GMR
The Original

PREVALENCE OF EEG ABNORMALITIES IN CHILDREN PRESENTING WITH FIRST UNPROVOKED SEIZURE

Muhammad Awais Mahmood[1], Abdul Raheem[2], Dr Misbah Arshad[3], Syed Muhammad Sheharyar Zanjani[4], Dr. Sughra Wahid[5], Dr Ahmad Yar[6*], Dr Aamir Sohail[7]

[1]Paediatrics Department, Allied Hospital, Faisalabad, Email:- drowais952@gmail.com
[2]Paediatrics Department, The Children's Hospital, Lahore, Raheem.baloch67 @gmail.com
[3]Post Graduate Resident Department of paediatrics, Avicenna Medical College and Hospital Lahore
mishaarshad08@gmail.com
[4]Medical Officer Paediatric Medicine, Mayo Hospital Lahore, Email: smszanjani89@gmail.com
[5]Hospital/Institute: KRL Hospital Islamabad Designation: Consultant Pediatrician and Head of the Pediatric Department, Email: sughra9@hotmail.com
[6]Postgraduate resident Paediatrics Department, The Children's Hospital Lahore, ahmi57979@gmail.com
[7]Postgraduate resident Paediatrics Department, The Children's Hospital Lahore, dr.aamir7215@gmail.com
*Corresponding Author:Dr Ahmad Yar, ahmi57979@gmail.com

ABSTRACT

Background: EEG is an important diagnostic tool, but the frequency of EEG abnormalities varies among children.
Objective: To determine the prevalence of EEG abnormalities in children presenting with a first unprovoked seizure.
Methods: This cross-sectional descriptive study was conducted in the Paediatrics Department, Allied Hospital, Faisalabad from January 2022 to June 2022, included 105 children presenting with first unprovoked seizure. Demographic data, seizure characteristics, family history, developmental history, neurological examination findings, and EEG results were recorded. EEG findings were classified as normal or abnormal, and abnormal findings were further categorized according to pattern.
Results: The mean age was 6.82 ± 3.91 years. Males were 61 (58.1%) and females were 44 (41.9%). Generalized tonic-clonic seizure was the most common seizure type, observed in 62 (59.0%) children. EEG abnormalities were found in 47 (44.8%) patients, while 58 (55.2%) had normal EEG findings. Focal epileptiform discharges were the most common abnormality, seen in 21 (20.0%) children. Abnormal EEG findings were significantly associated with focal seizure type ($p = 0.041$), family history of epilepsy ($p = 0.039$), developmental delay ($p = 0.024$), and abnormal neurological examination ($p = 0.041$).
Conclusion: EEG abnormalities were common among children presenting with first unprovoked seizure, with focal epileptiform discharges being the most frequent abnormality. EEG is useful for clinical evaluation, risk assessment, and further management planning in pediatric patients after a first unprovoked seizure.

INTRODUCTION

Seizures are one of the most frequent neurological emergencies seen in routine paediatric practice and are a significant reason for children attending hospital, for their parents to worry, and are a frequent indication for neurological assessment [1]. A first unprovoked seizure is a seizure that occurs without an acute precipitating cause like a fever, infection, metabolic disturbance, head trauma, or toxic exposure. Provoked seizures occur secondary to known and reversible causes, whereas unprovoked seizures are associated with concern about underlying epilepsy, structural brain abnormalities, or neurophysiological dysfunction [2]. A first unprovoked seizure in childhood is a significant clinical problem since it necessitates thorough evaluation to ascertain the cause of the seizure, the likelihood of recurrence, and appropriate management [3]. First unprovoked seizure is a common problem in children, and the reported incidence ranges from 23 to 61 per 100,000 children per year and is a frequent reason for pediatric neurology consultation. Risk of further seizure after the first unprovoked seizure is highly dependent upon clinical, EEG, and neuroimaging characteristics [4]. Early identification of the children at a higher risk is critical for prognosis, parental counselling, planning for follow-up, and deciding when to initiate antiepileptic treatment. EEG is one of the most vital tests in the assessment of a child with a first unprovoked seizure [5]. EEG measures brain activity and can identify abnormal activity that might indicate epileptiform discharges, loss of function in an area of the brain, generalized epileptic activity, slowing of the background brain activity, or other neurophysiological changes. It has an important role in elucidating the distinction between epileptic and non-epileptic events, determining seizure type, defining epilepsy syndromes, and estimating the risk of recurrence [6]. Findings on EEG after the first seizure that are abnormal are consistently predictive of a higher risk of subsequent seizures and could be important prognostic factors [7]. The rate of EEG abnormalities that occur after a child's first unprovoked seizure is variable by study (usually between 30% and 60%) and depends upon the patient's age, seizure type, the timing of EEG recording, and study method [8]. The presence of epileptiform abnormalities like spikes, sharp waves, spike and wave discharges, focal epileptic discharges, and generalized epileptic activity is especially important due to their relationship to the subsequent diagnosis of

epilepsy. Non-specific EEG changes like focal slowing or diffuse background changes can indicate cerebral dysfunction but may be less specific [9].
Another clinically relevant factor is the timing of the EEG performance. EEG's in the first 24-48 hours after onset of seizures have shown promise of improved diagnostic yield, especially for epileptiform abnormalities [10]. Sleep-deprived EEG may also help to detect subtle abnormalities. Examples of these benefits include the ability to further analyse the data, which may be difficult in some healthcare settings, especially in resource-limited settings, or the ability to access interpretation expertise, which may not be available in all settings [11]. However, the data may be useful in guiding clinical practice, as access to EEG and expertise in interpretation may vary across healthcare settings, particularly resource-limited settings [12]. The signs and symptoms of a first unprovoked seizure can be especially difficult to interpret in children, where age-related variability in the manifestations may make it difficult to differentiate an epileptic event from a syncope, breath-holding spell, Movement Disorder, Parasomnia, or Psychogenic Event [13]. EEG is thus an objective adjunct in the diagnostic assessment. However, a child with epilepsy may not have an abnormal EEG, and some children with normal nervous systems may have EEG abnormalities that need careful clinical interpretation [14].

Objective
To determine the prevalence of EEG abnormalities in children presenting with a first unprovoked seizure.

METHODOLOGY
This was a cross-sectional descriptive study conducted in the Paediatrics Department, Allied Hospital, Faisalabad from January 2022 to June 2022 A total of 105 children presenting with first unprovoked seizure were included in the study. Non-probability consecutive sampling technique was used. All children with a first episode of unprovoked seizure were included from 1 month to 15 years old. All patients, both male and female, were included. Patients were included if they had informed consent from their parents/guardians and had been evaluated with an EEG following the seizure episode. Children who had febrile seizures, acute symptomatic seizures, known epilepsy, history of seizures, central nervous system infection, head trauma, acute metabolic derangement, cerebral palsy, neurodegenerative disease, or were already taking anti-seizure medication were excluded. Those whose clinical records were incomplete or who had technically substandard EEGs were also excluded.

Data Collection
A structured proforma was used to record demographic and clinical data after obtaining informed consent from parents/guardians. Information provided comprised age, sex, seizure type, duration of seizure, family history of epilepsy, developmental history, neurological examination results and time interval between the seizure episode and the EEG recording. The routine electroencephalography was performed in all patients in the standard electrode configuration of the 10–20 system. All EEG records were reviewed by a consultant paediatric neurologist/neurophysiologist. EEG was considered normal or abnormal. Abnormal EEG results were subcategorized as focal epileptiform discharges, generalized epileptiform discharges, multifocal discharges, background slowing, or other abnormal results. EEG abnormality in children with first unprovoked seizure was the primary outcome variable.

Data Analysis
Data were entered and analyzed using SPSS version 26.0. Quantitative variables such as age and seizure duration were presented as mean ± standard deviation. Categorical variables such as gender, seizure type, family history, and EEG findings were presented as frequencies and percentages. The prevalence of EEG abnormalities was calculated as the proportion of children with abnormal EEG findings among the total study population. A p-value of ≤0.05 was considered statistically significant.

RESULTS
A total of 105 children were included in the study. The mean age was 6.82 ± 3.91 years. Most children were aged 6–10 years, 41 (39.0%), followed by 1–5 years, 34 (32.4%). There was a male predominance, with 61 (58.1%) males and 44 (41.9%) females. Family history of epilepsy was present in 18 (17.1%) children, developmental delay in 12 (11.4%), and abnormal neurological examination in 9 (8.6%).

Table 1. Baseline demographic and clinical characteristics of children (N = 105)

Variable	n (%) / Mean ± SD
Age, years	6.82 ± 3.91
1 month–1 year	8 (7.6)
1–5 years	34 (32.4)
6–10 years	41 (39.0)
11–15 years	22 (21.0)
Male	61 (58.1)
Female	44 (41.9)
Family history of epilepsy	18 (17.1)
Developmental delay	12 (11.4)
Abnormal neurological examination	9 (8.6)

Generalized tonic-clonic seizure was the most common seizure type, observed in 62 (59.0%) children, followed by focal seizure in 29 (27.6%) and focal to bilateral tonic-clonic seizure in 14 (13.3%). Most seizures lasted less than 5 minutes, 73 (69.5%), while 26 (24.8%) lasted 5–15 minutes and 6 (5.7%) lasted more than 15 minutes. Postictal drowsiness was reported in 68 (64.8%) children, urinary incontinence in 19 (18.1%), and tongue bite in 14 (13.3%). EEG was normal in 58 (55.2%) children, while abnormal EEG findings were present in 47 (44.8%). Focal epileptiform discharges were the most frequent abnormality, seen in 21 (20.0%) children, followed by generalized epileptiform discharges in 13 (12.4%), background slowing in 6 (5.7%), multifocal epileptiform discharges in 5 (4.8%), and nonspecific abnormalities in 2 (1.9%).

Table 2. Clinical seizure characteristics among study patients

Variable	n (%)
Generalized tonic-clonic seizure	62 (59.0)
Focal seizure	29 (27.6)
Focal to bilateral tonic-clonic seizure	14 (13.3)
Seizure duration <5 minutes	73 (69.5)
Seizure duration 5–15 minutes	26 (24.8)
Seizure duration >15 minutes	6 (5.7)
Postictal drowsiness	68 (64.8)
Tongue bite	14 (13.3)
Urinary incontinence	19 (18.1)
EEG finding	
Normal EEG	58 (55.2)
Abnormal EEG	47 (44.8)
Focal epileptiform discharges	21 (20.0)
Generalized epileptiform discharges	13 (12.4)
Multifocal epileptiform discharges	5 (4.8)
Background slowing	6 (5.7)
Nonspecific abnormality	2 (1.9)

Children with abnormal EEG had a slightly higher mean age than those with normal EEG (7.33 ± 4.09 vs 6.41 ± 3.72 years), but this difference was not statistically significant (p = 0.231). Gender was also not significantly associated with EEG abnormality (p = 0.605). However, abnormal EEG findings were significantly more common in children with a family history of epilepsy (25.5% vs 10.3%; p = 0.039), developmental delay (19.1% vs 5.2%; p = 0.024), and abnormal neurological examination (14.9% vs 3.4%; p = 0.041).

Table 3. Association of EEG abnormality with clinical variables

Variable	Normal EEG (n = 58)	Abnormal EEG (n = 47)	p-value
Age, years	6.41 ± 3.72	7.33 ± 4.09	0.231
Male	35 (60.3)	26 (55.3)	0.605
Female	23 (39.7)	21 (44.7)	
Family history of epilepsy	6 (10.3)	12 (25.5)	0.039
Developmental delay	3 (5.2)	9 (19.1)	0.024
Abnormal neurological examination	2 (3.4)	7 (14.9)	0.041

EEG abnormalities also varied significantly by seizure type (p = 0.041). Abnormal EEG was most frequent among children with focal seizures, 17 (58.6%), followed by focal to bilateral tonic-clonic seizures, 7 (50.0%), and generalized tonic-clonic seizures, 23 (37.1%).

Table 4. EEG abnormality according to seizure type

Seizure type	Normal EEG	Abnormal EEG	p-value
Generalized tonic-clonic seizure	39 (62.9)	23 (37.1)	0.041
Focal seizure	12 (41.4)	17 (58.6)	
Focal to bilateral tonic-clonic seizure	7 (50.0)	7 (50.0)	

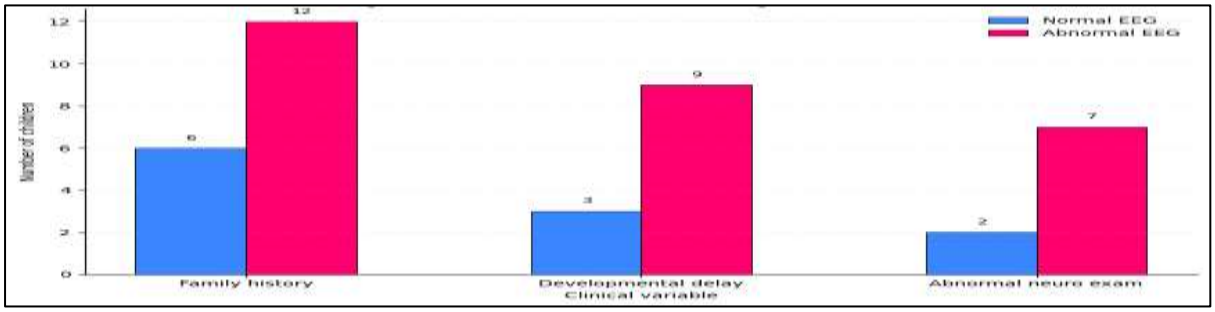

Figure 1: This figure demonstrates the association between selected clinical variables and EEG findings in children presenting with a first unprovoked seizure.

DISCUSSION

We evaluated EEG abnormalities in 105 children with an unprovoked first seizure. Forty-seven children (44.8%) had EEG abnormalities and 58 children (55.2%) had normal EEG. It confirms the importance of EEG as a valuable first seizure diagnostic tool, as almost 50% of children with their first unprovoked seizure already have abnormal electrical activity in their brain. The most common EEG abnormality was focal epileptiform discharges in 21 (20.0%) children followed by generalized epileptiform discharges in 13 (12.4%). This discovery indicates that focal epileptic activity occurs relatively frequently in children with first unprovoked seizure. Clinically it is relevant as focal EEG changes can signal focal irritability in the cortex and can direct further evaluation, which may be neuroimages if applicable [15].

The seizures most seen in this study were generalized tonic-clonic seizures (62, 59.0%) and focal seizures (29, 27.6%). The children with focal seizures were more likely to have abnormalities noted on their EEG (17/58.6% vs 23/37.1% in children with GTC seizures). This association was statistically significant ($p = 0.041$) and suggested that focal seizure semiology is more strongly related to abnormal EEG findings. EEG abnormalities were strongly related to a family history of epilepsy. Of those children with abnormal EEG, 12 (25.5%) had a positive family history in comparison with 6 (10.3%) children with normal EEG ($p = 0.039$) [16]. This corroborates the view that genetic susceptibility may play a role in the epileptiform activity of children with an unprovoked seizure. This should be taken into account when evaluating and counselling the patient with a positive family history. Abnormal EEG was also significantly associated with DD, 9 children with abnormal EEG had DD compared with 3 children with normal EEG ($p = 0.024$) [17]. Abnormal neurological examination was also more common in the abnormal EEG group (7 (14.9%) children) than in the normal EEG group (2 (3.4%) children) ($p = 0.041$). These results indicate that children with underlying neurodevelopmental/neurological abnormalities are more likely to have abnormal EEG patterns following a first unprovoked seizure [18]. The results of this investigation highlight the importance of considering EEG in children with their first unprovoked seizure, especially if they have focal seizures, developmental delay, abnormal neurologic examination, or a family history of epilepsy [19]. While a normal EEG does not rule out epilepsy, abnormal EEG results may help determine the likelihood of seizures returning, the type of seizures, how to treat them, and whether additional testing is necessary [20].

Limitations

There are some limitations of this study. The results are from a single-center, cross-sectional study with a relatively small sample of 105 children and may not be generalizable to a larger population of children. Routine studies alone were used to obtain EEGs, so that a prolonged or video EEG may have resulted in the detection of more intermittent epileptiform abnormalities. The timing of the EEG following the onset of seizures was not uniform for every patient and may have affected the diagnostic yield. This study lacked assessment of prognostic significance due to the lack of neuroimaging correlation and long-term follow-up for seizure recurrence. Furthermore, as an observational study, there is limited ability to determine cause-and-effect relationships between clinical factors and EEG abnormalities.

CONCLUSION

EEG abnormalities were observed in a substantial proportion of children presenting with first unprovoked seizure, with abnormal findings present in 44.8% of cases. Focal epileptiform discharges were the most common abnormality. Abnormal EEG findings were significantly associated with focal seizure type, positive family history of epilepsy, developmental delay, and abnormal neurological examination.

REFERENCES

1. Masood, R., Malik, M., Rana, M. T., Habib, S., Nawaz, A., & Habib, T. (2025). Clinical Outcomes and Frequency of Electroencephalographic Abnormalities in Patients with First Unprovoked Seizure in a Tertiary Care Hospital: A Cross-Sectional Study: Electroencephalographic Findings in Seizure. *Pakistan Journal of Health Sciences*, *6*(6), 145–149. https://doi.org/10.54393/pjhs.v6i6.2363
2. Tarhani F, Nezami A, Heidari G, Dalvand N. Factors associated with febrile seizures among children. Ann Med Surg (Lond). 2022 Feb 11;75:103360. doi: 10.1016/j.amsu.2022.103360. PMID: 35198190; PMCID: PMC8850670.
3. Nazir N, Sabri AA, Ahmad N, Akram MN, Hussain HA, Rasool AG. Epidemiological study of epilepsy in Faisalabad. The Professional Medical Journal. 2020 Dec; 27(12): 2608-12. doi: 10.29309/TPMJ/2020.27.12.4685. DOI: https://doi.org/10.29309/TPMJ/2020.27.12.4685
4. Potnis VV, Albhar KG, Nanaware PA, Pote VS. A review on epilepsy and its management. Journal of Drug Delivery and Therapeutics. 2020 May; 10(3): 273-9. doi: 10.22270/jddt.v10i3.4090.
5. DOI: https://doi.org/10.22270/jddt.v10i3.4090
6. Debicki DB. Electroencephalography after a single unprovoked seizure. Seizure. 2017 Jul; 49: 69-73. doi: 10.1016/j.seizure.2017.03.001. DOI: https://doi.org/10.1016/j.seizure.2017.03.001
7. Huff JS, Morris DL, Kothari RU, Gibbs MA, Emergency Medicine Seizure Study Group. Emergency department management of patients with seizures: a multicenter study. Academic Emergency Medicine. 2001 Jun; 8(6): 622-8. doi: 10.1111/j.1553-2712.2001.tb00175.x.
8. DOI: https://doi.org/10.1111/j.1553-2712.2001.tb00175.x
9. Iván Alfredo De Ávila Consuegra, Abel Enrique Manjarres Guevara, Jennifer Patricia Vargas Gomez, Isaias Alberto Siado Palencia, Hector Alexander Rodriguez Rojas. Diagnostic and therapeutic approach to patients with

first seizure episode. World Journal of Advanced Research and Reviews. 2024 Apr; 22(1): 1530-8. doi: 10.30574/wjarr.2024.22.1.1210. DOI: https://doi.org/10.30574/wjarr.2024.22.1.1210
10. Jiménez-Villegas MJ, Lozano-García L, Carrizosa-Moog J. Update on first unprovoked seizure in children and adults: A narrative review. Seizure. 2021 Aug; 90: 28-33. doi: 10.1016/j.seizure.2021.03.027. DOI: https://doi.org/10.1016/j.seizure.2021.03.027
11. Leibetseder A, Eisermann M, LaFrance Jr WC, Nobili L, von Oertzen TJ. How to distinguish seizures from non-epileptic manifestations. Epileptic Disorders. 2020 Dec; 22(6): 716-38. doi: 10.1684/epd.2020.1234. DOI: https://doi.org/10.1684/epd.2020.1234
12. Mohammadpoory Z, Nasrolahzadeh M, Amiri SA. Classification of healthy and epileptic seizure EEG signals based on different visibility graph algorithms and EEG time series. Multimedia Tools and Applications. 2024 Jan; 83(1): 2703-24. doi: 10.1007/s11042-023-15681-7. DOI: https://doi.org/10.1007/s11042-023-15681-7
13. Smith PE. Initial management of seizure in adults. New England Journal of Medicine. 2021 Jul; 385(3): 251-63. doi: 10.1056/NEJMcp2024526. DOI: https://doi.org/10.1056/NEJMcp2024526
14. Catarina Franco A, Parreira S, Bentes C, Pimentel J. Management of a first unprovoked epileptic seizure in adolescence and adulthood. Epileptic Disorders. 2021 Aug; 23(4): 537-51. doi: 10.1684/epd.2021.1296. DOI: https://doi.org/10.1684/epd.2021.1296
15. Hernandez-Ronquillo L, Thorpe L, Feng C, Hunter G, Dash D, Hussein T et al. Diagnostic accuracy of ambulatory EEG vs routine EEG in patients with first single unprovoked seizure. Neurology: Clinical Practice. 2023 May; 13(3): e200160. doi: 10.1212/CPJ.0000000000200160.
DOI: https://doi.org/10.1212/CPJ.0000000000200160
16. Hsiao CL, Chen PY, Chen IA, Lin SK. The Role of Routine Electroencephalography in the Diagnosis of Seizures in Medical Intensive Care Units. Diagnostics. 2024 May; 14(11): 1111. doi: 10.3390/diagnostics14111111. DOI: https://doi.org/10.3390/diagnostics14111111
17. Carpio A, Salgado C, DiCapua D, Fleury A, Suastegui R, Giagante B et al. Causes and prognosis of adults experiencing a first seizure in adulthood: A pilot cohort study conducted in five countries in Latin America. Epilepsia Open. 2024 Apr; 9(2): 776-84. doi: 10.1002/epi4.12900. DOI: https://doi.org/10.1002/epi4.12900
18. Tanaka LA and Yamamoto LG. First Time Non-Provoked Seizure Presentation to the ED Decision Analysis. SVOA Paediatrics [Internet]. 2024 Aug; 3(4): 122-31. Available from: https://sciencevolks.com/paediatrics/pdf/SVOA-PD-03-077.pdf. doi: 10.58624/SVOAPD.2024.03.077.
DOI: https://doi.org/10.58624/SVOAPD.2024.03.077
19. Adji AS, Angel SCS, Adiwinoto RP, Suwito BE, Puspitasari A. Simple febrile seizure et causa bronchopneumonia with complex congenital heart disease. Glob Cardiol Sci Pract. 2024 Aug 1;2024(4):e202432. doi: 10.21542/gcsp.2024.32. PMID: 39351479; PMCID: PMC11439419.
20. Adebiyi EO, Eletta RY, Ogedengbe W, Kolade-Ernest OJ, Hunter J. A descriptive analysis of febrile seizure hospitalizations in children with congenital heart disease in the United States. Cureus. 2023 doi: 10.7759/cureus.44128.
21. Murni et al. IK. Feasibility of screening for critical congenital heart disease using pulse oximetry in Indonesia. BMC Pediatr. 2022;22(1) doi: 10.1186/s12887-022-03404-0.
22. Sawires R, Buttery J, Fahey M. A review of febrile seizures: Recent advances in understanding of febrile seizure pathophysiology and commonly implicated viral triggers. Frontiers Media SA. 2022 doi: 10.3389/fped.2021.801321