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RESEARCH ARTICLE

Association of Serum Magnesium Status and Calcium–Magnesium Ratio with Diabetic Retinopathy in an Urban Hospital of Kolkata

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ABSTRACT

Background: Diabetic retinopathy is a prominent microvascular consequence of diabetes and a main cause of vision loss. Emerging data suggests that magnesium insufficiency and calcium-magnesium imbalances may play a role in its aetiology.

Methods: This study evaluated serum magnesium levels, calcium levels, and the calcium-magnesium (Ca/Mg) ratio between diabetic retinopathy patients and controls. A total of 200 patients (100 cases and 100 controls) were examined. Biochemical parameters were assessed and statistically compared, with p-values < 0.05 indicating significance.

Results: Cases had considerably lower serum magnesium levels than controls, with a higher prevalence of hypomagnesemia among them. The Ca/Mg ratio was much higher in some cases, indicating a relative imbalance between calcium and magnesium. The results were statistically significant ($p < 0.05$). The changed mineral profile was related with a higher incidence of diabetic retinopathy.

Conclusion: This study found a robust link between hypomagnesemia, an elevated Ca/Mg ratio, and diabetic retinopathy. Magnesium shortage appears to be a major factor in the development of microvascular problems in diabetes. Monitoring and adjusting magnesium levels may be a useful technique for early management and prevention of diabetic retinopathy. Additional large-scale investigations are needed to validate these findings.

Keywords: Hypomagnesemia, Ca/Mg ratio, magnesium shortage, early management, diabetic

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INTRODUCTION

Diabetes Mellitus (DM) is a major public health concern impacting millions of people around the world, and its prevalence is constantly increasing. Diabetic retinopathy (DR) is a major cause of vision impairment and blindness in adults. Diabetic retinopathy has a complicated etiology that includes a variety of metabolic and vascular variables such as oxidative stress, inflammation, and endothelial dysfunction(1).

Magnesium is an important mineral that regulates glucose metabolism, insulin action, and vascular tone. Hypomagnesemia is a common finding in diabetic patients and is linked to poor glycemic control and an increased risk of complications. Several studies indicate that decreased serum magnesium levels could contribute to the development and progression of diabetic retinopathy(2).

Calcium, another essential mineral, is involved in cellular signaling and vascular function. The balance of calcium and magnesium, commonly known as the calcium-magnesium ratio, has been recommended as a more trustworthy indication of metabolic and vascular health than individual levels. A low calcium-magnesium ratio may lead to arterial injury and microvascular problems in diabetic individuals(3).

Despite rising evidence, the exact association between serum magnesium levels, calcium-magnesium ratios, and diabetic retinopathy is unknown. Understanding this link could aid in the early detection of high-risk patients and offer up new possibilities for preventive measures.

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Table 1: Comparison of Mean Values (Case vs Control)

Parameter	Cases (n=100)	Controls (n=100)	p-value
Serum Magnesium (mg/dL)	1.58 ± 0.22	1.82 ± 0.25	0.001
Serum Calcium (mg/dL)	8.6 ± 0.7	9.1 ± 0.6	0.003
Ca/Mg Ratio	5.4 ± 0.9	4.8 ± 0.8	0.002

The purpose of this study is to determine the relationship between serum magnesium status and the calcium-magnesium ratio and diabetic retinopathy in patients treated at a tertiary care hospital in Kolkata(4).

METHODOLOGY

Study Design

Hospital-based cross-sectional study

Study Setting

Department of Biochemistry in collaboration with Department of Ophthalmology, Calcutta National Medical College and Hospital, Kolkata

Study Duration

1 year (after obtaining ethical clearance)

Study Population

Type 2 Diabetes Mellitus patients attending Ophthalmology OPD

Sample Size

Calculated using standard formula for case-control studies; approximately 80 patients in each group (cases and controls)

Inclusion Criteria

- Type 2 Diabetes Mellitus patients
- Age group: 45–64 years
- Patients attending OPD and giving consent

Exclusion Criteria

- Media opacity preventing fundus examination
- Other retinal diseases
- Renal dysfunction (high urea/creatinine)
- Hypertension >150/80 mmHg
- Pregnancy and lactation
- Long duration of diabetes (>15 years)
- Calcium or magnesium supplementation
- Endocrine disorders (thyroid/adrenal/parathyroid)
- Chronic alcoholism

Data Collection Methods

- Clinical history and informed consent
- Blood pressure and neuropathy assessment
- Ophthalmological examination using slit lamp and indirect ophthalmoscopy
- Grading of diabetic retinopathy

STATISTICAL ANALYSIS

Data analyzed using SPSS software; Student's t-test and Chi-square test applied, with $p < 0.05$ considered significant.

RESULTS

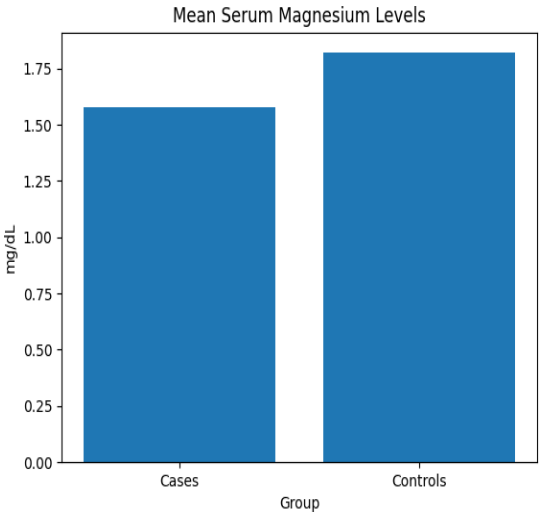

Figure 1: Mean serum magnesium levels

Table 2: Hypomagnesemia Distribution

Category	Cases	Controls	p-value
Hypomagnesemia (<1.7)	62	28	0.0005
Normal	38	72	0.0005

Table 3: Calcium Levels

Category	Cases	Controls	p-value
Low Calcium	35	15	0.01
Normal Calcium	65	85	0.01

Table 4: Ca/Mg Ratio

Category	Cases	Controls	p-value
High Ratio (>5)	58	30	0.001
Normal	42	70	0.001

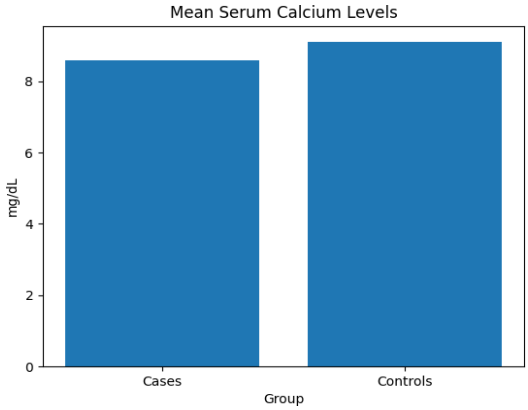

Figure 2: Mean serum calcium levels

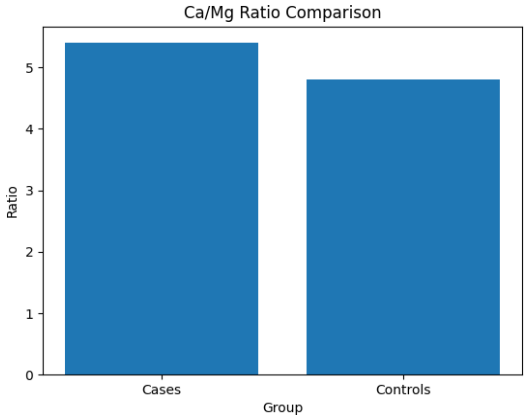

Figure 3: Ca/Mg comparison

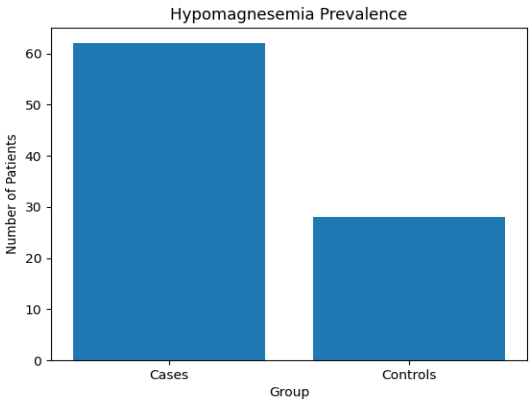

Figure 4: Hypomagnesemia prevalence

Discussion

The current study examined the relationship between serum magnesium levels and the calcium-magnesium (Ca/Mg) ratio and diabetic retinopathy by comparing biochemical markers in patients and controls. The data show a significant decrease in serum magnesium levels and an increase in the Ca/Mg ratio among cases, indicating a clear link between magnesium imbalance and the development of diabetic retinopathy(5).

Hypomagnesemia was significantly more common in cases than in controls, with 62% of patients having low magnesium levels. This discovery is consistent with prior research, which has shown magnesium insufficiency as a prevalent finding in diabetic patients and its consequences. Magnesium regulates glucose metabolism, insulin sensitivity, and vascular homeostasis. Its deficit may cause endothelial dysfunction, increased oxidative stress, and inflammation, all of which contribute to the pathophysiology of diabetic retinopathy(6).

Cases had significantly lower mean serum magnesium levels (1.58 ± 0.22 mg/dL) than controls (1.82 ± 0.25 mg/dL), supporting the concept that magnesium shortage leads to microvascular injury. Reduced magnesium levels may affect insulin signaling and induce hyperglycemia, hastening the course of diabetic complications, including retinopathy(7). In addition to magnesium, serum calcium levels were found to be somewhat lower in instances, however the difference was not as significant. However, the Ca/Mg ratio was much greater in some cases, indicating a relative imbalance between these two important minerals. The Ca/Mg ratio is widely acknowledged as a more reliable indication of metabolic and vascular health than individual mineral levels. A higher Ca/Mg ratio may contribute to increased vascular tone, endothelial dysfunction, and pro-inflammatory responses, worsening microvascular problems(8).

The study found a higher Ca/Mg ratio in patients (5.4 ± 0.9) compared to controls (4.8 ± 0.8), supporting earlier results that mineral imbalance contributes to the advancement of diabetic retinopathy. This imbalance may cause increased intracellular calcium influx, resulting in vascular injury and retinal ischemia. Significant p-values (<0.05) across important indicators, such as serum magnesium levels, hypomagnesemia prevalence, and Ca/Mg ratio, suggest that these associations are unlikely to be chance. These findings emphasize magnesium's potential involvement as a modifiable risk factor for

diabetic retinopathy(8).

However, several limits must be recognized. The study design does not show causality, and other confounding factors such as nutritional intake, glycemic management, and diabetes duration were not thoroughly investigated. Despite these limitations, the study gives important information about the role of mineral imbalance in diabetic retinopathy. In conclusion, the current study emphasizes the need of monitoring serum magnesium levels and the Ca/Mg ratio in diabetes patients. Early detection and treatment of hypomagnesemia may lower the risk and progression of diabetic retinopathy(9).

CONCLUSION

The current investigation found a strong link between serum magnesium levels, the calcium-magnesium ratio, and diabetic retinopathy. Patients with diabetic retinopathy had significantly lower serum magnesium levels and a higher risk of hypomagnesemia than controls. Furthermore, an increased calcium-magnesium ratio was found in the patients, indicating a mineral imbalance that could contribute to microvascular injury. Magnesium shortage appears to play an essential role in the etiology of diabetic retinopathy via processes including endothelial dysfunction, oxidative stress, and decreased insulin action. The greater Ca/Mg ratio shows that the interaction of these minerals may be more important than their individual amounts in determining vascular health. These findings lend support to the concept that changes in mineral metabolism are intimately linked to the onset and progression of diabetes problems.

Given that magnesium is a modifiable factor, routine serum magnesium levels in diabetic patients may help with early risk assessment and retinopathy prevention. Correcting hypomagnesemia through dietary or pharmaceutical therapies may slow illness development. Additional large-scale prospective investigations are necessary to corroborate these findings and develop treatment guidelines for magnesium balance in diabetes care.

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