# Evaluation of Association Between Serum Magnesium and Serum Lipid Profile in Type 2 Diabetes Mellitus

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**ABSTRACT**

There is accumulating evidence that the changes which occur in the metabolism of some micronutrients in diabetes mellitus might have a role in the pathogenesis and complications of this disease. Low magnesium level has been linked to reduced insulin sensitivity and increased risk of type 2 diabetes mellitus. Hypomagnesaemia has been implicated in adversely affecting diabetic complications. The abnormal high concentrations of serum lipids in diabetics is due, mainly to increase in the mobilization of free fatty acids from fat depots, since insulin inhibits the hormone sensitive lipase. The relationship between magnesium status and an atherogenic lipid profile, however, is less clear with studies presenting conflicting results depending on the population examined. Because serum magnesium and lipid profile reflect closely related component of the same disease process, a strong relationship between these variables may be anticipated. We selected 50 patients of Type-2 diabetes mellitus and 50 normal healthy individuals to evaluate this association. The statistical analysis depicted a negative non significant correlation between serum cholesterol (r=-1.89, p> 0.05) and triglyceride (r= -0.011, p> 0.05) with serum magnesium while HDL showed a non significant positive (r=0.176, p> 0.05) correlation. This study shows that serum magnesium may not be related to insulin resistance in the prediction of cardiovascular events.

**Keywords:** Serum Magnesium, Serum Lipid, Type 2 Diabetes Mellitus

## INTRODUCTION

Diabetes mellitus, especially type 2, is a public health problem which has reached epidemic proportions due to the rapidly increasing rates of this disease worldwide. Target organ complications caused secondary to diabetes, will be one of the most important medical concerns of the coming decades.[1] There is accumulating evidence that the changes which occur in the metabolism of some micronutrients in diabetes mellitus might have a role in the pathogenesis and complications of this disease.[2] A growing body of evidence suggests that magnesium plays a pivotal role in reducing cardiovascular risks and may be involved in the pathogenesis of diabetes itself.[3] Hypomagnesaemia has been implicated in adversely affecting diabetic complications.[4] Magnesium is known to be related to carbohydrate and fat metabolism. Magnesium is essential in the glycolytic cycle that converts sugar to ATP (Adenosine triphosphate) bioenergy. Mg helps to stabilize ATP; indeed 80% of magnesium inside the cell is complexed with ATP.[5,6] The abnormal high concentrations of serum lipids in diabetics is due, mainly to increase in the mobilization of free fatty acids from fat depots, since insulin inhibits the hormone sensitive lipase.[7] The relationship between magnesium status and lipid profile, however, is less clear with studies presenting conflicting results depending on the population examined. Since serum magnesium and lipid profile appears to be closely related component of the same disease process, a strong relationship between these variables may be anticipated.

## MATERIAL AND METHODS

The present study was a case control prospective study undertaken in the Department of Biochemistry in collaboration with Department of Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar. A total of 100 subjects willing to participate in the study with informed consent were included in the study. 50 patients of poorly controlled Type 2 Non Insulin Dependent Diabetes Mellitus (NIDDM) between 40-65 yrs of age, of either sex whose HbA1c was >7% and 50 healthy, age and sex matched controls from the same population but without any disease and without family history of DM.

**Exclusion criteria:** Patients suffering from type-1 DM, patients with acute complications of DM like Diabetic ketoacidosis, history of acute infections, other ailments like gross congestive heart failure, tuberculosis, gout, rheumatoid arthritis and skeletal muscle injury, serum creatinine > 1.5mg/dl, renal failure and those giving positive dip stick test for proteinuria were not included in the study.

The patients and controls were screened for fasting blood sugar (FBS), lipid profile, and serum magnesium and the values were compared with that of normal healthy subjects. Serum Magnesium was estimated by Calmagite method (Grindler et al 1971)[8] Total Serum Cholesterol was be estimated by CHOD-PAP Method (Allain C.C. et al 1974)[9] b. Serum Triglyceride was be estimated by GPO-Trinder Method. (McGowan MW et al 1983)[10] Serum High Density Cholesterol (HDL-C) was be estimated by Phosphotungstic Acid Method (Gordon T. Et al 1977)[11] Low Density Lipoprotein-Cholesterol (LDL-C) and Very Low Density

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| | Cases (Mean±SD) | Controls (Mean±SD) | p value |
|---|---|---|---|
| Fasting blood sugar (mg/dl) | 194.38 ± 53.60 | 100.30 ± 12.46 | < 0.001* |
| HbA1c (% ) | 8.758 ± 1.83 | 5.148 ± 0.51 | < 0.001* |
| Total cholesterol (mg/dl) | 223.20 ± 45.41 | 174.46 ± 33.90 | < 0.001* |
| Triglycerides(mg/dl) | 224.70 ± 76.77 | 161.14 ± 32.42 | < 0.001* |
| HDL-C(mg/dl) | 40.48 ± 8.18 | 55.00 ± 12.04 | < 0.001* |
| Serum Magnesium ( mEq/L ) | 1.09 ± 0.29 | 2.09 ± 0.29 | <0.001* |
| *P<.001 =highly significant; **p<0.05-significant; ***p>0.05- non significant | | | |

**Table-1:** Comparison of various parameters estimated in patients and controls

| | Serum Magnesium ( mEq/L ) | |
|---|---|---|
| | r | p |
| Fasting blood sugar (mg/dl) | -0.541 | 0.000* |
| HbA1c (% ) | -0.320 | 0.024** |
| Total cholesterol (mg/dl) | -1.89 | 0.189*** |
| Triglycerides(mg/dl) | - 0.011 | 0.938*** |
| HDL-C(mg/dl) | 0.176 | 0.221*** |
| *P<.001 =highly significant, **p<0.05-significant, ***p>0.05-non significant | | |

**Table-2:** Correlation of Serum Magnesium in type 2 Diabetes Mellitus with FBS, HbA1c and lipid profile

Lipoprotein-Cholesterol (VLDL-C) by Freidwald equation (Freidwald equation W.T.1974)

## RESULT

There was no significant effect of age (p>0.05) and sex distribution (p > 0.05) in the study. Table 1 show that FBS, HbA1c, total cholesterol, triglyceride levels were significantly high while serum magnesium and HDL-C were significantly low in cases as compared to the controls.

Table 2 shows that FBS had a highly significant and HbA1c had a significant correlation with serum magnesium in type 2 diabetics. Total cholesterol, triglycerides and HDL-C had a non-significant correlation with serum magnesium in type 2 diabetic patients.

## DISCUSSION

In our study Plasma Lipid profile showed significant increase (p< 0.001) in Total Cholesterol (TC), Triglycerides (TG), Low Density Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) in diabetics when compared to controls. In contrast there was significant decrease (p< 0.001) in HDL-C in diabetics. (Tables 1) It is known that cholesterol, triglycerides, LDL and VLDL are elevated in diabetic patients. The abnormal high concentrations of serum lipids in diabetics is due, mainly to increase in the mobilization of free fatty acids from fat depots, since insulin inhibits the hormone sensitive lipase. Excess fatty acids in serum of diabetics are converted into phospholipids and cholesterol in liver. These two substances along with excess triglycerides formed at the same time in liver may be discharged into blood in the form of lipoproteins.[7] These results were supported by studies of M. M. Yassin et al (2010)[12] and Dayanand C D et al (2010)[13]

In our study, it was observed that the difference between the mean ± SD values for serum magnesium in normal individuals (2.09 ± 0.29 mEq/L) and patients (1.09±0.29 mEq/L) was highly significant (p< 0.001) with patient group having significantly lower levels than the normal individuals. (Table 1) These findings were supported by Monika K Walti et al (2003)[14] and R D Ankush et al (2009)[15] who stated that the patients of type 2 diabetes have lower serum levels of magnesium than the normal and this difference is highly significant. The reasons for the high prevalence of Mg deficiency in diabetes may include increased urinary excretion due to hyperglycemia and osmotic diuresis, lower dietary intake, or impaired absorption of Mg compared to healthy individuals.

In our study, we found a highly-significant (p< 0.001) negative (-0.541) correlation between serum magnesium and fasting blood sugar in type 2 diabetic patients. (Table 2) These findings were supported by Mc Nair P et al (1982)[16] and Jing M A et al (1995)[17] who also stated that there existed a highly-significant negative correlation between fasting blood sugar and serum magnesium in type 2 diabetic patients. Magnesium depletion has a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2 diabetes as well as on the evolution of complications such as retinopathy, thrombosis and hypertension.[14] Insulin secretion requires magnesium: magnesium deficiency results in impaired insulin secretion.[3] It has been suggested that hypomagnesemia may induce altered cellular glucose transport, reduced pancreatic insulin secretion, defective post receptor insulin signaling, and/or altered insulin–insulin receptor interactions.[18] It was suggested that Mg acts as a second messenger for insulin. Mg deficiency decreases insulin sensitivity via an alteration of the insulin receptor associated tyrosine kinase in type 2 diabetes. Further, Mg deficiency has been proposed as a novel factor implicated in the pathogenesis of late diabetic complications.[15] Preventing low magnesium status in diabetics may therefore be beneficial in the management of the disease. In our study, we found a significant (p< 0.05) negative (-0.320) correlation between serum magnesium and HbA1c in type 2 diabetic patients. (Table 2) These findings were supported by R D Ankush et al (2009)[15], who also stated that there existed a significant negative correlation between HbA1c and serum magnesium in type 2 diabetic patients hence hypomagnesemia shows an inverse relationship between glycemic control and serum Mg levels.

In our study, total cholesterol and triglyceride however showed a negative non significant correlation with serum

magnesium while HDL showed a non significant positive correlation. (TABLE 2) According to the results of our study it can be argued that serum magnesium may not be related to altered lipid profile in the prediction of cardiovascular events. Hamid Nasri et al (2008)[19] observed that serum magnesium had a significant negative correlation with total cholesterol, a non significant negative correlation with triglyceride and a non significant positive correlation with HDL.

It is not possible to predict the effect that high or low magnesium might have on the physiological processes that affect serum lipid levels. Magnesium is important as a co-factor in lipid metabolism. The rate limiting step in cholesterol synthesis, at HMG-Co A reductase, can be activated through magnesium requiring enzymes.[20] It has been suggested that low magnesium may impair HMG-CoA reductase inactivation via phosphorylation. Conversely reactivation of HMG-CoA reductase also requires magnesium. Whether intracellular high magnesium promotes HMG-CoA reductase activity or inactivity has not been established. Magnesium is also important for the activity of the extracellular enzymes Lecithin-Cholesterol acyl transferase and Lipoprotein lipase.[20] Given the wide diversity of magnesium requiring processes and the many factors affecting serum Mg levels especially in metabolically compromised individuals it is difficult to predict which magnesium-dependent processes would dominate and affect plasma lipid levels. Rather on the basis of the relationships we observe between serum Mg levels and plasma lipid levels we hypothesize that a major factor affecting and confounding the results of other studies is a binding interaction between serum Mg and lipoprotein particles possibly through phospholipid head groups on the lipoprotein surface. This binding seems likely given the affinity of certain phospholipids head groups for divalent cations, like magnesium.[21,22] As a confounding factor this may also diminish the utility of total serum Mg measurements in reflecting magnesium status. One drawback in present study can be the smaller size of population hence further prospective studies are suggested to confirm the results.

## CONCLUSION

Hypomagnesaemia and altered lipid profile is common among the patients of type 2 diabetes mellitus when compared to the normal healthy non-diabetic individuals. But the present study did not find a significant correlation between these two parameters hence it can be argued that serum magnesium may not be related to altered lipid profile in the prediction of cardiovascular events.

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