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ASSESSMENT OF SERUM MAGNESIUM LEVEL IN ISCHEMIC STROKE

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ABSTRACT

Background: Stroke is a major cause of mortality and disability worldwide. Magnesium (Mg^{2+}) plays an important neuroprotective role in ischemic stroke through N-methyl-D-aspartate (NMDA) receptor blockade, calcium channel antagonism, and reduction of excitotoxic neuronal injury. Low serum magnesium levels may contribute to the development and progression of ischemic stroke. **Aim:** To assess serum magnesium levels in patients with ischemic stroke and determine their association with demographic and clinical risk factors. **Methods:** This cross-sectional observational study included 120 adult patients diagnosed with acute ischemic stroke. Data regarding age, gender, hypertension, diabetes mellitus, smoking status, and serum magnesium levels were collected and analyzed. Hypomagnesemia was identified according to standard laboratory reference values. Statistical analysis was performed using the chi-square test, with a p-value of less than 0.05 considered statistically significant. **Results:** Among the 120 patients enrolled, 66% were older than 60 years. Hypomagnesemia was detected in 40 patients (33.3%). Most hypomagnesemic patients were older than 60 years, indicating a significant association between increasing age and low serum magnesium levels. A slight male predominance was observed among hypomagnesemic patients (56% vs. 44% females). Hypertension was present in 100 patients (83.3%) and showed a significant association with hypomagnesemia (p=0.044). Diabetes mellitus was reported in 91 patients (75.8%), and 60% of hypomagnesemic patients were diabetic, with a significant relationship between diabetes and low serum magnesium levels (p=0.005). Smoking was reported in 46 patients (38.3%), but no significant association was found with hypomagnesemia. **Conclusion:** Low serum magnesium is common among patients with ischemic stroke and is significantly associated with advanced age, hypertension, and diabetes mellitus, suggesting its potential role as a risk factor for ischemic stroke.

KEYWORDS: Serum, magnesium, ischemic, stroke.

INTRODUCTION

Stroke, also known as cerebrovascular accident (CVA), is defined as the sudden onset of a neurological deficit resulting from a focal vascular cause. It remains a major public health problem worldwide because of its high mortality and long-term disability rates. The diagnosis of stroke is primarily clinical and is supported by laboratory investigations and neuroimaging studies such as computed tomography (CT) and magnetic resonance imaging (MRI) to confirm the diagnosis and differentiate ischemic from hemorrhagic stroke.[1] Ischemic stroke accounts for approximately 80–85% of all stroke cases and occurs as a consequence of cerebral arterial occlusion leading to reduced blood flow and oxygen delivery to brain tissue. The resulting ischemia initiates a complex cascade of biochemical and molecular events, including energy depletion, membrane depolarization, calcium influx, oxidative stress, and excitotoxicity, ultimately leading to neuronal injury and cell death.[2,3] The ischemic penumbra, a region of functionally impaired but potentially salvageable brain tissue surrounding the infarct core, represents an important therapeutic target in acute stroke management.[3] Stroke incidence increases markedly with advancing age, with nearly two-thirds of cases occurring in individuals older than 65 years. Several established risk factors contribute to stroke development, including hypertension, diabetes mellitus, dyslipidemia, smoking, obesity, atrial

iufibrillation, and physical inactivity.[2] Identification of modifiable risk factors is essential for both primary and secondary prevention strategies. Magnesium (Mg^{2+}) is the fourth most abundant cation in the human body and the second most abundant intracellular cation. It plays a critical role in numerous physiological processes, including enzymatic reactions, energy metabolism, ion transport, neuromuscular conduction, and vascular regulation.[4] Experimental and clinical studies have suggested that magnesium possesses neuroprotective properties that may be beneficial in ischemic stroke. Magnesium inhibits glutamate release, blocks N-methyl-D-aspartate (NMDA) receptors, reduces calcium influx into neurons, preserves blood-brain barrier integrity, and decreases cerebral edema, thereby limiting ischemic neuronal damage.[5,6] Furthermore, magnesium exerts vasodilatory effects on cerebral and systemic blood vessels, potentially improving cerebral perfusion and reducing ischemic injury.[7,8] Hypomagnesemia has been associated with several cardiovascular and metabolic disorders, including hypertension, diabetes mellitus, and atherosclerosis, all of which are recognized risk factors for ischemic stroke.[4] Therefore, evaluating serum magnesium levels in patients with ischemic stroke may provide valuable insights into its potential role as a modifiable risk factor and therapeutic target. The present study aimed to assess serum magnesium levels among patients with ischemic stroke and determine their association with selected demographic and clinical characteristics.

METHOD

Study Design and Setting

This hospital-based observational cross-sectional study was conducted at Al-Yarmouk Teaching Hospital, Baghdad, Iraq, between July 2019 and February 2020. The study enrolled 120 consecutive patients admitted with a diagnosis of acute ischemic stroke. Ethical approval was obtained from the relevant institutional authorities, and informed consent was obtained from all participants or their legal representatives before enrollment.

Study Population

The study included adult patients aged 16 years and older of both sexes who were admitted during the study period. Eligible participants were those with clinically confirmed acute ischemic stroke within the first five days of symptom onset, supported by neuroimaging findings.

Inclusion Criteria

1. Patients aged 16 years or older.
2. Clinically confirmed acute ischemic stroke within five days of onset.
3. Both male and female patients.
4. Provision of informed consent to participate in the study.

Exclusion Criteria

Patients were excluded if they had transient ischemic attack (TIA), intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), cerebral venous thrombosis (CVT), stroke duration exceeding five days, systolic blood pressure below 90 mmHg, serum creatinine level greater than 3 mg/dL, pregnancy, or any clinical condition requiring therapeutic magnesium administration.

Data Collection

Data were collected through direct patient interviews and review of medical records using a structured data collection form. Information obtained included age, sex, date of admission, blood pressure, history of hypertension, diabetes mellitus, smoking status, neuroimaging findings (CT scan or MRI), and serum magnesium level.

Measurement of Serum Magnesium

Venous blood samples were obtained after overnight fasting and collected in sodium citrate tubes. Serum magnesium concentration was measured using a photometric method, one of the most commonly employed techniques in routine clinical laboratories because of its accuracy, rapidity, and ease of automation. The method is based on metallochromic indicators that undergo color changes upon selective binding with magnesium ions. All measurements were performed using an AU480 Chemistry Analyzer.

Statistical Analysis

Data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) software. Quantitative variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Stratification was performed according to age, hypertension, diabetes mellitus, and smoking status. Associations between categorical variables were evaluated using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 120 patients of acute ischemic stroke were included with 66% > 60 years of age and 44% < 60 years old. Means age of the patients was 63.26 ± 9.91 years as shown in (figure 1).

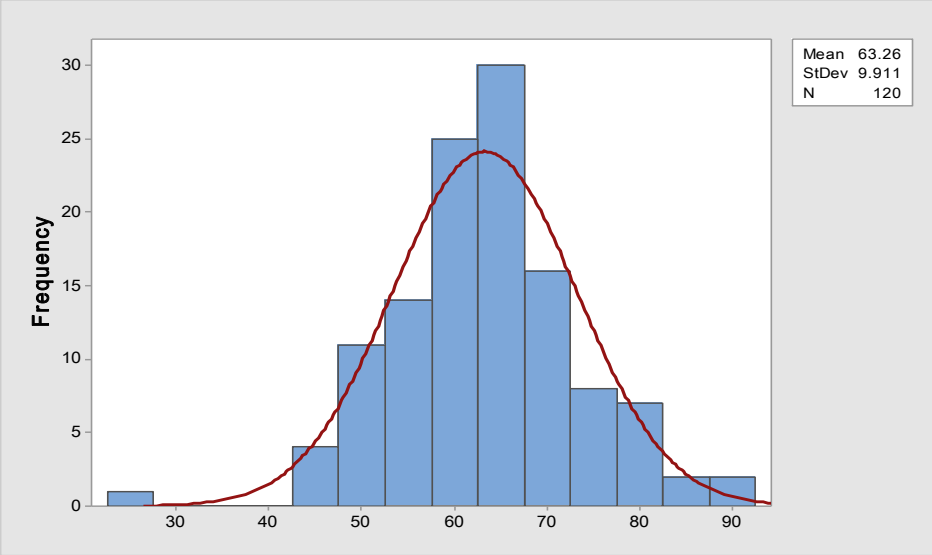

Figure 1: Distribution of cases by age.

Out of the 120 cases, 68(57%) were male while the remaining 52 (43%) were female. The hypomagnesaemia was found in 40 of patients (33%) out of 120 cases as shown in (figure 2).

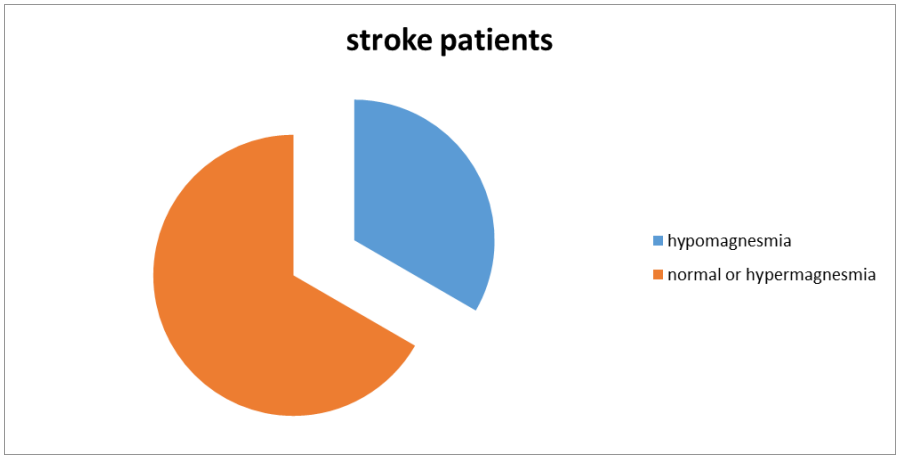

Figure 2: Distribution of cases by hypomagnesaemia.

At the time of admission (at the first 48hr) the mean serum Mg2+ concentration was found 1.86 mg/dl ± 0.344 in acute stroke.

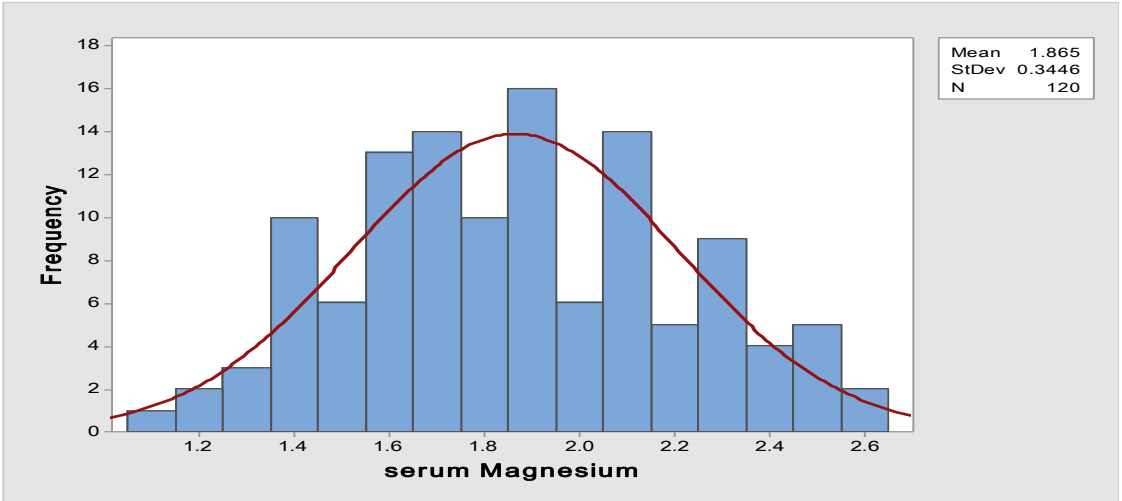

Figure 3: distribution of cases by S.Mg^{2+} level.

The stratification with regard to age, gender, history of hypertension, history of diabetes and history of smoking. Among the 40 hypomagnesaemic patients, the majority 34 out of 80 were older than 60 years old, the remaining 6 who have level Mg^{2+} > 1.7 mg /dl were younger than 60 years old. As in table 1.

Table 1: stratification with regard to age.

Age	Normal or hypermagnesaemia	Hypomagnesaemia	Total	Chi square	P value
	Number	Number			
>60y	46	34	80	9.850	0.002
<60 y	34	6	40		
Total	80	40	120		

Among the hypomagnesaemia patients there were a male predominance n 67% while the female percentage were 33% but with no significant relationship. As in table 2.

Table 2: stratification with regard to gender.

Sex	Normal or hypermagnesaemia	Hypomagnesaemia	Total	Chi square	P value
	Number	Number			
Male	41	27	68	2.916	0.088
Female	39	13	52		
Total	80	40	120		

History of HT was in the majority of patients 83% (100 out of 120). It should note from chi-square test, that there is a significant difference in the qualitative parameter of history of HT with the following p-value (0.044) out of the total hypomagnesaemia patients. As in table 3.

Table 3: stratification with regard to hypertension.

History of hypertension	Normal or hypermag-nesaemia	Hypomagnesaemia	Total	Chi square	P value
	Number	Number			
Yes	63	37	100	4.046	0.044
No	17	3	20		
Total	80	40	120		

History of diabetes was slightly lower than of HT 75% (91 out of 120) 60 % of the total hypomagnesaemia patients were diabetic. Also from chi – square test there is a a significant relation between diabetes and low serum Mg^{2+} with p value 0.005. as in table 4.

Table 4: stratification with regard to diabetes mellitus.

History of diabetes mellitus	Normal or hypermagnesaemia	Hypomagnesaemia	Total	Chi square	P value
	Number	Number			
Yes	67	24	91	7.871	0.005
No	13	16	29		
Total	80	40	120		

Lastly in our study history of smoking, as most of the female's patients were nonsmoker, only 46 out of 120 (38%) were smoker, in which 42.5% were having low serum Mg^{2+}. As in table 5.

Table 5: stratification with regard to smoking.

History of smoking	Normal or hypermagnesaemia	Hypomagnesaemia	Total	Chi square	P value
	Number	Number			
Yes	29	17	46	0.438	0.508
No	51	23	74		
Total	80	40	120		

DISCUSSION

Magnesium is an essential intracellular cation involved in numerous physiological and biochemical processes, including enzymatic reactions, cellular energy metabolism, neuronal transmission, and vascular regulation. Several studies have highlighted its importance in clinical medicine, particularly its neuroprotective role in ischemic stroke. Magnesium

exerts its protective effects through antagonism of N-methyl-D-aspartate (NMDA) receptors, inhibition of glutamate-mediated excitotoxicity, and reduction of calcium influx into neurons, thereby limiting ischemic neuronal injury and delaying cell death following cerebral ischemia.[9] In the present study, hypomagnesemia was detected in 33.3% of patients with acute ischemic stroke, with a mean serum magnesium level of 1.86 mg/dL. This finding is comparable to that reported by Ghayyur et al. (2017), who found hypomagnesemia in 35.5% of stroke patients with a mean serum magnesium level of 1.5 mg/dL.[10] Conversely, Romero et al. (2012) reported a lower prevalence of hypomagnesemia, identifying serum magnesium levels below 1.8 mg/dL in only 24% of patients with ischemic stroke.[11] These findings support the hypothesis that magnesium deficiency is frequently encountered among stroke patients. Age is a well-established non-modifiable risk factor for ischemic stroke. In the current study, two-thirds of patients were older than 60 years, and hypomagnesemia was significantly more prevalent among elderly patients. Similar age distributions have been reported by Gu et al. and Ghayyur et al., who observed mean ages of approximately 60 years among stroke patients.[10,12] The higher prevalence of hypomagnesemia in older individuals may reflect age-related changes in dietary intake, gastrointestinal absorption, and renal handling of magnesium. Regarding gender, males represented the majority of stroke patients and hypomagnesemic cases. However, no statistically significant association was observed between gender and serum magnesium levels. This finding is consistent with the results of Ghayyur et al.[10], suggesting that gender does not independently influence magnesium status among stroke patients. Hypertension was the most common comorbidity identified in this study and demonstrated a significant association with hypomagnesemia. Similar findings were reported by Ghayyur et al.[10] Magnesium deficiency has been implicated in the pathogenesis of hypertension through its effects on vascular tone and endothelial function. Furthermore, a meta-analysis by Zhang et al. demonstrated that magnesium supplementation significantly reduced both systolic and diastolic blood pressure, supporting the role of magnesium in blood pressure regulation.[13] Diabetes mellitus was also significantly associated with low serum magnesium levels. Previous studies have shown that hypomagnesemia is common among patients with poorly controlled diabetes and may contribute to insulin resistance and vascular complications.[14] Although smoking was observed in a considerable proportion of patients, no significant association was found between smoking and hypomagnesemia. This finding may be related to the relatively small sample size despite evidence suggesting that chronic smoking can reduce serum magnesium levels and increase cardiovascular risk.[15]

CONCLUSION

Low serum magnesium (Mg^{2+}) is common among patients with acute ischemic stroke and may represent a potential risk factor for its development. Significant associations were observed between hypomagnesemia and advanced age, hypertension, and diabetes mellitus. However, no significant relationships were found between serum magnesium levels and either gender or smoking status.

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