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ORIGINAL RESEARCH

Estimation of serum magnesium levels in acute stroke

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ABSTRACT

Background: Stroke is one of the leading global causes of morbidity, death, and long-term effects. Magnesium is one of the primary intracellular divalent cations in the human body. About 25 grams of magnesium are found in a healthy adult; of this, 50% are found in the skeleton, and the remaining 1% are found in the extracellular fluid (ECF). Magnesium ions can shield neurons by preserving blood flow to the brain. It shields the brain from ischemia injury.

The brain receives less blood during an ischemic stroke, depriving it of glucose and oxygen, which reduces the energy required to maintain the ionic gradients. Low magnesium levels cause vasoconstriction and damage the vascular endothelium, which accelerates the development and progression of atherosclerosis. Magnesium inhibits the accumulation of lipids in the aorta wall, slowing the progression of atherosclerosis. The severity of prognosis for stroke patients is correlated with serum magnesium levels in our study using the Modified Rankin Scoring System.

Objective: To study serum magnesium levels in patients with acute stroke

Materials and method: Our study is a cross-sectional, single-centred study. Patients diagnosed with acute stroke who are admitted to I.P.D. and visit Medicine O.P.D. provide data. Clinical observations, a CT scan, or Brian's M.R.I. were used to confirm the acute stroke patients. Individuals who were admitted to the hospital with acute stroke, as confirmed by CT scan results and clinical symptoms, or Brian's M.R.I. at OPD and IPD, were included. There will be an 18-month study period. On admission, patients are clinically examined using the Modified Rankin Scale. Measurement of magnesium 3ml of bloodis collected in a plain tube with a clot activator incubated at room temperature for 30 minutes.The centrifuge is at 3000rpm for 10 minutes at room temperature, and the serum is separated. The serum is analysed in a fully automated analyser VINTROSE5.1 by COLORIMETRIC METHOD.After the data was entered into a Microsoft Excel sheet, statistical analysis was conducted using a statistical tool for social science. A value of $P < 0.05$ shows statistical significance. The two-tailed approach will be used for all statistical tests.

Results and discussion: Our study population consisted mainly up of male patients (73.33%). In the study population, hypertension (41.67%) was a more common risk factor than type 2 diabetes mellitus (25%), and the majority had no comorbidities at the time of presentation.

The average serum magnesium level was 2.008, with a standard deviation of 0.2358. The study found a statistically significant relationship between MRS and serum magnesium levels, implying that they are inversely connected. Patients with a higher score (3 - 6) had significantly lower serum magnesium levels than those with a lower score (0 -2). (p value = <0.045). Based on our findings, serum magnesium can be utilised as a prognostic marker for acute ischemic stroke.

Conclusion: Our study found that low serum magnesium levels are associated with poorer outcomes in acute stroke patients, as assessed by the Modified Rankin Scale (MRS). This shows that serum magnesium levels could be a useful prognostic marker for assessing stroke severity and predicting outcomes.

Keywords: Stroke, Serum Magnesium, Prognostic marker, Modified Rankin Scale,

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INTRODUCTION

The World Health Organization (WHO) defines a stroke as the rapidly emerging clinical indications of a focal (or global) impairment of brain function that lasts for more than 24 hours or results in death and has no other evident cause than vascular origin. [1]

The incidence and prevalence of cerebrovascular illnesses are increasing in India as a result of rapidly rising risk factors such as diabetes mellitus and hypertension, which affect a significant portion of adults. [2] Strokes are the most frequent vascular illness in several Asian countries. [6] According to World Health Organization (WHO) forecasts, by 2030, 80% of strokes would occur in low- and middle-income countries. Stroke will also cause 7.9% of all fatalities in low-income countries, trailing only ischemic heart disease and HIV/AIDS. The global stroke incidence has been found to be 2/1000 people per year, with roughly 4/1000 in the 45-84 age range. [7,8]

Magnesium (Mg) is one of the many essential micronutrients in the human body and the second most prevalent intracellular cation. It functions as a cofactor in approximately 300 enzyme systems that regulate a wide range of human physiological responses. [3] Magnesium is a key intracellular divalent cation in the human body. A healthy adult contains approximately 25 grams of magnesium, with 50% of that in the skeleton and the remaining 1% in the extracellular fluid (ECF). [2]

Magnesium regulates peripheral blood flow, blood pressure, and vasomotor tone naturally. It is also a calcium antagonist. Adenosine triphosphate (ATP) and magnesium are mostly complex in the brain. [9] It has been demonstrated that a shortage of magnesium causes vasoconstriction and exacerbates arterial endothelial damage, which accelerates the onset and advancement of atherosclerosis. [10]

During an ischemic stroke, the brain's blood flow is diminished, depriving it of oxygen and glucose and lowering the amount of energy required to maintain the ionic gradients.

In the penumbral cortex, glutamate is released at high amounts when blood flow is interrupted for a long time. Glutamate release was dysregulated, and there was excessive neuronal depolarisation. [4,5] We aimed to study the correlation between Magnesium Deficiency among patients admitted with acute stroke.

METHODS OF COLLECTION OF DATA

SOURCE OF DATA

Data is collected from patients who attend Medicine O.P.D. and are admitted to I.P.D. with an acute stroke diagnosis at B.L.D.E. DU SHRI. B M Patil Medical College, Hospital and Research Centre, Vijayapura. Patient/Attender has given informed consent to examine serum magnesium levels in patients with acute stroke. The study term is 18 months.

INCLUSION CRITERIA

Patient hospitalised with acute stroke verified by clinical symptoms and C-T scan or Brian's M.R.I. in O.P.D. and I.P.D. of B.L.D.E. (D U) S.H.R.I. B M Patil Medical College Hospital and Research Center Vijayapura.

EXCLUSION CRITERIA

Stroke patient having any malignancy.
Renal impairment G.I.T. and therapy.
The Patient is on a diuretic.

COLLECTION OF DATA

Data collection will follow a proforma, including patient history, clinical examination, and appropriate investigations for patients who meet inclusion and exclusion criteria and provide consent to participate in the trial. Demographic Information, history, and a thorough investigation shall be documented. On admission, patients have a clinical examination using the Modified Rankin Scale.

Table no.1: Modified Rankin Scale.

MRS score	Description
0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability: unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability: requiring some help but able to walk without assistance
4	Moderately severe disability. Unable to attain own bodily needs without assistance, or unable to walk unassisted
5	Severe disability, bedridden incontinence and requiring constant nursing care and attention
6	Death

Measurement of magnesium 3ml of blood is collected in a plain tube with a clot activator incubated at room temperature for 30 minutes. The centrifuge is at 3000rpm for 10 minutes at room temperature, and the serum is separated. The serum is analysed in a fully automated analyserVINTROSE5.1 by COLORIMETRIC METHOD.

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RESULTS

AGE AND GENDER-WISE DISTRIBUTION[n=60]

NO OF PATIENT IN PERCENTAGE

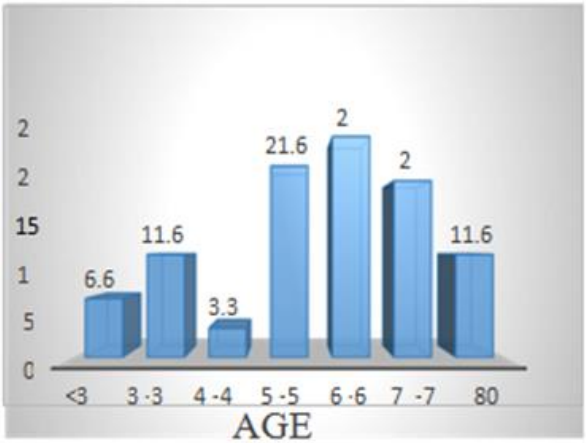

FIGURE 1: AGE-WISE DISTRIBUTION

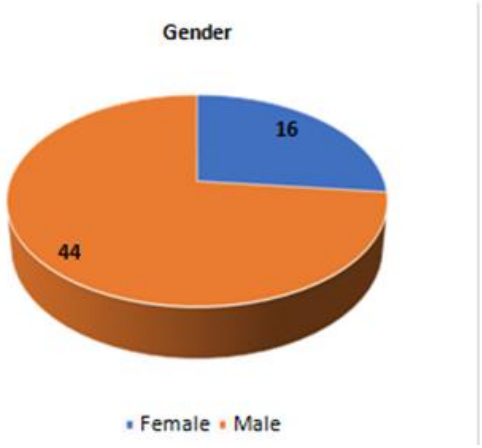

FIGURE 2: GENDER-WISEDISTRIBUTION

Maximum participants belonged to the age group of 60-69 years (25%), while the least number of patients belonged to the age group of 40-49 years (3.33%).

This gender distribution indicates a significantly higher incidence of acute stroke in males compared to females within this study population. The data suggests that males are more likely to experience acute stroke than females.

Table 2: Modified Rankin Scale wise distribution

MRS GRADING	NUMBER OF PATIENTS
1	4 (6.67%)
2	31 (51.67%)
3	11 (18.33%)
4	11 (18.33%)
5	3 (5%)

The table categorises 60 acute stroke patients by the Modified Rankin Scale (MRS). Most patients (51.67%) scored 2, indicating mild disability.

Table: 3 Serum magnesium level wise distribution

Serum magnesium	Number of patients (%)
<1.8	9 (15%)
1.8-2.4	48 (80%)
2.5+	3 (5%)

The above table shows 60 patients of Acute Stroke distributed according to serum magnesium level in patients where the maximum number of participants belonging to the grade 1.8-2.4(48 patients) were studied while the least number of patients belonged to the Grade >2.5+ (3 patients). Scores of 1 (6.67%), 3 (18.33%), 4 (18.33%), and 5 (5.00%) reflect varying degrees of disability and dependency.

Table: 4 Serum Magnesium level correlated with Modified Rankin Scale of patients in acute stroke

Sr. Mg	MRS grading						
	Count	1	2	3	4	5	Total
<1.8		0	1	2	5	1	9
	%within mrs	0.0%	3.2%	18.2%	45.5%	33.3	15.3%
1.8-2.4	**Count**	4	27	9	6	2	48
	%within mrs	100%	87.1%	81.8%	54.5%	66.7%	79.7%
2.5+	**Count**	0	3	0	0	0	3
	%within mrs	0.0%	9.7%	0.0%	0.0%	0.0%	5.0%
Total	**Count**	4	31	11	11	3	60
Chi square (p value)		P=0.045					

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Out of 60 patients, the maximum number of participants belonging to the Grade 2 MRS (31 patients) were studied, while the lowest number of patients belonged to the Grade 5 (3 patients). Serum magnesium level in our patients where the maximum number of participants belonging to the grade 1.8-2.4(48 patients) were studied while the least number of patients belonged to the Grade >2.5+ (3 patients). The distribution of participants' serum magnesium levels was as follows: 4 had levels below 1.8 mg/dL, 27 had values between 1.8 and 2.4 mg/dL, and 3 had levels over 2.5 mg/dL. According to the research, there may be a relationship between serum magnesium levels and Modified Rankin Scale (MRS) scores. This shows that different magnesium levels could have an impact on the level of disability experienced by stroke patients.

DISCUSSION

Magnesium ions play a role in various physiological processes associated with ischemia. In the brain, magnesium is primarily bound to adenosine triphosphate (ATP). It serves as an essential cofactor in protein synthesis, metabolism, and cellular energy production [9]. Active blood-brain barrier transport regulates brain magnesium levels, keeping cerebrospinal fluid values higher than serum levels (typically 1.1 mmol/l versus 0.8 mmol/l). [13] Serum magnesium levels were inversely linked with the incidence of hypertension and stroke in the Atherosclerotic Risk in Communities [ARIC] study. [14,15]

As recent studies have shown that serum magnesium level has gained much importance because its role in endothelial injury, causes vasoconstriction. Patients with Acute stroke are very much susceptible to cardiovascular system involvement-related morbidity and mortality. [11] We noticed that patients with acute stroke who had low serum magnesium levels have a poor prognosis based on the MRS score.

Our study included 60 patients, 44 of whom were male (73.33%) and 16 of whom were female (26.673%). We included people aged 18 and up to 90. In the Kaur J et al. [16] study, 54% of stroke patients were men and 46% were female. The study comprised 50 individuals with acute ischemic stroke aged 40 to 89 years. Among our 60 patients, 15 (25%) and 19 (31.7%) had a history of Type 2 diabetes and hypertension, respectively.

Acute ischemic strokes in the past have been reported by Ibrahim et al. [11] in 75 Type 2 Diabetes mellitus patients. According to the investigation's findings, the patient's serum magnesium content was significantly lower than that of the controls.

The mean serum magnesium level was 2.008mg/mL, with a median of 2.000mg/dL. In the Firoj Hossain et al [12] investigation, all 50 patients had a mean serum magnesium level of 1.59 (SD ±0.37) mg/dL.

In our study, 48 (80%) of the patients had serum magnesium levels ranging from 1.8 to 2.4 mg/dl. Fewer patients had levels <1.8 mg/dL (4 patients) or >2.5 mg/dL (3 patients). This distribution suggests that most patients had magnesium levels within the normal range, with only a small proportion having either low or high levels. In Hossain MF et al study [12] 33 individuals out of 50 had an ischemic stroke. Serum magnesium levels ranged from 1.0 to 1.4 mg/dl in 17 (34%) of the patients, then from 1.5 to 1.8 mg/dl in 11 (22%) of the patients, 1.9 to 2.0 mg/dl in 04 (08%) of the patients, and >2.0 mg/dl in 01 (02%) of the patients.

In Kaur J et al [16], serum magnesium levels in individuals with transient ischemic episodes and stroke were significantly lower than in control persons. In a study by Cojocaru IM et al., [17] forty patients with acute ischemic stroke, 26 women and 14 men, as well as sex- and age-matched controls, it was found that serum magnesium levels were lower in ischemic strokes; the mean serum magnesium value upon admission was 1.39 +/- 0.213 mmol/L; 48 hours after the stroke began, it was 1.47 +/- 0.181 mmol/L compared to 1.66 +/- 0.138 mmol/L in the controls; additionally, the severity of paresis degree was higher in the patients.

In our study, the correlation between serum magnesium levels and the Modified Rankin Scale was also assessed. The study found that patients with lower serum magnesium levels (<1.8 mg/dL) and higher levels (>2.5 mg/dL) had various degrees of disability according to the MRS, but no additional details of this correlation were presented. Adhikari S et al [18] 2019 identified a negative correlation between serum magnesium and MRS. There was a negative relationship between serum magnesium levels and MRS scores in patients with acute ischemic stroke.

The middle and later years of life are when cerebral vascular disease is most common. Compared to women, men are more likely to have a stroke. Stroke Incidences were highest in the 60-69 age group. Magnesium levels are significantly reduced in patients with acute stroke. A worsening of neurological state appears to be associated with a decline in serum magnesium levels during the acute phase of a stroke.

Confirming the link between acute stroke and serum or dietary magnesium levels in larger prospective trials calls for more research. The study's small sample size signified that the sample wasn't representative of the population, which was a limitation.

CONCLUSION

Our study found that low serum magnesium levels are linked to poorer outcomes in acute stroke patients, as judged by the Modified Rankin Scale (MRS). Patients with low serum magnesium levels exhibited higher MRS values, indicating more severe impairment. This suggests that serum magnesium levels could serve as a valuable prognostic marker for assessing stroke severity and predicting outcomes. The findings

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highlight that acute stroke patients with reduced serum magnesium levels are more likely to experience worse functional outcomes. Thus, monitoring serum magnesium could provide important insights into patient prognosis and help guide treatment strategies for improving stroke outcomes.

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