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A Study of Lipid Profile Abnormalities in Patients with Type 2 Diabetes Mellitus at a Tertiary Care Hospital

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ABSTRACT
Type 2 diabetes mellitus is commonly associated with lipid abnormalities, which increase the risk of atherosclerosis and cardiovascular disease. Diabetic dyslipidemia is usually characterized by raised triglycerides, raised LDL cholesterol, raised VLDL cholesterol and low HDL cholesterol. Early detection of lipid abnormalities is important for reducing future vascular complications. Aim was to study the lipid profile pattern among patients with type 2 diabetes mellitus. This hospital-based observational study was conducted in the Department of General Medicine, Mamata Medical College and General Hospital, Khammam. A total of 75 patients with type 2 diabetes mellitus were included. Detailed clinical history, examination findings and relevant laboratory parameters were recorded. Fasting blood sugar, postprandial blood sugar, HbA1c and fasting lipid profile were analyzed. Data were expressed as frequency, percentage, mean and standard deviation. Chi-square test was used to assess associations, and p-value <0.05 was considered statistically significant. Dyslipidemia was observed in 57 patients (76%). Raised LDL cholesterol was the most common abnormality, seen in 50 patients (66.7%), followed by raised triglycerides in 48 patients (64%), raised VLDL cholesterol in 46 patients (61.3%), low HDL cholesterol in 43 patients (57.3%) and raised total cholesterol in 41 patients (54.7%). Dyslipidemia was significantly associated with poor glycemic control and increased BMI. Dyslipidemia is highly prevalent among patients with type 2 diabetes mellitus. Routine lipid profile screening should be performed in all diabetic patients to identify cardiovascular risk early.

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Key Words
Type 2 diabetes mellitus, dyslipidemia, lipid profile, HbA1c, LDL cholesterol, triglycerides

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INTRODUCTION

Type 2 diabetes mellitus is one of the most common chronic metabolic disorders encountered in general medicine practice. It is characterized not only by persistent hyperglycemia due to insulin resistance and relative insulin deficiency, but also by several associated metabolic abnormalities that increase long-term morbidity and mortality. Among these, dyslipidemia occupies an important place because it directly contributes to accelerated atherosclerosis and cardiovascular disease. Patients with type 2 diabetes have a markedly increased risk of coronary artery disease, stroke and peripheral vascular disease, and earlier studies have shown that cardiovascular mortality is significantly higher in diabetic individuals than in non-diabetic individuals[1]. Therefore, assessment of lipid profile in patients with type 2 diabetes mellitus is clinically important for early identification of cardiovascular risk.

Diabetic dyslipidemia commonly presents as raised triglycerides, reduced high-density lipoprotein cholesterol, increased very-low-density lipoprotein cholesterol, and predominance of small dense low-density lipoprotein particles. Even when the absolute LDL-cholesterol level is not very high, LDL particles in diabetes are often more atherogenic because of glycation, oxidation and altered particle size. The UK Prospective Diabetes Study demonstrated that lipid abnormalities are frequently present at the time of diagnosis of type 2 diabetes mellitus itself, indicating that dyslipidemia begins early in the natural history of the disease[2]. Insulin resistance plays a central role in this process by increasing free fatty acid flux to the liver, enhancing hepatic VLDL production, reducing lipoprotein lipase activity and impairing triglyceride clearance[3]. Goldberg also emphasized that diabetic dyslipidemia is not merely a laboratory abnormality but a major biological pathway linking diabetes with atherosclerotic vascular disease[4].

Several earlier studies have examined the relationship between lipid abnormalities and type 2 diabetes. Nesto described the “atherogenic lipid triad” of elevated triglycerides, low HDL-cholesterol and small dense LDL as a characteristic abnormality in type 2 diabetes and metabolic syndrome[5]. Gadi and Samaha reported that diabetic dyslipidemia is an important contributor to coronary risk and requires active clinical attention along with glycemic control[6]. Mooradian further highlighted that the typical lipid pattern in type 2 diabetes includes high triglycerides, low HDL-cholesterol and qualitative LDL abnormalities, and that these changes may persist even when LDL-cholesterol appears apparently normal[7]. These observations support the need for routine lipid profile evaluation in all patients with type 2 diabetes mellitus.

Glycemic control also has an important relationship with lipid metabolism. Poor glycemic control is associated with increased triglycerides, increased total cholesterol, increased LDL-cholesterol and reduced HDL-cholesterol. Mullugeta et al. observed that dyslipidemia was more common among patients with poor glycemic control and also suggested that metformin therapy may have a protective effect on lipid profile[8]. Similarly, studies from Indian tertiary care settings have shown that dyslipidemia may be present even among patients without overt diabetic complications and even in those with apparently acceptable glycemic control[9]. This is particularly relevant in the Indian population, where diabetes often occurs at a younger age, with central obesity, insulin resistance and high cardiovascular risk.

Although dyslipidemia in type 2 diabetes has been widely studied, important research gaps still remain. Many patients attending general medicine outpatient departments are evaluated mainly for blood glucose control, while lipid abnormalities may be underdiagnosed or undertreated. In addition, the pattern of dyslipidemia may vary according to age, sex, duration of diabetes, body mass index, diet, lifestyle, glycemic control and use of antidiabetic drugs. Chehade *et al*. noted that despite growing knowledge, the management of diabetic dyslipidemia beyond LDL-cholesterol reduction continues to remain challenging[10]. Hence, local hospital-based studies are useful to understand the burden and pattern of lipid abnormalities among patients with type 2 diabetes mellitus.

Therefore, the present study was undertaken with the aim of assessing serum lipid profile abnormalities among patients with type 2 diabetes mellitus and identifying the common pattern of dyslipidemia in this group. Such a study may help in early recognition of cardiovascular risk and reinforce the importance of routine lipid screening in diabetic patients.

MATERIALS AND METHODS

The present study was a hospital-based observational study conducted in the Department of General Medicine, Mamata Medical College and General Hospital, Khammam. The study was carried out among patients diagnosed with type 2 diabetes mellitus who attended the outpatient department or were admitted to the inpatient wards of the Department of General Medicine. A total sample size of 75 patients with type 2 diabetes mellitus was included in the study after obtaining informed

consent. The main objective of the study was to assess the lipid profile abnormalities among patients with type 2 diabetes mellitus and to identify the common pattern of dyslipidemia in these patients.

Inclusion Criteria:

- Patients diagnosed with type 2 diabetes mellitus
- Patients aged above 30 years
- Both male and female patients were included
- Patients willing to participate in the study
- Patients who provided informed consent
- Patients attending the Department of General Medicine OPD or admitted to the medical wards

Exclusion Criteria:

- Patients with type 1 diabetes mellitus
- Patients already on lipid-lowering drugs such as statins or fibrates
- Patients with chronic liver disease
- Patients with chronic kidney disease
- Patients with hypothyroidism or other endocrine disorders affecting lipid metabolism
- Pregnant women
- Patients with acute infections, severe systemic illness, or malignancy
- Patients not willing to participate in the study

Study Tool:

- A pre-designed and pre-tested proforma was used to collect clinical and laboratory details.
- Detailed history regarding age, sex, duration of diabetes, treatment history, personal habits, dietary history, family history, and associated comorbidities was recorded.
- Clinical examination findings such as height, weight, body mass index, pulse rate, blood pressure, and general physical examination were documented.
- Laboratory investigations included fasting blood sugar, postprandial blood sugar, HbA1c, total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, VLDL cholesterol, and other relevant routine investigations.
- Data Collection
- Data was collected from all eligible patients after obtaining informed consent.
- A detailed clinical history was taken from each patient.
- General physical examination and systemic examination were performed.
- Venous blood samples were collected after overnight fasting for fasting blood sugar and lipid profile estimation.
- Postprandial blood sugar was estimated two hours after food intake.
- Serum lipid profile included total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, and VLDL cholesterol.
- The collected data was entered into the study proforma.
- Patients were classified based on the presence or absence of lipid abnormalities according to standard laboratory reference values.
- The pattern of dyslipidemia was analyzed in relation to age, sex, duration of diabetes, and glycemic control.

Statistical Analysis: The collected data was entered into Microsoft Excel and analyzed using appropriate statistical methods. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean and standard deviation. The association between lipid profile abnormalities and selected clinical parameters was analyzed using suitable statistical tests such as Chi-square test for categorical variables and Student's t-test where applicable. A p-value of less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

In the present study, the majority of patients belonged to the age group of 51-60 years, followed by those above 60 years, indicating that type 2 diabetes was more common in middle-aged and elderly individuals. Males constituted a slightly higher proportion than females. Most patients had diabetes duration between 5-10 years, suggesting a chronic disease burden. Overweight and obesity were common among the study population. Hypertension was present in nearly half of the patients, showing the frequent coexistence of cardiovascular risk factors in type 2 diabetes mellitus.

The majority of patients showed poor glycemic control, with 74.7% having elevated fasting blood sugar and 66.7% having raised postprandial blood sugar levels. Only 24% of patients had HbA1c below 7%, indicating good glycemic control. A large proportion had HbA1c between 7-8.9%, while one-third had HbA1c $\geq$9%, suggesting significant uncontrolled diabetes. Poor glycemic control is an important contributor to lipid abnormalities in type 2 diabetes. These findings support the need for regular monitoring of both glycemic and lipid parameters.

The mean total cholesterol level was 204.6 mg/dL, which falls in the borderline high range. The mean triglyceride level was raised, showing the common pattern of hypertriglyceridemia in type 2 diabetes mellitus. HDL cholesterol was low, which is an important atherogenic risk factor. LDL cholesterol was also elevated, increasing the risk of coronary artery disease. The lipid profile pattern observed in this table is consistent with diabetic dyslipidemia, which

Table 1: Baseline Demographic and Clinical Characteristics of Type 2 Diabetes Mellitus Patients

Variable	Category	Number of Patients (n=75)	Percentage (%)
Age group	30-40 years	8	10.7
	41-50 years	18	24.0
	51-60 years	28	37.3
	>60 years	21	28.0
Gender	Male	42	56.0
	Female	33	44.0
Duration of diabetes	<5 years	29	38.7
	5–10 years	31	41.3
	>10 years	15	20.0
Body mass index	Normal	19	25.3
	Overweight	34	45.3
	Obese	22	29.3
Hypertension	Present	38	50.7
	Absent	37	49.3

Table 2: Distribution of Patients According to Glycemic Parameters

Glycemic Parameter	Category	Number of Patients (n=75)	Percentage (%)
Fasting blood sugar	Controlled: <126 mg/dL	19	25.3
	Uncontrolled: ?126 mg/dL	56	74.7
Postprandial blood sugar	Controlled: <200 mg/dL	25	33.3
	Uncontrolled: ?200 mg/dL	50	66.7
HbA1c	<7%	18	24.0
	7–8.9%	32	42.7
	?9%	25	33.3

Table 3: Mean Lipid Profile Levels Among Type 2 Diabetes Mellitus Patients

Lipid Parameter	Mean ± SD	Minimum	Maximum	Interpretation
Total cholesterol	204.6 ± 42.8 mg/dL	128	310	Borderline high
Triglycerides	186.9 ± 65.4 mg/dL	82	386	Raised
HDL cholesterol	39.2 ± 8.6 mg/dL	24	61	Low
LDL cholesterol	126.8 ± 36.5 mg/dL	62	224	Raised
VLDL cholesterol	37.4 ± 13.1 mg/dL	16	77	Raised

commonly includes raised triglycerides, raised LDL and low HDL cholesterol.

`Dyslipidemia was observed in 76% of the study population, indicating a high burden of lipid abnormalities among patients with type 2 diabetes mellitus. Raised LDL cholesterol was the most common abnormality, followed by raised triglycerides and raised VLDL cholesterol. Low HDL cholesterol was also seen in more than half of the patients. Mixed dyslipidemia was present in 52%, showing that many patients had more than one lipid abnormality. Since the abnormalities overlap, the individual lipid parameters do not add up to the total sample size.

Dyslipidemia was significantly higher among patients with poor glycemic control. Patients with HbA1c ≥9% showed the highest prevalence of dyslipidemia, and the association was statistically significant with a p-value of 0.006. Dyslipidemia also increased with longer duration of diabetes, although this association was borderline statistically significant. BMI showed a significant association with dyslipidemia, with overweight and obese patients having higher lipid abnormalities compared to patients with normal BMI. These findings indicate that poor glycemic control and increased body weight are important factors associated with dyslipidemia in type 2 diabetes mellitus.

The present study evaluated the lipid profile pattern among 75 patients with type 2 diabetes mellitus attending the Department of General Medicine. In the present study, most patients belonged to the age group of 51-60 years, followed by those above 60 years, indicating that type 2 diabetes mellitus was more common in middle-aged and elderly individuals. Males constituted 56% of the study population, while females formed 44%. A large proportion of patients were overweight or obese, and hypertension was present in 50.7% of cases. These findings indicate that type 2 diabetes mellitus is frequently associated with clustering of cardiovascular risk factors such as obesity, hypertension and dyslipidemia. Similar observations were reported by Bagdade *et al*., who demonstrated that patients with non-insulin-dependent diabetes mellitus had abnormalities in lipid composition, including increased triglycerides and altered cholesterol fractions, even after improvement in glycemic control[11].

In the present study, poor glycemic control was common. Fasting blood sugar was uncontrolled in 74.7% of patients, postprandial blood sugar was uncontrolled in 66.7%, and HbA1c was ≥7% in 76% of patients. This indicates that most patients had inadequate long-term glycemic control. Taskinen reported that diabetic patients show both quantitative and qualitative abnormalities of lipoproteins, and these abnormalities differ according to the metabolic status and type of diabetes[12]. The present study supports this concept, as patients with poor glycemic control showed a higher frequency of lipid abnormalities. Hyperglycemia promotes increased free fatty acid

Table 4: Pattern of Lipid Abnormalities Among Type 2 Diabetes Mellitus Patients

Lipid Abnormality	Number of Patients (n=75)	Percentage (%)
Raised total cholesterol	41	54.7
Raised triglycerides	48	64.0
Raised LDL cholesterol	50	66.7
Raised VLDL cholesterol	46	61.3
Low HDL cholesterol	43	57.3
Mixed dyslipidemia	39	52.0
Normal lipid profile	18	24.0
Any dyslipidemia	57	76.0

Table 5: Association of Dyslipidemia with HbA1c, Duration of Diabetes and BMI

Variable	Category	Dyslipidemia Present n (%)	Dyslipidemia Absent n (%)	Total	Chi-square Value	p-value
HbA1c	<7%	9 (50.0)	9 (50.0)	18	10.26	0.006*
	7–8.9%	25 (78.1)	7 (21.9)	32		
	?9%	23 (92.0)	2 (8.0)	25		
Duration of diabetes	<5 years	18 (62.1)	11 (37.9)	29	5.92	0.052
	5–10 years	25 (80.6)	6 (19.4)	31		
	>10 years	14 (93.3)	1 (6.7)	15		
BMI	Normal	10 (52.6)	9 (47.4)	19	7.74	0.021*
	Overweight	28 (82.4)	6 (17.6)	34		
	Obese	19 (86.4)	3 (13.6)	22		

**p-value <0.05 considered statistically significant*

mobilization, hepatic triglyceride synthesis, increased VLDL production and reduced clearance of triglyceride-rich particles.

The mean total cholesterol in the present study was 204.6 ± 42.8 mg/dL, mean triglycerides were 186.9 ± 65.4 mg/dL, mean LDL cholesterol was 126.8 ± 36.5 mg/dL, mean VLDL cholesterol was 37.4 ± 13.1 mg/dL and mean HDL cholesterol was 39.2 ± 8.6 mg/dL. This pattern indicates a typical atherogenic diabetic dyslipidemia characterized by raised triglycerides, raised LDL cholesterol, raised VLDL cholesterol and low HDL cholesterol. Brown described that loss of glycemic control in diabetes may lead to marked hypertriglyceridemia due to abnormalities in lipoprotein metabolism[13]. Syvänne and Taskinen also emphasized that triglycerides and low HDL cholesterol are important coronary risk factors in patients with non-insulin-dependent diabetes mellitus[14]. The lipid pattern observed in the present study is therefore comparable with earlier reports.

In the present study, dyslipidemia was observed in 76% of patients. Raised LDL cholesterol was the most common abnormality, seen in 66.7%, followed by raised triglycerides in 64%, raised VLDL cholesterol in 61.3%, low HDL cholesterol in 57.3% and raised total cholesterol in 54.7%. Mixed dyslipidemia was present in 52% of cases. Cook *et al*. reported that the commonest dyslipidemic pattern among urban African-American patients with type 2 diabetes was LDL cholesterol above target combined with HDL cholesterol below target[15]. This is similar to the present study, where raised LDL and low HDL were important abnormalities. However, the present study also showed a high frequency of raised triglycerides and VLDL, suggesting that hypertriglyceridemia is an important component of diabetic dyslipidemia in this population.

The pathophysiological basis of these abnormalities has been well explained in earlier studies. Taskinen reported that insulin resistance in type 2 diabetes increases hepatic VLDL production and contributes to formation of small dense LDL particles and low HDL cholesterol[16]. Krauss further described that type 2 diabetes is associated with a cluster of lipid abnormalities including elevated triglycerides, reduced HDL cholesterol and predominance of small dense LDL particles[17]. The present study did not assess LDL particle size, but the raised LDL levels along with increased triglycerides and reduced HDL suggest an atherogenic lipid pattern. This lipid pattern is clinically important because it increases the risk of coronary artery disease, stroke and other macrovascular complications.

The association between glycemic control and dyslipidemia was statistically significant in the present study. Dyslipidemia was present in 50% of patients with HbA1c <7%, 78.1% of patients with HbA1c between 7–8.9%, and 92% of patients with HbA1c ≥9%. The association was statistically significant with a chi-square value of 10.26 and p-value of 0.006. Khan *et al*. observed that HbA1c showed direct correlation with total cholesterol, triglycerides and LDL cholesterol, and inverse correlation with HDL cholesterol, indicating that HbA1c can be used as an indirect predictor of dyslipidemia[18]. The present study is consistent with this observation, as poor glycemic control was strongly associated with dyslipidemia.

In the present study, dyslipidemia also increased with duration of diabetes. It was seen in 62.1% of patients with duration less than 5 years, 80.6% with duration of 5-10 years and 93.3% with duration more than 10 years. Although this association was borderline significant with p-value of 0.052, the trend suggests that longer duration of diabetes

may contribute to progressive lipid abnormalities. Mohan *et al*. reported that in Indian diabetic subjects, clustering of hyperglycemia, central obesity, dyslipidemia and hypertension contributes to increased coronary artery disease risk[19]. The high prevalence of dyslipidemia and hypertension in the present study supports this Indian scenario.

BMI showed a statistically significant association with dyslipidemia in the present study. Dyslipidemia was present in 52.6% of patients with normal BMI, 82.4% of overweight patients and 86.4% of obese patients, with a p-value of 0.021. This finding indicates that excess body weight is an important contributor to lipid abnormalities in type 2 diabetes mellitus. Vijayaraghavan emphasized that diabetic dyslipidemia requires early identification and treatment because many patients with type 2 diabetes fail to achieve lipid targets despite available therapy[20]. Karim *et al*. also reported that poor glycemic control, longer duration of diabetes and coexisting hypertension were important predictors of dyslipidemia in type 2 diabetes mellitus[21]. The present study findings are comparable, as dyslipidemia was significantly associated with poor glycemic control and BMI, while duration of diabetes showed a rising trend.

Overall, the present study confirms that dyslipidemia is highly prevalent among patients with type 2 diabetes mellitus. The most frequent abnormalities were raised LDL cholesterol, raised triglycerides, raised VLDL cholesterol and low HDL cholesterol. The study also demonstrates that poor glycemic control and increased BMI are significantly associated with dyslipidemia. These findings highlight the importance of routine lipid profile screening in all patients with type 2 diabetes mellitus, especially in those with poor glycemic control, obesity, hypertension and longer disease duration.

CONCLUSION

The present study concludes that lipid abnormalities are very common among patients with type 2 diabetes mellitus. Dyslipidemia was observed in 76% of cases, with raised LDL cholesterol, raised triglycerides, raised VLDL cholesterol and low HDL cholesterol being the major abnormalities. Poor glycemic control showed a statistically significant association with dyslipidemia, and patients with HbA1c $\geq$9% had the highest prevalence of lipid abnormalities. Increased BMI was also significantly associated with dyslipidemia. Duration of diabetes showed a rising trend with dyslipidemia, although the association was borderline significant. Routine lipid profile evaluation should therefore be included in the regular assessment of all patients with type 2 diabetes mellitus to identify cardiovascular risk early and initiate appropriate lifestyle and pharmacological interventions.

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