



Original Article

Assessment of Lipid Profile among Sudanese patients with Type 2 Diabetes Mellitus

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ABSTRACT

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Background: Diabetes mellitus is a major health issue that is one of the leading causes of cardiovascular disease. Recent studies have found a link between uncontrolled diabetes and cardiovascular disease, with dyslipidaemia predicting glycated-hemoglobin (HbA1c), which could be a major contributor to type 2 diabetes complications and etiology.

Objectives: The objective of present study was estimate lipid profiles among control and uncontrolled type 2 diabetic patients.

Subjects and Methods: Analytical case control based study, One hundred twenty participate were included in study, 70 patients with DM as case group refer to Abuagala Center and difference follow up diabetic center and 50 non diabetic subjects taken as control group males and females their age between 20 to 80 years. Fasting blood glucose (FBG), blood HbA1c, and serum lipid parameters were measured by CobseC311 from Roche instrument. Data was analyzed using SPSS version 22, which expressed as (mean±SD) with p.value.

Result: Among 120 participant the levels of fasting blood glucose, blood HbA1c, and Triglyceridewere increased significantly in T2DM (161.7±72.5mg/dl), (8.88±3.9 %), (121±61.9 mg/dl) when compare with control group (91.28±13.9), (5.7±0.50), (80±11.7) with P.value (0.000), while total Cholesterol, High Density Lipoprotein, and Low Density Lipoprotein were not significant different in T2DM when compared with control group. There was weak positive correlation between HbA1c with FBG, CHOL, LDL, and HDL (r = 0.207, P =0.089, r = 0.186, P =0.124, r = 0.167, P =0.168, r = 0.308, P =0.01) respectively, while TG had weak negative correlation (r = -0.146, P =0.228).

Conclusion: The results indicated to considerable increase in the lipid profile levels in type two diabetic patients when compared with healthy controls group which may lead to increase in coronary risk factors.

Introduction

Diabetes mellitus type two is a metabolic disorder that is characterized by hyperglycemia in the context of insulin resistance and relative lack of insulin (1). The gradual increasing in diabetes mellitus prevalence worldwide and is reaching epidemic proportions. The prevalence of diabetes in adults globally is estimated to be

6.4%, affecting 285 million people in 2010 and may be expected to increase until 7.7% affecting about 439 million people in 2030. Lipid abnormalities associated with diabetes are called dyslipidemias instead of hyperlipidemias a result of the changes may be in both quantity and types of the lipoproteins. Diabetes mellitus (DM) is a one of common secondary cause of increase lipid in blood,

especially, if glycaemic control is poor, which in-turn is an important risk factor for atherosclerosis and coronary heart disease (2). The rise in diabetes prevalence worldwide can be associated with an inescapable increase in the long-term complications. Diabetes menaces to increase morbidity and mortality as a consequences of its complications which include macrovascular and microvascular (3). Diabetic dyslipidemia (DD) is one of common diabetes mellitus macrovascular complications (4). DM is considered as a major health which is one of the most important risk factors for cardiovascular disease (CVD) in both developed as well as developing countries (5). Dyslipidemias frequent more than 75% among patients with type 2 DM (T2DM) exclusively mixed dyslipidemia. Due to insulin resistance, the components of DD is characterized by quantitative and type of lipids which contributing to CVD risk (6). Lipids level in controlled diabetic patients is normal level as normal individual (Non-diabetic patients); but some studies concluded to abnormalities in lipid levels include uncontrolled diabetic patients (7). The risk factors for atherosclerosis include increase cholesterol, triglyceride and LDL, also decrease HDL which all this aspect of dyslipidemia are found in poor glycemic control in T2DM (8). As a result of increase LDL particles in parallel with increase VLDL and IDL, which that mean high apolipoprotein B levels. In other hand, the high levels of postprandial serum triglycerides are illustrated the increase probability to cardiovascular disorders. The high lipids level in blood lead to accumulated in body tissues and causes obesity and consequence of insulin resistance which term as metabolic syndrome. The obesity is the most criteria obvious in patients with T2DM, which is mean, T2DM patients had high blood glucose because insulin resistant, as result of it increase lipogenesis especially cholesterol and LDL and decrease HDL according to diabetic control status (9).

Subjects and Methods

Study population: -

The analytical case control study conducted in Abuagla center for diabetic patients, Wad Madani, Gezira state, Sudan during the period 2018 to 2021 for followup. One hundred twenty individuals were included in this study, 70 patients with T2DM as case group and 50 healthy non diabetic subjects taken as control group with their match age and sex, age ranged between 20 to 80 years.

Sample collection:

About 1.5 ml to 3 ml of venous blood was obtained as a part of the required investigation for these children. The blood samples were placed in a sterile plain tube, allowed for clotting at room temperature for 30 minutes and then centrifuged at 1500 rpm for 5 minutes. All sera were stored at -20°C pending testing. Samples were tested for CMV-specific IgM antibodies by commercially available IgM capture ELISA kits (Bioactiva, Germany). CMV negative samples were also tested for CMV-specific IgG antibodies. The manufacturer's instructions were strictly adhered to in the performance and interpretations of the tests and results.

Sample collection:

Five ml of blood were collected from each patient and healthy individual (control group) and divided as follows: Two ml of blood in EDTA tubes for HbA1c, one ml of blood was withdrawn into

fluoride tube for measuring fasting blood glucose and two ml of blood were withdrawn in heparin tube for analyzed lipid profiles. Lipid profiles, FBG and HbA1c were analyzed using Cobas C311 (Roche diagnostics, Germany) clinical chemistry analysis.

Principle of glucose estimation test:

Glucose was estimated by enzymatic reference method with hexokinase. Hexokinase catalyzes the phosphorylation of glucose to glucose-6-phosphate by Adenosine triphosphate (ATP). Glucose-6-phosphate dehydrogenase oxidizes glucose-6-phosphate in the presence of Nicotinamide Adenine Dinucleotide Phosphate to gluconate-6-phosphate.

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Principle of HbA1c test:

The blood sample is diluted and mixed with tris(hydroxyl methyl)aminomethane buffer to release hemoglobin from the erythrocytes. A fraction of the sample is conveyed into a reaction chamber where it is mixed with sodium lauryl sulfate (SLS). SLS is used to form the SLS-hemoglobin complex. The concentration of total hemoglobin is calculated by measuring SLS-hemoglobin complex with a wavelength of 525 nm. Hemoglobin A1c (HbA1c) in another fraction of the sample is first denatured by potassium ferricyanide and sucrose laurate. Denatured HbA1c was bonds with HbA1c antibody on the latex particle. Latex agglutination inhibition reaction then occurs by reacting of the agglutinator that has synthetic antigen which can bond with HbA1c antibody. The concentration of HbA1c is calculated by measuring the latex agglutination inhibition reaction with a wavelength of 625 nm. % HbA1c value is measured using a ratio of concentrations of HbA1c to total hemoglobin.

Principle of serum Cholesterol:

Cholesterol esters are cleaved by the action of cholesterol esterase to yield free cholesterol and fatty acids. Cholesterol oxidase then catalyzes the oxidation of cholesterol to cholest-4-en-3-one and hydrogen peroxide. In the presence of peroxidase, the hydrogen peroxide formed effects the oxidative coupling of phenol and 4-aminophenazone to form a red quinone-imine dye.

Principle of serum HDL Cholesterol:

Homogeneous enzymatic colorimetric assay In the presence of magnesium ions and dextran sulphate, water-soluble complexes with LDL, VLDL, and chylomicrons are formed which are resistant to Polyethylene glycol (PEG)-modified enzymes. The cholesterol concentration of HDL cholesterol is determined enzymatically by cholesterol esterase and cholesterol oxidase coupled with PEG to the amino groups.

Principle of serum LDL Cholesterol:

Homogeneous enzymatic colorimetric assay Cholesterol esters and free cholesterol in LDL are measured on the basis of a cholesterol enzymatic method using cholesterol esterase and cholesterol oxidase in the presence of surfactants which selectively

solubilize only LDL. The enzyme reactions to the lipoproteins other than LDL are inhibited by surfactants and a sugar compound.

Principle of serum Triglycerides:

Triglycerides are hydrolyzed by lipoprotein lipase (LPL) to glycerol and fatty acids. Glycerol is phosphorylated to glycerol-3-phosphate by ATP in a reaction catalyzed by glycerol kinase (GK). The oxidation of glycerol-3-phosphate is catalyzed by glycerol phosphate oxidase (GPO) to form dihydroxyacetone phosphate and hydrogen peroxide (H₂O₂). In the presence of peroxidase (POD), hydrogen peroxide affects the oxidative coupling of 4-chlorophenol and 4-aminophenazone to form a red-colored dye.

Ethical consideration

Ethical approval was obtained from health ministry Gezira State, when the ethical permission was obtained from faculty of medical laboratories sciences, university of Gezira and informed consent was collected from diabetic patients under privacy and was used only for this study.

Data Collection and Data Analysis

The data was collected by structural a questionnaire and then analyzed using statistical package for social science (SPSS) computer version (22). The blood sample is diluted and mixed with tris(hydroxyl methyl)aminomethane buffer to release hemoglobin from the erythrocytes. A fraction of the sample is conveyed into a reaction chamber where it is mixed with sodium lauryl sulfate (SLS). SLS is used to form the SLS-hemoglobin complex. The concentration of total hemoglobin is calculated by measuring SLS-hemoglobin complex with a wavelength of 525 nm. Hemoglobin A1c (HbA1c) in another fraction of the sample is first denatured by potassium ferricyanide and sucrose laurate. Denatured HbA1c bonds with HbA1c antibody on the latex particle. Latex agglutination inhibition reaction then occurs by reacting of the agglutinator that has synthetic antigen which can bond with HbA1c antibody. The concentration of HbA1c is calculated by measuring the latex agglutination inhibition reaction with a wavelength of 625 nm. % HbA1c value is measured using a ratio of concentrations of HbA1c to total hemoglobin.

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Results

A total of 120 patients with T2DM (Case; 70 - Control; 50) were included in this study. The mean ± SD of FBG in case and control was 161.7 ± 72.5 mg/dl, 91.28 ± 13.9 mg/dl, HbA1c was 8.9 ± 1.9 %, 5.8 ± 0.5 %, CHOL was 171.8 ± 37.3 mg/dl, 169.7 ± 20.8 mg/dl, Triglyceride was 121.9 ± 62.0 mg/dl, 80.2 ± 11.78 mg/dl, HDL-C was 37.9 ± 13.8 mg/dl, 40.4 ± 4.58 mg/dl, and LDL-C was 113.2 ± 34.8 mg/dl, 121.7 ± 24.6 mg/dl respectively in cases then control group, with significant differences in FBG, HbA1c and TG (P. value 0.000). The mean ± SD of FBG, HbA1c, CHOL and TG were higher in cases than controls and the mean ± SD of HDL and LDL were lower in case than controls (Table 1)

Table 1: FBG, HbA1c and Lipid Profiles in cases and controls

	Cases				
	Control	N	Mean	S. D	P.value
FBG	Case	70	161.739	72.5483	0.000
	Control	50	91.280	13.9869	
HbA1c	Case	70	8.889	1.8800	0.000
	Control	50	5.778	.5024	
CHOL	Case	70	171.771	37.2536	0.704
	Control	50	169.740	20.8393	
TG	Case	70	121.871	61.9682	0.000
	Control	50	80.160	11.7861	
HDL	Case	70	37.887	13.7605	0.155
	Control	50	40.420	4.5807	
LDL	Case	70	113.229	34.8334	0.123
	Control	50	121.660	24.6176	

FBG: Fasting Blood glucose HbA1c: Glycated hemoglobin CHOL: Total cholesterol TG: Triglycerides HDL: High density lipoprotein LDL: Low density lipoprotein

The mean value of CHOL and HDL were slightly higher and significant differences in female compared with male patients (P-value 0.013 and 0.030) respectively, while FBG, TG and LDL were slightly higher in female compared with male patients and insignificant differences with P-value (0.80, 0.091 and 0.232) as shown in Table 2.

Table 2: FBG and Lipid profile with T2DM

	Sex	N	Mean	SD	P. value
FBG	Female	4	163.488	79.9597	0.801
	Male	2	159.179	61.4185	
CHOL	Female	4	181.095	32.6615	0.013
	Male	2	157.786	39.8584	
TG	Female	4	131.429	68.7495	0.091
	Male	2	107.536	47.7598	
HDL	Female	4	40.410	16.5651	0.030
	Male	2	34.104	6.5166	
LDL	Female	4	117.548	30.6556	0.232
	Male	2	106.750	40.0154	

Among diabetic patients group hypercholesterolemia, hypertriglyceridemia and Abnormal LDL-C levels were found in 16 (23%), 14 (20%), 44 (63%) respectively on the other hand HDL-C was less than 40 mg/dl in 48 (69%) of them. (Table 3)

Table 3: Comparison of FBG and Lipid profile in cases according to normal rang.

Parameters	Normal		Abnormal	
	Number	Percent %	Number	Percent %
FBG	28	41	41	59
CHOL	54	77	16	23
TG	56	80	14	20
HDL	22	31	48	69
LDL	26	37	44	63

Patients were divided into two groups according to their glycemic index (HbA1c); the first group consisted of control patients with HbA1c values less than 7.0% and the second group consisted of uncontrolled patients with HbA1c values more than 7.0%. Uncontrolled patients had increase values of FBG, CHOL, HDL and LDL while TG was increased among controlled. The FBG of patients did not show any significant differences according to HbA1c control (p = 0.86). There was non-significant differences in CHOL (p = 0.43), while demonstrated a significant differences with TG (p = 0.006). The differences in HDL was statistically non-significant (p = 0.23). Furthermore, it was found non-significant differences in LDL (p = 0.09) (Table 4)

Table 4: FBG and Lipid profiles in diabetic patients according to glycemic control

	Control	N	Mean	SD	P. Value
FBG	Control	7	157.3	85.7	0.86
	Un-Control	62	162.2	71.7	
CHOL	Control	7	161.1	50.8	0.43
	Un-Control	63	173.0	35.8	
TG	Control	7	181.4	103.3	0.006
	Un-Control	63	115.3	52.9	
HDL	Control	7	32.0	9.5	0.23
	Un-Control	63	38.5	14.1	
LDL	Control	7	92.1	33.7	0.09
	Un-Control	63	115.6	34.4	

There was positive insignificant correlation between HbA1c with FBG, CHOL and LDL (r = 0.207, P = 0.089, r = 0.186, P = 0.124, r = 0.167, P = 0.168) respectively while HDL had positive significant correlation (r = 0.308, P = 0.01). Moreover, TG was negative insignificant correlation (r = -0.146, P = 0.228). (Table 5).

Table 5: The correlation between HbA1c with FBS and Lipid profiles

	FBG	CHOL	TG	HDL	LDL
Pearson correlation	0.207	0.168	-0.146	0.308**	0.167
Sig(2 tailed)	0.089	0.124	0.228	0.01	0.168
N	69	70	70	70	70

** Correlation is significant at the 0.01 level (2-tailed).

Discussion

Diabetes mellitus especially poor glycaemic control is a common secondary causative agent of hyperlipidaemia, which is major risk factor for atherosclerosis and lead to coronary heart disease (3). Most of previous studies associated between the importance of attaining optimal glycemic control and reducing the risk of CVD (10). One present reduction in HbA1c reduces the possibility of myocardial infarction by about 14%, risk of microvascular complications by about 37%, emphasizing to maintaining of HbA1c goals less than 7% for diabetic adults patients. Indeed, high level of blood glucose is regarded to be a promoting factor of high blood LDL and other pathology lead to atherosclerosis (11). The finding of this study is emphasizing the predictive role of lipid level for glycemic control status in DM2 patients. There was increased in FBG, HbA1c and TG levels in case group when compared with control group with highly significant differences (P .value 0.000), the mean of CHOL levels is higher in cases than controls and showed non-significant differences with P. value 0.70 despite this there was decreased in HDL and LDL levels in cases group via control group, this finding agree with study done by Artha and others in 2019 (12) and also agree with study done by Sabahelkhier, K.M and others in 2016 (13). According to the gender classification the data showed that there was no significant difference between males and females (p > 0.05) in glycemic parameters as well as lipid profile except CHOL and HDL which were increased in female than male, this study was disagree with Muhammad Adnan and others from Pakistan reported that the Gender was significantly associated with HDL Cholesterol (p-value

0.000); and triglycerides (p-value 0.001) Furthermore, a study from Italy done by Giuseppina Russo and others showed that significant decrease levels of CHOL, HDL and LDL while TG showed increase level and other study carried out in Sudan done by Amar Babikir and others showed no significant difference between males and females. Hyperlipidemia in females may be due to the effects of sex hormones on body fat distribution, which leads to differences in lipoproteins(14) except in HDL values which are significantly higher in females. In diabetic patients group about 8% of participants showed dyslipidaemia, all of them had history of diabetes mellitus and some of them were female, age above 60 year and had low physical activity. Dyslipidemia is highly prevalent among women. Women undergo a number of hormonal changes throughout their lives that have significant effects on lipoprotein metabolism(15). This study shows that the diabetic patients group had hypercholesterolemia, hypertriglyceridemia and decrease HDL levels which are major risk factors for cardiovascular diseases. Insulin impacts the liver Apo lipoprotein production which regulates the enzymatic activity of lipoprotein lipase and Cholesterol ester transport protein. Also insulin deficiency reduces the activity of hepatic lipase. These are main causes of dyslipidemia in Diabetes mellitus(16). In this study the T2D patients with an HbA1c value $\geq 7.0\%$ had significant increase in the levels of FBG, CHOL, HDL and LDL-C without significant differences (P. Value ≥ 0.05) while the level of TG had significant differences with (P. Value 0.006). Awadalla .H and others from Sudan reported there was no significant difference in TG, CHOL, LDL, and HDL between the glycemic control group and the uncontrolled group(17). Shahwan and others from United Arab Emirates reported there was significant difference in CHOL and LDL-C without significant changes in TRI and HDL-C compared with the uncontrolled group(18). Meen .J and others from India showed that HbA1c was associated with FBG, CHOL, HDL, and LDL(16). These results may be due to different in life style of population included in studies and other causes the HbA1c levels are stable over a period of time, whereas lipids levels and blood glucose levels are dynamically changing, this led to different results (19).

Conclusion

The study concluded that there was significant difference between the level FBG, HbA1c and TG in diabetic patients' group when compared with healthy individual (control group). There was no statistically significant difference between males and females diabetic patients in FBG, glycemic parameters as well as lipid profile except CHOL and HDL which were increased in female than male. Also there was significant difference between triglycerides concentration and HbA1c in diabetic patients. Dyslipidemia was found in majority of patients with Type-2 DM especially patients with poor or uncontrolled blood glucose level.

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Conflict of Interest

No conflict of interest

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