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Original Research Article

CLINICAL RADIOLOGICAL AND ELECTRO-PHYSIOLOGICAL PROFILE OF ADULT-ONSET SEIZURE

Nithin Krishna Raj K[1], Sony Smitha[2], Ranjit Kumar K C[3]

[1]*Junior Resident, Government Medical College Kannur, Campus Rd, Pariyaram, Kerala, India*
[2]*Assistant Professor Department of Neurology, Government Medical College Kannur, Campus Rd, Pariyaram, Kerala, India*
[3]*HOD and Professor Department of General Medicine, Government Medical College Kannur, Campus Rd, Pariyaram, Kerala, India*

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Corresponding Author:
Dr. Nithin Krishna Raj K,
Junior Resident, Government Medical College Kannur, Campus Rd, Pariyaram, Kerala, India.
Email: nithinraj97@gmail.com

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ABSTRACT

Background: About 2% of adults experience a seizure at some point. There won't be another for two thirds of these sufferers. To narrow down the diagnostic procedure to specific etiologies, select the most effective treatment, and provide potentially important prognostic information, the type of seizure that happened must be determined. The aim is to assess the association of clinical, radiological and electrophysiological findings in seizure.

Materials and Methods: We conducted a hospital based cross sectional study in the Dept of Medicine, Government medical college Kannur. Following detailed history and thorough clinical examination, necessary investigations were undertaken in all the patients such as CBC, random blood glucose, renal function tests, liver function tests, serum levels of sodium, potassium, calcium and magnesium, NCCT brain, MRI brain (with contrast if clinically indicated), and EEG Results, CSF study (where clinically indicated) were analysed with appropriate statistical methods.

Results: The study on adult-onset seizures involved 136 participants, predominantly older adults, with 55.1% over 60 years old, 31.6% between 41-60, and 13.2% between 18-40. The gender distribution was nearly equal, with 52.9% females and 47.1% males. Key comorbidities included diabetes mellitus (36.7%), hypertension (35.2%), and cerebrovascular accidents (24.8%). Most participants (75.7%) experienced generalize seizures, while 24.3% had focal seizures. The most common abnormal EEG finding was spike and wave disharges observed in 31.4 %. A strong correlation was found between abnormal imaging and abnormal EEG findings ($P < 0.001$).

Conclusion: The findings emphasize the need for a multidisciplinary approach, incorporating clinical, radiological, and electrophysiological evaluations, to diagnose and manage seizures effectively. Our findings contribute to the growing body of evidence on adult-onset seizures, providing valuable insights for clinical practice and future research.

Keywords: Seizures, Aetiology, EEG, Clinical profile.

INTRODUCTION

A seizure is a paroxysmal event resulting from abnormal, excessive, and hypersynchronous electrical discharges arising from a group of neurons within the central nervous system (CNS). Clinically, seizures manifest as sudden, brief, and episodic disturbances that may affect consciousness, behavior, emotions, motor activity, or sensory perception. These events may be recognized by the patient or bystanders as unusual sensory experiences, involuntary movements, autonomic changes, or altered awareness.[1]

Epilepsy refers to a condition characterized by recurrent, unprovoked seizures, indicating the presence of an underlying chronic neurological disorder. When epilepsy begins after the age of 20, it is most often associated with metabolic or toxic disturbances, or it may arise as a consequence of structural brain pathology. Common etiologies

include prior central nervous system injuries such as traumatic brain injury, stroke, infections, or an earlier isolated seizure episode. Importantly, there may be a significant latent interval—sometimes lasting months or even years—between the initial CNS insult and the eventual development of recurrent seizures.[2,3]

About 2% of adults experience a seizure at some point in their lives. Among them, nearly two-thirds will never have a second seizure. "Epilepsy is defined as the occurrence of two or more unprovoked seizures. Its incidence worldwide ranges from 0.3% to 0.5% in different population groups, and the prevalence is estimated at approximately 5–10 per 1,000 individuals.".[3,4] To narrow the diagnostic evaluation to specific etiologies, select the most appropriate treatment, and provide important prognostic information, it is essential to determine the type of seizure that has occurred. With advances in pharmacotherapy and modern neuroimaging techniques, the diagnosis and management of seizures have become significantly easier and more precise.[4]

The etiology of seizures is best understood as multifactorial, reflecting the interplay between genetically determined seizure thresholds, underlying metabolic disturbances or predisposing illnesses, and acute precipitating factors. Virtually any pathology affecting the brain has the potential to provoke seizures. In elderly individuals, cerebrovascular disease is the most frequently identified cause, whereas in children, prenatal or perinatal insults remain the predominant contributors.

Status epilepticus represents one of the most common and serious neurological emergencies across childhood, adolescence, and adulthood. Its causes are diverse, ranging from complex febrile seizures, degenerative neurological disorders, alcohol-related factors, and acute central nervous system infections such as meningitis or encephalitis, to stroke, or long-standing epilepsy. In rare cases, status epilepticus may even be the initial presentation of epilepsy.[5,6]

Despite the clinical significance of seizures and their varied etiologies, limited research has explored the causes of new-onset seizures in South India, underscoring the need for region-specific data to guide diagnostic and therapeutic strategies.

MATERIALS AND METHODS

We conducted a hospital based cross sectional study in the Department of Medicine, Government medical college Kannur, outpatient and inpatient wards between 2023 –2024. As a part of this research proposal, we intended to study the clinical profile of adult-onset seizures among patients who presented with seizures satisfying the definition by International League against Epilepsy, to casualty/admitted during the study period. To estimate the same we included 130 patients who satisfied the inclusion and exclusion criteria.

Inclusion Criteria

All patients presenting with symptomatic seizures, with age of 18 years and above and have given informed consent

Exclusion Criteria

Patient age <18 years

Patients already on treatment for seizures

Patients first seizure <18 years of age

Alcohol withdrawal seizures

Sample size

Calculated by the formula

$N = Z^2pq/d2$

N= Sample size

Z=1.96 corresponding to 5% level of significance

P = Prevalence (from a previous study showed prevelance of metabolic causes which is one of most common causes of seizure to be 10%).[7]

Q= 1-prevalence

D= allowable error on either sides of P;

With the above formula, sample size required was 130

Sampling: Convenient sampling

Study procedure: This study was conducted in the Department of Medicine of Govt. medical college, Kannur. It is a cross-sectional study of patients with acute onset seizures in adults admitted in the medical wards or attending the outpatient department/casualty. The study was conducted after obtaining the permission of the Institutional Ethics Committee. Written informed consent was obtained from study participant/legally authorized representative before enrolling him/her for the study. Following detailed history and thorough clinical examination, necessary investigations were undertaken in all the patients such as CBC, random blood glucose, renal function tests, liver function tests, serum levels of sodium, potassium, calcium and magnesium, NCCT brain, MRI brain (with contrast if clinically indicated), and EEG results, CSF study (where clinically indicated) were analysed with appropriate statistical methods

Statistical methods: Data was entered in Excel and analyzed using Stata 14.02 and graphs were depicted using Microsoft excel/SPSS. Continuous variables like the measurement parameters were summarized as Mean ± Standard deviation or median with interquartile range based on normality. Categorical variables were summarized as frequency and proportions. Comparison of qualitative variables with the outcome was analyzed by Chi-square test. A p-value < 0.05 was considered as statistically significant. Approval by the institutional research committee and ethics committee was taken. Written and informed consent by the study subject was taken.

RESULTS

Table 1: Age, gender distribution and comorbidities among the study participants (N=136)

Characteristics	Frequency (%)
Age group	
18-40 years	18 (13.2)
41-60 years	43 (31.6)
>60 years	75 (55.1)
Gender	
Male	64 (47.1)
Female	72 (52.9)
Comorbidities	
DM	50 (36.7)
HTN	48 (35.2)
CVA	32 (24.8)
Family history	
Yes	18 (13.2)
No	118 (86.8)
Type of seizures	
Focal	33 (24.3)
Generalized	103 (75.7)
Past history	
Yes	0 (0.0)
No	136 (100.0)
Associated symptoms	
Fever	18 (13.2)
Headache	20 (14.7)
Vomiting	48 (35.3)
Nil	50 (36.7)

In our study of 136 participants, the age distribution was primarily skewed towards older adults, with 55.1% over the age of 60, 31.6% between 41-60 years, and 13.2% between 18-40 years. The gender distribution was nearly balanced, with females making up 52.9% and males 47.1% of the participants. Regarding comorbidities, 36.7% of the participants had diabetes mellitus (DM), 35.2% had hypertension (HTN), and 24.8% had a history of cerebrovascular accidents (CVA). Additionally, a family history of similar conditions was reported by 13.2% of the participants, while 86.8% had no such family history.

The majority of participants experienced generalized seizures (75.7%), with the remaining 24.3% having focal seizures. Interestingly, none of the participants had a past history of seizures. Associated symptoms varied, with vomiting being the most common (35.3%), followed by headache (14.7%) and fever (13.2%). A significant portion, 36.7%, reported no associated symptoms. These findings highlight the prevalence of seizures among older adults and the common comorbidities and symptoms associated with these conditions.

Table 2: EEG findings among the study participants (N=136)

Characteristics	Frequency (%)
EEG	
Normal	66 (48.5)
Abnormal	70 (51.5)
EEG abnormality	
Abnormal background slowing	19 (27.1)
Abnormal spike and wave discharges	22 (31.4)
Abnormal spike discharges	10 (14.3)
Abnormal sharp wave and spike	9 (12.8)
Abnormal background slowing plus spike and wave discharges	4 (5.7)
Abnormal background slowing plus abnormal sharp wave and spike	3 (4.2)
Special remarks	
Focal	24 (36.4)
Generalized	44 (63.6)
IEDs	
Yes	20 (13.2)
No	39 (86.8)

Among the 136 study participants, EEG findings were almost evenly split, with 48.5% showing normal results and 51.5% showing abnormalities. The types of EEG abnormalities varied: abnormal background slowing was present in 27.1% of cases, abnormal spike and wave discharges in 31.4%, abnormal spike discharges in 14.3%, and abnormal sharp wave and spike in 12.8%. A smaller proportion of participants had combined abnormalities, such as abnormal background

slowing plus spike and wave discharges (5.7%), and abnormal background slowing plus abnormal sharp wave and spike (4.2%).

Analysis of abnormal findings in EEG showed focal abnormalities in one third and generalised abnormalities in the rest. Additionally, interictal epileptiform discharges (IEDs) were observed in 13.2% of the participants, while the remaining 86.8% did not exhibit IEDs. These findings suggest a significant presence of various EEG abnormalities among the study population, highlighting the diversity of EEG patterns associated with seizure activity.

Table 3: Imaging findings among the study participants (N=136)

Imaging	
Normal	61 (24.3)
Abnormal	75 (75.7)
Type of Imaging	
CT	58 (42.6)
MRI	47 (34.5)
Type of abnormality	
PRES	4 (5.3)
SAH	1 (1.3)
Acute infarct	7 (9.3)
Age related atrophy	8 (10.6)
Basal meningeal enhancement	2 (2.7)
Calcification of basal ganglia	1 (1.3)
Cortical venous thrombosis	4 (5.3)
Encephalitis	5 (6.7)
Glioma	3 (4.0)
Gliosis/old infarct	15 (20.0)
Granuloma	1 (1.3)
Intracranial bleed	9 (12.0)
Metastases	7 (9.3)
NPH	2 (2.7)
SDH	1 (1.3)
Tuberculoma	5 (6.6)
CSF pattern	
Bacterial meningitis	5 (25.0)
Encephalitis	2 (15.0)
tubercular meningitis	7 (35.0)
Viral encephalitis	5 (25.0)
Metabolic causes of seizures	
Hyponatremia	34 (25.0)
Hypocalcemia	10 (7.3)
Hypomagnesemia	0

Among the 136 study participants, imaging findings revealed that 75.7% had abnormal results, while 24.3% had normal imaging. Computed tomography (CT) was the most common imaging method used, accounting for 42.6% of cases, followed by magnetic resonance imaging (MRI) at 34.5%. The types of abnormalities identified included gliosis or old infarct (20.0%), intracranial bleed (12.0%), age-related atrophy (10.6%), acute infarct and metastases (each 9.3%), encephalitis (6.7%), posterior reversible encephalopathy syndrome (PRES) and cortical venous thrombosis (each 5.3%), glioma (4.0%), basal meningeal enhancement and normal pressure hydrocephalus (NPH) (each 2.7%), subdural hematoma (SDH), calcification of basal ganglia, granuloma, and subarachnoid hemorrhage (SAH) (each 1.3%).

Regarding cerebrospinal fluid (CSF) patterns, tubercular meningitis was observed in 35.0% of the cases, bacterial meningitis and viral encephalitis each in 25.0%, and encephalitis in 15.0%. These findings highlight a significant prevalence of abnormal imaging results among the participants, with a wide range of abnormalities and a notable presence of infectious and inflammatory conditions in the CSF patterns. We noted that hyponatremia resulted in 25% of cases of seizures.

Table 4: Distribution of Biochemical parameters among the study participants (N=136)

CSF pattern	
Sodium	132 (11.3)
Calcium	8.6 (0.8)
Potassium	4.1 (0.5)
Magnesium	1.9 (0.9)
Creatinine	1.3 (0.6)
Total counts	7077.9 (2780.5)
RBS	143.7 (49.7)

The distribution of biochemical parameters among the 136 study participants shows the following mean values (with standard deviations in parentheses): sodium levels averaged 132 mmol/L (11.3), calcium levels 8.6 mg/dL (0.8), potassium levels 4.1 mmol/L (0.5), and magnesium levels 1.9 mg/dL (0.9). The mean creatinine level was 1.3 mg/dL (0.6). Total white blood cell counts averaged 7077.9 cells/µL (2780.5), and random blood sugar (RBS) levels averaged 143.7 mg/dL (49.7).

These biochemical parameters provide insight into the physiological status of the participants, reflecting electrolyte balance, renal function, and blood sugar levels. The standard deviations indicate variability in these measures among the participants, highlighting the diverse biochemical profiles present in the study population.

Table 5: Association between radiology and EEG findings (N=136)

Clinical status	EEG Abnormal Frequency (%)	EEG normal Frequency (%)	P value
Imaging Abnormal	67 (89.3)	8 (10.7)	<0.001
Imaging normal	3 (4.9)	58 (95.1)	

The association between radiology and EEG findings among the 136 study participants shows a significant correlation. Among participants with abnormal imaging results, 89.3% also had abnormal EEG findings, while only 10.7% had normal EEG results. Conversely, of those with normal imaging, only 4.9% had abnormal EEG findings, whereas 95.1% had normal EEG results. The P-value for this association is less than 0.001, indicating a statistically significant relationship between abnormal radiological findings and abnormal EEG results.

This strong association suggests that participants with abnormal imaging are highly likely to also exhibit abnormal EEG patterns, underscoring the importance of utilizing both diagnostic tools for a comprehensive assessment of neurological conditions. The significant P-value reinforces the reliability of this correlation.

DISCUSSION

In our study of 136 participants, the age distribution was primarily skewed towards older adults, with 55.1% over the age of 60, 31.6% between 41-60 years, and 13.2% between 18-40 years. Regarding comorbidities, 36.7% of the participants had diabetes mellitus (DM), 35.2% had hypertension (HTN), and 24.8% had a history of cerebrovascular accidents (CVA). Additionally, a family history of similar conditions was reported by 13.2% of the participants, while 86.8% had no such family history. These findings highlight the importance of family history in incidence of seizures.

The majority of participants experienced generalized seizures (75.7%), with the remaining 24.3% having focal seizures. These findings were noted to be similar to other studies that has also showed that generalised seizures were the commonest cause of seizures.[3,8] Associated symptoms varied, with vomiting being the most common (35.3%), followed by headache (14.7%) and fever (13.2%). A significant portion, 36.7%, reported no associated symptoms. These findings highlight the prevalence of seizures among older adults and the common comorbidities and symptoms associated with these conditions.

Among the 136 study participants, EEG findings were almost evenly split, with 48.5% showing normal results and 51.5% showing abnormalities. The types of EEG abnormalities varied: Abnormal background slowing was present in 27.1% of cases, Abnormal spike and wave discharges in 31.4%, Abnormal spike discharges in 14.3%, and Abnormal sharp wave and spike in 12.8%. A smaller proportion of participants had combined abnormalities, such as Abnormal background slowing plus spike and wave discharges (5.7%), and abnormal background slowing plus abnormal sharp wave and spike (4.2%). Nature of EEG showed around 1/3rd of them was focal and the rest were generalised. These findings highlight the pattern of EEG findings commonly encountered among adults, and is noted to comparable to other studies done across various other study settings.[5,7]

Among the 136 study participants, imaging findings revealed that 75.7% had abnormal results, while 24.3% had normal imaging. Computed tomography (CT) was the most common imaging method used, accounting for 42.6% of cases, followed by magnetic resonance imaging (MRI) at 34.5%. The types of abnormalities identified included gliosis or old infarct (20.0%), intracranial bleed (12.0%), age-related atrophy (10.6%), acute infarct and metastases (each 9.3%), encephalitis (6.7%), posterior reversible encephalopathy syndrome (PRES) and cortical venous thrombosis (each 5.3%), glioma (4.0%), basal meningeal enhancement and normal pressure hydrocephalus (NPH) (each 2.7%), subdural hematoma (SDH), granuloma, and subarachnoid hemorrhage (SAH) (each 1.3%). Another study done by Sivakumaran et al also showed a similar pattern of etiologies across adults with seizures.

Among participants with abnormal imaging results, 89.3% also had abnormal EEG findings, while only 10.7% had normal EEG results. Conversely, of those with normal imaging, only 4.9% had abnormal EEG findings, whereas 95.1% had normal EEG results. The P-value for this association is less than 0.001, indicating a statistically significant relationship between abnormal radiological findings and abnormal EEG results. Hosalli et al in their study in Mysore, south India also showed a similar

finding. This strong association suggests that participants with abnormal imaging are highly likely to also exhibit abnormal EEG patterns, underscoring the importance of utilizing both diagnostic tools for a comprehensive assessment of neurological conditions. The significant P-value reinforces the reliability of this correlation EEG abnormalities in our study, including delta grades and dysrhythmias, indicate disrupted cortical activity and neuronal hyperexcitability. Delta waves are typically associated with diffuse cerebral dysfunction, often seen in encephalopathies. Dysrhythmias, characterized by irregular brain wave patterns, suggest localized or generalized brain pathology. The presence of Interictal epileptiform abnormalities in a subset of participants confirms the epileptogenic potential of their brain conditions.[10]

Biochemical parameters in our study provide insights into the metabolic and physiological status of the participants. Hyponatremia (low sodium levels) and hypocalcemia (low calcium levels) are known to lower the seizure threshold by altering neuronal excitability. Elevated creatinine levels suggest impaired renal function, which can lead to electrolyte imbalances and uremic encephalopathy, contributing to seizures. The variability in biochemical measures highlights the need for individualized management based on comprehensive metabolic evaluations.[9,10]

Limitations:

1. **Cross-Sectional Design**: The cross-sectional nature of the study limits the ability to establish causal relationships. Longitudinal studies are needed to determine the temporal sequence and causality of observed associations.
2. **Single-Center Study**: Conducted at a single center, the study's findings may not be fully generalizable to other settings with different population demographics and healthcare practices.
3. **Lack of Longitudinal Follow-Up**: The study does not include long-term follow-up data, which is crucial for understanding the progression and long-term outcomes of adult-onset seizures.

CONCLUSION

The study on adult-onset seizures involved 136 participants, predominantly older adults, with 55.1% over 60 years old, 31.6% between 41-60, and 13.2% between 18-40. The gender distribution was nearly equal, with 52.9% females and 47.1% males. Key comorbidities included diabetes mellitus (36.7%), hypertension (35.2%), and cerebrovascular accidents (24.8%). Most participants (75.7%) experienced generalized seizures, while 24.3% had focal seizures. The types of EEG abnormalities varied: commonly abnormal spike and wave discharges in 31.4%, while imaging revealed that 75.7% had abnormal results, including gliosis, intracranial bleeds, and encephalitis. The study also examined cerebrospinal fluid (CSF) patterns, noting cases of tubercular meningitis (35%), bacterial meningitis, and viral encephalitis (each 25%), and encephalitis (15%). Biochemical parameters showed mean values for sodium (132 mmol/L), calcium (8.6 mg/dL), potassium (4.1 mmol/L), magnesium (1.9 mg/dL), and creatinine (1.3 mg/dL). A strong correlation was found between abnormal imaging and abnormal EEG findings ($P < 0.001$), emphasizing the importance of using both diagnostic tools. These comprehensive findings highlight the complex interplay of clinical, radiological, and biochemical factors in adult-onset seizures. The findings of our study provide a comprehensive profile of adult-onset seizures, highlighting the significant role of age, comorbidities, and structural brain abnormalities. The high prevalence of generalized seizures, diverse EEG patterns, and imaging abnormalities underscores the complexity of seizure disorders in adults.

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