ORIGINAL PROF-625

DIABETES MELLITUS;
ROLE OF MAGNESIUM

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ABSTRACT

OBJECTIVE: To study the effects of magnesium supplementation on electrolytes homeostasis, lipid profile and metabolic control. **DESIGN:** Twenty six non-insulin dependant diabetic patients before and after two months magnesium administration orally. **SETTING** Patients selected from OPD Medical Units, B. V. Hospital, Bahawalpur. **PERIOD:** 1998 to 2000. **SUBJECTS** : 26 non-insulin dependant diabetic patients of both sex, age-ranged 40-80 years. **METHODOLOGY**: Various biochemical kit methods used by spectrophotometery, serum calcium and magnesium were analyzed by atomic absorption spectrophotometer. **RESULTS:** Serum Mg and Ca levels were found to be lower significantly in diabetic patients as compared to controls. But after magnesium supplementation, these levels were sufficiently increased. Clinically, lipids levels and metabolic control (glucose and HbA1c) were improved significantly along with anti-diabetic therapy. **CONCLUSIONS:** Magnesium supplements to the NIDDM patients have beneficial effects on electrolyte metabolism as well as overall metabolic homeostasis.

INTRODUCTION

Magnesium is one of the most plentiful elements which forms about 2.5% of crust of the earth[1]. It is widely distributed in the nature, however, milk is a relatively poor dietary source (10-11 meq/L)[1]. Daily intake of magnesium is 20-40 meq. Adult human body contains 21-28 gms (2000 meq). Out of which approximately 50% is distributed in bones[2]. Magnesium is the fourth most abundant cation in

the body and the second most plentiful intra-cellular cation, next to potassium[3].

Previous studies showed that magnesium metabolism is altered in patients with diabetes mellitus[4,5]. In diabetic ketoacidosis, gross urinary loss of magnesium occurred and marked hypomagnesemia developed during insulin therapy[5,6].

In type II diabetic patients, hypomagnesemia can be both a consequence or a cause of increased insulin resistance[7]. The fact that chronic magnesium supplements in diabetic patients improves both Islet beta cell response and insulin action[8], favors the hypothesis that hypomagnesemia is closely related to insulin resistance in these patients. It has been suggested that type II diabetic patients may be benefitted from chronic therapeutic administration of magnesium salt[8].

PATIENTS & METHODS

The study was carried out on 26 non-insulin dependant diabetic patients who were selected from OPD B.V. Hospital Bahawalpur. General characteristics and criteria of the patients included in the study were as under;

The patients were using oral hypoglycemic agents (OHA) like sulphonylureas and bigunides for the last 5-12 years.

1. Age	2. Sex	3. Weight	4. B P	5. Liver functions	6. Renal functions	7. Duration of disease	8. Glycemic control	9. Socioeconomic status
40-80 yrs	M & F	50-70 kg	Normal	Normal	Normal	5-12 yrs	Insufficient	Average Pakistani

Control group of 25 non diabetic normal healthy subjects were selected from the general population, matching for age, sex, weight and socioeconomic status. Fasting blood samples were obtained from patients and controls after an overnight fast. Serum was extracted and analyzed for the following parameters;

1. Serum magnesium and calcium by PYE Unicom SP-9 Atomic Absorption Spectrophotometer.

2. Serum sodium and potassium by Corning 410 C Flame Photometer.

3. Serum lipids, total cholesterol, triglyceride, LDL-cholesterol and HDL-cholesterol by kit method of Bohringer Mannheim Gmb H Diagnostic.

4. Serum glucose by a chemical kit of Human Laboratories Ltd.

5. Glycosylated HbA_{1c} was measured in whole blood by modified Ion-exchange chromatography, using assay kit of Human Laboratories.

MAGNESIUM SUPPLEMENTATION TO DIABETIC PATIENTS

Daily each patient was given 245 mg magnesium as 2 grams of MgI_2, $6H_2O$, filled in empty capsules up to a period of 2 months. The patients also continued their anti-diabetic therapy in the form of oral hypoglycemic agents.

Blood samples were again drawn and analyzed in the same way for the same parameters. Statistical significance of the results was assessed by a student's "t" test.

RESULTS

Table-I. The Data of normal controls and diabetic patients with non insulin dependant diabetes mellitus (NIDDM).

Characteristics	Patients	Controls
Number	26	25

Table-I. The Data of normal controls and diabetic patients with non insulin dependant diabetes mellitus (NIDDM).

Characteristics	Patients	Controls
Gender (M/F)	11/15	10/15
Age (years)	65.2±8	64.9±8
Weight	67.5±5.0	65.8±5.6
BP systolic (mmHg)	126±14	128±15
Diastolic	78±9	75±8
Duration of NIDDM (Yrs)	7.5±1.1	-
Duration of OHA use (years)	6.7±2.0	-

Table I indicates basic and general informations of controls and patients with non-insulin dependant diabetes (NIDDM). The mean values of age, gender ratio, weight and blood pressure appeared to be almost non-significant between controls and patients.

Table II shows that the serum magnesium and calcium levels were significantly lower (P<0.001) in patients before magnesium supplementation than controls but after magnesium intake these levels were elevated significantly, reaching nearly the control values. Serum potassium and sodium did not differ significantly from controls but after intake of magnesium for the period of two months, the serum potassium levels sufficiently increased, even exceeded the control values.

Table-II. Comparison of metabolic data in patients with non insulin dependant diabetes mellitus (NIDDM) before and two months after magnesium administration orally (245 mg magnesium/day). The values are shown in mean ± SD.

Biochemical parameters	Controls (n=25)	No of patients (n=26)	
		Before Mg	After Mg
S. ELECTROLYTES			
Magnesium (mEq/L)	1.72±0.09	1.41±0.22***	1.70±0.10d
Calcium (mEq/L)	5.00±0.30	4.52±0.35***	4.90±0.31c
Potassium (mEq/L)	4.00±0.23	3.90±0.21	4.10±0.22a
Sodium (mEq/L)	140±9.0	137±8.0	138.9±10
S. LIPID PROFILE			
Triglyceride (mg/dl)	130±90	149±14**	138±10a
Cholesterol (mg/dl)	196±38	231±31***	218±27b
LDL-cholesterol (mg/dl)	129±21	169±25	145±22
HDL-cholesterol mg/dl	47±7	35±6*	43±7b
METABOLIC CONTROL			
HbA_{1c} (Gm%)	4.6±0.6	8.9±0.9***	8.4±0.7a
S. Glucose (mg/dl)	88±9	219±24***	201±20a

Level of significance: *P<0.05, **P<0.02, ***P<0.001 as compared to controls.
a. P<0.05, b. P<0.02, c. p<0.01, d. P<0.001 after Mg than before.

The mean values of serum triglycerides and cholesterol were significantly higher and HDL-cholesterol was

significantly lower in diabetic patients than those of controls. After the use of magnesium, the serum triglycerides and cholesterol decreased significantly, P<0.05 and P< 0.02 respectively. Clinically serum HDL–cholesterol was also improved significantly (P<0.02) whereas LDL-cholesterol did not show any significant difference statistically before and after magnesium as compared with controls (table II).

As far as the metabolic control is concerned, the glucose and blood HbA_{1c} in diabetic patients were significantly higher (P<0.001) than the normal limits of control values. However, these parameters were found to be reduced significantly (P<0.05) when observed after magnesium supplementation at least for up to two months (table II). Values are indicated as mean ±SD, OHA=Oral hypoglycemic agents.

DISCUSSION

Magnesium is an essential element as a cofactor in both glucose transporting mechanism of cell membranes and various enzymes important in carbohydrate oxidation. Previous studies have reported low serum and erythrocytes magnesium levels in non insulin dependant diabetic patients[9,10]. Low serum magnesium levels have also been shown to contribute to glucose homeostasis impairment in magnesium deficient rats[11].

The present study shows that the mean values of serum magnesium and calcium were significantly lower (P<0.001) in 26 non insulin dependant diabetic patients than controls but after two months magnesium supplementation (245 mg/day), these values were elevated significantly. The serum potassium and sodium levels were already within lower normal limits, not differing from controls but after the use of magnesium salt, further increase in their levels was observed. The potassium level even exceeded the controls and became significant (P<0.05) as compared to the level before magnesium consumption. Clinically, lipid profile and the metabolic control (s. glucose and HbA_{1c}) was also improved in diabetic patients on magnesium intake.

In the light of present findings, it has been hypothesized that a long term administration of magnesium salt produces beneficial effects on electrolytes and lipid metabolism as well as on glucose homeostasis in elderly non insulin dependant diabetic subjects suggesting that the element may slightly enhance β-cell response of endocrine pancreas to glucose[12]. Magnesium concentration modulate intra cellular potassium and a good β-cell response, though not demonstrated, may be secondary to an increase in potassium and calcium levels[13]. As far as the metabolic control is concerned, we believe that appropriate or restored intracellular magnesium content might improve insulin action, as suggested by Durlach and Rayssigneir[14]. Furthermore, a possible simple relationship between improved metabolic control and enhanced β-cell response to nutrients or a combination of both possibilities can not be excluded.

In conclusion, our present study highlights that magnesium supplementation improves the overall metabolic homeostasis and thus may be a useful adjuvant to the classic hypoglycemic agents in the treatment of non insulin dependant diabetic subjects.

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