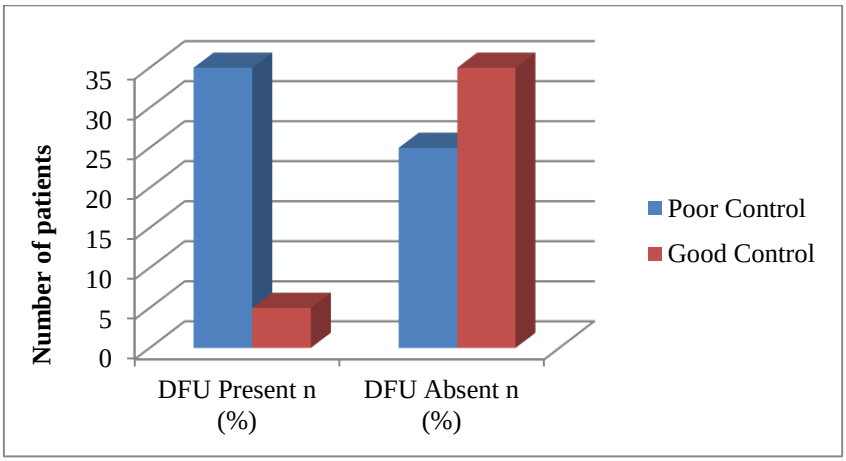

Figure 2: Glycemic Control (HbA1c) and DFU

The present study included a total of 100 patients with Type 2 Diabetes Mellitus, out of which 50 patients had peripheral neuropathy and 50 patients did not have neuropathy. The study demonstrated a significant association between peripheral neuropathy and the occurrence of diabetic foot ulcers (DFU). Among the 50 patients with neuropathy, 30 (60.0%) developed DFU, while 20 patients (40.0%) did not develop DFU. In contrast, among the 50 patients without neuropathy, only 10 patients (20.0%) developed DFU, whereas 40 patients (80.0%) remained free of ulcers. This revealed that the association between peripheral neuropathy and DFU was highly significant ($p = 0.001$).

The present study included a total of 100 patients with Type 2 Diabetes Mellitus, of whom 40 patients had peripheral arterial disease (PAD) and 60 patients did not have PAD. The analysis showed a significant association between PAD and diabetic foot ulcer (DFU). Among the 40 patients with PAD, 25 patients (62.5%) developed DFU, while 15 patients (37.5%) did not develop DFU. In contrast, among the 60 patients without PAD, 15 patients (25.0%) developed DFU and 45 patients (75.0%) remained free of ulcers. Statistical analysis revealed that the association between PAD and DFU was significant ($p = 0.003$).

The present study included a total of 100 patients with Type 2 Diabetes Mellitus, of whom 30 were smokers and 70 were non-smokers. The analysis demonstrated a significant association between smoking status and the occurrence of diabetic foot ulcers (DFU). Among the 30 smokers, 18 smokers, (60.0%) developed DFU, while 12 smokers, (40.0%) did not develop DFU. In contrast, among the 70 non-smokers, 22 non-smokers (31.4%) developed DFU and 48 non-smokers (68.6%) remained free of ulcers. Statistical analysis showed that the association between smoking and DFU was significant ($p = 0.02$).

The present study included a total of 100 patients with Type 2 Diabetes Mellitus, of whom 60 had poor glycemic control and 40 had good glycemic control. The analysis demonstrated a highly significant association between glycemic control and the occurrence of diabetic foot ulcers (DFU). Among the 60 patients with poor glycemic control, 35 patients (58.3%) developed DFU, while 25 patients (41.7%) did not develop DFU. In contrast, among

the 40 patients with good glycemic control, only 5 patients (12.5%) developed DFU and 35 patients (87.5%) remained free of ulcers. Statistical analysis showed a highly significant association between glycemic control and DFU ($p < 0.001$).

The present study included a total of 100 patients with Type 2 Diabetes Mellitus, of whom 30 had a previous history of foot ulcer and 70 had no such history. The analysis showed a significant association between previous ulcer history and the occurrence of diabetic foot ulcers (DFU). Among the 30 patients with a previous history of ulcer, 20 (66.7%) developed DFU, while 10 patients (33.3%) did not develop DFU. In contrast, among the 70 patients without any previous ulcer history, 20 patients (28.6%) developed DFU and 50 patients (71.4%) remained free of ulcers. Statistical analysis revealed that the association between previous ulcer history and DFU was significant ($p = 0.005$).

DISCUSSION

In the present study, diabetic foot ulcer (DFU) showed a significant association with peripheral neuropathy, peripheral arterial disease (PAD), smoking, poor glycemic control, and previous history of foot ulcer among patients with Type 2 Diabetes Mellitus. Peripheral neuropathy was strongly associated with DFU ($p = 0.001$), where 60.0% of patients with neuropathy developed ulcers. Similar findings were reported by Armstrong DG, Boulton AJM, and Bus SA [11], who stated that neuropathy with loss of protective sensation is the primary initiating factor in DFU. Likewise, Singh N, Armstrong DG, and Lipsky BA [12] emphasized that repetitive unnoticed trauma due to neuropathy significantly increases ulcer risk.

Peripheral arterial disease (PAD) was also significantly associated with DFU ($p = 0.003$), with 62.5% of patients with PAD developing ulcers. This finding is supported by Lu Q [13], who reported that ischemia plays a major role in poor wound healing and increased amputation risk. In addition, Abbas ZG and Archibald LK [14] highlighted that PAD markedly worsens the prognosis of diabetic foot infections.

Smoking showed a significant association with DFU ($p = 0.02$), with 60.0% of smokers developing ulcers. This is consistent with the findings of Xia N [15], who identified smoking as an important modifiable risk factor that impairs microvascular circulation and delays healing. Similarly, Boyko EJ, Ahroni JH, and Stensel V [16] reported higher ulcer incidence among smokers with diabetes.

Poor glycemic control demonstrated the strongest association with DFU ($p < 0.001$), with 58.3% of poorly controlled patients developing ulcers. This observation aligns with Rodríguez-Rodríguez N [17], who demonstrated that hyperglycemia impairs leukocyte function and increases infection risk. Furthermore, Lavery LA, Armstrong DG, and Wunderlich RP [18] found that poor glycemic control significantly increases both incidence and recurrence of diabetic foot ulcers.

Previous history of foot ulcer was also significantly associated with DFU ($p = 0.005$), where 66.7% of patients with prior ulcers developed recurrence. This finding is supported by Armstrong DG, Boulton AJM, and Bus SA [11], who reported that previous ulceration is the strongest predictor of recurrence due to persistent biomechanical and vascular abnormalities. Similarly, Boyko EJ et al. [16] emphasized that recurrent ulcers are common in patients with prior foot lesions.

CONCLUSION

The present study concludes that diabetic foot ulcer in patients with Type 2 Diabetes Mellitus is strongly associated with multiple interrelated risk factors. Peripheral neuropathy and peripheral arterial disease were found to be major clinical predictors, significantly increasing the likelihood of ulcer development. Poor glycemic control further emerged as a key determinant, highlighting the importance of metabolic regulation in preventing foot complications. In addition, behavioral factors such as smoking and clinical history of previous foot ulcer were also significantly associated with increased risk of diabetic foot ulcer formation and recurrence.

Overall, diabetic foot ulcer is a multifactorial condition influenced by both modifiable and non-modifiable risk factors. Early identification of high-risk patients through regular screening, strict glycemic control, smoking cessation, and proper foot care education plays a crucial role in prevention. A multidisciplinary approach is essential to reduce complications, prevent recurrence, and minimize the burden of disability associated with diabetic foot ulcers.

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