Original Article

Evaluation of Relationship of Diabetic Foot Ulcers with Peripheral Arterial Disease in Patients Diagnosed with Type 2 Diabetes Mellitus

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A R T I C L E   I N F O

A B S T R A C T

Diabetes mellitus that is poorly treated commonly results in the development of diabetic foot ulcers, which is one of the condition's most serious effects. The most typically affected areas of the foot are those that are continually under pressure and prone to friction. Diabetic foot ulcers are caused by a variety of factors. It is estimated that between 10% and 20% of diabetics also have peripheral arterial disease (PAD). In many cases, there are no obvious signs. **Objective:** To evaluate the of relationship of diabetic foot ulcers with peripheral arterial disease in patients diagnosed with type 2 diabetes mellitus. **Methods:** We performed a cross-sectional investigation at Shaikh Zayed Hospital from august 2022 to February 2023, involving individuals aged 50 years or older who were diagnosed with type 2 diabetes mellitus. Our study encompassed the assessment of both variables, where we examined the ankle-brachial index for each participant and documented relevant clinical details and anthropometric measurements. **Results:** Mean age of these patients was 61.34 years with a standard deviation of 3.61. In terms of gender distribution, 105 individuals were male, accounting for 63.63% of the sample, while 60 were female, representing 36.36%. The mean time with diabetes was 18.21 years with a standard deviation of 3.12. The mean ulcer size measured 8.61 millimeters with a standard deviation of 0.11. For patients with diabetic foot ulcers, there were 64 (78.04%) cases with peripheral arterial disease. **Conclusions:** This study identified a correlation between peripheral arterial disease and diabetic foot ulcers among individuals diagnosed with type 2 diabetes mellitus.

I N T R O D U C T I O N

Poorly controlled diabetes mellitus frequently leads to the development of diabetic foot ulcers, representing one of the condition's gravest consequences. Those with diabetes, neuropathy, peripheral vascular disease, or untreated foot problems are at increased risk. It's also a major reason people lose limbs, as it can lead to foot osteomyelitis [1, 2]. Areas of the foot consistently under pressure and subject to friction are most commonly affected. The causes of diabetic foot ulcers are multifaceted. Poor glycemic control, calluses, foot deformities, lack of proper foot care, wearing shoes that do not fit well, dry skin, poor circulation, underlying peripheral neuropathy etc. are all major contributing factors [3]. The prevalence of diabetic foot ulcers is anticipated to increase concurrently with the growing annual rate of new diabetes diagnoses [4, 5]. Up to half of all diabetic foot ulcers can be traced back to peripheral artery dysfunction, making it a major contributor to the onset of these sores [6]. There is a correlation between diabetes and PAD, with up to 11% of people with diabetes impacted by PAD compared to 4% of non-diabetic individuals [7, 8]. It is estimated that between 10 and 20 percent of people with diabetes also have

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peripheral artery disease (PAD). In many cases, there are no noticeable symptoms. Diabetics generally suffer from greater degrees of distal vascular disease and are more likely to develop peripheral arterial disease [9]. Significant morbidity, including as pain and impairment in function, amputation, and increased mortality, is linked to PAD. The lifetime prevalence of diabetic foot ulcer (DFU) is believed to be between 12 and 25 percent among people with diabetes. Amputation of lower extremity is a common result of diabetic foot ulcer since healing might take months to years. Neuropathy is the primary contributor to DFU, however further risk factors like peripheral artery disease, poor diabetes management, and inadequate self-care also play a role [10 ,11]. Patients having type 2 diabetes often suffer from impaired blood circulation, making them more susceptible to PAD, which can reduce blood flow to the extremities. Understanding this relationship is crucial for early detection, management and prevention of diabetic foot ulcers in these individuals, ultimately improving their quality of life and reducing amputation rates.

METHODS

This cross-sectional study was conducted at Shaikh Zayed Hospital from August 2022 to February 2023. Our study included 165 patients with type 2 diabetes of both genders aged ≥ 50 years. This study was approved by the Institutional Review Board, Shaikh Zayed Hospital on January 21, 2022 Reference IRB/SZH/291. The sample size of 165 cases was calculated taking a PAD frequency to be 52.5% in patients with type II diabetes mellitus keeping 80% confidence interval and 5% margin of error using WHO calculator [12]. Data on demographics, diabetes duration, ulcer characteristics, and relevant clinical parameters were collected. Measurements included ulcer size, duration, HbA1C levels, and ankle-brachial index to evaluate peripheral arterial disease. HbA1c levels were determined using latex agglutination on a DCA 2000 analyzer, while lipid levels were assessed with a Hitachi-902 autoanalyzer. Peripheral arterial disease (PAD) assessment included measuring the ankle-brachial index (ABI) utilizing a handheld Doppler device. Participants with an ABI of 0.9 or below were categorized as having PAD. Diabetic Foot Ulcers (DFUs) patients underwent examination through a standardized clinical approach, encompassing thorough inspection, palpation, and evaluation of ulcer characteristics. Data analysis involved the use of SPSS software version-22. Continuous variables were assessed through chi-square tests were applied to analyze categorical variables.

RESULTS

The mean age of these patients was 61.34 years with a standard deviation of 3.61. In terms of gender distribution, 105 individuals were male, accounting for 63.63% of the sample, while 60 were female, representing 36.36%. Among the patients, a significant proportion had comorbidities, with 116 of them (70.3%) having hypertension, 8 (4.8%) reporting a history of tobacco smoking, and 10 (6.1%) having experienced a previous myocardial infarction (MI) or stroke. In terms of associated diseases, a small percentage of patients had infection (6.66%), and an even smaller percentage had gangrene (0.60%). Medication usage was also observed, with 110 patients (66.7%) taking antihypertensive drugs, 20 (12.1%) using lipid-lowering drugs, and 34 (20.6%) taking antiplatelet medications as shown in table 1.

Table 1: The demographic composition in terms of age and gender among the study (n=165)

Variables	Category	Frequency (%)
Age	Mean ± SD	61.34±3.61
Gender	Male	105 (63.63%)
	Female	60 (36.36%)
History of Comorbidities	Presence of Hypertension	116 (70.3%)
	Previous Tobacco Smoking	8 (4.8%)
	Previous MI or stroke	10 (6.1%)
Associated disease	Infection	6 (6.66%)
	Gangrene	1 (0.60%)
Medications	Antihypertensives	110 (66.7%)
	Lipid lowering drugs	20 (12.1%)
	Antiplatelets	34 (20.6%)

The average duration of diabetes was 18.21 years, with a standard deviation of 3.12. The mean ulcer size was 8.61 millimeters, with a standard deviation of 0.11. Furthermore, the ulcer duration had an average of 1.44 years, demonstrating notable variability among patients with a relatively high standard deviation of 2.91. The HbA1C percentage had a mean of 9.21, with a standard deviation of 2.17, depicting the average level of glycated hemoglobin in the study population as outlined in table 2.

Table 2: Details of sign, symptoms, positive abdominal masses and types of masses

Variables	Mean ± SD (%)
Time with diabetes (years)	18.21 ± 3.12
Ulcer size (mm)	8.61 ± 0.11
Duration of ulcer (years)	1.44 ± 2.91
HbA1C (%)	9.21 ± 2.17

There was a statistically significant correlation between the presence of Peripheral Arterial Disease (PAD) and Diabetic Foot Ulcers (DFU) in the study population. Individuals with PAD were three times more likely to have DFUs compared to those without PAD (OR = 3, 95% CI: 1.066–7.362, p < 0.001). Among the total participants, 64 had both PAD and DFU, while 18 had PAD but no DFU. On the other hand, 46 individuals had DFU without PAD, and 37 had

neither PAD nor DFU as shown in table 3.

Table 3: The correlation between PAD and DFU

Peripheral Arterial Disease			OR	95% Confidence Interval	p-value
Present	Absent	Total			
64	18	82			
46	37	83	3	1.066-7.362	p<0.001
110	55	165			

DISCUSSION

When atherosclerosis progresses to the point where it affects the lower extremities, as it does in diabetic patients, the result is peripheral artery disease and ischaemia. Diabetic foot and leg problems have emerged as a major public health issue in both the developed and the developing worlds. Diabetic foot wounds, which are caused by neuropathy and peripheral artery disease, can become infected, leading to the need for amputation of the lower extremities [13]. In many of the etiological variables contributing to the formation of diabetic foot ulcers can be diagnosed earlier utilizing simple and inexpensive technology in a clinical setting, thereby reducing the negative effects of diabetic foot ulcers [14]. Both Rhee *et al.,* and Okello *et al.,* found a statistically significant gender imbalance favoring women [15, 16]. These results were similar to but not statistically significant from other investigations. One study found that males were more likely to have PAD than females due to the higher prevalence of smokers among males. Our individuals did not have a high rate of smoking either currently or historically [17]. In a study by Moreira *et al.,* it was found that 78% of patients with diabetic foot ulcers (DFU) concurrently had peripheral arterial disease (PAD) which was similar to our study. Their research established a significant association between PAD and DFU, with an odds ratio (OR) of 3 (95% confidence interval, CI: 1.087–8.242) and a highly significant p-value of <0.001 [18]. A study conducted in the Netherlands, involving 1,229 patients with type II diabetes, revealed that only 49% of patients with diabetic foot ulcers (DFU) also had peripheral arterial disease (PAD). This discrepancy may be attributed to various factors, such as differences in ethnicity (possibly the prevalence of European ancestry, EAP), a higher incidence of smoking, or neuropathies among diabetic individuals, all of which are also associated with the development of DFU [19]. In a study conducted in Mexico, which focused on a Latin population similar to our own, 65% of diabetic patients with DFU were found to have coexisting PAD, a result that aligns more closely with our findings. However, it's worth noting that the disparities between our study and the Mexican study could be attributed to the case-control design used, where only 20 cases of DFU were considered alongside 40 control subjects without DFU [20]. Our research only applies to patients with diabetes in tertiary hospitals; its results cannot be extrapolated to the wider population. We did not account for the possibility that other factors, such as lifestyle and socioeconomic position, contribute to the increased risk of PAD in diabetic individuals. It may be useful for future studies of PAD in this cohort to investigate the effect of these variables.

CONCLUSIONS

In conclusion, this study systematically examined the association between diabetic foot ulcers and peripheral arterial disease in individuals diagnosed with type 2 diabetes mellitus.

Authors Contribution

Conceptualization: AY
Methodology: AY, MH, AF
Formal analysis: MUK
Writing-review and editing: AY, FB, QS

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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