Analytical Study of Potassium and Magnesium Serum Level Disturbance in Uncontrolled Type Ii Diabetic Patients

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Abstract
The relationship between FBS and serum potassium and magnesium in type 2 diabetes individuals was established. FBS and serum potassium had a substantial positive connection. In contrast, Findings that the level of Magnesium is higher in the group of study than that in the control. 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 potassium in the study group ranging from 3.100 m.mol/L up to 6.700 m.mol/L with the mean value about 4.392 and standard deviation about ±0.776while Serum potassium in the control group ranging from 2.800 m.mol/L up to 4.600 m.mol/L with the mean value about 3.720 and the standard deviation about ±0.577. The serum magnesium in the study group ranged from 1,200 mmol/L up to 4.100 mmol/L with an average value of 2.832 and a standard deviation of 0.739 ± while it is in the control group ranged from 1,600 mmol/L up to 2.600 mmol/L with a mean of Value 2.117 and standard deviation ± 0.288
Keywords: DM, HBA1C, Hyperkalemia, Magnesium, disturbances

1. Introduction

Electrolyte disturbances are commonly seen in clinical practice. These are mostly encountered in hospitalized populations and occurring in a wide spectrum of patients (ranging from asymptomatic to severly critically ill) and becoming associated with the increased mortality and morbidity [1, 2] The disturbances of electrolyte homeostasis are also frequently observed in community subjects. Community-acquired electrolyte disorders, even chronic and mild, are related to poor prognosis[2]. Electrolytes in living systems include sodium, potassium, chloride, bicarbonate, calcium, phosphate, magnesium, copper, zinc, iron, manganese, molybdenum, copper, and chromium[3]. Water comprises 60% of body weight for an average adult, although the percent is less in obesity, because adipose tissue containing lesser water than other tissues. The total body content of water is classified functionally into extracellular (ECF equalizing about 20% of total body weight) and intracellular fluid (ICF equalizing about 40% of total body weight) separated by cell membrane which have its active sodium pump, that ensures the sodium level remains largely in ECF[3, 4]. Diabetes mellitus is a disease characterized by long standing chronic hyperglycemia that is arising from defect in insulin function or its secretion or both. it is a major and increasing global disease and of great health importance[5] .The incidence percent is increasing in the developed countries of the world, specifically type 2 Diabetes mellitus, due to the increasing incidence of obesity and reduced daily physical activity levels[6].patients with diabetes are at high risk of chronic complications that may have effects on many organs and systems and responsible for most of mortality and morbidity accompanied the disease. As long as the disease is in progress, diabetic patients are at increasing risk of the development of many complications such as damage to the blood vessels, metabolic imbalances, effect on the electrolyte balance and changing the proportion of the electrolytes[7]. The patients number affected by the diabetes still continue to rise worldwide. Estimations suggesting that 438 million persons will be affected by diabetes mellitus in 2030. The diabetes prevalence worldwide is of great concern that is about 20% up to 50% of newly onset of type II diabetes is noticed in younger generation[8]. Diabetes is an important risk factor for ischemic heart disease (IHD), (ESRD) end stage renal disease and stroke[9, 10].

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 profile in a form of (fasting blood sugar (FBS) and electrolytes in a form of serum potassium and magnesium 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

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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 7200.

3. Results and Discussion

Analytical Statistics

Data were described, analyzed, and presented using (SPSS version -22, Chicago, Illinois, USA) the Statistical Package of Social Science. Statistical analyses may be divided into two categories: The descriptive Analysis (percentage, frequency, and minimum, mean, maximum, and standard deviation for quantitative variables, and graphs:

Table 3.1 Normality test of electrolytes among groups.

Vars.	Shapiro-Wilk #					
	Groups					
	Study			Control		
	Statistic	df	P value	Statistic	df	P value
FBS	0.955	50	0.055	0.931	30	0.051
HBA1C	0.957	50	0.081	0.973	30	0.622
K	0.957	50	0.067	0.935	30	0.067
Mg	0.969	50	0.206	0.949	30	0.158

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 an SD of ±16.959. Table 3.2 and figure 3.1 shows the descriptive and the statistical tests of FBS among groups.

Table 3.2 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		

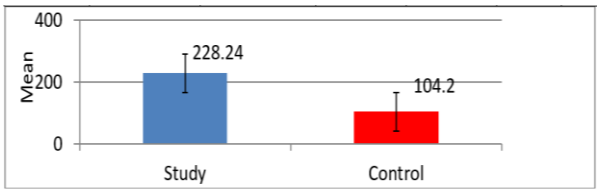

Figure 3.1 shows descriptive and statistical tests of FBS among groups.

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. Serum potassium in this study showed that the test of potassium among study and control group shows that 2 patients in the study group was having hypokalemia which represent 14.29% of the total hypokalemic value of all cases and represent 4% of the total study cases. The HBA1C test between the study group and the control group showed that 6 patients in the study group had a normal level representing 16.67% of the total normal value of all cases and representing 12% of the total study cases. The obtained results also showed that 30 individuals in the control group with normal HBA1C represented 83.33% of the total normal value of all cases and represented 100% of the total control cases. Distribution of HBA1C among groups.

Table 3.3 Statistical and descriptive analysis ofHBA1C between groups.

			Groups		Total
			Study	Control	
HBA1C	normal	Count	6.00	30.00	36.00
		% Within HBA1C	16.67	83.33	100.00
		% Within Groups	12.00	100.00	45.00
		% Of Total	7.50	37.50	45.00
	Hyper	Count	44.00	0.00	44.00
		% Within HBA1C	100.00	.00	100.00
		% Within Groups	88.00	.00	55.00
		% of Total	55.00	.00	55.00

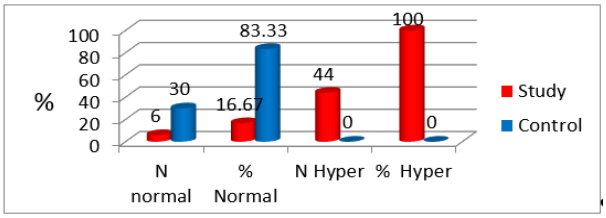

Figure 3.2 shows descriptive and statistical tests of HBA1C among groups.

Blood HBA1C in the study group ranging from 5.500up to 14.00 with the mean value about 8.640 and the standard deviation about ±2.227while blood HBA1C in the control group ranging from 4.100 up to 6.500 with a mean value of 5.403 and a standard deviation of ±0.595. Table 3.2 and figure 3.2 shows the descriptive and the statistical tests of HBA1C among groups.

Table 3.4 Descriptive and statistical test of HBA1C among groups.						
Groups	Minimum	Maximum	Mean	±SD	T test	P value
Study	5.500	14.000	8.640	2.227	7.779	0.000 Sig.
Control	4.100	6.500	5.403	0.595		
Total	4.100	14.000	7.426	2.386		

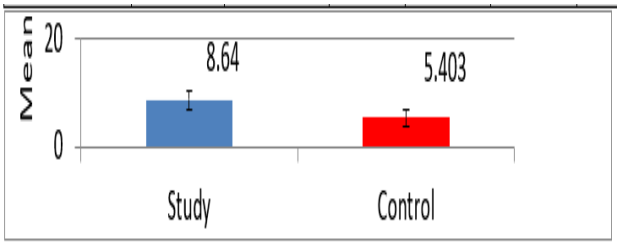

Figure 3.3 shows the descriptive and the statistical tests of HBA1C among groups.

The above results show that HBA1C in the study group is more than in the control population group with significant difference with P-value 0.00. It also showed that 12 individuals in the control group suffer from hypokalemia, representing 85.71% of the total value of hypokalemia for all cases and they represent 40% of the total control cases. 43 patients in the study group having normal potassium level which represent 70.49% of the total normal potassium value of all cases and represent 86.00% of the total study cases. It also show that 18 individual in the control group having normal potassium value which represent 29.51% of the total normal potassium value of all cases and represent 60.00% of the total control cases.Serum potassium shows to be elevated in 5 patients in the study group which represent 100.00% of the total hyperkalemic value of all cases and represent 10% of the total study cases while no one in the control group was having hyperkalemia as shown in table (5.6) and figure (3.4).

Table 3.5 Distribution of potassium level among groups.					
			Groups		Total
			Study	Control	
K	hypokalemia	Count	2.00	12.00	14.00
		% Within K	14.29	85.71	100.00
		% Within Groups	4.00	40.00	17.50
		% Of Total	2.50	15.00	17.50
	Normal	Count	43.00	18.00	61.00
		% Within K	70.49	29.51	100.00
		% Of thin Groups	86.00	60.00	76.25
		% Of Total	53.75	22.50	76.25
	Hyperkalemia	Count	5.00	0.00	5.00
		% Within K	100.00	0.00	100.00
		% Within Groups	10.00	0.00	6.25
		% Of Total	6.25	0.00	6.25

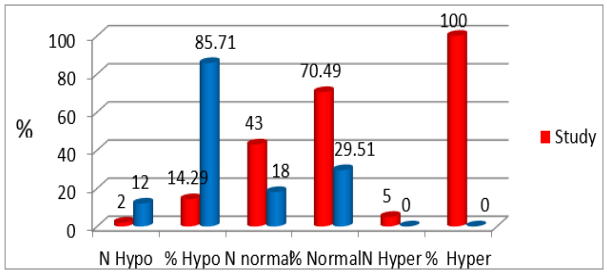

Figure (3.4) Distribution of potassium levels among groups.

The above results show that the normal potassium level and hyperkalemia are more in the study than those in the control group while hypokalemia is more pronounced in control group than in the group of study.Serum potassium in the study group ranging from 3.100 m.mol/L up to 6.700 m.mol/L with the mean value about 4.392 and the standard deviation about ±0.776while Serum potassium in the control group ranging from 2.800 m.mol/L up to 4.600 m.mol/L with the mean value about 3.720 and the standard deviation about ±0.577. Table 3.12 and figure 3.11 shows Descriptive and statistical test of potassium among groups.

Table 3.6 the descriptive and the statistical tests of potassium among groups.						
Groups	Minimum	Maximum	Mean	±SD	T test	P value
Study	3.100	6.700	4.392	0.776	4.106	0.000 Sig.
Control	2.800	4.600	3.720	0.577		
Total	2.800	6.700	4.140	0.776		

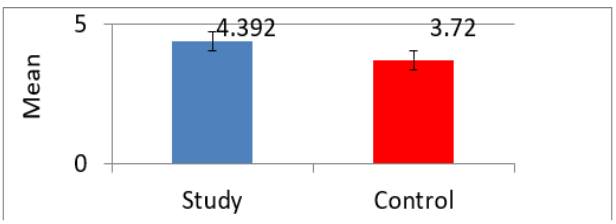

Figure 3.5 shows the descriptive and the statistical tests of potassium among groups.

The above results show that the potassium level is higher in study group than that in group of control with significant difference and *P* value 0.00.The serum potassium level was increased significantly in patients with type 2 diabetes than the healthy control group, that agree the studies done in 2005 and 2008.[1, 2]In agreement with this study Hosen and Talabani have shown rising the level of potassium in

diabetic group than in the control group but were non significant[11, 12].On other side, a study done by Al-Jameil has shown a hypokalemia in diabetics population than in the control that was not significant also [13]. But a study done by Wang shows that 1.2% of diabetics having hyperkalemia with only 0.6% of the diabetics having hypokalemia[14].This study also showed that the magnesium test between the study group and the control group showed that 3 patients in the study group suffer from hypomagnesaemia, which represents 100% of the total hypomagnesaemia value for all cases and represents 6% of the total study cases. It was also found that 0 individuals in the control group suffer from hypomagnesaemia, which represents 0% of the total hypomagnesaemia value for all cases and represents 0% of the total cases of control, while 10 patients in the study group have a normal magnesium level that represents 28.57% of the total cases of controls. Total normal magnesium value for all cases and represents 20.00% of the total study cases. As well as, It was found that 25 individuals in the control group had a normal Mg value which represented 71.43% of the total normal Mg value for all cases and represented 83.33% of the total control cases.Hypermagnesaemia is appeared in 37 patients in the study group which represents 88.10% of the total hypermagnesaemia value for all cases and represents 74.00% of the total study cases while hypermagnesaemia was identified in 5 individuals in the control group representing 11.90% of the total. The hypermagnesaemia value for all cases and represents 16.67% of the total control cases as shown in the table (3.6) and figure (3.5).

Table 3.7 the distribution of magnesium level among groups.

			Groups		Total
			Study	Control	
Mg	hypomagnesemia	Count	3.00	0.00	3.00
		% Within Mg	100.00	.00	100.00
		% Within Groups	6.00	.00	3.75
		% Of Total	3.75	.00	3.75
	normal	Count	10.00	25.00	35.00
		% Within Mg	28.57	71.43	100.00
		% Within Groups	20.00	83.33	43.75
		% Of Total	12.50	31.25	43.75
	hyper	Count	37.00	5.00	42.00
		% Within Mg	88.10	11.90	100.00
		% Within Groups	74.00	16.67	52.50
		% Of Total	46.25	6.25	52.50

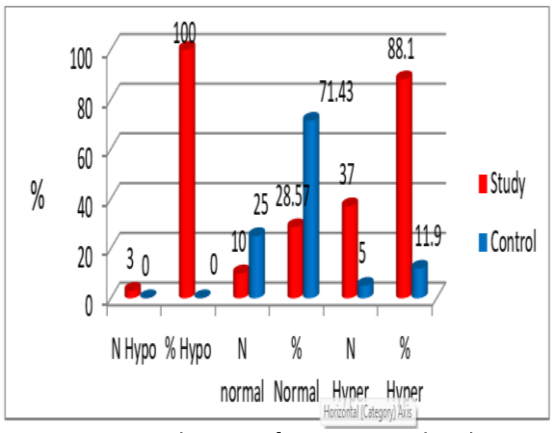

Figure 3.5 Distribution of magnesium level among groups.

The above results show that hypomagnesaemia and hypomagnesaemia were recorded in the study more than those in the control group, while the normal level was recorded in the control group more than that in the study.The serum magnesium in the study group ranged from 1,200 mmol/L up to 4.100 mmol/L with an average value of 2.832 and a standard deviation of 0.739 ± while it is in the control group ranged from 1,600 mmol/L up to 2.600 mmol/L with a mean of Value 2.117 and standard deviation ± 0.288.Table 3.7 and Figure 3.6 show the descriptive and the statistical tests for magnesium between groups.

Table 3.7 the descriptive and the statistical tests of magnesium among groups.

Groups	Minimum	Maximum	Mean	±SD	T test	P value
Study	1.200	4.100	2.832	0.739	4.106	0.000 Sig.
Control	1.600	2.600	2.117	0.288		
Total	1.200	4.100	2.564	0.700		

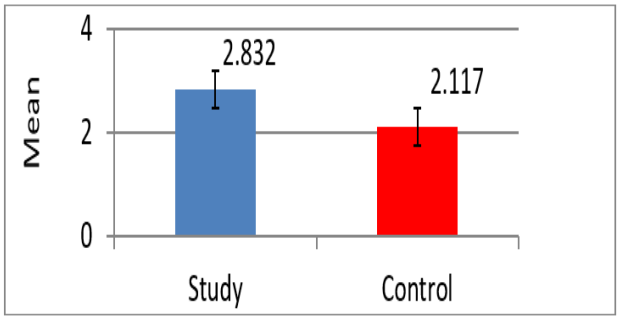

Figure 3.6 shows the descriptive and the statistical tests of magnesium among groups.

Findings above show that level of Magnesium is higher in the study group than that at the control one with significant difference and P value 0.000. Hypomagnesaemia has been linked to insulin resistance as a causative factor, also it is being a consequence for hyperglycemia, and if it is chronic it will lead to installation of micro and macrovascular complications of the diabetes, worsening magnesium deficiency[15-17].The mechanism

connecting the DM and the hypomagnesaemia was still not so clear, although some of the metabolic studies demonstrating that the supplementation of Mg has a great beneficial effect on the insulin action and in the metabolism of glucose [18]. The commonest causative factor for chronic hyperkalemia in patients with diabetes is the decreasing tubular secretion of the potassium due to hyporeninemic hypoaldosteronism syndrome and also might be due to the increasing in the potassium efflux from the cell into the serum in hyperosmolality because of hyperglycemia, that also causes a relative rise in derive of the extracellular fluid from the interstitial spaces. The osmotic effects having a diluting effects on the serum electrolytes concentration that may cause hyponatremia[19, 20].Another mechanism causing lowering of serum sodium and rising serum potassium might be due to the decreased activity of the Na^+-K^+-ATPase during hyperglycemia.be related to hypertonicity.[21]
Hypomagnesaemia has been related as a cause of insulin resistance, also being a consequence of hyperglycemia, and when it is chronic leads to the installation of macro and microvascular complications of the diabetes, worsening the magnesium deficiency. (18)

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
HBA1C	6.35	94	96.7	103.3	5.84	28.48	0.06	0.979	Excellent	0.000
K^+	3.85	80	53.3	146.7	27.29	1.71	0.38	0.729	Good	0.001
Mg^{+2}	2.45	74	83.3	116.7	23.79	4.43	0.31	0.826	V.good	0.000

The above results show that the most useful tests for differentiation and prediction of electrolyte disturbances and in comparison, between groups as excellent is FBS, while potassium is good in both differentiation and comparison between the groups, magnesium is very good in both differentiation and comparison between the groups with a significant result in differentiation.

4. Conclusion

According to this study, electrolyte imbalances are typical in diabetes individuals. about 10% of individuals with diabetes had hyperkalemia and 86% having normal potassium level while only 4% having hypokalemia. The magnesium readings of diabetic participants show 6% having hypomagnesaemia, 20% with normal magnesium level and 74% having hypermagnesemia. 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.

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