Analytical Study of Some Electrolytes Disturbance in Uncontrolled Diabetic Patients

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Abstract

The relationship between FPG and serum sodium and chloride in type 2 diabetes individuals was established. FPG and serum sodium had a substantial negative connection. In contrast, there was a strong positive connection between FPG and serum chloride. In contrast, a significant positive correlation was found between FPG and serum chloride. When compared to the control group, the study group's serum fasting blood glucose varied from 94 mg/dl up to 480 mg/dl with a mean value of 228.240 and an SD of 100.703, while the control group's varied from 80 mg/dl up to 146 mg/dl with a mean value of 104.200 and an SD of 16.959. Moreover, Serum sodium in the study group ranged from 129,000 mmol/L up to 143,000 mmol/L with an average value of 136,192 and a standard deviation of 3.606 ± while serum sodium in the control group ranged from 129,000 mmol/L up to 146 mmol/L with a mean a value of 138.167 and a standard deviation of ±4.11. Serum Chloride in the study group ranged from 76.000 m.mol/L up to 109.000 m.mol/L with a mean value of 95.818 and a standard deviation of ±7.585 while Serum Chloride in the control group ranged from 82.000m.mol/L up to 109.000 m.mol/L with a mean value of 97.177. According to our study (r = -0.091, p = 0.296) that there is no relationship between FPG and serum sodium agree. The findings of a study with plasma sodium and chloride (r = -0.244, p = 0.017), and (r = 0.21, p = 0.04), respectively. Only the proportion of afflicted individuals was larger in the hyponatremia and hypochloremia outcomes, but there were no discernible variations in the mean level of the values.

Keywords: EElectrolytes,sodium,chloride,Disturbance, DM

1. Introduction

The body contains a large variety of ions, or electrolytes, which perform a variety of functions. Cell excitability, signal conduction, transport mechanisms, and cell mobility are all dependent on the electrolyte gradient across cell membranes. Electrolytes can also operate as second messengers, co-enzymes, or structural elements. Fluid and electrolyte balance must be considered not just in terms of external gain or loss, but also of shifts that occur between internal fluid compartments as a result of illness… Sodium, potassium, chloride, bicarbonate, calcium, phosphate, magnesium, copper, zinc, iron, manganese, molybdenum, copper, and chromium all seem to be electrolytes in biological systems. [1]. Electrolyte abnormalities are now one of the main factors affecting human health. [2]. While sodium, chloride, and bicarbonate make up the majority of the extracellular electrolytes, potassium, magnesium, phosphate, and sulfate make up the majority of the intracellular electrolytes. [3]. The regulation of osmotic equilibrium, the maintenance of fluid balance, and equal distribution and conservation of bodily fluids are all related to sodium. [4]. Elevated morbidity and mortality are linked to electrolyte disturbances, which are often seen in clinical practice and are mostly seen in hospital populations across a wide range of patients (from asymptomatic to critically sick)[5, 6]. Electrolyte homeostasis abnormalities are also often reported in community participants. Even moderate and persistent community-acquired electrolyte abnormalities have a bad prognosis. [7]. Most electrolyte abnormalities include many factors. Nutritional condition, gastrointestinal absorption capacity, concurrent acid-base abnormalities, pharmacological drugs, other concomitant disorders (mostly renal disease), or acute sickness, alone or in combination, are only a few of the pathophysiological variables that might have a significant impact.[8]. Given that the aforementioned components are frequently present in diabetics, particularly decreased renal function, malabsorption syndromes, acid-base disorders, and multidrug regimens, diabetes mellitus (DM) is one of the illnesses with an elevated prevalence of electrolyte abnormalities.[9].Electrolytes and blood glucose have a complicated interaction that depends on several variables, including age, lifestyle, physical activity, and other related disorders. [10]. Additionally, one of the side effects of diabetes, diabetic nephropathy, is characterized by the decreased renal function that can result in electrolyte imbalance because high blood sugar harms nephrons by changing electrolyte absorption and reabsorption.[11, 12].

2. Experimental

Patients and blood sampling

This study was conducted in Al Khali's general hospital and laboratories of department of chemistry in the college of education for pure science at the University of Diyala for a period between (October 2021) (and March 2022) 80 individuals were studied with their blood sugar

doi.org/10.31838/hiv22.02.376 Received: 17.07.22, Revised: 29.07.22, Accepted: 13.08.22

profile in a form of (fasting blood sugar (FBS) and electrolytes in a form of serum sodium and chloride 80 individuals were divided into two groups. control group (30 individuals) who were free from diabetes mellitus their age ranging from (16-72). studied group (50 patients) who were complaining of diabetes mellitus type 2 their ages ranged from (16-80). Blood sample of
(5 ml) aspirated via venesection by plastic sterile disposable syringes which were transferred to a sterile disposable well-protected gel tube free from (EDTA) between 8.00-9.00 am. for each patient. After blood aspiration, it was centrifuged directly at (4000rpm for 5min.), then (2 ml) of serum was used to check our variables in the study. The (2 ml) of serum was used to detect the concentration of each variable by the colorimetric method by using Cecil spectrophotometer ce 7200. All calculations depend on this equation:

$$Csample = \frac{\text{Cstandard} \times \text{Asample}}{\text{A standard}}$$

Csam = Concentration of samples, Cst= Concentration of standard
Asam = Absorbance of samples, Ast= Absorbance of standard

3. Results and Discussion

Analytical Statistics

Data were described, analyzed, and presented using the Statistical Package for Social Science (SPSS version -22, Chicago, Illinois, USA). Statistical analyses may be divided into two categories: Descriptive Analysis (frequency, percentage, and minimum, maximum, mean, and standard deviation for quantitative variables, and graphs: Simple and Cluster chart bars. Two-Dimensional Inferential Analysis (Independent Sample the parametric test of the difference between two groups is the T-test. Tests for the normality of quantitative variance should be performed using the Shapiro-Wilk and Levene methods, when the predicted cell count of fewer than 5 is less than 20%, use chi-square to assess the relationship between two qualitative variables' distributions. Receiving Operating Characteristic: The statistical graphical perspective and the capacity to distinguish between health and disease, or between any other two states that may be referred to by a variety of words, including Positive predictive value (PPV) is the likelihood that a subject's desired condition or ailment will manifest itself positively. (TP/TP+FP).
A negative predictive value (NPV) is the percentage of patients with a negative test result who do not have the disease out of all the participants with negative test results. (TN/TN+FN).
The likelihood ratio for positive test findings (LR+) indicates the likelihood that a positive test result will occur in patients with the condition as opposed to healthy individuals Significant *P*<0.05.

Table 3.1 Normality test of electrolytes among groups.

Vars.	Shapiro-Wilk					
	Groups					
	Study			Control		
	Statistic	Patients group	P value	Statistic	control	P value
FBS	0.955	50	0.055	0.931	30	0.051
Na	0.972	50	0.283	0.933	30	0.060
CL	0.962	50	0.108	0.981	30	0.842

The number of diabetic patients in the study group under 50 years of age was 24 patients and 26 patients of age over 50 years while the total number of healthy individuals was 20 patients for age less than 50 years and 10 patients for persons over 50 years of age. Table 3.2 shows the distribution of age and groups

Table 3.2 shows age and groups

Age	Groups				Total	
	Study		Control			
	N.	%	N.	%	N.	%
Less than50	24.00	48.00	20.00	66.67	44.00	55.00
More than 50	26.00	52.00	10.00	33.33	36.00	45.00

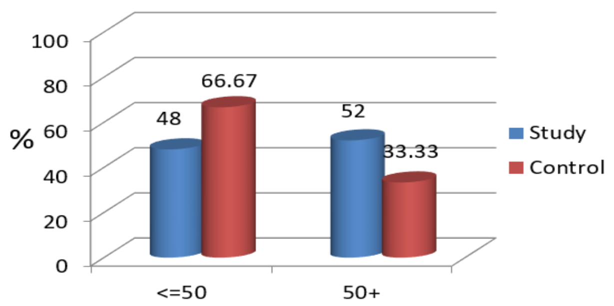

Figure 3.1 Illustrated and statistical test of age among groups

In our study, the youngest patient was 16 years old while the oldest was 80 years old with a mean age of 49.840 and an SD of 12.829 ±. In the control group, the youngest patient was 16 years old and the oldest patient was 85 years old with a mean age of 45,200 and an SD of 17.401 ±
While table 3.3.

Table 3.3 Shows and statistical test of age among groups.

Groups	Minimum	Maximum	Mean	±SD	T test	P value
Study	16.000	80.000	49.840	12.829	1.367	0.175 NS
Control	16.000	85.000	45.200	17.401		
Total	16.000	85.000	48.100	14.776		

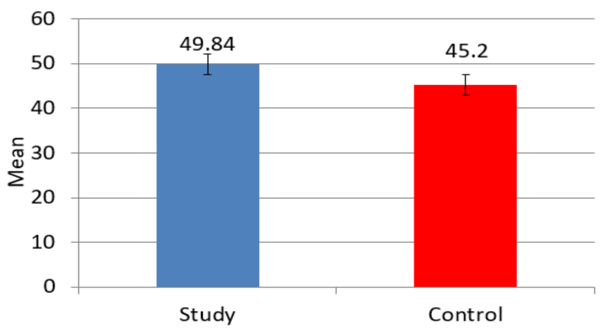

Figure 3.2 shows descriptive and statistical tests of age among groups.

Serum fasting blood glucose in the study group was recorded from 94 mg/dl up to 480 mg/dl an approximate amount of 228.240 and an SD of ±100.703 while Serum fasting blood glucose in the control group ranged from 80 mg/dl up to 146 mg/dl having a mean of 104.200and and SD of ±16.959. Table 3.4 and figure 3.3 shows Descriptive and statistical test of FBS among groups.

Table 3.4 Statistical and descriptive analysis of FBS between groups.						
Groups	Minimum	Maximum	Mean	±SD	T-test	P value
Study	94.000	480.000	228.240	100.703	6.674	0.000 Sig.
Control	80.000	146.000	104.200	16.959		
Total	80.000	480.000	181.725	100.237		

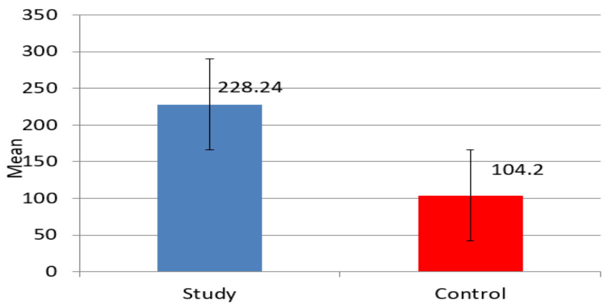

Figure 3.3 shows descriptive and statistical tests of FBS among groups.

The data above demonstrate a significant difference between FBS in the study group and that in the control group, with a P-value of 0.00. Also, the study shows that the test of sodium among the study and control group shows that 17 patients in the study group was having hyponatremia which represents 77.27% of the total hyponatremia value of all cases and represents 34% of the total study cases. It also shows that 5 individuals in the control group had hyponatremia which represents 22.73% of the total hyponatremia value of all cases and represents 16.67% of the total control cases.

33 patients in the study group had normal sodium levels which represent 56.90% of the total normal sodium value of all cases and represent 66% of the total study cases. It also showed that 25 individuals in the control group had normal sodium values which represent 43.10% of the total normal sodium value of all cases and represent 83.33% of the total control cases as shown in table (3.5) and figure (3.4) Distribution of sodium level among groups.

Table (3.5) Distribution of sodium levels among groups.					
			Groups		Total
			Study	Control	
Sodium	hypernatremia	Count	17.00	5.00	22.00
		% within Na	77.27	22.73	100.00
		% within Groups	34.00	16.67	27.50
		% of Total	21.25	6.25	27.50
	normal	Count	33.00	25.00	58.00
		% within Na	56.90	43.10	100.00
		% within Groups	66.00	83.33	72.50
		% of Total	41.25	31.25	72.50

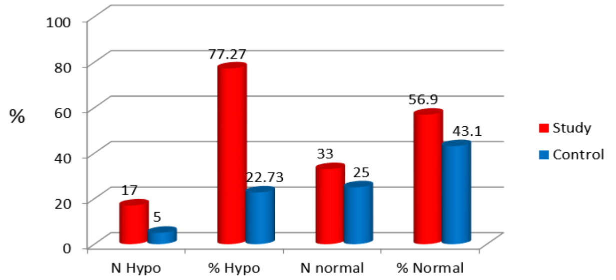

Figure (3.4) Distribution of sodium levels among groups.

The aforementioned findings demo

Serum sodium in the study group ranged from 129,000 mmol/L up to 143,000 mmol/L having a mean value of 136,192 and an SD of 3.606 ± while serum sodium in the control group ranged from 129,000 mmol/L up to 146 mmol/L with a mean a value of 138.167 and a standard deviation of ±4.111. Table 3.7 and Fig. 3.6 show the descriptive and statistical tests for sodium between groups.

Table 3.6 Descriptive and statistical test of Sodium among groups.						
Groups	Minimum	Maximum	Mean	±SD	T test	P value
Study	129.000	143.000	136.192	3.606	2.249	0.024 Sig.
Control	129.000	144.000	138.167	4.111		
Total	129.000	144.000	136.933	3.898		

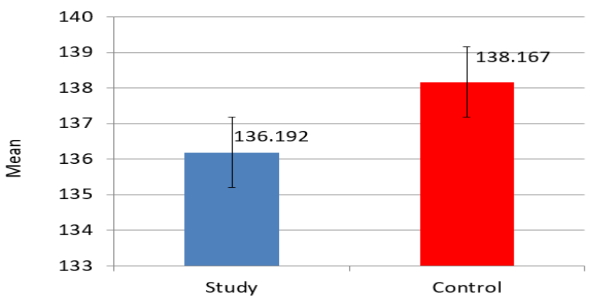

Figure 3.5 shows Descriptive and statistical tests of Sodium among groups.

The aforementioned findings demonstrate that there is a significant difference between the sodium levels in the study group and the control group, with a P-value of 0.024. In our research, we discovered that type 2 diabetes patients had considerably lower blood salt levels than healthy controlsl[13-16]. However there is a contrast in the study by other studies, they have shown high serum sodium levels in diabetic patients than in healthy control[17, 18](99,100).

Serum chloride in this study showed that the potassium test between the study group and the control group showed that 22 patients in the study group had hypochloremia which accounted for 62.86% of the total hypochlorous value in all cases and represented 44% of the total study cases. It was also found that 13 individuals in the control group suffer from hypochloremia, representing 37.14% of the total value of hypochloremia in all cases and representing 43.33% of the total control cases. 27 patients in the study group had normal chloride levels which represent 64.29% of the total normal chloride value of all cases and represent 54.00% of the total study cases. It also showed that 15 individuals in the control group had a normal chloride value, representing 35.71% of the total natural chloride value for all cases and representing 50.00% of the total control cases.

Serum chloride shows to be elevated in 1 patient in the study group which represents 33.33.00% of the total hyperchloremic value of all cases and represent 2% of the total study cases while hyperchloremia was identified in 2 individuals in the control group who represent 66.67% of the total hyperchloremic value of all cases and represent 6.67% of the total control cases as shown in table (3.7) and figure (3.6) Distribution of Chloride level among groups.

Table (3.7) Distribution of Chloride levels among groups.					
			Groups		Total
			Study	Control	
Chloride	Hypo	N.	22.00	13.00	35.00
		% within Chloride	62.86	37.14	100.00
		% within Groups	44.00	43.33	43.75
		% of Total	27.50	16.25	43.75
	normal	N.	27.00	15.00	42.00
		% within Chloride	64.29	35.71	100.00
		% within Groups	54.00	50.00	52.50
		% of Total	33.75	18.75	52.50
	Hyper	N.	1.00	2.00	3.00
		% within Chloride	33.33	66.67	100.00
		% within Groups	2.00	6.67	3.75
		% of Total	1.25	2.50	3.75

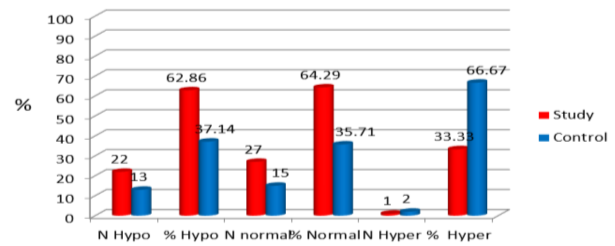

Figure (3.6) Distribution of Chloride level among groups.

The previous results reveal that whereas hyperchloremia in the control group is only marginally higher than in the study group, the observed normal chloride level and hypochloremia are greater in the study group than in the control group.Serum Chloride in the study group ranged from 76.000 m.mol/L up to 109.000 m.mol/L with a mean value of 95.818 and a standard deviation of ±7.585 while Serum Chloride in the control group ranged from 82.000m.mol/L up to 109.000 m.mol/L with a mean value of 97.177 and a standard deviation of ±6.765. Table 3.9 and figure 3.8 shows Descriptive and statistical test of Chloride among groups.

Table 3.8Descriptive and statistical test of Chloride among groups						
Groups	Minimum	Maximum	Mean	±SD	T test	P value
Study	76.000	109.000	95.818	7.585	0.807	0.422
Control	82.000	109.000	97.177	6.765		NS
Total	76.000	109.000	96.328	7.275		

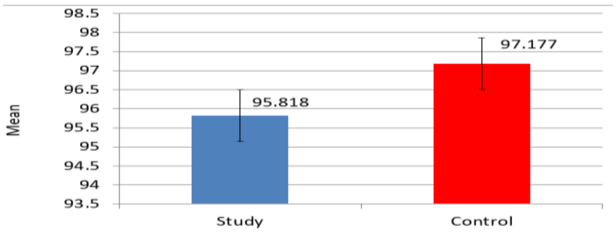

Figure 3.7 shows Descriptive and statistical tests of Chloride among groups

The findings above show that although there is a lower level of chloride in the study group than in the control group, there is no statistically significant difference between the two groups, and the P value is 0.42.We discovered that type 2 diabetes individuals had considerably higher serum chloride levels than healthy controls [16-18]. Additionally, we have demonstrated the relationship between FPG and the levels of blood sodium, potassium, and chloride in people with type 2 diabetes. Serum sodium and FPG had a substantial negative association. In contrast, a strong positive connection between serum chloride and FPG was discovered. Our research has demonstrated that there is no meaningful relationship between FPG and serum sodium ($r = -0.091$, $p = 0.296$)[19]. Our observations on serum sodium and chloride were corroborated by other studies ($r = -0.244$, $p = 0.017$)[14]. Normal sodium reabsorption occurs in the proximal convoluted tubule of the kidney, but in diabetes mellitus, excessive urination occurs because of hyperglycemia, which can cause the maximal excretion of sodium through urine. This was previously believed to be the mechanical cause of reduced blood sodium levels in type 2 diabetes.[20]. The concentration of serum electrolytes is diluted by these osmotic processes, which may result in hyponatremia. [21, 22]. Na+-K+-ATPase activity may have reduced hyperglycemia, which might be another reason causing decreasing blood sodium levels. Type II diabetes individuals had higher levels of hyperchloremia than non-diabetic patients, which may be related to hypertonicity.[23]

Area Under the Curve										
Test Result Variable(s)	Optimal Cutoff point	% sensitivity	% specificity	PPV	NPV	+LR	-LR	Area		p value*
FBS	130	84	90	110	15.09	8.40	0.18	0.920	Excellent	0.000
Na+	133.25	76	16.7	183.3	58.97	0.91	1.44	0.333	Not useful	0.013
CL-	93.5	74	33.3	166.7	43.84	1.11	0.78	0.463	Not useful	0.581

The above results show that the most used tests for differentiation as excellent are FBS, while other tests are not useful such as sodium, chloride with significant results for sodium, while chloride with no significant results

4. Conclusion

According to this study, electrolyte imbalances are typical in diabetes individuals. More than 40% of individuals with diabetes had hyponatremia. The mean chloremia readings of diabetic participants and control subjects did not differ from one another. This study demonstrated the value of serum electrolyte testing in the treatment of diabetic patients. Additional research with large sample size is needed to examine the relationship between blood electrolyte levels and the severity of hyperglycemia.

Sponsorship: No funding sources

Conflicting interests: None declared

Ethical approval: The study was approved by the department of chemistry in the college of education for pure science at the University of Ethics Committee.

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