Serum Magnesium Level in Diabetic and Hypertensive Patients with Ischemic Stroke

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ABSTRACT

Background: Stroke is a prevalent medical emergency and a leading cause of mortality, with increasing incidence in many lower- and middle-income countries due to unhealthy lifestyle practices. Among the two main types of stroke, ischemic stroke accounts for approximately 85% of cases.

Study Aim: This study aimed to determine serum magnesium levels in patients with ischemic stroke who also have a history of diabetes and hypertension.

Methods: This observational study was conducted in the Medicine Department at Combined Military Hospital from July to December 2015, involving patients with acute ischemic stroke who also had diabetes and hypertension. A total of 51 patients meeting the inclusion criteria were selected using purposive probability sampling.

Results: Of the 51 patients assessed, 33 were male and 18 were female, with average ages of 62.89±10.45 years for males and 65.75±9.78 years for females. Hypertension was controlled in 18 patients and uncontrolled in 33; similarly, diabetes was controlled in 12 and uncontrolled in 39 patients. Control of diabetes was defined as HbA1c < 7% over the past three months, while control of blood pressure was defined as BP < 140/90 mm Hg over the same period. The average serum magnesium level across all subjects was 0.69±0.11 mmol/l. Hypomagnesemia was observed in 66.7% (34) of patients, with an average serum magnesium level of 0.63±0.049 mmol/l in these individuals. Mean serum magnesium levels in patients with controlled and uncontrolled blood pressure were 0.80±0.03 mmol/l and 0.63±0.01 mmol/l, respectively. Among those with controlled and uncontrolled diabetes, mean serum magnesium levels were 0.73±0.13 mmol/l and 0.67±0.10 mmol/l, respectively.

Conclusion: Serum magnesium levels are low in acute ischemic stroke, hypertension and diabetes are associated.

Keywords: Serum magnesium, Ischemic stroke, Diabetes mellitus, Hypertension, Stroke assessment.

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INTRODUCTION

Stroke is a common medical emergency and leading cause of death. In numerous low and middle-income countries, it is increasing due to the adoption of less healthy lifestyles. Of the two types, ischemic stroke comprises 85% of patients.

Diabetes and hypertension are recognized as independent risk factors for ischemic stroke. Magnesium (Mg) deficiency is also considered a potential risk factor, as it may contribute to cerebrovascular atherosclerosis and associated complications, including stroke.

Cerebral ischemia is primarily triggered by thromboembolic events that result from atherosclerosis in the major extracranial vessels, such as the carotid artery and aortic arch. Approximately 20% of infarctions occur due to in-situ thrombosis, caused by disease affecting small perforating arteries. The risk factors for ischemic stroke largely mirror those associated with vascular disease.[1]

Magnesium is an essential cation for biological processes and has recently earned significant interest in clinical medicine, particularly concerning the impact of its deficiency on cardiovascular health. It is the fourth most abundant cation in the body and ranks as the second most prevalent intracellular cation after potassium.[2] Main source of Magnesium are green leafy vegetables, banana, pumpkin seeds, black beans dark chocolate etc.

Magnesium's primary functions include protein synthesis, neuron function, blood pressure regulation, blood sugar regulation, neurotransmitter release, metabolism, and antioxidant formation. The pathogenesis of diabetes, insulin resistance, atherosclerosis, and hypertension has all been linked to magnesium shortage or changes in its metabolism. Since the occurrence of cardiovascular illnesses is significantly inversely correlated with serum magnesium levels, magnesium in particular has been the focus of numerous investigations.[3]

It reduces the risk of diabetes and decreases blood pressure. When it comes to preventing ischemic damage to neurons and glia, magnesium may work in a variety of ways.[4-6] It is engaged in several physiological processes, such as calcium channel antagonism, NMDA receptor blocking, glutamate release antagonism, and cerebral blood flow maintenance, all of which may be related to cerebral ischaemia.[7-15]

The incidence of hypomagnesaemia in individuals with type 2 diabetes ranges from 13.5% to 47.7%. A number of factors may be involved, including poor nutrition, malabsorption, excessive use of alcohol and foods high in carbohydrates, autonomic dysfunction, altered insulin metabolism, glomerular hyper filtration, osmotic diuresis, recurrent metabolic acidosis, hypophosphatemia, and hypokalemia. Several studies have shown an unfavorable association between serum magnesium levels and glycemic control, and hypomagnesaemia has been associated with type 2 diabetes.[16]

Hypomagnesaemia has been associated with high blood pressure. According to a number of studies, people with hypertension had lower serum magnesium levels than people with normotension.[17]

Recent studies highlight the importance of magnesium in ischemic stroke and indicate that the mineral is being used in clinical trials to prevent cardiovascular disease, lower blood pressure, and prevent diabetes mellitus.[18]

At first aim would be to find out serum magnesium level in patients population specified here, then to explore any relation of the mineral with diabetes or hypertension

among study population. This will be relevant as more studies are being conducted to explore the therapeutic prospect of the mineral.

OBJECTIVE

The objective of this study was to find out the serum magnesium level in ischemic stroke with diabetes and hypertension.

MATERIALS AND METHODS

This cross-sectional observational study was conducted in the Medicine department of Combined Military Hospital Dhaka over six months (July 2015 - December 2015) to assess serum magnesium levels in patients with acute ischemic stroke, diabetes, and hypertension. The study included 51 patients admitted within 48 hours of stroke onset, using purposive non-probability sampling. Inclusion criteria were patients over 18 years, of both sexes, who provided informed written consent. Exclusion criteria included pregnant or critically ill patients, those with known factors affecting serum magnesium levels (e.g., kidney injury, diuretic use), and patients in a coma. Ethical approval was obtained from the Combined Military Hospital Ethical Review Committee, and participants were informed about the study's aims, procedures, risks, and benefits in their local language before providing consent. Confidentiality and anonymity were maintained. The investigator closely supervised all study aspects, including case selection, follow-up, patient investigation, data entry, and analysis. Data were processed using SPSS version 20.0, with results presented in mean, standard deviation, and percentages. Two-sample z-tests examined the association between serum magnesium and blood pressure/ hypertension status, with a significance level set at $P<0.05$.

RESULT

TABLE-I: Demographic Characteristics of our Study Patients (n = 51)

Characteristics		n	%
Gender	Male	33	64.7
	Female	18	35.3
Age	≤ 50 yrs	7	13.7
	51-60 yrs	13	25.5
	> 60 yrs	31	60.8
Education	Illiterate	8	15.7
	Primary	30	58.8
	SSC	10	19.6
	HSC	2	3.9
	Graduate	1	2.0
Economic Status	Upper class	6	11.8
	Middle class	20	39.2
	Lower to lower middle class	25	49.0

Table-1 presents the demographic characteristics of the study patients (n = 51). The majority of the patients were male (64%), with females comprising 35% of the sample. Most patients were over 60 years old (60%), highlighting the prevalence of ischemic stroke, diabetes, and hypertension in older adults.

TABLE-II: Mean serum magnesium, HbA1c, RBS on admission (n=51)

	n	Minimum	Maximum	Mean	Std. deviation (±)
Serum magnesium (mmol/I)	51	0.50	1.00	0.69	0.11
HbA1c (%)	51	6.00	10.5	7.73	1.01
RBS (mmol/l)	51	6.50	25.00	12.14	3.67

Table-2 shows mean serum magnesium, HbA1c and RBS on admission. Total patients analysis shows that on admission, mean serum magnesium was below normal (0.69 mmol/l), mean HbA1c was higher or uncontrolled (7.33%), mean RBS (random blood sugar) 12.14 mmol/l which is higher than normal.

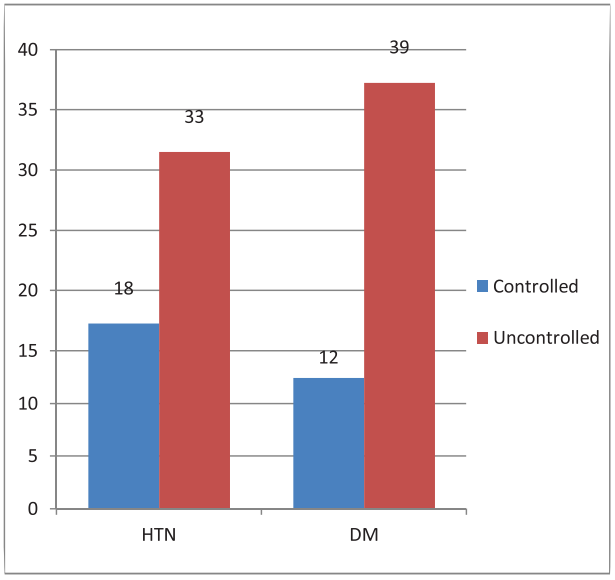

Fig-1: Distribution of patients on the basis of status of diabetes and hypertension (n=51)

Figure-1 present the distribution of patients on the basis of status of diabetes and hypertension. When status of diabetes and is analyzed, 39 had uncontrolled HbA1c and 33 had uncontrolled blood pressure out of total 51.

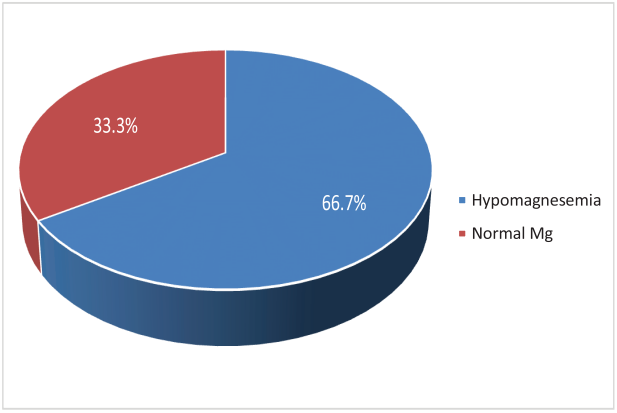

Fig-2: Distribution of patients on the basis of severity of serum level magnesium (n=51)

Figure-2 shows the distribution of patients on the basis of severity of serum level magnesium. Serum magnesium was found to be low (below 0.75 mmol/l) in 34 (66.7%) and normal in 17 (33.3%), no one found to have higher magnesium level.

TABLE-III: Distribution of Serum Magnesium Levels Based on Hypertension Status and Diabetes Status (n=51)

Control Status		Normal Magnesium (n)	Hypomagnesaemia (n)	Total
Status of BP Control	Controlled	17	1	18
	Uncontrolled	0	33	33
	Total	17	34	51
Status of DM Control	Controlled	6	6	12
	Uncontrolled	11	28	39
	Total	17	34	51

Table-3 presents the distribution of serum magnesium levels based on the control status of hypertension and diabetes among 51 patients. The analysis reveals that in the controlled hypertension group, the majority of patients (17 out of 18) had normal serum magnesium levels, with only 1 patient exhibiting hypomagnesaemia.

TABLE-IV: Comparison of Magnesium Levels (in mmol/l) According to Hypertension Status (n=51)

Status	N	Mean	Std. Error	Z Score	P Value
Controlled HTN	18	0.80	0.03	5.96	<0.05
Uncontrolled HTN	33	0.63	0.01		

Table-4 shows comparison of magnesium levels (in mmol/l) according to hypertension status. In the uncontrolled HTN, there was lower magnesium than the controlled group and it is statistically significant (P value <0.05).

Table-5: Comparison of Magnesium Levels (in mmol/l) According to Diabetes Status (n=51)

Status	N	Mean	Std. Deviation	Std. Error	Z Score	P Value
Controlled DM	12	0.73	0.13	0.04	1.34	>0.05
Uncontrolled DM	39	0.67	0.10	0.02		

Table-5 shows comparison of magnesium levels (in mmol/l) according to diabetes status. In the

uncontrolled DM patients, there was lower magnesium than the controlled group but it is not statistically significant (P value > 0.05).

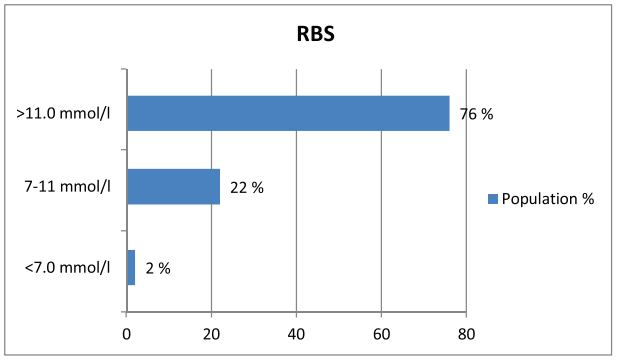

Fig-3: Distribution of Patients on the Basis of Glycemic Status on Admission (n=51)

Figure-3 shows the distribution of patients on the basis of glycemic status on admission. On admission 76% (39) patients had random blood glucose level over 11.0 mmol/l, 22% (11) had 7-11 mmol/l and 2% (1) had <7.0 mmol/l.

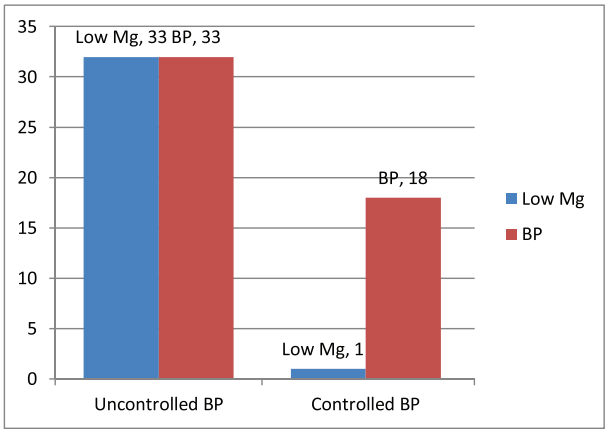

Fig-4: Distribution of Hypomagnesaemia Patients on the Basis of Status Hypertension (n=33)

Figure 4 presents the distribution of hypomagnesaemia patients on the basis of status hypertension. Out of 34 patients with low magnesium, 33 had uncontrolled BP and 1 had controlled. The total numbers of patient with uncontrolled BP were 33 and with controlled BP were 18.

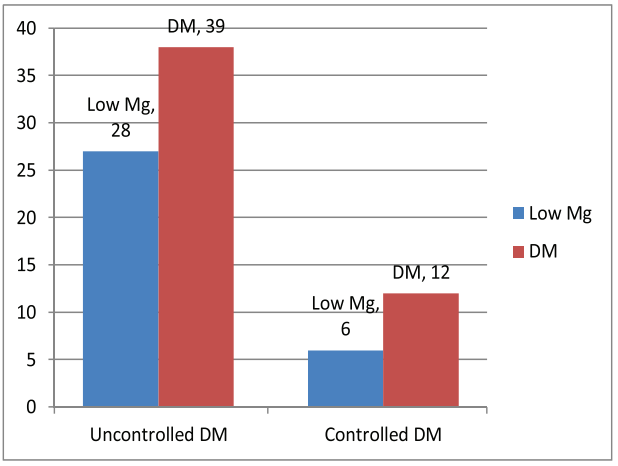

Fig-5: Distribution of Hypomagnesaemia Patients on the Basis of Status of Diabetes (n=33)

Figure-5 shows the distribution of Hypomagnesaemia Patients on the Basis of Status of Diabetes (n=33). Out of 33 patients with low magnesium, 28 had uncontrolled DM and 6 had controlled. The total number of patients with uncontrolled DM was 39 and with controlled DM were 12.

DISCUSSION

A total of 51 patients were evaluated, of which 33 (64.7%) were males and 18 (35.3%) were females, age of the patients ranged from 45 to 80 years with the mean 64.72 (SD=10:02) The mean ages of male and female subjects were 65.75 (SD +9.78) and 62.89 (SD 10:45) respectively. This observation matches with a study done by Alia Saberi et al., total of 67 patients (41 males and 26 females) with mean age of 69.60 13.58 years, with acute ischemic stroke were included.7 In a north Indian study by Khan et al., the average age of the stroke were found to be above 50 years but below 80 years, in accordance with this study 20 Researchers led by Aaron Folsom from the University of Minesottas School Of Public Health reported mean age of acute ischemic stroke among 577 patients was 55 8.33 yours.[19]

We found that 30 (58.8%) patients had completed the primary education, 10 (19.6%) completed SSC; 25 (49.0%) belonged to lower to middle class, 20 (39.2%) to middle class and 6 (11.8%) to higher class economy. This is in relation to our overall population and these variables have influence on outcome variables.

Muhammed Khalid Shaik et al., Hyderabad, Pakistan showed similar data with majority population in the low socio economic (60%) and rural group (72%).17 The blood pressure was uncontrolled in 33 (64.7%) patients: controlled in 18 (35.3%) patients. The serum magnesium level found in the former group with a mean was 0.63 (SD 0.01) mmol/l whereas in the latter it was 0.80 (SD +0.03) mmol/l. In a similar study reported 66% patients with uncontrolled hypertension to find out serum magnesium levels, the randomized controlled trial included 120 patients. The mean scrum magnesium were 60 (SD=123) and 0.94 (SD-0.56) mmol/l.[20]

In the current study, glycemic status was found to be uncontrolled in 39 (76.5%) patients, whereas it was controlled in 12 (23.5%) The serum magnesium level found in the former group with a mean was 0.67 (SD +0.10) mmol/l, whereas in the latter it was 0.73 (SD (0.13) mmol/l. Glycemic status was defined by HbAlc level. Cojocaru enrolled 1500 ischemic stroke patients and reported uncontrolled hyperglycemia was 38%. The mean serum magnesium level were 0.77 (SD +2.05) and 0.83 (SD 3.02) mmol/l.[21]

After admission into the hospital, the mean HbAlc and random blood sugar level were 7.73 (SD1.01)% and 12.14 (SD 3.67) mmol/l respectively. Altura BT et al., conducted a study with 576 patients of ischemic stroke. He found. Mean HbAlc and random blood sugar 7.2% and 10.8 mmol/l respectively these patients were 0 diabetic so result is not correlated.[22]

Champagne er at., reported 48% patients with uncontrolled diabetes who had comorbid hypertension and evaluated after an ischemic event.[23] Hypomagnesaemia occurred at an incidence of 13.5 to 47.7% among patients with type 2 diabetes, mean HbAlc level was reported of 6.8% in a study done by Siegler.[16] In the current study it is much higher, as a result hypomagnesaemia occurred at a higher incidence.

The mean serum magnesium in overall subjects was 0.69 (SD 0.11) mmol/1 Hypomagnesaemia was observed in 34 (66.6%) subjects 17 (33.3%) had normal serum magnesium. The mean serum magnesium level in hypomagnesaemia individuals was 0.63 (SD 0.049) mmol/l. In this study magnesium support was not provided. Muhammed Khalid Shaikh reported hypomagnesaemia in 6216 patients, but the study population had less percentage of uncontrolled hypertension and diabetes, hypertension was controlled in 72% and diabetes in 65%, the mean magnesium level shown in the patients with hypomagnesaemia was 0.68 (SD 11.2) mmol/l whereas in the overall patients it was 0.72 (SD 8.22) mmol/l.17 It matches with current study as it has a higher proportion of hypertensive and diabetic patients with greater proportion in uncontrolled status. Kotwal and colleagues identified a notable relationship between serum magnesium concentrations and ischemic stroke.[24] The average serum magnesium levels observed in individuals with hypomagnesaemia, normomagnesaemia, and hypomagnesaemia who are hypertensive and diabetic were 1.15, 1.53, and 0.75 ± 0.72, and 0.55 ± 0.63 mmol/l, respectively. The hypomagnesaemia group constituted 21% of the study population.[23]

LIMITATIONS OF THE STUDY

This study was conducted at the Combined Military Hospital, Dhaka, and focused on patients with ischemic stroke. The sample size

was small due to time and resource constraints and the purposive sampling method used limits population representation.

CONCLUSION

Stroke has some known risk factors. Serum magnesium levels are low in acute ischemic stroke, hypertension and diabetes. It seems that severity of hyperglycemia and hypertension are the important determinants for the changes in serum magnesium level.

Financial support and sponsorship
No funding sources.

Conflicts of interest
There are no conflicts of interest.

Ethical approval
The study was approved by the Institutional Ethics Committee.

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