Association of serum magnesium level with microalbumin in urine of newly detected type-2 diabetes mellitus

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Abstract

Background : Magnesium (Mg++) deficiency is associated with poor glycemic control and Mg++ supplementation lowers blood sugar, improves insulin sensitivity and delays diabetic complications such as diabetic nephropathy, diabetic neuropathy, diabetic retinopathy.

Objective : This study was designed to know the status of serum Mg++ in type 2 diabetic subjects with microalbuminuria and normoalbuminuria.

Methodology : This study was conducted at the Department of Laboratory Medicine (Clinical Pathology) in collaboration with BIRDEM General Hospital, Dhaka. In this study, serum magnesium level and urine microalbumin level of 120 newly detected type 2 diabetic patients were measured. Both levels were measured by biochemical auto analyzer (Siemens Dimension RL Max).

Result : The mean microalbumin level was found 22.9±3.1 mg/L with range from 2-105 mg/L and the mean magnesium level was found 1.9±0.3 mg/dl with range from 1.5-2.4 mg/dl. Pearson's correlation coefficient was -0.353 between serum magnesium level and urine microalbumin which was statistically significant (p value < 0.05). Therefore, there was a linear negative correlation between serum magnesium level and urine microalbumin.

Conclusion : The present study revealed negative correlation between serum magnesium level and urine microalbumin.

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Introduction

Magnesium (Mg^{++}) is the fourth most abundant cation in the human body.[1,2] One of the potential pathophysiological mechanisms linking serum magnesium to microalbuminuria is an amplification of insulin resistance. Magnesium acts as a mild, natural calcium antagonist. Therefore, the level of intracellular calcium is increased in magnesium deficiency subjects. This increased intracellular calcium may compromise the insulin responsiveness of a dipocytes and skeletal muscles which leads to the development of insulin resistance.[2] Another study has also found that insulin deficiency or insulin resistance can affect the tubular absorption of magnesium, leading to hypomagnesemia in diabetic patients.[2] Finally, a vicious circle formed by mutual influence between insulin resistance and hypomagnesemia which can increase the risk of microalbuminuria.[3] Magnesium (Mg^{++}) plays a key role in many fundamental biological processes including metabolism and DNA synthesis. Mg^{++}deficiency may cause endothelial cell dysfunction, inflammation and oxidative stress.[1] Endothelial cells could be injured through inflammatory response. It causes an increase in capillary permeability particularly in glomerular vessels. It induces kidneys to undergo transient proteinuria. The changes can be measured by increased levels of microalbuminuria.[4,5]

Insulin and glucose are important regulators of magnesium metabolism. Intracellular magnesium plays a key role in regulating insulin action, insulin-mediated-glucose-uptake and vascular tone.[6] Reduced intracellular magnesium concentrations result in a defective tyrosine-kinase activity, postreceptorial impairment in insulin action and worsening of insulin resistance in diabetic patients.[2]

Hypomagnesaemia is usually indicative of a systemic magnesium deficit. Depletion in intracellular and serum ionized magnesium can be found in many subjects with total serum magnesium still in the normal range.[6] It was

found that 25-39% of diabetics have low concentrations of serum magnesium.[7] Magnesium deficit in the diet would induce insulin resistance in humans.[2] If it is chronic, it may lead to macro-vascular and micro-vascular complications of diabetes. Hypomagnesaemia independently predicts the progression to end stage renal disease in patients with advanced type 2 diabetic nephropathy.[2]

Oxidative stress is an important causative factor for microalbuminuria.[8,9] Magnesium has antioxidant property. Hence, oxidative stress has association between low serum magnesium and microalbuminuria.[3]

A low magnesium intake and an increased urinary loss of magnesium appear the most important mechanisms that may favor magnesium depletion in patients with type 2 diabetes.[1] Mg^{++}intake is inversely longitudinally associated with the incidence of diabetes.[10] Approximately one-third of subjects with type 2 diabetis mellitus (DM) have hypomagnesaemia mainly caused by enhanced renal excretion. Magnesium deficiency is associated with poor glycemic control and magnesium supplementation improves insulin sensitivity and delays complications.[1,11]

In this study,we try to find out the status of serum Mg^{++} in type 2 diabetic subjects with microalbuminuria and normoalbuminuria.

Materials and Methods

This cross sectional study was conducted at the Department of Laboratory Medicine (Clinical Pathology) in collaboration with Department of Biochemistry and Molecular Biology, BSMMU and BIRDEM General Hospital, Dhaka. The duration of study period was from March 2016 to February 2017. Total 120 subjects of newly detected type 2 diabetes mellitus were included. Serum magnesium and urine microalbumin levels in all newly detected type 2 diabetic patients were measured. Both levels were measured by biochemical auto analyzer (Siemens Dimension RL Max). Other types of diabetes such as type-1 diabetes, gestational diabetes etc, patients with UTI/Pyelonephritis, patients who were on magnesium based antacid medication, on long term diuretics, with malabsorption or chronic diarrhea, on dialysis were excluded. Measurement of serum concentration of magnesium and micro albumin in urine is easy and not expensive. Therefore, to know the status of serum magnesium and microalbuminuria in type 2 diabetic subjects for this study was not difficult.

Result And Observations

Total 120 subjects of newly detected type 2 diabetes mellitus were included. Serum magnesium level and urine microalbumin level were measured. After detecting the level of microalbumin in urine, patients were grouped into normoalbuminuria and microalbuminuria group. Finally correlation coefficient of magnesium and urinary microalbumin were calculated by using Pearson's correlation coefficient test.

Table I : Distribution of the study patients by serum magnesium (n=120)

Serum magnesium (mg/dl)	Number of patients	Percentage
<1.8 (low)	36	30.0
1.8-2.4 (normal)	84	70.0
Mean±SD	1.9±0.3	
Range (min, max)	1.5,2.4	

Table I shows serum magnesium level of the study patients, it was observed that 36(30.0%) had low level (<1.8 mg/dl) and 84(70%) had normal level (1.8-2.4). The mean serum magnesium level was found 1.9±0.3 mg/dl and ranged from 1.5 to 2.4 mg/dl.

Table II : Distribution of the study patients by urine microalbumin (n=120)

Urine microalbumin(mg/L)	Number of patients	Percentage
Normoalbuminuria (<20)	78	65.0
Microalbuminuria (20-199)	42	35.0
Mean±SD	22.9±3.1	
Range (min, max)	2,105	

Table 11 shows urine microalbumin of the study patients, it was observed that 42(35.0%) patients had microalbuminuria and 78(65.0%) had normoalbuminuria. The mean microalbumin level was found 22.9±3.1 mg/dl with range from 2-105 mg/dl.

Table III: Comparison between urine microalbumin level with age (n=120)

Age (in years)	Urine microalbuminuria (mg/L)				*p* value
	Normo albuminuria (n=78)		Microalbuminuria (n=42)		
	n	%	n	%	
30	4	5.1	8	19.0	
31-40	28	35.9	14	33.3	
41-50	38	48.7	18	42.9	
51-60	6	7.7	2	4.8	
>60	2	2.6	0	0.0	
Mean±SD	44.3±8.7		40.2±7.5		0.076 ns
Range (min, max)	30,73		28,55		

ns= not significant

p value reached from unpaired t-test

Table III shows comparison between age with urine microalbumin level. It was observed that in normoalbuminuria group, 38(48.7%) patients were belonged to 41-50 years and in microalbuminuria group, it was 18(42.9%) patients. The mean age was found 44.3±8.7 years in normoalbuminuria group and 40.2±7.5 years in normoalbuminuria group. The difference was statistically not significant (p>0.05) between two group.

Table IV: Comparison between urine microalbumin level with sex (n=120)

Sex	Urine microalbumin level (mg/L)				*p* value
	Normoalbuminuria (n=78)		Microalbuminuria (n=42)		
	n	%	n	%	
Male	34	43.6	30	71.4	0.039[s]
Female	44	56.4	12	28.6	

s= significant *p* value reached from chi square t-test

Table V : Comparison between serum magnesium with urine microalbumin(n=120)

Serum magnesium (mg/dl)	Urine microalbumin (mg/L)				*p* value
	Normoalbuminuria (n=78)		Microalbuminuria (n=42)		
	n	%	n	%	
<1.8 (low)	22	28.2	14	33.3	
1.8-2.4 (normal)	56	71.8	28	66.7	
Mean±SD	2.2±0.3		1.9±0.2		0.001[s]
Range (min, max)	1.5,2.4		1.5,2.2		

s= significant *p* value reached from unpaired t-test

Table V shows comparison between serum magnesium level with urine microalbumin. It was observed that 22(28.2%) patients had low serum magnesium in normoalbuminuria group and 14(33.3%) in microalbuminuria group. The mean serum magnesium was found 2.2±0.3 mg/dl in normoalbuminuria and 1.9±0.2 mg/dl in microalbuminuria group. The difference was statistically significant (p<0.05) between two groups.

Discussion

The cross sectional study was aimed at determining the serum magnesium concentration in newly detected diabetic population and correlating it with microalbumin level in urine. The findings of this study was compared with the results of some other published articles elsewhere in the world to verify the results. In this study, 120 patients of newly detected type 2 diabetes mellitus were included. It was observed that 36(30.0%) had <1.8 mg/dl and 84(70%) had normal serum magnesium level (1.8-2.4 mg/dl) and the mean ± SD for serum magnesium in study population was 1.92 ± 0.3 mg/dl. Shaikh M k et al. found that the mean ± SD for serum magnesium in overall subjects was 1.34 ± 0.53. The hypomagnesemia was identified in 08 (14.5%) patients of type 1 diabetes and 47 (85.5%) of type 2 diabetes (p=0.02). The hypomagnesemia was identified in patients with diabetes mellitus (type 1 and type 2) with statistical significant values.[12] In another study done by Ferdousi S et al. found that serum magnesium concentration in the type 2 diabetic patients was found significantly (p<0.001) lower than that of control group.[13] The reasons of decreased magnesium in type 2 diabetes mellitus might be due to higherurinary losses or impaired absorption of magnesium as compared to healthy persons. Urinary microalbumin level was measured in 120 subjects of newly detected type 2 diabetes mellitus.

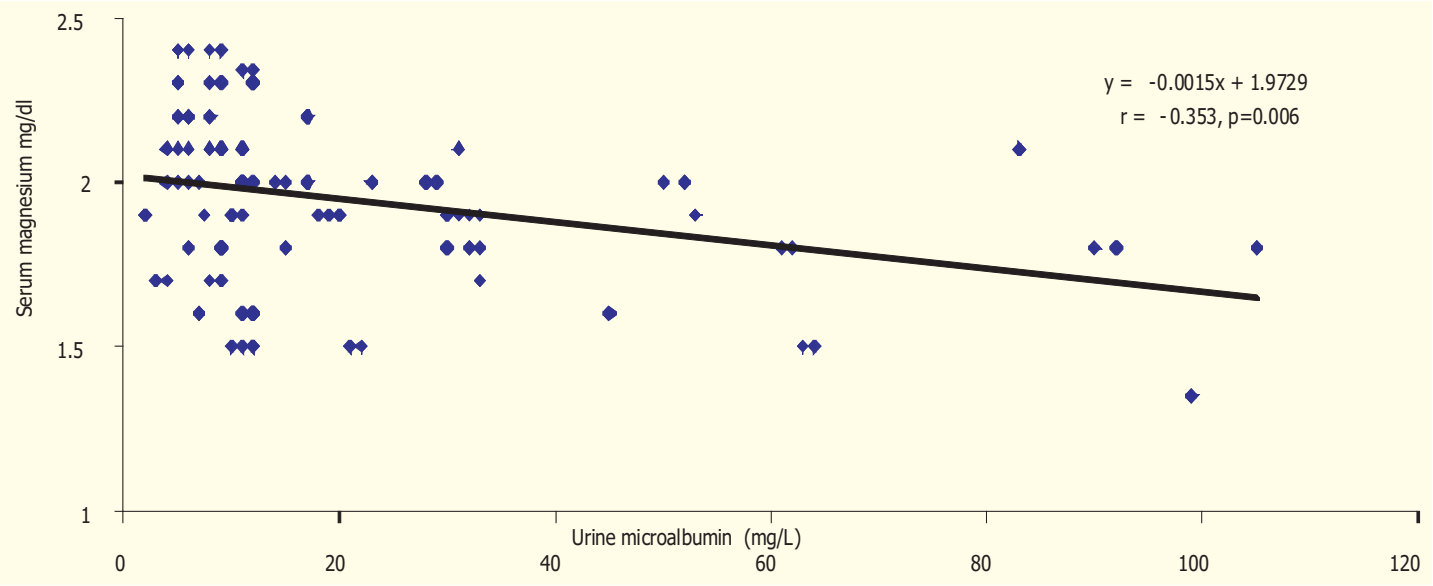

Figure 1: Scatter diagram shows correlation between urine microalbumin and serum magnesium (n=120).

Figure 1 shows significant negative correlation (r=-0.353; p=0.006) between urine microalbumin and serum magnesium level, the correlation was statistically significant (p<0.05).

It was observed that 42(35.0%) patients had microalbuminuria and 78(65.0%) had normoalbuminuria. The mean microalbumin level was found 22.9±3.1 mg/L with range from 2-105 mg/L.Xu B et al had shown that 11.37% of the study population had

microalbuminuria.[10] In another study done by Varghese et al.(2016) found that overall prevalence of microalbuminuria 36.3%.[8]

It was observed that in normoalbuminuria group, 48.7% patients were belonged to 41-50 years and in microalbuminuria group, it was 42.9%. The mean age was found 44.3±8.7 years in normoalbuminuria group and 40.2±7.5 years in microalbuminuria group. The difference was statistically not significant (p>0.05) between two groups. In a study done by Anesh T et al. found that the mean age of microalbuminuria group was 57.15±10.17.This difference in result might be due to demographical variation.[7]

In present study, It was observed that majority of the patients 71.4% in microalbuminuria group were male and it is 43.6% in normoalbuminuria group. The difference was statistically significant (p<0.05) between two group. In a study done by Anesh T et al,2016 found that 63.8% microalbuminic patients were male.[7] In another study, Rao P P et al. shown that about 66% were males and 34% were females in both group.[3] Therefore this study was consistent with the previously published studies.

It was observed that 22(28.2%) patients had low serum magnesium in normoalbuminuria group and 14(33.3%) in microalbuminuria group. The mean serum magnesium was found 2.2±0.3 mg/dl in normoalbuminuria and 1.9±0.2 mg/dl in microalbuminuria group. The difference was statistically significant (p<0.05) between two groups. In the present study, the mean serum Mg^{++} levels in normoalbuminuria and microalbuminuria were 2.2 ± 0.3(mg/dl) and 1.9 ± 0.2 (mg/dl), respectively. The results of present study was consistent with the studies done by Rao P P et al. and Anesh T et al.[3,7]

The negative correlation(r=-.353) between serum magnesium level and urinary microalbumin level in newly detected type 2 diabetes mellitus patients was statistically significant (P<0.05). In a study conducted by Anesh T et al. found statistically significant correlation (p<0.001) between serum magnesium and urine microalbumin.[7] Sakaguchi Y et al., (2012) also found statistically significant correlation (p=0.004) between these two parameters in diabetic patients.[1]

Conclusion

Patients with low serum magnesium levels at diagnosis of diabetes mellitus are associated with chances of microalbuminuria. Therefore, hypomagnesemia should be treated as a risk factor in developing microalbuminuria in early diabetes mellitus cases.

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