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Original Article

A clinical study of serum phosphate and magnesium in type II diabetes mellitus

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ABSTRACT

Objective: To assess serum phosphate and magnesium level in type-2 diabetic patients in comparison with those of control subjects. **Methodology:** There were 100 diabetic patients and 100 age matched non-diabetic (control) subjects included in this study. Serum phosphate, serum magnesium and fasting and postprandial blood sugar measured among the diabetic and control groups using SPSS version 16.0 for analysis. **Results**: Serum phosphate level was significantly lower in diabetic patients (2.92 ± 0.75) as compared to control subjects (3.38 ± 0.49). Serum magnesium levels were significantly lower in diabetic patients (0.9 ± 0.15) compared to controls (2.75 ± 0.46**) Conclusion**: The study reveals that hyperglycemia may reduce serum levels of magnesium and phosphorus.

Keywords: Magnesium, phosphate, type 2 diabetes mellitus.

INTRODUCTION

Diabetes mellitus is a metabolic disorder which affects many people in the world. Diabetes is currently emerging as an important health problem with a significant global burden[1.] Assuming that age – specific prevalence remains constant, the number of people with diabetes in the world is expected to approximately double between 2000 and 2030, based solely upon demographic changes[2] Accordingly, the WHO has called the disease [the emerging epidemic][3]. Genetic and environmental factors contribute to the pathogenesis of diabetes and acts as a trigger for the disease among subjects at high-risk because of inherited susceptibility. Earlier works demonstrating the existence of glucose tolerance factor in yeast with the identification of the active component as trivalent chromium sparked off interest on the status of other trace and macro elements in health and diseases including diabetes. Direct associations of trace macro elements with Diabetes mellitus have been observed in many research studies. Insulin action on reducing blood glucose was reported to be potentiated by some trace elements as chromium, magnesium, vanadium zinc, manganese and phosphate. Mg depletion has a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2 diabetes[4, 5] as well as on the evolution of complications such as, retinopathy, thrombosis and hypertension[6-8]mostly age group between 35- 60. Moreover, low serum Mg is a strong independent predictor of the development of type 2 diabetes[9]Phosphorus is widely distributed element in the human body. Diabetes mellitus may result in whole body phosphate depletion due to osmotic dieresis and decreased muscle mass. Therefore, the aim of our study was to determine the serum levels of phosphate and magnesium in diabetic patients and control subjects and their association with age, gender and glycemic status.

MATERIALS AND METHODS

This is a cross sectional study approach on diabetic patients. It was conducted at the clinical chemistry laboratory. Patients were enrolled based on the following Criteria:

Inclusion criteria: All type 2 diabetic patients, both genders, aged 30-65 years.

Exclusion criteria: Include past medical history of hyperactive and hypothyroidism, current smokers, heavy alcoholics. Chronic infection affects bone (tuberculosis, osteomyelitis), bone tumors, chronic renal failure, hematological disorders and connective tissue disorders.

Study area and study population: One hundred diabetic patients (50 males, 50 females), aged 30-

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65 years; and other 100 healthy subjects (matched for age and sex), were included in the study. All subjects Signed informed consent and filled questionnaires. Duration of the study is around 6 months.

Methodology: Blood samples were collected after a twelve hour fasting period (Overnight fasting) under aseptic. Conditions, the obtained blood sample were centrifuged and plasma was separated. The plasma was analyzed for the fasting and postprandial blood sugar, estimated by GOD-POD method[10].Serum samples were separated from whole blood collected into tubes without anticoagulant, after clotting was complete, the tubes were then centrifuged at 2700g for 10 minutes. Serum was removed and assayed for magnesium and phosphorus. Taussky, H.H., and Shorr, E.: a micro colorimetric method for the Determination of Inorganic Phosphorus[11]. Gindler, E.M. and D.A. Heth, a Colorimetric determination with bound calmagite of magnesium in human blood serum[12].

Statistical analysis: Student's t-test was performed to analyze the difference in means between groups. P value was considered significant when it is less than or equal 0.001.

RESULT

Table1: Blood sugar levels

Blood sugar variables	Levels	Controls	Cases	P Value
FBS(mg/dl)	<110	100	38	
	>110	0	62	<0.001
PLBS(mg/dl)	<130	100	14	<0.001
	>130	0	86	

The FBS and PLBS values of controls and cases are shown in table1. In which 100% controls had <110 mg/dl. Whereas in case of diabetics 38% of them showed < 110mg/dl and 62% of them showed >110mg/dl. There is an increase in FBS values of patients as compared to controls as statistically significant (p<0.001). In case of PLBS 14% of them showed <130 and 86% of them showed >130 mg/dl. There is an increase in PPBS values of patients as compared to controls as statistically significant (p<0.001).

Table 2: Levels of serum phosphorus

Serum phosphorus	Control	Cases
Decreased (<2.5mg/dl)	0	62
Normal (2.5- 4.5mg/dl)	100	38
Increased (>4.5mg/dl)	0	0
Total	100	100
Inference	62% of patient had the serum phosphorus is decreased in cases with P<0.001	

Serum phosphorus levels of controls and cases were shown in table 2. 100% of controls showed a normal serum phosphorus level in the range of 2.5-4.5 mg/dl and in diabetic cases 62% showed decreased levels than the normal range, i.e. <2.5mg/dl and the remaining 38% of them were in normal range. Serum magnesium levels of controls and cases were shown in table 2.100% of controls showed normal serum magnesium level in the range of 1.0-3.5/dl mg/dl and in diabetic cases 56% showed decreased levels than the normal range, i.e. <1.0 mg/dl and the remaining 44% of them were in normal range (table: 3).

Table 3: Levels of serum magnesium

Serum magnesium	Control	Cases
Decreased (<1.0mg/dl)	0	56
Normal (1.0-3.5mg/dl)	100	44
Increased (>3.5mg/dl)	0	0
Total	100	100
Inference	56% of patient had the serum magnesium is decreased in cases with p<0.001	

Table 4: Levels of FBS, PLBS, Serum phosphorus and Serum magnesium

Biochemical Parameters	Controls	Cases	P value
FBS (mg/dl)	89.74± 9.82	155.5±86.6	<0.001
PLBS (mg/dl)	112.3± 2.65	245.2±112.5	<0.001
Serum phosphorus (mg/dl)	3.38± 0.49	2.9±0.75	<0.001
Serum magnesium(mg/dl)	2.15± 0.46	0.9± 0.1	<0.001

Levels of FBS, PPBS are significantly increased compared to normal and serum phosphorus and serum magnesium significantly decreased compared to normal subjects.

DISCUSSION

Diabetes mellitus is the most common chronic metabolic disorder with high rate of morbidity characterized by the impaired metabolism of glucose and other energy yielding fuels as well as by the late development of vascular and neuropathic complications. Diabetes comprises a group of disorders involving distinct pathogenic mechanisms, for which hyperglycemia is the common denominator. Hyperglycemia role in turn plays an important role in disease related complications. Like accelerated atherosclerosis, retinopathy, nephropathy, neuropathy and diabetic foot. In our study, we took 100 cases of diabetes mellitus compared with 100 healthy controls FBS, PPBS, serum magnesium and serum phosphorus were estimated in the above groups.

Blood Glucose**:** Blood glucose is the principal sugar of mammalian blood. It normally amounts to 65-110mgldl (FBS) and up to 160 mg/dl (PPBS) after a high carbohydrate meal is a normal range. In general repeated FBS levels > 126 mg/dl and PLBS > 200 mg/dl or higher are suggestive of diabetes. Diabetes who are under control exhibit a wide variations in their plasma glucose concentrations The diagnosis of diabetes on the measurement of plasma glucose level In our study the FBS values of the patient was 155.56, 86.67 mg/dl well above the American diabetes association (ADA) criteria to diagnose diabetes and the PLBS which was higher than upper limit 245.28, 112.53 whereas control group had blood glucose values as 89.74 9.82 and 112.32 12.65 for FBS and PPBS respectively suggestive of normoglycemia. These values correlate well with clinical diagnosis.

Serum Phosphorus: Serum phosphorus is widely distributed element in the human body. It is present in both organic and inorganic forms, but only inorganic phosphorus is measured. Inorganic phosphorus in the form of hydroxy apatite (in bone) plays an important role in structural support of the body and also provides phosphate for intracellular and extracellular fluid. Intracellular phosphate is also a component of nucleotide derivatives such as NADP, ATP, GTP etc., is involved in nucleic acid structure, formation and also in regulation of intermediately metabolism of proteins, carbohydrates, fats, gene transcription and cell growth. It also has a significant role as a body buffer mechanism. Many studies have found decreased in the concentration of phosphate in poorly regulated diabetic patients and the level increases when blood glucose is controlled. Gartner et al[13]in their study in juvenile onset of diabetic patients found that as plasma glucose decreased from 221 mg/dl to 95.5 mg/dl, serum inorganic phosphorus 4.9-5 mg/dl In our studies, diabetes mellitus patients, showed a decrease in serum phosphorus level [14] P<0.001.This is in concordance with a study done by E. I. ugwuja.

Serum Magnesium: Mg is mainly an intracellular cation, with less than 1% of total body content present in the extracellular fluids. The Mg concentration in serum represents not more than 0.3% of total body Mg[14]. Nevertheless, serum or plasma Mg measurement is the most readily available and widely used test of Mg status. In human studies, instituting a diet low in Mg produces a predictable decline in serum Mg [15, 16, 17.] However, there are a number of reports of low Mg values in various blood cells and tissues associated with normal serum/plasma Mg concentrations [18]. It appears, therefore that plasma Mg concentration is an insensitive, but a highly specific indicator of low Mg status. Of the total Mg in serum, around 55% is present as free ionized Mg2+, 15% are complexed to anions (e.g. Bicarbonate, citrate and sulfate) and 30% are bound to proteins, mainly albumin [19]. It could therefore be argued that in diabetics with microalbuminuria, serum Mg might be reduced because of lower serum albumin concentration. Pickup etal[20] found no difference in serum Mg concentration between type 1 diabetics with microalbuminuria or clinical proteinuria compared to diabetics with normal albumin excretion. In contrast, Corsonello et al., [21] demonstrated significantly lower ionised serum Mg in type 2 diabetic patients with microalbuminuria or clinical proteinuria. Similar to findings from other countries in Europe and North America, the mean plasma Mg concentration of the type 2 diabetics was significantly lower than in controls. The striking finding in our study was the high prevalence of low plasma Mg concentrations among the diabetic subjects. Serum Mg concentrations of 44% of the diabetics were below the reference range, a prevalence of low magnesium status that is similar to that reported in type 2 diabetics in outpatient clinics in the US .

CONCLUSION

Our findings suggest that low magnesium status and phosphorus in type 2 diabetes mellitus. Phosphorus and magnesium depletion may increase the risk of secondary complications, preventing low magnesium and phosphorus status in diabetes may therefore be beneficial in the management of the disease.

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Conflict of Interest: Nil

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