Original Research Article

Correlation between Hemoglobin A1c and Serum Lipid Profile in Type 2 Diabetic Patients Referred to the Diabetes Clinic in Gorgan, Iran

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ABSTRACT

Introduction: Hyperlipidemia is a common risk factor for diabetes and its cardiovascular complications. The aim of this study was to investigate the association between hemoglobin A1c (HbA1c) levels and serum lipids in patients with type 2 diabetes. **Materials and Methods:** This descriptive-analytical and cross-sectional study was conducted in 2016 on 484 patients with type 2 diabetes referred to the Diabetes Clinic in Gorgan, Iran. Blood samples were taken from all patients and sent to laboratory for measurement of HbA1c, FBS and serum lipids. Data were collected via registration forms. The data were analyzed with SPSS software (version 20) using independent t-test, Mann-Whitney U test and Pearson's and Spearman's coefficient tests. **Results:** Mean age of subjects was 56.61 ± 12.65 years with age range of 17 to 92 years. Mean duration of the disease was 13.52 ± 7.55 years (range: 1-44 years). Mean HbA1c level was 8.83 ± 1.8 mg/dl. There was a statistically significant correlation between HbA1c level and serum cholesterol (P=0.001), triglyceride (P=0.009), low-density lipoprotein (P=0.003) and FBS (P=0.0001). However, there was no statistically significant relationship between HbA1c and high-density lipoprotein levels (P= 0.8). **Conclusions:** High level of HbA1C is associated with dyslipidemia and can be used as predictors of cardiovascular disease in type 2 diabetes patients.

KEYWORDS: HbA1c, Serum lipids, Diabetes Mellitus, Fasting blood sugar

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INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder caused by complex interaction of genetic, environmental and lifestyle factors. DM mortality rates are on the rise due to various factors such as unhealthy diet, physical inactivity, obesity and smoking (1). Cardiovascular disease (CVD) is one of the main causes of death in diabetic patients. Hyperlipidemia and atherosclerosis are among the main causes of CVD in diabetics. Therefore, in addition to hemoglobin A1c (HbA1c) control, it is necessary to examine the serum lipid profile of diabetic patients and take appropriate action based on age and type of disorder (2). The cause and mechanism of atherosclerosis are still being studied, but the combination of glucose and lipoproteins is known as a causative factor. It has been demonstrated that combination of low-density lipoprotein (LDL) with glucose might influence LDL's affinity to its receptors and increase their half life (3). Patients with type 2 diabetes are four times more likely to die from CVD compared to healthy individuals (4).

HbA1c is a good indicator of the long-term control of diabetes, and can provide information on glucose control over the past two to three months. It has been recently revealed that HbA1c levels can be used as an independent risk factor for CVD (5) and stroke (6) in diabetics and healthy individuals. In this regard, Ravipati et al. found a direct correlation between HbA1c levels and the severity of CVD in diabetic patients (7). Moreover, newborns of mothers with high levels of HbA1c are more likely to develop CVD in the future (8).

Studies have shown that decrease in HbA1c levels of people with type 2 diabetes

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reduces the risk of CVD (9, 10). It is estimated that a 0.2% decrease in the HbA1c level could reduce the risk of developing CVD by 10% (3).

Based on the results of various studies, the appropriate control of diabetes, early screening and timely prevention of diabetes complications significantly improve prognosis and reduce treatment costs. Considering the necessity of evaluating serum lipids in diabetic patients, this study aimed to determine the relationship between level of HbA1c and serum lipids in type 2 diabetic patients.

MATERIAL AND METHODS

This descriptive-analytical and cross-sectional study was performed on all type 2 diabetic patients referred to the Diabetes Clinic in Gorgan (Iran) in 2016. Patients with type 1 diabetes, gestational diabetes, prednisolone-induced diabetes and those who did not visit the clinic for testing were excluded from the study.

The subjects were selected through convenience sampling. All type 2 diabetic patients with an active record at the clinic who were referred to the clinic between March and May 2016 were enrolled in the study. The largest possible sample size (484 subjects) was calculated according to Kahon et al. (11), using the NCSS software at type I error of 0.05 and power of 0.80.

Informed consent was taken from all subjects. Data were collected using a researcher-made information registration form that included demographic and disease-related information. In addition, records of HbA1c, blood glucose, total cholesterol, triglyceride, LDL-cholesterol and HDL-cholesterol levels were collected.

Venous blood samples were taken after 12 hours of fasting and in standard conditions to measure level of fasting blood sugar (FBS), glycosylated hemoglobin and lipids. Within 2-3 hours of sampling, serum was separated and level of FBS and serum lipids was measured by glucose oxidase enzymatic method (using Hitachi Autoanalysis and Pars Azmun reagents, Iran). The Friedewald's equation was used to calculate LDL-cholesterol level in patients with triglyceride level lower than 400 mg/dl. Moreover, blood sample was taken and collected in tube containing EDTA, and HbA1c level was measured within four hours of sampling by chromatography.

The data collected with the questionnaire and the results of testing were analyzed with SPSS software (version 20) and using Pearson correlation coefficient and t-test. Mean level of serum lipids was compared with the values determined as treatment goals by the American Diabetes Association. The association of serum lipid levels with duration of the disease and HbA1c level was evaluated. According to the recommendation of the American Diabetes Association in 2015, all diabetic patients over 40 years of age were prescribed to take atorvastatin (20 mg) at night.

RESULTS

Overall, 484 patients (328 females and 156 males) were studied. Mean age of subjects was 56.61 ± 12.65 years (range: 17-92 years). Mean duration of the disease was 13.52 ± 7.55 years (range: 1-44 years). Mean level of HbA1c, triglycerides, cholesterol, LDL and HDL was 8.93 ± 1.76, 159.88 ± 93.91, 172.54 ± 44.53, 97.25 ± 43.99, and 45.81 ± 12.18 mg/dl, respectively. There was a direct, significant correlation between HbA1c and cholesterol, triglyceride and LDL levels. However, there was no significant correlation between HbA1c and HDL levels (Table 1).

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Table 1. Results of the Spearman correlation coefficient between serum lipids and HbA1c levels in patients with type 2 diabetes

Parameters	Correlation coefficient	P-value
Cholesterol	0.151	0. 001**
Triglyceride	0. 124	0. 006**
LDL	0. 131	0. 004**
HDL	0. 01	0.821

The mean level of HbA1c and serum lipids was compared between males and females. The results showed that cholesterol and HDL levels were significantly lower in males compared to females (Table 2).

Table 2. HbA1c level and serum lipid profile of type 2 diabetic patients based on gender

Parameters	Males (N=156)	Females (N=328)	P-value Mann–Whitney U test
HbA1c	8.94 ± 1.84	8.92 ± 1.72	0.93
Cholesterol	165.04 ± 45.14	176.12 ± 43.85	0.017*
Triglyceride	156.71 ± 93.72	161.39 ± 94.11	0.531
LDL	96.89 ± 354.54	97.41 ± 38.18	0.253
HDL	42.73 ± 12.15	47.87 ± 11.93	0.000**
FBS	186.92 ± 80.29	188.28 ± 79.44	0.742
2-hour postprandial blood glucose	288.52 ± 109.02	274.2 ± 107.93	0.128

Data are presented as mean ± standard deviation

HbA1c and 2-hour postprandial blood glucose levels had a direct, significant correlation with the duration of the disease, while the amount of triglyceride was inversely related to the duration of the disease. Moreover, HDL levels had an inverse relationship with the patient's age (Table 3).

Table 3. The relationship of serum lipids, blood glucose and HbA1c levels with age and duration of the disease in diabetic patients

Parameters	Relationship with age	P-value Spearman's correlation coefficient	Relationship with duration of the disease	P-value Spearman's correlation coefficient
HbA1c	-0.02	0.66	0.156**	0.001
Cholesterol	0.83-	0.068	-0.01	0.827
Triglyceride	0.063-	0.170	-0.106*	0.02
LDL	0.026-	0.566	-0.007	0.874
HDL	**0.136-	0.003	0.009	0.846
FBS	0.067-	0.144	0.047	0.305
2-hour postprandial blood glucose	0.011	0.824	0.128**	0.009

* Significant relationship at 0.05

** Significant relationship at 0.01 (with a year increase in the disease duration, triglyceride level decreases by 0.106)

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Subjects were then divided into controlled Hb1Ac and uncontrolled Hb1Ac groups. Comparison of the biochemical variables between the two groups showed that FBS, 2-hour postprandial blood glucose and triglyceride levels were significantly higher in subjects with uncontrolled Hb1Ac level (Table 4).

Table 4. Comparison of serum lipids and glucose levels among type 2 diabetics with controlled HbA1c and uncontrolled HbA1c levels

Parameters	Controlled HbA1c (N=96)	Uncontrolled HbA1c (N=388)	P-value Mann–Whitney U test
Cholesterol	169.04 ± 47.98	43.66 173.32 ±	0.360
Triglyceride	138.57 ± 73.53	165.15 ± 97.67	0.015*
LDL	99.09 ± 57.30	96.79 ± 40.10	0.697
HDL	46.05 ± 13./29	45.75 ± 11.9	0./889
FBS	139.53 ± 50.85	199.8 ± 80.98	0.00**
2-hour postprandial blood glucose	213.67 ± 73.49	300.50 ± 106.17	0.00**

Data are presented as mean ± standard deviation
* Significant relationship at 0.05
** Significant relationship at 0.01

DISCUSSION

The mean level of HbA1c was 8.83 mg/dl in patients with type 2 diabetes, which indicates the lack of appropriate glucose control in the patients. Consistent with our study, in study of Keramati et al. in Mashhad (Iran), HbA1c level was higher than 0.07 mg/dl in more than half of diabetic patients (12). In a study in India, the mean level of HbA1c was 8.9 ± 1.88 mg/dl in male diabetics and 8.80 ± 1.76 mg/dl in female diabetics (13). Inconsistent with our findings, Hassan et al. (2013) reported the mean HbA1c level as 9.19 mg/dl in diabetic patients, but found no statistically significant relationship between HbA1c, cholesterol and LDL levels (14).

We found a significant relationship between HbA1c and FBS levels, which is in line with findings of some other studies (12, 14, 15). Except for LDL level, we found significant relationships between HbA1c, FBS, cholesterol and triglyceride levels.

Pujari found a statistically significant correlation between HbA1c level and dyslipidemia (15). In Oman, Al-Alawi reported a correlation between improved dyslipidemia and HbA1c control (16). In a similar study in India, the mean HbA1c level was 7.34 ± 1.24 mg/dl, and high total cholesterol, high LDL and low HDL were found in 59.9%, 98%, and 65% of subjects, respectively. In line with our findings, the mentioned study reported a significant positive correlation between HbA1c, total cholesterol, triglyceride, HDL and LDL levels (17).

In 2013, Parial et al. reported that 86% of patients and almost all patients with foot ulcer had high HbA1c levels (8.88 mg/dl), while 88% of patients without diabetic foot ulcer had satisfactory HbA1c level. HbA1c, creatinine, cholesterol, LDL and triglyceride levels had a significant positive correlation with diabetic foot ulcers, indicating that HbA1c and creatinine may be major contributors to diabetic foot ulcer. Similar to our findings, they found that HbA1c is significantly associated with dyslipidemia (18).

In a study in India on females patients with type 2 diabetes, HbA1c had a positive correlation with total cholesterol (r=0.414) and LDL (r = 0.8686) levels, which is consistent with our findings (19). In 2014, a study reported a significant association

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between high HbA1c and FBS levels. The age of patients had a significant inverse relationship with total cholesterol, triglycerides and LDL. HbA1c level had a significant direct relationship with total cholesterol, triglycerides and LDL but not with HDL (20). In a study by Mahajan and Koley, HbA1c had a significant positive correlation with blood glucose, total cholesterol, triglyceride, LDL and HDL levels (21). In Pakistan, Naeem et al. found that female diabetics had significantly increased systolic and diastolic blood pressure, total cholesterol and LDL level compared to male patients. They also showed that triglyceride has a positive correlation with HbA1c of 7%. In addition, 14.2% and 28% of patients with HbA1c of >7% had cerebrovascular disease and ischemic heart disease, respectively. These results suggest that the relationship between HbA1c level and serum lipids of patients with type 2 diabetes might be a useful predictor of CVD in these patients (22).

In the present study, HbA1c had a significant correlation with cholesterol, triglyceride and LDL levels, while there was no significant association between HDL level and HbA1c. Some believe that elevated triglyceride and decreased HDL levels are the most common lipid disorders in diabetic patients, and claim that LDL level is relatively similar to non-diabetic individuals (23).

CONCLUSION

The results of this study indicate that the diabetic patients in our study area do not have satisfactory HbA1c levels. In addition, HbA1c has a direct, significant correlation with total cholesterol, triglyceride and LDL but not with HDL. Our results indicate that HbA1c might be suitable for predicting dyslipidemia and CVD in diabetic patients. We also suggest conducting further studies on satisfactory HbA1c control in diabetic patients.

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