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Original Research Article

Evaluate the differences in serum magnesium levels and lipid profile with correlation of hemoglobin A1C levels in type 2 diabetes patients: a case control study

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ABSTRACT

Background: Magnesium deficiency is a common problem in diabetic patients. Magnesium deficiency may increase the incidence of Type 2 Diabetic (T2D) and occurrence complications. Objective of this study aimed at determining the differences in serum magnesium levels and lipid profile among patients newly diagnosed with T2D and normoglycemic individuals.
Methods: The cross sectional observation study design was conducted at Sri Aurobindo Medical College, from March 2018 to April 2019. Source populations were all patients who attending to the OPD, Department of General Medicine. A total of 75 patients were enrolled in this study. This study was divided in two group's cases group (T2D) and second control group (Non-diabetic). First group not initiated on any oral-hypoglycaemic, anti-hypertensive or lipid lowering drugs, and healthy patients were included in control group.
Results: Triglycerides (TG), Total Cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C) showed significantly ($p<0.001$) higher mean levels in T2D compared to the controls. The Magnesium and High-Density Lipoproteins-cholesterol (HDL-C) levels were significantly ($p<0.001$) lower among the T2D group compared to the control group. There was a significant inverse correlation ($r2= 0.567$, $p<0.001$) between Hemoglobin A1C (HbA1c) levels and serum magnesium.
Conclusions: Serum magnesium levels and lipid profile were significantly different in T2D patients compared to control group.

Keywords: Hemoglobin A1C, Lipid profile, Serum magnesium, Type 2 diabetes

INTRODUCTION

Magnesium is the second most abundant intracellular cation in the body. It plays a significant role in many metabolic pathways, especially in glucose metabolism, by acting as a cofactor for several enzymes. It plays a vital role in insulin secretion, insulin binding and homeostasis.[1] Type 2 Diabetes (T2D) became more complicated with the advent of the concept of insulin resistance syndrome which includes dyslipidemia to be playing an important role in the development of atherosclerosis resulting in macro-vascular complications.[2] Diabetes is also associated with disturbances in electrolyte metabolism (Sodium and magnesium tend to decrease while potassium increases). Among the electrolytes, only serum magnesium significantly correlates with the level of Hemoglobin A1C (HbA1c) and thus may be related to long-term control of diabetes.[3] Low levels of magnesium have shown to damage tyrosine kinase activity and receptors

involved in signaling.[4] Both intracellular and extracellular magnesium deficits are associated with T2D.[5] Hypertension is known to be associated with alterations in lipid metabolism which gives rise to abnormalities in serum lipid and lipoprotein levels. It has also been documented that presence of hyperlipidaemia substantially worsens the prognosis in hypertensive patients.[6] Hypomagnesaemia may be considered as one of the aggravating factors for insulin resistance. The kidneys lose their ability to maintain magnesium levels during periods of uncontrolled hyperglycaemia. The loss of magnesium in urine may then result in lower blood levels of magnesium.[7] Thus serum magnesium and serum lipid profile are expected to show marked differences in diabetic patients compared to normal individuals. This study aimed at determining the differences in serum magnesium levels and lipid profile among patients newly diagnosed with T2D and normoglycemic individuals attending to a tertiary care hospital.

METHODS

The cross sectional observation study was conducted at Sri Aurobindo Medical College, from March 2018 to April 2019. Source populations were all patients who attending to the OPD, Department of General Medicine. A total of 75 patients were enrolled in this study. All the recruited patients were explained about the study and written consent was taken from every patient dually signed by her. A detailed history regarding socio-demographic variables and duration of disease was asked and clinical examination findings together were recorded in a proforma. Body mass index (BMI) were calculated as weight, divided by height squared (kg/m2). All the participants were subjected to blood investigations like blood glucose levels measured using Glucose-oxidase method, Serum magnesium levels by Ion sensitive electrode method and lipid profile estimated by enzymatic calorimetric methods. This study was divided in two groups. First 35 cases (T2D group) and second 35 (control group). All the cases in T2D group were confirmed diabetics proved normotensives, not initiated on any oral-hypoglycaemic, anti-hypertensive or lipid lowering drugs, and second control group healthy patients with normal blood glucose and no family history of diabetes.

Inclusion criteria

Diabetic patients attending medicine OPD, referral from diabetic OPD, and indoor patients at SAIMS. All the patients between 20 and 80 years of age and who are accessible.

Exclusion Criteria

Patients taking magnesium supplementation, loop diuretics and those with liver disease, congestive heart failure and cerebrovascular disorders were excluded.

Statistical Analysis

Data were entry in excel sheet and statistically analyzed. The mean difference between continuous variables was estimated using student t-test and chi-square test. P-value of less than 0.05 was considered statistically significant.

RESULTS

The mean age was 34.5±3.3 years. Majority were males (74.2%) and females (25.7%), BMI Obese (≥23), Non-obese (<23), Vegetarian 13(37.1%) vs 11(31.4%), Non-vegetarian 24(62.8%) vs 24(68.5%) were showed in table 1. The serum magnesium levels were significantly ($p<0.001$) lower among the T2D compared to the control group (Table 2).

Table 1: Socio-demographic characteristics of cases and control groups.

Variables	Cases (n=35)	Controls (n=35)	p value
Age; years			
20-30	13 (37.1%)	11 (31.4%)	
31-40	22 (62.8%)	24 (68.5%)	0.614
Gender			
Male	24 (68.5%)	28 (80%)	
Female	11 (31.4%)	7 (20%)	0.274
BMI; kg/m2			
Obese (≥23)	10 (28.5%)	14 (40%)	
Non-obese (<23)	25(71.4%)	21(60%)	0.313
Food Habits			
Vegetarian	13 (37.1%)	11 (31.4%)	
Non-vegetarian	22 (62.8%)	24 (68.5%)	0.614

BMI: Body Mass Index
Data were presented in numbers (percentage)

Triglycerides (TG), Total Cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C) showed significantly (p<0.001) higher mean levels in diabetics compared to the controls. High-Density Lipoproteins-cholesterol (HDL-C) was lower among the cases giving a clue about the unfavorable lipid derangements in diabetic patients compared to the control group. (Table 2). There was a significant inverse correlation (r2=0.567, p<0.001) between HbA1c levels and serum magnesium. As HbA1c (%) increased magnesium levels showed decreasing trend (Figure 1).

Table 2: Lipid profile and serum magnesium levels compared between groups.

Biochemical parameters	Cases (n=35)	Controls (n=35)	p-value
HbA1c levels	8.63±1.2	5.83±0.8	<0.001
Magnesium (mmol/l)	0.41±0.05	0.78±0.02	<0.001
TG (mg/dl)	220±18.8	131±22.2	<0.001
TC (mg/dl)	248±38.3	188±9.7	<0.001
HDL-C (mg/dl)	42.7±6.7	53±8.2	<0.001
LDL-C (mg/dl)	157±28.3	101±7.8	<0.001

HbA1c : Hemoglobin A1C, TG: Triglycerides, TC: Total Cholesterol, HDL-C: High-Density Lipoproteins-Cholesterol LDL-C: Low-Density Lipoprotein-Cholesterol
Data was presented in mean± standard deviation

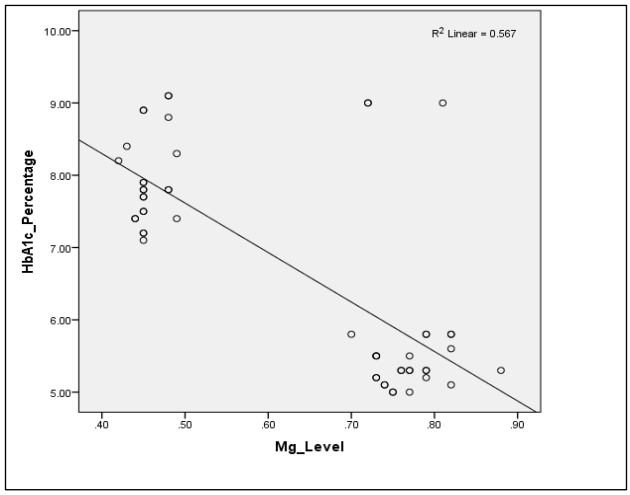

Figure 1: Correlation scatter-plot of HbA1c levels against serum magnesium levels.

DISCUSSION

In this present study serum magnesium levels and serum lipid profile was examined in patients. In the present study, the serum magnesium levels were significantly (p<0.001) lower magnesium (0.41±0.05mmol/L) among the diabetics compared to the control group magnesium (0.78±0.02 mmol/L). Similar results were reported in a study done by Karim et al. which showed that the serum magnesium was found to be significantly lower (p<0.001) and in newly diagnosed normotensive T2D patients compared to healthy controls.[8] Suboptimal and high TG levels were observed in cases compare to control group whereas low levels of HDL-C were observed in 42.7±6.7 vs 53±8.2. Similar observation was made in a study conducted in north Indian population, wherein TG was the most prevalent lipid abnormality.[9] Hepatic lipase, which is responsible for clearing HDL particles from the circulation, shows increased activity in the presence of insulin resistance and causes HDL-C levels to decline.[10] The magnesium levels were still within the normal range in this study unlike there was real hypomagnesaemia reported in present study in diabetics. Sendhav et al. in their study documented that lipid profile showed a significant rise (p <0.01) of TG, TC, LDL-C, and very low-density lipoprotein-cholesterol (VLDL-C) along with increase in fasting blood glucose among diabetics in comparison with controls (p<0.01). [11] In present study, author was able to document a significant increase in TGs, LDL-C, TC and drop in HDL-C among T2D group when compared to normal individuals. The increase or decrease in lipids did not find any essential correlation with magnesium levels as was documented in the study by Nasri where significant inverse correlations of serum magnesium with serum cholesterol, LDL-C and serum HbA1c were reported.[12]

Thus the usage of magnesium as a marker of glycemic variability or any linear relationship models between magnesium and HbA1c levels are possible but there is a need for large scale prospective studies for authenticity. Similarly, correlation of magnesium levels with lipids in T2D may not be useful as the biological plausibility to establish any linear relationship between these parameters remains non-evidence-based.

CONCLUSION

The serum magnesium levels are lower among diabetic subjects as compared to control group. The lipid profile also shows higher triglycerides, LDL-C, Cholesterol levels and lower HDL-C levels in T2D compared to control group. Thus, serum magnesium and lipid profile can be used as reliable parameters to predict severity of T2D.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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