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Original Research Article

Evaluation of Lipid Profile and Vitamin D Levels in Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Analytical Study

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Abstract:

Background: Vitamin D deficiency is a widespread concern, affecting populations in countries with both abundant and limited sunlight exposure. This deficiency has been associated with an increased risk of developing type 2 diabetes mellitus (T2DM), insulin resistance, and impaired insulin synthesis. Therefore, this study aimed to investigate the relationship between 25-hydroxyvitamin D levels and lipid profile in patients with type 2 diabetes mellitus (T2DM) compared to healthy control subjects.

Materials and Methods: A cross-sectional analytical study enrolled 300 participants aged 25 to 65 years. Among them, 150 had T2DM, while the remaining 150 were age- and gender-matched healthy individuals. Blood samples were collected from all participants to measure 25-hydroxyvitamin D, total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels. Statistical analysis was performed using IBM SPSS 26.0.

Results: The T2DM group exhibited significantly higher levels of TC, TG, and LDL compared to the healthy control group. Conversely, T2DM patients had significantly lower levels of serum 25-hydroxyvitamin D compared to healthy controls. However, no statistically significant correlations were found between TC, TG, HDL, LDL, and 25-hydroxyvitamin D levels.

Conclusion: This study confirms the heightened risk of dyslipidemia in T2DM patients with elevated TC, TG, and LDL levels. It also highlights the association between T2DM and lower levels of 25-hydroxyvitamin D. Managing dyslipidemia is crucial in T2DM, and further research is needed to explore interventions for optimizing vitamin D levels and improving lipid profiles.

Keywords: 25(hydroxy) vitamin D, lipid profile, type 2 diabetes mellitus.

Introduction

Type 2 diabetes (T2DM) is the most prevalent form of diabetes, and its global impact on mortality and morbidity is significant. T2DM is characterized by impaired insulin secretion or sensitivity and is often associated with factors such as obesity, older age, ethnicity, and genetic predisposition [1,2]. The role of vitamin D in T2DM is mediated through its interaction with the vitamin D receptor (VDR), which acts as a transcription factor [3]. Vitamin D plays a vital role in various metabolic processes, including immune regulation, atherosclerosis prevention, endothelial function, blood pressure control, and cardiovascular disease (CVD) prevention [4]. In T2DM, abnormalities in vitamin D levels are linked to insulin resistance, poor glycemic control, and systemic inflammation. The prevalence of impaired fasting glucose and metabolic syndrome is on the rise due to increasing global levels of glycemic imbalance [5]. Vitamin D deficiency has been associated with T2DM, insulin resistance, obesity, and metabolic disorders in numerous recent studies [6]. Cardiovascular disease is a major cause of mortality among individuals with T2DM, and one proposed mechanism linking vitamin D deficiency to cardiovascular disease is its impact on lipid profile regulation. High triglyceride levels, increased levels of low-density lipoprotein, and decreased levels of high-density lipoprotein are three lipid abnormalities that are closely related to insulin resistance and an increased risk of atherosclerotic consequences [7]. The relationship between low vitamin D levels and impaired glucose tolerance remains somewhat unclear. However, specific randomized clinical trials have demonstrated that vitamin D3 modestly affects insulin secretion, insulin resistance, and HbA1c levels [8]. Therefore, the objective of the current study was to evaluate 25-hydroxyvitamin D levels and lipid profile in individuals with T2DM and compare them with those of healthy control subjects. By examining these levels, we aim to gain further insights into the potential association between vitamin D status and T2DM.

Materials and Methods

Subject Recruitment: In the present cross-sectional analytical study, 300 participants were included, 150 with type-2 diabetes mellitus and 150 apparently healthy controls, who were matched for age and sex and ranged in age group from 25 to 65 years.

All the participants diagnosed with T2DM were obtained from the outpatient and inpatient departments of the Department of Medicine, Rohilkhand Medical College and Hospital (RMCH), Bareilly, Uttar Pradesh, India. The healthy control participants were obtained from apparently healthy patients who turned up in the hospital for health checkup, as well collected from apparently healthy non-teaching staffs and workers from the same institute who consented to the study. All participants were included in the study after acquiring their informed written consent.

Ethical consideration: The study was initiated after approval by the Institutional Ethics Committee, RMCH, Bareilly (Ref. No. IEC/RMCH/84/2022/AUG and University Ethics Committee BIU/REG/PhD/412).

Inclusion and Exclusion Criteria:

Inclusion for the case, the participants diagnosed with T2DM as per the American Diabetic Association guidelines (10) aged between 25-65 years, with 10-12 hours of overnight fast, plasma glucose ≥126 mg/dl, and HbA1c ≥6.5 % were included in the study.

Inclusion for the control, participants with nondiabetic history, aged between 25-65 years, with 10-12 hours of overnight fast were included in the study.

Exclusion criteria for case and control

While those persons suffering from acute and chronic infections, alcohol consumers, pregnant, and smokers were excluded from the study.

Blood sample collection:

A skilled and certified phlebotomist obtained six milliliters of venous blood using standard aseptic techniques. The blood was collected in plain and fluoride tubes, ensuring adherence to established protocols.

Sample analysis procedure

The serum levels of 25-hydroxyvitamin D were estimated using an ELISA assay (Calbiotech Diagnostic's kit) and analyzed using the Erba Lisa Scan-2 EM. Lipid profile parameters i.e, TC was estimated by the CHOD-PAP method, TG was estimated by the GPO-Trinder method, HDL by the PEG–PAP method, LDL was calculated by Friedwald formula, and Fasting plasma glucose was estimated by the GOD-POD method. Commercially available kits (Erba Diagnostic) were used to assess plasma glucose, TC, TG, and HDL using an Erba Chem-7 Semi-auto Biochemistry analyzer. Routine biochemical parameters were promptly analyzed on the same day after sample collection. Simultaneously, serum samples were carefully preserved in Eppendorf tubes and securely stored at a temperature of -20 degrees Celsius, ensuring optimal conditions for subsequent analysis of 25-hydroxyvitamin D. In all the steps, biomedical waste management was strictly followed.

Statistical analysis

Data analysis was conducted using SPSS version 26.0, statistical software commonly employed in social sciences. The chi-square test was used to assess the association between gender and the presence of T2DM. This test was applied to compare the observed frequencies of males and females in the T2DM and control groups and determine if any significant differences existed.

The results were presented as mean ± SD (standard deviation). To compare quantitative variables between the two groups, an independent sample t-test was used. Pearson correlation was used to assess any correlation between the lipid profile and 25-hydroxyvitamin D levels. A significance level of $p < 0.05$ was considered to indicate statistical significance for all the data.

Results: The current study enrolled 150 participants diagnosed with Type 2 Diabetes Mellitus (T2DM) as cases and an equal number of healthy participants as controls, matched in age and gender. The mean ages of the cases and controls were 48.89±8.81 and 48.43±8.86 years, respectively. Table 1 shows the gender distribution of the cases and controls. Compared to the healthy controls, T2DM patients exhibited significantly elevated levels of total serum cholesterol, triglycerides, and LDL ($p<0.001$ for all). However, there was no notable difference in HDL levels ($p=0.40$). Furthermore, T2DM patients had notably lower serum 25-hydroxyvitamin D levels compared to healthy controls ($p=0.016$) (Table 2).

Table 1: Gender distribution of case and control subjects

Gender	T2DM (n=150)	Control (n=150)	p-value
	N (%)	N (%)	
Male	74(49.0)	77(51.0)	0.72
Female	76(51.0)	73(49.0)	

Table 2: Mean of age and clinical parameters of case and control subjects

Parameters	T2DM (n=150)	Control (n=150)	p-value
Age (years)	48.89±8.81	48.43±8.86	0.65
TC (mg/dl)	173.59±43.51	148.34±28.73	0.001*
TG (mg/dl)	141.78±94.81	92.50±26.37	0.001*
HDL (mg/dl)	43.78±14.27	45.04±10.16	0.40
LDL (mg/dl)	103.21±41.58	83.36±30.72	0.001*
Vitamin D (ng/ml)	31.14±13.16	34.98±14.17	0.016*

Values expressed as Mean± Standard Deviation. *Statistically Significant as $p<0.05$. TC= total cholesterol; TG= triglyceride; HDL= high-density lipoprotein; low-density lipoprotein.

The correlation analysis revealed no significant associations between 25-hydroxyvitamin D levels and the lipid profile variables (TC, TG, HDL, and LDL) in patients with type 2 diabetes mellitus. These findings suggest that there is no linear relationship between vitamin D levels and these lipid parameters in T2DM cases based on the current dataset (Table 3).

Table 3: Pearson correlation coefficient among the study parameters in T2DM cases

Correlation variable	25-hydroxyvitamin D Pearson correlation (r_p)	p-value
TC	-0.061	0.458
TG	0.048	0.563
HDL	0.073	0.372
LDL	-0.075	0.364

TC= total cholesterol; TG= triglyceride; HDL= high density lipoprotein; low density lipoprotein; 25(OH) vit. D = 25 hydroxy vitamin D

Discussion

Vitamin D is an essential nutrient recognized for its potential influence on pancreatic insulin secretion and action, playing a crucial role in the pathogenesis of T2DM [11,14]. Although the precise protective mechanisms are not yet fully understood, several hypotheses have been proposed based on previous research.

Firstly, vitamin D has been suggested to enhance insulin sensitivity by promoting glucose uptake in peripheral tissues. It is believed that adequate vitamin D levels can optimize insulin receptor function, improving insulin sensitivity [12]. Additionally, vitamin D has been shown to modulate pancreatic beta-cell function and enhance insulin secretion. By activating vitamin D receptors in pancreatic beta cells, vitamin D may regulate the synthesis and release of insulin, contributing to glucose homeostasis [12].

Furthermore, vitamin D has been linked to the regulation of lipid metabolism. Dyslipidemia, characterized by elevated total cholesterol, LDL, and triglyceride levels, is a common feature in T2DM and poses a risk for cardiovascular complications. Vitamin D has been suggested to influence lipid profile by promoting gene expression in lipid metabolism and cholesterol homeostasis [13]. It may benefit by reducing triglyceride levels, improving LDL particle size and composition, and increasing HDL cholesterol, thus mitigating the risk of atherogenic complications.

In this cross-sectional analytical study, we observed that T2DM patients had significantly higher levels of total serum cholesterol, LDL, and triglycerides compared to the healthy control group, while HDL levels showed no significant difference. These findings align with the results of several other studies [15–16]. For instance, Al-Shaheeb S. et al. [17] reported significantly elevated triglyceride and LDL levels in T2DM patients but found no statistical difference in HDL and total cholesterol levels. Arora PK. et al. [18] found increased triglycerides and low HDL levels in diabetic patients but no significant difference in total cholesterol or LDL levels.

Furthermore, we found that the mean level of 25 (OH) vitamin D was significantly lower in T2DM cases compared to healthy controls. This finding is consistent with studies conducted by Kostoglou-Athanassiou I. et al. [19] and Arafat ES. et al. [20] which also reported significantly lower levels of 25(OH) vitamin D in diabetic patients compared to control subjects. However, our correlation analysis did not observe statistically significant associations between lipid profile parameters (total cholesterol, triglycerides, HDL, LDL) and 25(OH) vitamin D levels. It is worth noting that previous research has presented conflicting results regarding the relationship between lipid profile and vitamin D levels. Jorde R. et al. [21] found a strong correlation between HDL and 25(OH) vitamin D, whereas an inverse relationship was observed between triglycerides and 25 (OH) vitamins D. Similarly, Banerjee R et al. [22] reported a negative correlation between 25 (OH) vitamin D and total cholesterol and LDL, but a positive correlation with HDL. Giri R. et al. [23] also noted an inverse relationship between 25(OH) vitamin D and HDL, but a positive relationship with total cholesterol, VLDL, LDL, and triglycerides.

However, further research is warranted to elucidate the complex relationship between lipid profile parameters, vitamin D, and T2DM, as the existing literature presents varying results. Understanding these associations can contribute to developing targeted interventions for managing and preventing complications associated with T2DM.

Conclusion

The study's findings suggest that those with T2DM are more likely to experience dyslipidemia, which can result in cardiovascular issues. The higher levels of total cholesterol, triglycerides, and LDL in diabetic patients are proof of this. Analyzing the lipid profile of people with T2DM can help with early management and lower the likelihood of the condition worsening. In addition, the study found that people with T2DM have lower 25(OH) vitamin D levels than people in the control group. As a result, taking vitamin D supplements is advised for those with T2DM. Such a treatment may enhance insulin secretion and glucose control, enhancing overall health results.

Limitation

There are several limitations in the present study that should be considered. Firstly, the data collection did not consider variables such as dietary habits, duration of sunlight exposure, and individuals' indoor and outdoor occupations. These factors could potentially influence the results and should be taken into account in future studies. Secondly, the sample size in this study was relatively small and not diverse enough to generalize the findings to a larger population in India. To obtain more comprehensive insights, it is advised to conduct large-scale, multi-centric studies that encompass a broader range of participants.

Additional Information

Disclosures

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