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Original Research Article

Evaluation of Serum Magnesium in Type 2 Diabetes Mellitus and Diabetic Nephropathy in Young Individuals

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Abstract

Background/Aims: The link between microalbuminuria and magnesium depletion is debatable, and serum ionised magnesium levels have not previously been investigated in individuals with various stages of diabetic nephropathy. Therefore, the goal of this study was to assess circulating ionised magnesium concentrations in patients with non-insulin-dependent diabetes mellitus (NIDDM) and incipient or overt diabetic nephropathy.

Methods: We measured fasting plasma glucose, creatinine, creatinine clearance estimate, total cholesterol and triglycerides, and serum ionised magnesium (ISE) in 30 NIDDM patients with urinary albumin excretion rate (UAER)! 20 Ìg/min (nor-moalbuminuria), 30 NIDDM patients with microalbuminuria (20! UAER! 200 Ìg/min), 30 NIDDM patients with clinical proteinuria (UAER 1200 Ìg/min), and 20 healthy subjects.

Results: Serum ionised magnesium levels in diabetes patients were considerably lower than in control participants (0.49 B 0.06 vs. 0.58 B0.05 mmol/l, p! 0.001). Furthermore, diabetic individuals with microalbuminuria or clinical proteinuria had a substantial drop in serum ionised magnesium levels. Serum magnesium levels were considerably lower ($p<0.001$) in instances with retinopathy compared to controls. There was a significantly significant negative connection between serum magnesium and glycosylated haemoglobin (HbA1c) in diabetic nephropathy.

Conclusion: Good glycaemic management and hypomagnesaemia both had an impact on the severity of diabetic retinopathy in the research population. These measures might be utilised as a supporting diagnostic tool in type 2 Diabetes.

1. INTRODUCTION:

Type II Diabetes Mellitus (DM) is a metabolic condition characterised predominantly by hyperglycemia. It is caused by insulin resistance or relative insulin deficiency (1). Chronic hyperglycemia is a significant cause of microvascular problems, including nephropathy. Metabolically generated inflammation has been regarded as a critical stage in the aetiology of type 2 diabetes (2,3). Aside from that, the metabolism of various minerals has been shown to change in DM, and these elements may play unique roles in the aetiology and course of the illness. Among these minerals, magnesium is the most significant. Magnesium is the body's fourth most abundant cation, ranking second in the intracellular environment. Magnesium is a cofactor in phosphorylation of glucose and aids in carbohydrate metabolism (4).

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Poor glycaemic management is linked to magnesium insufficiency, and magnesium supplementation enhances insulin sensitivity (5). Furthermore, a strong body of research indicates a connection between hypomagnesaemia and a number of type 2 diabetic problems, such as neuropathy, retinopathy, foot ulcers, and albuminuria (6–8). The connection between severe type 2 diabetic nephropathy and magnesium insufficiency Numerous studies have been conducted on this parameter. Therefore, the objectives of this investigation were as follows. To determine blood magnesium levels in diabetic nephropathy and type 2 diabetes subjects, respectively

2. METHODOLOGY:

The study comprised 75 patients with clinically proven type 2 diabetic nephropathy and 75 individuals with type 2 diabetes mellitus who visited the nephrology outpatient department at Index Hospital on Nemawar Road in Indore. As controls, sixty (70) healthy adults of the same gender and age were included. Patients with severe inflammatory illnesses, infections, heart or renal difficulties, and diabetes-related microvascular complications were excluded from the study. The study excluded patients taking diuretics, magnesium supplements, blood sugar-altering drugs, and pregnant women. The study's data, clinical examination, and medical records were used to determine whether or not patients with type 2 diabetes had nephropathy.

Biochemical analysis:
A 3 ml venous blood sample was obtained under aseptic conditions while fasting and after eating. It was allowed to coagulate before serum was separated using centrifugation. The following parameters were examined. The patients' medical records provided demographic information such as age, gender, CKD aetiology, diabetes, hypertension, dyslipidaemia, pre-existing cardiovascular disease (CVD) or stroke, and medication (angiotensin-converting enzyme inhibitors [ACEIs], angiotensin II receptor blockers [ARBs], statins, loop and thiazide diuretics, and Mg oxide [MgO]). Constipation is the most common reason for prescription MgO in Japan, and no research subjects received it off-label.

Laboratory data such as SCr, calcium (Ca), phosphorous (P), magnesium (Mg), albumin, and haemoglobin A1c (HbA1c) levels were assessed from the initial blood samples collected from most patients shortly after admission. If they were not available, the most recent measurement obtained within one month after admission was utilised. Because HbA1c levels were determined by high-pressure liquid chromatography, the estimated National Glycohemoglobin Standardisation Program (NGSP) equivalent values for HbA1c were derived using the following formula: HbA1c (NGSP) equals HbA1c plus 0.4 (9). When the serum albumin level was 4.0 g/dL, the serum calcium level was changed as follows: Corrected serum Ca level (mg/dL) = measured serum Ca level (mg/dL) + (4.0 2 serum albumin [g/dL]) (10).

A 24-hour urine sample was collected upon admission to determine creatinine clearance (CCr) and urine protein (UP). Standard procedures were used to test all parameters at the clinical chemistry laboratory at Osaka General Medical Centre. All statistical methods were carried out with SPSS statistical software package release 7.5 (SPSS Inc, Chicago, Ill., USA). For multiple comparisons, the ANOVA one-way test was used, followed by the Scheffé post-hoc test. Pearson's correlation coefficient and multiple linear regression analysis were used to

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determine the relationships between the variables under study. Two-tailed results of p! 0.05 were deemed statistically significant.

3. RESULT:

In this study, 75 cases of type 2 diabetes (n = 75) with diabetic nephropathy, 75 cases of type 2 DM without retinopathy, and 75 healthy controls (n = 70) were included in a comparative case-control analysis. Serum magnesium levels were measured, examined, and linked to HbA1c. The mean ± standard deviation was used to express the results. Table 1 provides a summary of the general characteristics of the participants examined. When comparing diabetic individuals with microalbuminuria or clinical proteinuria to those with normoalbuminuric diabetes, the BMI values of the former group were greater than those of the latter. NIDDM patients with microalbuminuria or clinical proteinuria had slightly higher systolic blood pressure, but there was no discernible difference in mean or diastolic blood pressure between the groups under investigation.

Table: 1. General characteristics of thepatients studied

Variables	Controls	Diabetes Mellitus	Diabetic Nephropathy
	(n = 70)	(n = 75)	(n = 75)
Age	45±14	45±13	45±17
Sex, M/F	8/12	15/15	12/18
BMI, kg/m^2	23.1B1.2	28.2B3.1*	28.1B5.1*
SBP, mm Hg	119.5B7.6	135.8B17.3	142.3B19.5*
DBP, mm Hg	74.5B5.0	78.8B7.5	77.5B10.6

Table 2: shows the gender distribution. Out of 75 cases of retinopathy, 38(52%) were males and 37(48%) were females. Out of 75 controls, 42(45 %) were males and 33(45%) were females and it was not statistically significant (p=0.38).

Gender	Diabetic with nephropathy -n (%)	Diabetic without nephropathy -n (%)	Controls - n (%)
Male	38(52)	42(55)	40(55)
Female	37(48)	33(55)	35(45)

The mean serum magnesium (mg/dL) in cases of nephropathy was 1.970 ± 0.41, in cases without nephropathy was 2.07± 0.45 and in controls was 2.79 ±0.47 and was highly significant ($p < 0.0001$)

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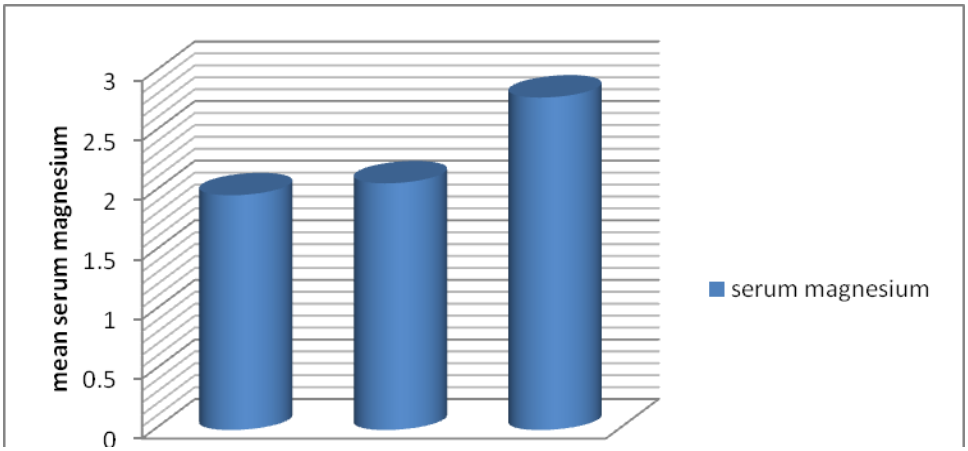

Fig. 1: Comparision of serum magnesium in between the groups

Table 3: Comparison of serum magnesium (mg/dl) levels between control and diabetic nephropathy

	DM with nephropathy	**DM without retinopathy**	**Controls**
Serum magnesium(mgdL)	1.970 ± 0.41	2.07± 0.45	2.79± 0.47

Table 4: Biochemical features and serum ionized magnesium levels in the patients studied

Variables	Controls	Diabetic Nephropaty	Diabetes mellitus
	(n = 70)	(n = 75)	(n = 75)
Creatinine, mg/dl	0.79±0.10	0.80±0.14	0.99±0.15
Creatinine clearance, ml/min	115.2±8.6	98.5±22.6	78.2±24.5*,+
Fasting glucose, mg/dl	73±7	164±30**	176±78**
HbA1c, %	4.4±0.5	7.1±1.2**	8.8±1.5**, +++
Cholesterol, mg/dl	195±6.6	200±37	215±46
Triglycerides, mg/dl	65±12	121±55	185±87**, ++
Ionized magnesium, mmol/l	0.58±0.05	0.45±0.04**	0.36±0.08**, +++

Data are mean ± SD.

*p !0.05, ** p !0.001 vs. controls. + p !0.05, ++ p !0.01, +++ p !0.001 vs.

4. DISCUSSION:

Diabetes mellitus is an endocrinological condition that causes significant metabolic and oxidative stress. Diabetic nephropathy is a significant microvascular consequence of uncontrolled diabetes mellitus and one of the primary causes of chronic kidney disease. The findings indicate that oxidative stress has the most significant role in the development of the

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problems. Numerous risk factors have been linked to the onset and progression of nephropathy in diabetic individuals.
Many trace elements are essential to human metabolic activity. Numerous studies have established the critical functions of minerals like magnesium in glucose metabolism (11). In light of this, the current study was conducted to investigate the clinical utility of serum magnesium as a potential biochemical marker that is affordable and has some diagnostic and prognostic value. In this case-control research, we compared blood magnesium levels in 75 DM patients with nephropathy, 75 DM patients without nephropathy, and 70 healthy controls. This parameter's significance between groups, diagnostic value, and connection with HbA1c are analysed and addressed.

Magnesium deficiency, as well as increased UAER, has been linked to insulin resistance [12, 13], poor glycometabolic regulation [14, 15], and lipid metabolism changes [16, 17] in diabetic patients. Furthermore, evidence shows that poor magnesium metabolism may play a role in the pathogenesis of cardiovascular problems associated with diabetes and obesity [18, 19].
As previously shown in other reports [20], our study confirms the presence of magnesium depletion in diabetic patients and appears to be consistent with previous reports indicating that both microalbuminuria and clinical proteinuria are associated with relevant magnesium metabolism alterations [21-22].

Furthermore, our findings suggest that serum ionised magnesium measurement may be a sensitive indication of magnesium homeostasis problems in NIDDM patients with various stages of diabetic nephropathy. In fact, all diabetes categories revealed a substantial drop in serum ionised magnesium compared to controls. These findings suggest that incipient or overt diabetic nephropathy may impair renal magnesium handling, contributing to the pathogenesis of magnesium deficiency in diabetics, and that serum-free magnesium concentrations can distinguish between patients with and without diabetic nephropathy. This cannot be identified by testing serum magnesium levels. and the nega tive correlation between HbA1c and magnesium levels would be in accordance with this hypothesis. Plasma triglycerides and cholesterol concentrations have been reported to be negatively related to serum ion ized magnesium in elderly subjects with impaired glucosetolerance [23].

5. CONCLUSION:

Serum magnesium levels were considerably lower in patients of diabetic nephropathy, suggesting that inflammation and oxidative stress play a role in the development of diabetes complications. Hypomagnesaemia had a substantial correlation with HbA1c. Estimating blood magnesium and HbA1c levels can help us forecast the start and progression of diabetic nephropathy. Magnesium supplementation, along with other nutritional treatments, may help to slow the progression of diabetic nephropathy and associated problems. Further research on a larger sample size is required to confirm our findings before drawing solid conclusions about the efficacy of these markers for diagnosing diabetes complications such as nephropathy.

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