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Disturbance of Electrolytes Homeostasis in Diabetic Patients from Misan Province

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Abstract

The present study aims to investigate the possible alteration of electrolyte homeostasis due to osmotic variations caused by diabetes mellitus and the possible association of serum electrolytes and hyperglycemia caused by the disease. Serum electrolyte levels in diabetics and non-diabetic people were monitored in Misan Province.. Each group consists of 20 persons, 14 males and 6 females. The age of the diabetic patients group ranged between 23-71 years. In the non-diabetic group, age varied between 25-56 years in males and 23-72 in females. The findings of the present study confirmed slight variations in electrolyte balance in diabetes II patients compared with normal people in Misan Province. The variations were significant in the case of calcium ions. Diabetics showed higher values of sodium and lower values of potassium than the normal group. Results were discussed given the contradicted findings of hyper- and hypo-electrolyte levels in diabetes in previously reported investigations.

Keywords: Electrolytes, Homeostasis, Diabetes, Misan, Iraq

Introduction

In physiology, the primary electrolytes are sodium (Na^{+}), potassium (K^{+}), calcium (Ca^{+2}), magnesium (Mg^{+2}), chloride (Cl^{-}) ad bicarbonate ($HCO3^{-}$) [1]. Several studies have estimated the electrolyte levels in diabetes mellitus in several countries and showed the association between electrolytes and hyperglycemia.[2,3] A study done to compare the effect of metformin, glibenclamide and their combination on electrolyte imbalance found low sodium and higher potassium in all these cases with insignificant differences [2]. Alterations in electrolyte homeostasis may lead to physiologic disorders. Insulin has been shown to activate Na± /K± -ATPase enzyme. Therefore, low serum insulin level reduces Na± /K± -ATPase activity with poor Na± and K± metabolism as a result and so transport across biomembranes as well as hindered monosaccharide uptake by intestinal epithelia occurs. In diabetes mellitus, hyperglycemia causes glucose induced osmotic diuresis with resultant loss of body fluids and electrolytes[4].

Diabetes is one of the diseases which frequently lead to electrolyte distortion [5,3]. In a diabetic condition, high blood glucose increases plasma osmolarity which in turn creates an osmotic driving

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force that drifts water movement from the intracellular spaces to the extracellular spaces [6]. This osmotic drift and water movement has two major effects on electrolyte concentration in the body. It could lead to a dilution effect lowering electrolyte concentration if they are extracellular or increasing the extracellular concentration if the water movement carries along intracellular electrolytes to the extracellular space, especially in a state of insulin deficiency [7]. This osmotic drift leads to a condition termed as electrolyte disorder or imbalance. Both hyper- and hypo-electrolyte levels are observed in diabetes. Certain studies have shown hyperkalaemia, hypernatraemia, and hypermagnesaemia etc., to occur in diabetic patients as well as hypokalaemia and hyponatraemia are also possible due to osmotic diuresis, antidiabetic agents or exogenous insulin administration [8,9,10]. The derangement of chloride in diabetes remains unclear.

The present study aims to investigate the possibility of alteration of electrolyte homeostasis due to osmotic variations caused by Diabetes II. This can be done by monitoring electrolyte levels in diabetic and non-diabetic patients in Misan Province. Very few works have been done in Iraq in general and especially in the Southern provinces on this subject ad this study is the first one in Misan Province.

Materials and Methods

Sampling

The study sample consists of two categories: Diabetics and non-diabetics groups. Each group consists of 20 persons, 14 males and 6 females. The males of the non-diabetic group ranged in age between 25-56 years while the females range was 23-72 years. In the diabetic group males ranged between 23-71 years of age and females between 25-71 years.

Biochemical analysis

The determination of sodium, potassium, and calcium in the blood can be analyzed by atomic spectroscopic methods. Flame AAS based methods was used. Atomic absorption spectrophotometer with a digital readout Model LW E60B from Land wind company. The wavelength range must be 200-800 nm. Wavelength settings for the analyses: Sodium: 589.6 nm, Potassium: 766.5 nm, Calcium: 422.7 nm.

Sodium chloride (NaCl), Potassium chloride (KCl) and Calcium carbonate (CaCO3) are used to prepare the standard solutions with 10 mg/l concentrations for calibration [11]. Several solutions for Na, K and Ca, were prepared by transforming 1, 2, 5, 10, 15, 20, 40, and 50 ml of the standard solution to 100 ml volumetric flasks. The concentrations in the solutions will be 0,1, 0,2, 0,5, 1,0, 1,5, 2,0, 4,0 and 5,0 mg/l respectively. Two ml of the sample was then added to a test tube and run the samples in the centrifuge unit, then 10 µl of the plasma was

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added and read the absorption (or emission) signal from the readout. The calibration graph is then used to find the concentration in the sample.

Results

Comparison between diabetic and non-diabetic groups

The comparisons between serum electrolytes levels in diabetic and non-diabetic patients are shown in Table (1) and Fig. (1). Serum calcium varied between 1.10 mM/L in diabetic and 1.18 mM/L in non-diabetic persons respectively. T-test values (Table 1) showed significant differences ($p < 0.01$). Serum chloride varied between 103.5 mM/L in diabetic and 104.8 mM/L in non-diabetic persons respectively. Differences between the examined groups were not significant ($p > 0.05$). Serum potassium varied between 3.82 mM/L in diabetic and 4.10 mM/L in non-diabetic persons respectively. Differences between the experimental groups were not significant ($p > 0.05$). Serum sodium varied between 139.5 mM/L in diabetic and 138.4 mM/L in non-diabetic persons respectively. Data of statistical analysis using T-test (Table 1), however, shows that t differences were not significant ($p > 0.05$).

Table (1): Serum electrolytes (mmol/L) of diabetics and non-diabetics in Misan

Indication	Sig	T-test values	Non- diabetic group		Diabetes group		Ions
			Range	Mean±SD	Range	Mean±SD	
Sig.	0.008*	2.787	0.94 – 1.33	1.169 ± 0.016	130.7 – 151.0	1.091 ± 0.103	Calcium
N.S	0.071	1.855	99.8 - 109.0	104.685 ± 2.122	97.8 – 108.1	103.440 ± 2.539	Chloride
N.S	0.142	1.499	3.24 - 5.17	4.038 ± 0.123	2.94 – 5.15	3.786 ± 0.115	Potassium
N.S	0.523	0.644	127.2 - 143.5	138.380 ± 3.670	130.7 – 151.0	139.335 ± 1.235	Sodium

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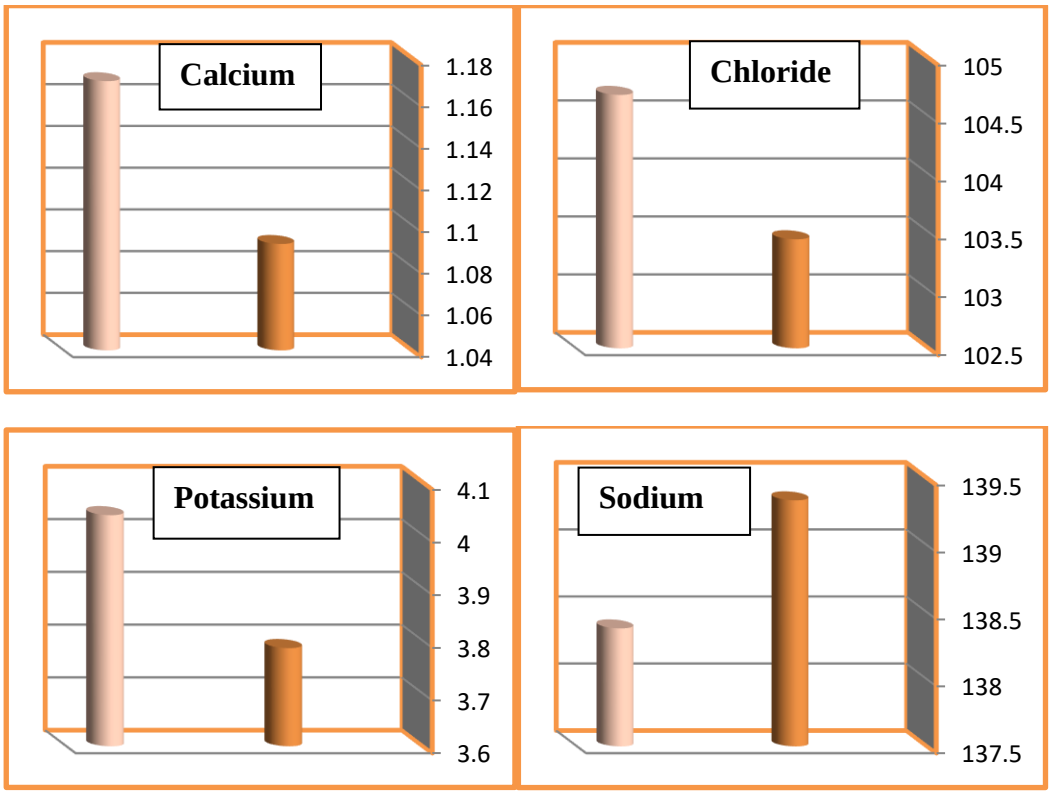

Fig (1): Comparison of serum sodium (mM/L) in diabetics and non-diabetics

Effect of Gender

In the diabetic group, nearly similar values of calcium, and chloride are seen in both males and females, while higher values of potassium and sodium were seen in females than males. In the non-diabetic group nearly similar values of calcium, sodium and chloride are seen in both males and females, while higher values of potassium were seen in males than females (Table 2).

Table (2): Electrolytes concentrations (m.mol/L) in males and females of the diabetic and non-diabetic groups

Diabetics		**Ca^{++}**	**Cl^{-}**	**K^{+}**	**Na^{+}**
Male No. 14	Av. ± SD	1.08±**0.10**	104.13±2.29	3.72±0.56	129.3±37.5
Females No. 6	Av. ± SD	1.09±0.09	101.81±2.50	3.93±0.34	139.2±7.08

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Non diabetics		Ca^{++}	Cl^{-}	K^{+}	Na^{+}
Male No.14	Av. ± SD	1.17±0.07	105.01±2.04	4.121±0.65	138.35±4.96
Female No. 6	Av. ± SD	1.17±0.06	105.43±2.28	3.93±0.17	138.63±2.39

Effect of Age

Apart from sodium, data of Table (3) shows no clear relationship between serum electrolytes and age in the diabetic patients. Only serum sodium concentration in the diabetic group showed higher values in young people (20-40 years) than older people (more than 40 years).
Data of Table 4 showed neither ascending nor descending trend due to age group. This leads to the conclusion that there is no clear relationship between the serum ion concentrations and age in the control non-diabetic group.

Table (3): Electrolytes concentrations (mM/L) in various age groups of diabetic and non-diabetic groups

Age group (years)	No.	Ca+2	Cl-	K+	Na+
20-30	**4**	1.09	105.3	3.46	140.6
31-40	**6**	1.05	101.91	4.18	140.3
41-50	**6**	1.10	103.51	3.70	138.2
51-60	**1**	1.33	101.9	3.79	0
61-70	**1**	1.11	106.8	3.33	138.3
71-80	**2**	1.03	103.15	3.7	136.1

Age group (years)	No.	Ca+2	Cl-	K+	Na+
20-30	**4**	1.122	105.15	3.84	140.37
31-40	**3**	1.16	103.93	4.02	133.2
41-50	**6**	1.20	104.15	3.97	139.73
51-60	**6**	1.16	104.58	4.28	136.61
71-80	**1**	1.22	108.90	3.8	138.4

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Discussion

Several studies have estimated the electrolytes levels in diabetes mellitus in several countries and showed the association between electrolytes and hyperglycemia [12]. According to a study done by Javaid, et al. (2007) they compared metformin, glibenclamide and combination of these two, to see the effect on electrolyte imbalance and found that low sodium and higher potassium was seen in all these cases with insignificant difference [6].

Diabetes is one of the diseases which frequently lead to electrolyte distortion [3]. In a diabetic condition, high blood glucose increases plasma osmolarity which in turn creates an osmotic driving force that drifts water movement from the intracellular spaces to the extracellular spaces [7]. This osmotic drift and water movement has two major effects on electrolyte concentration in the body. It could lead to a dilutional effect lowering electrolyte concentration if they are extracellular, or increase the extracellular concentration if the water movement carries along intracellular electrolytes to the extracellular space especially in a state of insulin deficiency [13]. This osmotic drift leads to a condition termed as electrolyte disorder or imbalance. Both hyper- and hypo-electrolyte levels are observed in diabetes. Certain studies have shown hyperkalaemia, hypernatraemia, and hypermagnesaemia etc., to occur in diabetic patients as well as hypokalaemia and hyponatraemia are also possible due to osmotic diuresis, antidiabetic agents or exogenous insulin administration [2]. The derangement of chloride in diabetes remains unclear.

Conclusions

1. Findings of the present study confirmed slight variations in electrolytes balance in diabetes II patients compared with normal people in Misan Province.
2. The variations were significant in the case of calcium ion.
3. Diabetics showed higher values of sodium and lower values of potassium than normal group.
4. The subject of effect of diabetes on electrolyte balance need more research as studies showed hypernatremia & hyperkalemia, while others showed hyponatremia & hypokalemia.

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