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Assessing Incidence and Association of Serum Magnesium Levels, Serum Uric Acid Levels and Microalbuminuria in Patients with Type 2 DM: An Observational Study

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Magnesium, Uric acid, Microalbuminuria, Type 2 diabetes

ABSTRACT

Aim: The aim of the study was to assess the incidence and association of serum magnesium levels, serum uric acid levels and microalbuminuria in patients with type 2 DM.

Methods: The present study was a hospital based, cross-sectional study, conducted for a period of 1.5 years from January 2022 to June 2023, carried out on 100 patients diagnosed with type 2 diabetes mellitus. The study was done in the department of Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India on patients who satisfied the inclusion criteria, after taking an informed written consent from all the subjects.

Results: In our study, 43% of the population belonged to 51-60 years of age group followed by 21% in 31-40 age group. There were 84 males and 16 females in the study. Serum magnesium levels were on the lower side in 90% of the population and only 10% had levels within the normal range in our study. Serum uric acid levels were elevated in 68% of the study population whereas 32% were within the normal range or low. Out of 100, 82 were having Microalbuminuria and 14 were having macroalbuminuria. In our study, there was a strong positive correlation between, hypomagnesemia and microalbuminuria, with highly significant p value of 0.000. Out of 100, 82 were having Microalbuminuria and 14 were having macroalbuminuria, 90 patients had elevated serum Mg levels, i.e., 90%. In our study, there was a positive correlation between, high uric acid levels and microalbuminuria with a highly significant value of 0.000. Out of 82 study population with microalbuminuria, 68 had elevated serum uric acid levels.

Conclusion: There was a significant microalbuminuria in patients with type 2 DM, with reduced serum Mg levels and elevated serum uric acid levels as compared with patients who had serum Mg and uric acid levels within the normal range.

1. INTRODUCTION

Chronic vascular complications in type 2 diabetes (T2DM) are the deteriorating conditions underlined by inflammation.[1] The chronic vascular complications in diabetes mellitus (DM) are classified by vascular size into macro- and microvascular diseases. The chronic vascular complications are a serious problem, since they generally yield devastating outcomes for the T2DM patients, which include coronary arterial disease (CAD), cerebrovascular disease (CVD), peripheral arterial disease (PAD), diabetic nephropathy (DN), diabetic retinopathy (DR), and diabetic peripheral neuropathy (PN).[2] Higher levels of serum insulin may decrease uric acid (UA) clearance by kidneys and predispose to Uric

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acid injury.[3] Several large epidemiologic studies have reported that elevated serum UA concentration is associated with cardiovascular disease.[4] Microalbuminuria means significant increase in albumin excretion rate (AER)[5] and may reflect a generalized defect in vascular permeability and a concomitant atherogenic diathesis.[6]

Magnesium (Mg) is the most abundant intracellular cation and the fourth uttermost abundant mineral in the human body.[7] Because of its many essential roles in the human body, including protein synthesis, Mg has been used for the prevention and treatment of many diseases.[8] Some studies suggest that there is a relationship between serum Mg level and Microalbumnuira.[9-11] It's also observed that low Mg level was associated with complications of diabetes like diabetic retinopathy in caucasians but not in black African diabetics.[12] Urate (soluble form of uric acid) is known to scavenge superoxide radicals, hydroxyl radicals and other free radicals and may have therapeutic influences.[13] In spite of this, definitive role of uric acid in diabetes is not yet understood but hyperuricemia in glucose intolerance and uncontrolled diabetes is thought to be closely associated.[14,15]

In the early microalbuminuria stage, intensive multifactorial therapy that includes glycemic, lipid and blood pressure control, in addition to smoking cessation, has induced remission and improved renal function.[16,17] There is little evidence of the contribution of these factors in the prevention of the progressive loss of renal function in advanced diabetic nephropathy.[18] The evidence is limited to the effect of hypertension management and a low-protein diet.[19] Despite the use of these intensive therapies, the loss of renal function progresses, after the onset of overt nephropathy, to ESRD in the majority of cases. One study reported that various recent early biomarkers are associated with the development of diabetic nephropathy.[20]

The aim of the study was to assess the incidence and association of serum magnesium levels, serum uric acid levels and microalbuminuria in patients with type 2 DM.

2. MATERIALS AND METHODS

The present study was a hospital based, cross-sectional study, conducted for a period of 1.5 years from January 2022 to June 2023, carried out on 100 patients diagnosed with type 2 diabetes mellitus. The study was done in the department of General Medicine, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India. Patients who satisfied the inclusion criteria, after taking an informed written consent from all the subjects were included in the study.

Inclusion and exclusion criteria

All the type 2 diabetic patients hospitalized at Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India of any age and gender are included in the study. Those Patients with type 1 diabetes mellitus, patient with history of alcohol intake, gout fever, UTI (urinary tract infections), arthritis, acute myocardial infarction, recent major surgery/major trauma, hypertensive, recent (6 months) intervention with ACE inhibitors and those on chemotherapeutic agents (anti-neoplastic drugs) were excluded from the study.

A pre-structured proforma was used to collect the data. Detailed history was taken from the patients about the fever, chest pain, breathlessness, lifestyle, history of chronic disease, current medications including anti diabetic drugs (oral agents or Insulin), anti-hypertensive agents, uricosuric drugs and chemotherapeutic agents. Personal history (alcohol etc.) was taken. Fasting and post prandial sugar levels, HBA1C levels for diagnosis of type 2 DM, serum magnesium and serum uric acid levels were also estimated. Urinary albumin excretion was assessed by urinary albumin: creatinine ratio in spot sample. Those who died during the hospital stay, date & cause of death were recorded. The patients were divided into the following groups according to the degree of albuminuria as follows: normal: <30 mg/day, microalbuminuria: 30-300 mg/day and macroalbuminuria: >300 mg/day.[21] The serum uric acid normal range is 3-7 mg/dl in male whereas it's 2.5-6 mg/dl in female.[22] For serum magnesium, a serum level of 1.4.-2 mg/dl is considered to be in normal range.[23]

Statistical analysis

Collected data from the study population were entered into Microsoft Excel 2007 and Epi Info 7. Their demographic data analysis was performed. Descriptive data were expressed as frequency, percentage, Chi-square test, Fisher Exact and 't' test were applied whenever applicable. The entire data were analyzed using the software graph pad, $p<0.05$ was considered to be statistically significant and $p<0.001$ was considered to be statistically highly significant.

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3. RESULTS

Table 1: Age and gender distribution in the study group

Age groups (years)	**N**	**%**
31-40	21	21
41-50	16	16
51-60	43	43
61-70	17	17
Above 70	3	3
Gender		
Male	84	84
Female	16	16

In our study, 43% of the population belonged to 51-60 years of age group followed by 21% in 31- 40 age group. There were 84 males and 16 females in the study.

Table 2: Serum magnesium levels, serum uric acid levels and Microalbuminuria in the study group

Serum magnesium	**N**	**%**
Elevated	90	90
Normal/low	10	10
Serum uric acid		
Elevated	68	68
Normal/low	32	32
Albuminuria		
Microalbuminuria	82	82
Macroalbuminuria	14	14
Normal	4	4

Serum magnesium levels were on the lower side in 90% of the population and only 10% had levels within the normal range in our study. Serum uric acid levels were elevated in 68% of the study population whereas 32% were within the normal range or low. Out of 100, 82 were having Microalbuminuria and 14 were having macroalbuminuria

Table 3: Serum magnesium and microalbuminuria

Serum magnesium	**Microalbuminuria**	**Macroalbuminuria**	**Normal**	Total N (%)
Elevated	74	14	2	90
Normal/low	8	0	2	10
Total	82	14	4	100 (100)

In our study, there was a strong positive correlation between, hypomagnesemia and microalbuminuria, with highly significant p value of 0.000. Out 82 study population with microalbuminuria, 90 patients had elevated serum Mg levels, i.e., 90%.

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Table 4: Serum uric acid and microalbuminuria

Serum uric acid	Albuminuria; N (%)			Total N (%)
	Microalbuminuria	Macroalbuminuria	Normal	
Elevated	56	12	0	68
Normal/low	26	2	4	32
Total	82	14	4	100 (100)

In our study, there was a positive correlation between, high uric acid levels and microalbuminuria with a highly significant value of 0.000. Out of 82 study population with microalbuminuria, 68 had elevated serum uric acid levels.

4. DISCUSSION

Chronic vascular complications in type 2 diabetes (T2DM) are the deteriorating conditions underlined by inflammation.[24] The chronic vascular complications in diabetes mellitus (DM) are classified by vascular size into macro- and microvascular diseases. The chronic vascular complications are a serious problem, since they generally yield devastating outcomes for the T2DM patients, which include coronary arterial disease (CAD), cerebrovascular disease (CVD), peripheral arterial disease (PAD), diabetic nephropathy (DN), diabetic retinopathy (DR).[25]

In our study, 43% of the population belonged to 51-60 years of age group followed by 21% in 31- 40 age group. There were 84 males and 16 females in the study which were comparable to the study conducted by Tseng et al where the mean age of T2DM was 62.8±10.8 years, and in a study by Xu et al the mean age was 61.11±10.01 years.[26,27] In our study, there was a strong positive correlation between, hypomagnesemia and microalbuminuria, with highly significant p value of 0.000. Out of 100, 82 were having Microalbuminuria and 14 were having macroalbuminuria, 90 patients had elevated serum Mg levels, i.e., 90%. There was a statistically significant increased incidence of microalbuminuria in patients with hypomagnesemia as compared with normal levels.

Our findings were similar to study done by Xu et al who showed that serum magnesium was inversely associated with the prevalence of microalbuminuria.[27] Gupta et al also showed increased incidence of microalbuminuria in T2DM patients with hypomagnesemia.[28] The exact relationship between hypomagnesemia and microalbuminuria in DM is not known. Oxidative stress is becoming increasingly recognized as an important factor for microalbuminuria.[29] Magnesium has been reported to possess antioxidant property.

Serum magnesium levels were on the lower side in 90% of the population and only 10% had levels within the normal range in our study. Serum uric acid levels were elevated in 68% of the study population whereas 32% were within the normal range or low. In our study, there was a positive correlation between, high uric acid levels and microalbuminuria with a highly significant value of 0.000. Out of 82 study population with microalbuminuria, 68 had elevated serum uric acid levels. Hence, oxidative stress may be one of the mechanisms that underlie the association between serum Mg and microalbuminuria. Magnesium depletion is said to reduce the insulin sensitivity, thereby increasing the risk of secondary complications.[30] In our study, 65% of the population with positive microalbuminuria showed hyperuricemia. There was statistically significant increased incidence of microalbuminuria in patients with hyperuricemia as compared with normal/low serum uric acid levels. The present study shows a strong relationship between hyperuricemia and microalbuminuria, which was similar to findings of study done by Chin-Hsiao. Our findings were similar to study done by Bonakdaran et al which also concluded that higher serum uric acid concentrations were associated with a greater probability of albuminuria in patients with type 2 diabetes mellitus.[31] Uric acid is the final breakdown product of adenosine, which plays an important role in the pathophysiology of insulin resistance.[32] Hyperinsulinemia resulting from insulin resistance can decrease the renal excretion, increase the renal absorption, and increase the production of uric acid. Microalbuminuria is an integral part of metabolic syndrome characterized by insulin resistance.[33]

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5. CONCLUSION

Based on the results of present study, serum magnesium level was inversely related with the incidence of microalbuminuria whereas there was linear association with high serum uric acid level. Good glycemic control and correction of hypomagnesemia and hyperuricemia could be effective to reduce the incidence of microalbuminuria and progression of renal impairment in type 2 diabetic mellitus.

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