VOLUME-7, ISSUE-12, DECEMBER-2018 • PRINT ISSN No 2277 - 8160

Original Research Paper

Medical Science

"CORRELATION BETWEEN SERUM ELECTROLYTES AND FASTING BLOOD GLUCOSE WITH HBA1C IN DIABETIC PATIENTS"

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ABSTRACT

INTRODUCTION: Serum electrolytes play an important role in intermediary metabolism and cellular function, including enzyme activities and electrical gradients. Alterations in serum electrolyte levels have been reported in diabetes mellitus. This electrolyte imbalance can in turn alter the course of the diabetes mellitus and its management. Through this study, we tried to understand the correlation between serum electrolytes like Sodium, Potassium & Magnesium with that of Fasting blood glucose & Glycosylated Hemoglobin in type 1 and type 2 Diabetes Mellitus.

MATERIALS & METHODS: Patients attending diabetic OPD at SAIMS medical college, Indore were randomly selected for any gender between the age group 16 to 70 years .A total 150 patients (50 type 1 diabetic & 100 type 2 diabetic , classified on the basis of ADA criteria) were included in the study. Using different automated techniques, Fasting blood sugar(FBS),Glycosylated hemoglobin (HbA1c) and serum electrolytes were assessed after collecting blood samples.

RESULTS: In our study, a significant statistical difference ($p<0.05$) was observed when HbA1c levels were correlated with serum sodium levels, both in type 1 as well as type 2 diabetics . The association between Serum sodium and FBS was significant in type 2 diabetics only. When considering the whole study population together, Serum sodium levels were statistically significantly related with both FBS levels and HbA1c levels. The association of both Serum Potassium & Serum Magnesium with that of FBS and HbA1c levels was not significant.

CONCLUSION: FBS levels showed significant negative correlation with Serum Sodium in type 2 diabetics and Glycosylated hemoglobin showed significant negative correlation with Serum Sodium in diabetic patients, both type 1 and type 2. Serum Potassium and Serum Magnesium were not related with FBS or HbA1c levels.

KEYWORDS : Electrolyte disturbance, HbA1c Glycosylated hemoglobin, serum magnesium, serum electrolytes,type 1 & type 2 diabetes

INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic disorders that results in hyperglycemia because of defects in insulin secretion or its action or both[1]. It is emerging as a global endemic both in developing and developed countries[2].It is characterized by recurrent or persistent hyperglycemia, and is diagnosed by demonstrating any one of the following: fasting blood sugar (FBS) level at or above 126 mg/dL, plasma glucose at or above 200 mg/dl two hours after a 75 g oral glucose load as in a glucose tolerance test (GTT), random plasma glucose at or above 200 mg/dl, (WHO report, 2006) [3].The prevalence of diabetes in India is found to be 2.4% in rural and 4–11.6% in urban population[4].

Glycosylated hemoglobin (HbA1c) is a commonly used marker for determining long-term control of blood sugar.The HbA1c test is done every 3 to 4 months, and unlike blood sugar levels, the test does not change with any recent changes in diet, exercise or medicines[5]. Higher levels, indicating poorer control of blood glucose have been associated with cardiovascular disease, nephropathy & retinopathy[6].The HbA1c assay is the basis of treatment guidelines and is used universally to adjust therapy [7,8].

The electrolytes like – sodium, potassium and magnesium, have a very important role in cellular function and intermediary metabolism including enzyme activities and electrical gradients.But, deficiency of insulin or its resistance may lead to electrolyte abnormalities. Hyperglycemia sets the internal environment for osmotic diuresis while causing a dilutional effect on electrolyte concentrations [9].The altered status of the cations may lead to diabetic ketoacidosis, hyperosmolar coma and other potential complications[10,11].

Magnesium, the second most abundant intracellular cation is an important element for health and disease. Diabetic nephropathy and other complications are most likely to be worse in concurrent magnesium deficiency[11].

Through this study we tried to understand the correlation between serum electrolytes like Sodium, Potassium & Magnesium with that of fasting blood glucose & Glycosylated hemoglobin in type 1 and type 2 Diabetes Mellitus.

MATERIALS & METHODS:

This was a hospital based cross sectional study conducted in the department of Biochemistry in collaboration with department of Medicine, at Sri Aurobindo Medical College & Post Graduate institute, Indore during the period February 2014 to July2015. A total of 150 patients from both genders, either on oral hypoglycaemic agents or insulin or both, (aged between 16 to 70) were included in the study out of which 50 were type 1diabetic patients (allocated group 1) and 100 were of type 2 diabetes mellitus (allocated group 2).Exclusion criteria include patients with gestational diabetes, kidney disease, cancer or coronary artery disease. Patients using drugs such as diuretics, other antihypertensive agents, potassium chloride or any medications known to alter electrolyte status were also excluded from the study.

Blood samples were collected after 10 to 12 hours of overnight fasting. VITROS 5,1 FS machine was used for all the tests. Serum sodium, potassium & magnesium levels (expressed in millimoles per litre, mMol/L) were estimated with the use of ISE indirect method. Fasting blood glucose level was assessed by enzymatic glucose oxidase peroxidase method (expressed in percentage) and HbA1c was estimated by turbidimetric inhibition method.

STATISTICAL ANALYSIS:

SPSS 12.0 (Statistical Package for the Social Sciences) was used to analyze the data. Demographic data were applied with descriptive

statistics like Frequency,Percentage, Mean, and Standard Deviation. Regression analysis was used to test the hypothesis and results with p value less than 0.05 were considered to be statistically significant.

Correlation coefficient was used to measure how strongly the two variables are related and the coefficient of determination (R2) was used to explain how much variability of one factor can be caused by its relationship to another factor.

RESULTS

In present study, total 150 patients were included, of which 50 patients of type 1 DM were assigned group 1 and 100 patients of type 2 DM were assigned group 2. The age range of the patients was from 16-56 years in group 1 and 32 –70 in group 2, with 46.8 ± 17.07 years as mean age of the whole study population.

Of 150, 85 patients were male (56.67 %) and 65 (43.33 %) females. The duration of diabetes ranged from 6 months to 37 years in group 1 and 8 months to 29 years in group 2. As medication, total 64 patients (50 group 1 &14 group 2) were on insulin therapy, while 80 (group 2) were on oral hypoglycaemic agents while 6 patients (group 2) were on a combination of both.

TABLE 1

Characteristics	Type 1 DM n (%)	Type 2 DM n (%)
Mean Age	26.36 ± 8.59	57.02 ± 9.26
Gender distribution		
Male	27 (54 %)	58 (58 %)
Female	23 (46 %)	42 (42 %)

Table 2 shows the mean values for the both the study groups individually. For the whole study population the mean for fasting plasma glucose was 161.84 ± 66.85 mg/ dl , HbA1c - 8.73 ± 2.50 % , Serum sodium - 133.98 ± 7.27 mMol/L, Serum potassium - 4.08 ± 0.87 mMol/L and Serum Magnesium - 1.94 ± 0.20 mMol/L. The difference between the two groups for the values was found to be significant (p value < 0.05) for fasting blood glucose, HbA1c levels and for serum sodium, while it was not significant for serum potassium and magnesium levels.

Table 2

Characteristics	Type1 DM (%)	Type2 DM (%)	p value
Mean FBS value	186.1 ± 78.14	149.71 ± 57.09	< 0.01
Mean HbA1c value	10.004 ± 2.46	8.09 ± 2.28	< 0.01
Mean Sodium levels	132.34 ± 7.06	134.81 ± 7.27	0.02
Mean Potassium levels	4.11 ± 0.68	4.06 ± 0.95	0.38
Mean Magnesium levels	1.97 ± 0.19	1.93 ± 0.20	0.16

Table 3 shows, the fasting serum glucose and HbA1c levels in the both groups (types 1 and 2 diabetics) expressed along with the R2 (coefficient of regression) and the correlation coefficients. The p values were calculated for each parameter in each group.

The association between sodium as the outcome variable and the FBS as independent variable, calculated by R2 revealed significant association (negative correlation) in type 2 group (p= 0.004) but it was insignificant in type 1 diabetic patients. The results were also insignificant for correlation of FBS with serum potassium and magnesium in both the groups.

Using the same statistical tests between HbA1c and serum electrolytes, the p value was significant when serum sodium was compared with HbA1c levels for both the groups (p value being 0.025 and 0.04 respectively, negatively correlated in both groups). The results were insignificant for correlation of HbA1c with both serum potassium and magnesium in both the groups.

When the data was analyzed for whole group it appears that neither potassium nor magnesium levels shows significant association when correlated with either FBS levels or HbA1c levels. But for Serum Sodium, the levels shows statistically significant association with both FBS levels (p= 0.001) as well as with HbA1c levels (p = 0.0004).

Table 3

Parameter		Type 1 DM	Type 1 DM	Total Patients						
		CC	R2	p value	CC	R2	p value	CC	R2	p value
FBS	Na	-0.144	0.021	0.31	-0.278	0.077	< 0.01	-0.256	0.064	< 0.01
	K	-0.106	0.011	0.46	0.124	0.015	0.219	0.051	0.002	0.534
	Mg	-0.0865	0.007	0.55	0.053	0.002	0.6	-0.042	0.001	0.607
	Na	-0.3161	0.099	0.02	-0.205	0.042	0.04	0.281	0.079	< 0.01
	K	-0.119	0.0142	0.41	0.133	0.017	0.187	0.072	0.005	0.381
HbA1c	Mg	-0.038	0.001	0.9	0.044	.002	0.66	-0.010	0.0001	0.899

CC : Correlation coefficient, R2 : coefficient of regression
p values < 0.05 considered significant

DISCUSSION

Most diabetics have a high probability of developing cardiovascular, cerebrovascular and renal complications and are frequently associated with serum electrolyte disturbances during the course of the disease. This study intends to compare the difference between serum electrolytes abnormalities in type1 and type 2 diabetic individuals & patient outcome.

In our study, the mean serum Sodium levels was 133.98 ± 7.27 mMol/L while for potassium it was 4.08 ± 0.87 mMol/L. Similar studies done in the past had shown similar results with decrease in serum sodium levels among diabetics (Na = 138.1±1.8mMol/L, K= 4.1± 0.3 mMol/Land) in study by Khalid et al[12]and (Na = 129.3 ± 5.1mMol/L , K = 4.4±0.4 mMol/L) by Noura Al Jameil[13].

Al- Rubean K et al also demonstrated significant reduction in serum sodium level among types 1 or 2 diabetic patients especially among insulin-treated patients. No significant association was demonstrated by serum potassium with FBS and degree of diabetes control[14]

In the study done by **Khalid et al**[12], the association between sodium as the outcome variable and the FBS as independent variable calculated by R2 revealed signficant association in type 1 diabetic subject, and type 2 groups. The p value was also strongly significant in the total group when looking at serum sodium with both fasting blood sugar and HbA1c.

In our study, we found a statistically significant association between serum Sodium and FBS only in type 2 diabetic patients but not in type 1 diabetic patients, but the association was significant when comparison were made for the total group.

For Glycosylated haemoglobin the association was significant in study by Khalidet al in the whole study group but not in individual groups of type 1 or type 2diabetics whereas in our study we found HbA1c to be correlated with sodium levels both for type 1 & type 2 patients and also for the total study group. There was neither a

significant correlation of serum potassium levels with FBS norwith HbA1c levels in any of the two groups. Also Serum Potassium failed to show any correlation even if the whole study population levels were considered.

Regarding mean serum magnesium in our study overall mean was 1.94 ± 0.20 mMol/L which was comparable to study by **Asha S Khubchandani (average levels 1.94 ± 0.26mMol/L)** [15]

Azad KM and Assimina found the mean Magnesium levels to be lower (0.70 ± 0.01mMol/L, and 0.79 ± 0.09 mMol/L respectively) in diabetics with poor glycmeic control and Serum Mg was negatively correlated with FBS and HbA1c respectively in Ramdass also is linked to poor control of Diabetes Mellitus type 2 and depletion of serum magnesium occurs exponentially with duration of disease. [18]

Though few of the above studies suggest a negative correlation between serum Magnesium levels and HbA1c or FBS levels, our study results conclude that the Correlation does not exist, neither between Serum Mg & FBS, nor between Mg levels & HbA1c levels both in type 1 and type 2 diabetics.

CONCLUSION

This study showed significant negative correlation of FBS levels with serum sodium in type 2 diabetics, but not in type 1 patients. But Glycosylated hemoglobin showed significant negative correlation with serum sodium in diabetic patients, both type 1 and type 2. Serum potassium and serum magnesium were not found to be associated with FBS or HbA1c levels.

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