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Research Article

To evaluate the levels of glycated hemoglobin, serum calcium, magnesium, phosphate, uric acid and microalbuminuria in patients with newly diagnosed type 2 diabetes mellitus

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ABSTRACT

Background: Over the past three decades, the number of people with diabetes mellitus has more than doubled globally, making it one of the most important public health challenges to all nations. Therefore, the present study was undertaken to compare the levels of HbA1c, serum calcium, serum magnesium, serum phosphate, serum uric acid and microalbuminuria in patients with newly diagnosed type 2 diabetes mellitus with normal healthy individuals.
Methods: This is a cross sectional study and was undertaken in the Department of Biochemistry, SKIMS-MC&H, Bemina, Srinagar. Total 300 subjects included in this study were divided into 2 groups. Group I: included 150 normal healthy individuals, who were in the age group 30-80 years, of either sex. Group II: included 150 newly diagnosed patients of Type 2 diabetes mellitus in the same age group. Fasting blood samples were drawn and investigated for serum calcium, magnesium, phosphorus, uric acid, blood sugar and HbA1c. 24-hours urine was taken for estimation of microalbuminuria, and these values were compared with those of normal healthy subjects. Means ± standard deviation were calculated and student t-test was applied to find out significance level.
Results: Mean serum levels of FBS, HbA1c, calcium, magnesium, phosphate, uric acid were 89.71 ± 9.22, 4.68 ± 0.47, 9.61± 0.84, 2.23 ± 0.41, 3.45 ± 0.46, 4.21 ± 1.04 in controls (group-I) and 145.57 ± 76.61, 8.94 ± 2.38, 8.09 ± 0.18, 1.92 ± 0.27, 2.82 ± 0.68, 7.01 ± 0.27 in cases (group-II) respectively (<0.001). Microalbuminuria showed significant mean difference between cases and controls 35.01 ± 41.30 and 15.35 ± 2.60 (<0.001).
Conclusion: There is decrease in serum calcium, magnesium and phosphate levels, all these plays an important role in the regulation of glucose level in the blood. Hence oral supplementation of all these ions other than diet is recommended. Increased serum uric acid and microalbuminuria was seen with reduced glucose tolerance hence early estimation of both the parameters should be done while monitoring case of Type-2 diabetes and thus will help to decrease the incidence of renal complications.

Keywords: Glycated Hemoglobin, Calcium, Magnesium, Phosphate, Uric Acid, Microalbuminuria, Type 2 diabetes mellitus

INTRODUCTION

Over the past three decades, the number of people with diabetes mellitus has more than doubled globally, making it one of the most important public health challenges to all nations. The causes of the epidemic of diabetes mellitus are embedded in a very complex group of genetic and epigenetic systems interacting within an equally complex societal framework that determines behaviour and environmental influences.[1] It has been predicted that the countries with the largest number of people with diabetes mellitus will be from India, China, and United States in the year 2025.[2]

Glycated hemoglobin (HbA1c) a marker of chronic hyperglycemia, is associated with diabetes and its

complications and has been recommended as a diagnostic test. It is an indicator of average blood glucose concentration over the period of 2-3 months.[3]

A metabolic imbalance in inorganic phosphate occurs from the early onset of diabetes mellitus and may lead to a reduction of high energy phosphates and tissue hypoxia. These changes take place in the cells and tissues in which the entry of glucose is not controlled by insulin. Changes in serum phosphate level are related with severity of diabetes mellitus.[4] Evidences on basic and animal studies on calcium have been suspected as modifiers of diabetes risk. Recently there is enough evidence to suggest that altered calcium homeostasis may also play a role in the development of type 2 diabetes.[5]

Uric acid being an end product of the purine metabolism is associated with an increased future risk of diabetes, it may reduce the future risk of gout through the uricosuric effect of glucose or the impaired inflammatory response. Also, hyperuricaemia has been presumed to be a consequence of the insulin resistance.[6,7] Also magnesium is involved on multiple levels in insulin secretion, binding and activity. Cellular magnesium deficiency can alter the membrane bound sodium-potassium-adenosine triphosphate which is involved in the maintenance of glucose transport. Studies have shown that magnesium deficiency has a negative effect on the post-receptor signalling of insulin.[8,9]

The appearance of microalbuminuria in diabetes mellitus is a very important predictor of progression to overt proteinuria which leads to a steady decline in glomerular filtrate rate and ~50% of individuals reach End Stage Renal Disease in 7 to 10 years.[10] Therefore, the present study was undertaken to compare the levels of HbA1c, serum calcium, serum magnesium, serum phosphate, serum uric acid and microalbuminuria in patients with newly diagnosed type 2 diabetes mellitus with normal healthy individuals.

METHODS

This is a cross sectional study and was undertaken in the Department of Biochemistry, SKIMS-MC&H, Bemina, Srinagar. Total 300 subjects included in this study were divided into 2 groups:

- Group I: included 150 normal healthy individuals, who were in the age group 30-80 years, of either sex and without any family history of diabetes mellitus.
- Group II: included 150 newly diagnosed patients of Type 2 diabetes mellitus in the same age group i.e., 30-80 years.

Informed and written consents were taken from all the subjects who were included in the study. The patients who suffered from Type 2 diabetes mellitus with the acute complications of diabetes mellitus, those with a history of acute infections and other ailments like gross congestive heart failure, tuberculosis, gout, rheumatoid arthritis and skeletal muscle injury and renal failure and those who were on hypoglycaemic drugs and on insulin therapy were excluded from the study.

Fasting blood samples were drawn and investigated for serum calcium, magnesium, phosphate, uric acid, blood sugar and HbA1c and were analysed on Biolyzer-600. 24-hours urine was taken for estimation of microalbuminuria by immunoturbidometric method, and these values were compared with those of normal healthy subjects.

Statistics

The data obtained was compiled and analysed using SPSS 11.5 for Windows version. Means ± standard deviation were calculated and student t-test was applied to find out significance level. Statistical significance was defined as two-tailed $p < 0.05$ for all tests unless otherwise specified.

RESULTS

The mean age of the cases and controls were 55.42 ± 12.77 years (with 92 males and 58 females) and 55.72 ± 12.92 years (with 89 males and 61 females) respectively which was statistically insignificant (Table 1). The maximum number of patients was in the age group of 41-50 i.e. 40% (Table 2). Mean serum levels of FBS, HbA1c, calcium, magnesium, phosphate, uric acid were 89.71 ± 9.22, 4.68 ± 0.47, 9.61± 0.84, 2.23 ± 0.41, 3.45 ± 0.46, 4.21 ± 1.04 in controls (group-I) and 145.57 ± 76.61, 8.94 ± 2.38, 8.09 ± 0.18, 1.92 ± 0.27, 2.82 ± 0.68, 7.01 ± 0.27 in cases (group-II) respectively. The results indicates there is a statistically significant difference between the two groups (<0.001). Microalbuminuria showed significant mean difference between cases and controls 35.01 ± 41.30 and 15.35 ± 2.60 (<0.001). There was insignificant (>0.05) difference between urea and creatinine levels among group-I and group-II 29.7 ± 3.15, 32.24 ± 2.99 and 0.89 ± 0.17, 0.94 ± 0.11 respectively (Table 3).

Table 1: Showing the comparison in the gender between the two groups.

Sex	Group-I	Group-II	Total	p-value
Male	89 (59.3%)	92 (61.3%)	181 (60.3%)	>0.05
Female	61 (40.7%)	58 (38.7%)	119 (39.7%)	
Total	150	150	300	

Table 2: Showing the age distribution between the two groups.

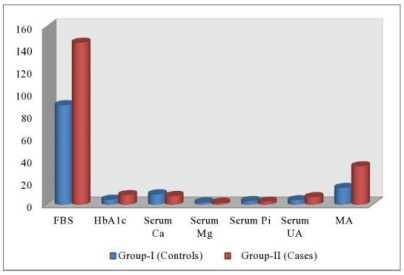
Age in years	Group-I (No. of controls)	Group-II (No. of Cases)
30-40	6	9
41-50	60	61
51-60	36	35
61-70	15	12
71-80	30	27
>80	3	6
Total	**150**	**150**

Table 3: Depicting Mean ± Standard deviation and significance of different parameters between two groups.

Parameter	Group-I (Controls)	Group-II (Cases)	P-value
Age in years	55.72 ± 12.92	55.42 ± 12.77	>0.05
FBS mg/dL	89.71 ± 9.22	145.57 ± 76.61	<0.001**
HbA1c %	4.68 ± 0.47	8.94 ± 2.38	<0.001**
Blood Urea mg/dL	29.7 ± 3.15	32.24 ± 2.99	>0.05
Serum Creatinine mg/dL	0.89 ± 0.17	0.94 ± 0.11	>0.05
Serum Calcium (Ca) mg/dL	9.61± 0.84	8.09 ± 0.18	<0.001**
Serum Magnesium (Mg) mg/dL	2.23 ± 0.41	1.92 ± 0.27	<0.001**
Serum Phosphate (Pi) mg/dL	3.45 ± 0.46	2.82 ± 0.68	<0.001**
Serum Uric acid (UA) mg/dL	4.21 ± 1.04	7.01 ± 0.27	<0.001**
Microalbuminuria (MA) mg/24hrs	15.35 ± 2.60	35.01 ± 41.30	<0.001**

DISCUSSION

In the present study, it was observed that the FBS levels of cases were significantly higher than that of controls. In our study the mean HbA1c levels for controls is 4.68 ± 0.47 and for diabetic cases is 8.94 ± 2.38. HbA1c levels are significantly raised in newly diagnosed Type 2 diabetic cases when compared with the controls. Several studies reported that there is a positive correlation between HbA1c and the duration of diabetic mellitus and a strong predictor of risk for diabetes complications.[11] Use of HbA1c can play a major role in case finding, in hospitalized patients with random hyperglycemia as it does not require fasting, necessitates fewer blood draws, unaffected by recent food intake or recent change in blood sugar levels.[12]



.Figure 1: Showing different parameters between controls and cases.

Our study showed lower levels of serum calcium levels in group-II as compared to group-I. Previous studies also suggest that altered calcium homeostasis may play a role in the development of type 2 diabetes as calcium intake is inversely associated with development of type 2 diabetes mellitus. Also, intake of calcium supplements were associated with a lower risk of type 2 diabetes mellitus.[13,14,15] In this study there were low levels of serum magnesium in diabetic cases, this can be possibly explained as diet low in magnesium,[16] osmotic diuresis causing high renal excretion of magnesium, insensitivity to insulin affecting intracellular magnesium transport and thereby causing increased loss of the extracellular magnesium,[17] and reduced tubular reabsorption due to insulin resistance.[18] Dietzel et al founded that maximal capacity of renal tubular reabsorption of phosphate/L of filtrate were significantly suppressed in diabetic patients and also reported that urinary phosphate excretion was three times higher in diabetic patients when compared to healthy controls this is in concordance with our study showing low phosphate levels in newly diagnosed diabetic patients.[19] The Rancho Bernardo Study showed that hyperuricemia have been associated with insulin resistance and is an independent predictor of incident type 2 diabetes in general populations.[20] One of the possible cause is the defect in urate transporter which is responsible for urate reabsorption from kidney leading to increased uric acid levels in diabetes mellitus.[21] Microalbuminuria being a well-known early predictor of diabetic nephropathy and is due to increased vascular permeability as well as endothelial dysfunction.

In our study microalbuminuria was seen in all cases and shows statistical significance as compared to non-diabetic controls.[22]

CONCLUSION

In conclusion, our study suggests that there is decrease in serum calcium, magnesium and phosphate levels, all these plays an important role in the regulation of glucose level in the blood. Hence oral supplementation of all

these ions other than diet is recommended in Type-2 diabetes. Increased serum uric acid and microalbuminuria was seen with reduced glucose tolerance hence early estimation of both the parameters should be done while monitoring case of Type-2 diabetes and thus will help to decrease the incidence of renal complications.

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