Biochemical comparison between DMII Iraqi patients with hypertension, who take hypertensive drugs and others not take a drug

Karar Kazem Mohammed[1*]; Ahmed Gh. Sabbar[2]; Haider H. Hmeash[3]
[1, 2, 3] College of Health and Medical Technologies, Middle Technical University- Baghdad, Iraq
Corresponding author* E-mail: kararkazemmohammed@gmail.com
Kararalabode55@gmail.com

Abstract

To measure the levels of some biochemical parameters between diabetes mellitus type 2 hypertensive patients under hypertensive treatment and non-take hypertensive treatment and compare it with healthy controls. Methods: This cross-sectional study was conducted in the Al-Zahra Teaching Hospital in the city of AL-Kut, Iraq, from November 2021 to March 2022. A total of 106 patients, 46 type II DM with hypertension individuals as cases divided into two groups (23 DM cases under antihypertensive treatment and 23 cases have no treatment) and 60 healthy individuals. In both, groups, biochemical measurement of Serum electrolytes (Na+, K+, Cl, Ca, Mg, and phosphate), HbA1c was studied, and the results were compared. Results: Diabetes mellitus Individuals under antihypertensive treatment sodium and phosphate showed a significant decrease (p-value less or equal to 0.01) and increase in potassium levels (p-value less than or equal to 0.05). While diabetes mellitus no antihypertensive treatment There was a significant increase in serum sodium levels which was found to be statistically highly significant (p-value less than or equal to 0.01). Conclusion: This study concludes that there is a significant association between sodium with antihypertensive treatment in patients with type 2 diabetes mellitus. Thus, serum electrolytes have to be routinely monitored in diabetic individuals since electrolyte derangements are markedly found in diabetes hypertension patients.

Keywords: DM II, Hypertension, electrolytes, HbA1c

1. Introduction

Diabetes is currently the world's largest epidemic and a serious concern due to its rising prevalence rate. Diabetes is a global health condition that affects 425 million people and is estimated to reach 629 million by 2045, according to the International Diabetes Federation [1]. Diabetes mellitus (DM) is a complex illness characterized by a variety of metabolic abnormalities and complications. This is characterized by hyperglycemia caused by either an absolute or relative insulin insufficiency [2]. Insulin deficiency, whether absolute or relative, affects the metabolism of carbohydrates, protein, fat, water, and electrolyte[3]. Diabetes is linked to several micro and macrovascular diseases, and if not controlled properly, it can lead to frequent hospitalization and increased mortality [4]. Diabetes mellitus is characterized by insulin resistance and impaired insulin secretion, Chronic hyperglycemia damages blood vessels and nerve cells throughout the body, resulting in microvascular problems such as retinopathy, neuropathy, and nephropath. Diabetes mellitus patients are at a greater risk of cardiovascular events, and the risk of vascular events is further heightened by coexistent hypertension [6]. Hypertension is about twice as prevalent in patients with diabetes as in those without the disease. Elevated blood pressure is often associated with obesity and insulin resistance in people with type II diabetes. Even though hyperinsulinemia may directly contribute to higher arterial pressures due to endothelial dysfunction and pressure effects, hypertension is commonly regarded as a renal condition. In contrast to type 1 diabetes, hypertension occurs even in the absence of renal dysfunction in type 2 diabetes mellitus [7].

Electrolytes are essential in numerous bodily activities, including fluid regulation, acid-base balance (pH), nerve transmission, blood clotting, and muscular contraction [8]. Electrolyte imbalance is frequent in diabetic patients, which may be caused by an altered electrolyte distribution and is connected to hyperglycemia-induced osmotic fluid shifts or total-body deficits caused by osmotic diuresis [9]. Potassium, magnesium, phosphate, and sulfate are the major electrolytes found in intracellular fluid, whereas sodium, chloride, and bicarbonate are found in extracellular fluid. Changes in electrolyte balance may result in a physiologic. Serum electrolytes are essential in intermediate metabolism and cellular function, including enzyme activity and the maintenance of electrical gradients [11]. The levels and concentrations of serum electrolytes are related to the levels of plasma glucose. Disturbance in the levels of different electrolytes is correlated to diabetes mellitus (DM) and can be life-threatening [12]. As a result, the study was conducted to compare the levels of serum electrolytes in type II diabetic persons with hypertension to healthy individuals as controls.

2. Materials and Methods

This cross-sectional study was conducted in the Al-

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Zahra Teaching Hospital in the city of AL-Kut, Iraq. This study includes 106 divided into 46 type II DM with hypertension individuals cases divided into two groups (23 DM cases under antihypertensive treatment and 23 cases have no treatment) and 60 healthy individuals.

3. Methodology

- **Study design**: Case-control study.
- **Study duration**: November 2021 –March 2022.
- **Study population:** Patients aged between 20-70 of both sexes were included in the study, and the following examinations were performed on them HbA1c, serum sodium, potassium, chloride, calcium, magnesium, and phosphate
- **Sample type:** 5 ml of vein blood (serum / whole blood).
- **Inclusion criteria:** Individuals with Type 2 Diabetes mellitus with hypertension.
- **Exclusion criteria:** Individuals with Type 1 DM, pregnancy, thyroid dysfunction, Diabetics with heart disease, and metabolic syndrome.
- **Study instruments:** HbA1C was measured by a Cobas c111 fully automated analyzer, while serum electrolyte was measured by an Abbott ARCHITECT c4000, which is a fully automated analyzer.
- **Data collection:** All information about each individual in the patients and healthy control group including the period of diabetes, age, other diseases he suffers from, and medical history was taken from each patient with a predesigned questionnaire case sheet.
- **Data analysis:** The data was analyzed by SPSS software.

4. Results

A total of 106 subjects were included in the present study, of whom 46 had DM with hypertensive divided into two groups (group 1 =23 under antihypertension treatment and group 2=23 have no treatment) and 60 healthy as control. The results in the table (1) showed a significant increase (P ≤0.01) in the concentrations of HbA1C, Also, there was a significant decrease (P ≤0.01) in the concentration of serum sodium, chloride, calcium, and phosphate, the results of the study showed a significant decrease (P≤0.05) in the concentrations of serum potassium and magnesium in DM group 1 in comparison with the control group respectively. (Table-1)

(Table-1): Comparison of serum electrolyte in diabetes type 2 under antihypertension treatment (group1) and healthy as a control group.

Parameters	DM and hypertensive – treat N=23 group 1			Normal N=60			P-value¥
	Mean	±	SD	Mean	±	SD	
HbA1C	7.77	±	1.18	4.43	±	0.30	0.001**
Na	135.1	±	1.55	139.9	±	1.89	0.001**
K	4.04	±	0.33	4.20	±	0.26	0.047*
Cl	102.17	±	2.35	103.85	±	1.90	0.004**
Ca	8.50	±	0.46	9.17	±	0.26	0.001**
Mg	1.61	±	0.07	1.79	±	0.10	0.014*
phosphate	3.33	±	0.38	3.75	±	0.27	0.001**

The results in a table (2) showed a significant increase (P ≤0.01) in the concentrations of HbA1c and serum sodium, also a significant decrease (P ≤0.01) in the serum level of potassium, chloride, phosphate, and a significant decrease (P ≤0.05) in the level of serum magnesium in DM group2 in comparison with the control group. (Table-2).

(Table-2): Comparison of serum Electrolyte in diabetes type 2 have no antihypertension treatment (group 2) and healthy as a control group.

Parameters	Hypertensive-not treat N=23 group 2			Normal N=60			P-value¥
	Mean	±	SD	Mean	±	SD	
HbA1C	7.93	±	1.10	4.43	±	0.30	0.001**
Na	145.2	±	3.94	139.9	±	1.89	0.001**
K	3.79	±	0.31	4.20	±	0.26	0.001**
Cl	101.91	±	2.50	103.85	±	1.90	0.002**
Ca	8.43	±	0.35	9.17	±	0.26	0.001**
Mg	1.62	±	0.07	1.79	±	0.10	0.015*
phosphate	3.52	±	0.24	3.75	±	0.27	0.001**

The results in a Table (3) in group 1 the results showed a significant decrease (135.1±1.55, P ≤0.01) in the concentration of serum sodium compared with group 2 significant increase (145.2±3.94, P ≤ 0.01) in the concentration of serum sodium, and a significant increase (4.04±0.33, P ≤0.01) in the concentration of serum potassium in group 1 compared with group 2 decrease (3.79±0.31, P ≤0.01) in the concentration of serum potassium. While no statistically significant in the concentration of HbA1c, chloride, calcium, magnesium, and phosphate between both groups 1, and 2. (Table, 3).

(Table, 3): Comparison of serum electrolytes in diabetes type 2 under antihypertension treatment (group 1) and diabetes type 2 with no antihypertension treatment (group 2).

Parameters	hypertensive – treat N=23 group 1			Hypertensive-no treat N=23 group 2			P-value¥
	Mean	±	SD	Mean	±	SD	
HbA1C	7.77	±	1.18	7.93	±	1.10	0.645
Na	135.1	±	1.55	145.2	±	3.94	0.001**
K	4.04	±	0.33	3.79	±	0.31	0.010**
Cl	102.17	±	2.35	101.91	±	2.50	0.717
Ca	8.50	±	0.46	8.43	±	0.35	0.528
Mg	1.61	±	0.07	1.62	±	0.07	0.308
phosphate	3.33	±	0.38	3.52	±	0.24	0.056

5. Discussion

Diabetes type 2 is an endocrine condition characterized by hyperglycemia, which occurs due to insulin resistance, and/or inadequate insulin secretion, or both [13]. Diabetes mellitus is usually associated with hypertension, which is defined by abnormalities in sodium metabolism at all physiologic levels, including whole-body, renal, and cellular [14]. The relationship of diabetes mellitus with electrolytes has been reported by many authors, Among these electrolytes sodium, potassium, chloride, calcium,

magnesium, and phosphate are of particular interest [15]. The primary cause of electrolyte imbalance in diabetes is hyperglycemia, which occurs when the body works to rid itself of excess blood glucose by increasing urine output. Increased urination causes water and electrolyte loss, which alters the body's electrolyte balance [16].

The present study in group 1 showed a significant reduction (P ≤0.01) in serum sodium (135.1±1.55), chloride (102.17±2.35), calcium (8.50±0.46), phosphate (3.33±0.38), magnesium (1.61± 0.07, P ≤0.05), and potassium (4.04±0.33, P ≤0.05) levels with increasing HbA1c as compared with the control group. Similar to our finding, another study also found low sodium and chloride levels in diabetes mellitus patients with taking anti-hypertension [17, 18]. Other studies conducted show low serum sodium, magnesium, phosphate, calcium, and little reduction in potassium as a result of the use of antihypertension [19-23], and this is also compatible with the study of Syed Muhammad Shahid found a decrease in serum sodium, magnesium, and calcium, increase in serum. While another study does not agree with our study, it includes a high level of potassium due to the type of treatment used to lower blood pressure [25]. Another study disagreed with ours and showed no effect on the electrolyte level in the blood, and this difference is due to the type of treatment used as antihypertensive is doxazosin [26]. In our study low serum, magnesium and some other electrolytes due to Osmotic diuresis accompanied by inappropriate magnesium were the prominent underlying mechanism of hypomagnesemia in these diabetic patients. Moreover, low serum Mg2+ levels can secondarily induce hypocalcemia, and hypophosphatemia, potentially causing further derangements in neuromuscular and cardiovascular physiology. Hypomagnesemia has been implicated in various long-term complications of DM, such as hypertension [27].

Our studies results showed in group 2 a significant increase (P ≤0.01) in the concentrations of HbA1c (7.93±1.10) and serum sodium (145.2±3.94), also a significant decrease (P ≤0.01) in the serum level of potassium (3.79±0.31), chloride (101.91±2.50), phosphate (3.52±0.24), calcium (8.43±0.35) and a significant decrease (P ≤0.05) in the level of serum magnesium (1.62±0.07) in diabetes mellitus have no antihypertensive treatment (group 2) in comparison with the control group. This is consistent with another study that showed an increase in the level of sodium after following up on diabetic patients who suffer from high blood pressure, An increase in the level of serum sodium was found, and a decrease in serum chloride, potassium, and magnesium [28-30]. In another study, compatible with our studies, it was observed that the serum sodium level was elevated in a patient suffering from type 2 diabetes with hypertension. While another study disagrees with our study, where the sodium level is lower compared to the control group, and imbalance in other serum electrolytes the reason for this is that the patients in this study suffer from high blood pressure and nephropathy, the reason is that the patients suffer from an advanced stage that has reached the level of renal impairment, which led to a change in the glomerular filtration rate and impairment in the function of the kidney, which in turn contributes to the electrolyte imbalance [33]. Another study disagrees with our study, no statistically significant differences were observed between diabetic patients with hypertension, and the reason is due to the adoption of a different diet in terms of taking salts with food [34]. In the present study, the causes of hypertensive in diabetic patients may be sodium retention because of insulin resistance, and the rise in plasma insulin levels may elevate blood pressure levels by a variety of mechanisms, including increased sympathetic activity and sodium retention [35]. This association could be explained based on three different pathophysiological mechanisms: Abnormal electrolyte transport across the membrane, a defect that alters the sodium-potassium exchange, sodium-calcium exchange, increasing the concentration of intracellular calcium ions that heightens vessels wall tension and smooth muscle contraction. Increased sympathetic nervous system activity. The altered cellular concentration induces water logging in the peripheral arteriolar wall. These mechanisms increased peripheral resistance and arterial pressure [36]. The current study found statistically significant differences when comparing group 1 and group 2 in the level of sodium and potassium in the blood, in-group 1 a significant decrease in the level of serum sodium and an increase in serum potassium level as a result of using antihypertensive therapy. Like potassium-sparing diuretics, they stimulate the body to get rid of fluid and sodium, Without causing a loss of potassium, a vital nutrient [37]. Unlike Group 2 significantly increased serum sodium this is due to more common patients with Diabetes Mellitus having hypertension may be as a result of insulin resistance (hyperinsulinemia), Insulin may have a role in the pathophysiology of hypertension in type 2 diabetes mellitus. The insulin was crucial in identifying insulin's glucose-independent effects on tubular salt reabsorption, It is theorized that insulin and glucose act together to induce tubular sodium reabsorption, potentially via ENaC (epithelial sodium channel) or SGLT2 (sodium/glucose cotransporter 2) [38]. The natriuretic impact of hyperglycemia is counterbalanced by the action of insulin based on the expression pattern of insulin resistance, it is not surprising to find that insulin increases the sodium reabsorptive activity of major renal sodium transporter proteins in nearly every cell type that reabsorbs sodium, from the proximal tubule throughout the collecting duct [39, 40].

6. Conclusion

In conclusion, the results reported here suggest that abnormal serum electrolytes induced by diabetes are implicated in the complications of Diabetes mellitus most commonly in the pathogenesis of hypertension. Electrolyte abnormalities are more common in patients with diabetes mellitus. Serum sodium is affected and reduced by antihypertensive treatment in diabetic hypertension patients.

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