STUDY OF CORRELATION BETWEEN ELECTROLYTE IMBALANCE AND SEIZURES IN CRITICALLY ILL PATIENTS

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ABSTRACT

Objectives: A seizure is described as an episode of neurological malfunction brought on by aberrant neuronal activity that causes an abrupt alteration in behavior, motor function, and sensory perception. Electrolytes are a major factor in the occurrence of seizures. Seizures typically happen when there is a sudden change in the electrolyte concentration. In this study, the electrolyte imbalance pattern was evaluated, and the potential consequences of these diseases on seizure patients were investigated.

Methods: This cross-sectional study involved 122 patients with new-onset focal or generalized seizures who were hospitalized in the medical wards and intensive care unit of Index Medical College, Hospital and Research Center. Those fulfilling inclusion and exclusion criteria were enrolled for the study and the blood samples were analyzed for sodium, potassium, calcium, and magnesium.

Results: Generalized tonic-clonic seizure (GTCS) was the most common type of seizure observed in this study, which affected 90 (73.8%) of the 122 patients, the focal seizure affected 26 patients (21.3%), and status epilepticus affected six patients (4.9%). Out of 122 patients, 33 patients (27%) had electrolyte imbalances. The most common abnormality observed was hyponatremia, seen in 30 patients (91%). Hypocalcemia (3%), hypomagnesemia (3%), and hypokalemia (3%) were the other abnormalities noted. Hyponatremia is more common in GTCS, and a strong correlation between seizure type and blood sodium status was found.

Conclusion: The study results showed a significant association between electrolyte imbalance and the first episode of seizures, the most common electrolyte abnormality being hyponatremia ($p<0.001$) followed by hypomagnesemia ($p<0.023$). Patients with metabolic causes of seizures were most frequently shown to have altered electrolytes among the other types of seizures.

Keywords: Seizures, Electrolyte Imbalance, ICU, Hyponatremia, Hypocalcemia.

INTRODUCTION

Seizures are transient events that include symptoms and signs of abnormal excessive hypersynchronous activity in the brain. Electrolyte disturbances and other metabolic derangements can be associated with epileptic seizures [1]. When such seizures occur in close temporal relation with the metabolic disturbance, they are sometimes referred to as acute symptomatic [2] (Commission, 1993), and their prognosis differs from that of unprovoked seizures [3]. Alterations of electrolyte gradients across cell membranes lead to both direct and indirect effects on neuronal excitability and synchronization, and the consequent abnormal neuronal discharge may facilitate epileptiform activities [4]. Several clinical conditions, including renal failure and dehydration, are linked to significant changes in plasma osmolality and electrolyte balance. These changes determine significant variations in brain metabolism and function, which raises the risk of seizures. Variations in the concentration and osmolality of extracellular ions impact synaptic transmissions and neuronal excitability.

A key component of brain functioning in the central nervous system is electrolyte homeostasis. The brain is one of the many organs and tissues that are affected by electrolyte imbalance, which must be identified and treated immediately to avoid serious and potentially fatal consequences. Emergency treatment is necessary because the neurological symptoms indicate the severity of acute neuronal dysfunction [5,6]. Acute and severe electrolyte imbalances can manifest with rapidly progressive neurologic symptoms or seizures, which can sometimes be the only presenting symptom. Hyponatremia, hypocalcemia, and hypomagnesemia are the electrolyte abnormalities that cause seizures most frequently [1]. It is therefore recommended to estimate serum electrolytes in addition to performing a thorough clinical history and evaluation and a basic blood workup. An accurate and prompt diagnosis is essential because treatment of the underlying electrolyte imbalance can prevent further episodes of seizures and brain damage [6,7].

Hyponatremia is by far the most common cause of seizures due to an electrolyte imbalance. The risk depends on the severity and the rate of onset [8]. Metabolic abnormalities such as electrolyte imbalances, hypoglycemia or hyperglycemia, renal failure, and liver failure may precipitate seizures at any age. Identifying the type of seizure and the etiology is essential for selecting appropriate therapy and predicting the prognosis and the risk of recurrence of seizure episodes. The purpose of this study is to evaluate the correlation between electrolyte imbalance and seizures in patients with serious illnesses.

METHODS

This cross-sectional descriptive study was conducted in the medical wards and ICU of Index Medical College, Hospital and Research Center, Indore (Madhya Pradesh) after obtaining IEC approval and written consent from the participants. A total of 122 patients with newly diagnosed focal or generalized seizures were included in the study. The age of subjects ranged between 20 and 70 years, and the educational status ranged from illiteracy to post-graduation. The rationale behind

the investigation and the expected results were explained to the participants.

Inclusion criteria

All patients with the first episode of focal or generalized seizures and patients with age of onset of seizures > 18 years were included in the study.

Exclusion criteria

Individuals with a prior history of seizures and those who refused to give consent were not allowed to participate in the study.

The relatives were asked in detail regarding the type of seizure, its duration, and any related symptoms such as fever, headaches, vomiting, limb weakness or loss of consciousness, falls or head injuries, alcohol intoxication, or withdrawal. In addition, a history of neurological or medical conditions was collected. A thorough examination was conducted, focusing on the nervous system, to identify any contributing factors, focal neurological impairments, or complications. A fundus examination was performed to check for retinopathy or papilledema. Fasting venous blood sample was collected from each participant in a plain vacutainer under all aseptic conditions after explaining the procedure to the subject. The blood sample was allowed to clot at room temperature for 15 min and serum was obtained by centrifugation at 3500 rpm (rotation per minute) for 10 min. Then, serum magnesium, serum calcium, serum potassium, and serum sodium were analyzed. The Statistical Package for the Social Sciences (SPSS) software, version 20, was used to compute and analyze the data. The data were shown as Mean ± SD. $p < 0.05$ was considered significant and $p < 0.001$ was considered highly significant.

RESULTS

From Table 1, it is evident that the age category of 41–60 years (59.8%) had a majority of patients (n=73), followed by the age group 20–40 years (21.3%). Only one patient was found below 20 years of age.

Table 2 shows that in this study, the most common type of seizure was generalized tonic-clonic seizures (GTCS) (73.8%), followed by focal seizures (21.3%). About 4.9% of patients presented with status epilepticus.

As indicated by Table 3, of the 122 patients in this study, 33 patients (or 27%) had abnormal electrolytes, while the remaining 73% had electrolytes within the normal range.

Table 4 shows that hyponatremia, which was observed in 30 patients (91%), was the most frequent electrolyte abnormality. Hypocalcemia, hypomagnesemia, and hypokalemia were the next most prevalent electrolyte abnormalities, observed in decreasing order, by 1.

Table 5 demonstrates that the proportions and frequencies between the groups were compared using Fisher's exact test, and the difference was found to be non-significant (NS) ($p > 0.93$).

DISCUSSION

Patients with seizures notice abrupt changes in their feelings, memories, behavior, or state of consciousness [9]. Although several pathophysiological explanations have been put out, it is generally accepted that a seizure results from a disruption of the normal equilibrium between excitation (E) and inhibition (I) in the brain [10]. Electrolyte ions, such as sodium and calcium, can pass through the neuron membrane to enter the intracellular space. The polarization status of the neuron membrane is affected by the entry of these ions into the intracellular environment, which leads to the release of an excessive, irregular, and controlled electric charge. Seizures may arise from this type of activity when it occurs widely across several neurons [11]. An intricate web of molecules, including those involved in the blood–brain barrier, neuronal and glial membrane mechanisms,

Table 1: Frequency distribution of type of age category

S. No.	Age category	n	%
1	<20 years	1	0.8
2	20–40 years	26	21.3
3	41–60 years	73	59.8
4	>60 years	22	18

Table 2: Frequency distribution of type of seizure

S. No.	Type of seizure	n	%
1	GTCS	90	73.8
2	Focal seizure	26	21.3
3	SE	6	4.9

GTCS: Generalized tonic-clonic seizure, SE: Status epilepticus

Table 3: Frequency distribution of electrolyte abnormality incidence

S. No.	Electrolyte abnormality	n	%
1	Present	33	27
2	Absent	89	73

Table 4: Frequency distribution of type of electrolyte abnormality

S. No.	Type of electrolyte abnormality	n	%
1	Hyponatremia	30	91
2	Hypocalcemia	1	3
3	Hypomagnesemia	1	3
4	Hypokalemia	1	3

and other processes, regulate the balance of ions entering and exiting the brain. Changes in the ion gradients across cellular membranes may promote epileptiform activity and have both direct and indirect effects on neuronal discharge.

In the current study, GTCS affected 73.8% of patients, with focal seizures accounting for 21.3% and status epilepticus for 4.9% of cases, respectively. This result corroborates with previous studies of Mohanta *et al.* (2019) [12] and Dhadke *et al.* (2016) [13].

Of the 122 individuals in the current study, 33 patients (27%) had abnormal electrolytes, while the remaining 73% had electrolytes within the normal range. This study clearly shows that hyponatremia, which was observed in 30 patients (91%), was the most frequent electrolyte abnormality. Hypocalcemia, hypomagnesemia, and hypokalemia were the next most prevalent electrolyte abnormalities, observed in decreasing order, by 1. The results of the present study were consistent with the work of Halawa *et al.* (2011) [14] and Sonkar *et al.* (2022) [15], who found hyponatremia as one of the most common factors leading to seizure activity and also found that with decreasing serum sodium levels the odds of seizure increase substantially. The high prevalence of hyponatremia in the present study also endorsed this relationship. The results of this study and a comparison with earlier studies in both adults and pediatric populations demonstrate that electrolyte imbalance is frequently noted in seizure activity.

This study aimed to determine electrolyte imbalances in patients with the first episode of seizures. The study's findings demonstrated that the first seizure episode was significantly correlated with electrolyte imbalance ($p < 0.001$), with hyponatremia being the most common electrolyte abnormality, followed by hypocalcemia, hypokalemia, and hypomagnesemia ($p < 0.023$). Electrolyte imbalances were more frequently observed in patients with metabolic causes of seizures

Table 5: Comparison of type of seizure between patients with and without electrolyte abnormality groups in the study

S. No.	Seizure type	Electrolyte abnormality absent (n=89)		Electrolyte abnormality present (n=33)		Chi-square value	df	P-value
		n	%	n	%			
1	GTCS	66	74.2	24	72.7	0.12	1	0.93 (NS)
2	Focal seizure	19	21.3	7	21.2			
3	SE	4	4.5	20	6.1			

GTCS: Generalized tonic-clonic seizure, SE

among the diverse causes of seizures. The current study's findings are consistent with the research conducted by Lee *et al.* 2000 [16], Hsu *et al.* 2005 [17], Beghi *et al.* 2009 [18], Halawa *et al.* [14].

CONCLUSION

Patients with hyponatremia, hypocalcemia, and hypomagnesemia are more likely to experience seizures, which are significant clinical symptom of electrolyte abnormalities. In these subjects, the successful management of seizures begins with an accurate diagnosis of the underlying electrolyte disturbances. For this reason, the initial diagnostic workup in individuals with seizures should include complete serum chemistry, including sodium, potassium, calcium, and magnesium. Early identification and correction of these disturbances are necessary to control seizures and prevent permanent brain damage.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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