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### Original Article

# Hypomagnesaemia in Diabetic patients and Biochemical action on the cardiovascular system

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#### ABSTRACT

**Introduction:** Diabetes Mellitus (DM) is a chronic disorder resulting from a number of factors in which an absolute or relative deficiency of insulin or its function occurs. It is projected that by the year 2025, India alone would have 57 million diabetics mainly of type 2 diabetes constituting 90% of the diabetic population. The most important risk factors contributing to the development of CHD include lipid disorders. Cardiovascular complications are the leading cause of mortality and morbidity in diabetics. **Material Methods:** In this study 40 subjects newly diagnosed with NIDDM, aged 35-55 years were selected. Among 39 subjects' 20 are males and 20 were females. 40 subjects of normal health individuals aged 35-55 years were selected for comparing with NIDDM subjects. 12hrs overnight fasting and a post prandial venous blood samples were collected and separated by centrifugation at 2000 rpm for 10 min separated samples same day done for estimation of serum magnesium, lipid profile, FBS AND PPBS were measured by commercial kits. **Statistics:** P<0.05 statistically significant, using these methods the effect of diabetic control on the levels of serum magnesium in diabetic patients was studied with correlation parameters cholesterol, triglycerides, HDL. The difference between the groups were assessed by the student t test for independent samples. Linear regression analysis was done to know the association between the variables. **Results:** In diabetic patients serum cholesterol, triglycerides levels were higher than the healthy control levels. **Discussion and Conclusion:** Excess lipids in blood may lead to major complications like atherosclerosis, hypertension. Serum magnesium levels were found decreased comparing with controls. This may lead to myocardial ischemia, cardiac diseases. So magnesium levels could be a cause and consequences of DM and high levels of lipids may be lead to cardiovascular risk.

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### 1. Introduction

Diabetes Mellitus (DM) is a chronic disorder resulting from a number of factors in which an absolute or relative deficiency of insulin or its function occurs. It is projected that by the year 2025, India alone would have 57 million diabetics mainly of type 2 diabetes constituting 90% of the diabetic population [1-2]. The most common and life threatening disorder that besets type 2 diabetic subjects is coronary heart disease (CHD). Irrespective of the ethnic background the risk for CHD among diabetic subjects is

greater by a factor of 2 to 4 compared to non-diabetic subjects [3]. Magnesium has a wide spread distribution being particularly concentrated in the bone, muscle and heart. It is a cofactor for over 300 enzymes particularly for those concerned with ATP and energy production. [4] Magnesium is also required for normal DNA function, cell permeability regulation and neuromuscular excitability. Magnesium is necessary for both the release and function of the parathyroid hormone and formation of 25-OH D3.

Approximately 50% of total body magnesium is found in bone. The other half is found predominantly inside cells of tissues and organs. Only 1% of magnesium is found in blood. Low magnesium is linked to a higher incidence of ischemic heart disease and cardiac death [5,6,7] and magnesium deficiency in skeletal muscle has been observed in patients who had a myocardial

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infarction.[8].Adeficiency of magnesium may result in an increased neuromuscular and cardiac excitability whilst on excess of the caution lead to depressed muscle performance or paralysis.[4]. Hypomagnesaemia occurs frequently in diabetic patients, especially those with poor glycaemic control [9]. Increased magnesium intake may improve insulin secretion and action [10,11], dyslipidaemia [12,13], and endothelial dysfunction [14], and decrease thrombotic tendency [15] and vascular contractility [10,15,16]. Hypomagnesemia has been related as a cause of insulin resistance, also being a consequence of hyperglycemia, and when it is chronic leads to the installation of macro and microvascular complications of diabetes, worsening the deficiency of Mg.[17,18]

The mechanism involving the DM and hypomagnesemia was still unclear, although some metabolic studies demonstrate that Mg supplementation has a beneficial effect in the action of insulin and in the glucose metabolism. [19,20]. Magnesium is known to play an important role in carbohydrate metabolism and its imbalance has been implicated in diabetes mellitus both as dietary magnesium and low serum magnesium levels. These are being recently implicated as risk factor for hypertension, diabetes mellitus and coronary artery disease. In view of these associations it was decided to study the relation between the diabetes and glucose control on one hand and serum lipids and magnesium on the other hand our baim is to study the change in circulating magnesium levels in diabetic patients wiseversa those in healthy controls,to evaluate the serum lipids in these patients as they are cardiovascular risk factor and to compare the serum magnesium levels in well controlled and not so well controlled in diabetic patients.

## 2. Material Methods

In this study 40 subjects newly diagnosed with NIDDM,aged 35-55 years were selected. Among 39 subjects' 20b are males and 20 were females.40 subjects of normal health individuals aged 35-55 years were selected for comparing with NIDDM subjects.Among the subjects 20 male and 20 female. 12hrs overnight fasting and a post pandrial venous blood samples were collected and separated by centrifugation at 2000 rpm for 10 min separated samples same day done for estimation of serum magnesium, lipid profile, FBS AND PPBS were measured by commercial kits.

### 2.1 Statistical analysis

P<0.05 Statistically significant, using these methods the effect of diabetic control on the levels of serum magnesium in diabetic patients was studied with correlation parameters cholesterol,triglycerides,HDL.The difference between the groups were assessed by the student t test for independent samples.Linear rtegression analysis was done to know the association between the variables

## 3. Results

**Table A: Age and sex distribution of the study population.**

Group	Number	Age (M±SD)	Male	Female
Control	40	48.3 ± 11.6	20	20
NIDDM	40	55.2 ± 10.2	20	20

**Table B: Biochemical parameters levels studied (M ±SD)**

Group	FBS (mg/dl)	Serum Cholesterol (mg/dl)	Serum Triglycerides (mg/dl)	Serum HDL (mg/dl)	Serum Magnesium (mg/dl)
Control	85.57±12.08	174.05±34.67	109.28± 62.39	43.20± 8.09	2.26± 0.24
NIDD	112.77± 41.89	195.13± 37.30	162.6± 101.4	47.28± 10.10	1.98± 0.32
Mp Value	<0.001	<0.05	<0.05	NS	<0.001

**Table C: Effect of diabetic control on the parameters studied (M ± SD)**

Group	Serum Cholesterol(mg/dl)	Serum Triglycerides (mg/dl)	Serum Magnesium (mg/dl)
FBS	186.06± 48.36	138.75± 79.02	2.42± 0.28
FBS	202.04± 46.96	190.54± 134.89	1.88 ± 0.32
pVALUE	NS	NS	<0.01

The blood levels of plasma FBS in NIDDM was found to be 112.77± 41.89 mg/dl as compared with control values 85.57 ± 12.08 mg/dl. This was found to be statistically significant (p<0.001).

#### 4. Discussion

Diabetes Mellitus is a chronic disease with altered carbohydrate metabolism. The total metabolic interactions of insulin products and its major role will be arrested and altered. Type -II diabetes, an end product of years of metabolic stress accompanying a state of insulin resistance is a chronic disorder [21]. The most important risk factors contributing to the development of CHD include lipid disorders. Cardiovascular complications are the leading cause of mortality and morbidity in diabetics. Framingham heart study (1974) demonstrated a direct association between diabetes and heart failure [22]. Diabetes patients with magnesium deficiency are at an increased risk of cardiovascular death, but none of these cardiac complications were seen in our patients, and although hypomagnesaemia is associated with low HDL cholesterol, high total cholesterol, and triglyceride levels[23,24]. The blood levels of FBS in NIDDM as compared with controls were found to be statistically significant (<0.001) and cholesterol, triglycerides, magnesium in NIDDM as compared with controls were found to be statistically significant but HDL were found to be not significant. The association between serum magnesium and blood sugars leads to several complications in human systems consequently triglycerides and HDL will also increase and causes major complications such as myocardial infarction and cardio vascular disease. Linear increase of HDL and Triglycerides, Cholesterol with serum magnesium levels were observed consistently over age groups and both sexes. In this study cholesterol, Triglycerides, HDL values showed significant increased with serum magnesium level irrespective of glucose level. Serum magnesium was significantly low in diabetics. Hypomagnesaemia in diabetic is usually observed in patients with deficient metabolic control, or associated to the DM chronic complications, according to clinical and epidemiological studies.[25,26] The responsible mechanisms for Mg deficiency in patients with diabetes have still not been clarified, mainly about the impact in the insulin resistance, in the development of diabetes and its chronic complications.[27,28,29]. The scientific evidences indicate the role of the calcium and Mg as mediators of the insulin action. In the DM occur chronic alterations of homeostasis of Mg intracellular, unchained by the unbalance between calcium and Mg.

Other studies had demonstrated positive effect in the administration of insulin over intracellular Mg concentrations. One of them, demonstrated an improvement of the intracellular Mg concentration in obese children and patients with type 1 and 2 DM, after the stimulation with 100 mU/mL of insulin.[30]. Despite of the deduction that the hypomagnesaemia is caused by the diabetes and not the opposite, the Mg deficiency also can influence in the onset of this disease. Hypomagnesaemia has been hypothesized to play a role in coronary heart disease. In renal disease mostly moderate hypomagnesaemia is seen. In hypertension magnesium levels might be lowered but their measurement does not seem relevant. In prediction of the severe pre eclamasia elevated magnesium concentration may play a role. Cardiac diseases are related to diminished magnesium levels, during myocardial infarction serum magnesium drops.[31]. Low serum magnesium level is a strong independent predictor of type 2 diabetics in white participants. Low dietary magnesium intake does not confer risk for type 2 Diabetes Mellitus replies that compartmentalization and renal handling of magnesium level and the risk for type 2 Diabetes[32]. Deficiency of magnesium is closely linked to abnormalities in calcium and

potassium metabolism. A fundamental interaction between magnesium and other ions seems to occur at the cellular level. Intracellular calcium concentrations are controlled within narrow limits, with transient increases rapidly returning to normal levels. The release of intracellular calcium plays a key role in many cell functions, both basic (cell division and gene expression) and specialized (excitation, contraction and secretion) [33]. Magnesium leads to improved insulin production in elderly people with NIDDM. Elders without diabetes can also produce more insulin because of magnesium supplements, according to some[34], but not all studies[35]. Metabolic abnormalities and cardio vascular vrisk are greater in these patients with upper body fat distribution middle age obese population can maintains normal circulating levels of magnesium in type 2 diabetics or older subjects magnesium status is intered.[36].

High temperatures would increase sweat losses and, consequently, among the minerals, Mg would be the most affected, because the losses would not be compensated by the diet and water intake. Magnesium is a critically important nutrient and a useful therapeutic agent. Depletion of magnesium and hypomagnesemia are relatively common but difficult to diagnose and have been implicated in several disorders. Hypomagnesemia has been hypothesized to play a role in Cardiac heart disease. Low magnesium concentration may contribute to the pathogenesis of coronary atherosclerosis.

#### 5. Conclusion

In diabetic type 2 patients serum cholesterol, triglycerides levels were higher than the healthy control levels, So Excess lipids in blood may lead to major complications like atherosclerosis, hypertension. Serum magnesium levels were found to decrease comparing with controls. This may lead to myocardial ischemia, cardiac diseases. Conclusion of our study magnesium levels could be a cause and consequences of DM and high levels of lipids may be lead to cardio vascular risk.

#### 6. References

- [1] King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025. Prevalence, numerical estimates and projection. *Diabetes Care*. 1998; 21:1414-1431.
- [2] Ramachandran A, Snehalatha C, Viswanathan V. Burden of type 2 Diabetes and its complications - The Indian Scenario. *Curr. Sci*. 2002; 83:1471-1476.
- [3] Deepa R, Arvind K, Mohan V. Diabetes and risk factors for coronary artery disease. *Curr. Sci*. 2002; 83 (12): 1497-1505.
- [4] Sheehan j p. Insulin resistance and hypomagnesemia, *br med j .clin resed*. 1982; 285:972.
- [5] de Valk HW. Magnesium in diabetes mellitus. *Neth J Med*. 1999; 54(4):139-146.
- [6] Djurhuus MS, Skott P, Vaag A. Hyperglycemia enhances renal magnesium excretion in type 1 diabetic patients. *Scan J Clin Lab Invest*. 2000; 60(5):403-409.
- [7] Karppanen H. Epidemiological aspects of magnesium deficiency in cardiovascular diseases. *Magnesium Bull*. 1986; 8:199-203.
- [8] Rasmussen HS, McNair P, Goransson L, Balslov S, Larsen OG, Aurup P. Magnesium deficiency in patients with ischemic heart disease with and without acute myocardial infarction uncovered by an intravenous loading test. *Arch Intern Med*. 1988; 148(2):329-332.
- [9] Tosiello L. Hypomagnesemia and diabetes mellitus. A review of clinical implications. *Arch Intern Med* 1996; 156: 1143-1148.
- [10] Barbagallo M, Dominguez LJ, Galioto A, Ferlisi A, Cani C, Malfa L. Role of magnesium in insulin action, diabetes and cardio-metabolic syndrome X. *Mol Aspects Med*. 2003; 24: 39-52.

- [11] Song Y, Manson JE, Buring JE, Liu S. Dietary magnesium intake in relation to plasma insulin levels and risk of type 2 diabetes in women. *Diabetes Care* 2004; 27: 59–65.
- [12] Itoh K, Kawasaka T, Nakamura M. The effects of high oral magnesium supplementation on blood pressure, serum lipids and related variables in apparently healthy Japanese subjects. *Br J Nutr*. 1997; 78:737–750.
- [13] Song Y, Ridker PM, Manson JE, Cook NR, Buring JE, Liu S. Magnesium intake, C-reactive protein, and the prevalence of metabolic syndrome in middle-aged and older US women. *Diabetes Care* 2005; 28: 1438–1444.
- [14] Touyz RM. Role of magnesium in the pathogenesis of hypertension. *Mol Aspects Med*. 2003; 24: 107–36.
- [15] Chakraborti S, Chakraborti T, Mandal M, Mandal A, Das S, Ghosh S. Protective role of magnesium in cardiovascular diseases: a review. *Mol Cell Biochem*. 2002; 238: 163–179.
- [16] Seelig MS, Heggveit HA. Magnesium interrelationships in ischemic heart disease: a review. *Am J Clin Nutr*. 1974; 27: 59–79.
- [17] Tosiello L. Hypomagnesemia and Diabetes Mellitus. *Arch Intern Med*. 1996; 156:1143–1148.
- [18] Correia ZMS, Freitas AM, Marcon IM. Risk factors related to the severity of diabetic retinopathy. *Arq Bras Oftalmol*. 2003; 66:739–43.
- [19] Lopez-Riadura R, Willett WC, Rimm EB, Liu S, Satamppper MJ, Manson JE, et al. Magnesium intake and risk of type 2 diabetes in men and women. *Diabetes Care*. 2004; 27(1):134–40.
- [20] Valk HW. Magnesium in diabetes mellitus. *Netherlands J Med*. 1999; 54:139–46.
- [21] Ajay, K. Coronary Artery Disease and Diabetes. *Cardiology Today*. 2001; 4: 221-224.
- [22] Saxena, K.K. Congestive Heart Failure in Diabetes. *Cardiology Today*; 2002; 2, 71-76.
- [23] Guerrero-Romero F, Rodriguez-Moran M. Hypomagnesemia is linked to low serum HDL cholesterol irrespective of serum glucose values. *J Diabetes Complication*. 2000; 14(5):272–276.
- [24] Baydas B, Karagoz S, Meral I. Effects of oral zinc and magnesium supplementation on serum thyroid hormone and lipid levels in experimentally induced diabetic rats. *Biol Trace Elem Res*. 2002; 88(3):247–253.
- [25] Tosiello L. Hypomagnesemia and Diabetes Mellitus. *Arch Intern Med*. 1996; 156:1143–8.
- [26] Ma J, Folsom AR, Melnick SL, Eckfeldt JH, Sharrett AR, Nabulsi AA. Associations of serum and dietary magnesium with cardiovascular disease, hypertension, diabetes, insulin, and carotid arterial wall thickness: the ARIC study. *J Clin Epidemiol*. 1995; 48(7):927–40.
- [27] Humphries S, Kushner H, Falkner B. Low dietary magnesium is associated with insulin resistance in a sample of young, nondiabetic black Americans. *Am J Hypertens*. 1999; 12:747–56.
- [28] Reis MAB, Velloso LA, Reyes FGR. Alterações do metabolismo da glicose na deficiência de magnésio. *Rev Nutr* 2002; 15(3):333–40.
- [29] Wa'lti MK, Zimmermann MB, Spinaz GA, Hurrell RF. Low plasma magnesium in type 2 diabetes. *Swiss Med Wkly*. 2003; 133:289–92.
- [30] Takaya J, Higashino H, Kotera F, Kobayashi Y. Intracellular magnesium of platelets in children with diabetes and obesity. *Metabolism* 2003; 52(4):468–71.
- [31] Text book of biochemistry for medical students by D.M. Vasudevan and sree kumara; 2nd edition :120-123.
- [32] Walmsley ,GH. White. A guide to diagnostic clinical chemistry:199-204.
- [33] Volpe P. and Vezu L, *Magnes. Res*. 1993; 6: 267–274.
- [34] Paolisso G, Scheen A, Cozzolino D, *J. Clin. Endocrinol. Metab*. 1994; 78: 1510–1514.
- [35] Smellie, W. S., O'Reilly, D., Martin, B. J, *Santamaria, J. ibid*. 1993; 57: 594–595.
- [36] Davidson -Principles and Practice of medicine .18th edition; 475-496.