ORIGINAL ARTICLE

Correlation between Glycated Hemoglobin, Serum Glucose and Serum Lipid Levels in Type 2 Diabetes

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Abstract

Objective: Diabetes mellitus is the most common metabolic disease. One of the most common problems in diabetic patients is atherosclerotic cardiovascular disease which is induced by hyperlipidemia. Impaired lipid metabolism resulting from uncontrolled hyperglycemia has been implicated in cardiovascular complications in diabetic patients. Also, glycated hemoglobin (HbA1c) has been regarded as an independent risk factor for cardiovascular disease. The aim of this study was to examine the correlation between HbA1c, fasting blood sugar (FBS) and 2 hours postprandial glucose (2hpp) with serum lipid levels in type 2 diabetes.

Materials and Methods: In this study, 100 diabetic patients in Yazd Diabetes Research Center were chosen. FBS, 2hpp, HbA1c and serum lipid levels were analyzed in patients. Serum Lipids and glucose were measured by enzymatic method. HbA1c was measured by DS5 analyzer and DS5 Pink Reagent kit.

Results: There was significant correlation between FBS and total cholesterol (TC) (r=0.25, *P*=0.039), 2hpp with TC (r=0.338, *P*=0.033) and 2hpp with LDL (r=0.39, *P*=0.01), but there were no correlations between HbA1c and TC (r=0.2, *P*=0.06), HbA1c and triglyceride (*P*=0.2, r=-0.14), HbA1c and HDL (*P*=0.25 r=-0.14) and HbA1c with LDL (*P*=0.08, r=0.2).

Conclusion: The results of this study showed that the high levels of serum glucose are associated with high levels of cholesterol and LDL and can be a risk factor for cardiovascular diseases.

Keywords: Diabetes, lipid, HbA1c, FBS, 2hpp

Introduction

Diabetes mellitus is one of the most common problems caused by a combination of insulin resistance and impaired insulin secretion by pancreatic β cells (1-4). Type 2 diabetes has a rising attitude globally. The worldwide spread of diabetes among general population is estimated to increase to 300 million in 2025 (5,6). One of the most common problems in diabetic patients is atherosclerotic cardiovascular disease which is induced by lipid abnormalities (7-14).

Impaired lipid metabolism resulting from uncontrolled hyperglycemia has been implicated in cardiovascular complications in diabetic patients (15). Also, Mohsin et al. in

2013 reported that lipid abnormalities are due to resistance to insulin and hyperglycemia and include decreased high-density lipoprotein (HDL), increased small dense low-density lipoprotein (LDL) and elevated triglycerides (TG) (16). The risk of fatal cardiovascular disease among diabetic subjects is comparable with subjects who have had a previous myocardial infarction. This increased risk has been mainly attributed to hyperglycemia, dyslipidemia and inflammatory mechanisms (17). Glycated hemoglobin (HbA1c) is a routinely used marker for long-term glycemic control. In accordance with its function as an indicator for the mean blood glucose level, HbA1c predicts the risk of diabetic complications in diabetes patients. Therefore, regardless of classical risk factors like dyslipidemia, elevated HbA1c has now been regarded as an independent risk factor for atherosclerotic cardiovascular disease in subjects with or without diabetes. Estimated risk of atherosclerotic cardiovascular disease has shown to be increased by 18% for each 1% increase in absolute HbA1c value in diabetic population (18). Ahmad khan in 2007 suggests that HbA1c can predict serum lipid levels in both male and female diabetic patients and HbA1c was regarded as an independent risk factor for coronary heart disease (19). He observed a direct correlation between HbA1c and the severity of coronary artery disease (CAD) in diabetic patients. Whereas, improving the glycemic control could reduce the risk of cardiovascular events in diabetic patients. Moreover, reducing cardiovascular risks resulted in the improvement of HbA1c even in the absence of any specific intervention targeted at improving glycemic control (19). Another study in 2011 showed that cardiovascular disease (CVD) is significantly higher in people with high levels of HbA1c (20). The purpose of this study was to evaluate correlation between glycated hemoglobin (HbA1c), fasting (FBS) and 2 hours postprandial (2hpp) blood sugars with serum lipid levels in type 2 diabetic patients.

Materials and Methods

Sample Collection

In this study, 100 diabetic patients (54 women and 46 men) aged 40 to 60 years in Yazd Diabetes Research Center in 2010 were chosen. Inclusion criteria were Type 2 diabetes mellitus for more than 5 years diagnosed according to American Diabetes Association criteria with HbA1c more than 7%. Exclusion criteria were cigarette smoking, diabetic complications, current treatment with antioxidant drugs or other medications except for oral hypoglycemic agents, using vitamins or minerals supplements in the last two months, renal failure, uncontrolled hypertension, history of stroke and chronic liver disease, pregnancy, lactation, serum TG more than 400 mg/dl, total cholesterol (TC) more than 250 mg/dl, and FBS more than 250 mg/dl. Moreover, patients needed changing dosage or type of medications were excluded.

Blood Collection

Blood samples were obtained from patients after at least 8 hours fasting. Serum was separated from the clots after complete coagulation (l h in room temperature) by low speed centrifugation (15 min at 2000 g).

FBS, 2hpp and HbA1c Assay

FBS and 2hpp were measured by colorimetric method (GPO-PAP) with Photometer 5010 and Pars Azmoon kit, Iran. HbA1c was assayed using lysed whole blood samples and by DS5 analyzer and DS5 Pink Reagent kit.

Lipid Assay

Lipid profiles: TC, TG, HDL were measured by enzymatic method and Pars Azmoon kit. LDL was analyzed by Friedewald method (19).

Statistical Analysis

Statistical analysis was performed using SPSS software (version 11.5) and Pearson's test were used for analysis of data.

Results

In this study, 100 patients were chosen. Serum lipid levels, FBS, 2hpp and HbA1c were

evaluated according to the above criteria. Table 1 shows the mean levels of serum lipids. Table 2 shows the mean levels of FBS, 2hpp and HbA1c. Table 3 represents the relationship between lipids and FBS, 2hpp and HbA1c.

The results of this study showed no relationship between HbA1c and TC (r=0.2, *P*=0.06), HbA1c and TG (r=-0.14, *P*=0.2), HbA1c and HDL (r=-0.14, *P*=0.25), and HbA1c and LDL (r=0.2, *P*=0.08).

Also, there was a significant relationship between FBS and TC (r=0.25, *P*=0.039), but there was no relationship between FBS with TG, HDL and LDL. In addition, there was a correlation between 2hpp and cholesterol (r=0.338, *P*=0.033) and between 2hpp and LDL (r=0.39, *P*=0.01), but no relationship was found between 2hpp and HDL.

Discussion

Results of this study showed significant correlation between FBS and TC as well as between 2hpp with TC and LDL; but, there was no correlation between HbA1c and serum lipid levels. Studies have shown that high level of cholesterol, triglyceride, LDL and low HDL in type 2 diabetics is well known risk factors for cardiovascular diseases. The cause of dyslipidaemia in type 2 diabetes mellitus may be that insulin is not working well which in turn influences the liver apolipoprotein production (22). In a study, Khan et al. have shown that there is a direct correlation between FBS and HbA1c with TC, TG and LDL and inverse correlation with HDL (15). In another study, the positive correlation between FBS and postprandial blood glucose with TC, TG, LDL and very low-density lipoprotein (VLDL) indicated the risk of cardiovascular diseases in the patients. Thus, it can be deduced that diabetic populations with higher blood glucose levels are more fain to cardiovascular diseases (23). Also, this study showed that HbA1c can be used as a potential biomarker for predicting dyslipidemia in diabetic patients (23).

In another study, Mahato et al. observed significant correlations between HbA1c with TC, LDL and LDL/HDL ratio (18). In a study, HbA1c demonstrated significant positive relationship with TC, TG, HDL and LDL (22). Nishimura et al. reported significantly higher CVD in persons with high levels of HbA1c (20). Ahmad khan suggested that HbA1c can predict serum lipid levels in both male and female diabetic patients (19). Also, Ramona et al. reported that HbA1c is a marker routinely used for long-term glycemic control and they observed a direct and significant correlation between HbA1c with TC, TG and LDL, and reverse correlation with HDL (24).

Conclusion

The result of this study showed that high levels of serum glucose are associated with high level of TC and LDL. High levels of LDL speed up atherosclerosis and thereby increase the risk for heart attack and stroke.

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Table 1- Mean levels of serum lipids

Variable	Mean ±SD
TG (mg/dl)	194.5±70.5
HDL (mg/dl)	51.2±7.3
LDL (mg/dl)	105.00±30.3
TC (mg/dl)	190.3±35.3

Table 2- Mean serum levels of FBS, 2hpp and HbA1c

Variable	Mean ±SD
FBS(mg/dl)	184.47±35.5
2hpp(mg/dl)	296.5±34.5
A1c(percent)	8.7±1.65

Table 3-The Correlation between serum lipids and FBS, 2hpp and HbA1c.

Variable	TC		TG		HDL		LDL	
FBS	p= 0.039	r= 0.25	p= 0.16	r= 0.17	p= 0.83	r= -0.21	p= 0.94	r=0.2
2hpp	p= 0.033	r= 0.33	p=0.51	r= 0.1	p= 0.66	r=0.68	p= 0.01	r= 0.39
HbA1c	p= 0.06	r= 0.2	p=0.2	r= -0.14	p= 0.25	r= -0.14	p= 0.08	r= 0.2

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