Serum Soluble Endoglin Level and Dyslipidemia Among Patients with Type2 Diabetes Mellitus.

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Received: 21.1.2025 **Accepted: 30.4.2025**

Abstract

Background: Diabetes mellitus type 2, which has recently become a global health issue, is a multi-etiological metabolic disease characterized by persistent hyperglycemia due to defects of insulin secretion and its action, associated with abnormality in carbohydrates, lipid and metabolism proteins. Dyslipidemia is a common feature of T2DM. Endoglin is a transforming Growth Factor β co-receptor, homodimer, transmembrane glycoprotein linked by disulfide bond. This study aimed to investigate the relation between sENG levels and dyslipidemia among type 2 diabetic patients, also to evaluate their relationship with diabetic complication.
Methods: Eighty-nine patients with T2DM are enrolled, with 89 apparently healthy persons with the same age and sex as controls. Sociodemographic characters and anthropometric measurements were informed for both cases and controls. Overnight fasting samples were collected for biochemical analysis (soluble ENG, FBG, HbA1c and lipid profile).
Results: The type 2 diabetic patients sENG level was significantly higher than controls. Also, increase sENG levels in diabetic patients have FBG levels more than (130 mg/dl), HbA1c greater than 7% and in diabetic complication cases was statistically significant than controls. The type2 diabetic lipid profile was higher than in control with statistically significant difference.
Conclusions: An increase of sENG level in diabetic patients and in patients with diabetic complications especially in those with more than one complication, indicate that sENG may be used in the development and prognosis of DM and resulted complications.

Keywords: Soluble endoglin, type 2 diabetes mellitus, dyslipidemia, lipid profile, diabetic complication.

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Introduction

Diabetes mellitus type 2, which has recently become a global health issue, is a multi-etiological metabolic disease characterized by persistent hyperglycemia due to defect of insulin secretion and its action, associated with abnormality in the carbohydrates, lipid and proteins metabolism, causing hyperlipidemia in addition to hyperglycemia (1). In 2019, International Diabetes Federation (IDF) was recorded 463 million diabetes mellitus cases, a number that will likely at 2045 increase to become 700 million (2). Prevented of someT2DM cases can be, by refine the major changeable risk factors include weight gain, decrease physical activity and an unhealthy nutrient, in contrary to unchangeable risk factors (race and genetic factors/ history of family) (3). Obesity has become a large health issue over the recent few decades, which is related to high risk for type2 diabetes mellitus, high blood pressure, dyslipidemia and cardiovascular diseases (4).

Diabetic dyslipidemia is a common feature of T2DM identified by high fasting triglyceride levels, decrease HDL-C concentration, and normal/elevate LDL-C concentration and small dense low-density lipoprotein cholesterol (5). The most important metabolic disturbance in this process are T2DM and IR, leading to reduce insulin effect on lipoprotein lipase enzymes leads to increase lipolysis in adipose tissue, disturbance metabolism of chylomicrons and very low-density lipoprotein cholesterol and their clearance and enhance liver and intestine overproduction of lipoproteins riches with triglyceride (TRLs) (6). In the presence of high concentration of VLDL-C, exchange of triglycerides in VLDL-C for cholesterol in HDL-C was led to increase sdLDL-C and TG-enriched HDL-C which undergo hydrolysis of its triglyceride portion and fall its concentration (7).

Endoglin is a transforming Growth Factor β co-receptor, homodimer, transmembrane glycoprotein linked by disulfide bond (8). It is composed of three domains: extracellular, transmembrane and cytoplasmic domains. It is predominantly expressed in endothelial cells, in addition to activated monocytes, macrophages, smooth muscle cells and hepatic stellate cells (9). Soluble endoglin is a result of matrix metalloproteinase proteolytic activity near the plasma membrane released nearly a whole extra cytoplasmic domain in the circulation. The MMP12 and MMP14 are the most important member of metalloproteinase family in this process (10). Soluble endoglin can be employ as an indicator and biomarker of variable diseases such as heart and blood vessels diseases and metabolic disturbances such as arterial high blood pressure, diabetes mellitus, familial hypercholesterolemia, preeclampsia and endothelial dysfunction (11, 12). The aims of this study are to comparison of type2 diabetic patients sENG levels with control and to correlates its level with lipid profile, age, fasting blood sugar and glycated hemoglobin (HbA1c). Also, to estimates the extent of diabetic dyslipidemia prevalence among T2DM patients.

Material and Methods

Study population

This was a case-control study done at Department of Biochemistry in Basrah College of Medicine; Basrah university, southern Iraq, from January 2024 to October 2024. The study included 178 participants categorized as 89 cases of T2DM patients and 89 apparently healthy persons with similar age and sex as control. All the study's populations attended the TDEMC in Thi-Qar governorate, south of Iraq, either for medical consultation or programmed examinations. T2DM was diagnosed depended on the Criteria of the ADA (13). Each participant in this study signed an informed written consent and questionnaire includes information about some socio-demographic characteristics of the study population. For each participant, the body weight, height, hip circumference (H.C) and waist circumference (WC) were recorded. Both the index of body mass (BMI) (kg/m2) (14) and the ratio of waist to hip (WHR) was calculated (15).
Samples collection

The study's populations blood samples were obtained after an overnight fasting. Five ml of blood were collected and divided into the following; two ml was dispended in an anticoagulant tube (K3EDTA) to be used in the measurement of HbA1c levels, The serum obtained from the rest of blood sample was divided into 2 parts. One part put in Eppendorf tube (EP) and stored at -20 C° for less than one month for subsequent analysis of endoglin and other part was used to estimate the fasting blood sugar (FBS), and lipid profile.

Biochemical measurements

The level of endoglin was determined by Enzyme-linked immunosorbent assay (ELISA) technique using a kit provided by Elabscience Biotechnology Co.(Lot No WX03N6T84134), HbA1c levels was measured by ion exchange high performance liquid chromatography (HPLC) using The Bio-Rad D-10TM Dual Program HbA1c Kit provided from Bio-Rad USA (Variant™ hemoglobin testing system; Bio-Rad Laboratories Inc., Hercules, CA, USA) (REF 220-0201). The level of serum glucose was determined by enzymatic method using Glucose kit (Abbott Architect C4000), supplied from Abbott GmbH & Co. KG, Germany (REF 3L82-22). The level of serum cholesterol, triglyceride, HDL-C were measured by enzymatic colorimetric method using corresponding kits supplied from Abbott GmbH & Co. KG, Germany (TC; REF 7D62-22), (TG; REF 7D74-22), (HDL-C; REF 3K33-22). Serum LDL-C and VLDL-C were calculated according to Friedewaid's equation (16).

Statistical Analysis:

Statistical Package for Social Science (SPSS) program version 28 was used to analyze the data. For continuous data, independent t-test and one–way analysis of variance (ANOVA) were used. For categorical data, Chi-square (χ^2 test) has been used. Pearson correlation was used to find out the correlation coefficient (r-value) of sENG with other biochemical parameters and other variables in the study population. P-value of less than 0.05 was considered as the lowest limit for significance.

Results

*Note: All tables mentioned in this section are provided at the end of the article

The differences between patients age, sex, diabetic family history, BMI and WHR and controls were insignificant statistically. The mean value age of the patients was (45.04±11.28) years with slight male preponderance. More than three quarter of the patients have family history of DM, and the majority of the diabetic patients were overweight (mean value of BMI was 29.176±5.473) while the mean value of WHR was 0.994 ± 0.108. The sENG levels of patients were significantly higher compared to control. Also, the differences between patients FBG, HbA1c and lipid profile and controls were significant statistically.

More than half of diabetic patients have abnormal lipid profiles concentrations except in HDL-C where 47.2% of patients have abnormal levels (table 2). The sENG levels of those patients were higher when compared to patients with normal lipid profiles, however, they were without statistical significant difference.

Table (3) showed that the majority of patients have FBG levels more than (130 mg/dl) (82%) and HbA1c greater than 7% (79.8 %). They have higher significant sENG levels as compared to patients with normal levels for both FBS and HbA1c. Most of diabetic patients have diabetic complication (77.5%) and 40.5% have more than one diabetic complications with the significant highest sENG levels among those with diabetic complications as compared to those without complications.

Table (4) showed positive correlation between sENG with FBG and HbA1c in patients with type2 diabetes mellitus, however, there was statistically insignificant correlation between sENG and the lipid profiles.

Discussion

Type 2 diabetes was onset early (younger than 45 years old) in the individual with adiposity, low-grade inflammation, lipid disturbance, smoking and inactive lifestyles (17). The mean age value in this study was (45.044±11.283) years for diabetic patients and this in consistent with the study of Abd HA et al (18). Hormonal variations, sociocultural behaviours, environmental changes and genetic differences, all factors might explain the variation in the T2DM distribution among males and females (19). In this study the number of males were higher than females, which agreed the results of Rakhis Sr SA et al study (20).

Globally changed toward sedentary lifestyles, consuming high calorie diets and urbanization increasing the prevalence of adiposity dramatically over the recent several decades (21). In this study, the majority of diabetic patients were overweight (BMI = 29.176±5.473), while the mean value of WHR were (.994 ± .108). Only 20.2% of patients were achieved good glycemic control (HbA1c<7%). The present study revealed that mean value of HbA1c% were 9.07± 2.21 and this was agreed with finding of Jasem NM et al (22).

The type 2 diabetic patients mean value of serum ENG level in this study were higher than controls with significant differences statistically. The same results were reported by Bilir B studies (23). The levels of sENG were significantly higher in patients with FBS >130 mg/dl and HbA1c levels more than 7% as compared to those patients with good glycemic control, this result was in accordance with study of Ali et al (24). A significant positive correlation as showed by Pearson correlation analysis between sENG with FBG and HbA1c. Similar results were obtained by the study conducted by Antwi-Baffour S et al (25). It has been stated that chronic hyperglycemia or glucose level variations could be an initiative of increased oxidative stress, low-grade inflammation and advanced glycation end products (AGEs), all of which may lead to activation of ECs, which lead to increase the synthesis of ENG (26).

Although the serum endoglin level was higher among those with high lipid profiles as compared to patients with normal lipid profiles, however, they have no statistical significant difference. Similar findings were obtained by Wang L et al (27) and Krauss RM et al (28). Also, the correlation between serum endoglin levels in diabetic patients and lipid profile parameters were insignificant statistically and this is in accordance with finding of Chen H et al (29). This could be explained by the fact that endoglin expression is influenced more by overall metabolic disturbance rather than solely by individual lipid profile components (30). The current study revealed that more than three quarters of patients (77.5%) had diabetic complications, most of them experiencing more than one diabetic complication. Interestingly, all the type2 diabetic patients with complications have high endoglin levels, while the highest mean level of sENG was observed in patients with more than two complications, which was significantly differ when compared to those without di complications. Similar results were also reported by several other studies (31, 32). An Y et al. has concluded elucidated that the increased endoglin levels are more likely linked to inflammation and to the oxidative stress in T2DM patients, both of which are well known mechanisms that exacerbate the development of complications" (33).

Conclusion

A higher level of sENG level was found in T2DM patients compared to control, with a significantly higher level in patients with diabetic complications and especially those with more than one complications as compared to those without complications, implying that sENG may be used in the development and prognosis of DM and resulted complications and suggest that sENG may have the potential to be used as an indicator of diabetic complications. The high prevalence of diabetic dyslipidemia in patients may be exacerbate the risk for the development of diabetic complications.

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Table (1): sociodemographic, clinical and biochemical data of study populations.

Variable		Cases (89)	Controls (89)	P-value*
Age (years)		45.044±11.283	44.640±11.269	.492
Sex	Males	46 (51.7%)	45 (50.6%)	.881#
	Females	43 (48.3%)	44 (49.4%)	
F.H. of DM		68 (76.4%)	58 (65.2%)	.099
BMI (kg/m2)		29.176±5.473	28.132± 4.088	.076
WHR		.994 ± .108	.972 ± .116	.095
Endoglin (ng/ml)		2.443 ± .587	1.782 ±.715	< .001
FBG (mg/dL)		216.651± 78.718	96.110 ± 7.861	< .001
HbA1c %		9.511 ± 2.215	5.061 ± .294	< .001
TC (mg/dL)		200.157 ±55.060	168.988 ± 34.781	< 0.001
TG (mg/dL)		159.134 ±69.582	139.337 ± 45.182	.013
HDL-C (mg/dL)		45.516 ±11.181	48.887 ± 8.646	.013
LDL-C (mg/dL)		121.089 ±52.436	92.134 ± 31.335	< 0.001
VLDL-C (mg/dL)		33.820 ± 13.854	27.887 ± 9.054	.002

The data in table (1) were presented as (number and percentage) and (Mean± SD), (*) level of significant between cases and controls, p-value < 0.05 was significant, independent student T-test, # Chi square test.

Table (2): Patients sENG levels distribution according to lipid profile.

Parameter		Pt. distribution	Endoglin(ng/ml)	P-Value*
S.TC (mg/dL)	<200	44(49.4%)	2.337±.633	.190 #
	200-239	24(27.0%)	2.605±.539	
	≥240	21(23.6%)	2.479±.512	
S.TG (mg/dL)	<150	38(42.7%)	2.334±.630	.226 #
	150-199	27(30.3%)	2.589±.530	
	≥200	24(27.0%)	2.452±.563	
S.HDL-C (mg/dL)	Normal	47(52.8%)	2.466 ±.619	.115 *
	At risk	42(47.2%)	2.422 ±.563	
S.LDL-C (mg/dL)	<100	37(41.6%)	2.355±.656	.699 #
	100-129	15(16.9%)	2.503±.569	
	130-159	20(22.5%)	2.520±.553	
	≥160	17(19.1%)	2.492±.498	
S. VLDL-C (mg/dL)	≤30	38(42.7%)	2.334±.630	.065 *
	>30	51(57.3%)	2.525±.545	

The data in table (2) were presented as (number and percentage) and (Mean± SD), (*, #) level of significant between patient's groups, p-value < 0.05 was significant, (*) independent sample student T-test, (#) one way ANOVA test.

Table (3): Patients sENG levels distribution according to FBG, HbA1c and diabetic complications

Parameter		Pt. distribution	Endoglin(ng/ml)	P-Value *
FBS (mg⁄ dL)	≤130	16 (18.0)	1.972 ± .571	< 0.001 *
	>130	73 (82.0)	2.547 ± .541	
HbA1c%	Good control <7%	18 (20.2)	2.107 ± .601	.004 #
	Fair control 7-8%	11 (12.4)	2.238 ± .626	
	Poor control >8%	60 (67.4)	2.582 ± .531	
Diabetic complication	no complication	20 (22.5)	2.133 ±.609	.030 #
	HT(Hypertension)	11 (12.4)	2.471 ± .567	
	DPN (diabetic peripheral neuropathy)	8 (9.0)	2.295 ± .498	
	DRP (diabetic retinopathy)	7 (7.9)	2.564 ±.649	
	CVD (cardiovascular diseases)	7 (7.9)	2.531 ± .502	
	have 2 complications	16 (18.0)	2.370 ± .399	
	have more than 2 complications	20 (22.5)	2.783 ± .618	

The data in table (3) were presented as (number and percentage) and (Mean± SD), (*, #) level of significant between patient's groups, p-value < 0.05 was significant, (*) independent student T-test, (#) one way ANOVA test.

Table (4): Pearson Correlation of sENG levels with the patient's biochemical data.

Variable	Soluble Endoglin	
	Correlation Coefficient	P value
fasting glucose	.223*	0.036
glycated hemoglobin	.310**	0.003
total cholesterol	0.114	0.287
Triglyceride	0.078	0.466
HDL-C	-0.088	0.410
LDL-C	0.112	0.294
VLDL-C	0.109	0.307

**. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed)