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Examination of electroencephalography (EEG) parameters within 24 hours after the first seizure

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ABSTRACT

Background:
Abnormal EEG is a predictor of seizure relapse. Obtaining data related to the diagnosis and outcome of the first seizure is necessary for improving care for these patients. We aimed to examination of electroencephalography parameters within 24 hours after the first seizure attack.

methods:
This cross-sectional study was done on 91 patients with the first seizure attack who referred to Alavi Hospital in Ardabil in 2023 were included in the study. The necessary information including age, sex, etiology of seizure, type of seizure and routine and stimulation modalities with abnormal waves were collected.

Results:
Of all patients, 47 (51.6%) were men and 44 (48.4%) were women with an average age of 38 years. According to the type of seizure in patients, in 69 cases (75.8%), it was generalized type. Electroencephalography (EEG) findings were reported as normal in 50 cases (54.9%). In patients with abnormal EEG, in 34 patients (82.9%) these waves were found in routine modality, 4 cases (9.8%) in Hyperventilation (HV) modality and other 3 cases (7.3%) in photic stimulation (Ph.S) modality. There was a significant relationship between EEG findings and the etiology as well as the type of seizure.

Conclusions:
The results of this study showed that, in idiopathic cases, the most common EEG finding was normal, whereas in cases of hypoglycemia, the most common finding was non-epileptic abnormal waves. Furthermore, in focal seizures, the most common EEG finding was also non-epileptic abnormal waves.

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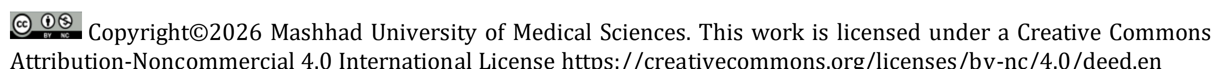
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Introduction

A seizure is a transient event caused by excessive or synchronous abnormal neuronal activity in the brain and is classified into focal, generalized, and unclassified types (1). The incidence of seizures ranges from 40 to 70 per 100,000 annually in high-income countries, with nearly double that rate in poorer nations. Seizures account for 1% of hospital admissions and 3% of emergency department visits. The first seizure may vary from a brief twitch to a tonic-clonic episode and can occur with or without a precipitating factor (2). Its differential diagnosis is broad, including syncope, transient ischemic attacks, metabolic encephalopathies, sleep disorders, cardiac arrhythmias, and psychogenic nonepileptic seizures (PNES). Status epilepticus in adulthood is a neurological emergency requiring prompt evaluation and management according to established guidelines (3).

Diagnosis is made through clinical observation, neurological examination, EEG, and sometimes advanced imaging. Early EEG (within 24 hours) and MRI are the preferred diagnostic tools (2,4). Modern approaches include quantitative EEG analysis and machine learning methods for seizure detection (5,6). EEG reports must describe frequency, amplitude, waveform, and localization using standardized terminology (7). Abnormal EEG findings include slow waves, epileptiform discharges (interictal and ictal), and generalized spike-waves. However, the presence or frequency of generalized spike-waves in idiopathic generalized epilepsies does not have a significant association with syndromic diagnosis or treatment outcome; detailed clinical history remains key for diagnosis (8). Early EEG after a first unprovoked seizure in children provides valuable prognostic information (4). In the emergency department, predictors of early seizure recurrence include abnormal EEG findings (9). Following severe traumatic brain injury in children, early quantitative EEG can help predict the development of post-traumatic epilepsy (10). Additionally, early-phase EEG power spectrum analysis may differentiate acute encephalopathy from prolonged febrile seizures (11). A computational biomarker for idiopathic generalized epilepsy using resting-state EEG has also been proposed (12).

The first seizure is an unforgettable event for patients and families. Due to social stigma, patients often conceal first seizures out of fear of embarrassment, loss of driver’s license, or employment concerns, leading to limited data (2). Thus, evaluating a first seizure is a common and important neurological issue (1). Seizures are divided into true (epileptic) seizures and psychogenic nonepileptic seizures (PNES). PNES are behavioral episodes resembling true seizures but lacking organic causes. Differentiating between true seizures and PNES can be challenging, as many patients have both conditions. Accurate distinction is essential for treatment selection and prognosis (1,2,3). A practical, empathetic approach is recommended for managing PNES (1,13). Treatment options for PNES include psychotherapy and multidisciplinary care (2,3).

Studying EEG changes within 24 hours after a first seizure is critical for identifying seizure type and guiding management (4,9,11). This study was conducted with the aim of investigating EEG changes during the first 24 hours in patients who were admitted to Ardabil Alavi Hospital with their first seizure in 2023.

Methods

This descriptive cross-sectional study was conducted on 91 patients with their first seizure attack who referred to the Neurology Center of Alavi Hospital in Ardabil city in 2022. Patients who experienced their first seizure attack were included in the study. Data, including age, gender, seizure etiology, seizure type, and EEG findings, were collected using a checklist. The data were analyzed using SPSS version 26 software. The relationship between EEG changes and variables such as age group, seizure etiology, and seizure type was examined using Fisher's exact test. The relationship between abnormality types of modalities with seizure

type and etiology was analyzed using the chi-square test. The significance level was set at less than 0.05 for all analyses.

Ethical approval

This study was approved by the Ethics Committee of Ardabil University of Medical Sciences (registration code: IR.ARUMS.MEDICIN.REC.1401.040).

Results

Of all the patients, 47 (52%) were male. Forty-three percent (39 patients) were in the under-30 age group. Seizures were of the generalized type in 69 cases (76%), simple partial type in 7 cases, and complex partial type in 15 cases. Regarding symptomatic etiologies, 49 cases were idiopathic, and 21 cases were attributed to tramadol consumption (Figure 1). Overall, EEG findings were reported as normal in 50 cases (55%). Slowing waves were reported in 2 cases, and epileptiform (or optic) discharges in 39 cases. Among patients with abnormal EEG findings, these waves were observed during routine modulation in 34 patients (83%), during hyperventilation (HV) modulation in 4 cases, and during photic stimulation (Ph.S) modulation in 3 cases. There was a significant correlation between EEG findings and seizure etiology as well as seizure type, but no significant correlation with gender or age (Table 1). The relationship between seizure etiology and modulation modality was not statistically significant (Table 2).

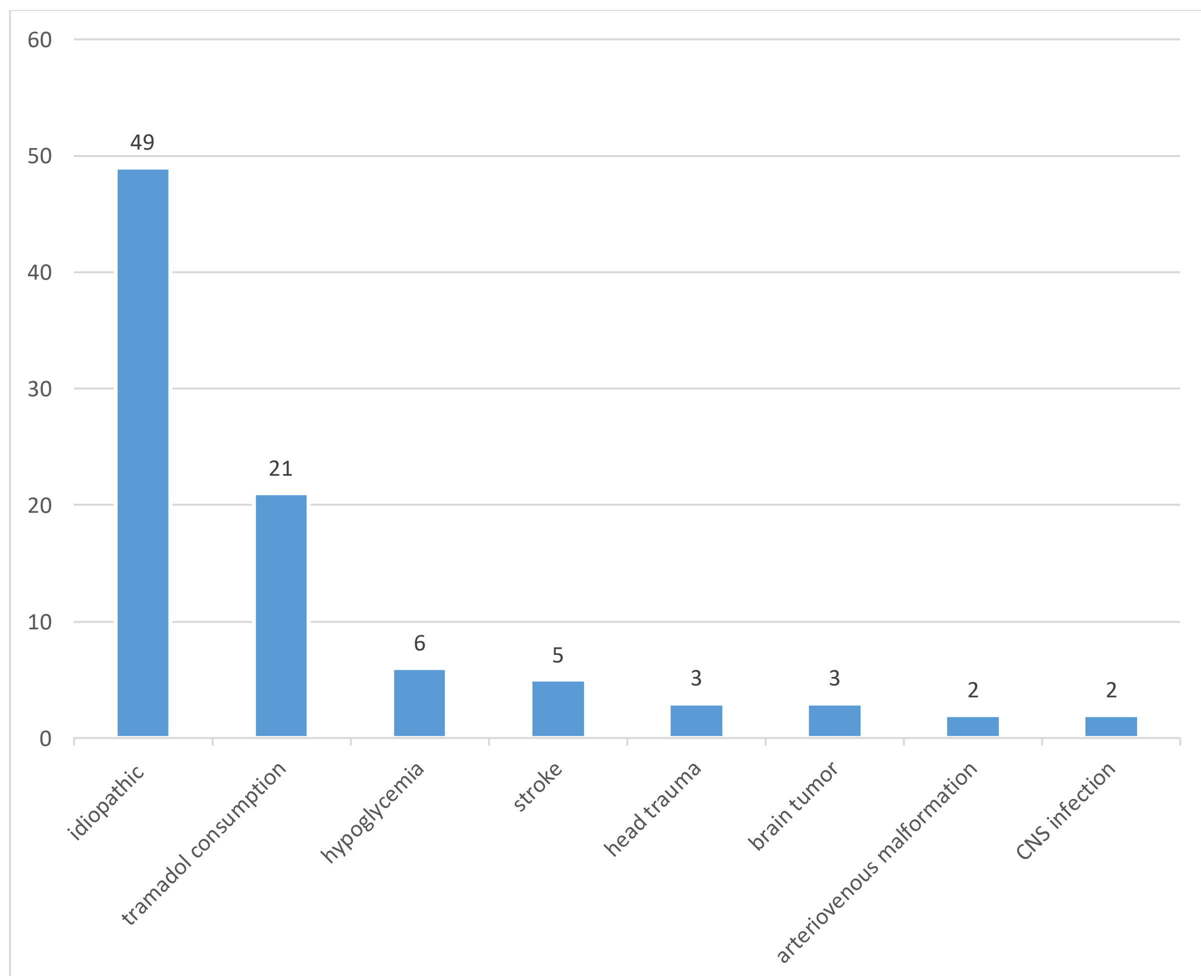

Figure 1. Frequency of symptomatic etiologies in studied cases

Table 1. Frequency of EEG findings by variables in studied patients

Variables		EEG findings			p-value
		Normal	Slowing wawes	Epileptic discharge	
Etiology of seizure	idiopathic	35	0	14	0.001*
	tramadol consumption	1	0	5	
	hypoglycemia	3	0	18	
	Others (stroke, head trauma, brain tumor, arteriovenous malformation, CNS infection)	11	2	2	
Gender	Male	23	2	22	0.24
	Female	27	0	17	
Age groups	<30	16	1	22	0.093
	30-40	10	0	6	
	50-40	9	0	3	
	>50	15	1	8	
Type of seizure	Generalized	43	2	24	0.001*
	SPS and CPS	7	0	15	

Chi-square test; *: p<0.05.

Table 2. Relation between etiology of seizure and type of Modality in studied patients

	Modality			p-value
	Routine	HV	Ph.S	

Etiology of seizure	Idiopathic	11	2	1	0.095
	Hypoglycemia	5	0	0	
	Tramadol consumption	15	2	1	
	Head trauma & CNS infection & Brain tumor	3	0	1	

Chi-square test; *: $p<0.05$.

Discussion

In the present study, 91 patients with a first seizure (47 males, 44 females; mean age 38 years) were evaluated, suggesting a slightly higher incidence in males. The highest frequency of first seizures was observed in the under-30 age group (39 patients). Regarding seizure type, generalized seizures were the most common (69 cases), followed by complex partial (15 cases) and simple partial (7 cases). Most cases were idiopathic (49 patients). Among symptomatic etiologies, tramadol use was the most frequent (21 cases), followed by hypoglycemia (6 cases), stroke (5 cases), head trauma (3 cases), brain tumor (3 cases), cerebral vascular malformation (2 cases), and CNS infection (2 cases).

EEG findings were normal in 50 cases (54.9%) and abnormal in 41 cases (45.1%). Among abnormal EEGs, 2 cases showed slowing waves and 39 cases showed epileptic discharges. Regarding activation methods, abnormal waves were observed during routine modulation in 34 patients, during hyperventilation stimulation in 4 patients, and during photic stimulation in 3 patients. A significant relationship was found between EEG findings and both etiology and seizure type: in idiopathic cases, a normal EEG was most common, whereas in tramadol-related cases, abnormal epileptic waves predominated. In focal seizures (complex partial type), abnormal epileptic waves were the most frequent finding. No significant relationship was observed between EEG findings and demographic variables.

These results are consistent with previous findings. A study on early EEG after a first unprovoked seizure in children reported that early EEG provides valuable prognostic information (4). In the emergency department setting, abnormal EEG findings have been identified as predictors of early seizure recurrence (9). Following severe traumatic brain injury, early quantitative EEG has been shown to help predict the development of post-traumatic epilepsy (10). Additionally, early-phase EEG power spectrum analysis may differentiate acute encephalopathy from prolonged febrile seizures (11).

Our observation that generalized spike-waves are common in idiopathic generalized epilepsies aligns with recent work showing that while generalized spike-waves are a hallmark EEG finding, their presence or frequency does not have a significant association with syndromic diagnosis or treatment outcome (8). This supports the clinical primacy of detailed history-taking over specific EEG characteristics for syndromic classification, as also emphasized in current literature (8). Furthermore, advanced analytical methods, such as heterogeneous recurrence analysis of imaged EEG and lightweight neural network approaches, have been proposed to improve spatiotemporal seizure detection (5,6). A computational biomarker for idiopathic generalized epilepsy using resting-state EEG has also been introduced (12). These modern techniques may help address the well-recognized issue of false-negative standard EEG recordings (7).

Regarding psychogenic nonepileptic seizures (PNES), which are an important consideration in the differential diagnosis of first seizures, a practical and empathetic approach to evaluation has been recommended (13,14). Treatment for PNES typically involves psychotherapy and multidisciplinary care (15,16), and accurate differentiation between epileptic seizures and PNES is essential for appropriate management and prognosis (14–16). Status epilepticus in adults represents a distinct neurological emergency requiring prompt management according to established guidelines (3).

It should also be noted that the diagnostic yield of EEG is highly dependent on its timing. An EEG obtained within 24 hours of presentation provides diagnostic information in approximately half of cases and helps distinguish between generalized and focal seizures; delaying the EEG beyond 24 hours markedly reduces its diagnostic yield (2). In the present study, various activation methods (hyperventilation and photic stimulation) did not show a significant correlation with seizure type or etiology—an area worthy of further investigation using larger sample sizes and standardized activation protocols.

Conclusion

The results of this study showed that in cases of idiopathic seizures, EEG findings were mostly normal, whereas in cases related to tramadol use, EEG findings were predominantly abnormal epileptic waves. Additionally, among focal seizures, the highest frequency of abnormal findings was related to epileptic waves (in complex partial seizures). In the present study, no significant relationship was found between EEG findings and demographic variables, nor between provocative abnormalities and demographic variables, etiology, or seizure type.

Several limitations should be acknowledged. The lack of accurate information from patients may have affected the reliability of the obtained data, particularly if the reported timing of seizures and hospital visits was imprecise and did not fall within the initial 24-hour window. Furthermore, if a patient mistakenly did not report previous attacks and was therefore incorrectly included in the study as a first-attack case, this could have influenced the results.

It is suggested that similar studies be conducted with consideration of the following characteristics based on the examinations performed. Since most of the patients in our study sought medical attention for their first seizure, it is recommended that individuals with a history of recurrent seizures also be examined and studied. Furthermore, conducting a similar study to examine the relationship between EEG parameters and seizure recurrence is necessary.

Acknowledgments

None

Conflict of Interest

None

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