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Relationship of body mass index (BMI) to dyslipidemia in Type2 diabetes mellitus

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Abstract: T2DM is a chronic disease characterized by hyperglycemia as a result of insulin dysfunction. Both Dyslipidemia and obesity are considered cardinal features of T2DM.
Aims: To study the relationship of BMI with serum lipid profile in T2DM patients.
Methods: The study consisted of 200 T2DM patients and 200 control individuals. Phenotypic parameters included are body mass index (BMI), and fasting blood sugar (FBS) and lipid profile.
Results :The statistical analyses used to analyze the data.A significant positive correlation of serum TC, TG and LDL levels and significantly negative correlation of serum HDL levels with BMI in patients with T2DM ($p<0.001$).
Conclusion: Dyslipidemiaare associated with BMI in T2DM.
Keywords: T2DM, BMI**,** lipid profile

1. Background

Type 2 diabetes mellitus (T2DM) is multifactorial disease that wide spreading in the world. Obesity considered risk factor for many diseases such as T2DM, ischemic disease, hypertension and others. (1,2,3). The abnormal fat accumulation in the body are calculated by body mass index (BMI) (4). Dyslipidaemia is a well recognized and modifiable risk factor for cardiovascular diseases which is currently a leading cause of morbidity and mortality world-wide (5).

2: Materials and Methods

2.1. Materials

2.1.1: Individuals

The study was taken place in the biochemistry department laboratory in college of medicine / University of Kufa which contain two included two class (T2DM patients and control group). The study started from February 2016 to May 2017.

The number of study was 200 T2DM patients who have age from 45-63 year with mean 54.23 ± 8.89. the patients all patients were analysis by doctors in the AL Sader Teaching Hospital in al Najaf AL Ashraf Province.The inclusion criteria : The fasting plasma glucose ,HbA1c and OGTT.The study include 200 obese control subjects . With age ranged between 44-62 years with mean 53.79 ± 8.98.

2.1.2: Diagnosis criteria

The fasting blood glucose more than 7 mmol/l and HbA1c more than 6.5 mmol/l consider in the diagnosis of T2DM. Also measurement of lipid profile and the body mass index are considered according to WHO 2012

Table (2.1) :classification of obesity according to WHO 2012

Classification	**BMI(kg/m^2)**
Underweight	<18 .50
Normal range	18.50 - 24.99
Overweight	≥25.00
Obese	≥30.00
Obese class I	30.00 - 34.99
Obese class II	35.00 - 39.99
Obese class III	≥40.00

2.1.3:Kits

table (2.2)In this study used chemicals present in the

kits	**company**
Blood glucose kit	BIOLABO (France) CAT NO. 80009) SRM ®
HDL - C kit	BIOLABO(France) BIOLABO Kit (86516)
Total cholesterol Kit	BIOLABO(France)
Triglyceride Kit	BIOLABO(France)(80019)

2.2: Methods

2.2.1:Blood Sampling

Three milliliters of blood, was placed in plain tubes. It was left at room temperature for coagulation (10-15 minutes) . then blood was centrifuged at 2000 xgfor10-15 minutes. Sera were obtained and divided into two parts and stored at -20˚C until analysis for estimation of biochemical measurements (fasting blood sugar, lipid profile and HbA1c).

2.2.2: measurement of fasting blood glucose level

Principle

The concentration of glucose in sample related to absorption of complex (quinonium) at 500nm .these enzymatic method contain Glucose-oxidase enzyme (GOD) that oxidize glucose to gluconic acid and H2O2(6,7).blood glucose kit (BIOLABO) company.

$$\text{Glucose} + O_2 + H_2O \xrightarrow{\text{GOD}} \text{Gluconic acid} + H_2O_2$$

$$H_2O_2 + \text{Phenol} + \text{4-Amino-antipyrine} \longrightarrow \text{Quinonimin} + 4H_2O$$

2.2.3: Measurement of lipid Profile

2.2.3.1:Measurement of fasting total cholesterol (TC) concentration

The principle of measurement of TC-cholesterolis enzymatic method include the following reactions : (8,9).BIOLABO Total cholesterol Kit.

Cholesterol esterase
Cholesterol esters → cholesterol+ free fatty acids

Cholesterol oxidase
Cholesterol +O2 → 4-cholestenona +H2O2

Peroxidase
H2O2+Phenol+4-Amino-antipyrine → Quinonimin +4H2O

The T-CHconcentrationdepending on absorption of complex at 500nm.

2.2.3.2: Measurement of fasting triglycerides (TG) concentration

The enzymatic method include the following reaction: (10). BIOLABO Kitcompany.

Lipase
Triglycerides → Glycerol + free fatty acids

GK
Glycerol + ATP → Glycerol 3 phosphate +ADP

GPO
Glycerol 3 phosphate+ O_2 ⇄ Dihydroxyacetone Phosphate+ H_2O_2

POD
H_2O_2 +4-Chlorophenol+PAP → Quinoneimine (pink) + H_2O

Where.

GK = Glycerol Kinase

GPO = Glycerol 3 Phosphate oxidase

POD = Peroxidase

2.2.3.3:Measurement of high-density lipoprotein cholesterol (HDL-C) level.

Enzymatic method depending on HDLprecipitation by using of Phosphotungstic acid and MgCl2.after centrifugation ,HDL-C was collected from In the supernatant then treated as total cholesterol . (11) the procedure related manufacturer BIOLABO Kit.

2.2.3.4:Determination of VLDL-cholesterol

The VLDL-cholesterol measurement by division of TG by 5 to give mg/dl of VLDL-cholesterol (148).

2.2.3.5: Determination of LDL-cholesterol

The LDL-cholesterolis measurement by indirect method**:**(12)

LDL-cholesterol = total cholesterol – (HDL–cholesterol + VLDL–cholesterol)

2.3. Statistical analysis

The program SPSS version 20 was used to analysis the data by:Mean ± SD.,Student's t-test was used to lipid profile in the patients relative to the control group,the linear regression analysis was applied to evaluate the relationships among lipid profile and BMI of T2DM subjects.AndSignificant variation was considered when the P value was less than 0.05.

3. Results

The clinical data and biochemical parameters of 200 patients with T2DM are shown in table 3.1. The mean BMI of the participants was 32.1 ± 1.84 kg/m2. Results of the blood glucose and lipid profile such as Cholesterol (mg/dl), Triglycerides (mg/dl), VLDL (mg/dl), HDL (mg/dl) and LDL (mg/dl) are significantly different between two groups.

Table 3.1: Clinical and biochemical characteristics of study subjects

parameters	Diabetes	Nondiabetes	P value
No (M/F)	200 (105/95)	200 (115/85)	
Age	54.23 ± 8.89	53.79 ± 8.98	0.62
BMI ($kg/m^{2)}$)	32.1 ± 1.84	30.96± 2.69	< 0.0001
FBS (mg/dl)	245 ± 3.53	87.3 ± 7.59	< 0.0001
Cholesterol (mg/dl)	231.6 ± 5.67	229.08 ± 6.59	0.0001
Triglycerides (mg/dl)	250.12 ± 6.41	248.11 ± 2.82	0.0001
VLDL (mg/dl)	50.02 ± 6.41	47.82 ± 1.59	0.0001
LDL (mg/dl)	141.23 ± 7.22	180.25 ± 6.65	0.0001
HDL (mg/dl)	37.29 ± 3.48	39.58 ± 6.36	0.0001
HbA1c	8.09 ± 0.82	4.56 ± 0.49	0.0001

3.2.The correlation of Lipid profile patients with BMI in T2DM

3.2.1: A significant correlation was recorded between BMI and serumT-CH in patients with T2DM (r=0.93, p=0.000). Figure (3-1).

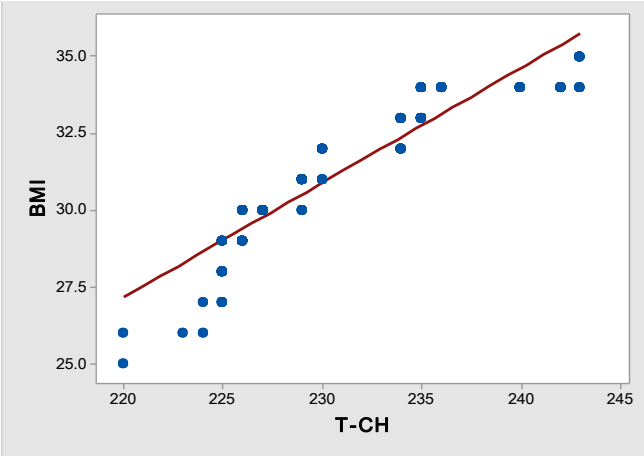

Figure (3-1): The correlation of BMI with total cholesterol concentration in T2DM.

3.2.2.There is a negative significant correlation was recorded betweenBMI and serum HDL- levels in patients with T2DM (r=-0.96, p=0.000). Figure (3-2).

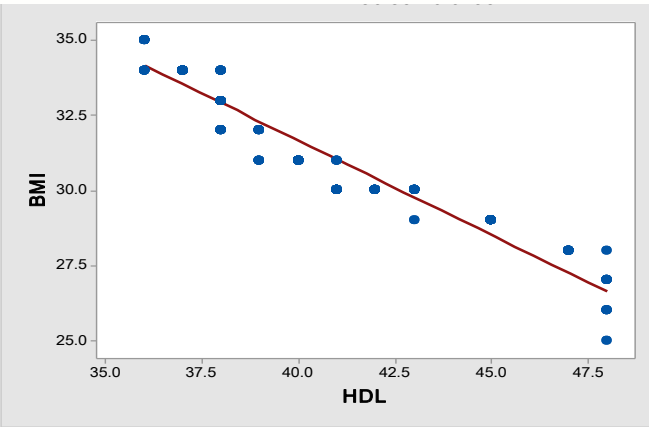

Figure (3-2): The correlation of BMI with serum HDL concentration in T2DM

3.2.3.There is a positive significant correlation was found between BMI and serum LDL levels in T2DM (r=0.93, p=0.000). Figure (3-3).

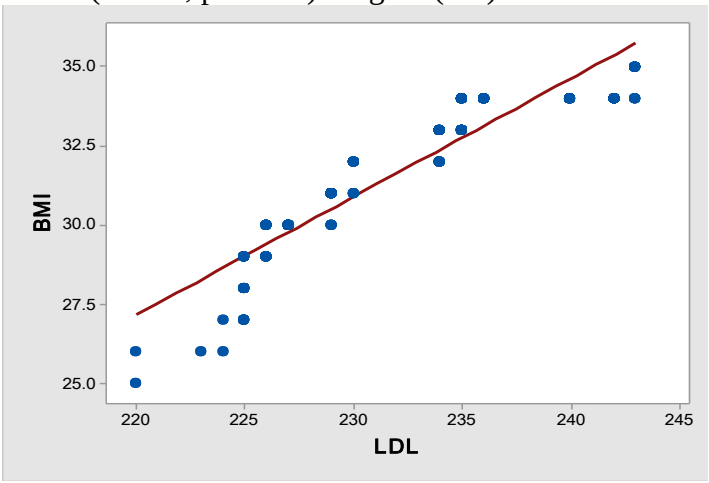

Figure (3-3): The correlation of BMI with LDL-cholesterol concentration.

3.2.4. A positive significant correlation was found between BMI and serum TG. levels with T2DM (r=0.94, p=0.000). Figure (3-4).

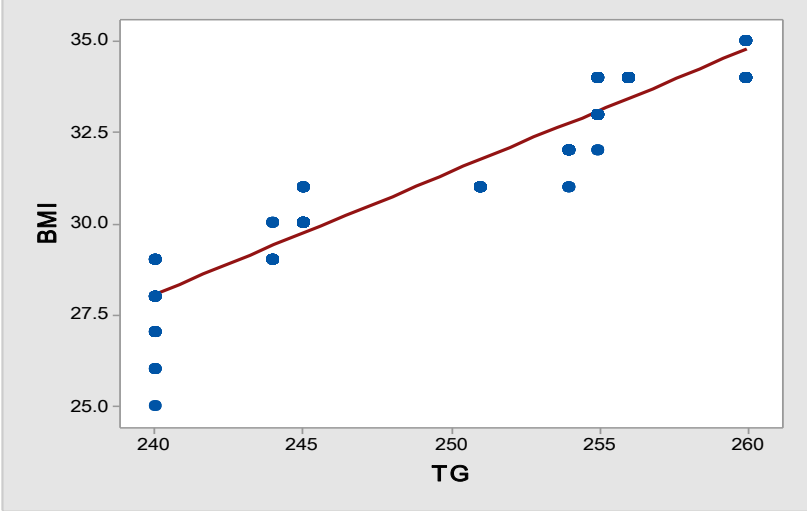

Figure (3-4): The correlation of BMI with total cholesterol concentration in T2DM

4. Discussion

Dyslipidemia is a cardinal feature in T2DM especially uncontrolled diabetes, these abnormality may aggravate the cardiovascular disease in diabetic patients , on other hand obesity is well known risk for both T2DM and dyslipidemia (13,14,15,16).

In this case control study a significant elevation of serum cholesterol ,TG,LDL and VLDL were observed in T2DM ,in contrast a significant low level of HDL were reported in T2DM. These results are agree with many of previous studies (17,18,19,20,21,22).

Obesity subjects are more prone to development of dyslipidemia (23,24).
The results of present study show a positive correlation between BMI with T-CH,TG, LDL,VLDL levels .these results are agreement with many studies (25,26).

The dyslipidemia in diabetic patients are related to increase free fatty acids reach to the liver which causes high TG,LDL,VLDL levels and low HDL .the increase production of TG from liver to the blood then activate the secretion of apo B and VLDL.the VLDL is transported the TG in exchange with HDLtransported cholesteryl ester through the action of cholesteryl ester protein . from that the results are accumulate VLDL and TG . the HDL riched with TG is hydrolysis by hepatic lipase or lipoprotein lipase leading to eliminated by renal glomeruli (27).

The another pathway for low HDL-c in diabetes includes resistance to the action of insulin to regulation of apo A-I synthesis.(28,29). In addition to that the 3rd pathway of pathogenic mechanism od dyslipidemia in diabetes is related to increase the inflammatory cytokines e.g. (TNF alpha) which increase the insulin resistance and then dysfunction of apo A-I (30).

The dyslipidemia in obesity is elevated fasting and postprandial TG, LDL and low HDL-C. The high level of TG is the major factor for lipid profile disorders (31,32).

The source of plasma free fatty acids are : lipolysis of TG- lipoproteins and lipolysis in adipose tissue. plasma FFA are elevated in obese subjects as increased fatty acid release from adipose tissue and a decrease in elimination of in plasma FFA (33–34). The increase in FFA and obesity-stimulate the inflammation which play a role in the aggravate of insulin resistance (35).

Some fatty acids are cytotoxic Saturated fatty acids (SFA)can induced inflammation by stimulate the synthesis of pro-inflammatory cytokines like IL-1, IL-6 and TNF-α, which is increase insulin resistance whereas poly unsaturated fatty acids has anti-inflammatory properties (36,37,38).

Treatment of obesity-associated dyslipidemia should be focused on lifestyle changes including weight loss, (39). Physical exercise (40,41,42) and a healthy diet (43). Lifestyle changes synergistically improve insulin resistance and dyslipidemia (44).

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