

Original Research Article

ELECTROLYTE ABNORMALITIES IN SEIZURE PATIENTS AND THEIR ASSOCIATION WITH SEIZURE TYPE: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Electrolyte imbalance is a common and potentially reversible cause of seizures, influencing neuronal excitability and clinical presentation. However, its association with seizure type and related biochemical parameters remains inadequately explored.

Materials and Methods: This cross-sectional study was conducted in the Department of Medicine, MLN Medical College, Prayagraj, among 100 adult patients presenting with seizures. Demographic details, seizure type, and laboratory parameters including serum electrolytes (sodium, potassium, magnesium, and calcium) were recorded. Statistical analysis was performed using Chi-square test with $p < 0.05$ considered statistically significant.

Results: The mean age of participants was 54.22 ± 19.60 years, with a male predominance (72%). Generalized tonic-clonic seizures (GTCS) were the most common type (64%), followed by focal seizures (27%) and status epilepticus (9%). Electrolyte abnormalities were highly prevalent, with hyponatremia (82%) and hypercalcemia (94%) being the most frequent findings. A significant association was observed between serum sodium ($\chi^2=37.878$, $p < 0.001$) and potassium ($\chi^2=9.322$, $p=0.049$) levels with seizure type. Hyponatremia was predominantly associated with GTCS, while hypernatremia was more common in status epilepticus. No significant association was found with magnesium or calcium levels.

Conclusion: Electrolyte imbalance, particularly hyponatremia, plays a significant role in seizure presentation. Routine evaluation and timely correction of electrolyte abnormalities are essential for effective management and may reduce the need for long-term antiepileptic therapy.

Keywords: Seizures; Electrolyte imbalance; Hyponatremia; Hypernatremia; Hypercalcemia.

INTRODUCTION

Seizures are a common neurological emergency encountered in clinical practice and may arise due to a wide range of aetiologies, including metabolic, structural, infectious, and idiopathic causes. Among metabolic causes, disturbances in electrolyte balance are particularly important as they are potentially reversible and often overlooked.^[1] Electrolyte abnormalities can alter neuronal excitability and lead to acute symptomatic seizures without necessarily indicating epilepsy.^[2]

Electrolyte imbalances such as hyponatremia, hypernatremia, hypocalcemia, and hypomagnesemia have been well documented to precipitate seizures. Sodium imbalance, particularly hyponatremia, is one of the most common electrolyte disturbances associated with seizures and may present with generalized tonic-clonic seizures or even status epilepticus.^[3] Severe derangements in serum sodium levels have been shown to significantly increase the risk of seizures, especially when changes occur rapidly.^[4]

Several studies have highlighted that electrolyte abnormalities are frequently encountered in patients

presenting with seizures and may serve as an important underlying cause, particularly in acute settings.^[5] For instance, hyponatremia has been reported as a major contributing factor in new-onset seizures in different populations, emphasizing the need for early recognition and correction.^[6] Furthermore, seizures induced by electrolyte disturbances often do not require long-term antiepileptic therapy, as correction of the underlying imbalance can lead to resolution of symptoms.^[7]

Despite their clinical significance, the relationship between electrolyte imbalance and seizure characteristics, biochemical parameters, and clinical outcomes remains inadequately explored. Therefore, the present study was conducted to assess the pattern of electrolyte imbalance and its association with seizure type, biochemical parameters, and clinical outcomes among patients presenting with seizures.

Aims and Objectives

To assess the association between serum electrolyte imbalance and seizure type among patients presenting with seizures

Objectives

1. To evaluate the pattern and prevalence of electrolyte imbalances among patients presenting with seizures.
2. To determine the association between serum electrolyte abnormalities and type of seizures.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Medicine at MLN Medical College, Prayagraj, a tertiary care referral center catering to patients from Uttar Pradesh and adjoining states. The study population comprised adult patients (≥ 18 years) presenting with seizures. Data collection was carried out over a period of 18 months, from May 2020 to October 2021.

The sample size was calculated using the formula $n = Z^2 \times p(1-p) / d^2$, assuming a prevalence (p) of 0.5, confidence level of 95% ($Z=1.96$), and precision (d)

of 0.10, yielding a sample size of 96. After rounding off, a total of 100 patients were included in the study. Patients aged 18 years or older presenting with seizures were included, while those with seizures due to identifiable causes such as cerebrovascular accidents, subarachnoid hemorrhage, tuberculoma, cavernous sinus thrombosis, febrile seizures, hypoglycemia, alcohol withdrawal, and uremic encephalopathy were excluded. Patients unwilling to participate were also excluded. Ethical approval was obtained from the Institutional Ethics Committee, and informed consent was taken from all participants. At enrollment, demographic details were recorded, and seizure type was classified based on clinical evaluation and relevant investigations including CT/MRI and EEG wherever indicated. Laboratory investigations included hematological parameters (hemoglobin and total leukocyte count) and biochemical parameters (random blood sugar, serum bilirubin, AST, ALT, urea, and creatinine). Serum electrolytes, including sodium, potassium, magnesium, and calcium, were measured and categorized based on standard reference ranges. Patients were followed up until discharge, referral, or death, and duration of hospital stay was recorded.

Data were entered into Microsoft Excel 2013 and analyzed using IBM SPSS version 21.0. Descriptive statistics were expressed as frequencies, percentages, and mean \pm standard deviation and for Inferential statistics Chi-square test was used. A p-value of <0.05 was considered statistically significant.

RESULTS

The study included 100 patients with seizures, with ages ranging from 18 to 92 years. The majority of participants were in the age group of 61–70 years (23%), followed by 51–60 years (18%) and 31–40 years (14%). The mean age of the study population was 54.22 ± 19.60 years. Males constituting 72% of the study population, while females accounted for 28% of total study participants. [Table 1]

Table 1: Socio-demographic Characteristics of Study Participants (n=100)

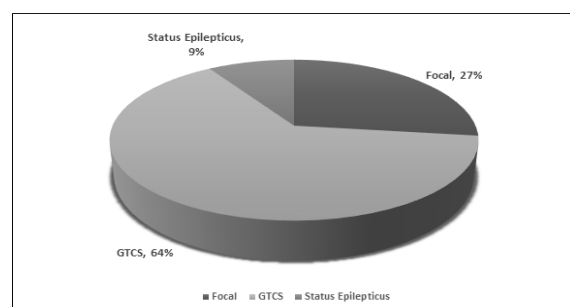
Socio-demographic characteristics		Frequency (n=100)	Percentage (%)
Age (years)	<20	5	5.00%
	21–30	9	9.00%
	31–40	14	14.00%
	41–50	13	13.00%
	51–60	18	18.00%
	61–70	23	23.00%
	71–80	4	4.00%
	81–90	12	12.00%
	>90	2	2.00%
Mean Age \pm SD = 54.22 \pm 19.60			
Sex	Male	72	72.00%
	Female	28	28.00%

Table 2: Distribution of Serum Electrolyte Abnormalities among Study Participants (n=100)

Electrolyte	Low n (%)	Normal n (%)	High n (%)
Sodium (n=100)	82 (82.0%)	8 (8.0%)	10 (10.0%)
Potassium (n=100)	54 (54.0%)	37 (37.0%)	9 (9.0%)
Magnesium (n=100)	33 (33.0%)	67 (67.0%)	0 (0.0%)
Calcium (n=100)	5 (5.0%)	1 (1.0%)	94 (94.0%)

Table 3: Association of Serum Electrolyte Status with Seizure Type (n=100)

Electrolyte	Status	Focal n (%)	GTCS n (%)	Status Epilepticus n (%)	χ^2 (p-value)	p-value
Sodium	Hypo (n=82)	21 (25.6%)	58 (70.7%)	3 (3.7%)	37.878	<0.001
	Normal (n=8)	4 (50.0%)	4 (50.0%)	0 (0.0%)		
	Hyper (n=10)	2 (20.0%)	2 (20.0%)	6 (60.0%)		
Potassium	Hypo (n=54)	14 (25.9%)	37 (68.5%)	3 (5.6%)	9.322	0.049
	Normal (n=37)	10 (27.0%)	24 (64.9%)	3 (8.1%)		
	Hyper (n=9)	3 (33.3%)	3 (33.3%)	3 (33.3%)		
Magnesium	Hypo (n=33)	7 (21.2%)	25 (75.8%)	1 (3.0%)	3.625	0.163
	Normal (n=67)	20 (29.9%)	39 (58.2%)	8 (11.9%)		
Calcium	Hypo (n=5)	3 (60.0%)	2 (40.0%)	0 (0.0%)	3.6	0.463
	Normal (n=1)	0 (0.0%)	1 (100.0%)	0 (0.0%)		
	Hyper (n=95)	24 (25.3%)	61 (64.2%)	9 (9.5%)		

**Figure 1: Distribution of Seizure Types among Study Participants (n=100)**

[Figure 1] showed the distribution of seizure types among the study participants, with generalized tonic-clonic seizures (GTCS) being the most common (64%), followed by focal seizures (27%) and status epilepticus (9%).

A high proportion of patients showed electrolyte abnormalities. Hyponatremia was the most common abnormality, observed in 82% of patients, followed by hypokalaemia in 54% and hypomagnesemia in 33% of cases. Notably, hypercalcemia was present in 94% of patients, while only 1% had normal calcium levels. [Table 2]

[Table 3] showed association of serum electrolyte status with seizure type. Serum sodium levels showed a strong and statistically significant association with seizure type ($\chi^2=37.878$, $p<0.001$). Hyponatremia was predominantly associated with generalized tonic-clonic seizures (70.7%), while hypernatremia was more commonly observed in patients with status epilepticus (60.0%). Serum potassium levels also demonstrated a statistically significant association with seizure type ($\chi^2=9.322$, $p=0.049$), although the distribution was relatively less distinct compared to sodium.

No significant association was observed between seizure type and serum magnesium ($\chi^2=3.625$, $p=0.163$) or calcium levels ($\chi^2=3.6$, $p=0.463$). These findings suggest that while sodium and potassium imbalances may influence the type of seizure presentation, magnesium and calcium abnormalities do not appear to have a significant relationship with seizure type in this study population.

DISCUSSION

In the present study, the majority of patients were middle-aged to elderly, with a mean age of $54.22 \pm$

19.60 years and a male predominance (72%). Similar demographic patterns have been reported by Nardone R. on acute symptomatic seizures, where adults—particularly older individuals—are more prone due to metabolic and systemic causes rather than primary epilepsy. Acute symptomatic seizures are frequently associated with underlying reversible factors such as electrolyte imbalance.^[7]

Electrolyte abnormalities were highly prevalent in the present study, with hyponatremia observed in 82% of patients. This finding is comparable to other studies where hyponatremia has been reported as the most common electrolyte abnormality in seizure patients. For instance, a study by Fatima M reported hyponatremia in up to 91% of seizure cases, highlighting its dominant role in seizure pathogenesis.^[8] Furthermore, hyponatremia has been consistently associated with neurological manifestations including seizures, emphasizing its clinical importance.^[9]

The strong association observed between serum sodium levels and seizure type in the present study ($p<0.001$) is supported by existing literature. Previous studies have demonstrated that severe sodium imbalance can precipitate seizures and even status epilepticus, particularly when the change in sodium levels is rapid.^[4] A retrospective study by Halawa I et al. also found a direct association between hyponatremia and occurrence of seizures in hospitalized patients, further validating the findings of the present study.^[10]

Serum potassium levels also showed a statistically significant association with seizure type ($p=0.049$) in the present study. Although fewer studies have explored this relationship, potassium imbalance is known to affect neuronal membrane potential and excitability. However, compared to sodium, its role in seizure generation is less consistently demonstrated in clinical studies, which aligns with the relatively weaker association observed in the present study.^[4]

In contrast, no significant association was found between seizure type and serum magnesium or calcium levels. Similar findings have been reported in other studies where magnesium and calcium abnormalities, although biologically relevant, did not show consistent statistical association with seizure characteristics.^[7] However, it is important to note that most literature identifies hypocalcaemia rather than

hypercalcemia as a common metabolic cause of seizures, due to its effect on increasing neuromuscular excitability and lowering seizure threshold.^[11] In contrast, hypercalcemia is more frequently associated with neuropsychiatric manifestations such as confusion and altered sensorium rather than seizures.^[12] Therefore, the high prevalence of hypercalcemia (94%) observed in the present study represents a notable deviation and may be attributable to population characteristics, laboratory variations, or underlying metabolic conditions.

Overall, the findings of the present study are consistent with existing evidence that electrolyte imbalance—particularly hyponatremia—is a major contributing factor in seizure occurrence and type. Hyponatremia is well recognized as a leading reversible cause of acute symptomatic seizures, with studies demonstrating that both the severity and rapidity of sodium decline significantly influence seizure risk.^[13] Early identification and correction of electrolyte abnormalities are therefore crucial, as most electrolyte-related seizures resolve with correction of the underlying imbalance and may not require long-term antiepileptic therapy.^[14]

CONCLUSION

Electrolyte abnormalities, particularly hyponatremia, are highly prevalent in patients presenting with seizures and show significant association with seizure type. Sodium and potassium imbalances influence seizure presentation, whereas magnesium and calcium do not demonstrate a significant relationship. Routine evaluation and prompt correction of electrolyte disturbances are essential for optimal management and prevention of unnecessary long-term therapy.

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