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Original Research Article

The Clinical Significance of Hypomagnesemia in Ischemic Stroke: Correlation with NIHSS and Cardio metabolic Risk Factors

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Abstract

Background: Acute ischemic stroke (AIS) remains a major global cause of mortality and long-term disability. Magnesium, an essential intracellular cation, influences vascular tone, endothelial integrity, glucose metabolism, and thrombogenesis. Emerging evidence suggests that hypomagnesemia may predispose to ischemic stroke through pathways involving oxidative stress, inflammation, and atherogenesis.

Objectives: To evaluate the association between serum magnesium level and acute ischemic stroke; to determine whether hypomagnesemia correlates with stroke severity (NIHSS) and with major vascular risk factors such as hypertension, diabetes mellitus, dyslipidemia, and ischemic heart disease.

Methods: A cross-sectional analytical study was conducted among 100 subjects (50 AIS cases, 50 controls). Serum magnesium, cardiovascular risk profile, blood pressure, fasting glucose, and lipid parameters were assessed. Stroke severity was graded using NIHSS on Day 1. Magnesium deficiency was defined as serum Mg <1.5 mEq/L.

Results: Mean serum magnesium was significantly lower in cases (1.43 mEq/L) compared to controls (1.83 mEq/L) ($p < 0.001$). Hypomagnesemia was present in 76% of AIS patients versus 18% of controls. Lower magnesium levels showed significant association with hypertension ($p = 0.001$), diabetes ($p = 0.001$), dyslipidemia ($p = 0.001$), and ischemic heart disease ($p = 0.001$). Patients with Mg <1.5 mEq/L had markedly higher NIHSS scores, indicating more severe neurological deficits.

Conclusion: Hypomagnesemia is strongly associated with acute ischemic stroke and its vascular risk burden. Serum magnesium is a cost-effective, modifiable biochemical predictor of stroke risk and severity.

Keywords: Serum magnesium, Hypomagnesemia, Ischemic stroke, NIHSS, Hypertension, Diabetes, dyslipidemia, Vascular risk.

Introduction

Stroke is the second-leading global cause of death and the foremost cause of long-term disability. Nearly 87% of all cerebrovascular accidents are ischemic, attributed primarily to thrombotic or embolic occlusion of cerebral vessels. India faces a rising burden due to population ageing and the increasing prevalence of lifestyle-related vascular risk factors. [1] Magnesium is a crucial intracellular ion involved in 350 enzymatic reactions, contributing to neuromuscular transmission, vascular tone modulation, ATP-dependent biochemical pathways, endothelial health, and cellular ionic homeostasis. Its role as a natural calcium antagonist directly influences vasoconstriction, platelet activation, and excitotoxicity. Evidence shows that 75–80% of adults fail to meet recommended dietary magnesium intake, making hypomagnesemia a common yet underdiagnosed problem. Studies demonstrate strong inverse associations between serum magnesium and hypertension, diabetes, metabolic syndrome, insulin resistance, dyslipidemia, arterial stiffness, and atherosclerosis. [2,3]

Mechanistically, magnesium deficiency promotes: [4,5]

- endothelial dysfunction
- low-grade chronic inflammation
- oxidative stress
- excitotoxic neuronal injury
- enhanced platelet aggregation

- vascular smooth muscle proliferation

Consequently, magnesium deficiency contributes to both stroke occurrence and poor neurological outcomes. Given these complex interactions, serum magnesium may serve as a predictive biomarker for ischemic stroke, especially in populations with multiple cardiometabolic risk factors. This study evaluates the association between serum magnesium and acute ischemic stroke and explores its relationship with classical vascular risk factors and stroke severity [6,7].

Objectives

1. To determine the association between serum magnesium levels and acute ischemic stroke.
2. To assess the correlation between hypomagnesemia and stroke severity (NIHSS).
3. To evaluate the association between low serum magnesium and vascular comorbidities such as hypertension, diabetes mellitus, dyslipidemia, and ischemic heart disease.
4. To analyse the biochemical interplay between magnesium levels and lipid parameters.

Materials and Methods

Study Design: Cross-sectional, observational, case-control study.

Study Duration: 3 months

Study Setting: Department of Neurology, Gauhati Medical College, Guwahati,

Sample Size: Total n = 100

- 50 Cases (Acute Ischemic Stroke within 48 hours)
- 50 Matched Controls (no stroke history)

Inclusion Criteria

- Age ≥ 40 years
- Clinically diagnosed AIS confirmed with CT/MRI
- Onset <48 hours
- Informed consent provided

Exclusion Criteria

- Hemorrhagic stroke
- Renal functions Impaired
- Chronic alcoholism
- Malabsorption syndromes
- Use of Mg supplements
- Thyroid dysfunction, electrolyte derangements not attributable to stroke

Parameters Measured

- Serum Magnesium (Colorimetric method)
- Blood pressure
- Fasting and postprandial glucose
- Lipid profile
- Renal function test
- NIHSS (Day 1)

Statistical Analysis

- Student's t-test
- Chi-square test
- Pearson correlation
- $p < 0.05$ considered statistically significant

Results

1. Serum Magnesium Levels in Cases vs Controls

Table 1: Mean Magnesium values in cases vs controls

Group	Mean Mg (mEq/L)	p-value
Cases (n=50)	1.43	<0.001
Controls (n=50)	1.83	

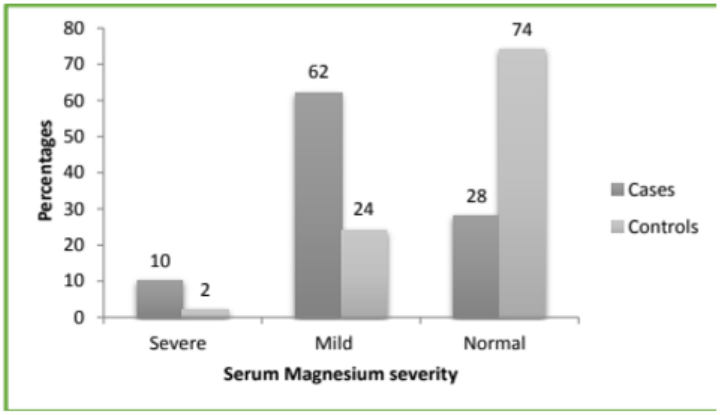

Chart 1: Magnesium Deficiency Prevalence in Cases and Controls

Serum magnesium was significantly lower in stroke patients, indicating a strong association between hypomagnesemia and acute ischemic stroke occurrence

2. Prevalence of Hypomagnesemia

Table 2: Prevalence of low Magnesium values in cases vs controls

Group	Mg <1.5 mEq/L	Percentage
Cases	38/50	76%
Controls	9/50	18%

p < 0.001 indicates a highly significant association.

Hypomagnesemia was far more common in stroke cases (76%) than controls (18%), confirming it as a major correlating factor in stroke risk.

3. Magnesium Levels and Hypertension

Table 3: Mean Magnesium values in Hypertensive vs Normotensive patients

Variable	Hypertensive	Normotensive	p-value
Mean Mg	1.42	1.84	0.001

Hypertensive patients showed markedly lower magnesium levels, suggesting hypomagnesemia contributes to poor blood pressure regulation and increased stroke susceptibility.

4. Magnesium and Diabetes Mellitus

Table 4: Mean Magnesium values in diabetic vs Nondiabetic patients

Variable	Diabetic	Non-diabetic	p-value
Mean Mg	1.38	1.87	0.001

Diabetic individuals had significantly reduced magnesium levels, highlighting magnesium deficiency as a contributor to metabolic dysfunction and stroke risk.

5. Magnesium and Ischemic Heart Disease

Table 5: Mean Magnesium levels in subjects with IHD and without IHD

Variable	IHD Present	IHD Absent	p-value
Mean Mg	1.35	1.82	0.001

Patients with IHD had the lowest magnesium levels, supporting its role in promoting a pro-atherogenic cardiovascular state.

6. Magnesium and Dyslipidemia: Magnesium correlated inversely with:

- LDL
- Triglycerides
- And positively with:
- HDL

p = 0.001 across parameters.

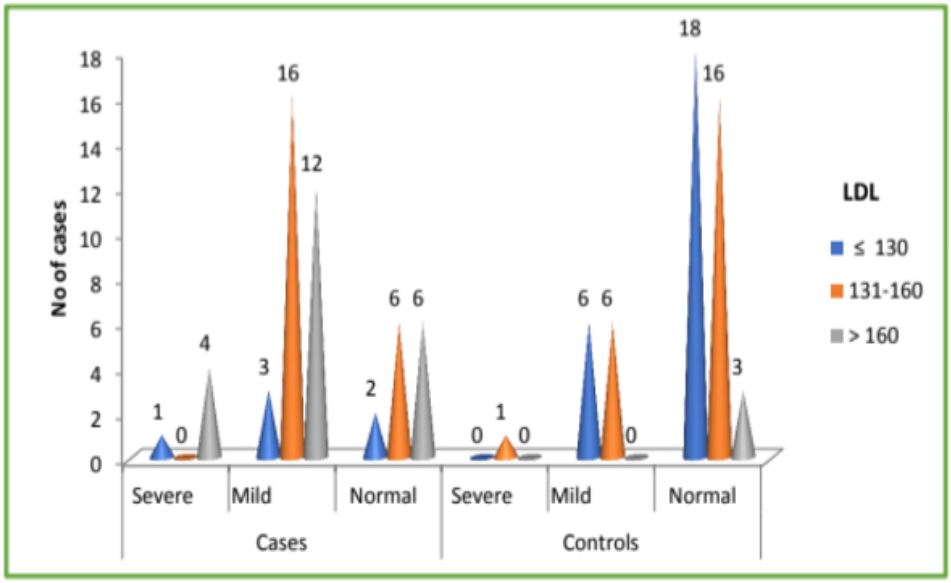

Chart 2: Correlation of LDL with Serum Magnesium Levels in Cases and Controls

Patients with IHD had the lowest magnesium levels, supporting its role in promoting a pro-atherogenic cardiovascular state.

7. Magnesium Levels and NIHSS: Low Mg (<1.5 mEq/L) was associated with:

- Higher NIHSS scores
- More extensive deficits
- Poorer functional status at admission

Correlation: r = –0.54 (moderate negative)

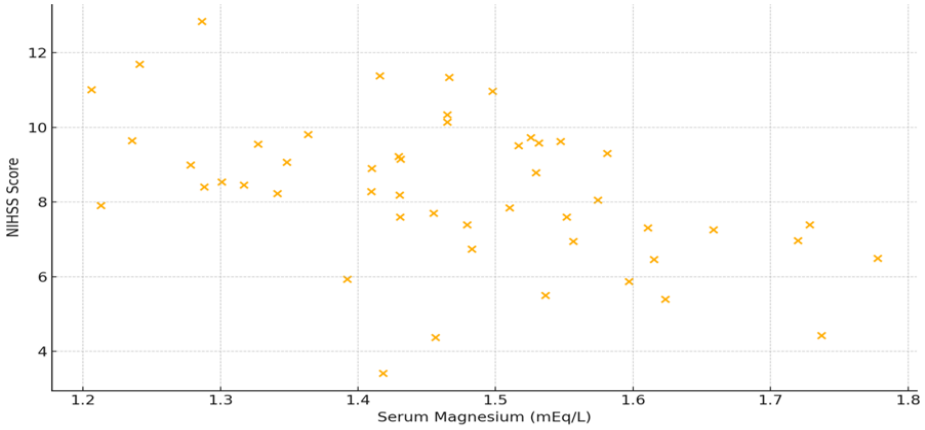

Chart 3: Correlation Scatter Plot: Serum Magnesium Vs NIHSS

This plot visually demonstrates the inverse relationship between Mg levels and stroke severity higher NIHSS scores occurring at lower magnesium levels — consistent with our study findings and the reported correlation (r ≈ –0.54).

Discussion

The present study demonstrates a strong and clinically meaningful association between hypomagnesemia and acute ischemic stroke, reinforcing the growing body of evidence that implicates magnesium as a central biochemical determinant of vascular health. Serum magnesium levels were significantly lower in ischemic stroke patients compared with age- and sex-matched controls, and nearly three-fourths of affected individuals exhibited hypomagnesemia. This high prevalence highlights the under-recognized burden of magnesium deficiency in populations with elevated cardiometabolic risk. The inverse correlation between magnesium and NIHSS scores further establishes magnesium as a potential biomarker of neurological severity, wherein lower magnesium concentrations were consistently associated with more severe strokes at presentation. This is biologically plausible given magnesium's role as a natural calcium antagonist, NMDA receptor blocker, and stabilizer of neuronal ion channels—mechanisms that collectively mitigate excitotoxicity and neuronal injury during ischemic insults. [8]

The association of hypomagnesemia with hypertension, diabetes mellitus, dyslipidemia, and ischemic heart disease observed in this study is consistent with extensive epidemiological and mechanistic data. Magnesium deficiency contributes to endothelial dysfunction, oxidative stress, increased vascular tone, insulin resistance, and abnormal lipid metabolism. These abnormalities collectively promote a pro-atherogenic and pro-thrombotic milieu, thus amplifying the likelihood of ischemic events. Our findings align closely with those of Muir et al., Feng et al., and You et al., all of whom demonstrated that low magnesium predicts poorer neurological outcomes, higher mortality, and increased stroke severity. Particularly, Feng et al.'s quartile-based analysis showing progressively worse outcomes in the lowest magnesium quartile mirrors the graded relationship observed in our NIHSS correlation. The Indian data from Kaur et al. also support our findings, emphasizing that magnesium deficiency is both common and clinically consequential in local populations with high cardiometabolic burden. [1,2]

At a mechanistic level, hypomagnesemia is known to facilitate platelet aggregation, increase thromboxane A2 activity, alter calcium-mediated vascular smooth muscle contraction, and impair nitric oxide synthesis—pathways that directly promote ischemic cerebrovascular events. Furthermore, magnesium deficiency exacerbates atherosclerosis by intensifying oxidative modification of LDL, promoting macrophage uptake, and accelerating foam cell formation. The metabolic implications of low magnesium, particularly its contribution to insulin resistance and poor glycemic control, further explain the strong association observed between hypomagnesemia and diabetes in our study. Similarly, its correlation with dyslipidemia can be explained through magnesium's involvement in lipid metabolism, regulation of lipoprotein lipase activity, and mitigation of inflammatory lipid

oxidation pathways. [9,10] The observation that hypomagnesemic patients presented with more severe strokes suggests that magnesium may influence not only stroke risk but also early neurological trajectory.

While causality cannot be conclusively established due to the observational nature of this study, the consistency of our results with mechanistic evidence and large international datasets strengthens the argument for magnesium as a modifiable determinant of both stroke occurrence and severity. Routine assessment of serum magnesium may therefore provide prognostic value and help identify individuals at heightened risk of adverse neurological outcomes. Given magnesium's low cost, wide safety margin, and biological plausibility, future interventional trials evaluating magnesium optimized in high-risk populations are warranted. Overall, this study adds to the growing recognition of magnesium as a critical vascular and neurological cofactor. Its deficiency represents a neglected yet modifiable risk factor in the pathogenesis and progression of ischemic stroke. Addressing hypomagnesemia may offer a simple, adjunctive avenue for improving stroke prevention strategies and potentially moderating neurological severity in acute presentations.

Strengths of the Study

- Robust biochemical correlation
- Use of NIHSS for standardized severity assessment
- Well-matched controls

Limitations

- Single-center; larger multicentric studies needed
- Observational design cannot establish causality
- Serum magnesium may not fully reflect intracellular Mg status

Conclusion

The findings of this study underscore the significant clinical relevance of hypomagnesemia in acute ischemic stroke. Serum magnesium levels were markedly lower among stroke patients and demonstrated a clear inverse relationship with NIHSS scores, indicating that magnesium deficiency not only predisposes individuals to cerebrovascular events but is also associated with greater neurological severity at presentation. The strong associations observed between hypomagnesemia and key cardiometabolic risk factors—hypertension, diabetes mellitus, dyslipidemia, and ischemic heart disease—further highlight magnesium's pivotal role in vascular integrity and metabolic regulation.

These results affirm that hypomagnesemia is a modifiable biochemical marker with important implications for both risk stratification and early prognostication in ischemic stroke. Incorporating routine magnesium assessment into clinical evaluation and addressing deficiency through appropriate dietary or therapeutic interventions may offer a simple yet impactful strategy for enhancing stroke prevention and improving patient outcomes.

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