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## Original Research Article

## Correlation of fasting and postprandial dyslipidemia with macrovascular complications of diabetes mellitus

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## ABSTRACT

**Introduction:** The most prevalent form of the disease, type 2 Diabetes Mellitus is often asymptomatic in the early stages and it may remain undiagnosed for many years. The insulin resistance in the liver leads to failure of the hyperinsulinaemia to suppress the gluconeogenesis, which increases fasting glucose levels and decreases Postprandial hypertriglyceridemia results in a proatherogenic environment which leads to atherosclerosis and macrovascular complications in type 2 diabetes mellitus. It is believed that atherosclerosis is a postprandial phenomenon with respect to lipids, as we are in the postprandial state for most of the day. Increased glucose production in the liver occurs early in the course of diabetes, and it is likely in skeletal muscles after the onset of the insulin secretory abnormalities and the insulin resistance [4]. Due to the insulin resistance in the adipose tissue and obesity, the free fatty acid (FFA) flux from the adipocytes is increased, which in turn leads to an increase in lipid [very low-density lipoprotein (VLDL) and triglycerides] synthesis in the hepatocytes. This is responsible for the dyslipidaemia which is found in type 2 diabetes mellitus [elevated triglycerides, reduced HDL, and increased low-density lipoprotein (LDL) particle]. Individuals with type 2 diabetes mellitus are at increased risk of developing microvascular and macrovascular complications. Increased postprandial glucose (PPG) concentrations contribute to suboptimal glycemic control.

**Objective:** To correlate fasting and postprandial dyslipidemia with macrovascular complications of diabetes.

**Materials and Methods:** This is a cross-sectional study, wherein written informed consent was taken after giving detailed information to the participants regarding the study. Patients who were in the age group of 35-65 years, admitted in the Department of Medicine, RRMCH from November 2017 for next 18 months with Diabetes Mellitus who met a predefined inclusion and exclusion criteria were studied. The study was initiated after obtaining clearance from the institution's ethical committee.

**Results:** IHD changes were found in 8 cases and 3 controls, LVH by voltage criteria was found in 15 cases and 8 controls. IHD changes found in cases and controls are 16% and 6% respectively. LVH changes found in cases and controls are 30% and 16% respectively. Abnormal 2D Echo findings in our study were mainly IHD and LVH. The occurrence of IHD was more in cases compared to controls with statistical significance ( $p < 0.05$ ). Peripheral vascular disease in our study was found in 25 patients i.e. 25% of the study group. In cases, it was found in 20 patients and in controls, it was found in 5 patients i.e. 40% and 10% respectively. The occurrence of PVD was more in cases compared to controls with statistical significance ( $p < 0.05$ ). Stroke in our study is found in 7 patients i.e. 7% of the study group. In cases, it was found in 6 patients and in controls, it was found in 1 patient i.e. 12% and 2% respectively.

**Conclusion:** It could be said that there is an increase in the occurrence of postprandial dyslipidemia with increasing age, irregular treatment, increase in HbA1c, FBS, PPBS and with the past history of HTN, CVA, PVD and IHD. All macrovascular complications (IHD, CVA, PVD) were found more in the case compared to controls with statistical significance. So it could be said that there is an increase in the occurrence of macrovascular complications with an increase in postprandial dyslipidemia.

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## 1. Introduction

In the modern world, the growing incidence of type 2 diabetes mellitus (T2DM) is a critical problem. Most subjects with T2DM have insulin resistance and are at increased risk of developing cardiovascular disease (CVD). Excess morbidity and mortality in T2DM are mainly due to dyslipidemia. Postprandial triglyceridemia is a distinct component of diabetic dyslipidemia.<sup>1</sup> Postprandial hypertriglyceridemia results in a proatherogenic environment which leads to atherosclerosis and macrovascular complications in type 2 diabetes mellitus. It is believed that atherosclerosis is a postprandial phenomenon with respect to lipids, as we are in the postprandial state for most of the day<sup>2, 3</sup> Increased glucose production in the liver occurs early in the course of diabetes, and it is likely in skeletal muscles after the onset of the insulin secretory abnormalities and the insulin resistance.<sup>4</sup> Due to the insulin resistance in the adipose tissue and obesity, the free fatty acid (FFA) flux from the adipocytes is increased, which in turn leads to an increase in lipid [very low-density lipoprotein (VLDL) and triglycerides] synthesis in the hepatocytes. This is responsible for the dyslipidaemia which is found in type 2 diabetes mellitus [elevated triglycerides, reduced HDL, and increased low-density lipoprotein (LDL) particles].<sup>4</sup> Individuals with type 2 diabetes mellitus are at increased risk of developing microvascular and macrovascular complications. Increased postprandial glucose (PPG) concentrations contribute to suboptimal glycemic control. Postprandial hyperglycemia is one of the earliest abnormalities of glucose homeostasis associated with type 2 diabetes mellitus and is markedly exaggerated in diabetic patients with fasting hyperglycemia.<sup>5, 6, 7</sup> Correcting the postprandial hyperglycemia may form a key part of the strategy for the prevention and management of CVDs in diabetes.

It is not clearly known whether diabetic patients with macrovascular diseases have greater abnormalities of postprandial TG metabolism than those without. In view of the above said the study was carried out to find out the characteristics of postprandial lipid levels in patients with type 2 diabetes mellitus and its impact on the vascular complications.

## 2. Objective of The Study

To correlate fasting and postprandial dyslipidemia with macrovascular complications of diabetes

## 3. Material and Methods

This is a descriptive cross-sectional study.

Patients who were in the age group of 35-65 years, admitted in the Department of Medicine, RRMCH from November 2017 for next 18 months with Diabetes Mellitus who met a predefined inclusion and exclusion criteria were studied.

The study was initiated after obtaining clearance from the institution's ethical committee.

### 3.1. Inclusion criteria

All type 2 DM patients who were in the age group of 35-65 years on regular treatment with OHA which had a duration of diabetes of more than 5 years in medicine OPD, diabetic clinic and wards.

### 3.2. Exclusion criteria

1. Type I DM patients
2. Patients with congenital hyperlipidemia
3. Diabetic patient on the hypolipemic drug.
4. Patients on insulin therapy
5. Gestational Diabetic patients
6. Patients with thyroid disease
7. Patients not willing for the study

### 3.3. Sample

50 cases of type 2 diabetes mellitus with abnormal fasting lipid profile (one or more lipid parameter) and 50 controls of type 2 diabetes mellitus with normal fasting lipid profile.

### 3.4. Operational definitions

1. Type 2 Diabetes mellitus patients were classified as having type 2 DM using clinical criteria such as a present/prior history of usage of OHAs or usage of a combination of insulin and the OHAs.

### 3.5. Diabetes is diagnosed by world health organization (WHO) criteria

1. Fasting plasma glucose (FPG)-126 mg/dl (7.0 mmol/l) or,
2. 75 g oral glucose tolerance test (OGTT) with fasting plasma glucose >126 mg/dl (7.0

mmol/l) and/or 2 hours plasma glucose >200 mg/dl (11.1 mmol/l) or,

1. Glycated hemoglobin (HbA1c) > 6.5mg/dl or 48 mmol/mol, or
2. Random plasma glucose >200 mg/dl (11.1 mmol/l) in the presence of classical diabetes symptom

1. Plasma glucose is measured by Randox autoanalyser using the colorimetric method without deproteinisation using glucose oxidase enzyme.

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2. Dyslipidaemia: Abnormal lipid profile includes the following either singly or in combination, triglyceride (TG) levels >150 mg/dl, high density lipoprotein cholesterol (HDL-C) (for men < 40 mg/dl and women > 50 mg/dl), low density lipoprotein cholesterol (LDL-C) >100mg/dl.

Lipid profile using RANDOX autoanalyser. All parameters expressed in milligram /decilitre. Cut-off values according to NCEP ATP III guidelines.[7]

### 3.6. NCEP ATP III criteria for lipids

**Table 1:** LDL Cholesterol (mg/dL)

<100	Optimal
100-129	Near optimal/above optimal
130-159	Borderline high
160-189	High
>190	Very high

**Table 2:** Total cholesterol (mg/dL)

<200	Desirable
200-239	Borderline high
>240	High

**Table 3:** HDL Cholesterol (mg/dL)

<40	Low
>60	High

Also, considered abnormal is an elevated total serum cholesterol level  $>200\text{mg/dl}$

### 3.7. Study protocol

Subjects fulfilling inclusion criteria were selected for the study. Each subject made two visits to the study hospital during which medical history, physical examination, systemic examinations and relevant investigations were carried out and they were advised to take a low fat diet consisting of 60% carbohydrates, 25% fats and 15% proteins divided into 3 meals. Complete clinical history including name, age, sex, occupation, residence, presenting symptoms, duration of diabetes was noted. The general examination includes vitals i.e. pulse, supine and standing blood pressure at 3 minutes, general body survey, waist to hip ratio will be recorded. Systemic examination of cardiovascular, respiratory, gastrointestinal and CNS was done. Patients were examined, investigated and evaluated for specific complications of diabetes.

### 3.8. Following selection, the following was done

1. History, (including family history) to judge the likelihood of a familial lipid disorder
2. A complete clinical examination (including fundus)
3. CBC, ESR, Peripheral smear.
4. Renal function test, Liver function test, TSH, Serum Electrolytes
5. Fasting and Postprandial blood sugars, HbA1C.
6. Urine Routine,
7. BT, CT, PT/INR, aPTT
8. ECG and 2D Echo
9. CT scan / MRI scan of the brain.
10. Chest X-ray (PA view).
11. USG Abdomen
12. Fasting Lipid Profile, Fasting LDL, LDL
13. Total cholesterol
14. Chylomicrons, VLDL & HDL are eliminated by cholesterol esterase and oxidase then the specific measurement of LDL cholesterol is made after the release of LDL by detergents.
15. LDL- Cholesterol
16. Triglycerides: GPO-PAP method. Triglycerides are determined after enzymatic hydrolysis with lipases and indicator quinonimine is formed is measured by colourimetric method.
17. HDL-Cholesterol: Chylomicrons, VLDL & LDL are eliminated by cholesterol esterase and oxidase then the specific measurement of HDL cholesterol is made after the release of HDL by detergents.
18. VLDL cholesterol: Calculated from total cholesterol  $-(\text{LDL} + \text{HDL cholesterol})$ .

The data was collected in pre-prepared proforma and then transferred to a master chart for analysis.

## 4. Sample Size Estimation Calculation

### 4.1. Sample size

This is a descriptive cross-sectional study which was done in the Department of Medicine, RRMCH, Bangalore.

50 cases of type 2 diabetes mellitus with abnormal fasting lipid profile (one or more lipid parameter) and 50 controls of type 2 diabetes mellitus with normal fasting lipid profile.

## 5. Data and Statistical Analysis

The data collected was analyzed using mean, mode for demographic data and frequency percentage for the analysis of the clinical data.

Statistical Analysis was done using SPSS software version 23.0. A 'p' value less than 0.05 ( $p < 0.05$ ) is considered significant.

The various measures of central tendencies and graphical representations were used to analyze the data.

The data was analyzed using SPSS version 20. Mean and standard deviation will be applied between two groups. 't' test was applied to know the mean difference between two groups.

## 6. Observation and Results

**Table 4:** Age distribution among patients in the study

Age (years)	Number			Percentage		
	Cases	Controls	Total	Cases	Controls	Total
35-45 Years	11	12	23	22.00%	24.00%	23.00%
46-55 Years	17	21	38	34.00%	44.00%	38.00%
56-65 years	22	17	39	44.00%	34.00%	39.00%
Total	50	50	100	100.00%	100.00%	100.00%

In the present study, when we evaluated the age distribution of the cases in the study we found that the most common age group was between the ages of 56-65 years, 39 patients belonged to this group with 22 patients in the test and 17 patients in the controls. 38 patients belonged to 46-55 years age group with 17 patients in the test and 21 patients in the controls. 23 patients belonged to 35-46 years age group with 11 patients in the test and 12 patients in the control respectively.

**Table 5:** Distribution of gender in study

Gender	Number	Percentage
Male	61	61.00%
Female	39	39.00%
Total	100	

In the present study, 61.00% were males and 39.00% were females.

**Table 6:** Distribution of occupation among patients in the study

Occupation	Number			Percentage		
	Cases	Controls	Total	Cases	Controls	Total
Housewife	6	7	13	12.00%	14.00%	13.00%
Teacher	7	7	14	14.00%	14.00%	14.00%
Businessman	14	19	33	28.00%	38.00%	33.00%
Retired	3	4	7	6.00%	8.00%	7.00%
Tailor	5	1	6	10.00%	2.00%	6.00%
Manual labourer	11	11	22	22.00%	22.00%	22.00%
Gardener	4	1	5	8.00%	2.00%	5.00%
Total	50	50	100	8.00%	2.00%	100.00%

In the present study, 33 % were Businessman, 22 % were Manual labourer, 14 % were teachers, 14 % were housewives.

**Table 7:** Distribution of residence among the subjects in the study

Locality	Number			Percentage		
	Cases	Controls	Total	Cases	Controls	Total
Rural	15	12	27	30.00%	24.00%	27.00%
Urban	35	38	73	70.00%	76.00%	73.00%
Total	50	50	100	100.00%	100.00%	100.00%

The maximum number of patients belonged to urban areas (73 out of 100 patients i.e.73%). Both in control and cases maximum no of patients were from urban areas( 38 and 35 patients in controls and cases respectively).

**Table 8:** Distribution of addictions among patients in the study

Addiction	Number			Percentage		
	Cases	Controls	Total	Cases	Controls	Total
Alcohol	13	10	23	26.00%	20.00%	23.00%
Tobacco chewing	5	4	9	10.00%	8.00%	9.00%
Smoking	12	7	19	24.00%	14.00%	19.00%
NIL	20	29	49	40.00%	58.00%	49.00%
Total	50	50	100	100.00%	100.00%	100.00%

40% in the cases and 48% in the control group had no addictions. Alcoholism was the commonest, seen in 26% of the cases and 20% of controls. Smoking was seen in 24% of the cases and 14% of the controls. Tobacco chewing was seen in 10% and 16.00% of cases and control respectively.

**Table 9:** Distribution of the patients according to duration of diabetes in the study

Duration	Number			Percentage		
	Cases	Controls	Total	Cases	Controls	Total
5-10 years	16	14	30	32.00%	28.00%	30.00%
10-15 years	19	20	39	38.00%	40.00%	39.00%
>15 years	15	16	31	30.00%	32.00%	31.00%
Total	50	50	100	100.00%	100.00%	100.00%

16 cases had a duration of diabetes of 5-10 years, 19 cases had a duration of diabetes of 10 to 15 years and 15 cases had a duration of diabetes of >15 years and in the controls 14 cases had a duration of diabetes of 5-10 years, 20 cases had a duration of diabetes of 10 to 15 years and 16 cases had a duration of diabetes of more than 15 years.

**Table 10:** Distribution of the cases in the study based on treatment

Treatment	Number		Percentage			P value
	Cases	Controls	Total Cases	Controls	Total	
OHA single	38	49	87	76.00%	98.00%	87.00%
OHA-combinations	12	1	13	24.00%	2.00%	13.00%
Total	50	50	100	100.00%	100.00%	100.00%
				%	%	%
						<0.0001

Most of the patients in both cases and controls were on treatment with a single OHA. 76.00% and 98.00% among of cases and controls respectively. This was statistically significant  $p < 0.05$ .

**Table 11:** Comparison of mean fasting lipid parameters

Group	Minimum	Maximum	Mean	Std. Deviation
Cases	50	196	229.70	19.810
LDL	50	20	30.12	7.553
HDL	50	97	218.10	66.565
TG	50	218	259.82	19.888
Total choles-				
terol				
controls	50	79	110.16	13.365
LDL	50	27	47.74	9.705
HDL	50	74	165.20	40.069
TG	50	127	157.90	17.081
Total				
Fasting P Value		<0.001	<0.001	<0.001

There is a statistically significant increase in total cholesterol, LDL and Triglycerides (P value <0.05) in Fasting state of the cases compared to controls.

*Descriptive Statistics*

**7. Discussion**

In 2000, India was the world capital of diabetes with the highest number of people with diabetes mellitus (31.7 million) followed by China (20.8 million) & the United States (17.7 million) in second and third place respectively. Cardiovascular disease (CVD) is a significant cause of illness, disability, and death among individuals with diabetes. The macrovascular complications of diabetes—Coronary Heart Disease (CHD), Cerebrovascular Accidents

**Table 12:** Comparison of mean postprandial lipid parameters

Group	Minimum	Maximum	Mean	Std. Deviation
Cases	50	216	259.50	19.431
Ldl-pp	50	17	27.12	7.553
Hdl-pp	50	245	286.62	19.727
Total Choles-				
terol-pp				
Tg-pp	50	115	236.10	66.565
controls	50	110	141.76	13.540
Ldl-pp	50	30	50.74	9.705
Hdl-pp	50	150	192.50	17.210
Total Choles-				
terol-pp				
Tg-pp	50	92	183.20	40.069
Post prandial P Value		<0.001	<0.001	<0.001

There is a statistically significant increase in total cholesterol, LDL and triglycerides (P value <0.05) in Postprandial state of the cases compared to controls.

**Table 13:** Comparison of mean lipid parameters within cases

Fasting	Minimum	Maximum	Mean	Std. Deviation
Ldl	196	299	229.7	19.81
Hdl	20	68	30.12	7.533
Tg	97	410	218.1	66.565
Total	218	326	259.82	19.888
Post-prandial	Minimum	Maximum	Mean	Std. Deviation
Ldl-pp	216	319	256.5	19.431
Hdl-pp	17	65	27.12	7.553
Tg-pp	115	428	236.1	66.565
Total	245		286.62	19.727
P value	<0.01	>0.05	<0.01	<0.01

There is a statistically significant increase in total cholesterol, LDL, Triglycerides (P value <0.05) in Postprandial state of the cases compared to their fasting state.

**Table 14:** Comparison of mean lipid parameters with in controls

	Minimum	Maximum	Mean	Std.Deviation
Fasting				
LDL	79	137	110.16	21.816
HDL	27	67	47.74	10.361
TG	74	245	165.20	40.069
Total	127	194	157.90	21.833
Postprandial	Minimum	Maximum	Mean	Std. Deviation
LDL-pp	110	168	141.76	12.915
HDL-pp	30	70	50.74	9.697
TG-pp	92	263	183	39.445
Total	150	229	192	16.80
P value	Ldl <0.01	Hdl >0.05	Tg <0.01	Total <0.01

There is a statistically significant increase in total cholesterol, LDL, Triglycerides, (P value <0.05) in Postprandial state of the controls compared to their fasting state.

**Table 15:** Comparison of fbs and ppbs with in controls

	Cases	Controls	P Value
FBS	142.09	122.17	0.00
	+45.86	+33.42	
	212.35	181.96	0.00
	+67.97	+33.77	
P Value	0.00	0.00	

There was a statistically significant increase in PPBS value in both cases and controls compared to their FBS values and also there is a significant increase in PPBS values in cases compared to PPBS values in controls (p = 0.00).

**Table 16:** Comparison of hba1c among cases and controls

Group	Minimum	Maximum	Mean	Std.-Deviation
Cases HBA1C 50	5.7	8.4	7.142	0.8318
controls HBA1C 50	4.6	6.2	5.554	0.4367

**Table 17:** Comparison of macrovascular complications among cases and controls

Macrovascular complications	Frequency		Percent		P value
	Cases	controls	Cases	Controls	
NIL	13	41	26	82	<0.05
CVA	6	1	12	2	<0.05
IHD	11	3	22	6	<0.05
PVD	20	5	40	10	<0.05
Total	50	50	100	100	

All three macrovascular complications in our study were found more in cases compared to the controls. Statistical significant was found (p <0.05). 14% had IHD (11 in cases and 3 in controls), 25% had PVD (20 in cases and 5 in controls), 7% had CVA (6 in cases and 1 in controls),

**Table 18:** Comparison of type of strokes among cases and controls

Type of strokes	Cases	Controls
Ischemic stroke	5	1
Hemorrhagic stroke	1	0
Total	6	1

Out of 100 subjects, 7 (7%) patients were having the evidence of stroke of which 6 patients were having an ischemic stroke and 1 was having the evidence of hemorrhagic stroke. Out of 50 cases 6(12%) patients were having the evidence of stroke of which 5 were ischemic strokes and 1 was hemorrhagic stroke. The overall prevalence of stroke found was 7% in which ischemic stroke and hemorrhagic stroke were 6% and 1% respectively.

(CVA), and Peripheral Vascular Disease (PVD)— all being different facets of the same vascular damage — account for more than 70% of all deaths in individuals with diabetes. CVD events are four times more common in individuals with diabetes, occur at a younger age, and have a much higher case fatality rate, this is more so in Indians. Coronary Artery Disease in Indians (CADI) is a phenomenon by itself. In fact, people with diabetes and no history of vascular disease have the same risk of having a heart attack or dying of vascular disease as non-diabetic individuals with a prior history of cardiovascular disease. Lipid and lipoprotein abnormalities are common in the diabetic population due to the effects of insulin deficiency and insulin resistance on key metabolic enzymes.

In a study by Puthenveedu et al (2017) at Madhurai medical college, India found that persistent postprandial hypertriglyceridemia may result in a proatherogenic environment leading to atherosclerosis and macrovascular disease in type 2 diabetes subjects. LDL oxidation in the postprandial state is affected by an acute increase in glucose levels. Thus, oxidative modification of LDL cholesterol may contribute to higher CVD risk in diabetic patients, and elevated triglyceride levels may contribute to the rapid LDL oxidation seen in Type 2 DM. Due to lack of studies including these criteria in cases and controls distribution, comparison was not possible in some points. In the present study 100 type 2 diabetes mellitus patients, divided into 50 cases and 50 controls satisfying inclusion criteria were considered. The study comprises 61 male patients & 39 female patients. Prevalence of diabetes was highest in the age group 56–65 years 39 out of 100. Sarha Wild et al in their study noted the highest prevalence of type 2 diabetes in the age group of 41–64 years in developing countries (Finding consistent with our study) while in developed countries it is highest in people >65 years. In another study by Santosh YL et al, they noted the highest prevalence of diabetes in the age group 61–70 years (24.92%) while age group 51–60 had 21.42% cases.

In our study the maximum number of patients had a duration of diabetes for >10 years. 30 patients had a duration of diabetes between 1-5 years. 39 and 30 patients had diabetes duration between 10-15 years and >15 years respectively. In this study, distribution of fasting dyslipidemia (cases) is more in 56-65 yrs age group, while in study carried out by Kusum Bali, et al the distribution of dyslipidemia among the different age groups was almost similar: 82.6% in < 45 years, 82.9% in 45-60 years and 83.7% in > 60 years, the difference was not statistically significant.<sup>61</sup> In our study we found the distribution of fasting dyslipidemia is slightly higher in males as compared to females, findings are consistent with the study by Kusum Bali, et al, where they found dyslipidemia is more in males (133 males out of 285 DM type 2 patients). In the present study, we found fasting dyslipidemia was maximum in both cases and controls with the duration of diabetes >10 yrs. In the present study IHD was found in 14 out of 100 patients, 11 in cases and 3 in controls i.e. 22% and 6% respectively. Evidence of IHD was found more in cases compared to controls, statistical significance was found ( $p < 0.05$ ). In a study carried out by Angelo Avogaro, et al they found that the age-standardized incidence rate (per 1,000 person/years) of first CHD event was 28.8 in men and 23.3 in women.

In a study carried out by R.P. Agrawal, et al in 4067 patients of DM 2 they found that the prevalence of CHD was 12.4% and the risk of CHD in known Type 2 diabetic patients was higher in men than in women. Of the diabetic men 60% showed high (20–40%) or very high (>40%) risk of CHD, while 56% of the women had values compatible with moderate (10–20%), mild (5–10%) or low (<5%) risk of CHD ( $p < 0.05$ ). In a study carried out by Deepa D. V., et al in Bellary, Karnataka. in 100 newly diagnosed DM 2 patients they found the prevalence of peripheral vascular disease 11%.<sup>64</sup> In a study carried out by R.P. Agrawal, et al in 4067 patients of DM 2 they found PVD was present in 735 patients, prevalence 18.1%. In this study we found CVA in 7 out of 100 patients, in cases evidence of CVA was found in 6 patients out of 50 i.e. 12% and in controls it was found in 1 patient out of 50 patients i.e. 2%. Evidence of CVA is found more in cases compared to controls with statistical significance. ( $p < 0.05$ ). The overall prevalence of stroke found was 7 out of 100 patients (7%) out of which 6 patients had an ischemic stroke and 1 had a hemorrhagic stroke.

In a study carried out by Nafisa C Vaz, et al To determine the prevalence of diabetes mellitus (DM) and its associated diabetic complications in rural Goa, India they found Among the total 1,266 study participants about 130 (10.3%) were diabetics And prevalence of cerebrovascular accidents (CVAs) was 6.9%. In a study carried out by Seppo Lehto, et al they concluded that the risk of stroke in non-insulin dependent diabetes mellitus (NIDDM) men was about threefold and in NIDDM women fivefold higher than

that in corresponding nondiabetic individuals. Low levels of HDL cholesterol (<0.90 mmol/L), high levels of total TGs (>2.30 mmol/L), and the presence of hypertension (HTN) were associated with a twofold increase in the risk of stroke mortality or morbidity.

In a study carried out by Jasmina Djelilovic-Vranic, et al Ischemic stroke was confirmed in 78.0%, of which 32% were lacunar infarcts and 22% hemorrhagic. The most common risk factors were hypertension 85%, then smoking in 65%, diabetes mellitus in 39.0%, in 27.38% dyslipidemia, the previous stroke in 26.69%, in 23.57% arrhythmia. In the baseline sample, 30.06% of patients had previously diabetes mellitus and in 8.94% the diabetes was diagnosed during hospitalization, while dyslipidemia was known from earlier in 22.0% and in 5.38% cases was detected during the hospitalization.

## 8. Summary

This study was conducted in the department of medicine, Rajarajeswari medical college and hospital Bangalore. In the present study 100 type 2 diabetic patients, divided into 50 cases and 50 controls satisfying inclusion criteria were considered.

The findings are summarized as follows:-

1. A maximum number of diabetic individuals belonged to the age group 56-65 years (39 out of 100 patients i.e. 41%). A maximum number of cases were in the age group of 56-65 years (22 out of 50 patients i.e. 44%), while the maximum number of controls belonged to 46-55 years age group (21 out of 50 patients i.e. 42%).
2. The maximum number of patients belonged to urban areas (73 out of 100 patients i.e. 73%). Both in control and cases maximum no of patients were from urban areas (38 and 35 patients in controls and cases respectively).
3. Past history of HTN, IHD, PVD and CVA were significantly more in cases as compared to controls, statistical significance was found ( $P < 0.05$ ).
4. More patients in cases were on irregular anti-diabetic treatment as compared to controls (15 patients in cases and 2 in controls).
5. IHD changes were found in 8 cases and 3 controls, LVH by voltage criteria was found in 15 cases and 8 controls. IHD changes found in cases and controls are 16% and 6% respectively. LVH changes found in cases and controls are 30% and 16% respectively.
6. Abnormal 2D Echo findings in our study were mainly IHD and LVH. IHD was found in 11 cases and 3 controls, LVH was found in 18 cases and 10 controls. IHD changes found in cases and controls are 22% and 6% respectively. LVH changes found in cases and controls are 36% and 20% respectively.

7. There was a significant elevation of mean values of total serum cholesterol, LDL and TG of cases and controls in the postprandial state compared to their fasting state, statistical significance was found ( $P < 0.05$ ).
8. Mean values of total serum cholesterol, LDL and TG of cases in fasting state were significantly more compared to controls in fasting state, statistical significance was found ( $P < 0.05$ ).
9. Mean values of total serum cholesterol, LDL and TG of cases in the postprandial state were significantly more compared to controls in the postprandial state, statistical significance was found ( $P < 0.05$ ).
10. Mean values of both FBS and PPBS in cases were higher compared to controls ( $P < 0.05$ ). Mean values of PPBS in cases and controls were significantly more compared to their respective FBS values ( $P < 0.05$ ).
11. The mean HbA1c values in cases were higher (7.142) compared to controls (5.554).
12. Ischemic Heart disease was found in 14 patients i.e. 14% of the study group. In cases, it was found in 11 patients and in controls, it was found in 3 patients i.e. 22% and 6% respectively. The occurrence of IHD was more in cases compared to controls with statistical significance ( $p < 0.05$ ).
13. Peripheral vascular disease in our study was found in 25 patients i.e. 25% of the study group. In cases, it was found in 20 patients and in controls, it was found in 5 patients.
14. Stroke in our study is found in 7 patients i.e. 7% of the study group. In cases, it was found in 6 patients and in controls, it was found in 1 patient i.e. 12% and 2% respectively. The occurrence of CVA was more in cases compared to controls with statistical significance ( $p < 0.05$ ). Ischemic strokes were more common than haemorrhagic strokes.

## 9. Conclusion

1. Prevalence of diabetes was highest in the age group 56-65 years in our hospital.
2. As the duration of diabetes increases, there is an increased prevalence of dyslipidemia in the cases.
3. Past history of HTN, IHD, PVD and CVA were found significantly more in subjects with fasting and postprandial dyslipidemia (cases) compared to those without (controls).
4. Patients on irregular treatment (63%) were more in the study group (cases) compared to controls. So it could be said that patient not on regular treatment are more prone to have dyslipidemia. (fasting as well as postprandial).
5. There was a significant increase in total serum cholesterol, LDL and TG in postprandial states of cases compared to that in controls, so it could be said that diabetic patients with fasting dyslipidemia are more

prone to have dyslipidemia in the postprandial state.

6. Cases were having significantly higher FBS and PPBS compared to the controls, so it could be said that as blood sugar increases the occurrence of dyslipidemia increases.
7. HbA1c was significantly higher in cases compared to controls, so it could be said that as HbA1c increases there is an increase in the occurrence of dyslipidemia.
8. It could be said that there is an increase in the occurrence of postprandial dyslipidemia with increasing age, irregular treatment, increase in HbA1c, FBS, PPBS and with the past history of HTN, CVA, PVD and IHD.
9. All macrovascular complications (IHD, CVA, PVD) were found more in the case compared to controls with statistical significance. So it could be said that there is an increase in the occurrence of macrovascular complications with an increase in postprandial dyslipidemia.
10. It could be said that there is an increase in the occurrence of macrovascular complications with an increase in postprandial dyslipidemia, increasing age, irregular treatment and increase in HbA1c, FBS and PPB

## 10. Source of funding

None.

## 11. Conflict of Interest

None.

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