Original Article

Prevalence of Ischemic Changes in Foot Arteries on Doppler Ultrasound in Type 2 Diabetic Patients in a Tertiary Care Hospital

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ABSTRACT

Objective: To ascertain the frequency of Doppler-confirmed foot ischemia in individuals with type 2 diabetes mellitus (T2DM) and assess its correlation with glycemic control, treatment strategy, comorbid conditions, and disease duration.

Study Design: Analytical-Cross Sectional Study

Place and Duration of Study: This study was conducted at the Dr. Ruth K.M. Pfau Civil Hospital in Karachi between September 2024 and February 2025.

Methods: Consecutive sampling was used to select 107 individuals with type 2 diabetes mellitus (T2DM), ranging in age from 30 to 80. Comorbidities, treatment type, length of illness, and HbA1c levels were among the information gathered. Following lower-limb Doppler ultrasonography, arterial flow was classified as either normal (triphasic) or abnormal (biphasic/monophasic) for each participant. The Chi-square and independent t-tests were used in the statistical analysis, which was carried out using SPSS version 25. A p-value of less than 0.05 was deemed statistically significant.

Results: Among the 107 participants, 78 (72.9%) had abnormal Doppler flow (mean age 56.8 ± 10.2 years; 55.1% male), according to the results. Poor glycaemic control (HbA1c ≥ 7%) was found to be significantly correlated with abnormal flow ($p = 0.03$). The mean length of diabetes was longer in patients with ischaemic changes (12.6 ± 6.1 years vs 8.4 ± 5.7 years; $p = 0.02$). Abnormal flow was more common in oral hypoglycemic users (83.6%) than in insulin users (67.6%), though this difference was not statistically significant ($p = 0.11$).

Conclusion: Most people with type 2 diabetes mellitus had subclinical foot ischaemia, especially those with longer disease duration and poorer glycaemic control. For prompt management and the avoidance of major ischaemic complications, routine Doppler evaluation is highly recommended.

Key Words: Type 2 diabetes mellitus, Doppler ultrasonography, Foot vasculopathy, HbA1c, Peripheral arterial disease.

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INTRODUCTION

Diabetes mellitus (DM) is a rapidly growing public health concern, especially in low- and middle-income nations like Pakistan.

According to recent pooled analyses, the prevalence of diabetes in Pakistan is approximately 13.7% (95% CI: 10.7–17.3) for adults, whereas national surveys like the Second National Diabetes Survey of Pakistan (NDSP 2016–2017) found that the prevalence among adults could reach 26.3%[1,2]. These results demonstrate the staggering prevalence of diabetes in the nation.

Both micro and macrovascular diseases are examples of vascular complications of diabetes that greatly increase morbidity and disability. One of the worst is lower extremity peripheral vascular disease (PVD), which increases the risk of ischaemia, ulceration, and amputation[3,4].

Chronic hyperglycemia, oxidative stress, inflammation, and endothelial dysfunction are all part of the pathophysiology that causes diabetic patients to develop atherosclerosis more quickly[5].

Even in asymptomatic people, Doppler ultrasonography is a sensitive, non-invasive diagnostic technique that enables assessment of flow haemodynamics and early vascular alterations. Its clinical utility in identifying

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lower limb arterial disease in diabetics has been highlighted by recent studies, particularly when paired with other imaging modalities like CT angiography[6,7]. The lack of research on Doppler-detected foot vasculopathy in diabetic patients in Pakistan, however, restricts the potential for early intervention.

Poor glycaemic control (HbA1c), a longer duration of the disease, treatment modalities (oral hypoglycemics vs. insulin), and comorbidities like hypertension and ischaemic heart disease are clinical factors linked to vascular dysfunction in diabetes[8]. Preventing the development of severe vascular disease requires addressing these risk factors.

The current study attempts to ascertain the frequency of Doppler-detected foot ischemia among diabetic patients in Karachi and investigate its correlation with HbA1c, duration of diabetes, and treatment modality, given the high prevalence of diabetes and the dearth of local data.

METHODS

During the six months from September 2024 to February 2025, this cross-sectional analytical study was carried out in the medical department of Dr. Ruth K.M. Pfau Civil Hospital in Karachi. The study used a non-probability consecutive sampling technique to include 107 patients with type 2 diabetes mellitus. As long as they provided written informed consent, adult patients aged 30 to 80 who had a documented history of type 2 diabetes mellitus spanning at least a year were eligible to participate. Patients with severe heart, lung, or kidney conditions unrelated to diabetes that could prevent Doppler examination were not included, nor were those with type 1 diabetes mellitus.

Daniel's formula for prevalence studies was used to determine the minimum necessary sample size, which came out to be 107.

$$Z^2 \times p\,(1\text{-}p)) / d^2 = n$$

in which d = 8% margin of error, Z = 1.96 at 95% CI, and p = 19.9% (expected prevalence of peripheral arterial disease in diabetic patients reported in prior literature)[9].

Clinical and demographic information, such as age, gender, length of diabetes, type of treatment (insulin or oral hypoglycemics), and comorbidities like ischaemic heart disease and hypertension, were gathered using a structured proforma. In order to evaluate glycaemic control, glycated haemoglobin (HbA1c) was measured during the previous three months. Every participant had their lower limb arteries Doppler ultrasonographically examined using a high-frequency linear probe. Atherosclerotic alterations were also noted, and flow patterns were classified as either triphasic (normal) or aberrant (biphasic or monophasic).

Abnormal Doppler flow in one or both lower limb arteries was considered vascular dysfunction for analytical purposes. While the duration of diabetes was stratified into less than 10 years and ≥10 years, glycaemic control was classified as either good (HbA1c < 7%) or poor (HbA1c ≥ 7%). Version 25.0 of SPSS was used to analyse the data. For continuous and categorical variables, respectively, descriptive statistics were displayed as means with standard deviations and as frequencies and percentages. The Chi-square test was used to assess relationships between categorical variables and vascular dysfunction, and the independent sample t-test was used to compare continuous variables. A statistically significant p-value was defined as less than 0.05.

The study received approval from Dow University of Health Sciences' Institutional Review Board (Ref: IRB-2610/DUHS/2024). All participants gave their written informed consent, and patient confidentiality was rigorously upheld during the entire study.

RESULTS

The study included 107 diabetic patients in total. The cohort's mean age was in the mid-50s, and its members ranged in age from young adults to elderly patients, with a male preponderance in the gender distribution. Many participants had a long-standing disease burden, as evidenced by the mean duration of diabetes, which was roughly 10 years. With a mean HbA1c level above 8% and values varying greatly among the group, glycaemic control was generally subpar.

Table No.1: Demographic and comorbidity profile of study participants (N = 107)

Variable / Comorbidity	Frequency (n) / Mean ± SD (Range)	Percentage (%)
Male	73	68.2%
Female	28	26.2%
Age (years)	53.3 ± 9.7 (35–75)	
Duration of diabetes (years)	11.3 ± 5.5 (3–30)	
HbA1c (%)	8.7 ± 2.2 (6.0–16.7)	
No known comorbids	76	71.0%
Hypertension	13	12.1%
Hypertension, Ischemic heart disease	11	10.3%
Hypertension, Chronic kidney disease	4	3.7%
Hepatitis c, Tuberculosis	3	2.8%

The vast majority of patients (71.0%) had no known comorbidities. The most prevalent condition among those with related conditions was hypertension (12.1%), which was followed by hypertension and ischaemic heart disease (10.3%). Lower percentages had a dual

diagnosis of TB and hepatitis C (2.8%) or hypertension with chronic kidney disease (3.7%). Crucially, no patient in this dataset had ischaemic heart disease by itself without hypertension (table 1)

The results of Doppler ultrasonography revealed that only a small percentage of patients had normal triphasic flow, while a significant portion displayed aberrant arterial flow patterns, primarily biphasic and monophasic. On Doppler imaging, a few cases also showed signs of atherosclerotic plaque development (table 2)

Table No. 2: Vascular findings (N = 107)

Finding	Frequency (n)	Percentage (%)
Flow pattern: Triphasic	8	7.5%
Flow pattern: Biphasic	21	19.6%
Flow pattern: Monophasic	63	58.9%
Any abnormal flow (mono/biphasic)	84	78.5%
Any plaque/atherosclerosis	5	4.7%

Table No.3A: HbA1c categories vs abnormal flow

HbA1c Category	Abnormal flow (n, %)	Normal flow (n, %)	Total (n)
<7% (Good control)	12 (54.5%)	10 (45.5%)	22
≥7% (Poor control)	66 (83.5%)	13 (16.5%)	79

Chi-square = 6.66, p = 0.01

Table No.3B: Mean HbA1c by Doppler flow pattern

Flow pattern	Mean HbA1c ± SD
Abnormal (n=78)	8.91 ± 2.25
Normal triphasic (n=23)	7.84 ± 1.93

t-test, p = 0.03 (abnormal vs. normal triphasic)

Table No.4A: Duration of diabetes categories vs abnormal flow (N=107)

Duration of diabetes	Abnormal flow (n, %)	Normal flow (n, %)	Total (n)
<10 years	48 (70.6%)	20 (29.4%)	68
≥10 years	36 (92.3%)	3 (7.7%)	39

Chi-square = 5.7, p = 0.017

Table No. 4B: Mean duration of diabetes by Doppler flow pattern

Flow pattern	Mean duration ± SD (years)
Normal triphasic flow	7.57 ± 3.12
Abnormal flow	12.24 ± 5.45

t-test, p = 0.0 (abnormal vs. normal triphasic)

There were 101 patients with available HbA1c data; most of them had poor glycaemic control, but a smaller number had adequate levels. Patients with poor glycaemic control were more likely to have abnormal arterial flow, and this relationship was statistically significant (Table 3A). The association between poor glycaemic status and vascular dysfunction was further supported by the fact that the mean HbA1c level was higher in people with abnormal Doppler findings than in those with normal triphasic flow (Table 3B).

Doppler findings were found to be significantly correlated with the length of diabetes. Compared to patients who had the disease for a shorter period of time, those who had a longer duration were more likely to show abnormal arterial flow patterns. Those with abnormal Doppler results also had a longer mean duration of diabetes, which supports the association between chronic hyperglycemia and progressive vascular impairment (Tables 4A and 4B).

Of the 107 patients, 73 (68.2%) were taking oral hypoglycemics (OHA) and 34 (31.8%) were taking insulin. 23 out of 34 insulin users (67.6%) and 61 out of 73 OHA users (83.6%) had abnormal Doppler flow. Vascular dysfunction and treatment modality did not statistically significantly correlate (Chi-square = 2.6, p = 0.107). Therefore, although the difference was not statistically significant, abnormal flow seemed to be slightly more common in OHA users than in insulin users.

Table No.5: Treatment modality and abnormal Doppler flow (N=107)

Treatment modality	Abnormal flow (n, %)	Normal flow (n, %)	Total (n)
Insulin (n=34)	23 (67.6%)	11 (32.4%)	34
OHA (n=73)	61 (83.6%)	12 (16.4%)	73

Chi-square = 2.6, p = 0.107

DISCUSSION

This study assessed the prevalence of Doppler-detected foot vasculopathy in patients with type 2 diabetes mellitus in a Karachi tertiary care setting and investigated its relationships with comorbidities, treatment modality, duration of diabetes, and glycaemic control. Vascular dysfunction was present in over two-thirds of diabetic patients, according to the findings, underscoring the substantial prevalence of subclinical peripheral arterial disease (PAD) in this demographic.

According to our research, patients with poor glycaemic control (HbA1c ≥7%) were more likely to have abnormal Doppler flow. This result is in line with earlier studies showing that hyperglycemia raises the risk of PAD by promoting endothelial dysfunction, oxidative stress, and accelerated atherosclerosis[10,11]. In a similar vein, a large cohort analysis from the UK Biobank showed that a graded increase in vascular

complications was linked to every unit increase in HbA1c[12]. HbA1c was also highlighted in a recent review as a trustworthy surrogate marker for estimating macrovascular risk in diabetes[13].

In our study, the length of diabetes was another significant predictor of vascular dysfunction. Individuals who had diabetes for more than ten years experienced abnormal flow much more frequently than those who had the disease for less time. Given that chronic exposure to hyperglycemia gradually worsens vascular damage, this is biologically conceivable[14]. Similar findings were found in a Korean cohort, where PAD was independently predicted by the length of diabetes[15].

Our data revealed an intriguing trend regarding treatment modality: patients taking oral hypoglycemics were more likely to have abnormal flow than those taking insulin, although this difference was not statistically significant. Patients who started taking insulin might have had more stringent monitoring or, at the time of the study, had comparatively better glycaemic control. Other South Asian studies have also reported a similar lack of clear association[16,17].

The high frequency of vascular dysfunction may have been caused by comorbidities, which were common among our patients, especially ischaemic heart disease and hypertension. Endothelial damage is exacerbated by hypertension, and ischaemic heart disease and PAD share an atherosclerotic pathway[18]. These cardiovascular risk factors have been shown to cluster in diabetic patients in a number of studies from Pakistan and nearby nations[19].

In contrast to certain international reports, our study had a higher overall frequency of Doppler-detected foot vasculopathy. This could be because of variations in the study population, diagnostic standards, and baseline risk factors[20]. Crucially, Doppler ultrasonography demonstrated efficacy in detecting vascular dysfunction at an early stage, promoting its use as a useful screening method in high-risk diabetic populations. Early detection enables the use of antiplatelet or lipid-lowering medications to slow the progression of limb-threatening ischaemia, optimise blood pressure and glucose control, and implement lifestyle changes in a timely manner.

The cross-sectional design, single-center setting, and relatively small sample size are the study's primary limitations, which may restrict generalisability. However, it highlights the necessity for more extensive, multicenter studies in Pakistan and offers significant local evidence on the burden of diabetic vasculopathy.

CONCLUSION

Most people with type 2 diabetes mellitus had subclinical foot ischaemia, especially those with longer disease duration and poorer glycaemic control. For prompt management and the avoidance of major ischaemic complications, routine Doppler evaluation is highly recommended.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Hafiza Bazarqa, Muhammad Tanveer Alam, Syed Muhammad Kashif
Drafting or Revising Critically:	Hari Lal, Muhammad Luqman
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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