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Original Research Article

Pattern of Microvascular Complications in Type 2 Diabetes Mellitus: A Retrospective Observational Study

Aditya Prakash[1], Dhananjay Prasad[2], Rashmi Kumari[3], Rashmi Sinha[4]

[1]Senior Resident, Department of Emergency Medicine, Bhagwan Mahavir Institute of Medical Sciences (BMIMS), Haryana, India

[2]Senior Resident, Department of Emergency Medicine, Bhagwan Mahavir Institute of Medical Sciences (BMIMS), Haryana, India

[3]Professor & HOD, Department of Medicine, Bhagwan Mahavir Institute of Medical Sciences (BMIMS), Haryana, India

[4]Additional Professor, Department of Medicine, Rajendra Institute of Medical Sciences Ranchi (RIMS), Haryana, India

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Corresponding Author: Rashmi Sinha

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Abstract:

Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia and associated long-term complications affecting multiple organ systems. Among these, microvascular complications such as diabetic retinopathy, nephropathy, and neuropathy significantly contribute to morbidity and reduced quality of life.

Objective: To evaluate the pattern and prevalence of microvascular complications among patients with Type 2 Diabetes Mellitus attending a tertiary care hospital.

Methods: A retrospective observational study was conducted at Bhagwan Mahavir Institute of Medical Sciences (BMIMS), over a period from January 2025 to December 2025. Medical records of 150 patients diagnosed with Type 2 diabetes mellitus were reviewed. Data regarding demographic profile, duration of diabetes, and presence of microvascular complications were collected. Statistical analysis was performed using SPSS version 25. Chi-square test was used to determine associations, with $p < 0.05$ considered statistically significant.

Results: Out of 150 patients, 86 (57.3%) developed at least one microvascular complication. Diabetic neuropathy was the most common (34%), followed by retinopathy (28%) and nephropathy (21%). A statistically significant association was observed between duration of diabetes and development of complications ($p = 0.012$).

Conclusion: Microvascular complications are common among patients with Type 2 diabetes mellitus. Early screening and strict glycemic control are essential to reduce disease burden.

Keywords: Type 2 Diabetes Mellitus, Microvascular Complications, Diabetic Neuropathy, Diabetic Retinopathy, Diabetic Nephropathy.

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Introduction

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both. It is one of the most important non-communicable diseases worldwide and represents a major public health challenge due to its rapidly increasing prevalence and associated complications. The condition leads to metabolic disturbances involving carbohydrate, fat, and protein metabolism and may cause long-term damage to multiple organs [1].

The global burden of diabetes has increased substantially during the past few decades. According to estimates from international health agencies, hundreds of millions of adults are currently living with diabetes, and the prevalence is expected to rise further in the coming years due to population aging, urbanization, and lifestyle changes. Developing countries are experiencing particularly rapid growth in diabetes prevalence, making effective prevention and management strategies essential [2].

India has emerged as one of the countries with the highest number of individuals affected by diabetes. Rapid urbanization, sedentary lifestyle, dietary modifications, and genetic susceptibility contribute to the rising incidence of Type 2 diabetes mellitus in the Indian population. The disease often remains undiagnosed for several years, leading to the

development of chronic complications by the time patients seek medical care [3].

Type 2 diabetes mellitus accounts for approximately 90–95% of all diabetes cases and is strongly associated with insulin resistance and relative insulin deficiency. Long-standing hyperglycemia contributes to structural and functional changes in blood vessels, which ultimately result in both macrovascular and microvascular complications affecting different organ systems [4].

Among these complications, microvascular damage represents a major cause of morbidity and disability among diabetic patients. Persistent hyperglycemia leads to endothelial dysfunction, oxidative stress, and activation of various metabolic pathways that damage small blood vessels. These pathological processes contribute to the development of diabetic retinopathy, diabetic nephropathy, and diabetic neuropathy, which collectively constitute the major microvascular complications of diabetes [5].

Diabetic retinopathy is one of the most common complications of long-standing diabetes and remains a leading cause of preventable blindness among working-age adults worldwide. The condition results from progressive damage to the retinal microvasculature, leading to microaneurysms, hemorrhages, and ultimately vision impairment if left untreated. Early detection through routine ophthalmological examination plays a critical role in preventing irreversible visual loss [6].

Diabetic nephropathy is another serious microvascular complication characterized by progressive deterioration of kidney function. It typically manifests as persistent albuminuria, declining glomerular filtration rate, and increased risk of end-stage renal disease. Chronic hyperglycemia induces structural changes in the glomeruli, including thickening of the basement membrane and mesangial expansion, ultimately impairing renal filtration capacity [7].

Peripheral neuropathy is frequently observed in patients with long-standing diabetes and represents one of the most common causes of neuropathic pain. The condition occurs due to damage to peripheral nerves, resulting in symptoms such as numbness, tingling, burning sensations, and loss of protective sensation in the extremities. These changes significantly increase the risk of foot ulcers and lower limb amputations [8].

The development of microvascular complications is closely associated with poor glycemic control and longer duration of diabetes. Chronic exposure to elevated glucose levels leads to accumulation of advanced glycation end products, increased oxidative stress, and activation of inflammatory pathways that contribute to vascular injury. These mechanisms collectively accelerate the progression of diabetic complications [9].

Several epidemiological studies have demonstrated that the prevalence of diabetic microvascular complications varies across different populations and healthcare settings. Factors such as duration of diabetes, glycemic control, lifestyle habits, and access to healthcare services play an important role in determining the overall risk of complications among diabetic individuals [10].

Early identification of these complications is essential for preventing irreversible organ damage and improving patient outcomes. Screening programs for diabetic retinopathy, nephropathy, and neuropathy allow clinicians to detect complications at an early stage and initiate appropriate therapeutic interventions to slow disease progression [11].

Hospital-based observational studies provide valuable insights into the pattern and frequency of diabetic complications within a specific population. Such studies help clinicians understand the burden of disease and guide the development of targeted prevention and management strategies in clinical practice [12].

In resource-limited settings, lack of awareness, delayed diagnosis, and inadequate follow-up often contribute to the increased burden of diabetes-related complications. Strengthening healthcare infrastructure and promoting regular monitoring of diabetic patients can significantly reduce the occurrence of long-term complications [13].

Therefore, understanding the pattern of microvascular complications among patients with Type 2 diabetes mellitus is important for improving clinical management and developing preventive strategies. The present study was conducted to evaluate the prevalence and pattern of microvascular complications among patients with Type 2 diabetes mellitus attending a tertiary care hospital in Bihar [14].

Materials and Methods

Study Design: The present study was conducted as a retrospective observational study designed to evaluate the pattern of microvascular complications among patients diagnosed with Type 2 diabetes mellitus. The study involved systematic review and analysis of previously recorded clinical data from hospital medical records.

Study Setting: This study was carried out at Bhagwan Mahavir Institute of Medical Sciences (BMIMS), Bihar, India, which functions as a tertiary care teaching hospital providing medical services to both rural and urban populations in the surrounding region.

Study Duration: The study covered the period from January 2025 to December 2025, during which medical records of patients diagnosed with Type 2 diabetes mellitus were reviewed and analyzed. Data were collected retrospectively from hospital case files and electronic records maintained in the medical records department.

Study Population: The study population consisted of patients diagnosed with Type 2 diabetes mellitus who attended the hospital during the study period. A total of 150 patients meeting the eligibility criteria were included in the final analysis.

The diagnosis of Type 2 diabetes mellitus had been established by treating physicians based on standard diagnostic criteria including clinical assessment and laboratory investigations such as fasting plasma glucose and glycated hemoglobin levels.

Sample Size: A total sample size of 150 patients was included in the study. This sample size was considered adequate for evaluating the prevalence and pattern of microvascular complications within the hospital population and was based on the availability of complete medical records during the study period.

Eligibility Criteria

Inclusion Criteria

Patients were included in the study if they met the following criteria:

- Confirmed diagnosis of Type 2 diabetes mellitus
- Age ≥ 30 years
- Availability of complete medical records
- Documentation of investigations related to diabetic complications

Exclusion Criteria

The following patients were excluded from the study:

- Patients diagnosed with Type 1 diabetes mellitus
- Gestational diabetes mellitus
- Patients with incomplete clinical records
- Patients with other chronic systemic diseases affecting nerves, kidneys, or retina unrelated to diabetes

Data Collection Procedure: Data were collected retrospectively from hospital medical records using a structured data collection format designed specifically for the study.

The following information was recorded for each patient:

1. **Demographic Characteristics**
    - Age
    - Gender
2. **Clinical Characteristics**
    - Duration of diabetes mellitus
    - Presence of microvascular complications
3. **Microvascular Complications Assessed**

The following diabetic complications were identified based on documented clinical evaluation and diagnostic investigations:

Diabetic Retinopathy: Diagnosis was based on ophthalmological examination findings recorded in patient records, including fundoscopic evaluation performed by ophthalmologists.

Diabetic Nephropathy

Nephropathy was identified based on clinical documentation of:

- Persistent **albuminuria**
- Abnormal **renal function tests**
- Physician diagnosis recorded in medical records.

Diabetic Neuropathy

Peripheral neuropathy was determined based on:

- Clinical symptoms such as numbness, tingling, burning sensation
- Neurological examination findings documented in medical records.

Study Variables

The main variables analyzed in the study included:

Independent Variables

- Age
- Gender
- Duration of diabetes

Outcome Variables

- Presence of microvascular complications
- Type of complication (neuropathy, retinopathy, nephropathy)

Outcome Measures

Primary Outcome: The overall prevalence of microvascular complications among patients with Type 2 diabetes mellitus.

Secondary Outcomes

- Pattern and distribution of specific microvascular complications
- Association between duration of diabetes and occurrence of complications
- Relationship between gender and presence of complications

Statistical Analysis: All collected data were entered into Microsoft Excel and subsequently analyzed

using Statistical Package for the Social Sciences (SPSS) version 25.0.

Descriptive Statistics

- Continuous variables such as age were expressed as mean ± standard deviation (SD).
- Categorical variables such as gender, duration of diabetes, and presence of complications were summarized as frequencies and percentages.

Inferential Statistics

The Chi-square (χ^2) test was applied to evaluate the association between categorical variables, including:

- Duration of diabetes and presence of microvascular complications
- Gender and occurrence of complications

Level of Statistical Significance

- **$p < 0.05$** was considered statistically significant.
- **$p \geq 0.05$** was considered statistically not significant.

Results

A total of 150 patients diagnosed with Type 2 diabetes mellitus were included in the present retrospective observational study. All records fulfilled the inclusion criteria and were analyzed.

1. **Demographic Characteristics of the Study Population**

The age distribution of patients included in the study is presented in Table 1. The mean age of the study population was 52.6 ± 10.8 years. The majority of patients belonged to the 41–50 years age group (30%), followed by 51–60 years (26.7%).

Table 1: Age Distribution of Patients

Age Group (Years)	Number (n=150)	Percentage (%)
30–40	32	21.3
41–50	45	30.0
51–60	40	26.7
>60	33	22.0

The gender distribution of the patients is shown in Table 2. Out of the 150 patients, 82 (54.7%) were males and 68 (45.3%) were females, indicating a slightly higher proportion of male patients.

Table 2: Gender Distribution of Patients

Gender	Number (n=150)	Percentage (%)
Male	82	54.7
Female	68	45.3

2. **Prevalence of Microvascular Complications**

The overall prevalence of microvascular complications among the study population is presented in Table 3.

Out of the 150 patients, 86 patients (57.3%) were found to have at least one microvascular complication, while 64 patients (42.7%) had no evidence of microvascular complications.

Table 3: Overall Prevalence of Microvascular Complications

Category	Number	Percentage (%)
Present	86	57.3
Absent	64	42.7

This distribution is graphically illustrated in Figure 1, which demonstrates that more than half of the diabetic patients had developed microvascular complications.

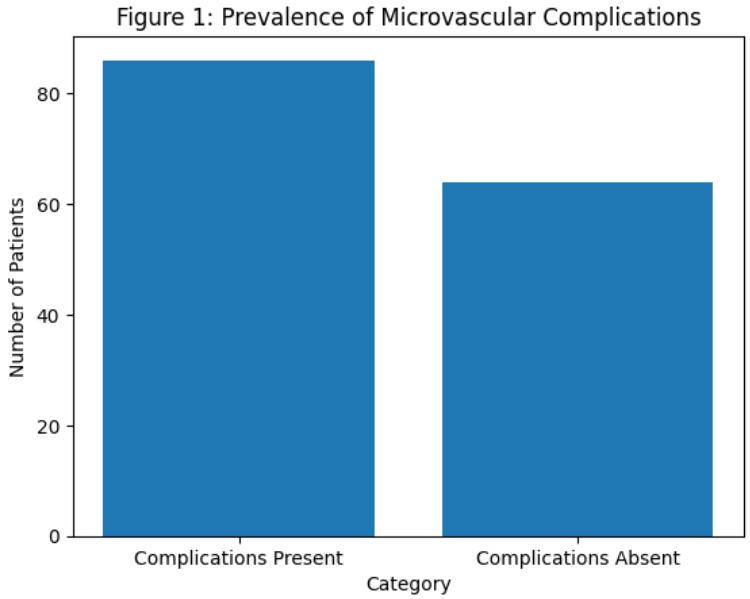

Figure 1: Prevalence of Microvascular Complications

3. Pattern of Microvascular Complications

The distribution of different types of microvascular complications observed in the study population is shown in Table 4.

Among the complications, diabetic neuropathy was the most common (34%), followed by diabetic retinopathy (28%) and diabetic nephropathy (20.7%).

Table 4: Pattern of Microvascular Complications

Complication	Number (n=150)	Percentage (%)
Neuropathy	51	34.0
Retinopathy	42	28.0
Nephropathy	31	20.7

The distribution of these complications is represented graphically in Figure 2, where neuropathy shows the highest frequency compared to other complications.

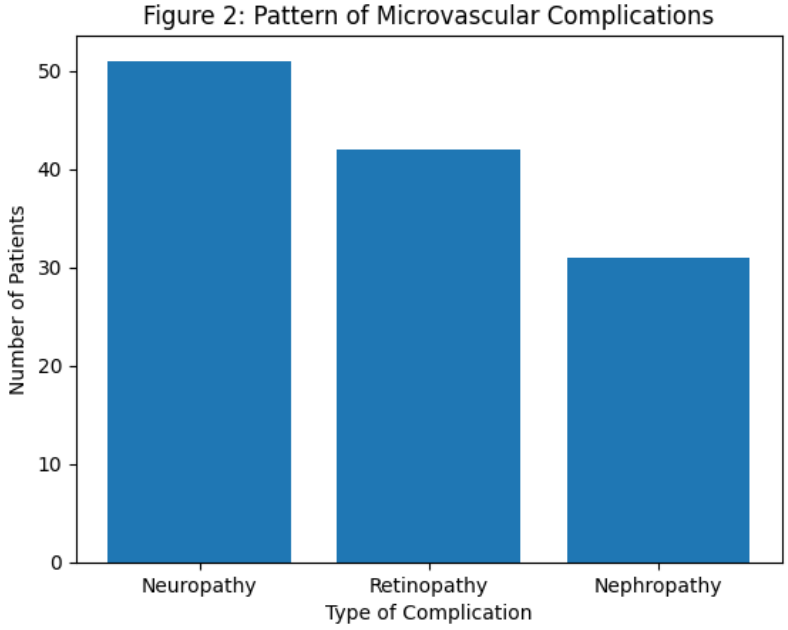

Figure 2: Pattern of Microvascular Complications (Neuropathy, Retinopathy, Nephropathy)

4. **Duration of Diabetes and Microvascular Complications**

The relationship between duration of diabetes and occurrence of microvascular complications is shown in Table 5.

Patients with a longer duration of diabetes (>10 years) showed a higher prevalence of complications compared to those with shorter duration of disease.

Table 5: Duration of Diabetes vs Microvascular Complications

Duration of Diabetes	Complications Present	Complications Absent	Total
<5 years	18	30	48
5–10 years	34	22	56
>10 years	34	12	46
Total	**86**	**64**	**150**

Statistical analysis using the Chi-square test demonstrated a significant association between duration of diabetes and development of microvascular complications.

Chi-square (χ^2) = 8.21

p-value = 0.012

Since $p < 0.05$, the association was considered statistically significant.

This relationship is visually depicted in Figure 3, which shows an increasing trend in complication rates with longer duration of diabetes.

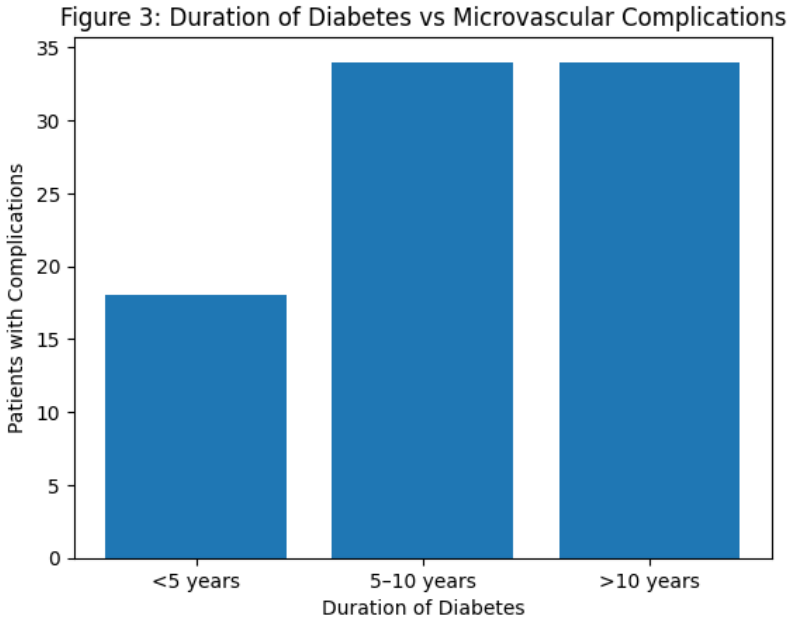

Figure 3: Duration of Diabetes vs Microvascular Complications

5. **Gender-wise Distribution of Microvascular Complications**

The association between gender and occurrence of microvascular complications is presented in Table 6.

Table 6: Gender vs Microvascular Complications

Gender	Complications Present	Complications Absent	Total
Male	48	34	82
Female	38	30	68
Total	**86**	**64**	**150**

The prevalence of complications was:

- **58.5% in males**
- **55.9% in females**

However, statistical analysis using the Chi-square test showed no significant association between gender and complications.

Chi-square (χ^2) = 0.11

p-value = 0.73

Since $p > 0.05$, the association was not statistically significant.

Summary of Key Findings: The present study revealed that microvascular complications were present in 57.3% of patients with Type 2 diabetes mellitus. Among the complications, diabetic neuropathy was the most common, followed by retinopathy and nephropathy. The occurrence of complications was found to increase significantly with longer duration of diabetes, whereas no significant association was observed with gender.

Discussion

The present study evaluated the pattern of microvascular complications among patients with Type 2 diabetes mellitus in a tertiary care hospital. The findings revealed that more than half of the patients developed at least one microvascular complication.

The prevalence of microvascular complications observed in this study (57.3%) is comparable to previous studies conducted in similar clinical settings [15,16].

Diabetic neuropathy was found to be the most common complication in this study. Similar findings have been reported in earlier research, where neuropathy was the most frequently observed microvascular complication among diabetic patients [17].

Neuropathy occurs due to chronic hyperglycemia leading to nerve damage through metabolic and vascular mechanisms [18]. Early detection is important to prevent complications such as diabetic foot ulcers and amputations.

Retinopathy was the second most common complication identified in this study. Several studies have reported similar prevalence rates, highlighting the importance of regular ophthalmic screening among diabetic patients [19].

Diabetic nephropathy was observed in 20.7% of patients. This complication is one of the leading causes of chronic kidney disease and end-stage renal failure worldwide [20].

The study also found a significant association between duration of diabetes and development of complications. Patients with longer duration of disease had higher prevalence of complications, which is consistent with earlier research findings [21].

Persistent hyperglycemia over time causes progressive damage to small blood vessels, leading to microvascular complications [22].

Another important observation was the higher proportion of complications among middle-aged and elderly patients. Age-related metabolic changes and longer disease duration may contribute to this finding [23].

Hospital-based screening programs play a crucial role in identifying complications early and initiating appropriate management strategies [24].

Effective diabetes management including glycemic control, lifestyle modification, and regular monitoring can significantly reduce the risk of complications [25].

Conclusion

The present study demonstrates that microvascular complications are common among patients with Type 2 diabetes mellitus.

Neuropathy was the most frequently observed complication, followed by retinopathy and nephropathy.

Longer duration of diabetes was significantly associated with increased risk of complications.

Early detection through regular screening and proper glycemic control is essential to reduce the burden of diabetic complications.

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