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# To Study the Prevalence of Peripheral Vascular Disease in Diabetic Foot Disease and its Influence on Clinical Outcome

[1]Dinesh Singh, [2]Manisha Singh, [3]Rajesh Prajapati, [4]Shyam Gupta and [5]Prashant Shrivastava

*[1]Gajra Raja Medical College and J.A. Group Of Hospitals Gwalior(MP)*
*[2-5]Department of General Surgery GRMC Gwalior MP*

**ABSTRACT**

Diabetic Foot Disease (DFD) is a severe complication of diabetes mellitus characterized by a range of conditions from minor skin lesions to deep infections and gangrene. Peripheral Vascular Disease (PVD), a manifestation of systemic atherosclerosis, significantly contributes to the progression and severity of DFD, complicating the healing process and increasing the risk of infection and limb loss. Understanding the prevalence of PVD in DFD is essential for developing effective management strategies. This study aims to investigate the prevalence of PVD in patients with DFD and evaluate its influence on clinical outcomes, specifically focusing on the need for revascularization, the incidence of amputations, and wound healing processes. This prospective observational study was conducted at the Department of Surgery, J.A. Group of Hospitals and G.R. Medical College, Gwalior, with a sample size of 100 participants. The study included 50 cases and 50 controls, all diagnosed with DFD based on clinical criteria. Patients were divided into groups based on the presence or absence of PVD. Data were collected on demographics, clinical parameters and outcomes, and statistical analyses were performed to evaluate the influence of PVD on clinical outcomes. Among patients with DFD, 28% also had PVD. The presence of PVD was associated with significantly worse outcomes, including higher rates of major and minor amputations and poorer wound healing. The average Ankle Brachial Pressure Index (ABPI) was lowest in the PVD group (0.63), indicating severe arterial obstruction. Statistical analysis confirmed significant differences in clinical outcomes based on the presence of PVD. PVD is prevalent in a significant proportion of DFD patients and is associated with poorer clinical outcomes. Early detection and targeted management strategies, including revascularization and lifestyle modifications, are crucial for improving patient outcomes and preventing complications such as amputations.

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**Key Words**
Diabetic foot disease, peripheral vascular disease, prevalence, amputation, revascularization, wound healing, ankle brachial pressure index

**Corresponding Author**
Manisha Singh,
Department of General Surgery GRMC Gwalior MP
dsdoneriya@gmail.com

**Author Designation**
[1]Final Year Surgery Resident
[2,3,5]Professor
[4]Assistant Professor

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## INTRODUCTION

Diabetic foot disease (DFD) is one of the most severe and common complications of diabetes mellitus, characterized by a spectrum of conditions ranging from simple skin lesions to deep infections and gangrene[1]. It is a major cause of morbidity, potentially leading to lower extremity amputations and significantly impacting the quality of life. The pathophysiology of DFD is multifactorial, with peripheral neuropathy, poor glycaemic control and peripheral vascular disease (PVD) being the primary contributors. Among these, PVD plays a crucial role in the progression and severity of diabetic foot ulcers, making it a significant focus in managing DFD[2].

Peripheral vascular disease, a manifestation of systemic atherosclerosis, leads to the narrowing and occlusion of blood vessels in the lower extremities. In patients with diabetes, the risk of developing PVD is significantly heightened due to the complex interplay of hyperglycemia, endothelial dysfunction and chronic inflammation[3]. The presence of PVD in diabetic patients with foot ulcers not only complicates the healing process but also increases the risk of infection, gangrene and ultimately, limb loss. Understanding the prevalence of PVD in diabetic foot disease is essential for developing effective prevention and treatment strategies[4].

The influence of PVD on clinical outcomes in diabetic foot disease is profound. Patients with concomitant PVD and diabetic foot ulcers exhibit poorer prognosis, with delayed wound healing, higher rates of infection, and a greater likelihood of requiring surgical interventions, including amputations[5]. Additionally, the presence of PVD is associated with increased mortality in these patients, highlighting the need for early detection and aggressive management. Evaluating the impact of PVD on clinical outcomes can guide clinicians in tailoring treatment plans and improving patient care[6].

Despite the recognized importance of PVD in diabetic foot disease, the exact prevalence of PVD among patients with diabetic foot complications remains inadequately defined in many populations[7]. Variations in the prevalence of PVD may be influenced by factors such as duration of diabetes, glycemic control and access to healthcare. Prevalence studies are vital for identifying at-risk populations, optimizing resource allocation and implementing targeted interventions. Moreover, understanding the prevalence of PVD in diabetic foot disease can help predict the burden of complications and guide preventive efforts[8].

The findings from this study could have far-reaching implications for both clinical practice and future research. By establishing a clear link between peripheral vascular disease and diabetic foot outcomes, this research may prompt the adoption of more rigorous screening protocols for PVD in diabetic patients, particularly those presenting with foot complications[9]. Additionally, the study could highlight gaps in current treatment approaches, thereby encouraging the development of novel therapeutic strategies that address the vascular component of diabetic foot disease more effectively[10].

Further research could explore the benefits of early intervention in PVD, such as the use of pharmacological agents, endovascular procedures, or surgical revascularization, in preventing the progression to more severe diabetic foot complications. The study's insights could also pave the way for multidisciplinary approaches, combining vascular and diabetes care to reduce the global burden of diabetic foot disease[11].

Given the complex and multifactorial nature of diabetic foot disease, including the significant role of peripheral vascular disease, a multidisciplinary approach to management is increasingly recognized as essential[12]. Such an approach involves the collaboration of various healthcare professionals, including endocrinologists, vascular surgeons, podiatrists, and wound care specialists, working together to address the diverse needs of patients[13].

Early identification of PVD in diabetic foot patients, followed by coordinated care involving both medical and surgical interventions, can significantly improve outcomes[14]. This study highlights the importance of integrating vascular assessments into routine diabetes care and highlights how a comprehensive, team-based approach can lead to better management of diabetic foot disease, ultimately reducing the risk of complications such as amputations and improving overall patient quality of life[15s].

The primary aim of this study is to investigate the prevalence of peripheral vascular disease (PVD) in patients with diabetic foot disease using clinical diagnostic criteria and relevant investigations. The study also aims to evaluate the clinical outcomes of these patients, specifically focusing on the need for revascularization procedures, the incidence of major or minor amputations and the wound healing process. Additionally, the study seeks to compare the clinical outcomes of diabetic patients with PVD to those of non-diabetic patients with PVD, particularly in terms of amputation rates and wound healing, to better understand the differential impact of diabetes on the progression and management of peripheral vascular disease.

## MATERIALS AND METHODS

This prospective observational study, titled "To Study the Prevalence of Peripheral Vascular Disease in Diabetic Foot Disease and its Influence on Clinical Outcomes," was conducted at the Department of Surgery, J.A. Group of Hospitals and G.R. Medical College, Gwalior, with a sample size of 100

participants. This study included 50 cases and 50 controls. Cases included patient with diabetic foot disease and control include non diabetic having peripheral vascular disase based on clinical diagnostic criteria. Study included all age groups.

## RESULTS AND DISCUSSIONS

In this study of patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD), 28% (14 out of 50) of those with DFD also had PVD, while 72% (36 patients) did not. The PVD group predominantly included patients aged ≥40, with the majority of DFD with PVD patients aged 50-60 years. The mean ages were 53.62 years (SD=9.82) for DFD with PVD, 54.67 years (SD=12.09) for DFD without PVD and 59.60 years (SD=10.43) for the PVD group. The Chi-Square test (28.135, p=0.0005) revealed a significant age-related difference in PVD prevalence among DFD patients, underscoring the importance of age-specific interventions.

The average Ankle Brachial Pressure Index (ABPI) values across three groups reveal significant differences in arterial blood flow. The Diabetic Foot Disease (DFD) without Peripheral Vascular Disease (PVD) group has the highest ABPI at 1.11, indicating normal arterial flow. In contrast, the DFD with PVD group shows a lower average ABPI of 0.82, reflecting moderate arterial insufficiency. The PVD group, with an average ABPI of 0.63, indicates severe arterial obstruction. These findings underscore the impact of PVD on arterial blood flow, with the most severe impairment seen in those with PVD alone, while DFD patients without PVD maintain normal ABPI levels.

The distribution of clinical outcomes among patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) varies significantly across treatment groups. Debridement and revascularization yielded the most favorable outcomes, with 22 and 21 patients, respectively, achieving good results. Conversely, below-knee amputation and toe amputation were associated with higher rates of major and minor amputations, respectively; below-knee amputation led to 7 major amputations and 1 death, while toe amputation resulted in 15 minor amputations. The Chi-Square test statistic (202.917,p<0.0001) confirms a significant difference in outcomes across treatments, emphasizing the critical role of treatment choice in optimizing patient outcomes.

The mean values of various parameters for patients with diabetic foot disease (DFD) with and without peripheral vascular disease (PVD), as well as patients with PVD alone, reveal significant differences. The mean Random Blood Sugar (RBS) is 188.64 mg/dl (SD=36.36) for DFD without PVD, 207.43 mg/dl (SD=52.55) for DFD with PVD, and 101.92 mg/dl (SD=14.41) for PVD alone (p<0.0001). Postprandial Blood Sugar (PPBS) averages are 334.03 mg/dl (SD=45.22), 352.86 mg/dl (SD=50.35) and 153.62 mg/dl (SD = 21.67) respectively (p < 0.0001). The duration of diabetes is longest in DFD with PVD (14.92 years), followed by DFD without PVD (8.83 years) and PVD alone (6.20 years) (p<0.0001). Symptom duration also varies, with DFD without PVD at 61.28 days, DFD with PVD at 48.54 days and PVD alone at 39.56 days (p<0.0001). These findings underscore the need for tailored management strategies for each subgroup based on their distinct clinical profiles.

The study's mortality distribution among patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) reveals the following: 13 of 14 patients with both DFD and PVD survived, while 1 patient died. All 36 patients with DFD without PVD and all 50 patients with PVD alone survived, resulting in a total of 99 survivors and 1 death. The Chi-Square test value of 6.205 with 2 degrees of freedom and a p-value of 0.0449 indicates a statistically significant difference in mortality among the groups. This suggests that patients with both DFD and PVD have a higher mortality risk, emphasizing the need for vigilant monitoring and management of these patients.

The study's distribution of clinical outcomes among patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) reveals significant differences. Among those with DFD and PVD, 6 had a good outcome, 3 underwent major amputation, 4 had minor amputations and 1 patient expired. In the DFD without PVD group, 28 patients had a good outcome, while 8 developed non-healing ulcers, with no amputations or deaths. In the PVD group, 21 patients had a good outcome, 4 underwent major amputation, 16 had minor amputations and 9 had non-healing ulcers. The Chi-Square test (32.507, p<0.0001) indicates a statistically significant difference in outcomes, suggesting that PVD notably worsens clinical outcomes in DFD patients, leading to higher amputation and non-healing ulcer rates. Early intervention and tailored treatment are essential to improve outcomes for these patients.

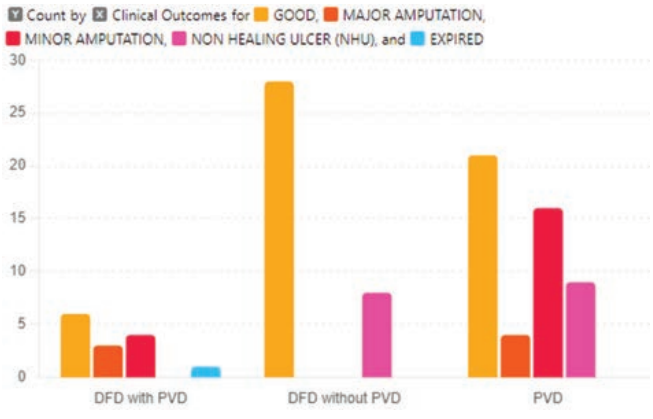


Fig. 1: Clinical Outcomes Distribution

**Table 1: Average value of abpi (ankle brachial pressure index)**

| Groups | Average value |
|---|---|
| DFD with PVD | 0.82 |
| DFD without PVD | 1.11 |
| PVD | 0.63 |

**Table 2: Clinical outcomes by treatment**

| Treatment groups | GOOD | EXPIRED | MAJOR AMPUTATION | MINOR AMPUTATION | NHU |
|---|---|---|---|---|---|
| Antibiotics | 5 | 0 | 0 | 0 | 1 |
| Below Knee Amputation | 0 | 1 | 7 | 0 | 0 |
| Debridment | 22 | 0 | 0 | 0 | 10 |
| Forefoot Amputation | 0 | 0 | 0 | 3 | 1 |
| I and D | 4 | 0 | 0 | 0 | 5 |
| LS with Omentopexy | 2 | 0 | 0 | 0 | 0 |
| Omentopexy | 1 | 0 | 0 | 0 | 0 |
| Revasculazation | 21 | 0 | 0 | 2 | 0 |
| Toe Amputation | 0 | 0 | 0 | 15 | 0 |
| Total | 55 | 1 | 7 | 20 | 17 |
| Chi-Square Statistic ($X^2$): 202.917; DF: 32 p value: <0.0001 | | | | | |

**Table 3: Comparison of other clinical parameters between the groups**

| Parameter | DFD without PVD Mean (SD) | DFD WITH PVD Mean (SD) | PVD Mean (SD) | p-value |
|---|---|---|---|---|
| RBS (mg/dl) | 188.64 (36.36) | 207.43 (52.55) | 101.92 (14.41) | <0.0001 |
| PPBS (mg/dl) | 334.03 (45.22) | 352.86 (50.35) | 153.62 (21.67) | <0.0001 |
| Duration of Diabetes (Years) | 8.83 (5.60) | 14.92 (7.15) | 6.20 (5.34) | <0.0001 |
| Duration of Symptoms (Days) | 61.28 (80.10) | 48.54 (63.31) | 39.56 (47.64) | <0.0001 |

**Table 4: Mortality distribution**

| Mortality Distribution | NO | YES |
|---|---|---|
| DFD with PVD | 13 | 1 |
| DFD without PVD | 36 | 0 |
| PVD | 50 | 0 |
| Total | 99 | 1s |
| Chi-Square value: 6.205; DF: 2; p-value: 0.0449 | | |

**Table 5: Distribution of treatment groups**

| Treatment groups | DFD with PVD | DFD without PVD | PVD | Total |
|---|---|---|---|---|
| Debridment | 2 | 22 | 8 | 32 |
| Revasculazation | 3 | 8 | 12 | 23 |
| I and D | 1 | 3 | 5 | 9 |
| Toe Amputation | 3 | 0 | 12 | 15 |
| Below Knee Amputation | 4 | 0 | 4 | 8 |
| Forefoot Amputation | 1 | 0 | 3 | 4 |
| Antibiotics | 0 | 3 | 3 | 6 |
| LS with Omentopexy | 0 | 0 | 2 | 2 |
| Omentopexy | 0 | 0 | 1 | 1 |
| Total | 14 | 36 | 50 | 100 |
| Chi-Square value: 40.304; DF: 16; p-value: 0.0007 | | | | |

**Table 6: Cholesterol levels summary statistics**

| Cholesterol Levels | count | mean | std | Min | 25% | 50% | 75% | max |
|---|---|---|---|---|---|---|---|---|
| DFD with PVD | 14 | 233.57 | 51.96 | 182 | 204.5 | 213.5 | 255 | 370 |
| DFD without PVD | 36 | 198.47 | 28.06 | 140 | 182.5 | 196 | 209.5 | 263 |
| PVD | 50 | 209.28 | 26.80 | 158 | 190 | 208.5 | 230.25 | 260 |
| F-Statistic: 4.856; P-Value: 0.0098 | | | | | | | | |

**Table 7: Summary statistics of wound healing time**

| Wound healing time | count | mean | std | min | 0.25 | 0.5 | 0.75 | max |
|---|---|---|---|---|---|---|---|---|
| DFD with PVD | 13 | 70.54 | 69.17 | 5 | 20 | 30 | 150 | 180 |
| DFD without PVD | 33 | 72.79 | 60.04 | 5 | 30 | 60 | 120 | 210 |
| PVD | 42 | 81.95 | 77.41 | 8 | 20 | 60 | 150 | 240 |
| F-Statistic: 2.001; P-Value: 0.1415 | | | | | | | | |

The study shows significant differences in treatment modalities among patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD). Debridement was most common, with 22 patients in the DFD without PVD group, 8 in the PVD group and 2 in the DFD with PVD group. Revascularization was primarily observed in the PVD group (12 patients), followed by the DFD without PVD (8 patients) and DFD with PVD (3 patients) groups. Toe and below-knee amputations were more frequent in the PVD group (12 and 4 patients, respectively). The Chi-Square test (40.304, p=0.0007) confirms a significant difference in treatment choices, indicating that PVD significantly influences the selection of treatment strategies in DFD patients.

Cholesterol levels among patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) show significant differences. In the DFD with PVD group, the mean cholesterol level is 233.57 mg/dL (SD=51.96), with a range from 182-370 mg/dL and a median of 213.5 mg/dL. For DFD without PVD, the mean cholesterol level is 198.47 mg/dL (SD=28.06), ranging from 140-263 mg/dL with a median of 196 mg/dL. In the PVD group, the mean cholesterol level is

209.28 mg/dL (SD=26.80), ranging from 158-260 mg/dL with a median of 208.5 mg/dL. The F-Statistic of 4.856 and p-value of 0.0098 indicate a statistically significant difference in cholesterol levels among the groups, with DFD patients with PVD showing the highest levels, underscoring the importance of targeted lipid management in these patients.

Wound healing times among patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) show variability but no statistically significant differences. For DFD with PVD, the mean healing time is 70.54 days (SD=69.17), with a range from 5-180 days and a median of 30 days. In DFD without PVD, the mean healing time is 72.79 days (SD=60.04), ranging from 5 to 210 days with a median of 60 days. For PVD alone, the mean healing time is 81.95 days (SD=77.41), with a range from 8-240 days and a median of 60 days. The F-Statistic of 2.001 and p-value of 0.1415 indicate no statistically significant difference in wound healing times across these groups, suggesting that PVD does not significantly impact wound healing time in this population.

Diabetes mellitus (DM) causes complications like diabetic foot disease (DFD) and peripheral vascular disease (PVD), leading to foot ulcers and limb amputations. PVD, common in type 2 diabetes, increases cardiovascular risks. Peripheral vascular interventions (PVI) like angioplasty and stenting improve blood flow and benefit both diabetic and non-diabetic patients[16].

The study reveals that 28% of diabetic foot disease patients have peripheral vascular disease (PVD), underscoring the importance of thorough vascular assessments. This aligns with Muthiah *et al.* (2017), who found a 38% prevalence of peripheral artery disease (PAD) in diabetic foot patients, particularly affecting males aged 40-60[17].

The study found that most patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) are aged 50-60, while those without PVD are mostly 60-70. The Chi-Square test (28.135) confirms significant age-related differences in PVD prevalence, emphasizing the need for targeted interventions. Similar findings were reported[18].

The study shows a significant gender disparity in diabetic foot disease (DFD) and peripheral vascular disease (PVD), with only one female in both groups and 13 males in the DFD without PVD group. The PVD group had 2 females and 48 males. The Chi-Square test (19.177) indicates a higher PVD prevalence among males. Iacopi *et al.* (2023) similarly found that men had higher healing rates but longer recovery times, highlighting the need for gender-specific PVD management strategies[19].

The study shows a significant link between smoking and peripheral vascular disease (PVD) in diabetic foot disease (DFD) patients, with smokers more prevalent in the PVD group. The Chi-Square test (14.125) confirms smoking as a key risk factor. Walicka *et al.* (2024) emphasize smoking cessation's crucial role in improving diabetes management, reducing risks like myocardial infarction and stroke[20].

The study shows that residency does not significantly impact the distribution of peripheral vascular disease (PVD) among diabetic foot disease (DFD) patients. Most patients with DFD and PVD reside in rural areas, while those without PVD are mostly urban. Lin *et al.* (2015) similarly found that location does not significantly influence DFD prevalence[21].

The study shows no significant difference in literacy distribution among diabetic foot disease (DFD) and peripheral vascular disease (PVD) patients, with similar proportions of literate and illiterate individuals across groups. This suggests literacy does not significantly impact PVD prevalence. Chen *et al.* (2019) also found limited evidence linking health literacy to diabetic foot disease risk, though longitudinal studies are needed to fully assess its impact[22].

The study indicates that peripheral vascular disease (PVD) does not significantly affect the length of hospital stay for diabetic foot disease (DFD) patients, with similar mean stays across groups (F-Statistic: 0.551). Malone *et al.* (2014) suggest that other factors, like bypass surgery and infections, are more influential in extending hospital stays. Amin *et al.* (2016) emphasize the importance of effective therapy for diabetic foot ulcers, noting that PVD presence does not significantly impact wound healing times (F-Statistic: 2.001). Additionally, DFD patients with PVD had higher cholesterol levels, underscoring the need for targeted lipid management[23-24].

The study highlights significant differences in footwear among diabetic foot disease (DFD) and peripheral vascular disease (PVD) patients, with Uccioli and Giacomozzi (2012) noting that footwear type can influence PVD prevalence. Proper footwear is crucial for managing and preventing PVD, especially in diabetic patients with peripheral neuropathy. The study also shows that debridement is the most common treatment for DFD with PVD, while revascularization and amputations are more frequent in PVD patients, emphasizing the need for tailored strategies. Aloweni *et al.* (2022) report that PVD significantly worsens clinical outcomes, stressing the importance of early intervention[25-26].

The study found that diabetic foot disease (DFD) patients with peripheral vascular disease (PVD) have a higher mortality risk, with 1 death among 14 patients, underscoring the need for vigilant monitoring. Ikem *et al*. (2010) report that 28% of DFD patients also have PVD, highlighting Doppler as a reliable assessment tool. Significant correlations between PVD and factors like systolic blood pressure, diabetes duration and tobacco use emphasize the importance of targeted

management to prevent complications in these patients. Tailored strategies are crucial to reduce risks and improve outcomes[27].

The study found that patients with diabetic foot disease (DFD) and peripheral vascular disease (PVD) exhibit higher blood sugar levels and longer diabetes duration than those with PVD alone. Bergin *et al.* (2009) stress the need for a multimodal approach, including regular foot care and blood glucose control, to optimize DFD management. McNeil *et al.* (2023) report that debridement and revascularization improve outcomes, while amputations are linked to higher mortality. Additionally, the Ankle Brachial Pressure Index (ABPI) is a crucial tool, with lower values in PVD patients indicating severe arterial obstruction, as noted by Sachin (2016)[28-30].

## CONCLUSION

This study highlights the significant prevalence of peripheral vascular disease (PVD) in patients with diabetic foot disease and its substantial impact on clinical outcomes. The findings highlight the importance of comprehensive vascular assessments, targeted management strategies and lifestyle interventions, such as smoking cessation, to improve outcomes. The higher prevalence of PVD among older and male patients, along with its strong association with smoking, emphasizes the need for age- and gender-specific approaches. Tailored treatments, including revascularization and appropriate footwear, are crucial for managing PVD and enhancing patient quality of life. Future research should focus on optimizing treatment protocols.

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