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Vascular Complications of Type 2 Diabetes Mellitus in the Elderly: A Cross-Sectional Study

Pathipaka Divya[1], Deepti P Deshmukh[2], Reddy Manohar Naidu[3], Pranav Nagpure[4]

[1]Senior Resident, Department of General Medicine, Indira Gandhi Government Medical College and Hospital, Nagpur, Maharashtra, India
Corresponding Author Email: *udayasri96[at]gmail.com*

[2]Associate Professor, Department of General Medicine, IGGMCH, Nagpur, Maharashtra, India

[3]Senior Resident, Department of General Medicine, IGGMCH, Nagpur, Maharashtra, India

[4]Senior Resident, Department of General Medicine, IGGMCH, Nagpur, Maharashtra, India

Abstract: ***Background**: Type 2 diabetes mellitus (T2DM) in the elderly is increasingly prevalent and associated with significant vascular morbidity. Age of onset and duration of diabetes may influence the pattern and burden of vascular complications. **Objectives**: To estimate the prevalence of vascular complications in elderly patients with T2DM and compare them based on age of onset and duration of diabetes. **Methods**: A hospital-based cross-sectional study was conducted on 201 patients aged ≥65 years with T2DM. Patients were grouped into elderly-onset (onset ≥65 years) and middle-age-onset (onset <65 years). Vascular complications (microvascular and macrovascular) and age of onset and duration of diabetes were compared using Chi-square and t-tests. **Results**: Of the 201 patients, 40.3% had elderly-onset T2DM. Microvascular complications were more prevalent in middle-age-onset patients (retinopathy 29.2% vs.25.9%; neuropathy 50% vs.23.5%; nephropathy 75.8% vs.29.6%; p<0.001 for latter two). Coronary artery disease was significantly higher in elderly-onset group (67.9% vs.45.8%, p<0.01), while cerebrovascular and peripheral vascular disease showed no significant difference. Longer diabetes duration was associated with higher prevalence of all complications. **Conclusion**: Middle-age-onset diabetes is associated with a higher burden of microvascular complications, while elderly-onset patients are more prone to coronary artery disease. Age of onset and duration of diabetes should guide individualized risk assessment and management.*

Keywords: Type 2 Diabetes Mellitus, Elderly, Microvascular, Macrovascular, Coronary Artery Disease, Age of Onset

1. Introduction

Type 2 Diabetes Mellitus (T2DM) has emerged as a major global health challenge, with a rapidly increasing prevalence worldwide. According to estimates by the International Diabetes Federation, the number of individuals living with diabetes is projected to increase substantially over the coming decades. [1]

The burden of diabetes among the elderly population has risen markedly, as evidenced by national health survey data demonstrating a steady increase in prevalence among individuals aged 65 years and above. [2] In India, studies have reported that approximately 17–20% of the elderly population is affected by diabetes mellitus, reflecting the growing magnitude of this problem. [5]

Advances in medical care and increased life expectancy have resulted in a higher number of patients surviving into older age with long-standing diabetes, while simultaneously contributing to an increase in elderly-onset diabetes. The age at which diabetes is diagnosed plays a crucial role in determining the risk and pattern of vascular complications. Individuals diagnosed at a younger age are exposed to prolonged hyperglycemia, predisposing them to a higher lifetime risk of microvascular and macrovascular complications. [3], [4]

Middle-age-onset and elderly-onset diabetes represent two clinically distinct groups, differing in metabolic characteristics, cardiovascular risk factors, and complication profiles. Understanding these differences is essential for tailoring management strategies and optimizing outcomes in elderly diabetic patients.

2. Methods

This hospital-based cross-sectional observational study was conducted between November 2022 and August 2024 in the medicine wards, geriatric outpatient department, and diabetes clinic of a tertiary care center. A total of 201 patients aged 65 years and above with a confirmed diagnosis of Type 2 Diabetes Mellitus were enrolled after obtaining informed consent.

Demographic details, age at onset of diabetes, duration of disease, glycemic status, and cardiovascular risk factors including hypertension, obesity, dyslipidemia, smoking, and sedentary lifestyle were recorded. Clinical evaluation included measurement of blood pressure, body mass index, waist–hip ratio, ankle–brachial index, and assessment for peripheral neuropathy. Relevant laboratory investigations and diagnostic tests were performed to identify both microvascular and macrovascular complications.
Patients were categorized based on age at diabetes onset (<65 years and ≥65 years), and comparisons were made to assess the prevalence of vascular complications.

Statistical Analysis:
Data was recorded on a Microsoft Excel spreadsheet. Statistical analysis was performed using Epi Info version 7.2.0.1 and SPSS student version 16.0 (SPSS Inc, Chicago, USA). The differences in the distribution of discrete variables were analysed using Pearson Chi square test or Fischer's exact

test, whichever was applicable. The significance of the difference in continuous variables was analysed by student t test. Correlation was seen using Pearson's correlation coefficient. The P value of <0.05 was considered significant.

3. Results

The majority of the patients (73.13%) in our study were in the age group of 65–74 years, with a mean age of 70.66 years. In a significant proportion of patients (59.70%), diabetes was detected before the age of 65, indicating an earlier onset of the disease in many individuals. Females constituted the majority of the study population, accounting for 56.22%, while males comprised 43.78%. Most patients had a diabetes duration of 5–10 years (42.79%), followed by those with a duration of less than 5 years (35.82%) and more than 10 years (21.39%). A significant association was observed between the duration of diabetes and age of onset, with most patients having both a duration of 5–10 years and an onset before 65 years; as the duration of diabetes increased, the proportion of patients with onset before 65 years also increased.

Nephropathy was the most common microvascular complication observed in the study, affecting 57.21% of patients, followed by peripheral neuropathy (39.30%) and retinopathy (27.86%), while coronary artery disease emerged as the most prevalent macrovascular complication. (Table: 1)

Among patients with diabetes onset before 65 years of age, there was a statistically significant higher prevalence of nephropathy and neuropathy compared to those with onset at or after 65 years. Conversely, patients with diabetes onset at or after 65 years showed a significantly higher prevalence of coronary artery disease (54.73%) and peripheral vascular disease, whereas the prevalence of cerebrovascular disease did not differ significantly between the age groups. (Table: 2)

A longer duration of diabetes was associated with a higher prevalence of microvascular complications, with nephropathy showing the strongest association, followed by peripheral neuropathy and then retinopathy. Interestingly, coronary artery disease was more prevalent in patients with a diabetes duration of less than 5 years (68.05%), while peripheral vascular disease was more common (6.98%) in those with a duration of 5–10 years. (Table: 3)

Among the risk factors, retinopathy correlated significantly with hypertension and a sedentary lifestyle, peripheral neuropathy with smoking and a sedentary lifestyle, and nephropathy with hypertension, a sedentary lifestyle, and obesity. Coronary artery disease correlated significantly with hypertension, smoking, and a sedentary lifestyle. Peripheral vascular disease was significantly correlated with a sedentary lifestyle, while cerebrovascular disease was significantly correlated with a sedentary lifestyle and obesity. (Table: 4)

Table 1: Prevalence of Vascular Complications (Macrovascular & Microvascular)

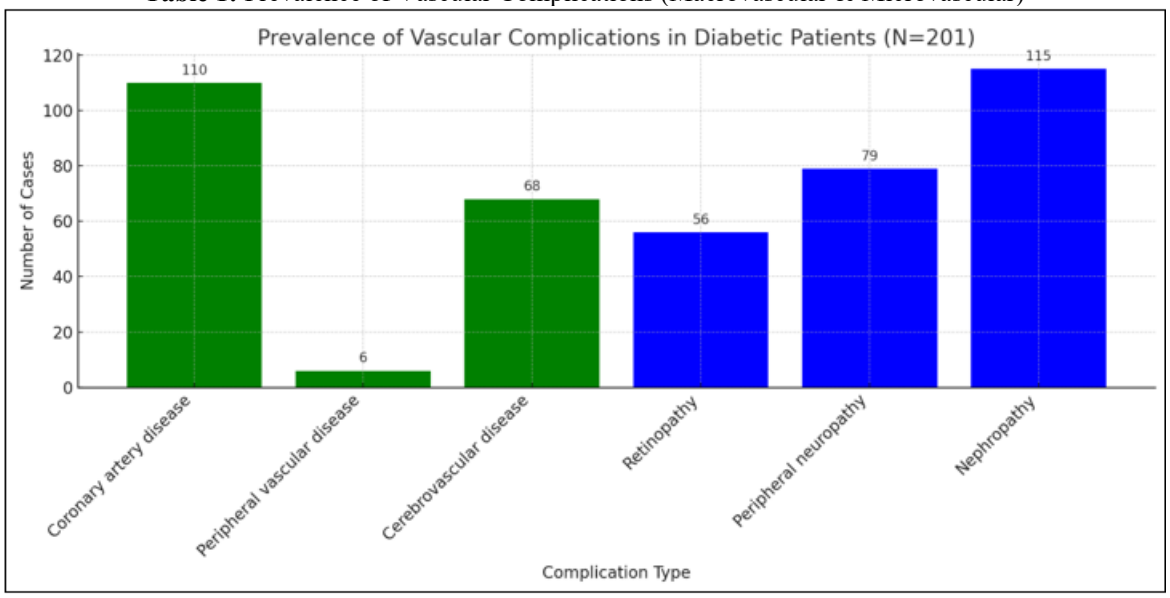

Table 2: Distribution of Vascular Complications of Type 2 Diabetes Mellitus According to Age of Onset

COMPLICATION	Onset <65years (n=120)	Onset >/=65years (n=81)	Chi square test p value
Retinopathy	35 (29.17%)	21 (25.93%)	0.61
Peripheral neuropathy	60 (50%)	19 (23.46%)	0.0001
Nephropathy	91 (75.83%)	24 (29.63%)	0.0001
Coronary artery disease	55 (45.83%)	55 (67.90%)	0.002
Peripheral vascular disease	06 (5.0%)	0 (0%)	0.04
Cerebrovascular disease	41 (34.17%)	27 (33.33%)	0.9

Table 3: Distribution of Vascular Complications of Type 2 Diabetes Mellitus According to Duration of Diabetes Mellitus

Duration of Diabetes	Retinopathy	Peripheral Neuropathy	Nephropathy	Coronary Artery Disease	Peripheral Vascular Disease	Cerebrovascular Disease
<5years	12 (16.67%)	19 (26.38%)	10 (13.89%)	49 (68.05%)	0 (0%)	26 (36.11%)
5-10years	28 (32.55%)	39 (45.34%)	66 (76.74%)	43 (50.00%)	06 (6.98%)	34 (39.53%)
>10years	16 (37.20%)	21 (48.83%)	39 (90.69%)	18 (41.86%)	00 (00%)	08 (18.60%)
Chi square test	0.02	0.01	0.00%	0.02	0.01	0.05

Table 4: Correlation between vascular complications of Type 2 Diabetes Mellitus and cardiovascular risk factors

Complication	Hypertension	Smoking	Sedentary lifestyle	Obesity	Dyslipidaemia
Coronary artery disease	r=0.2791 p<0.001*	r= 0.2361 p<0.001*	r=0.1411 p=0.04*	r=0.1235 p=0.081	r=0.669 p=0.34
Peripheral vascular disease	r=0.1217 p=0.08	r=0.0735 p=0.30	r= 0.2226 p=0.001*	r=0.0389 p=0.58	r=0.035 p=0.62
Cerebrovascular disease	r=0.1112 p=0.11	r=0.0634 p=0.37	r= 0.2152 p=0.002*	r=0.1421 p=0.04*	r=0.018 p=0.79
Retinopathy	r=0.1394 p=0.04*	r=0.1134 p=0.109	r=0.1495 p=0.03*	r=0.0163 p=0.81	r=0.056 p=0.42
Peripheral neuropathy	r=0.0920 p=0.19	r= 0.1941 p=0.006*	r=0.2989 p<0.001*	r=0.0271 p=0.70	r=0.1181 p=0.09
Nephropathy	r=0.2145 p=0.002*	r= 0.0046 p=0.94	r=0.1666 p=0.01*	r=0.4844 p<0.001*	r=0.0421 p=0.55

4. Discussion

The present study evaluated the relationship between age at onset of diabetes mellitus (DM), duration of disease, and the prevalence of microvascular and macrovascular complications among 201 patients. The findings demonstrate that earlier onset and longer duration of diabetes are associated with a higher burden of complications, highlighting the need for early diagnosis and comprehensive risk-factor management.

A majority of patients (73.13%) belonged to the 65–74-year age group, reflecting the increased prevalence of type 2 diabetes in older adults due to age-related insulin resistance and metabolic changes. [1], [2] Notably, 59.70% of patients had an onset of diabetes before 65 years of age. Early-onset diabetes is clinically significant as it leads to prolonged exposure to hyperglycemia and is strongly associated with an increased risk of both microvascular and macrovascular complications. Similar findings were reported by Huo et al. and Nanayakkara et al., who demonstrated that younger age at diagnosis is associated with higher vascular complication rates and increased mortality. [3], [4]

Microvascular Complications

Microvascular complications were highly prevalent in the present study, with diabetic nephropathy being the most common (47.29%), followed by peripheral neuropathy (39.30%) and diabetic retinopathy (27.86%). The increasing prevalence of these complications with longer duration of diabetes is consistent with the progressive microvascular damage caused by chronic hyperglycemia. The prevalence of retinopathy is comparable to that reported in the Wisconsin Epidemiologic Study of Diabetic Retinopathy, which showed a strong association between disease duration and retinopathy development. [6] The high burden of nephropathy aligns with findings from the Diabetes Control and Complications Trial and the UK Prospective Diabetes Study, both of which demonstrated that poor glycemic control and longer disease duration significantly increase nephropathy risk. [7], [8] The prevalence of peripheral neuropathy in this study is consistent with observations from the Rochester Diabetic Neuropathy Study. [9]

Macrovascular Complications

Macrovascular complications were also prominent, reflecting the accelerated atherosclerosis associated with diabetes. Prolonged hyperglycemia, in combination with other cardiovascular risk factors, contributes to increased risk of coronary artery disease and peripheral vascular disease. Haffner et al. established diabetes as a coronary heart disease risk equivalent, emphasizing the substantial macrovascular risk associated with long-standing diabetes. [10]

A study by Jude et al. revealed that diabetes significantly increases the risk of lower-extremity amputation, often due to the progression of peripheral vascular disease; however, the present study found fewer cases of peripheral vascular disease, possibly due to demographic differences and variation in study settings. [11]

The study found no significant difference in the prevalence of cerebrovascular disease between the two age groups, which may suggest that factors other than age at onset, such as blood pressure control and lipid management, play a more dominant role in the development of this complication.

I Risk Factors and Correlation with Diabetic Complications

The present study demonstrated significant associations between hypertension, sedentary lifestyle, dyslipidemia, smoking, and obesity with the prevalence of both microvascular and macrovascular complications in patients with type 2 diabetes mellitus. These findings are concordant with existing national and international literature that identifies these factors as major determinants of diabetes-related vascular morbidity. [10]

Hypertension
Hypertension showed a strong and significant correlation with both microvascular and macrovascular complications in the present study. Evidence from the ADVANCE trial demonstrated that intensive blood pressure control significantly reduced the incidence of diabetic nephropathy and retinopathy in patients with type 2 diabetes. [12] Similarly, the UK Prospective Diabetes Study (UKPDS) reported that every 10 mmHg reduction in systolic blood pressure was associated with significant reductions in diabetes-related deaths, myocardial infarction, and microvascular complications. [13] These findings support the crucial role of stringent blood pressure control in preventing vascular complications, consistent with our observations.

Sedentary Lifestyle
A sedentary lifestyle was significantly associated with increased prevalence of both microvascular and macrovascular complications in this study. The Look AHEAD (Action for Health in Diabetes) study demonstrated that intensive lifestyle interventions focusing on increased physical activity and weight loss resulted in improved glycemic control and reduced cardiovascular risk in individuals with type 2 diabetes. [14] Additionally, a meta-analysis by Boulé et al. showed that structured exercise interventions significantly reduced HbA1c levels, which is known to lower the risk of microvascular complications. [15] These findings emphasize the protective role of regular physical activity, aligning with the results of the present study.

Dyslipidemia
Dyslipidemia in the current study was significantly correlated with macrovascular complications. The Heart Protection Study demonstrated that statin therapy significantly reduced major vascular events in diabetic patients irrespective of baseline cholesterol levels. [16] Similarly, the CARDS trial showed that atorvastatin reduced the risk of first cardiovascular events in patients with type 2 diabetes without established cardiovascular disease. [17] Furthermore, the FIELD study reported that fenofibrate reduced the need for laser therapy in diabetic retinopathy, suggesting a beneficial role of lipid control in microvascular disease. [18] These findings support the observed association between dyslipidemia and vascular complications in our cohort.

Smoking
Smoking was found to be significantly associated with both microvascular and macrovascular complications in this study. The Framingham Heart Study reported a markedly increased risk of coronary artery disease, stroke, and peripheral vascular disease among diabetic smokers. [19] Additionally, the EURODIAB Prospective Complications Study demonstrated a strong association between smoking and the development of diabetic nephropathy and retinopathy. [20] These studies reinforce the adverse vascular effects of smoking and underscore the importance of smoking cessation as a key component of diabetes management.

Obesity
Obesity, particularly central obesity, showed a significant correlation with diabetic complications in the present study. Data from the National Health and Nutrition Examination Survey consistently demonstrated that higher body mass index is associated with an increased risk of cardiovascular disease in patients with diabetes. [14] The Look AHEAD study further showed that weight reduction through lifestyle interventions led to improvements in glycemic control, blood pressure, and lipid profiles, thereby reducing both microvascular and macrovascular risk. [14] These findings align with the association observed between obesity and complications in the current study.

Age of Onset and Complication Pattern
Previous studies have highlighted differences in complication patterns based on age of diabetes onset. Pradeepa et al. reported a higher prevalence of coronary artery disease in middle-age onset diabetes due to longer disease duration; however, in the present study, macrovascular complications such as coronary artery disease and peripheral vascular disease were significantly more prevalent in elderly-onset diabetes patients, possibly reflecting age-related vascular changes. [21]

Similarly, Anjana et al. from the ICMR-INDIAB study reported a higher prevalence of retinopathy and nephropathy in middle-age onset diabetes, attributed to prolonged hyperglycemic exposure. [22] Consistent with this, the present study demonstrated a significantly higher prevalence of retinopathy, neuropathy, and nephropathy among middle-age onset patients. Studies by Kengne et al. and Lee et al. further support the observation that while middle-age onset diabetes is associated with a higher cumulative microvascular burden, elderly-onset diabetes may experience more rapid progression of macrovascular disease due to aging-related vascular pathology. [23], [24]

5. Conclusion

Age at onset of diabetes significantly impacts the pattern of vascular complications in elderly patients. Tailoring management based on onset age and disease duration may improve outcomes.

6. Limitations

- Cross-sectional design cannot establish causality
- Single-center study; may limit generalizability
- Self-reported comorbidities may introduce recall bias

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