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Pattern of Microangiopathy in Type 2 Diabetic Patients Attending Suez Canal University Hospital

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Abstract

Background: **Diabetes is one of the fastest-growing global diseases of the 21st century. Today, more than half a billion people worldwide live with diabetes, with type 2 diabetes accounting for over 90% of cases.** ***Aim and Objectives:*** **The present study aimed to determine the impact of blood glucose control on the development of diabetic complications. The main objectives were to detect the pattern of microangiopathy in type 2 diabetic patients and to analyze factors associated with its development.** ***Methods:*** **This was a single-center, cross-sectional descriptive study conducted in the endocrinology and nephrology outpatient clinics of Suez Canal University Hospitals. Ninety (n=90) patients who met the inclusion criteria were included and assessed through personal interviews and a study questionnaire.** ***Results:*** **62.2% (n=56) of the diabetic patients had microangiopathy. Specifically, 35.6% had various stages of retinopathy, 62.2% had neuropathy, and 35.6% had nephropathy (micro-albuminuria). Additionally, early-stage chronic kidney disease (eGFR 60-89 mL/min/1.73 m^2) was present in 34.4% (n=31) of patients.** ***Conclusion:*** **Microvascular complications were present in over half of the diabetic patients, with neuropathy being the most prevalent, followed by nephropathy and retinopathy. Sociodemographic factors such as age, gender, residency, and educational level did not significantly affect the presence of microvascular complications. However, factors significantly associated with microvascular complications included poor housing, long duration of diabetes, uncontrolled diabetes, irregular drug use, fatty diet, obesity, high 2-hour Postprandial Glucose, high total cholesterol, and high Low-Density Lipoprotein.**

Keywords: endocrinology, disease, complications

Introduction

In 2019, approximately 54.8 million adults aged 20–79 years, or 12.8% of the regional population in Middle East and North Africa in this age group, have diabetes. In Egypt diabetes national prevalence in adults aged 20-79 was 15.2% in 2019 and 10.9 million representing 18.4 % of population in 2021. WHO estimates that diabetes is the 6th cause of death in 2021 and will be the 7th leading cause of death in 2030 [(1)]. Complications of diabetes contribute greatly to the increased mortality and morbidity associated with this disease. Diabetic complications are customarily divided into two main categories: Macro vascular complications including heart disease, stroke and peripheral arterial disease [(2)]. Patients with diabetes are 2 to 4 times more likely to have fatal or nonfatal coronary events or a stroke. Almost 70-80% of patients with T2DM die from one of these two conditions [(3)].

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Micro vascular complications, which include retinopathy, nephropathy and neuropathy. Approximately 40% of patients with diabetes have chronic kidney disease and almost 60%-70% of patients with diabetes have mild to severe forms of nervous system damage and 2.6% of global blindness can be attributed to diabetes. Micro vascular complications accounted for about half the total number of complications [2].

Micro vascular complications, the focus of this study, are leading causes of blindness, chronic kidney failure, and lower limb amputation so this study aims to reveal the pattern of these complications.

Methodology

Study Design and Site:

This study was carried out as a cross-sectional descriptive study aiming to describe the pattern of micro vascular complications among type 2 diabetic patients

The work was carried out in the endocrinology and nephrology outpatient clinics of Suez Canal University hospitals.

Study population:

All Patients were included according to the following criteria:

Inclusion criteria

-Patients above 30 years ago

-Patients already diagnosed as type 2 DM.

Exclusion criteria

-Age below 30 years.

-Pregnancy

-Patient who is blind before being diabetic

-Patient who is known to be CKD before being diabetic

-Patient who is known to have polycythemia or anemia or defect in protein C, S before being diabetic

Sample size

The sample size was calculated using the following formula:

$$n = \left[\frac{Z_{\alpha/2}}{E}\right]^2 * P(1-P) \quad (4)$$

Where:

n = sample size

$\mathbf{Z_{\alpha/2}}$ = 1.96 (The critical value that divides the central 95% of the Z distribution from the 5% in the tail)

$\mathbf{P_1}$ = Prevalence/proportion of microangiopathic complications among T2D patients in the study group = 9.88% [5].

E = Margin of error/Width of confidence interval = 10%

So, by calculation, the sample size is determined to be 90 patients after the addition of 10% drop-out proportion.

Data collection:

Patients who matched the inclusion criteria were included throughout the study and were assessed through a personal interview and study questionnaire.

The form which was used for data collection was composed of:

Part A. Sociodemographic data concerned with:

Name, Sex (male/female), Age, Residency (urban/rural), Marital status (married/not married/widow/divorced), Educational level (illiterate / < high school / > high school), Economic status (Income / Housing), Smoking (yes/no), (index……) and Medication covered (insurance, governmental or self paid)

Part B. Diabetes history including:

Duration of the disease (years), Type of used medications (insulin/tablet/insulin

and tablet) and the regularity of drug usage (regular/not regular) and the use of proper dosage (yes/no), Self monitoring blood glucose and regular follow up (yes/no), Diet (healthy food, alcohol , unhealthy food), Exercise (30 min /day for 5 days/week) and Family history of DM (yes/no), if yes (father , mother , both)

Part C. Co-morbid conditions: (Present/ absent), mention (Hypertension, Ischemic heart disease).

Part D. Measurements: Height (cm), Weight (kg), BMI, Waist circumference (cm), Blood pressure (Systolic 130 mmHg- Diastolic > 80 mmHg) according to American Heart Association

Fundus Examination

Neurological examination (pressure /touch sensation {pin prick monofilament test}, proprioception.

Part E. Laboratory findings: CBC, HbA1c (> 7 or < 7), fasting blood sugar (FPG), 2hours post prandial glucose (2PPG), Albumin to creatinine ratio (ACR) (positive or negative), Serum creatinine, Estimated Glomerular filtration rate (eGFR) calculated using CKD –EPI formula on Medscape calculator (60 -90 or >90), Lipid profile (Serum cholesterol, triglyceride, high density lipoprotein (HDL), low density lipoprotein (LDL) according to American Diabetes Association (ADA).

Diabetic nephropathy (DN) based on current guidelines using four main criteria: a decline in renal function, diabetic retinopathy, proteinuria, and a reduction in GFR.

DN is a clinical syndrome in DM patients characterized by persistent albuminuria (>300 mg/day or >200 μg/min) at 2 out of 3 examinations within 3-6 months, a progressive decrease in GFR, and hypertension [6].

Peripheral neuropathy was considered according to filament test and sensory testing scoring (stage1, stage2 clinical neurpathy, stage3 late complications of clinical neuropathy) [7].

Retinopathy was diagnosed by fundus examination by ophthalmoscopy and was staged to

Stage 1mild non proliferative diabetic retinopathy (NPDR)

At least one micro aneurysm, dot, blot or flame-shaped hemorrhages in all four fundus quadrants.

Stage 2 moderate NPDR (Intraretinal micro aneurysms and dot and blot hemorrhages of greater severity, in one to three quadrants. Cotton wool spots, venous caliber changes including venous beading, and intraretinal micro vascular abnormalities are present but mild).

Stage 3 severe NPDR (At least one of the following should be present):

a) Severe hemorrhages and micro aneurysms in all four quadrants of the fundus

b) Venous beading, which is more marked in at least two quadrants,

c) Intraretinal micro vascular abnormalities, which are more severe in at least one quadrant.

Stage 4 very severe NPDR (Two or more of the criteria for severe non- proliferative diabetic retinopathy, but without any proliferative diabetic retinopathy).

Stage 5 PDR

Micro-vascular pathology with capillary closure in the retina leads to hypoxia of tissue. The hypoxia leads to release of vaso proliferative factors which stimulate new blood vessel formation to provide better oxygenation of retinal tissue. These new vessels growing on the retina are called neo vascularization elsewhere (NVE) and those on the optic disc are called neo vascularization of the disc (NVD). These new vessels can bleed and produce hemorrhage into the vitreous [8].

Ethical consideration:

The study protocol was approved by the Research Ethics Committee of Faculty of Medicine, Suez Canal University and Suez Canal University hospital administration before starting the field work.

Patient informed consent was taken from each patient.

Statistical analysis

The collected data was computerized and statistically analyzed using SPSS program (Statistical Package for Social Science) version 26. Data was tested for normal distribution using the Shapiro Walk test. Data was presented as tables and graphs when appropriate. Qualitative data was represented as frequencies and relative percentages. Chi square test ($\chi 2$) and Fisher exact were used to calculate difference between qualitative variables as indicated. Level of P-value< 0.05 indicates significant while, P≥ 0.05 indicates non-significant difference.

Results

This study investigated 90 patients with type 2 diabetes mellitus, revealing that 56 (62.2%) had at least one microvascular complication, while 34 (37.8%) did not.

Demographic data, including age, gender, residency, marital status, education, income, smoking status, family history of diabetes, and comorbidities, showed no significant differences between patients with and without microvascular complications (Table 1). The overall mean age of the cohort was 56.91±9.03 years.

Regarding medication adherence, a significant difference was observed in regular drug use (p=0.002). Only 11.8% of patients without microangiopathy reported irregular use, compared to 42.9% of those with microangiopathy. Conversely, 88.2% of the non-complicated group consistently used medications versus 57.1% in the complicated group. Medication coverage, specific medication types, and adherence to proper drug dosage showed no significant differences between the groups. The mean diabetes duration for the entire cohort was 10.63±6.84 years. Specifically, patients without microangiopathy had a mean duration of 9.29±7.32 years, while those with microangiopathy had a mean duration of 11.45±6.47 years, with no statistically significant difference between groups (p=0.09). (Table 2)

Table (1) Demographic data of the study populations.

Variables		All DM (n=90)		DM without micro (n=34)		DM with micro (n=56)		p-value
		No.	%	No.	%	No.	%	
Gender	Female	67	74.4	24	70.6	43	76.8	0.51
	Male	23	25.6	10	29.4	13	23.2	
Age	Mean (SD)	56.91	9.03	55.41	8.50	57.82	9.29	0.18
Residency	Urban	50	55.6	22	64.7	28	50.0	0.17
	Rural	40	44.4	12	35.3	28	50.0	
Marital status	Married	75	83.3	32	94.1	43	76.8	0.11
	Divorced	4	4.4	0	0.0	4	7.1	0.52
	Widow	11	12.2	2	5.9	9	16.1	0.19
Education	Illiterate	44	48.9	16	47.1	28	50.0	0.79
	Below high school	21	23.3	5	14.7	16	28.6	0.31
	Above high school	25	27.8	13	38.2	12	21.4	0.21

*Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*

Table (2) comparison between the two study populations regarding information on medications

Variables		All DM (n=90)		DM without micro (n=34)		DM with micro (n=56)		p-value
		No.	%	No.	%	No.	%	
Medication coverage	Insurance	15	16.7	8	23.5	7	12.5	0.40
	Governmental	69	76.7	25	73.5	44	78.6	0.22
	Self-paid	6	6.7	1	2.9	5	8.9	0.18
Medication types	Insulin	43	47.8	13	38.2	30	53.6	0.11
	Oral hypoglycemic	45	50	21	61.8	24	42.9	0.13
	Both	2	2.2	0	0.0	2	3.6	0.08
Regular drug use	No	28	31.1	4	11.8	24	42.9	0.002**
	Yes	62	68.9	30	88.2	32	57.1	
Proper drug dose	No	14	15.6	2	5.9	12	21.4	0.05
	Yes	76	84.4	32	94.1	44	78.6	
Diabetes duration	Mean (SD)	10.63 (6.84)		9.29 (7.32)		11.45 (6.47)		0.09

*Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*

Patients with microvascular complications consistently exhibited significantly higher mean laboratory values for HbA1c (9.23±1.99% vs. 8.17±2.21%; p=0.021), Fasting Plasma Glucose (FPG) (208.48±96.60 mg/dL vs. 156.35±51.08 mg/dL; p=0.007), 2-hour Postprandial Glucose (2PPG) (291.68±127.50 mg/dL vs. 230.65±94.64 mg/dL; p=0.015), Albumin-to-Creatinine Ratio (ACR) (226.53±27.44 mg/mmol vs. 10.80±7.00 mg/mmol; p<0.0001), total

cholesterol (211.80±55.64 mg/dL vs. 180.18±43.61 mg/dL; p=0.008), and Low-Density Lipoprotein (LDL) (135.62±46.37 mg/dL vs. 104.79±34.73 mg/dL; p=0.003). Other laboratory parameters, including hemoglobin, total leucocytic count, platelets, serum creatinine, eGFR, triglycerides, and HDL, showed insignificant differences between the groups.(Table 3)

Table (3) comparison between the two study populations regarding laboratory characteristics.

Variables	All DM (n=90)		DM without micro (n=34)		DM with micro (n=56)		p-value
	Mean	SD	Mean	SD	Mean	SD	
Hemoglobin(g/dL)	12.59	1.12	12.797	1.138	12.46	1.10	0.20
Total leucocytic count(10^9/L)	7.03	1.67	7.09	1.53	6.99	1.77	0.64
Platelets(10^9/L)	276.38	62.37	284.35	61.42	271.54	62.99	0.32
HbA1c(%)	8.83	2.13	8.17	2.21	9.23	1.99	0.021*
FBG(mg/dL)	188.79	85.91	156.35	51.08	208.48	96.60	0.007**
2PPG(mg/dL)	268.62	119.39	230.65	94.64	291.68	127.50	0.015*
ACR(mg/mmol)	145.3	24.00	10.80	7.00	226.53	27.44	<0.0001**
Serum creatinine(mg/dL)	0.70	0.20	0.67	0.18	0.72	0.21	0.26
eGFR(mL/min/1.73 m2)	96.08	16.89	100.45	15.65	93.43	17.19	0.054
Total cholesterol(mg/dL)	199.86	53.44	180.18	43.61	211.80	55.64	0.008**
Triglycerides(mg/dL)	151.50	67.39	137.38	58.10	160.07	71.60	0.15
HDL(mg/dL)	45.12	11.26	44.65	10.81	45.41	11.61	0.81
LDL(mg/dL)	123.98	44.74	104.79	34.73	135.62	46.37	0.003**

HbA1c: glycated hemoglobin, FBG: fasting blood glucose, 2PPG: 2 hours postprandial glucose, ACR: albumin/creatinine ratio, eGFR: estimated Glomerular Filtration Rate, HDL: high density lipoprotein, LDL:low density lipoprotein *Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*

Overall, 62.2% (n=56) of diabetic patients had microangiopathy. The specific prevalence rates were: neuropathy 62.2% (n=56), retinopathy 35.6% (n=32), and nephropathy 35.6% (n=32), defined by micro-albuminuria (ACR ≥30 mg/g). Early-stage Chronic Kidney Disease (CKD), defined as eGFR 60–89 mL/min/1.73 m^2, was present in 34.4% (n=31) of patients. For retinopathy, 22.2% had Stage 1 mild NPDR, 7.8% Stage 2 moderate NPDR, 2.2% Stage 3 severe NPDR, and 3.3% Stage 5 PDR. For neuropathy, 61.1% presented with clinical neuropathy and 1.1% with complicated neuropathy. (Table 4)

Significant positive correlations were found between; retinopathy and unhealthy diet (p=0.035), irregular drug use (p<0.0001), improper drug dose (p=0.002), family history of diabetes (p=0.017), 2PPG (p=0.039), total cholesterol (p=0.044), LDL (p=0.007), nephropathy (p<0.0001), and neuropathy (p<0.0001).Neuropathy and unhealthy diet (p=0.003), irregular drug use (p=0.001), diabetes control

(p=0.013), FPG (p=0.003), 2PPG (p=0.016), total cholesterol (p=0.027), LDL (p=0.005), nephropathy (p<0.0001), and retinopathy (p<0.0001).Nephropathy and older age (p=0.038), marital status (p=0.030), irregular drug use (p<0.0001), improper drug dose (p=0.014), unhealthy diet (p=0.024), 2PPG (p=0.023), total cholesterol (p=0.017), triglycerides (p=0.007), HDL (p=0.021), LDL (p=0.007), retinopathy (p<0.0001), and neuropathy (p<0.0001).(Table 5, 6, 7)

Table (4) Prevalence data of microangiopathy and its pattern.

Variables		All DM (n=90)	
		No.	%
Microangiopathy	No microangiopathy	34	37.8
	Microangiopathy	56	62.2
Retinopathy	Absent	58	64.4
	Present	32	35.6
	Stage 1 mild NPDR	*20*	*22.2*
	Stage 2 moderate NPDR	*7*	*7.8*
	Stage 3 severe NPDR	*2*	*2.2*
	Stage 5 PDR	*3*	*3.3*
Neuropathy	Absent	34	37.8
	Present	56	62.2
	Clinical neuropathy	*55*	*61.1*
	Complicated neuropathy	*1*	*1.1*
Nephropathy (albuminuria)	Absent (ACR<30 mg/g)	58	64.4
	Present (ACR ≥30 mg/g)	32	35.6
DKD	Normal (eGFR ≥90 ml/min/1.73 m^2)	59	65.6
	CKD (eGFR 60-89 ml/min/1.73 m^2)	31	34.4

Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01

Table (5) Correlation between retinopathy and other study variables.

Variables	Retinopathy	
	Correlation coefficient	p-value
Diet	0.222	0.035*
Regularity of drug use	0.415	<0.0001**
Proper drug dose	0.321	0.002**
Family history of diabetes	0.251	0.017*
2PPG	0.218	0.039*
Total cholesterol	0.212	0.044*
LDL	0.283	0.007**
Nephropathy	0.753	<0.0001**
Neuropathy	0.427	<0.0001**

*Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*

Table (6) Correlation between neuropathy and other study variables.		
Variables	Neuropathy	
	Correlation coefficient	p-value
Diet	0.309	0.003**
Regularity of drug use	0.346	0.001**
Diabetes control	0.261	0.013*
FPG	0.311	0.003**
2PPG	0.253	0.016*
Total cholesterol	0.234	0.027*
LDL	0.292	0.005**
Nephropathy	0.586	<0.0001**
Retinopathy	0.427	<0.0001**
*Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*		

Table (7) Correlation between nephropathy and other study variables.		
Variables	Nephropathy	
	Correlation coefficient	p-value
Age	0.219	0.038*
Marital status	0.228	0.030*
Regularity of drug use	0.403	<0.0001**
Proper drug dose	0.258	0.014*
Diet	0.238	0.024*
2PPG	0.240	0.023*
Total cholesterol	0.252	0.017*
Triglycerides	0.281	0.007**
HDL	0.242	0.021*
LDL	0.283	0.007**
Retinopathy	0.753	<0.0001**
Neuropathy	0.586	<0.0001**
Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01		

Risk assessment (Odds Ratios) showed that uncontrolled diabetes (HbA1c >7%, OR=3.00, p=0.015), irregular drug use (OR=5.62, p=0.002), fatty diet (OR=4.12, p=0.004), obesity (BMI ≥30 kg/m^2, OR=2.37, p=0.049), high 2PPG (OR=2.92, p=0.047), high cholesterol (OR=4.13, p=0.026), and high LDL (OR=4.89, p=0.011) were significantly associated with an increased risk of microangiopathy. Poor housing (OR=2.00, p=0.099) and diabetes duration >10 years (OR=2.11, p=0.089) showed trends towards increased risk but were not statistically significant at the p<0.05 level.(Table 8)

Table (8) Risk assessment with odds ratios of significant variables for microangiopathy.				
Variables	OR	95% CI		p-value
		Lower limit	Upper limit	
Poor housing	2.00	0.77	5.17	0.099
Diabetes duration > 10 years	2.11	0.89	5.02	0.089
Uncontrolled diabetes (HbA1C >7%)	3.00	1.21	7.41	0.015*
Irregular drug use	5.62	1.75	18.12	0.002**
Fatty diet	4.12	1.54	11.02	0.004**
Obesity (BMI ≥ 30 kg/m^2)	2.37	0.96	5.87	0.049*
High 2PPG	2.92	0.99	8.61	0.047*
High cholesterol	4.13	1.10	15.46	0.026*
High LDL	4.89	1.32	18.16	0.011*
*Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*				

Multiple regression analysis identified irregular drug use (p=0.016), fatty diet (p=0.015), uncontrolled diabetes (p=0.019), high 2PPG (p=0.01), and high LDL (p=0.009) as independent factors for microangiopathy. These findings emphasize the importance of these modifiable factors in the development of diabetic microvascular complications.(Table 9)

Table (9) Multiple regression analysis.				
Variables	Unstandardized Coefficients		Standardized Coefficients	p-value
	B	SE	Beta	
(Constant)	0.668	0.260		0.012*
Irregular drug use	0.258	0.105	0.246	0.016*
Fatty diet	0.137	0.055	0.250	0.015*
Uncontrolled diabetes	0.084	0.035	0.194	0.019*
High 2PPG	0.001	0.000	0.220	0.01**
High LDL	0.010	0.004	0.226	0.009**
*Insignificant p-value >0.05, *significant p-value <0.05, **highly significant p-value <0.01.*				

Discussion

Diabetes mellitus (DM), the commonest metabolic illness, is one of the major public health concerns worldwide. The diabetes burden has been rising more rapidly in low- and middle-income countries than in high income countries (Schlesinger et al., 2022). One of the most prevalent consequences of diabetes, following uncontrolled chronic hyperglycemia, is diabetic microangiopathy, which mostly includes retinopathy, nephropathy, and neuropathy that are caused by pathological changes in capillaries (Sheleme et al., 2020). Diabetes related complications may result in many disabilities which cause a reduction of patients' quality of life and increase the burden on the healthcare system. Development of microvascular and macrovascular complications cause

significant morbidity and mortality among diabetics [11].

This study aimed to delineate the pattern of microangiopathy and assess the impact of blood glucose control on the appearance of these complications in a cohort of 90 patients with type 2 diabetes mellitus. Of these, 34 patients presented without microangiopathy, while 56 had at least one form of diabetic microangiopathy.

The mean age of patients in the current study was 56.91 ± 9.03 years. This finding aligns with several regional and international studies; for example, Seid et al. (2021) found a median age of 53 years among diabetics. Sheleme et al. (2020) [10] reported a mean age of 49.9 ± 14.2 years, with a large proportion aged 41 to 60 years. Zhao et al. (2021) [13] stated a mean age of onset of 55.8 ± 10.9 years for type 2 diabetes. Lee et al. (2021) [14] found a median age of 60 years, and Saini et al. (2021) [15] reported a mean age of 58.86 ± 9.85 years. This consistency suggests that type 2 diabetes and its complications are indeed prevalent in this age demographic, possibly due to age-related factors like increased insulin resistance and prevalent comorbidities. Notably, this study found no statistically significant differences in age or other demographic factors like gender, residency, or marital status between patients with and without microangiopathy, indicating that demographic variables alone did not differentiate complication status in this cohort.

The prevalence of microangiopathy in our study was 62.2% (n=56). Neuropathy was the most common microangiopathy (62.2%), followed by retinopathy (35.6%) and nephropathy (35.6% based on ACR ≥30 mg/g). The high prevalence of neuropathy is particularly interesting, potentially explained by its ability to develop in earlier stages of hyperglycemia, even pre-diabetes. This finding is consistent with Faselis et al. (2020) [16], who reported neuropathy as the highest percentage of complications (50%), and Lin et al. (2021) [17], who, in a systematic review, found neuropathy among more than 75% of type 2 diabetes patients. Sheleme et al. (2020) [10] also identified diabetic neuropathy as the most commonly identified microvascular complication (23.9%). On the other hand, lower percentages were found by Seid et al. (2021) [12], with retinopathy at 24.8%, nephropathy at 16.1%, and neuropathy at 8.1%. Similarly, Tochiya et al. (2023) [18] described lower percentages, with non-proliferative retinopathy in 20.3% and microalbuminuria in 30.1% of patients. These variations in prevalence across studies may be attributed to ethnic differences in susceptibility, disparities in diabetes control, varying prevalence of hypertension, and diverse socioeconomic and cultural factors, as well as differences in population characteristics, study periods, and diagnostic criteria for complications.

A critical aspect of our findings pertains to medication adherence and metabolic control. A significant difference was observed in regular drug use; 42.9% of patients with microangiopathy reported irregular use, compared to only 11.8% of those without complications. This stark contrast underscores the direct link between medication consistency and

the development of complications. Poor adherence directly impairs glycemic control, a primary driver of microvascular damage. While medication coverage and types did not differ, the consistency of drug use emerged as a key differentiator. The mean diabetes duration for the entire cohort is 10.63 ± 6.84 years. When comparing the two groups, the mean duration is 9.29 ± 7.32 years for patients without microangiopathy and 11.45 ± 6.47 years for patients with microangiopathy. The p-value of 0.09 indicates that there is no statistically significant difference in diabetes duration between patients with and without microvascular complications. While diabetes duration is a fundamental risk factor, our study suggests that in this particular population, the effectiveness of diabetes management (glycemic control, adherence, lipid management) might be more distinguishing factors than the length of time a person has had diabetes in determining the presence of microangiopathy.

Laboratory characteristics further showed the impact of metabolic dysregulation. Patients with microangiopathy consistently demonstrated significantly higher mean levels of HbA1c, FPG, 2PPG, ACR, total cholesterol, and LDL which confirm poorer glycemic control in the complicated group and renal microvascular damage. Higher total cholesterol and LDL levels highlight the role of dyslipidemia in accelerating microvascular disease progression. This aligns with the established understanding that sustained hyperglycemia damages capillary endothelial cells in the retina, mesangial cells in the renal glomeruli, and Schwann cells of the peripheral nervous system, leading to microvascular complications [17]. The lack of significant differences in other hematological and renal parameters (e.g., hemoglobin, serum creatinine, eGFR) suggests that these complications primarily manifest through metabolic dysregulation before leading to broader systemic derangements, or that the eGFR differences, while not statistically significant at p=0.054, trended towards lower values in the microangiopathy group.

Regression analysis identified several key risk factors and independent predictors for microvascular complications. Risk factors for microvascular complications included poor housing, long diabetes duration, uncontrolled diabetes (HbA1c > 7%), irregular drug use, fatty diet, obesity, high 2PPG, high cholesterol, and LDL. A reasonable explanation for poor housing is its indication of financial insecurities and poorer nutritional choices. Longer duration of diabetes means longer exposure to hyperglycemia, which is the main cause for developing complications. Crucially, multiple regression analysis confirmed that irregular drug use, fatty diet, uncontrolled diabetes, high 2PPG, and high LDL were independent predictors of microangiopathy. These findings resonate with external literature; for instance, Rasheed et al. (2021) [19] agreed that risk factors for diabetic retinopathy included diabetes duration >15 years and HbA1c >6.5%. Sheleme et al. (2020) [10] also identified duration of

diabetes (>10 years) and poor glycemic control as predictors. Annani-Akollor et al. (2019) [20] similarly reported that diabetes duration of 5–10 years and >10 years was associated with increased odds of developing T2DM-associated complications. Bruce and Mallika (2019) [21] associated high diabetic complication rates with obesity, disease duration above five years, and high HbA1c levels. Gebre and Assefa (2019) [22] suggested that patients with poor glycemic control were more likely to develop diabetic complications.

Conclusion

In conclusion, micro vascular complications were found to represent over half of the diabetic patients and the most popular was neuropathy followed by nephropathy and retinopathy. The micro vascular complications were not affected by sociodemographic data as age, gender, residency and educational level. However, micro vascular complications were affected by factors such as poor housing, long duration, uncontrolled diabetes, irregular drug use, fatty diet, obesity, high 2PPG, high cholesterol and LDL.

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