Study of Phosphate Levels in Sera of Patients with Metabolic Syndrome

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Abstract

Background: Metabolic syndrome represents the clustering ofrisk factors which promote the development of cardiovascular disease, including insulin resistance ,obesity and hypertension.

Objective: The aim of this study is to measureserum phosphate levels in patients suffer from metabolic syndrome to utilize this parameter in orderto confirm the diagnosis.

Materials & methods: A total of 100 patients with metabolic syndrome and 90 healthy control subjects with age range (50-60 years)were assigned in this cross-sectional study trialfrom April 2014 to January 2015 in Baghdad city. Thediagnosis of metabolic syndrome was based on thecriteria defined by International Diabetes Foundation (IDF). General information for each patient was obtained by a questionnaire designed for the study.Waist circumference measurement, fasting serum glucose, serum HDL level, serum triglyceride, serum phosphate and blood pressure estimation were done for each patient.

Results: Patients with metabolic syndrome found to have a considerably lower serum mean level of phosphate when compared with healthy control subjects. Metabolic syndrome patients have high prevalence of marginal phosphate deficiency in comparison control subjects. Results showed that patients with low serum phosphate level tend to have high prevalence of high fasting serum glucose, elevated blood pressure, low levels of HDL-cholesterol and high triglyceride values compared withhealthy control subjects.

Conclusion: Serumphosphate levels found to be significantly lower in patients with metabolic syndrome in comparisonwith healthyindividuals. Phosphate levels can be used as reliable marker in diagnostic criteria of this syndrome.

Introduction

Metabolic syndrome is a combination of different metabolically originated risk factors that induced the development of atherosclerotic cardiovascular disease[1]. The main abundant risk factors include obesity , insulin resistanceplasma glucosedyslipidemia and high blood pressure[2].Obesity is strongly correlated to insulin resistanceas considered by the International Diabetes Foundation (IDF) in 2005. The IDF predicted that centralobesity is crucial for diagnosis which specified by waist circumferences ≥94 cm in men and ≥80 cm in women[3].

In adult human phosphorus elementis widely distributed in body as inorganic and organic phosphate forms, its account approximately 1% of total body weight or roughly600 g .the majority of the phosphorus (85%)is locatedin the skeleton and teeth with remaining 15% in soft tissues.Phosphatein the blood stream is found as phospholipid , phosphate ester and inorganic phosphate with a concentration about 2.5 to 4.5 mg/dl , only 12% of phosphate in plasma is bound to protein. This valuesaredependent on meals and variation in the secretion of hormones such as PTH [4]. Nearly 70% of phosphorus is absorbed in intestineand excreted through kidney[5].The pathophysiological characteristics of metabolic syndrome remain unclearalthough there wereimportant recent advances in understanding of its consequences. The development of this constellation of cardiovascular risk factors has been explained recently related to the disturbances of phosphate metabolism [6,7]. Many scientific studies predicted that phosphate is involved directly in carbohydrate metabolism and found that hypophosphatemia can lead to impaired metabolism of glucose, insulin resistance as well as hyperinsulinemia[8,9].In addition, these studies explained that the development of the obesity, hypertension, and high lipid profile that form metabolic syndromemay directlycorrelate to reduced phosphate levels[10]. Higher serum phosphate even within the normal range is associated with incremental risk of cardiovascular disease events and mortality in people with and without chronic kidney disease [12,13]. Although declining kidney function leads to dysregulated phosphate homeostasis, levels of serum phosphate do not become abnormal until estimated glomerular filtration rate (eGFR) falls below 30 mL/min/m2 [14].

Materials and Methods

This research work was carried out at Baghdad Medical City Hospital from April 2014 to January 2015. Two groups of subjects conducted in this study, the patients group and the healthy control group . 100 patients with metabolic syndrome[female(58) and male(42)] , aged (50-60 years) were chosen from patients with Cerebrovascular disease. 90 healthy subjects[female(38),male (52)] with same age range were selected from the volunteers in the same hospital as control group.The control group were chosen with absence of either metabolic syndrome or any evidence of cardiovascular disease.

Blood samples:

About 10 ml of venous blood was obtained after an overnight fast using disposable needles and syringes. The blood was allowed to coagulate in plain tubes for 30-45 minutes at room temperature and then centrifuged at 3000 rpm for 10 minutes. The resulting sera were separatedand transferred into plain plastic tubes and kept frozen at -20ºC to be examined later .

Methods:

Serum phosphate levels wereevaluated by colorimetric method for the quantitative in vitro diagnostic measurement using kit manufactured by (Randox,UK) which based on theintereactionbetweeninorganic phosphate ions in serum and molybdic acid to form a phosphomolybdic acid complex which is reduced by ammonium iron$^{(II)}$ sulphate to molybdenum blue compound. The absorbance was measured at 690 nm[4] .

Statistical Analysis :

Results data were collected and analyzed using computer facility of SPSS version 10.0 for windows (SPSS, Chicago, Illinois, USA).Statistical tests used according to the need P value < 0.05 was considered as statistically significant.

Results

Resultsrevealed that mean serum phosphate levels were lower in metabolic syndrome patients than healthy control subjects, however the difference was not significant. The prevalence of marginal phosphate deficiency was significantly higher in metabolic syndrome subjects than control subjects(P< 0.05)as shown in (table 1).

Results showedin(table 2)a comparison between the mean values of serum phosphate in males and females. In addition a percentage of other related variables of the metabolic syndrome between males and females are shown. In this table, no significant sex difference in serum mean values and percentage were found

(Table 1): Biochemicaland clinical data of metabolic syndrome patients and healthy control subjects.

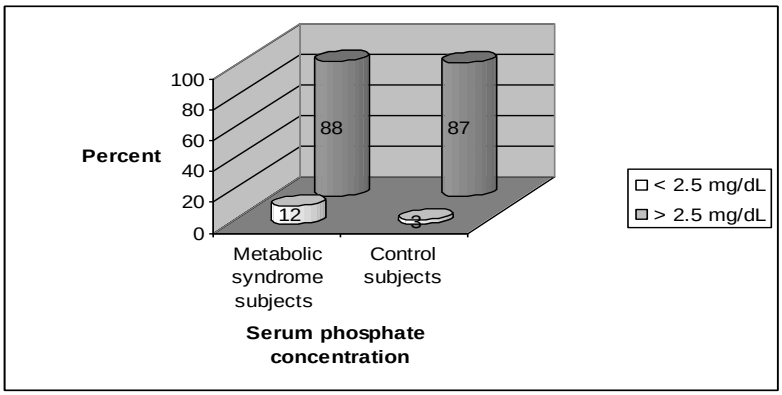
	Metabolic syndrome patients Mean± SD	Healthy control subjects Mean ± SD	P value
Number	**100**	**90**	
Age (Year)	**53.6 ± 6.3**	**51.9 ± 6.3**	**NS**
Male gender (%)	**42.0**	**46.6**	**NS**
Waist circumference (cm)	**105.2 ± 9.7**	**82.2 ± 8.8**	**<0.001**
Systolic BP(mmHg)	**142 ± 22.3**	**119.5 ± 9.3**	**<0.001**
Diastolic BP(mmHg)	**84.3 ± 11.4**	**77.3 ± 8.8**	**<0.001**
Phosphate (mg/dl)	**3.2 ± 0.7**	**3.4 ± 0.8**	**NS**
Prevalence of phosphate deficiency n (%)	**12 (12.0)**	**3(3.3)**	**<0.05**

(Table 2): Comparison of clinical and biochemical measurements between males and females with metabolic syndrome.

	Males Mean ± SD	Female Mean ± SD	P value
Number	**42**	**58**	
Age (year)	**52.8 ± 6.4**	**54.2 ± 6.2**	**NS**
Phosphate (mg/dl)	**3.0 ± 0.7**	**3.3 ± 0.7**	**NS**
High blood pressure[n(%)]	**32 (76.2)**	**45 (77.6)**	**NS**
Prevalence of phosphatedeficiency [n(%)]	**8 (19.0)**	**4 (6.9)**	**NS**

Figure(1) shows the prevalence of marginal phosphate deficiency among metabolic syndrome subjects and control subjects, 12 of 100 (12%) subjects with metabolic syndrome had serum phosphate below the cutoff of 2.5 mg/dl and 88 of them (88%) had serum phosphate above 2.5 mg/dl; 3 of 90(3.3%) control subjects had serum phosphate below the cutoff of 2.5 mg/dl and 87of them (96.6%) had serum phosphate above 2.5 mg/dl.

Data analysis of marginally low serum phosphate according to the cutoff values of phosphate < 2.5 mg/dl among metabolic syndrome subjects revealed that 83.3% (n=10) had high blood pressure, 83.3% (n=10) had high glucose, 58.3% [7] had high triglyceridemia and 66.6% (n=8) had low HDL-cholesterol as shown in (Table 3).



(Figure 1): Distribution of serum phosphate in metabolic syndrome and healthy control subjects

(Table 3): Characteristics of metabolic syndrome subjects with low serum phosphate concentration.

Characteristics	Serum phosphate<2.5 mg/dl	Serum phosphate>2.5 mg/dl
Number	***12***	***88***
Mean age (Years)	***54.2 ± 6.9***	***53.6 ± 6.3***
Males [n (%)]	***8 (66.7)***	***34 (38.6)***
Females [n (%)]	***4 (33.3)***	***54 (61.4)***
High blood pressure [n (%)]	***10 (83.3)***	***67 (76.1)***
High glucose [n (%)]	***10 (83.3)***	***69 (78.4)***
High triglycerides [n (%)]	***7 (58.3)***	***44 (50.0)***
Low HDL-Cholesterol [n (%)]	***8 (66.6)***	***55 (62.2)***

Discussion

Metabolic syndrome is a clustering of different medical conditions mainly type 2 diabetes and cardiovascular disease, including excessive waist circumference, high blood pressure, high blood glucose, elevated serum triglyceride and low high density lipoprotein(HDL) levels. The prevalence of metabolic syndrome increase with age ,degree of insulin resistance and obesity . Additional clinical data on the association between serum phosphate levels and characteristics of metabolic syndrome [6]. It has been shown that an unbalanced diet, with low phosphate content and high carbohydrate intake, may lead to reduced serum phosphate levels in peoples at risk of developing metabolic syndrome [7].

It has been predicted that patients with metabolic syndrome withlower phosphate concentrations compared with healthy population may result, from low intake of health dietary intake or reduced intestinal absorption of phosphate , increased urinary excretion, and internal redistribution [6].

Other scientific studyon patientswith metabolic syndrome who have reduced phosphate levels suggested that low phosphate levels in this type of patients may result from increasedextracellularphosphate transfer to intracellular compartment and explained that the increase in insulin level could be a major determinant of this processin patients with metabolic syndrome[11].

In addition another study observed that phosphate deficiency has been associated with changes in insulin sensitivity and glucose tolerance asphosphate is the active participant in energy metabolism[8].

Regarding the depletion of phosphate in individuals with hyperinsulinemia a study found thatin normal glycaemic status, both basally and after glucose stimulation are strongly associated with reduced insulin sensitivity [9].

Conclusion:

The present results clearly demonstrate that patients with metabolic syndrome have a higher prevalence of marginal phosphate deficiency in comparison to healthy controls ,so serum levels of phosphate can be used as reliable marker in diagnostic criteria of metabolic syndrome .

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