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Original Research Article

Dyselectrolytemia in hyperglycaemic crisis patients with uncontrolled non-insulin dependent diabetes mellitus

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ABSTRACT

Background: Diabetes is a group of disorders characterized by high blood glucose levels. Disturbances in serum electrolytes sodium (Na^+), potassium (K^+) and chloride (Cl^-) is found in diabetes. The objective of the study was to investigate the disturbances in concentrations of serum electrolytes in hyperglycaemic crisis, uncontrolled non – insulin dependent diabetes mellitus patients: early detection and treatment of such abnormalities, leading to better quality of life of patients.
Methods: Data was collected prospectively over a period of 1 year and analyzed retrospectively. Of the 131 subjects included in the study, two groups were formed; 60 hyperglycaemic diabetes mellitus patients and 71 healthy volunteer as controls. Biochemical analysis for Na^+, K^+, Cl^- was performed by ISE method using Easy – lyte automatic electrolyte analyzer. The random glucose levels were estimated by direct Hexokinase enzymatic method using Cobas Interga 400. Unpaired t-test was done to find out the difference between the two paired groups and Pearson's correlation was calculated to know the correlations between electrolytes and random glucose levels.
Results: In uncontrolled diabetes mellitus, increase in serum Na^+ and Cl^- levels were observed to be highly significant ($p<0.001$, respectively) while that of K^+ showed significant ($p<0.05$) alterations
Conclusions: The study demonstrated significant association of Na^+, K^+ and Cl^- with hyperglycaemia in patients with hyperglycaemic crisis in uncontrolled type 2 diabetes mellitus. So, electrolytes should be measured during the treatment of type 2 diabetes mellitus.

Keywords: Diabetes mellitus, Electrolytes, Hyperglycaemia, Random blood glucose

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[1,2] The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, like the eyes, kidneys, nerves, heart, and blood vessels.[1,2] Electrolytes have a pivotal role in maintenance of homeostasis inside the body, regulation of heart and brain function, body fluid balance, ventilation, pH and much more.[3] Diabetes mellitus (DM) is amongst those diseases which show frequent disturbances of electrolytes and acid -base relations, especially in patients with deranged renal function and other end-organ injury, mal-absorption syndromes, acid-base imbalances and multiple drug regimens and medications for diabetes management.[4-7] The knowledge and insight of the disease process and its management, would create the way for 'pathophysiology-directed therapy', leading to prevention of the several adverse effects associated with acid-base and electrolyte disorders and their management.[5]

Main objectives of the study were successful management of uncontrolled glycaemic states like DKA and HHS requires correction of dehydration, hyperglycemia, acid – base and electrolyte imbalances; identification of co-morbid and/or precipitating events like infection; along with frequent monitoring of patients.[8] This will facilitate early detection and treatment of such abnormalities, leading to better quality of life of patients.[9] As such it is needed to be studied extensively.

This study was conducted to investigate the disturbances in concentrations of serum electrolyte in hyperglycaemic crisis patients in Non-Insulin Dependent Diabetes Mellitus in Bhubaneswar, Odisha, Indian population.

METHODS

Study was a prospective, observational, case-control study conducted on 131 subjects from 1st July 2014 to 30th June 2015.

The case group comprised of 60 diabetic patients (33 men, 27 women; mean age 45.2±10.0). The patients having hyperglycaemic crisis in Type 2 diabetes were recruited from the Department of Emergency Medicine, IMS & SUM Hospital, Bhubaneswar, Odisha, India. The cases consisted of patients diagnosed as suffering from Type 2 Diabetes according to American Diabetes Association Guidelines, 2015; since last 10 years, having Random Plasma Glucose ≥250 mg%, treated using different non – insulin therapeutic regimens and marked as Hyperglycaemic Crisis by the physician. Patients diagnosed mainly with type 2 DM less than 10 years and with conditions like renal disease, chronic illness, pregnancy and alcohol intake were excluded from the study.

A total of 71 healthy controls (35 men, 36 women; mean age 43.4±9.0) with no history of diabetes were recruited from different departments of IMS & SUM Hospital, Bhubaneswar where they came for regular health checkup. Informed consent was obtained after all participants were given an explanation of the nature of the study. They completed a structured questionnaire regarding information on age, gender, medical and family history of any chronic diseases. This study was approved by the Institutional Ethical Committee of IMS & SUM Hospital, Bhubaneswar. All the analyses were done in the Central Laboratory, Department of Biochemistry, IMS & SUM Hospital, Bhubaneswar, Odisha, India.

Sample Collection

About 2.0 mL of venous blood sample was drawn from each subject following all aseptic precautions by a trained person, using a disposable syringe in a Fluoride tube for the estimation of random glucose level. For further biochemical investigations, serum in different vials, were separated by centrifugation at 3000 rpm for 10 minutes and analyzed.

Clinical analysis

Serum analysis for Na^+, K^+ and Cl^- was performed by ISE method using Easy-lyte automatic electrolyte analyzer (Medica Corporation). Plasma glucose level was estimated by Hexokinase method using Cobas Integra 400(Roche Diagnostics) at Central Laboratory, IMS & SUM Hospital, Bhubaneswar, Odisha, India.

Statistical analysis

The results were expressed as Mean±2SD. The statistical analysis of the data was carried out with Statistical Package of Social Science (SPSS), version 20.0. The comparisons between two groups were tested by Unpaired t-test. A 95% confidence interval was used. p values of less than 0.05 were considered as statistically significant while that less than 0.001 were considered as statistically highly significant. Pearson correlation Coefficient was used to evaluate correlation between two continuous outcomes among DM. Statistical analysis was done by statistician to remove bias.

RESULTS

The Case group comprised of 60 diabetic patients (33 men, 27 women); the mean age being 45.2±10.0. The Control group comprised of 71 healthy controls (35 men, 36 women); the mean age being 43.4±9.0, with no history of diabetes were recruited from different departments of IMS & SUM Hospital, Bhubaneswar where they came for regular health checkup.

Shown in Table 1 is the comparison of age and sex distribution among the DM compared to the controls.

Table 1: Comparison of Means ± 2SD of age & sex distribution in control and diabetic groups.

Parameter	Control	Diabetic
Number ‘n’	71	60
Age (years)	43.4±18.0	45.2±20.0
Sex (M)	35	33
Female (F)	36	27

The mean random blood glucose level in Control Group is 131±10.5 whereas the same in Case group is 213.7±29.22. The mean random blood sodium level in Control Group is 137.1±7.2 whereas the same in Case group is 152.23±6.48. The mean random blood potassium level in Control Group is 4.74±0.7 whereas the same in Case group is 4.88±0.66. The mean random blood chloride level in Control Group is 101.1±6.14 whereas the same in Case group is 108.5±7.06.

Shown in Table 2 is the random glucose level significantly ($p<0.001$) higher among the DM compared to the controls. The Sodium and Chloride levels were also highly significantly ($p<0.001$, respectively) higher in DM

when compared to the healthy controls. On the other hand, the Potassium levels were significantly related ($p<0.05$) among patients and controls.

Table 2: Comparison of means ± 2SD of glucose, sodium, potassium & chloride in control and diabetic groups.

Parameter	Control	Diabetic	p value
Glucose (mg/dl)	131±10.5	213.7±29.22	<0.001
Sodium (mmol/l)	137.1±7.2	152.23±6.48	<0.001
Potassium (mmol/l)	4.74±0.7	4.88±0.66	0.027
Chloride (mmol/l)	101.1±6.14	108.5±7.06	<0.001

DISCUSSION

In present study we have observed altered levels of electrolytes, in patients with Type 2 diabetes in hyperglycaemic crisis, in Bhubaneswar. In present study we have found significantly increased levels of Sodium in Case group (Table 1). Similar findings are reported by Kavelaars et al and Danowsky TS et al.[10,11] However, contradictory findings, i.e., hyponatraemia in diabetes mellitus, are reported by Namama Talabani, McNair P et al and George Liamis et al.[4,12,13] Poorly controlled DM may lead to the development of hypernatremia.[5] Depending upon the balance between the hyperglycemia-induced water movement out of the cells lowering sodium, and the glucosuria-induced osmotic diuresis increasing sodium, serum sodium concentration is variable in patients with uncontrolled DM.[5]

Present study showed significantly increased Potassium levels in diabetes group, similar to Uribarri J et al.[14] Acid-base equilibrium and hormones including insulin and catecholamines, largely influences transmembrane potassium distribution due to reduced renal function, acidosis, release of potassium from cells due to glycogenolysis, lack of insulin and hyporeninemic hypoaldosteronism.[14] Initial hypokalemia in DKA is uncommon, implying severe total body potassium depletion in excess of that usually encountered.[15,16] In contrary to our study, Sotirakopoulos N, et al concluded that the total potassium of the body in insulin dependent as well as non-insulin-dependent patients is reduced during periods of poor control of diabetes mellitus due to the use of diuretics, and increases when the blood glucose levels are normal.[6] However, hyperkalemia without renal failure and ketonuria may imply disturbance in potassium homeostasis.[12]

Elevated serum Chloride levels were found in patients with diabetes, which was also reported by Hammeke M et al.[17] Hyperchloremic Metabolic Acidosis may be due to extracellular fluid volume expansion with sodium chloride or resulting from coexistent renal tubular acidosis or diarrhea.[17] Insulin signaling transduction pathways seem to have a vital interaction with the Renin – Angiotensin – Aldosterone System (RAAS) and in disease pathogenesis of diabetes.[18] Short – term moderate hyperglycemia without glycosuria occuring during the early stages of DM has been associated with an increase in plasma renin activity by activation of circulatory and local (intrarenal) RAAS.[19]

In uncontrolled hyperglycaemia and insulin resistance states, circulatory Renin – Angiotensin – Aldosterone System (RAAS) is suppressed whereas local Renin – Angiotensin – Aldosterone System (RAAS) is activated, leading to upregulation of AT_1 receptor along with downregulation of AT_2 receptor and increased production of aldosterone.[20,21] Activation of NAPDH oxidase causes increase in oxygen free radicals in endothelial tissue, leading to tissue damage and chronic kidney diseases.[21] As such, RAAS inhibitors form the 1st line prevention and treatment for diabetic kidney damage and prevention of progression to kidney diseases.[20,21]

In present study, we found increased level of Chloride in patients with uncontrolled hyperglycaemia in diabetes mellitus (Table 1).

CONCLUSION

The study demonstrated significant association of Na^+, K^+ and Cl^- with hyperglycaemic crisis in patients with uncontrolled type 2 diabetes mellitus. So, electrolytes should be measured during the treatment of type 2 diabetes mellitus.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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