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A comparative study of electrolyte imbalances in controlled and uncontrolled diabetes mellitus

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Abstract

Objective: Our aim is to study the pattern of electrolyte imbalances in patients with diabetes mellitus and to compare the results among controlled and uncontrolled diabetes mellitus and also to find out the correlation between electrolyte levels and HbA1c.

Methods: This Cross-sectional study was conducted in a tertiary care hospital in Kerala for a period of one month. Blood samples were collected from 77 Diabetic subjects and 15 controls who were age and sex matched. Samples were analysed for HbA1c, sodium, potassium, chloride and magnesium levels.

Results: In our present study, there was significant lowering of magnesium levels in diabetes patients. While performing Pearson correlation between HbA1c and electrolytes, there was significant negative correlation of HbA1c with magnesium. Overall analysis of our study showed that there is no significant variation in sodium, potassium & chloride levels in diabetes mellitus patients compared to non-diabetics. Variation in magnesium levels were pronounced in uncontrolled diabetes mellitus patients compared to diabetes mellitus patients whose glycemic levels were under control.

Conclusion: Magnesium imbalance is common in diabetic people in our area, compared to other electrolyte imbalances. Diabetic people should be screened for electrolyte imbalances and steps must be taken to prevent their consequences.

Keywords: Electrolyte imbalance, diabetes, HbA1c, Sodium, Potassium, Chloride, Magnesium

Introduction

Diabetes mellitus is a metabolic disorder affecting about 10% of the total populations, and 1/5th of persons above the age of 50 years.(1) India has now more than 50 million people with type-2 diabetes and is being called as the "Diabetic capital" of the world.(2) With India having the highest number of diabetic patients in the world, this sugar disease is posing an enormous health problem in the country. The WHO estimate of worldwide diabetic prevalence of 171 million in 2000 is expected to grow substantially to 366 million by 2030.(3) The International Diabetes Federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025.(4)

Fluid and electrolyte balance play important roles in maintaining the homeostasis in the body, and also in protecting cellular function, tissue perfusion and acid-base balance. The relationship between blood glucose and electrolytes is complex and electrolyte imbalance may affect the course of diabetes and its management.(5)

Diabetic nephropathy is one of the complications of diabetes mellitus, which ultimately leads to renal failure, which is also a cause of electrolyte imbalance in diabetic patients. Diabetes mellitus was identified as an independent risk factor for hyponatremia and hypomagnesemia. Various pathophysiological factors like; nutritional status, coexistent acid-base imbalance, certain drugs, other comorbid diseases like renal disease or acute illness, alone or in combination, also play a key role in electrolyte imbalance.(6) Hence we determined to study the pattern of electrolyte imbalance in patients with diabetes mellitus and to compare the electrolyte levels in controlled and uncontrolled diabetes mellitus.

Materials and Methods

This cross sectional study was carried out in Department of Biochemistry of Pushpagiri Medical college Hospital. The study was conducted for a period of one month. This study includes 77 diabetic patients with HbA1c > 6 g% and 15 non diabetic subjects with HbA1c < 6g%. After obtaining consent from the patients, blood samples were collected and analysed for Sodium (Na+), Potassium (K+), Chloride (Cl-) and Magnesium (Mg2+) levels. Exclusion criteria include patients with acute complications of diabetes, renal disorders, vomiting or other causes of fluid loss.

HbA1c was analysed based on latex enhanced immune turbidimetric assay in Toshiba 25FR fully automated analyser. Electrolytes Na+, K+ and Cl- were analysed using ISE in Beckman Coulter AU 680 analyser. Serum Mg2+ was analysed in Toshiba 25FR analyser.

The results were tabulated and statistical analysis was done using SPSS software.

Results & Observation

This cross sectional study was conducted to analyse the electrolyte abnormalities in diabetes mellitus patients. The study group comprised of 92 subjects that included 47 (51%) females and 45 (49%) males. The age group of the study subjects ranged from 35 – 90 years. For all subjects serum electrolytes and HbA1c values were estimated. Of the 92 study subjects, 15 were non diabetic (HbA1c<6 g%) and were taken as

controls and 77 were diabetic (HbA1c > 6 g%) who were grouped as cases.

Mean value of HbA1c in controls and cases were 5.49 ± 0.295 and 8.25 ± 1.75 respectively. Electrolytes such as Sodium, Potassium, Chloride and Magnesium levels were estimated and compared between cases and controls. Values were expressed as mean ± standard deviation.

Table 1: Electrolyte levels in Diabetic and Non-diabetic Subjects

	Non-diabetic	Diabetic	P value
Sodium (mmol/l)	138 + 2.16	136 + 3.5	0.16
Potassium (mmol/l)	3.9 + 0.49	4.2 + 0.47	0.25
Chloride (mmol/l)	109 + 2.14	109 + 4.7	0.73
Magnesium (mg/dl)	1.99 + 0.20	1.74 + 0.41	0.02

While performing Pearson correlation between HbA1c and electrolytes, there was significant negative correlation of HbA1c with magnesium.

Table 2: Correlations between HbA1c and electrolytes

		Sodium	Potassium	Chloride	Magnesium
HbA1C	Pearson Correlation	-0.155	-0.167	-0.005	-.218*
	Sig. (2-tailed)	0.141	0.112	0.962	0.037

Comparison of electrolytes in controlled DM and uncontrolled DM and also with control group: Subjects with diabetes were further divided into 2 groups as controlled diabetes (group 1) and uncontrolled diabetes (group 2). HbA1c values < = 7 gm % were included in group 1 and HbA1c values > = 8 were included in group 2. The number of subjects in group 1 and group 2 were 26 and 36 respectively. Their mean HbA1c & electrolyte values are given in Table 3.

Table 3: HbA1c & Electrolyte values of group 1 & 2

	Group	Number	Mean	STD Dev
HBA1C	1	26	6.542	0.2817
	2	36	9.789	1.3292
Sodium	1	26	136.67	2.438
	2	36	136.15	4.151
Potassium	1	26	4.285	0.4324
	2	36	4.011	0.4898
Chloride	1	26	108.08	2.865
	2	36	109.2	5.902
Magnesium	1	26	1.881	0.343
	2	36	1.714	0.4155

On comparing these 2 groups with the control non diabetic group, it was found that the Magnesium values were significantly lowered in uncontrolled diabetes mellitus (group 2) than the diabetic group who were under control.

Discussion

Derangement of water and electrolyte balances may occur in subjects with DM, resulting from insulin deficiency, hyperglycemia and hyperketonemia. In our present study, there was significant lowering of magnesium levels in diabetes patients. While performing Pearson correlation between HbA1c and electrolytes, there was significant negative correlation of HbA1c with magnesium. Previous studies have shown that there is alteration in sodium and potassium levels in diabetic patients.[7,8,9] In contrast to those studies, overall analysis of our study showed that there is no significant variation in sodium, potassium & chloride levels in diabetes mellitus patients compared to non-diabetics. Variation in magnesium levels were pronounced in uncontrolled diabetes mellitus patients compared to diabetes mellitus patients who were under good control.

Magnesium deficiency may play a role in the development of endothelial dysfunction and altered insulin function. Ma *et al*. demonstrated that, in African Americans and Caucasians, serum Mg^{2+}level was significantly lower in subjects with prevalent CVD and diabetes.[10] Magnesium deficiency may accelerate atherogenesis via various mechanisms like elevation of inflammatory cytokines and lipid oxidation, increase in endothelial cell growth and inhibition of cellular DNA repair.[11,12,13] The various causes of low magnesium in diabetics include low intake in diet, abnormal intracellular magnesium transport, increased renal excretion due to osmotic diuresis, use of loop and thiazide diuretics or reduced renal tubular dysfunction due to insulin resistance.[14,15] Osmotic diuresis accompanied by inappropriate magnesuria was the prominent underlying mechanism of hypomagnesemia in diabetic patients. Magnesium deficiency may have clinical importance because of its cofactor role in enzymatic reactions involved in metabolic processes. Hypomagnesemia is associated with increased likelihood or progression of retinopathy in diabetic population. Epidemiologic data suggest that populations with low magnesium intake are at increased risk for hypertension, stroke, and other manifestations of atherosclerotic disease.[16]

It has been reported that even low Mg^{2+} levels that are still within the normal reference range are associated with all-cause mortality in patients with Type 2 Diabetes mellitus.[17] There could be various causes for low magnesium levels in diabetic patients.

They include the low diet intake of magnesium, osmotic diuresis leading to renal excretion of high levels of magnesium, insensitivity to insulin affecting the magnesium transport and reducing the tubular reabsorption of magnesium, diabetic autonomic neuropathy, irrational use of thiazide and loop diuretics, etc.[14,15] Patients with hypomagnesemia are at higher incidence of poor glycemic control as well as at the risk of developing retinopathy, neuropathy and diabetic foot ulcers.[18] Various studies on electrolyte imbalances in patients with diabetes have reported that Mg^{2+} intervention may be extremely useful in the prevention and treatment of the cardiometabolic syndrome.[19]

Conclusion

Electrolytes play an important role in controlling the fluid levels, acid base balance, regulation of neurological and myocardial functions, oxygen delivery and many other biological processes. Patients with Diabetes mellitus are more prone to develop electrolyte imbalances probably due to the complications they develop and the medications they receive. Hypomagnesemia is more prevalent in our study in diabetic population than the other electrolyte abnormalities. Hypomagnesemia as well as the other electrolyte imbalances must be kept in mind in treating the diabetic cases because prompt diagnosis of them would have a potential effect in preventing the risk of contracting many diseases. Hence, Screening for electrolyte imbalances should be considered in diabetic population and necessary steps may be taken to prevent its consequences. Further multi-centric research is recommended for accurate assessment of association of diabetes and electrolyte imbalance.

References

1. Goldberg A, Hammerman H, Petcherski S, Nassar M, Zdorovyak A, Yalonetsky S, et al. Hyponatremia and long-term mortality in survivors of acute ST-elevation myocardial infarction. Arch Intern Med. 2006;166(7):781-6.
2. Joshi SR. Management of Obese Indian Patient. Indian Journal of Obesity. 2005;I(1):11-20.
3. World health organization. Diabetic programme: Country and regional data Available from: http://www.who.int/ diabetes/ facts/ world figures/ en. Accessed May 20, 2010.
4. Sicree R, Shaw J, Zimmet P. Diabetes and impaired glucose tolerance. In: Gan D, editor. Diabetes Atlas. International Diabetes Federation. 3rd ed. Belgium: International Diabetes Federation; 2006 p. 15-103.
5. Goldberg A, Hammerman H, Petcherski S, Zdorovyak A, Yalonetsky S, Kapeliovich M, Agmon Y, et al. Prognostic importance of hyponatremia in acute ST-elevation myocardial infarction.Am J Med. 2004;117(4):242-8.
6. Liamis G, Liberopoulos E, Barkas F, Elisaf M. Spurious electrolyte disorders: a diagnostic challenge for clinicians. Am J Nephrol. 2013;38(1):50-7. doi: 10.1159/000351804. Epub 2013 Jun 26.
7. Menon V U, Kumar K V, Gilchrist A, Sugathan N T, Sundaram R K, Vasantha Nair, et al. Prevalence of known and undetected diabetes and associated risk factors in Central Kerala-ADEPS. Diabetes Res Clin Pract. Dec 2006;74(3):287-292.
8. Palmer BF. Managing Hyperkalemia Caused by Inhibitors of the Renin–Angiotensin–Aldosterone System. N Engl J Med 2004;351:585-592.
9. Uribarri J, Oh MS, Carroll HJ. Hyperkalemia in diabetes mellitus. J Diabet Complications. 1990;4(1):3-7.
10. Chiasson JL, Aris-Jilwan N, Belanger R, Bertrand S, Beauregard H, Ekoe JM, et al. Diagnosis and treatment of diabetic ketoacidosis and the hyperglycemic hyperosmolar state. Cmaj. 2003,168:859-866.
11. Ma J, Folsom AR, Melnick SL, Eckfeldt JH, Sharrett AR, Nabulsi AA, et al. Associations of serum and dietary magnesium with cardiovascular disease, hypertension, diabetes, insulin, and carotid arterial wall thickness: the ARIC study. Atherosclerosis Risk in Communities Study. J Clin Epidemiol. 1995;48(7):927–940. doi: 10.1016/0895-4356(94)00200-A. [PubMed]
12. Larsson SC, Orsini N, Wolk A. Dietary magnesium intake and risk of stroke: a meta-analysis of prospective studies. Am J Clin Nutr. 2012;95(2):362–366. doi: 10.3945/ajcn.111.022376. [PubMed].
13. Rodriguez-Moran M, Guerrero-Romero F. Low serum magnesium levels and foot ulcers in subjects with type 2 diabetes. Arch Med Res. 2001;32(4):300–303. doi: 10.1016/S0188-4409(01)00298-3.[PubMed]
14. Schulze MB, Schultz M, Heidemann C, Schienkiewitz A, Hoffmann K, Boeing H. Fiber and magnesium intake and incidence of type 2 diabetes: A prospective study and meta-analysis. Arch Intern Med.2007;167:956–65. [PubMed]
15. Paolisso G, Sgambato S, Passariello N, Giugliano D, Scheen A, D'Onofrio F, et al. Insulin induces opposite changes in plasma and erythrocyte magnesium concentrations in normal man. Diabetologia.1986;29:644–7. [PubMed].
16. A. Ascherio, E.B. Rimm, M.A. Herna´n, E.L. Giovannucci, I. Kawachi et al. Intake of Potassium, Magnesium, Calcium, and Fiber and Risk of Stroke Among US Men. Circulation 1998;98:1198-1204.
17. Neha Sharma, Umesh Kumar Pareek, Avdheshkumar Sharma, Ketan Mangukiya, Mali KL, Kaushik GG. Comparative study of role of Macro minerals & Electrolytes with Atherogenic index of plasma in Diabetic men and women. Medical Science, 2014,13(50),32-38.
18. Arundhati Dasgupta, Dipti Sarma, Uma Kaimal Saikia. Hypomagnesemia in type 2 diabetes mellitus. Indian J Endocrinol Metab. 2012;16(6):1000-1003.doi: 10.4103/2230-8210.103020.
19. Barbagallo M, Dominguez LJ. Magnesium intake in the pathophysiology and treatment of the cardiometabolic syndrome: where are we in 2006? J Cardiometab Syndr. 2006;1(5):356–357. doi: 10.1111/j.1559-4564.2006.06104.x. [PubMed]