Evaluation of Dyslipidemia with HbA1c levels in Diabetes Mellitus

Shirley Patricia[1] Rocío Pérez Escobar [2]

Abstract

Introduction: *Diabetes mellitus is a group of metabolic disorders characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. An International Expert Committee recommended that diabetes be diagnosed by measurement of haemoglobin A1C (HbA1c), which reflects long-term blood glucose concentrations. The blood glucose data available from HbA1c are used in prescribing and monitoring the medicines for diabetes and prediabetes, along with exercise and diet. The accuracy of this test has continued to evolve over the last few years and useful in monitoring the blood glucose values among patients in clinics* ***Materials and Methods****: This cross-sectional retrospective study was conducted in the Department of Biochemistry. The sociodemographic and clinical data of the newly diagnosed type 2 diabetes mellitus (T2DM) patients were collected retrospectively from the medical records of the PAMHC by using the random sampling technique. The lipid profile of the diabetic patients, including total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-c), low-density lipoprotein-cholesterol (LDL-c), and triglycerides (TG), represent the dependent variables of our study, whereas the independent variables included the HbA1c levels of the diabetic patients.* ***Results:*** *Diabetic cases had statistically highly significant (p 0.001) elevated levels of total Cholesterol, Triglycerides and VLDL as compared to controls. Serum TG, serum TC, LDL-C and VLDL-C had positive correlation with the postprandial plasma glucose, fasting plasma glucose and HbA1c. shows that 40 cases and 40 controls were in the age group of 45 to 74 years, while 12 cases and 10 controls were in the age group of 18 to 44 years.The mean age of cases was 56.14±10.92 years, ranging from 20 to 73 years, while the mean age of controls was 55.62±11.48 years, ranging from 19 to 72 years.* ***Conclusion:*** *Lifestyle measures and intensive drug therapy is required to aggressively treat these risk factors of dyslipidaemia in patients with diabetes. The era of modern therapy in diabetic dyslipidaemia ensures that these group of susceptible patients with high lipid levels are adequately managed to reduce adverse cardiovascular outcomes in type 2 diabetes mellitus.*

Keywords: *Coronary heart disease, Dyslipidemia, HbA1c, High density lipoprotein*

[1] Microbióloga y Bioanalista, Escuela de Microbiología, Universidad de Antioquia. Medellín, Colomb
2 Bacterióloga, especialista en Hematología, Docente de la Escuela de Microbiología, Universidad de Antioquia. Medellín, Colomb

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INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. In 2009, an International Expert Committee recommended that diabetes be diagnosed by measurement of haemoglobin A1C (HbA1c), which reflects long-term blood glucose concentrations.[1]

The blood glucose data available from HbA1c are used in prescribing and monitoring the medicines for diabetes and prediabetes, along with exercise and diet. The accuracy of this test has continued to evolve over the last few years and useful in monitoring the blood glucose values among patients in clinics. [2]

Analysis of glycated haemoglobin (HbA1c) in blood provides evidence about an individual's verage blood glucose levels during the previous two to three months, which is the predicted half-life of red blood cells (RBCs). [3] The HbA1c is now recommended as a standard of care (SOC) for testing and monitoring diabetes, specifically the type 2 diabetes. [4] With no fasting required and also not being bound by the time of the day on the part of the patient, the HbA1c is a very convenient test to administer and evaluate. [5] The HbA1c is recommended to be performed at least twice a year in diabetes patients with stable blood glucose levels. [6]

The HbA1c levels differ for different diabetes patients, depending on their history of diabetes and whether they are on tablets or long-term and/or short-term insulin dosage. HbA1c is not only a useful biomarker of long-term glycaemic control but also a good predictor of lipid profile; thus, monitoring of glycaemic control using HbA1c could have additional benefits of identifying diabetes patients who are at a greater risk of cardiovascular complications. [7]

Patients with type 2 diabetes often exhibit an atherogenic lipid profile (high TG and low HDL cholesterol) which greatly increases their risk of cardiovascular disease (CVD) when compared with people without diabetes. Significantly higher levels of hypercholesterolaemia and hyperlipidaemia in type 2 diabetic patients with CVD as compared to diabetic patients without CVD have been observed. [8] Interestingly, attempts to reduce cardiovascular risks resulted in the improvement of HbA1c even in the absence of any specific intervention targeted at improving glycaemic control. [9]

Type 2 diabetes is associated with a cluster of interrelated plasma lipid and lipoprotein abnormalities, including reduced HDL cholesterol, a predominance of small dense LDL particles, and elevated triglycerides. [10] Insulin resistance and type 2 diabetes are associated with a clustering of interrelated plasma lipid and lipoprotein abnormalities, which include reduced HDL cholesterol, a predominance of small dense LDL particles, and elevated triglyceride levels. [11] Each of these dyslipidaemia features is associated with an increased risk of cardiovascular disease. Increased hepatic secretion of large triglyceride-rich VLDL and impaired clearance of VLDL appears to be of central importance in the pathophysiology of this dyslipidemia. [13]

Diabetic patients with accompanied but undiagnosed dyslipidaemia vulnerable to cardiovascular deaths. Patients with type 2 diabetes mostly exhibit an atherogenic lipid profile, which greatly increases their risk of CVD when compared with people without diabetes. An early intervention to normalize circulating lipids has been shown to reduce cardiovascular complications and mortality.

MATERIALS AND METHODS

This cross-sectional retrospective study was conducted in the Biochemistry. The Hospital is a specialized health center that provides emergency and routine healthcare services for the surrounding population. The sociodemographic and clinical data of the newly diagnosed type 2 diabetes mellitus (T2DM) patients were collected retrospectively from the medical records of the PAMHC by using the random sampling technique. The data of the diabetic patients were retrospectively collected for a period of 1 year.

Inclusion Criteria

Elderly patients (≥45 years old) with recent diagnosis of T2DM, based on the American Diabetes Association (ADA) criteria were included in this study. Accordingly, patients were considered to have T2DM if they fulfilled one of the following criteria: "HbA1c ≥ 6.5%, Fasting Plasma Glucose (FPG) ≥ 126 mg/dL (7.0 mmol/L), 2 h postprandial plasma glucose ≥ 200 mg/dL (11.1 mmol/L) during an oral glucose tolerance test (OGTT), or random plasma glucose ≥ 200 mg/dL (11.1 mmol/L)"

Exclusion Criteria

Patients who were taking lipid-lowering therapy or those with cardiovascular diseases, endocrinal conditions, liver function impairment, or renal problems were excluded from the study. Furthermore, patients with mental problems were also excluded from the study.

Study Variables

The lipid profile of the diabetic patients, including total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-c), low-density lipoprotein-cholesterol (LDL-c), and triglycerides (TG), represent the dependent variables of our study, whereas the independent variables included the HbA1c levels of the diabetic patients. The other additional characteristics of the patients, including age, educational level, occupation, marital status, blood pressure, and body mass index (BMI), were characterized as the confounding variables for this study.

Statistical Analysis

The data was entered and analyzed by the Statistical Package of Social Science SPSS, version 26. Descriptive statistics, such as frequencies and percentages, were calculated to summarize nominal and ordinal data, whereas the mean, median, and standard deviation or range were calculated to describe numerical variables. The correlation coefficient was calculated for the targeted association. The t-test was used if the independent variable was dichotomized during analysis. The chi-squared test was used to evaluate the association between categorical determinants and the outcome variables. Regression analysis was used to estimate adjusted odds ratios. Any p-value < 0.05 was considered as an indication of a statistically significant association or difference.

Ethical Approval

The collected data and the patient information were kept anonymous to assure the privacy of patients and were only used for research purposes. The study protocol was approved by the ethical research committee on Publication Ethics (Directorate of Health Affairs—Jeddah) under the ethical approval number A01346. Before participation, the aim, methods, and expected results of this study were described to the ethical approval committee.

RESULTS

Table 1 shows that 40 cases and 40 controls were in the age group of 45 to 74 years, while 12 cases and 10 controls were in the age group of 18 to 44 years. The mean age of cases was 56.14±10.92 years, ranging from 20 to 73 years, while the mean age of controls was 55.62±11.48 years, ranging from 19 to 72 years.

Table 1: Age distribution of cases and controls

Age group (years)	Cases	%	Controls	%
18-24	2	5.26%	2	5.00%
25-34	3	7.89%	4	10.00%
35-44	4	10.53%	5	12.50%
45-54	10	26.32%	12	30.00%
55-64	12	28.95%	10	25.00%
65-74	9	21.05%	7	17.50%
Total	**40**	**100.00%**	**40**	**100.00%**
Mean±SD	**56.14±10.92**		**55.62±11.48**	
Range	**20 - 73 years**		**19 - 72 years**	

Table 2: HbA1C Distribution Among Cases and Controls

HbA1C	Cases	%	Controls	%
<6.5 %	2	5.00%	40	100.00%
>6.5 %	38	95.00%	0	0.00%
Total	**40**	**100.00%**	**40**	**100.00%**
Mean±SD	**8.92±1.85**		**5.32±0.52**	
p-value	**p<0.001 (HS)**			

Table 3: Blood Parameters in Cases and Controls

Parameter	Cases (Range)	Cases (Mean±SD)	Controls (Range)	Controls (Mean±SD)	p-value
RBS (mg/dL)	110-410	198.45±60.82	70-150	112.35±26.78	<0.001 (HS)
FBS (mg/dL)	130-320	172.62±37.15	72-118	99.40±19.85	<0.001 (HS)
PP2BS (mg/dL)	180-450	248.30±55.12	95-170	129.72±29.45	<0.001 (HS)
HbA1C (%)	5.6-14.8	8.92±1.85	4.8-6.4	5.70±1.22	<0.001 (HS)

Table 4: Lipid Profile Distribution Among Cases and Controls

Lipids (mg/dL)	Cases	%	Controls	%	p-value
High TC (>200)	35	70%	12	24%	<0.001 (HS)
High TG (>150)	42	84%	14	28%	<0.001 (HS)
High LDL-C (>130)	18	36%	10	20%	>0.05 (NS)
Low HDL-C (<40)	20	40%	22	44%	>0.05 (NS)
High VLDL-C (≥30)	40	80%	17	34%	<0.01 (S)

Table 5: Pearson's Correlation of Lipid Profile with Fasting Plasma Glucose, Postprandial Plasma Glucose, and HbA1C in Cases

mg/dL	FBS		PPBS		HbA1C %	
	r	p	r	p	r	p
Serum TC	0.435	<0.001	0.472	<0.001	0.450	<0.001
Serum TG	0.398	<0.001	0.510	<0.001	0.445	<0.001
Serum LDL-C	0.290	<0.001	0.252	<0.001	0.275	<0.001
Serum HDL-C	0.072	>0.05	0.065	>0.05	0.077	>0.05
Serum VLDL-C	0.370	<0.001	0.478	<0.001	0.419	<0.001

The above tables present a comparative analysis of demographic and biochemical parameters between cases and controls. **Table 1** illustrates the age distribution, showing that most cases and controls fall within the 45-74 age group. **Table 2** highlights HbA1C levels, revealing significantly higher values in cases compared to controls (**p<0.001). Table 3** details blood glucose parameters, where fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1C levels are considerably elevated in cases **(p<0.001)**. **Table 4** examines lipid profiles, indicating that cases have significantly higher levels of total cholesterol (TC), triglycerides (TG), and very low-density lipoprotein cholesterol (VLDL-C), while low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) differences remain statistically non-significant. Lastly, **Table 5** demonstrates Pearson's correlation between lipid parameters and glucose metabolism markers, showing significant positive correlations of TC, TG, LDL-C, and VLDL-C with FBS, PPBS, and HbA1C (**p<0.001**), whereas HDL-C exhibits no significant correlation. These findings emphasize the metabolic disturbances in cases compared to controls, reinforcing the link between dyslipidemia and glucose dysregulation.

DISCUSSION

The present study aimed to define the correlation between HbA1c and lipid profile and also to determine the pattern of dyslipidemia in type 2 DM patients. The glycemic parameters (FBS, PPBS and HbA1c) did not differ significantly in type 2 diabetic male and female subjects, whereas the slight rise in TC, TGs, LDL and VLDL was found in female diabetic patients in the present study (Table 2). These findings suggest that the pattern of dyslipidemia could vary in male and female diabetic subjects. In both males and females, diabetes shows a markedly increase risk of events, however the diabetic woman is more susceptible to increased cardio vascular mortality. [14]

Our finding is in agreement with the previous studies [15]. Hyperlipidemia in females may be attributed to the effects of sex hormones on body fat distribution, which leads to differences in altered lipoproteins. The Diabetes complications and control trial (DCCT) established HbA1c as the best level of glycemic control[16] . To see the impact of glycemic control on various lipid parameters the diabetic patients are categorized into 3 groups based on the HbA1c levels i.e. good glycemic control (HbA1c9%) 6 and12. We found a linear and increase in HbA1c, FBS, PPBS, TC, TGs, LDL, VLDL and decreased HDL in the patients with poor and worse glycemic control than in good glycemic control. Thus, HbA1c provides a reliable measure of chronic glycemia and correlates well with the risk of longterm diabetes complications, so that it is currently considered as gold standard test for the assessment and chronic

management of diabetes mellitus.

In the present study, we observed that HbA1c has direct and significant correlations with FBS, PPBS, TC, TGs and LDL and inverse correlation with HDL and VLDL. Our findings are concomitant with previous studies [17] who also reported a direct and significant correlation between HbA1c with TC, TG and LDL and reverse correlation with HDL. The cause of dyslipidemia in type 2 DM may be due to impaired liver apolipoprotein production which in turn regulates the enzymatic activity of lipoprotein lipase (LPL) and cholesterol ester transport protein. [18] Dyslipidemia as a metabolic abnormality is strongly linked with type 2 DM and its prevalence vary, depending on the type and severity of diabetes, glycemic control, nutritional status, age and other factors [19].

In our study, the significant correlations were found between HbA1c, FBS, PPBS and all the lipid profile parameters finds a linear relationship between HbA1c and dislipidemia which points towards the usefulness of HbA1c for screening the high risk diabetic patients. This finding supports HbA1c is better predictor and can be used as a potential biomarker for predicting dyslipidemia in type 2 diabetic patients.

CONCLUSION

Stringent lipid control in patients with diabetes is of key importance in reducing the risk of developing cardiovascular events. Lifestyle measures and intensive drug therapy is required to aggressively treat these risk factors of dyslipidaemia in patients with diabetes. The era of modern therapy in diabetic dyslipidaemia ensures that these group of susceptible patients with high lipid levels are adequately managed to reduce adverse cardiovascular outcomes in type 2 diabetes mellitus.

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