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Comparative Study of Serum Magnesium, Calcium, Potassium and Sodium Levels in Diabetics and Hypertensives with Acute Myocardial Infarction

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Abstract:
Introduction: *The importance of extracellular and intracellular magnesium has become gradually recognized during the last century. At the present moment, pathologies as common as diabetes, hypertension and dyslipidaemia are associated with an altered metabolism of magnesium.*
Aim: *Study included diabetics and hypertensives with Acute Myocardial Infarction to compare the levels of cations in these subgroups and also to find out any association of cation disturbances with these metabolic disorders.*
Materials & Methods: *Study was conducted in 75 patients (n=75) admitted to the intensive coronary care unit (ICCU) with chest pain and provisional diagnosis of Acute Myocardial Infarction (AMI). All the 75 patients were studied serially on 1st day of admission, 3rd day and 7th day after AMI. Patients without serious disease who were seen in the outpatient departments and healthy volunteers were taken as controls (n=30).*
Results: *There is significant decrease in Serum Magnesium and Serum Potassium levels in hypertensives and Diabetics on 1st day of AMI when compared to controls ($p<0.01$) with no significant change in $S.Ca^{+2}$ and $S.Na^{+}$ levels ($p>0.05$). There is significant decrease in Serum Magnesium levels in cases with diabetes ($p<0.05$) when compared to cases without diabetes. There is lowering of Serum Magnesium levels in cases with Hypertension when compared to cases with out hypertension , but there is no statistical significance. There is no statistically significant change in other electrolytes in cases with and without diabetes and in cases with and without hypertension.*
Conclusion: *There is significant decrease in Serum Magnesium levels in Diabetics with AMI when compared to cases without diabetes and lowering of $S.Mg^{+2}$ level in hypertensive cases with AMI, with no significant change in $S.Ca^{+2}$ and $S.Na^{+}$ levels.Low Magnesium Levels may be a cause or effect of Diabetes*
Keywords: *AMI (Acute Myocardial Infarction), Diabetes Mellitus, Magnesium.*

I. Introduction

Study included diabetics and hypertensives with Acute Myocardial Infarction to compare the levels of cations in these subgroups and also to find out any association of cation disturbances with these metabolic disorders. The importance of extracellular and intracellular magnesium has become gradually recognized during the last century. At the present moment, pathologies as common as diabetes, hypertension and dyslipidaemia are associated with an altered metabolism of magnesium, and this divalent cation is even being considered as a potential tool in the prevention or co-adjuvant treatment of ventricular arrhythmias, coronary heart disease and cirrhosis of the liver, among others.[1]

Habitually low intakes of magnesium and resulting abnormal magnesium metabolism are associated with etiologic factors in various metabolic diseases, in particular: cardiovascular; blood pressure; skeletal growth & osteoporosis; and diabetes mellitus.[2] Magnesium is essential for potassium transport. Evidence suggests that a deficit of magnesium is closely interrelated to potassium deficiency and refractory potassium repletion. Numerous experiments and clinical observations have credited magnesium with a positive influence on the incidence of migraine attacks.[3] Reduced erythrocyte magnesium (Mg) levels have been reported in the chronic pain syndromes: fibromyalgia syndrome (FS), chronic fatigue syndrome (CFS), myofascial pain syndrome (MPS) eosinophilia myalgia syndrome (EMS) and systemic lupus erythematosus (SLE). Calcium interacts with sodium, potassium and magnesium to help regulate blood pressure. Sodium helps regulate blood pressure and water balance in cells. Helps maintain acid-base balance and aids in muscle contraction and nerve impulse transmission. [4]

II. Materials and Methods

Study was conducted in 75 patients (n=75) admitted to the intensive coronary care unit (ICCU) of department of Cardiology and Acute medical care unit department of Medicine, Gandhi Hospital, with chest

pain and provisional diagnosis of Acute Myocardial Infarction (AMI). All were electrocardiographically proved cases of AMI ranging in age from 32-76 years with mean age of 54.1 ±11.2 (Males-45 and Females-30).

Patients without serious disease who were seen in the outpatient departments and healthy volunteers were taken as controls (n=30) with mean age of 49±9.9 (Females-14, Males-16). Diabetics were excluded and no control subject has a history or electrocardiographic evidence of ischemic or rheumatic heart disease, hypertension, congestive heart failure or renal failure. None was receiving any sort of medication.

Venous blood was collected under aseptic precautions after consent is taken and RBS, Blood Urea and Serum Creatinine were estimated to rule out diabetes and renal pathology among controls. Serum Magnesium, Calcium, Potassium and Sodium were estimated in both control and study groups. S. Magnesium was estimated by calmagite kit method.[5] S.calcium was estimated by O-cresolpthalein kit method [6] and S. electrolytes were estimated by flame photometry method.[7]

The following data were recorded in study group- age, sex, medication at the time of admission, treatment for hypertension and heart failure was registered. All patients were monitored with continous electrocardiogram (ECG) registration. All the 75 patients were studied serially on 1st day of admission, 3rd day and 7th day after AMI. Written consent was taken from each patient for participating in the study.Five ml of venous blood was collected on each occasion in plain sterile bottle and allowed to clot. Serum was separated immediately for estimation of serum creatinine, serum magnesium, calcium and electrolytes. Two ml of blood was taken in oxalate fluoride bottles on 1st day for estimation of Blood sugar and Blood urea. Random blood sugar was measured by King and Asatoor method. Blood urea was measured by Di acetyl monoxime (DAM) colorimetric method and serum creatinine by Jaffes alkaline picrate method.

Inclusion criteria

1) Patients with fresh, first attack of AMI proved by history, ECG findings or cardiac enzyme analysis.
2) Patients with or without diabetes and hypertension.

Exclusion criteria

1) Patients with renal failure.
2) Patients with other cardiovascular problems like cardiomyopathy, rheumatic or valvular heart diseases based on history and echocardiography reports.
3) Estimated time of infarction > 24 hrs prior to admission i.e. window period > 24hrs.

III. Results

Seventy five patients (n=75) with established ischemic heart disease were studied and their mean age being 54.1±11.2 ranging from 32-70 years. They were studied serially on 1st, 3rd and 7th day after Myocardial Infarction attack. Hence 75 patients were included under the study group (n=75). Study group (Group-I) was classified into three sub groups i.e. sub group Ia, Ib, Ic, i.e. 1st day , 3rd day and 7th day follow up study respectively. Out of 75 cases 25 cases were hypertensive (n=25) and 20 cases (n=20) were diabetic.

Thirty subjects without any heart disease and renal pathology, who were in control group the mean serum Magnesium was 1.08 ±0.26 mmol/litre and mean Ca^{+2} was 9.45±1.134 mg%. Mean serum Na^{+} and K^{+} were 137.38 ±3.67 meq/1 and 4.21 ± 0.394 meq/L respectively. (Table-1) Statistical analysis was made between control and subgroups Ia and Ib and Ic. Analysis is performed by student t-test. There is significant decrease in all the parameters on 1st day of myocardial infarction ($p<0.01$) with more significance ($p<0.001$) in case of serum Magnesium and Serum Potassium levels, but there was no significant difference between control and groups Ib and Ic ($p>0.05$) in all the parameters. Intra group comparisons are showing a progressive increase in serum Magnesium and serum Potassium, $S.Ca^{+2}$ and $S.Na^{+}$ levels by 7th day of follow up reaching near control values .(Table -1)

Table-1 Mean + SDs of Serum electrolytes in control and study groups on three days of follow up

Parameter	Control Group (n=30)	Study Group (n=75) Group I		
		Ia (1st day) (n=75)	Ib (3rd day) (n=75)	Ic (7th day) (n=75)
Serum Magnesium (mmol/L)	1.08 ± 0.26	0.74 ± 0.21***	0.956 ± 0.176	1.11 ± 21
Serum Calcium (mg/dl)	9.45 ± 1.13	7.04 ± 0.84**	8.6 ± 0.84	9.34 ± 0.97
Serum Sodium (meq/L)	137.38 ± 3.67	129.1 ± 10.12**	136 ± 6.55	139 ± 4.05
Serum Potassium (meq/L)	4.21 ± 0.39	2.92 ± 0.76***	3.41 ± 0.59	3.69 ± 0.601

***(p<0.001)**(p<0.01)

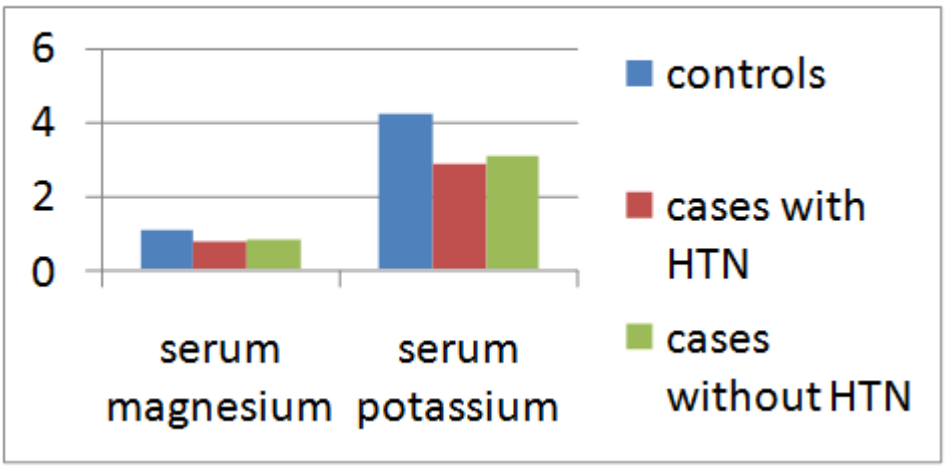
Mean levels of $S.Mg^{+2}$, Ca^{+2}, Na^{+} and K^{+} were compared in cases with and without Diabetes and Hypertension. [Table-2] There is significant decrease in Serum Magnesium and Serum Potassium levels in hypertensives and Diabetics when compared to controls ($p<0.01$) with no significant change in $S.Ca^{+2}$ and S. Na^{+}levels ($p>0.05$). Serum Magnesium level in cases with Diabetes is significantly lower than in cases without diabetes ($p<0.05$) . There is lowering of $S.Mg^{+2}$ in cases with hypertension in AMI cases but there is no statistical significance. There is no significant change in other electrolyte levels in the different groups (Table-2) Fig-1 & Fig-2.

Table-2 Mean+SD of electrolyte levels in cases with and without hypertension and diabetes respectively.

	Control (n=30)	**Cases with Hypertension (n=25)**	**Cases with Diabetes (n=20)**	**Cases without Diabetes and Hypertension (n=30)**
Serum Magnesium (mmol/L)	1.08 ± 0.26	0.74 ± 0.14	0.68 ± 0.24*	0.789 ± 0.24
Serum Calcium (mg/dl)	9.45 ± 1.13	8.23 ± 1.07	8.35 ± 1.00	8.4 ± 0.25
Serum Sodium (meq/L)	137.38 ± 3.67	127.8 ± 11.47	132.3 ± 10.5	133.8 ± 0.88
Serum Potassium (meq/L)	4.21 ± 0.39	2.88 ± 10.77	3.3 ± 0.94	3.1 ± 0.94

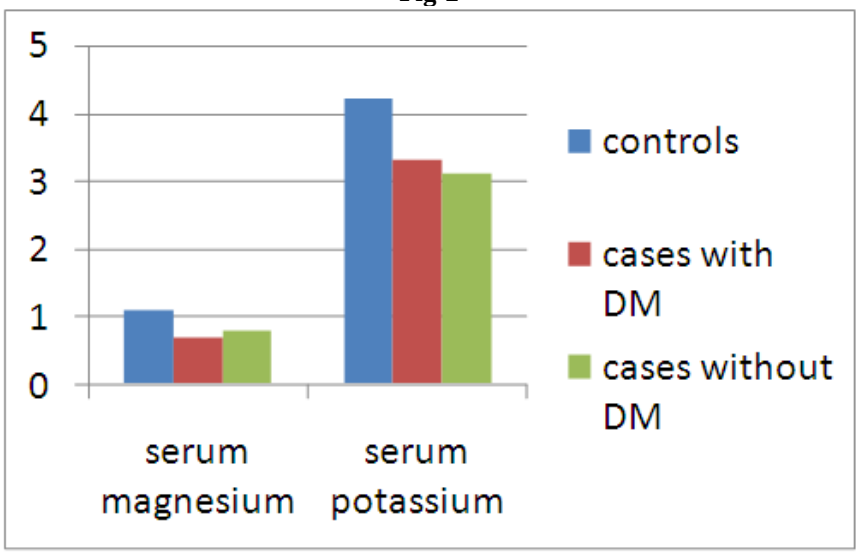
*($p<0.05$)

Fig-1



Serum Mg & Sr. K levels in Controls, Cases with and without Hypertension

Fig-2



Serum Mg & Sr. K levels in Controls and in Cases with and without Diabetes mellitus

IV. Discussion

There is significant decrease in Serum Magnesium levels in Diabetics with AMI when compared to cases without diabetes ($p<0.05$) and lowering of $S.Mg^{+2}$ level in hypertensive cases with AMI, with no significant change in $S.Ca^{+2}$ and $S.Na^{+}$ levels ($p>0.05$). Low magnesium levels in diabetic and hypertensive cases is due to the effect of treatment with diuretics or due to glucosuria which increases urinary Mg^{+2} losses. [8,9,10,11,12,13] Poor dietary intake, autonomic dysfunction altered insulin metabolism, glomerular hyperfiltration, osmotic diuresis recurrent metabolic acidosis, hypophosphatemia & hypokalemia may be contributory [14,15,16,17] So contributory mechanisms for hypomagnesemia are multifactorial.

Hypomagnesemia has been reported to occur in 13.5 to 47.7% of non hospitalized patients with type 2 Diabetes Mellitus compared with 2.3 to 15% among their counter parts without Diabetes Mellitus. [18,19,20,21,22,23]

Hypomagnesemia may induce altered cellular glucose transport, reduced pancreatic insulin excretion, defective postreceptor insulin signaling and altered insulin receptor interactions .[24] So Hypomagnesemia may be both cause and effect of impaired glucose metabolism. Our finding is in accordance with other studies. [19,20,23]

In adults, low serum and intracellular magnesium concentrations are associated with Insulin resistance, impaired glucose tolerance and decreased insulin secretion.

Low level of magnesium predisposes to increase in arterial pressure as Mg^{+2} acts peripherally to produce peripheral vasodilation and hence fall in blood pressure.

Low magnesium levels may promote endothelial cell dysfunction & aggregation and thrombogenesis via increased platelet aggregatioin and vascular calcifications [25] and may also lead to the induction of proinflammatory and profibrinogenic response. [26,27]

V. Conclusions

There is significant decrease in Serum Magnesium levels in Diabetics with AMI when compared to cases without diabetes and lowering of $S.Mg^{+2}$ level in hypertensive cases with AMI, with no significant change in $S.Ca^{+2}$ and $S.Na^{+}$ levels..Low Magnesium Levels may be a cause or effect of Diabetes..Maintaining the normal serum levels of Magnesium can prevent the development of Diabetes mellitus.

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