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MONITORING LIPID PROFILE IN DIABETES MELLITUS, CAD AND HEALTH

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Abstract
The pathophysiology of cardiovascular problems is significantly influenced by aberrant lipid profiles, which remain linked to both diabetes mellitus (DM) and coronary artery disease (CAD). An increased level of Low-Density lipoprotein cholesterol (LDL-C), triglycerides and low levels of High-Density lipoprotein cholesterol (HDL-C) also plays a role in increasing atherosclerosis among diabetic patients. The study aims at determining the role of lipid abnormalities in cardiovascular risk by conducting a study that will evaluate lipid profiles and glycemic control among South Indian patients with Type 2 Diabetes Mellitus as well as CAD. It was a cross-sectional observational study involving 500 patients with Type 2 Diabetes Mellitus and/or CAD in a tertiary care hospital in South India. HbA1c level was 8.97 on average indicating poor glycemic control. No major differences were established between patients who had CAD and those who had none meaning that CAD did not have a major impact on lipid profiles or glycemic control. There were weak correlations between Hemoglobin A1c (HbA1c) and lipid parameters, which means these parameters remain controlled independently. The diabetic patients with CAD had prevalence of lipid abnormalities, especially increased LDL-C and triglycerides. There was little influence of glycemic control on lipid profiles indicating that other factors including insulin resistance and genetic predisposition remain very instrumental in lipid abnormalities. This highlights the importance of lipid management of South Indian patients to minimize cardiovascular risks. Research is in its infancy to examine genetic and environmental determinants of the lipid metabolism of this population.

Keywords: Type 2 diabetes mellitus, coronary artery disease, lipid profile, glycemic control, cardiovascular risk.

1. Introduction

Diabetes Mellitus (DM) and coronary artery disease (CAD) remain among the most common chronic diseases in the world as both remain known to cause a lot of morbidity and mortality. Cardiovascular disease is known to be a risk of diabetes, and dyslipidemia is an important factor in this relationship (Abudawood et al., 2018). Dyslipidemia in diabetes is generally associated with increased levels of low-density lipoprotein cholesterol (LDL-C), triglycerides, and decreased levels of high-density lipoprotein cholesterol (HDL-C) all of which promote atherosclerosis (Klisic et al., 2017). Abnormal

lipids and more so dyslipidemia play a major part in the pathogenesis of CAD since they stimulate the development of arterial plaque, which causes vascular problems which include myocardial infarction, stroke, and peripheral artery disease (Arnold et al., 2020). The interplay between diabetes and dyslipidemia has been well-established, and one of the primary ways of reducing the cardiovascular risk of diabetic patients is lipid management (Kopin and Lowenstein, 2017). The lipid profile that includes total cholesterol level, triglycerides, LDL-C, and HDL-C is commonly utilized to assess cardiovascular risk and determine the therapeutic intervention. Disturbed lipid profile is a sign of a metabolic imbalance, e.g., insulin resistance and chronic hyperglycemia which remain frequent in type 2 diabetes (Alzahrani et al., 2019). It is important to note that dyslipidemia occurs in diabetic patients, which is an excellent predictor of poor cardiovascular events (Spannella et al., 2019). The lipid abnormalities of these patients remain critical to managing the level of blood glucose and prevent cardiovascular events as well as enhancing health outcomes (Jain et al., 2016).
The lipid abnormalities, especially the increase in LDL-C and triglycerides, have been thoroughly investigated in their contribution to the pathophysiology of diabetes as well as CAD. The high levels of triglycerides, as well as the high level of LDL-C and low level of HDL-C, remain frequently combined in diabetic patients, especially with type 2 diabetes (Li et al., 2025). Such lipid abnormalities also aid in the formation of atherosclerotic plaque in the coronary arteries, which eventually results in the constriction and hardening of the arteries, which is a characteristic of CAD (Hung et al., 2016). Lipid abnormalities remain also aggravated by insulin resistance, which is a primary characteristic of type 2 diabetes, and raises the synthesis of VLDL (very-low-density lipoprotein) and reduces the clearance of triglycerides (Aggarwala et al., 2016). Additionally, lipid metabolism change in patients with diabetes is usually accompanied by a pro-inflammatory and pro-thrombotic condition, which also contributes to the progression of CAD (Mbah et al., 2024). This systemic inflammation, along with lipid abnormalities, enhances the course of atherosclerosis, which predisposes to cardiovascular events heart attacks, strokes, etc. (Rosenblit, 2016). Lipid profiles remain therefore important in prevention and management of CAD in diabetic populations since it has a direct effect in the progression of vascular damage. Moreover, diabetic patients have their dyslipidemic profile which is usually different in comparison with the lipid abnormalities in non-diabetic people (Lee et al., 2016). To demonstrate the point, diabetes patients tend to have more small and dense LDL particles that remain more atherogenic than the larger, less dense LDL particles (Artha et al., 2019).

Type 2 diabetes and CAD have been on the increase in South India over the past decades, which is caused by genetic predisposition, urbanization, changes in diet, and sedentary lifestyles (Kalaivanan et al., 2017). Most South Indians have lipid abnormalities, especially diabetic people. It was found that diabetic persons in this area frequently have high LDL-C and triglycerides and low HDL-C levels, which remain the signs of high cardiovascular risk (Bhowmik et al., 2018). To illustrate, Sharahili et al. (2023) discovered that 72% of diabetic patients in Jeddah, Saudi Arabia, had abnormal lipid profiles, and they remain comparable to the results in South Indian population groups. It has been shown that Indian populations remain prone to insulin resistance and metabolic syndrome, which puts them at risk of developing lipid abnormalities and cardiovascular diseases earlier than other ethnicities (Rahnemaei et al., 2021). Moreover, poor diets which remain characterized by a lot of refined carbohydrates and fats as well as poor physical exercises remain also the contributing factors to the high prevalence of dyslipidemia in this group. This lipid profile regional difference highlights the necessity of specific healthcare services and regional-specific lipid abnormalities management in diabetic patients (Larifla et al., 2017).

Since the prevalence of type 2 diabetes and CAD is increasing in South India, it is imperative to determine the nature of lipid deviations within this community and in what way they affect cardiovascular health. In particular, the degree to which glycemic control affects lipid abnormalities and the risk of cardiovascular events in such a population is poorly comprehended (Moussavi et al., 2020). The research is supposed to close this gap by studying the lipid profile of the South Indian

patients with diabetes and CAD with special emphasis being the relationship between glycemic control and lipid parameters. The study aims to determine effective methods of control of lipid disorders by identifying the lipid disorders that prevail in this population in order to offer evidence of more effective ways to control lipid disorders that meet the needs of South Indian patients. Moreover, the results of this research may be used to formulate regional health policies which can effectively enhance cardiovascular outcomes in people with diabetes thus preventing the risk of CAD in the high-risk population.

Objectives of the study

1. To assess lipid profiles and the prevalence of lipid abnormalities in South Indian patients with Type 2 Diabetes Mellitus and Coronary Artery Disease (CAD).
2. To evaluate the correlation between glycemic control (HbA1c) and lipid abnormalities in patients with Type 2 Diabetes Mellitus and CAD.

2. Materials and Methods

2.1 Study design

This was a cross-sectional observational study taking place in a tertiary care hospital in South India. Between 2024 (January and December) 500 patients diagnosed with Type 2 Diabetes Mellitus and/or with coronary artery disease (CAD) were recruited. The selection of the participants was carried out according to their clinical history and their consent to participate. This research was intended to determine the lipid profiles and their association with glycemic control in diabetic and CAD patients. The review board of the hospital gave the ethical approval and all participants gave informed consent before they were recruited into the study.

2.2 Inclusion and exclusion criteria

The study was open to patients who were diagnosed with Type 2 Diabetes Mellitus and/or CAD, aged 30 years and above. The inclusion criteria involved that the participants would not have had any severe comorbidities like liver or kidney dysfunction and no history of acute myocardial infarction or stroke in the recent past. The exclusion criteria consisted of people on lipid-lowering therapy, pregnant women and other patients who had other major diseases of the system which may affect the level of lipids. To prevent individual variability in lipid and glycemic testing, only the individuals with stable glycemic levels without any substantial alterations in medication taken in the last three months were enlisted.

2.3 Data Collection Methods

2.3.1 Blood Sample Collection

All participants were requested to take blood samples following an overnight fast to reduce fluctuations in lipid levels. Venous blood samples were collected on the basis of the antecubital vein and samples were subjected to lipid analysis instantly. The glycemic control assessment also included fasting blood glucose (FBG) and HbA1c levels. Blood was taken to the laboratory where it was stored at -20degC until analysis in order to maintain stability and accuracy of the lipid measurements by separating the serum.

2.3.2 Lipid Profile Analysis

Standard enzymatic methods were used in the determination of the lipid profiles. Automated biochemical analyzers were used to quantify the total cholesterol, triglycerides, LDL-C, and the HDL-C. The Riedewald was used to calculate LDL-C, whereas HDL-C was directly measured by homogeneous enzymatic analysis. The lipid profile was also measured in all the participants to identify the occurrence of dyslipidemia and also to identify any relationships with glycemic control and CAD status. The accuracy and reproducibility of the assays in measuring lipids in all samples of the study were determined by calibration.

2.4 Statistical Methods

2.4.1 Data Analysis and Correlation

The analysis of the data was performed with the help of the SPSS. Lipid profiles and demographic data were summarized using the descriptive statistics. Continuous variables were represented in terms of mean +- standard deviation and categorical ones were in terms of percentage. Pearson correlation coefficient was used to estimate the relationship between the level of lipid abnormalities and that of HbA1c. T-tests were applied to check the difference in lipid profiles in patients who have and do not have CAD. The statistical significance was set at p-value less than 0.05. The research also performed a regression analysis in order to determine possible predictors of lipid abnormalities in diabetic and CAD patients taking into account confounding variables (age, gender, and the use of medication).

3. Results

3.1 Summary Statistics for Lipid Profile and HbA1c

The short statistics of the parameters of lipid profile and HbA1c of the study participants. Individual cholesterol ranged with a big standard deviation of 43.38 mg/dL with a mean of 225.02 mg/dL which is highly variable in cholesterol levels as shown in Table 1. The LDL-C was 120.28 mg/dL and the HDL-C was 54.85mg/dl. The level of triglycerides was 174.75 mg/dL, which implied moderate dyslipidemia. The mean HbA1c was 8.97 %, which has indicated that the glycemic control is not the best in the cohort. The big variation in lipid values reiterates the heterogeneity of lipid management among diabetic and CAD patients.

Table 1: Summary Statistics for Lipid Profile and HbA1c

Parameter	Mean	Std Dev	Min	Max	25%	50%	75%
Total Cholesterol	225.02	43.38	150.74	299.91	186.10	226.00	260.61
LDL-C	120.28	34.25	60.19	179.80	91.00	121.49	149.94
HDL-C	54.85	14.65	30.01	79.89	43.35	54.34	67.82
Triglycerides	174.75	42.58	100.00	249.58	137.65	176.10	210.53
HbA1c	8.97	1.79	6.04	11.99	7.34	9.00	10.55

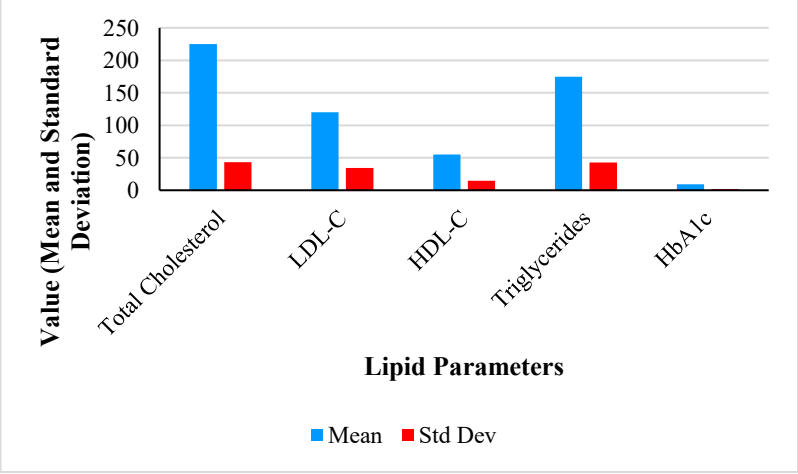

Figure 1: Comparison of Lipid Parameters (Mean and Standard Deviation)

The lipid parameters, namely, total cholesterol, LDL-C, HDL-C, triglycerides, and HbA1c mean values, and standard deviations were compared. The bar graph that shows the mean values and the standard deviation of each parameter as blue and red respectively as shown in Figure 1. The graph emphasizes the change in the amount of lipids with respect to various parameters, which gives a graphical representation of the distribution. The significant value of the difference between the mean and standard deviation of some lipid parameters indicates a great variation among the sample population especially in total cholesterol and triglycerides.

3.2 Lipid Profile Comparison Between CAD and Non-CAD Patients

Comparison between lipid profile and HbA1c status of patients with and without coronary artery disease (CAD). The mean of total cholesterol, LDL-C, HDL-C and triglyceride were slightly lower in CAD patients versus non-CAD patients, but none of the differences was statistically significant ($p > 0.05$) as shown in Table 2. The two groups had almost equal mean HbA1c levels (8.96% in non-CAD patients and 8.98% in CAD patients) which meant that the glycemic control was similar in both groups. The above results indicate that the occurrence of CAD did not substantially change the lipid profile or the glycemic control of this cohort.

Table 2: Lipid Profile Comparison Between CAD and Non-CAD Patients

Parameter	CAD (Mean)	Non-CAD (Mean)	p-value
Total Cholesterol	223.83	226.14	0.35
LDL-C	121.15	119.45	0.58
HDL-C	55.14	54.58	0.72
Triglycerides	178.37	171.32	0.31
HbA1c	8.98	8.96	0.89

3.3 Correlation Between HbA1c and Lipid Parameters

The relationship between the level of lipid parameters and the level of HbA1c was evaluated and given in Table 3. There was a weak positive correlation between HbA1c and LDL-C ($r = 0.075$) and triglycerides ($r = 0.009$), but neither of them was significant ($p = 0.14$ and $p = 0.80$, respectively) which as shown in Table 3. HbA 1c had a weak negative relationship with HDL-C ($r = -0.03$, $p = 0.62$) and no significant association with total cholesterol ($r = 0.006$, $p = 0.90$). These findings indicate that in this cohort, glycemic control had the least influence on lipid parameters, which means an independent regulation of lipid metabolism and glycemic control.

Table 3: Correlation Matrix for HbA1c and Lipid Parameters

Parameter	HbA1c	Total Cholesterol	LDL-C	HDL-C	Triglycerides
HbA1c	1.000	0.006	0.075	-0.03	0.009
Total Cholesterol	0.006	1.000	-0.057	-0.008	-0.003
LDL-C	0.075	-0.057	1.000	-0.000	-0.012
HDL-C	-0.03	-0.008	-0.000	1.000	-0.052
Triglycerides	0.009	-0.003	-0.012	-0.052	1.000

4. Discussion

The results of the study indicated that there was a substantial difference in lipid profiles and glycemic control among patients with Type 2 Diabetes Mellitus (T2DM) and coronary artery disease (CAD). The lipid profiles, in Table 1, showed that the total cholesterol, LDL-C, and triglycerides were high with the HDL-C levels being moderate. The heterogeneity of lipid control in this cohort is supported by the large variety of lipid values. Moreover, the mean HbA1c reading of 8.97% shows that there is poor glycemic control among the patients. This implies that the management of cardiovascular risk factors such as lipid abnormalities is still a challenge in the management of glycemic regulation since the optimal control of blood glucose levels among this group of patients seems to be a challenge. Table 2 on the comparison of lipid profiles between the CAD and non-CAD patients did not show any significant difference in the level of total cholesterol, LDL-C, HDL-C, triglycerides, and HbA1c. This observation would mean that the lipid profiles and glycemic control of the present study population were not significantly influenced by the presence of CAD. Also, this is additional corroborated by the weak correlations between the levels of lipids and HbA1c (Table 3), in which glycemic control has little effect on lipids. Particularly, the relationships between HbA1c and LDL-C, triglycerides, and HDL-C were insignificant and low; it might suggest that the glycemic and lipid metabolism can be kept under control independently.

The results of the study remain in line with some of the studies that show dyslipidemia in diabetic patients although glycemic control improved. Past studies have demonstrated that lipid abnormalities in diabetic patients remain not frequently corrected with the improvement of glycemic control, which implies that there remain other processes operating than the regulation of blood glucose (Tajaddini et al., 2023). The results in agreement with these studies indicate that glycemic control (measured by HbA1c) did not make much difference in the lipid profiles in this cohort. This may be explained by the multifactorial nature of the insulin resistance, genetic predisposition and other metabolic processes that affect the lipid metabolism in diabetic patients. One major conclusion of the study is the fact that there remain no significant differences in lipid profiles in CAD and non-CAD patients. The findings agree with the past research, which also reported that diabetic patients with CAD did not have significantly different lipid profiles compared to those without CAD (Tai et al., 2017). This may indicate that the lipid abnormalities that come with diabetes may not be worsened by the availability of CAD. Rather, the two conditions have common pathophysiological processes, including insulin resistance and persistent inflammation, which remain involved in lipid disorders. This is in contrast to the belief that the presence of CAD in diabetic patients causes more severe lipid imbalances (Zakir et al., 2023). In addition, LDL-C and triglyceride abnormalities in diabetic patients have been reported with a high prevalence in the population of south Indians, which is consistent with this cohort (Ye et al., 2021). This tendency suggests that lipid imbalances remain a specific vulnerability of patients with T2DM in South India, and this state leads to a high risk of cardiovascular events in patients. Such geographical differences in lipid profiles also underline the necessity of personalized lipid management approaches among South Indian patients, since such patients can be more actively treated to manage lipid levels efficiently. Also, lower correlations of the HbA1c and lipid parameters support the notion that glycemic regulation and lipid abnormalities of diabetic patients can be controlled independently of each other. It has also been supported by the past studies that propose that lipid imbalances in diabetes remain not only dependent on the glycemic control but also on other issues, including genetic differences, nutrition, and exercise (White et al., 2016).
The results of the study also have significant clinical implications on the management of diabetes and CAD in South India where the diseases remain very common. Considering the cardiovascular risk factors associated with the high LDL-C and triglycerides in this cohort, medical practitioners must consider more aggressive pharmaceutical lipid control, especially regarding the reduction of LDL-C and triglycerides, which remain the initial risk factors of cardiovascular risks. As the impact of glycemic control on lipid profiles was not significant, it is important to note that such other factors as diet, physical activity, and medication adherence might influence the management of lipid abnormalities in diabetic patients in a more effective way. Lifestyle modifications like the adoption of physical exercise and dietary changes remain to be highlighted in the treatment plan of such patients since they have been reported to enhance the lipid profiles besides decreasing the cardiovascular risk. Secondly, since genetic factors remain the most likely factors in lipid metabolism in South Indian populations, individual therapies based on genetic factors might be more practical in enhancing lipid control as well as cardiovascular risk reduction. Research in the future ought to examine the genetic and environmental causes of lipid abnormalities among South Indian populations to enhance the treatment measures.

This study has a number of weaknesses. First it has a cross-sectional design which does not enable us to develop causal association between glycemic control and lipid abnormalities. It would be possible to have a longer picture on in what way the improvement of glycemic control influences lipid profiles over time through longitudinal studies. Second, the research was done on one tertiary care center and might not be generalizable. Finally, the study failed to consider confounding variables including diet, physical exercises, and medication compliance, which might have affected the lipid profiles in both lipids and glycemic regulation. The limitations identified in the study should be addressed in future research which should use larger and diversified populations and assess the effectiveness of lifestyle factors and medications in the management of lipid abnormalities and improve glycemic control.

5. Conclusion

The study assessed the lipid status and the level of glycemic control among patients with coronary artery disease (CAD) and Type 2 Diabetes Mellitus (T2DM) in South India. The results showed that there were high variations in lipid levels with high total cholesterol, LDL-C, and triglyceride levels and moderate levels of HDL-C. Interestingly, the researchers did not find any significant differences in the lipid profiles or glycemic control between CAD and non-CAD patients, which indicates that there were no significant effects of CAD on the lipid metabolism in this group. With the high rates of dyslipidemia found in this cohort, one of the primary concerns of the healthcare provider must be comprehensive lipid monitoring, especially LDL-C and triglycerides as such remain the sources of cardiovascular risk among diabetic patients. Lipid profiles in patients with T2DM and CAD should be managed by regularly monitoring them and using more aggressive treatment plans, such as lipid-lowering therapy, lifestyle interventions, and pharmacological interventions. Subsequent research ought to be directed towards the knowledge of genetic, environmental and lifestyle causes of lipid abnormalities among South Indian diabetics and CAD patients. Longitudinal research is required to examine the long-term impact of the glycemic regulation on lipid metabolism and research the independent mechanisms that govern the lipid abnormalities and cardiovascular disease. More so, bigger multi-centered researches would assist in generalizing the results and determining the usefulness of specific lipid-lowering interventions among various populations.

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