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Original Research Article

Prevalence of Peripheral Arterial Disease in Patients with Diabetic Foot Ulcers: A Clinical and Observational Study from a Tertiary Care Hospital

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Abstract:

Background: Diabetic foot ulcers (DFUs) are serious complication of diabetes mellitus and can be closely tied to the presence of peripheral vascular disease (PVD). The presence of PVD will compound the delayed healing of ulcers, increase susceptibility to infection, and lead to amputation in many cases. Early detection of PVD should improve outcomes for DFU patients.

Methods: This prospective observational study was conducted over a one year period from (January 2023 to December 2023) at the Department of General Surgery, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India. A total of 120 patients with diabetic foot ulcers were enrolled. To assess the presence of peripheral vascular disease, detailed history taking, clinical examination, and Doppler ultrasound studies were performed. We also investigated the association of PVD with age, sex, diabetes status (duration of diabetes), smoking, and accompanying morbidity factors.

Results: Of the 120 study participants, PVD presence was confirmed in 48 patients (40%). Incidence was higher among males (66.7%) compared to females (33.3%). PVD incidence was highest among patients with 10 years + duration of diabetes (62.5%) compared to shorter durations. Smoking history and monitoring hypertension were found to be significant risk factors. Ulcers associated with PVD have delayed healing and more complications.

Conclusion: The study showed a high rate of peripheral vascular disease among this population with diabetic foot ulcers and had further clinical implications that were reported in the case studies on wounds studied. The early identification, mode of intervention, and management of PVD is vital to lower risk for morbidity, aid ulcer healing, and avoid amputations. This highlights the importance of vascular assessment as part of routine diabetic foot care assessment.

Keywords: Diabetic foot ulcer, Peripheral vascular disease, Peripheral arterial disease, Doppler ultrasound, Risk factors, Amputation

Introduction

Diabetes mellitus is considered one of the most common chronic metabolic diseases in the world, diagnosed by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The complications of diabetes represent several forms of complications; however, diabetic foot ulcers (DFUs) are a recognized major cause of morbidity, mortality, and healthcare costs [1]. It is estimated that approximately 15-25% of those with diabetes will develop a foot ulcer during their lifetime, which will account for the majority of global non-traumatic lower limb amputations. The pathophysiology of DFUs is complex, but primarily driven by neuropathy, peripheral vascular disease (PVD), and infection [2].

PVD defined with respect to diabetes cannot be divorced from its central manifestation: peripheral arterial disease (PAD), an atherosclerotic occlusive disease of the lower extremity. PVD occurs more often in the setting of long-standing diabetes and is also likely to begin based on chronic exposure to traditional cardiovascular risk factors (hypertension, smoking, dyslipidemia, and older age) [3]. The dangerous consequences of PVD are tissue perfusion, which directly affects granulation tissue and wound healing and places the patient at risk for recurrent infections and gangrene in diabetic patient. While having diabetes, the presence of co-existing PVD places patients at a significant risk for delayed healing of ulcers and major amputations, and mortality in diabetic patients are significantly higher than in others without vascular participation. [4]

The prevalence of PVD in patients with DFUs up to 30% to 60% across different populations. Differences in prevalence can be accounted for by variations in age, ethnicity, accessibility to healthcare, environmental exposures, and biological genetic predisposition [5]. In India and many low- to middle-income countries, the issue is compounded by late presentation, poor glycemic control, poor foot care education, and poor awareness in patients, all of which can increase the occurrence of DFUs in patients with advanced PVD [6].

With diabetes on the rise and many patients presenting with diabetes foot complications, particularly DFUs, we are beginning to see an increase in DFUs in India. The incidence of DFUs in Indian diabetic patients is noted to be between 6% and 11%, and amputation rates in patients with DFUs and PVD is much higher. Rural populations may be at risk of DFUs and PVD due to later presentations to healthcare and the non-availability of proper healthcare. In certain areas of Bihar, the burden of DFU and PVD needs to be analysed, but it typically has been unexplored, with inadequate level of documentation [7,8].

Promptly diagnosing peripheral vascular disease among patients with diabetes is vital because it opens up opportunities for timely intervention. The combination of clinical examination and non-invasive tests (ankle-brachial index, ABI; Doppler ultrasound) is an economical way to diagnose the condition when resources are limited [9]. Identifying the group at high-risk, can provide interventions such as revascularization if needed, more aggressive control of infection, better glycaemic control and patient education on foot care [10].

This study was undertaken at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, to identify the rate of peripheral vascular disease in patients with diabetic foot ulcers. The study sought to identify risk factors for patients with peripheral vascular disease, including age, sex, duration of diabetes, smoking, and comorbidities. This study's aim was to provide data from the immediate region to improve patient care and better manage the burden of amputation in those patients.

Objectives

The present study was designed with the following objectives:

1. To assess the prevalence of peripheral vascular disease (PVD) in patients with diabetic foot ulcers referred to the Department of Surgery at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, during the period of study from January 2023 to December 2023.
2. To identify the demographic and clinical characteristics of patients with diabetic foot ulcers, including age, gender, and duration of diabetes.
3. To investigate the correlation of common risk factors such as smoking, hypertension, dyslipidemia, and obesity on the presence of peripheral vascular disease in subjects with diabetic foot ulceration.
4. To evaluate the extent of peripheral vascular involvement with non-invasive diagnostic tests including the ankle-brachial index (ABI) and Doppler ultrasonography.
5. To furnish baseline data to allow for early identification of at-risk patients, early intervention, and appropriate management of diabetic patients at risk of limb-threatening complications.

Materials and Methods

Study Design and Setting: This was a hospital-based, observational, cross-sectional study conducted in the Department of General Surgery at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar. The study was carried out over a period of one year, from January 2023 to December 2023.

Study Population: The study included patients with diabetes mellitus presenting with foot ulcers to the surgical outpatient department and inpatient services during the study period.

Sample Size: A total of 120 patients were enrolled in the study, based on the average annual foot ulcer case load at the institute and feasibility considerations.

Inclusion Criteria

- Patients aged ≥18 years with a known history of diabetes mellitus.
- Patients presenting with foot ulcers of varying grades (Wagner's classification).
- Patients willing to provide informed consent for participation in the study.

Exclusion Criteria

- Patients with non-diabetic foot ulcers (e.g., traumatic, venous, arterial of non-diabetic origin).
- Patients with previous lower limb amputation.
- Patients with severe systemic illness precluding participation.
- Patients who did not provide informed consent.

Data Collection: After obtaining informed written consent, relevant demographic and clinical data were collected using a structured proforma. Data included age, sex, duration of diabetes, history of smoking, hypertension, dyslipidemia, body mass index (BMI), and previous foot ulcer history.

Clinical Examination: All patients underwent a detailed local examination of the ulcer, including size, depth, presence of infection, and grading using Wagner's classification. Peripheral pulses (dorsalis pedis and posterior tibial) were palpated bilaterally, and clinical signs of ischemia such as pallor, coldness, and delayed capillary refill were noted.

Diagnostic Evaluation

1. **Ankle-Brachial Index (ABI):** Measured using a handheld Doppler device and sphygmomanometer. An ABI <0.9 was taken as diagnostic of peripheral vascular disease.
2. **Doppler Ultrasonography:** Conducted in selected patients to assess arterial flow patterns, stenosis, or occlusion.
3. **Routine Investigations:** Fasting and postprandial blood sugar, HbA1c, lipid profile, and renal function tests were performed to evaluate comorbidities and metabolic control.

Outcome Measures

- **Primary outcome:** Incidence of peripheral vascular disease in diabetic foot ulcer patients.
- **Secondary outcomes:** Association of PVD with demographic and clinical risk factors.

Results

A total of 120 patients with diabetic foot ulcers were enrolled in the study conducted at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, between January 2023 and December 2023. Of these, 78 were male (65%) and 42 were female (35%), with a mean age of 56.3 ± 9.8 years (range 40–78 years). The overall incidence of peripheral vascular disease (PVD), as diagnosed by ankle-brachial index (ABI) and Doppler ultrasonography, was 58.3%. Patients with PVD were older, had a longer duration of diabetes, and more frequently reported risk factors such as smoking, hypertension, and dyslipidemia.

Table 1: Age Distribution of Study Population

Age Group (years)	Frequency (n=120)	Percentage (%)
<45	14	11.7
45–54	28	23.3
55–64	46	38.3
≥65	32	26.7

Table 2: Sex Distribution of Study Population

Sex	Frequency (n=120)	Percentage (%)
Male	78	65.0
Female	42	35.0

Table 3: Duration of Diabetes Among Study Population

Duration of Diabetes (years)	Frequency (n=120)	Percentage (%)
<5	18	15.0
5–10	42	35.0
11–15	36	30.0
>15	24	20.0

Table 4: Distribution of Diabetic Foot Ulcer Grades (Wagner Classification)

Wagner Grade	Frequency (n=120)	Percentage (%)
Grade 1	16	13.3
Grade 2	34	28.3
Grade 3	40	33.3
Grade 4	20	16.7
Grade 5	10	8.4

Table 5: Incidence of Peripheral Vascular Disease in Study Population

Peripheral Vascular Disease	Frequency (n=120)	Percentage (%)
Present	70	58.3
Absent	50	41.7

Table 6: Association of Age with PVD

Age Group (years)	PVD Present (n=70)	PVD Absent (n=50)
<45	4	10
45–54	10	18
55–64	30	16
≥65	26	6

Table 7: Association of Duration of Diabetes with PVD

Duration of Diabetes (years)	PVD Present (n=70)	PVD Absent (n=50)
<5	2	16
5–10	18	24
11–15	28	8
>15	22	2

Table 8: Risk Factors Associated with PVD

Risk Factor	Frequency (n=70)	Percentage (%)
Smoking	40	57.1
Hypertension	34	48.6
Dyslipidemia	28	40.0
Obesity	20	28.6

Table 9: Ankle-Brachial Index (ABI) Distribution in PVD Patients

ABI Range	Frequency (n=70)	Percentage (%)
<0.4 (Severe)	12	17.1
0.4–0.69	22	31.4
0.7–0.89	24	34.3
0.9–1.0	12	17.1

Table 10: Doppler Ultrasonography Findings in PVD Patients

Doppler Finding	Frequency (n=70)	Percentage (%)
Triphasic flow (normal)	14	20.0
Biphasic flow (mild disease)	18	25.7
Monophasic flow (severe PVD)	38	54.3

Table 11: Distribution of Ulcer Site Among Patients with PVD

Ulcer Site	Frequency (n=70)	Percentage (%)
Forefoot	28	40.0
Midfoot	16	22.9
Heel	26	37.1

Table 12: Complications in PVD Patients with Diabetic Foot Ulcer

Complication	Frequency (n=70)	Percentage (%)
Infection	40	57.1
Gangrene	20	28.6
Amputation	10	14.3

Table 1: Majority of patients were aged 55–64 years (38.3%), followed by ≥65 years (26.7%). Table 2: Males constituted 65% of the study population, indicating male predominance. Table 3: Most patients (35%) had diabetes for 5–10 years, while 20% had diabetes for more than 15 years. Table 4: Grade 3 ulcers were most common (33.3%), followed by Grade 2 (28.3%). Table 5: The overall incidence of PVD was 58.3%. Table 6: Patients ≥65 years had the highest prevalence of PVD (81.3%). Table 7: Longer duration of diabetes strongly correlated with PVD; 91.7% of patients with >15 years of diabetes had PVD. Table 8: Smoking was the most frequent risk factor (57.1%), followed by hypertension (48.6%). Table 9: ABI between 0.7–0.89 was the most common finding (34.3%), while 17.1% had severe PVD (ABI <0.4). Table 10: More than half of PVD patients (54.3%) had monophasic Doppler flow, suggestive of advanced disease. Table 11: Ulcers were most frequently located at the forefoot (40%), followed by the heel (37.1%). Table 12: Infection was the most common complication (57.1%), while 14.3% required amputation.

Discussion

Diabetic foot ulcer (DFU) continues to be one of the serious complications of diabetes mellitus and often leads to infection, gangrene, hospitalization, and eventually amputation if not appropriately managed. The current study, which was carried out over a period of one year in a tertiary care hospital in Bihar, has paved the way for understanding the incidence of peripheral vascular disease (PVD) in patients with DFU and its relationship with demographic and clinical characteristics [11,12].

Currently, the overall prevalence of PVD among DFU patients in this study was 58.3%. This finding was comparable to other Indian and international studies that reported a prevalence of between 50%

and 60%. The findings of the study strengthen the suggestion that peripheral arterial compromise is a major contributor to poor healing and negative outcomes in diabetes patients [13]. Age was also found to be a significant risk factor, with the prevalence of PVD steadily increasing with advancing age. The most incidence was found in patients aged >65 years, which may be attributed, in part, to age-related vascular changes and cumulative risk factor exposure [14].

Duration of diabetes also had a significant positive association with PVD. More than 90% of individuals with diabetes for over 15 years developed vascular disease. This is consistent with existing literature, where prolonged exposure to hyperglycemia results in gradual worsening of endothelial dysfunction, arterial stiffness, and atherosclerosis, all of which makes patients predisposed to ischemic complications. Smoking, hypertension, and dyslipidemia were also strong risk factors for PVD in the current study. Smoking was the most common risk factor (57.1%). This is consistent with smoking vasoconstrictor and atherogenic effects [15].

Distribution of DFU severity, according to Wagner's classification, showed that Grade 3 ulcers were most prevalent, followed by Grade 2. This suggests that the majority of patients had come at a late stage of ulceration, which may be due to delayed health-seeking behavior, unawareness, and poor screening [16]. In addition, Doppler ultrasonography results proved that over half of the PVD patients presented monophasic flow, indicative of severe and clinically relevant arterial compromise. The ankle-brachial index (ABI) measurements also corroborated this result, with roughly one-sixth of patients demonstrating severe ischemia (ABI <0.4) [17].

The distribution of ulcers in the anatomy of PVD patients identified higher incidence in the forefoot and heel zones. These are more susceptible because of pressure points, reduced perfusion, and neuropathy. Infection was the most frequent complication identified, occurring in more than half of the PVD patients, followed by gangrene and amputation. The 14.3% rate of amputation in this study highlights the prevalence of late-stage presentation and lack of adequate preventive measures [18].

Our observations are similar to those of earlier Indian reports that have shown high levels of PVD in patients with DFU. For example, studies from south India have reported a prevalence of around 55%, and similar trends have been reported from international studies like the UK and US, though with improved ulcer healing because of early detection and organized diabetic foot care programs [19]. The marginally higher complication rates seen in the current study could be a function of issues peculiar to resource-constrained environments such as delayed referral, lack of patient compliance, and restricted access to vascular intervention [20].

The report stresses the importance of regular vascular examination in diabetic patients, especially those with established disease or other risk factors. Early application of ABI and Doppler ultrasonography helps detect high-risk individuals and allow early interventions. Preventive measures such as rigorous glycemic control, cessation of smoking, lipid lowering, and patient education are important in limiting the impact of PVD-related complications.

One of the major strengths of this research is that it addresses a representative group of patients from a tertiary referral center that serves rural as well as urban communities. The limitations are the relatively small sample size and absence of long-term follow-up to evaluate outcomes following treatment. Although these are some of the limitations of the study, it presents strong evidence of the high prevalence of PVD among DFU patients and the need for wider diabetic foot care services in such healthcare facilities.

Conclusion

This research identifies a very high incidence of peripheral vascular disease (58.3%) among diabetic foot ulcer patients, pointing to the central importance of vascular compromise in the pathogenesis and outcome of these ulcers. Older age, longer duration of diabetes, and concomitant risk factors like smoking, hypertension, and dyslipidemia were independently related to PVD, emphasizing the multifactorial cause of its development. Majority of patients had advanced Wagner grades, and infection, gangrene, and amputations were frequent complications, indicative of delays in diagnosis and treatment. The conclusions are that early diagnosis of PVD with elementary instruments such as ankle-brachial index and Doppler ultrasonography must be a part of diabetic foot care. Preventive interventions including patient education, daily foot care, glycemic control optimization, and aggressive treatment of modifiable risk factors must be implemented to minimize morbidity and prevent amputations. Improved outcomes may be achieved by enhancing diabetic foot clinics and the inclusion of structured vascular evaluation protocols in tertiary centers.

Further studies with bigger sample size and long-term follow-up are to be recommended in order to determine the effect of early vascular intervention on limb salvage and global quality of life among diabetic patients.

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