The effect of BMI and glycemic control on S. potassium and S. calcium Disturbances among Diabetic Patients in Salah Al-Deen General Hospital

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Abstract

Background: Diabetes is endemic in Iraq with changeable prevalence in the last three decades and the sedentary lifestyle and westernization of dietary habits are also potentiating mortality and disability adjusted life years of diabetes mellitus in Iraq. The electrolyte disturbances among Iraqi Type 2 DM patients were frequent and correlated with poor glycemic control and abnormal lipid profile. Type 2 DM as a rule coincides with different parts of metabolic disorder, for example, high body mass index (BMI). High BMI is an indicator of a beginning of Type 2 DM in elderly age adult's 65–96 years. This study aims at evaluation of the effect of body mass index (BMI) on serum electrolyte disturbances in diabetic patients.

Patients and Methods: This study is a descriptive case control study conducted in Consultancy Clinics of Salah Al-Deen General hospital in Tikrit city through the period from 1st October 2017 to end of 2018. A convenient sample of 100 diabetic patients was compared with 100 healthy controls. The researcher measured the body weight for both groups using Seca scale instrument; the Body Mass Index was calculated for each subject. A sample of 5 ml of venous blood was collected by non-tourniquet method from diabetics and controls, and then 1 ml of blood was taken for EDTA tube for HbA1c. Four ml of blood was centrifuged for 10 minutes to take 1 ml of serum from the sample and taken to incubator for 20 minutes after adding some reagents to serum and reading results by spectrophotometer.

Results: Mean BMI of diabetic patients was 28.1±4.4 Kg/m2. Mean HbA1c level was significantly higher among diabetic patients (8.1±1.7) than the controls (4.4±0.5). Studying the serum electrolytes of diabetic patients showed that Mean serum potassium of diabetic patients was 3.9±0.5 mmol/L; 17% of patients had low serum potassium level. Mean serum calcium of diabetic patients was 9.1±0.6 mg/dl; 78% of them had low serum calcium level.

Conclusions: Concerning the result of this study, the following conclusions are obtained: hypocalcaemia is a frequent clinical issue of type 2 DM patients. Serum calcium of type 2 DM patients is more likely to be inversely related with body mass index of the patients. No significant differences were observed between diabetic patients and healthy controls regarding serum potassium level.

Key words: S. potassium, S. Calcium, DM, BMI

Introduction

Diabetes mellitus is a chronic illness that either happens when there is insufficient insulin or if the body can't use the insulin effectively. The global prevalence of diabetes was expected to be 8.3% in 2013 and expected to increase to 10.1% by 2035 among those aged 20-70 years[1].

Type-2 diabetes mellitus (DM) is a disorder presenting as hyperglycemia and abnormal metabolism, as a result of deficient insulin which may be associated with insulin resistance[2].

Derangement and imbalances of water and electrolytes are often the main presentation of many metabolic diseases in emergency departments of hospitals with different etiologies that need urgent medical intervention to prevent morbidity and mortality sequel [3]. The most common public associated disease correlated with electrolyte disturbances is diabetes mellitus, especially when uncontrolled, failure of multi-drugs, and complicated with ketoacidosis and kidney diseases [3]

Among type I diabetic patients, low or absence of insulin is regarded as an interesting facilitator of potassium withdrawal from cells [4]. Escape of potassium from intracellular to extracellular fields leads to high plasma tonicity and hyperkalemia [5]. Movement of water to extracellular fields caused by osmolarity changes is the main cause of potassium movement from cells toward extracellular field and is attributed to intracellular dehydration [6]. For that, treating hyperkalemia patients with dextrose in water alone and not accompanied by insulin administration is dangerous as the insulin endogenous secretion might be low or absent and lead to high plasma tonicity [7].

Hyperkalemia was confirmed among many patients with diabetic ketoacidosis, despite the fact that potassium level is lowered. This condition is caused by the extravagance of potassium, which arises from the extended transfer of sodium into the distal nephron in combination with the enhanced mineralocorticoid activity [8,9]. Hyperkalemia is caused by redistribution of potassium, which is a consequence of hypertonic and insulin deficiency rather than by metabolic acidosis. Potassium shifts caused by metabolic acidosis are more pronounced in hyperchloremic, non-anionic acidosis than in acidosis, which is available in diabetic ketoacidosis [10]. Anion gap= Na-(Cl+HCO3) Normal value=6-12meq/L, increase in DKA, lactic acidosis, ethinyl glycol poisoning, uremia and aspirin poisoning, while it decreases in hypoalbuminemia, plasma cell dyscrasia and bromide intoxication, and normal values occur in diarrhea, recovery from DKA, renal tubular acidosis and as a normal variant[10].

The hypocalcemia is frequently reported for cases of renal complications of diabetes like nephrotic disorder, as this disorder developed condition of high urine loss of 25-hydroxyvitamin D3 in addition to carrier proteins. Changes in parathyroid hormone levels detected in diabetic patients also have a significant role in lowering serum calcium levels [11]. Low magnesium levels among diabetes mellitus patients played a role in decreasing serum calcium level by impairment release of parathyroid hormones and lowering skeletal resistance to these hormones which in turn lower the serum calcium level [12]. Essential hyperparathyroidism is thought to be considered in patients with diabetes who have hypercalcemia, since in such people essential hyperparathyroidism happens at a rate that is a few times as high as that in the normal population. Hypercalcemia additionally occurs in patients with volume exhaustion, which leads to the expanded reabsorption of renal calcium [11,12].

The Iraqi population has faced in the last 3 decades an increased prevalence of DM, changed dietary habits, sedentary lifestyle as well as potentiating mortality and disability adjusted life years of diabetes mellitus in Iraq [13]. Usually the Iraqi DM patients were poorly controlled and presented in emergency units as poor glycemic control and abnormal lipid profile of patients, the figure with increased burden on Iraqi health services [14]. The interaction of low levels of some minerals with abnormal glucose metabolization in humans was not studied sufficiently especially in Iraq and did not differentiate between insulin-resistance associations and type 2 diabetes with macrominerals which provide the reasons for conducting the current study. This study aims at evaluation of the effect of body mass index (BMI) on serum electrolyte disturbances in diabetic patients.

Patients and Methods

This study is a descriptive case control study conducted in Consultancy Clinics of Salah Al-Deen General hospital in Tikrit city from 1st Oct. 2017 – end of April, 2018. A convenient sample of 100 type 2 DM patients and 100 healthy controls were randomly selected. The data collection was carried out through direct interview by a questionnaire sheet. The patients were assessed by full history and clinical examination, confirmation of diagnosis, DM history, and duration. The results of each patient were taken in the same day and recorded in the questionnaire. The calcium kit used was Bio Lab kits, while Spectrum kits were used for potassium (France). Normal limits of investigations; Serum potassium (3.5-5 mmol/L), Serum calcium (8.7-10.3 mg/dl)[15]. Ethical approval was obtained from Salah Al-Deen General Hospital Directorate. A written oral informed consent was taken from the patients and controls.

The body weight and height of the patients and controls were measured by researcher using Seca scale instrument; then body mass index was calculated by the researcher according to equation: BMI=weight/(height in meters) [16]. A sample of 5 ml of venous blood was collected by non-tourniquet method from diabetics and controls, and then 1 ml of blood was taken for EDTA tube for HbA1c. Four mls of blood was centrifuged for 10 minutes to take 1 ml of serum from the sample and taken to incubator for 20 minutes after adding some reagents to serum and

reading results by spectrophotometer. BMI according to Asian population; (17.5-23 is normal, 23-28 is overweight, >28 is obese) [17].

Results

Mean HbA1c level of diabetic patients was 8.15±1.7 %. There was a highly significant difference in HbA1c level between diabetic patients and healthy controls ($p<0.001$); mean HbA1c level was significantly higher among diabetic patients (8.1±1.7) than the controls (4.4±0.5). All these findings are shown in Figure 1.

No significant differences were observed between diabetic patients and healthy controls regarding the body mass index, the mean BMI was (28.1±4.4) among diabetic patients, versus (28±4.3) among healthy persons, as shown in Table 1.

No significant differences were observed between diabetic patients and healthy controls regarding serum potassium level ($p=0.5$). A highly significant association was observed between low serum calcium level and diabetic patients ($p<0.001$). All these findings are shown in Table 2.

Moreover, there was no significant correlation between serum potassium level of diabetic patients and each of patients' age, gender, BMI, HbA1c level, DM duration, smoking, HT history, anti-hypertensive drugs, anti-diabetic drugs, family history of DM and regular checking of RBS. All these findings are shown in Table 4. Furthermore, no significant correlation was observed between low serum calcium level of diabetic patients and each of patients' age, gender, HbA1c level, DM duration, smoking, HT history, anti-hypertensive drugs, anti-diabetic drugs, family history of DM and regular checking of RBS. A significant negative correlation was observed between serum calcium level of diabetic patients and BMI ($p=0.02$, $r=0.22$). All these findings were shown in Table 3.

Figure 1: Distribution of HbA1c mean according to diabetics and controls.

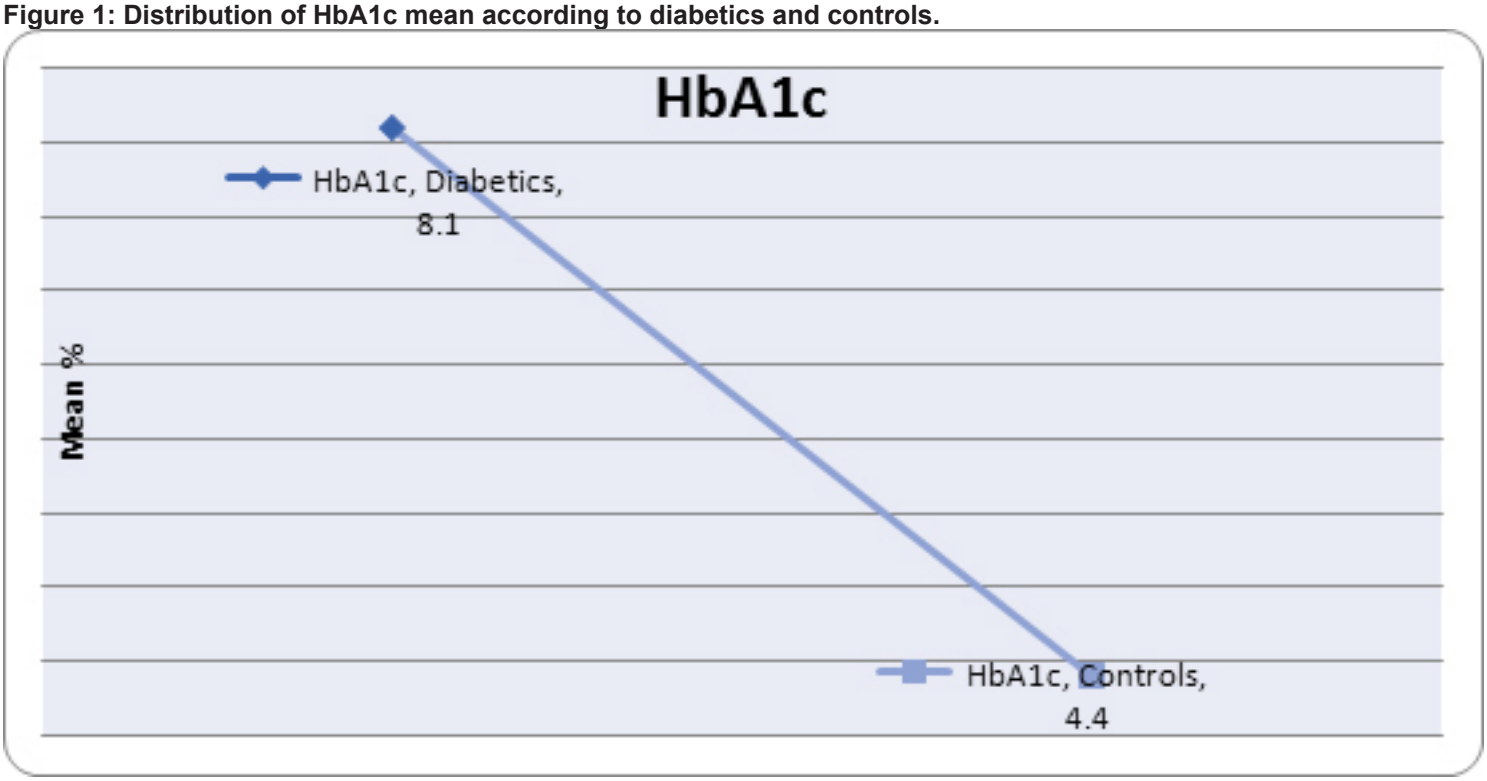

Table 1: Distribution of BMI according to Diabetics and Controls.

Variable	Diabetics	Controls	P
	Mean±SD	Mean±SD	
Mean±SD (Kg/m²)	28.1±4.4	28±4.3	0.8** NS

Table 2: Distribution of serum electrolyte levels according to diabetics and controls

Variable	Diabetics		Controls		P
	No.	%	No.	%	
Serum potassium					0.5*** NS
Low	17	17.0	20	20.0	
Normal	83	83.0	80	80.0	
Total	100	100	100	100	
Mean±SD (mmol/L)	3.9±0.5		3.8±0.3		0.1** NS
Serum calcium					<0.001* S
Low	78	78.0	21	21.0	
Normal	22	22.0	75	75.0	
High	0	-	4	4.0	
Total	100	100	100	100	
Mean±SD (mg/dl)	8±0.7		9.1±0.6		<0.001** S

* Fishers exact test, ** Independent sample t-test, *** Chi-square test, NS=Not significant, S=Significant.

Table 3: Correlations between study variables and serum potassium and calcium among diabetic patients.

Variable	Serum potassium		Serum calcium	
	r	P value	r	P value
Age	-0.07	0.04 NS	0.1	0.1 NS
Gender	0.1	0.2 NS	0.02	0.8 NS
BMI	-0.06	0.5 NS	-0.22	0.02 S
HbA1c	0.005	0.9 NS	-0.008	0.9 NS
DM duration	-0.01	0.8 NS	-0.01	0.8 NS
Smoking	0.02	0.8 NS	-0.05	0.5 NS
HT history	-0.1	0.3 NS	-0.1	0.1 NS
Anti-hypertensive drugs	-0.02	0.8 NS	0.02	0.7 NS
Anti-diabetic drugs	-0.04	0.6 NS	-0.1	0.2 NS
Family history of DM	0.05	0.5 NS	0.001	0.9 NS
Regular checking of RBS	0.1	0.1 NS	0.1	0.1 NS

NS Not significant. Ssignificant

Discussion

The electrolyte imbalance among diabetic patients is a frequent entity in hospitals. These disturbances are aggravated in hyperosmolarity status caused by hyperglycemia and diabetic ketoacidosis metabolic emergencies; as both of them cause osmotic diuresis [18].

In the current study, mean BMI of type 2 diabetic patients was 28.1±4.4 Kg/m2. This finding is similar to results of a previous Iraqi study that reported BMI mean of type 2 diabetic patients as 27.9±5.9 Kg/m2 [19].

The current study showed that 17% of diabetic patients had low serum potassium level while 20% of controls had low serum potassium level with no significant difference in mean serum potassium level between diabetic patients and controls (p=0.1). This finding coincides with results of Talabani's study in Iraq [20] which studied the electrolyte and lipid profile of non-insulin dependent diabetic patients in comparison to healthy controls and revealed no significant changes in serum potassium levels between study groups. This finding is inconsistent with results of Foo et al's [21] study in UK which recruited 2,482 patients with acute coronary syndrome (ACS) and found that diabetes mellitus among ACS patients is regarded as a significant predictor for high potassium level.

On other hand, Chatterjee et al's [22] study in USA reported that low serum potassium level is considered as a risk factor for development of diabetes mellitus due to a decreased B-cell sensitivity in pancreas to hyperglycemia leading to lower insulin release. Liamis et al (3) study in Greece stated that both hypokalemia and hyperkalemia may occur in diabetes mellitus; hypokalemia might be caused by shifting of K+ from extracellular to intracellular fluids due to insulin effect or loss of K+ from gastrointestinal lumen due to malabsorption or by excessive renal loss; while hyperkalemia might be attributed to shift of K+ from intracellular to extracellular fluids due to acidosis effect, hypertonicity, lack of insulin, drugs effect and lysis of cells or chronic hyperkalemia might be due to decrease the renal tubular secretion of K+ by hyporeninemic hypoaldosteronism syndrome [3].

In the present study, 78% of diabetic patients had low serum calcium level while 21% of healthy controls had low serum calcium level, with highly significant difference between the two study groups (p<0.001). This finding is similar to results of Al-Yassin et al's [23] study in Iraq which selected 70 type 2 diabetic patients in comparison to 70 healthy controls and found that serum calcium level was significantly lower than serum calcium level of controls. However, another study in Iraq conducted by Al-Selevany found that the DM type 2 had no effect on serum calcium level [24]. This difference might be attributed to fact that the Al-Selevany study included early onset type 2 DM patients and the effect of DM on calcium level observed later in the disease [25]. Many authors stated that hyperphosphatemia and hypomagnesemia caused by renal failure and volume depletion are the main causes of low serum calcium level among diabetic patients in addition to effects of vitamin D deficiency and parathyroid hormones [3, 25, 26]. Ahn et al's [27] study in South Korea documented that supplementation of population with vitamin D and calcium reduces the risk of type 2 DM development as the insulin sensitivity increased after calcium and vitamin D intake. In a national large population study carried out in Finland by Saltivo et al [28], it was found that serum calcium level is involved directly with all components of metabolic syndrome and specifically affected hyperglycemia.

In the current study, serum calcium of type 2 diabetic patients was significantly correlated with body mass index of patients (p=0.02). This finding coincides with results of Babikr et al's [29] study in Saudi Arabia which found a significant negative correlation between each of serum magnesium and calcium with BMI of type 2 diabetic patients. The serum calcium is found to be important for insulin activity intracellularly specifically in skeletal muscle and adipose tissue [30]. Alterations in calcium levels are affecting sensitivity of insulin [31]. Major et al's study in Canada revealed that calcium and vitamin D intake stimulated weight loss among obese women [32].

Conclusion

Hypocalcaemia is a frequent clinical issue of type 2 DM patients. Serum calcium of type 2 DM patients is more likely to be inversely related with body mass index of the patients. No significant differences were observed between diabetic patients and healthy controls regarding serum potassium level. Further studies are needed to explore the subject, as it is an important issue in the diabetic patient management.

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