Role of Cortisol, Insulin Resistance and Body Mass Index in predicting Cardiovascular Risk in Diabetic Hypertensive Patients

Abstract:
Cortisol is an essential for maintaining blood pressure, glucose metabolism, and immune function, chronically elevated cortisol levels contribute significantly to the development of both hypertension and diabetes. The aim of this study to study the relationship between serum cortisol with body mass index, insulin résistance and lipid profile in diabetic patients with and without hypertension. In this study, ninety people were split up into three groups . there was a positive significant correlation of cortisol with BMI, WHR, FBS, HbA*1C* ,TC, TG , B. urea with T2DM Without HP, while negative significant correlation with HDL-C. A strong positive correlation of cortisol with HOMA2-IR , TC, TG and LDL-C in T2DM Without HP and a positive significant correlation of cortisol with BMI, WHR, FBS, *HbA1C,* and B. urea in T2DM Without HP, while a negative correlation of cortisol with HDL-C in T2DM Without HP.
Conclusion: A strong positive correlation of Cortisol with insulin resistance and dyslipidemia with diabetic hypertension patients may be chronically elevated cortisol levels disrupt glucose and lipid metabolism and promote vascular dysfunction, increasing the risk of cardiovascular disease. Therefore, targeting stress and regulating cortisol may contribute to the prevention and management of metabolic and cardiovascular complications
Key wards: Body Mass Index, Cortisol, hypertension, insulin résistance, lipid profile, T2DM.

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Introduction:

Hypertension and diabetes mellitus are two of the most common chronic non-communicable diseases worldwide, and their coexistence represents a major public health challenge in 2025 (1). Individuals with diabetes are significantly more likely to develop hypertension due to shared pathophysiological mechanisms such as insulin resistance, endothelial dysfunction, inflammation, and obesity(2). When present together, hypertensive diabetes markedly increases the risk of cardiovascular disease, chronic kidney disease, stroke, and premature mortality. In many groups, optimal regulation of blood pressure and glycemia is still unsatisfactory despite advancements in pharmaceutical therapy and clinical guidelines (3). In 2025, the management of hypertensive diabetes emphasizes early detection, individualized treatment targets, and the use of cardioprotective and renoprotective therapies alongside lifestyle modification. Understanding the interaction between these conditions is essential for reducing complications and improving long-term outcomes(4). Cortisol is an essential for maintaining blood pressure, glucose metabolism, and immune function, chronically elevated cortisol levels contribute significantly to the development of both hypertension and diabetes (5). Excess cortisol increases blood pressure by enhancing vascular sensitivity to catecholamines, promoting sodium and water retention, and impairing nitric oxide–mediated vasodilation. In glucose metabolism, cortisol stimulates hepatic gluconeogenesis and reduces peripheral glucose uptake, leading to insulin resistance and hyperglycemia. Persistent cortisol elevation therefore increases the risk of type 2 diabetes(6).

Insulin resistance (IR) and hypertension (high blood pressure) are closely linked, often appearing together as part of metabolic syndrome, significantly raising the risk for Type 2 diabetes, heart disease, and stroke(7). IR makes cells less responsive to insulin, causing the pancreas to overproduce it (hyperinsulinemia), which in turn promotes sodium retention, activates the nervous system, and increases inflammation, all leading to higher blood pressure and eventual diabetes(8). Insulin resistance (IR) triggers hypertension and CVD by causing the pancreas to release excess insulin , which makes kidneys retain sodium and water, raising blood pressure; impairs the blood vessels' ability to relax (vasodilation) by reducing nitric oxide, promoting inflammation, and activating the sympathetic nervous system; and disrupts(lipid metabolism), creating pro-atherogenic particles and increasing inflammation, all leading to plaque buildup (atherosclerosis) and heart damage(9,10). The aim of this study to study the relationship between serum cortisol with body mass index , insulin résistance and lipid profile in diabetic patients with and without hypertension.

Material and Methods:

In this study, ninety people were split up into three groups. thirty (G1) control , thirty (G2) type 2 Diabetic mellitus without Hypertension and compared with thirty (G3) type 2 Diabetic mellitus with Hypertension, age between (40-60) , during 2025 in the national diabetes/ MUS . All participants' demographic information was recorded, including age, height, weight to determine BMI, waist, hip to determine WHR, and blood pressure. The Cobas e411/Germany kit was used to measure serum cortisol. For the laboratory study, blood samples were tested using the Cobes c111/Germany kit for fasting serum glucose (FSG), glycated hemoglobin (HbA1c), lipid profile (Total Cholesterol, Triglyceride, High Density Lipoprotein, Low Density Lipoprotein, and Very Low Density Lipoprotein), blood urea, and s. creatinin. The ELISA kit was used to measure c-peptide. The program C-peptide level was estimated and HOMA2-IR was calculated using the HOMA2-Calculator software, which can be obtained for free at (http://www.dtu.ox.ac.uk/homacalculator/download.php).

The statistical analysis was performed using Excel. The data's means and standard deviation (SD) are stated. "P-values below 0.01 were considered very significant, and p-values below 0.05 were considered significant."

Results:

In table (1) there was a highly significant increase of FBS , B. urea and S. creatinin among study groups(control, T2DM Without HP and T2DM With HP). While a highly significant decreased of cortisol among study groups(control, T2DM Without HP and T2DM With HP). A highly significant increase of BMI, waist, WHR, HbA1C, C-peptide, cholesterol, triglyceride, HDL-C, LDL-C, and VLDL-C between (Control versus T2DM Without HP and Control versus T2DM With HP) . while, there

was a highly significant decrease of HDL-C between (Control versus T2DM Without HP and Control versus T2DM With HP).

Table (1): General demographic characteristics among study groups(control, T2DM Without HP and T2DM With HP) .

	Control Group, *G1(N=30)*		T2DM Without HP G2 *(N=30)*		T2DM With HP *G3(N=30)*		
Characteristics	Mean	SD	Mean	SD	Mean	SD	*P*-value
Male/Female	14/16		17/13		16/14		-
Age (year)	44.767	5.697	49.3	4.692	51.733	7.451	*NS*#α*
BMI (kg.m^{-2})	25.891	3.534	29.476	5.076	30.666	4.975	*<0.001*#*
Waist (cm)	88.367	8.434	103.567	10.556	105.633	9.887	*<0.001*#*
Hip (cm)	102.733	9.67	106.533	8.148	104.4	10.002	*NS*#α*
W/H-Ratio	0.862	0.056	0.972	0.052	1.014	0.056	*<0.001*#*
Cortisol (mg/ml)	100.133	6.735	56.233	10.75	34.067	7.129	*<0.001*#α*
HOMA-IR%	2.07	3.733	3.563	1.243	3.81	0.952	*<0.001*#*
FBS (mg/dl)	96.7	5.004	155.733	27.711	195.133	56.387	*<0.001*#α*
HbA1C %	4.83	0.314	8.65	1.450	8.410	1.483	*<0.001*#*
C-Peptide (ng/ml)	1.823	0.332	3.857	1.212	3.917	0.841	*<0.001*#*
Cholesterol(mg/dl)	158.967	28.876	231.8	53.924	253	41.039	*<0.001*#*
TG (mg/dl)	93	9.255	216.8	65.043	230.2	72.485	*<0.001*#*
HDL (mg/dl)	52.7	5.478	38	4.379	37.2	4.390	*<0.001*#*
LDL (mg/dl)	82.533	30.425	154.133	52.803	150.333	46.536	*<0.001*#*
VLDL (mg/dl)	18.6	1.812	44.6	16.315	45.2	14.840	*<0.001*#*
Urea (mg/dl)	30.167	9.289	39.9	9.378	49.933	7.909	*<0.05#α*
Creatinine (mg/dl)	0.737	0.225	0.79	0.197	1.273	0.416	*<0.05#α*

All values are Mean ± SD
* p-value for Control versus T2DM Without HP .
# p-value Control versus T2DM With HP .
α p-value for T2DM Without HP versus T2DM With HP.
NS; No significant.
HP; Hypertensive Patients.
T2DM; Type 2 Diabetes Mellitus.

As shown in table (3) there was a positive significant correlation of cortisol with BMI, WHR, FBS, *HbA1C* ,TC, TG , B. urea with T2DM Without HP, while negative significant correlation with HDL-C. A strong positive correlation of cortisol with HOMA2-IR , TC, TG and LDL-C in T2DM Without HP and a positive significant correlation of cortisol with BMI, WHR, FBS, *HbA1C,* and B. urea in T2DM Without HP, while a negative correlation of cortisol with HDL-C in T2DM Without HP

Table 2: Correlation coefficient of *Cortisol* level with clinical variables among study groups.

Variables	T2DM Without HP	T2DM Without HP
	Correlation coefficient (r)	Correlation coefficient(r)
Cortisol vs *BMI*	0.363*	0.221*
Cortisol vs *WHR*	0.272*	0.211*
Cortisol vs FBG(mg/dl)	0.260*	0.316*
Cortisol vs *HbA1C %*	0.251*	0.226*
Cortisol vs c-peptide (ng/dl)	-0.116	0.139
Cortisol vs HOMA2-IR%	0.205	0.522**
Cortisol vs TC (mg/dl)	0.316*	0.568**

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Cortisol vs TG (mg/dl)	0.353*	0.891**
Cortisol vs HDL-C (mg/dl)	-0.253*	-0.391
Cortisol vs LDL-C (mg/dl)	0.397*	0.725**
Cortisol vs B.urea (mg/dl)	0.347*	0.467*
Cortisol vs S.creatinin (mg/dl)	0.115	0.105

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

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

Discussion:

Cortisol plays a significant role in the development and progression of diabetes mellitus with coexisting hypertension, often referred to as *hypertensive diabetes*. Its effects are mediated through metabolic, vascular, and hormonal mechanisms(11).

Cortisol promotes adipogenesis, particularly in visceral (central) fat depots, leading to increased BMI and waist circumference. In diabetes mellitus with hypertension, elevated cortisol contributes to increased BMI through preferential visceral fat accumulation, while higher BMI further amplifies cortisol activity. This vicious cycle worsens insulin resistance, glycemic control, and blood pressure, significantly increasing cardiometabolic risk(12).

Cortisol stimulates the liver to produce and release stored glucose into the bloodstream (gluconeogenesis and glycogenolysis). High cortisol levels can impair the ability of pancreatic beta-cells to secrete enough insulin to compensate for insulin resistance(13). In patients with type 2 diabetes, elevated cortisol secretion is associated with the presence and severity of diabetes complications, including retinopathy (eye disease), nephropathy (kidney disease), and neuropathy (nerve damage)(14).

In diabetic patients with and without hypertension , higher cortisol levels are associated with increased , FBS, and HbA1c levels. Cortisol contributes to poor glycemic control by promoting insulin resistance and beta-cell dysfunction, forming a potential feedback loop that worsens the condition this is agreement with (15,16). Also positive correlation of Cortisol with fasting blood sugar and HbA1c through well-established metabolic mechanisms, especially in people with diabetes mellitus and conditions associated with stress or hypertension. Cortisol increases blood sugar and HbA1c by stimulating hepatic glucose production, inducing insulin resistance, and sustaining chronic hyperglycemia, particularly in patients with diabetes mellitus (17).

In this study increased The association between cortisol and insulin resistance in patients with diabetes mellitus (DM) and hypertension is central to the pathophysiology of this combined metabolic–cardiovascular disorder(18). A strong positive correlation cortisol plays a pivotal role in promoting insulin resistance in diabetes mellitus with hypertension by impairing insulin signaling, increasing gluconeogenesis, and enhancing lipotoxicity, thereby worsening metabolic control and increasing cardiovascular risk this is agreement with (19).

The partnership between cortisol and lipid profile in patients with diabetes mellitus (DM) and hypertension is multifactorial and plays a key role in increasing cardiovascular risk. Elevated cortisol adversely alters the lipid profile in diabetes mellitus with hypertension by promoting insulin resistance, increasing atherogenic lipoproteins, and reducing protective HDL, thereby significantly increasing cardiovascular risk(20).

Elevated cortisol in diabetes mellitus with hypertension is strongly associated with increased total cholesterol, elevated LDL, reduced HDL, and accelerated cardiovascular disease this is agreement with (21,22). Cortisol acts as a central mediator linking stress, insulin resistance, dyslipidemia, and hypertension. The relationship between cortisol and cholesterol in patients with diabetes mellitus (DM) and hypertension is pathophysiologically interconnected and clinically important. It involves metabolic, endocrine, and cardiovascular mechanisms(23).

The partnership between cortisol and triglycerides in patients with diabetes mellitus (DM) and hypertension is strong and clinically significant, mainly mediated through insulin resistance, altered lipid metabolism, and vascular dysfunction this is agreement with(24) .

Elevated cortisol promotes hypertriglyceridemia in diabetes mellitus with hypertension by increasing lipolysis, hepatic triglyceride synthesis, and VLDL production while impairing triglyceride clearance, thereby significantly increasing cardiovascular risk(25).

The relationship between cortisol and high-density lipoprotein (HDL) in patients with diabetes mellitus (DM) and hypertension is predominantly inverse and contributes significantly to increased cardiovascular risk this is agreement with (26). Elevated cortisol is inversely associated with HDL cholesterol in diabetes mellitus with hypertension, leading to reduced HDL levels and impaired cardioprotective function, thereby increasing the risk of atherosclerosis and cardiovascular disease(27).

In this study a positive correlation between cortisol and blood urea because cortisol, as a catabolic stress hormone, increases protein breakdown, which directly leads to higher urea production. Additionally, chronic elevation of cortisol can impair renal function, hindering the excretion of urea this is agreement with (28).

Conclusion

A strong positive correlation of Cortisol with insulin resistance and dyslipidemia with diabetic hypertension patients may be chronically elevated cortisol levels disrupt glucose and lipid metabolism and promote vascular dysfunction, increasing the risk of cardiovascular disease. Therefore, targeting stress and regulating cortisol may contribute to the prevention and management of metabolic and cardiovascular complications.

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