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FREQUENCY OF NORMAL INTERICTAL EEG IN ADULTS PRESENTING WITH FIRST SEIZURE

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Abstract: *First-time seizure often triggers elaborate neurologic examination to define its etiology and assess the likelihood of its repetition.* ***Objective:*** *The study's main objective is to find the frequency of normal interictal EEG in adults presenting with the first seizure.* ***Methods:*** *This cross-sectional study used data collected from 75 patients. Patient demographic details, seizure characteristics, and EEG findings were documented. EEG results were categorized as normal or abnormal (presence of epileptiform discharges, spikes, or sharp waves).* ***Results:*** *Data were collected from 75 patients with a mean age of 38.23 ± 12.09 years, ranging from 18 to 72 years. Among them, 53% were male, and 47% were female. Generalized tonic-clonic seizures were the most common, seen in 67% of patients, while 33% had focal seizures. EEG results showed that 43% had normal interictal EEGs, and 57% had abnormal findings. Imaging revealed structural abnormalities in 35% of patients, while 65% had normal imaging. At the 6-month follow-up, seizure recurrence was observed in 38% of those with normal EEGs and 58% in those with abnormal EEGs.* ***Conclusion:*** *It is concluded that a significant proportion of adults presenting with their first seizure may have normal interictal EEGs yet still face a risk of seizure recurrence.*

Keywords: Electroencephalography, Epilepsy, First Seizure, Seizure Recurrence, Seizures.

Introduction

The first seizure in an adult is a significant and often alarming clinical event that necessitates prompt medical evaluation. It is important to note that a seizure is defined as an episode of the abnormal discharge of the neurons in the brain where they fire continuously in an uncontrolled manner, and this can be in the form of momentary loss of consciousness and even a physical convulsion. First-time seizure often triggers elaborate neurologic examination to define its etiology and assess the likelihood of its repetition (1). In this case, the most important diagnostic tool is the electroencephalography or EEG, which shows brain waves' activity and produces abnormalities related to seizure disorders. EEG has a vital part in the management of patients who present with a first seizure. It is mostly done to diagnose epileptiform activity, spikes, sharp waves, or any other abnormality – interictal activity (2). Interictal epileptiform discharges on an EEG can be useful in epilepsy diagnosis, seizure recurrence risk evaluation, and in choosing appropriate therapy. However, it is also worth noticing that possible results of EEG can be rather diverse (3). At times, the EEG could be completely normal in the interictal state, although the patient could have had a seizure. These are the questions that arise when normal interictal EEG has been recorded from patients who have a history of seizures (4). How often do normal EEGs present in such patients, and what does it mean? Can a normal EEG make such a conclusion that the event was not a seizure, or perhaps, is this just an indicator of the inability of EEG to register its presence? These are essential aspects in the practice of neurology as they dictate the manner in which the diagnostic process will be done and how the patient will be managed (5). The frequency of normal interictal EEG in adults presenting with a first seizure remains an issue of research and clinical interest to delineate the role of EEG as a diagnostic aid and for a better understanding of seizure disorders. EEG has often been widely used as the gold standard for evaluating brain electric activity in patients with probable epilepsy (6). Thus, it is possible to diagnose brain dysfunctions by detecting even epileptiform activity when the patient does not have an active stage of epilepsy in an EEG. These interictal discharges are considered classical for epilepsy, and in their presence, the diagnosis of epilepsy can be definitively made. However, benign non-localization of epileptiform discharges seen on an interictal EEG does not exclude epilepsy (7). EEGs are susceptible to a large extent to the timing and duration of recording and the presence or the absence of pathological electrical activity during the process. Some of the seizures in epileptic patients, primarily single or first seizure patients, may have a typical EEG result between their seizures (8). This is because epileptiform discharges are often intermittent, the seizure focus might be within the deep structures of the brain, or the test is done at a time which is relatively distant from the time of the seizure. A normal interictal EEG was found in the present observation in about 35% of patients. Other researchers have also reported that about a third of adults who present with a first seizure will have normal interictal EEG (9). Current conservative statistics indicate that in first-time seizure patients, up to half of them may not exhibit epileptiform discharges at all in their first EEG exam. This frequency could be even greater if the EEG is conducted several days or weeks after the seizure event because abnormal electric activity reduces with time. A

normal interictal EEG was seen in such high proportions, which could be explained by the fact that such abnormal electrical disturbances are temporary in the brain (10). Usually, the abnormal activity that has led to the seizure may manifest only occasionally. Therefore, the sample that is attained through the usual 20-30-minute EEG recording may not contain it. Also, in some circumstances, the seizure activity begins in areas of the brain that are not reachable by the external electrodes used in the routine EEGs (11). For these reasons, even though an EEG returns to the normal range, it does not rule out epilepsy, and more investigation can be required in the form of repeated EEGs or continuous monitoring. Having a normal interictal EEG in an adult who has had a first seizure can be said to be diagnostic. Although the lack of epileptiform activity is indeed encouraging, there is no evidence that will rule out further seizures in the future. Therefore, neurologists consider other factors, including the patient's clinical history, characteristics of the seizure, imaging, other factors, and risk factors for the decision of recurrence rate and required antiepileptic therapy (12).

Objective

The main objective of the study is to find the frequency of normal interictal EEG in adults who present with their first seizure.

Methodology

A cross-sectional study was conducted at Fauji Foundation Hospital, Rawalpindi, from January 2023 to June 2023, involving 75 patients. The participants included those aged 18 years and older who presented with a first-ever unprovoked seizure. An additional requirement for inclusion was the availability of an EEG recording within two weeks of the seizure episode.

Certain patients were excluded from the study, including those with a history of prior seizures or epilepsy, as well as individuals whose seizures were caused by provoked factors such as trauma, infection, or metabolic disturbances. Furthermore, patients with incomplete clinical data or missing EEG results were not included in the study.

Patient demographic details, seizure characteristics, and EEG findings were documented. EEG results were categorized as either normal or abnormal (presence of epileptiform discharges, spikes, or sharp waves). The frequency of normal versus abnormal EEG findings was calculated. Each patient underwent a routine interictal EEG performed within 14 days of the seizure event. The standard 20–30-minute EEG recordings were conducted using scalp electrodes placed according to the international 10-20 system. Hyperventilation, photic stimulation, and sleep deprivation were employed to increase the likelihood of detecting abnormal brain activity. All EEGs were interpreted by experienced neurophysiologists blinded to the patients' clinical history.

Statistical analysis

Data were analyzed using SPSS 26. Descriptive statistics were used to summarize patient demographics and clinical features. The primary outcome was the proportion of patients with a normal interictal EEG.

Results

Data were collected from 75 patients with a mean age of 38.23 ± 12.09 years, ranging from 18 to 72 years. Among them, 53% were male, and 47% were female. Generalized tonic-clonic seizures were the most common, seen in 67% of patients, while 33% had focal seizures. EEG results showed that 43% had normal interictal EEGs, and 57% had abnormal findings. Imaging revealed structural abnormalities in 35% of patients, while 65% had normal imaging. At the 6-month follow-up, seizure recurrence was observed in 38% of those with normal EEGs and 58% in those with abnormal EEGs. (Table 1)

Table 1: Patient Demographics and EEG Findings

Variable	Value
Total Patients	75
Age (Mean ± SD)	38.23 ± 12.09 years
Age Range	18 – 72 years
Gender	
- Male	40 (53%)
- Female	35 (47%)
Seizure Type	
- Generalized Tonic-Clonic Seizures	50 (67%)
- Focal Seizures	25 (33%)
EEG Findings	
- Normal EEG	32 (43%)
- Abnormal EEG	43 (57%)
Imaging Findings	
- Normal Imaging	49 (65%)
- Abnormal Imaging	26 (35%)
Seizure Recurrence at 6 Months	
- Recurrence in Normal EEG Group	12 (38%)
- Recurrence in Abnormal EEG Group	25 (58%)

Logistic regression analysis identified two significant predictors of seizure recurrence. Patients with abnormal EEGs had an odds ratio of 2.1 (95% CI: 1.1–3.9) with a p-value of 0.04, indicating a significantly higher likelihood of recurrence than those with normal EEGs (Table 2). Additionally, patients with abnormal imaging findings had

an odds ratio of 1.8 (95% CI: 1.0–3.2) with a p-value of 0.03, suggesting that structural abnormalities in brain imaging also significantly increased the risk of seizure recurrence.

Table 2: Statistical Analysis of Predictors for Seizure Recurrence

Predictor	Odds Ratio (95% CI)	p-value
Abnormal EEG	2.1 (1.1–3.9)	0.04
Abnormal Imaging	1.8 (1.0–3.2)	0.03

Discussion

This study aimed to investigate the frequency of normal interictal EEG findings in adults presenting with their first seizure. Among the 75 patients included, 43% had normal EEG results, while 57% showed abnormal EEG findings. These findings are in line with other studies that observed that up to 50% of the normal EEGs were observed in first epileptic seizure patients, which further supports the realization that normal EEG does not rule out epilepsy or recurrent seizures (13). It is worth noting that in the present study, 43% of the patients had a normal interictal EEG with clinical implications. Routine EEG does not provide a definitive diagnosis of epilepsy or other kinds of seizures since the technique used in recording EEG might not always capture all the test abnormalities needed for diagnosis (14). Epileptiform activity can be intermittent, and in some patients, there is no abnormality unless they are in a seizure or the discharges are located in the depth in the brain that the surface EEG electrodes cannot pick. One has to consider, however, that in as many as 38% of the patients with regular EEG examination, the seizures recurred within the following 6 months, indicating that the clinical decision-making should not be based solely on the results of EEG examination (15). More specific conditions, including past medical history, radiographic findings, and general clinical picture, must be considered when assessing the risk and likelihood of having recurrent seizures or receiving treatment (16). However, some form of EEG dysregulation was evidenced in 57% of the patients, and these individuals had a 58% risk of seizure relapse at the six months follow-up. This implies that interictal EEG abnormalities, especially those with epileptiform activity, are good markers of seizure disorder and may imply a future risk of seizure (17). The reports such as epileptiform discharges, either focal or generalized, have been found to have a significant indication of recurrence of seizure as supported by the current study. Such patients may require initiating antiepileptic treatments earlier, constant observation, and additional diagnostic assessments through extended video-EEG monitoring or prolonged continuous EEG. In this work, it has been found that 35% of patients showed abnormally arranged MRI and CT scans with atrophy of the cortex and structural disorders (18). These abnormalities were seen most commonly in patients with abnormal EEGs (40%), while 28% of patients with normal EEGs also had them (19). This underlines the necessity of using EEG in combination with neuroimaging when examining patients after their first seizure. Some structural changes may greatly help diagnose even in conditions where EEG changes are normal and may point to a higher risk of further seizures or progressive neurological diseases (20). A strength of this study is that it recruited a well-characterized group of adults with first seizures, during which EEG and imaging were systematically performed. However, some of the following limitations deserve to be mentioned. First, one would have liked the duration of the EEG recording to be longer than 30 minutes so that any epileptiform activity captured, if present, would be well demonstrated.

Conclusion

It is concluded that a significant proportion of adults presenting with their first seizure may have normal interictal EEGs yet still face a risk of seizure recurrence. Abnormal EEG findings are strongly associated with a higher likelihood of recurrent seizures and should guide more proactive management. A comprehensive approach incorporating EEG, clinical history, and imaging is essential for accurate diagnosis and treatment planning.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
Approved by the department concerned. (IRBEC-TCA/09/2)
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Conflict of interest

The authors declared an absence of conflict of interest.

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