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ASSESSMENT OF SERUM MAGNESIUM LEVEL AND ITS ASSOCIATION WITH OTHER BIOCHEMICAL MARKERS AMONG PATIENTS OF TYPE-II DIABETES MELLITUS

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Abstract:
Introduction and purpose: *The incidence of diabetes has been recognized as an important medical problem worldwide in recent years. Magnesium deficiency has a negative effect on glucose metabolism and plays a key role in the development of diabetic complications. Hence, in the current study, we attempt to explore the level of magnesium ion and other biochemical markers in diabetic participants and to probe credential signs and the association between correlations with other biochemical markers studied in diabetic participants.*
Place and Duration: *In the Medicine department of Pakistan Institute of Medical Sciences, Islamabad for one-year duration from February 2019 to February 2020.*
Subjects and methods: *The study involved 80 participants, consisting of two groups: 40 healthy participants with normal blood sugar, 40 participants with type 2 diabetes: systolic blood pressure, diastolic blood pressure, glycated hemoglobin (HbA1c), fasting blood sugar (FBS), electrolyte profile (sodium, potassium and magnesium), blood urea nitrogen (BUN) and creatinine. In addition, lipid profile (total cholesterol, triglycerides and HDL cholesterol) was analyzed among diabetic participants and the relationship between serum magnesium levels and biochemical markers.*
Results: *The participants with diabetes showed a significant change in FBS, HbA1c, BUN, creatinine, potassium and lipid profile compared to healthy participants, while participants with diabetes had sodium and magnesium levels compared to healthy participants. In addition, significant negative correlations with low serum magnesium and total cholesterol, HDL cholesterol and potassium were observed in diabetic patients.*
Conclusion: *The alterations in lipid and electrolyte profiles observed in diabetic participants have great potential as a diagnostic tool in clinical practice especially hypomagnesaemia which was widespread among our diabetic participants and its correlations with other biochemical markers studied bears important clinical implications in achieving better control of the risk of diabetic complications.*
Key words: *hypomagnesemia, diabetes, metabolism, correlation, lipids, electrolytes.*

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INTRODUCTION:

Diabetes is a metabolic disease resulting from misuse, manifesting itself as insulin deficiency or hyperglycemia. The incidence of diabetes (DM) has been recognized in recent years as an important medical problem worldwide. According to the International Diabetes Federation, it is estimated that about 415 million adult patients with type 2 diabetes will be in 2015, and 642 million will have diabetes by 2040. This is associated with various complications such as diabetes, hypertension, kidney disease, hyperlipidemia and cardiovascular disease. Diabetes is associated with imbalance in the metabolism of micronutrients. One of these micronutrients is magnesium. Magnesium is one of the intracellular cations in the body that plays an important role in many key metabolic pathways, such as cellular energy metabolism, regulation of ion transport and neuromuscular conduction. In addition, magnesium ion plays a key role in lipid metabolism due to the primary cofactor in various enzyme pathways, such as cholesterol metabolism, where it requires Mg2 + to regulate HMG-CoA reductase. In addition, lipase and magnesium lipoprotein lecithin play a key role in regulating cholesterol acyltransferase (LCAT) activity. The kidney plays a key role in regulating magnesium and maintaining its level in the blood.

Magnesium is considered a medicine to treat diabetes and common complications of diabetes. Magnesium is an important factor in the secretion and action of insulin. Previous studies have shown that magnesium deficiency interferes with insulin secretion and reduces the effects of peripheral insulin sensitivity. Therefore, there is a close relationship between metabolic control of diabetes and variable magnesium homeostasis. Magnesium deficiency has a negative effect on glucose metabolism and onset of diabetic complications in insulin-sensitive diabetic patients. Therefore, in this study, an attempt was made to investigate levels of magnesium ions and other biochemical markers in diabetic participants and to show signs of identity and association information among other biochemical markers studied in diabetic participants.

PATIENTS AND METHODS:

This study was held in In the Medicine department of Pakistan Institute of Medical Sciences, Islamabad for one-year duration from February 2019 to February 2020. This study involved 80 participants, out of which two groups were formed: 40 (20 men and 20 women) healthy participants, 40 (25 men and 15 women) patients with type 2 diabetes. All participants obtained informed written consent before initiating the investigation practice. All the procedures used were in line with ethical standards and the Helsinki Declaration. Diabetic participants were diagnosed according to the following criteria: fasting glucose ≥ 7 mmol / L and HbA1c ≥ 6.5%. Blood pressure (systolic and diastolic) was recorded. The age of the patients was 36–70 years. Participants with a history of cardiac dysfunction, chronic inflammatory diseases, hypothyroidism or other diseases were excluded from our study. Blood samples from all participants were collected after 10-12 hours on an empty stomach, centrifuged and aspirated, and stored at -20 ° C for further biochemical analysis. Biochemical tests of fasting blood glucose, lipid profile (total cholesterol, triglycerides and HDL cholesterol), blood urea nitrogen, creatinine, sodium, potassium and magnesium were tested according to the manufacturer's instructions using an automatic analyzer, ROCHE Cobas 6000 module (C- 501 and C-601). The HbA1c test was determined according to the manufacturer's protocol.

Statistics analysis

Data analysis was performed using SPSS statistical software version 18.0 (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± standard error. Statistical analysis was performed using one-way ANOVA analysis of variance, and the means were compared using Duncan's multi-range tests as a post-hoc test with a probability level of 5%. P <0.05 was considered statistically significant.

RESULTS:

Of the 40 participants with diabetes, 25 (62.5%) were men and 15 (37.5%) were women, while 20 (50%) were men and 20 (50%) were women in a healthy control group. Systolic blood pressure (SBP) was significantly (p <0.001) high in diabetic participants compared to healthy participants. In contrast, diastolic blood pressure (DBP) slightly increased in diabetic participants compared to healthy participants. Demographics of study participants are explained in Table 1.

Table 1 Demographic data of the healthy and diabetic participants (Mean ± Std. error)

Parameter	Healthy participants (n=40)	Diabetic participants (n=40)
Gender (M/F)	20/20	25/15
SBP(mmHg)	128.75 ± 0.86	149.90*** ± 1.91
DBP(mmHg)	80.03 ± 0.69	81.80 ± 1.06
M: male; F: Female; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; ***p<0.001 as compared to healthy participants		

Fasting blood sugar (FBS), glycated hemoglobin (HbA1c) and changes in lipid profile between healthy and diabetic participants are shown in Table 2. Diabetic participants showed a marked increase (p <0.001) in diabetic patients. The fasting blood, glycosylated hemoglobin, total cholesterol and triglycerides compared to healthy participants. Diabetic participants showed a significant decrease in HDL cholesterol (p <0.001) compared to healthy participants as shown in Table 2.

Table 2 Levels of fasting blood glucose, HbA1c, and lipid profile in healthy and diabetic participants (Mean ± Std. error)

Parameter	Healthy participants (n=40)	Diabetic participants (n=40)
FBS (mmol/l)	5.05 ± 0.11	8.97*** ± 0.20
HbA1c (%)	5.02 ± 0.13	8.27*** ± 0.13
Total cholesterol (mmol/l)	3.72 ± 0.09	5.03*** ± 0.10
Triglycerides (mmol/l)	1.24 ± 0.07	2.36*** ± 0.10
HDL-cholesterol (mmol/l)	1.26 ± 0.04	0.85*** ± 0.04
FBS: fasting blood sugar; HbA1c: glycated hemoglobin; HDL: High-density lipoprotein; ***p< 0.001 as compared to healthy participants		

Renal function and electrolyte profile were assessed by assessing blood urea nitrogen (BUN), creatinine, sodium (Na +), potassium (K +) and magnesium (Mg2 +) levels as summarized in Table 3. There was a significant increase in BUN, creatinine levels and potassium in participants with diabetes compared to healthy participants (Table 3). On the other hand, there was a significant and noticeable (p <0.001) decrease in sodium and magnesium levels in diabetic subjects compared to healthy participants, as shown in Table 3.

Table 3 Kidney profile and electrolyte profile in healthy and diabetic participants (Mean ± Std. error)

Parameter	Healthy participants (n=40)	Diabetic participants (n=40)
BUN (mmol/l)	4.32 ± 0.19	7.88*** ± 0.35
Creatinine(µmol/l)	75.52 ± 2.09	167.15*** ± 8.45
Sodium (mmo/l)	140.20 ± 0.41	135.39*** ± 0.48
Potassium (mmol/l)	4.29 ± 0.06	4.80*** ± 0.10
Magnesium (mmol/l)	0.97 ± 0.02	0.74*** ± 0.01
***p< 0.001		

Table 4 illustrates the correlation coefficients (Pearson) between serum magnesium (Mg2 +) and other biochemical markers in diabetic participants. Relatively higher fasting blood sugar (FBS), glycosylated hemoglobin (HbA1c) and creatinine were observed in patients with diabetes with low serum magnesium (Mg2 +), but the amount of negative correlation between serum Mg and previous markers was low and not significant. However, high serum cholesterol was significantly correlated with serum Mg (r = -0.94; p <0.05). Low serum HDL cholesterol was significantly correlated with serum Mg (r = -0.27; p <0.05). In addition, high serum potassium was significantly correlated with serum magnesium (r = -0.40; P <0.01) as shown in Table 4.

Table 4 Biochemical correlation between serum magnesium level and biochemical markers among diabetic participants (n=40)

Biochemical markers	Magnesium level	
	Correlation coefficient (r) value	p-value
FBG(mmol/l)	-0.03	NS
HbA1c (%)	-0.07	NS
Total cholesterol (mmol/l)	-0.29	p<0.05
Triglycerides (mmol/l)	0.15	NS
HDL-cholesterol (mmol/l)	-0.27	p<0.05
BUN (mmol/l)	0.16	NS
Creatinine(µmol/l)	-0.15	NS
Sodium (mmo/l)	0.08	NS
Potassium (mmol/l)	-0.4	p<0.01

NS: Non-significant; p<0.05 considered significant; p<0.01 considered highly significant

DISCUSSION:

Electrolyte imbalance in patients with diabetes is an unusual diagnostic tool in clinical practice and has a significant impact on the risk of developing diabetes complications. Therefore, our current study was an attempt to examine the levels of electrolyte profile and other biochemical markers in diabetic participants, and to clarify the signs of identity and biochemical correlations between magnesium and other biochemical markers studied in diabetic participants. In our study with 80 participants, two groups were created; 40 healthy participants with normal blood sugar levels and 40 participants with diabetes with abnormal glucose and glycosylated hemoglobin.

Current studies have shown a significant increase in fasting blood sugar in participants with diabetes and HbA1c compared to healthy participants. These results are consistent with the results of studies in which hyperglycemia and high glycosylated hemoglobin were observed in diabetic patients. Diabetic patients showed a change in lipid profile and were characterized by a significant increase in total cholesterol and triglycerides compared to healthy participants. In addition, people with diabetes have shown a marked decrease in HDL cholesterol. These findings are in line with previous studies that indicate that patients with diabetes show significant changes in lipid profile levels that play a key role in the development of dyslipidemia and other diabetic complications. There are many factors that contribute to changes in the lipid profile, such as hyperglycaemia and insulin deficiency or resistance in diabetic patients. The decrease in HDL cholesterol in people with diabetes increased the risk of cardiovascular disease due to a sensitive marker of lipoprotein levels rich in atherogenic triglycerides. Blood urea nitrogen and creatinine are the easiest way to control your kidney function.

This study showed a significant increase in blood urea nitrogen and creatinine levels in diabetic participants compared to healthy participants, our results represent a serious imbalance between high-glucose protein metabolism in the diabetic state and a negative nitrogen balance. Explains the high levels of urea nitrogen and creatinine in the blood of diabetic patients.

While significant changes in the electrolyte, sodium and magnesium profile decreased in diabetic participants, a significant increase in potassium levels was observed in diabetic participants. Our results are in line with previous reports showing that hyponatraemia and hypomagnesemia observed in people with diabetes associated with osmotic diuresis are caused by hyperglycemia and insulin resistance, which causes an increase in the loss of sodium and magnesium in the urine. Regarding the biochemical correlation between serum magnesium and other biochemical markers studied, an unusual correlation of magnesium in the blood with total serum cholesterol and HDL cholesterol was found in diabetic subjects. The association of magnesium with lipid dysfunction seems likely because it is an essential cofactor for lipid metabolism. Our results are consistent with those reporting a strong relationship between hypomagnesemia and the lipid profile in diabetic patients. In addition, low serum Mg levels are associated with the variable profile of renal function in diabetic patients and have shown that serum magnesium has a highly significant and insignificant negative correlation with serum creatinine and potassium, respectively. As agreed, Yossef et al., Pham et al., And Dasgupta et al. Hypomagnesaemia has been found to be a new predictor of end-stage renal disease in diabetic patients.

CONCLUSION:

The changes in lipid and electrolyte profiles observed in patients with diabetes have great potential in clinical practice, especially since hypomagnesaemia is spreading among our diabetic patients and their correlation with other biochemical markers in the study.

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