Association between Lipid Profiles and Renal Functions among Adults with Type 2 Diabetes

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Keywords

Diabetes type 2 · Renal function tests · Lipid profiles

Abstract

Introduction: Type 2 diabetes mellitus (T2DM) affects renal functions and lipid profiles of patients. **Objectives:** In this study, 100 patients (65 females, 35 males) with T2DM were evaluated to determine whether renal function characteristics and lipid profiles are associated with T2DM. **Methods:** Blood samples were collected from all patients with T2DM, and the levels of hemoglobin A_{1c} (HbA_{1c}), blood urea, serum creatinine, cholesterol, triglyceride (TGR), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) were analyzed. **Results:** A direct correlation of blood sugar and HbA_{1c} was observed with blood urea, serum creatinine, serum cholesterol, serum TGR, HDL, LDL, and VLDL. The results revealed elevated TGR levels in patients administered medications for hyperglycemia. Furthermore, serum TGR levels were significantly correlated with blood sugar levels ($p = 0.035$). Blood urea levels were significantly correlated with glycated hemoglobin ($p = 0.008$). Blood urea, serum creatinine, and serum cholesterol levels were highly significantly correlated with HbA_{1c} ($p =$

0.008, 0.017, and 0.005, respectively), while HDL, LDL, and VLDL were not significantly correlated with HbA_{1c}. **Conclusion:** This study highlights the importance of serum TGR and serum creatinine measurement for guiding the treatment of T2DM.

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Introduction

Diabetes mellitus is a metabolic disease that leads to higher than normal blood glucose levels. The two main types of diabetes mellitus are insulin-dependent diabetes mellitus (type 1) and non-insulin-independent diabetes mellitus (type 2). Type 2 diabetes mellitus (T2DM) typically occurs after the age of 40 years [1] and is caused by a deficiency of insulin or its secretion. Metabolism in numerous body tissues is influenced by insulin, glucagon, and epinephrine. Patients with diabetes suffer from hyperglycemia [2, 3], and high glucose levels influence the activity of enzymes such as glucose-6-phosphate dehydrogenase in human erythrocytes [4]. High levels of cholesterol (hypercholesterolemia) because of familial inheritance can also lead to diabetes. Approximately, 60–70%

Table 1. Variables of blood sugar, HbA_{1c}, blood urea, serum creatinine, serum cholesterol, serum triglyceride, serum HDL, LDL, VLDL, statistics, mean, standard deviation, minimum, maximum (descriptive statistics)

	N	Min.	Max.	Mean	Standard deviation
Blood sugar	100	99.0	574.0	229.580	106.7947
HbA _{1c}	100	4.70	12.80	8.5166	1.78246
Blood urea	100	14.0	125.0	31.254	12.5752
Serum creatinine	100	0.50	3.76	0.9343	0.33862
Serum cholesterol	100	63.0	1,280.0	174.82	121.1768
Serum triglyceride	100	37.0	1,595	201.39	181.4665
Serum HDL	100	19.0	76	45.990	9.8601
LDL	100	10.2	194	86.887	35.8780
VLDL	100	7.4	154.6	37.858	24.3010

of patients with T2DM exhibit dyslipidemia, with high levels of triglycerides (TGRs) and low levels of high-density lipoproteins (HDL) and low-density lipoproteins (LDL) [5]. When TGRs increase in the blood, the catabolism of HDL is elevated, leading to reduced HDL and increased LDL [6, 7].

Diabetes with dyslipidemia contributes to cardiovascular disease [8]. However, even when diabetes is controlled well, dyslipidemia is minimized but not eliminated. In recent years, studies of hypercholesterolemia have focused on fat. Hereditary familial hypercholesterolemia is caused by mutations that affect the LDL receptor gene or the gene of its ligand, apolipoprotein B [9, 10]. High levels of TGRs (hypertriglyceridemia) and low levels of HDL lead to increased fatty acids, which stimulate insulin resistance and cause β -cell dysfunction [11, 12]. High levels of fatty acids lead to moderate changes in insulin receptor levels and, along with glucose, disable β -cell function [13]. Therefore, evaluation of lipid profiles is necessary during the treatment of diabetes to control or avoid abnormalities arising from hypertriglyceridemia and low HDL. Many studies have indicated that high levels of LDL cholesterol in patients with diabetes are associated with an increased risk of cardiovascular diseases [14]. For type 1 and type 2, LDL must be less than 70 mg/dL to avoid high risk, but normal LDL must be less than 100 mg/dL [15]. Creatinine, a derivative of amino acids with a molecular mass of approximately 113 Da, is filtered through the glomeruli. Many studies have suggested a relationship between creatinine clearance and serum creatinine levels that depends on the glomerular filtration rate [16, 17]. In diabetes, small vessels in the kidney begin to bleed, because of which the kid-

Table 2. One-way analysis of variance of blood urea, serum creatinine, serum cholesterol, serum triglyceride, serum HDL, LDL, and VLDL by blood sugar (significant value, $p < 0.05$)

Blood sugar vs.	N	F	Significant ($p < 0.05$)
Blood urea	100	0.358	0.999
Serum creatinine	100	0.266	1.000
Cholesterol	100	0.194	1.000
Triglyceride	100	2.029	0.035
HDL	100	1.687	0.088
LDL	100	1.238	0.298
VLDL	100	0.784	0.782
HbA _{1c}	100	1.254	0.268

Table 3. One-way analysis of variance of blood urea, serum creatinine, serum cholesterol, serum triglyceride, serum HDL, LDL, VLDL, and blood sugar by HbA_{1c} (significant value, $p < 0.05$)

HbA _{1c} vs.	N	F	Significant ($p < 0.05$)
Blood urea	100	3.915	0.008
Serum creatinine	100	3.285	0.017
Cholesterol	100	4.340	0.005
Triglyceride	100	0.156	1.000
HDL	100	0.815	0.719
LDL	100	0.940	0.600
VLDL	100	0.615	0.895
Blood sugar	100	2.159	0.079

neys are unable to filter the blood and produce urine. Consequently, the body produces more water and salt than normal, resulting in weight gain, ankle swelling, and protein in the urine, along with buildup of waste materials in the blood. Renal failure due to diabetes can increase urea and creatinine levels in the blood [18]. The aim of this study was to determine whether the effects of T2DM on serum TGR and serum cholesterol levels lead to a higher risk of cardiovascular disorder and whether increased creatinine levels cause renal failure.

Materials and Methods

In this study, the age range of patients with T2DM was 40–65 years. Blood samples were collected from patients after fasting (at least 14 h) at 8 a.m. at the center in Erbil, Iraq in 2018. This study enrolled 100 patients (65 females, 35 males) with T2DM at the center in Erbil-City, Iraq in 2018. Patients visited the diabetic center for biochemical tests, which were conducted using an automatic analyzer. All patients were diagnosed by evaluating renal function and lipid profiles.

Fig. 1. Relationship of HbA_{1c} with serum urea.

Fig. 2. Relationship of HbA_{1c} with serum creatinine.

Procedure

Blood samples were collected and analyzed from all 100 patients using Gesan analyzer Chem 200 kits (Campobello di Mazara, Italy). The levels of hemoglobin A_{1c} (HbA_{1c}), blood urea, serum creatinine, cholesterol, TGR, LDL, HDL, and very low-density lipoprotein (VLDL) were measured. Approximately 0.01 μ L of blood was pipetted in an EDTA-containing tube along with 0.5 mL lysis solution and incubated for 5 min at 25 °C, and then HbA_{1c} was measured using the analyzer (Chem 200). To measure blood urea, creatinine, cholesterol, TGR, LDL, HDL, and VLDL, the serum was collected after centrifuging the tube for 10 min, followed by analysis using the analyzer (Chem 200).

Statistical Analysis

Statistical analysis of data was conducted by one-way analysis of variance with SPSS software v. 25 (SPSS, Inc., Chicago, IL, USA) to determine the correlation between blood sugar and HbA_{1c} with blood urea, creatinine, cholesterol, TGR, HDL, LDL, and VLDL. The mean and standard deviation were calculated using the same method.

Results

Renal function and lipid profiles of the 100 patients were measured using an automatic analyzer. Table 1 shows the correlation of blood urea, serum creatinine, cholesterol, TGR, HDL, LDL, and VLDL with blood sugar levels. The results indicated that serum TGR was significantly correlated with blood sugar. Table 2 shows the correlation between blood urea, serum creatinine, cholesterol, TGR, HDL, LDL, VLDL, and blood sugar with HbA_{1c}; blood urea, serum creatinine, and cholesterol levels were significantly correlated with HbA_{1c} levels. The mean, standard deviation and minimum and maximum values are shown in Table 1. Tables 2 and 3 show the val-

Fig. 3. Relationship of blood sugar with serum triglyceride.

ues for blood sugar, HbA_{1c}, blood urea, serum creatinine, cholesterol, TGR, HDL, LDL, and VLDL levels measured as well as their *p* values. Figures 1 and 2 show the relationship between HbA_{1c} and serum urea and serum creatinine levels. Figure 3 shows the relationship between blood sugar and serum TGR levels. Figures 4–6 show the deviation of serum TGR, creatinine, and urea from the normal range.

Discussion/Conclusion

The current study of 100 patients (65 females, 35 males) with T2DM revealed the factors directly influencing the renal functions and lipid profiles of the pa-

Fig. 4. Deviation of serum triglyceride from the normal range.

Fig. 5. Deviation of serum creatinine from the normal range.

tients. Our results demonstrate the importance of measuring lipid profiles and conducting renal function tests in patients with T2DM. Our results revealed significant correlation between T2DM and serum cholesterol, serum TGRs, HDL, LDL, VLDL, blood urea, and serum creatinine levels. The influence of each factor on T2DM was also evaluated. Serum TGR levels were not controlled in patients with T2DM and were highly significant, as shown in Table 2 ($p < 0.05$), despite administration of drugs against hyperglycemia. Blood urea and serum creatinine levels were significantly correlated with HbA_{1c} levels (Table 3). The distribution of the 100 patients with T2DM was also determined, as shown in Figures 1–3. Figure 4 shows that serum TGR is disrupted by high blood sugar levels in T2DM, while Figures 5 and 6 show that blood urea and serum creatinine levels also deviated from the normal range along with disrupted HbA_{1c} levels in patients with T2DM.

Blood urea and serum creatinine were very significantly ($p = 0.008$ and $p = 0.017$, respectively) correlated with HbA_{1c}. Filtration of creatinine is a major function of the kidneys, and higher levels of creatinine may cause renal failure [13, 19]. Statistical analysis revealed a significant correlation of HbA_{1c} levels with serum creatinine and serum cholesterol levels ($p = 0.017$ and $p < 0.005$, respectively) and a highly significant correlation between HbA_{1c} levels and blood urea levels ($p = 0.008$). A highly significant correlation ($p = 0.035$) was also found between se-

Fig. 6. Deviation of serum urea from the normal range.

rum TGRs and blood sugar levels. Previous studies of T2DM involving renal function tests, lipid profiles, and liver function tests did not focus on serum TGR and only involved statistical analyses and p values. Moreover, previous studies investigated general conditions. Our results agree with those of Rajeswari et al. [20] and Al-Rubeaan et al. [21].

In conclusion, we observed that patients were at a high risk of T2DM when blood sugar levels were not controlled. Patients with T2DM had high serum TGR and serum creatinine levels; this was because most patients did not control their diets and some had inherited high lipidemia. High levels of serum TGR, serum cholesterol, blood urea, and serum creatinine in T2DM patients can lead to cardiovascular disorders and renal failure. It is important for patients with T2DM to undergo such tests every 3 months to avoid complications such as cardiovascular diseases and renal failure. In addition to evaluating HbA_{1c} levels, our results showed that it is important to determine serum TGR levels, as most patients in the current study presented with hypertriglyceridemia. Lowering the risk of vessel diseases by increasing alpha-lipoprotein levels and decreasing TGR and lipoprotein levels may be accomplished by maintaining blood sugar near ideal levels.

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Statement of Ethics

The study was approved by Laila Qasim Diabetic Center after obtaining approval from the manager of the center, and oral informed consent was obtained from all patients.

Disclosure Statement

The author has no conflicts of interest to declare.

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