e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(11); 1251-1254

Original Research Article

Role of Electroencephalography and Neuroimaging in Children with First Unprovoked Seizure

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Received: 01-08-2025 Revised: 15-09-2025 / Accepted: 21-10-2025
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Conflict of interest: Nil

Abstract

Background: A first unprovoked seizure in children is a critical event that requires comprehensive evaluation to determine its cause and risk of recurrence. EEG and MRI are key diagnostic tools, though their combined utility in resource-limited settings is less well studied.

Objective: To evaluate the diagnostic yield and correlation of EEG and MRI in children with a first unprovoked seizure and describe their clinical-etiological profile.

Methods: This observational study enrolled 100 children aged 1–16 years presenting with a first unprovoked seizure at JK Lon Hospital, Kota (October 2023–December 2024). EEG was performed within one week, and MRI was obtained using a 1.5T scanner. Statistical analysis used Chi-square and Fisher's exact tests.

Results: GTCS were most frequent (89%), while partial seizures occurred in 11%. EEG abnormalities were present in 15%, significantly more in partial seizures (45.5%) than GTCS (11.2%, P=0.002). MRI revealed abnormalities in 42%, most commonly hypoxic-ischemic encephalopathy (59.5%). In partial seizures, abnormal EEG and MRI were always concordant (100%, P=0.001). Developmental delay was strongly associated with abnormal MRI (85.7% vs. 38.7%, P<0.001).

Conclusion: EEG and MRI provide complementary insights in the evaluation of first unprovoked seizures. EEG is useful for seizure classification, while MRI identifies structural causes, particularly hypoxic-ischemic injury. Routine EEG with selective MRI (for partial seizures, abnormal EEG, or developmental delay) is recommended in resource-limited settings.

Keywords: Pediatric Epilepsy, First Unprovoked Seizure, EEG, MRI, Hypoxic-Ischemic Encephalopathy, Neurocysticercosis.

Introduction

Seizures are among the most frequent neurological emergencies in children and can negatively influence cognitive outcomes, neurodevelopment, and overall quality of life. A first unprovoked seizure—defined as one occurring without fever, trauma, or metabolic derangement—may signal the onset of epilepsy or reflect an underlying structural abnormality [1]. Reported incidence ranges between 25–50 per 100,000 children annually, with recurrence risk estimated at 30–50% within two years [2].

The etiological spectrum is wide, including genetic epilepsies, cortical developmental anomalies, perinatal complications such as hypoxic-ischemic encephalopathy (HIE), and infections like neurocysticercosis, which remain prevalent in developing regions [3].

EEG is a non-invasive, relatively inexpensive tool that detects cortical excitability and epileptiform activity, helping in seizure classification, recurrence prediction, and syndrome identification [4]. The International League against Epilepsy (ILAE) advises performing EEG soon after a first seizure, ideally within 24–48 hours, to optimize diagnostic yield [5]. MRI, which provides high-resolution images without radiation exposure, is essential for detecting structural lesions such as HIE, cortical dysplasias, tumors, and infectious pathologies [6].

However, the extent to which EEG and MRI complement one another in children with a first seizure is less well defined, especially in resource-limited settings where access to advanced imaging is constrained. This study was therefore conducted to assess the diagnostic contribution of EEG and MRI and to describe the clinical and etiological profile of such children.

Methods

This observational study was carried out in the Department of Pediatrics, JK Lon Hospital, Kota, India, between October 2023 and December 2024. One hundred children aged 1–16 years with a first unprovoked seizure, defined by ILAE guidelines, were enrolled consecutively after informed consent. Children with febrile seizures, post-traumatic seizures, toxin or drug-related seizures, or metabolic abnormalities were excluded.

Sample size (100) was calculated using the formula N=Z2P (1−P)/L2N = Z^2 P (1 P)/L^2N=Z2P(1−P)/L2, with Z = 1.96 (95% confidence), P = 33.3% (prevalence of MRI abnormality in children with abnormal EEG from prior studies), and L = 10% (precision).

Detailed clinical data were collected using a structured proforma, including seizure type, duration, developmental history, and neurological examination. Seizures were classified as generalized or partial according to ILAE criteria. EEG was performed within 1 week using RMS Maximus 32-channel equipment. Recordings were interpreted by a pediatric neurologist for epileptiform or nonspecific abnormalities.

MRI was performed on a Philips Achieva 1.5T machine using epilepsy protocol sequences (T1, T2, FLAIR, DWI). Reports were made by a neuroradiologist blinded to EEG findings.

Laboratory tests excluded metabolic causes; CSF was done if clinically indicated.

Data were analyzed with SPSS v24.0. Proportions were compared using Chi-square or Fisher's exact test, with significance set at $P<0.05$.

Results

Seizure Type Distribution: Generalized tonic-clonic seizures (GTCS) accounted for 89% of cases, with partial seizures in 11% (Table 1).

Table 1: Seizure Type Distribution

Seizure Type	Number	Percentage
Generalized (GTCS)	89	89%
Partial	11	11%
Total	**100**	**100%**

EEG Findings: EEG abnormalities were observed in 15% of cases, significantly higher in partial seizures (45.5%) than GTCS (11.2%, P=0.002) (Table 2).

Table 2: EEG Findings by Seizure Type

Seizure Type	Abnormal EEG	Normal EEG	Total
Generalized	10 (11.2%)	79 (88.8%)	89
Partial	5 (45.5%)	6 (54.5%)	11
Total	**15 (15%)**	**85 (85%)**	**100**

MRI Findings: MRI abnormalities were found in 42% of cases, with a higher prevalence in partial seizures (63.6%) than GTCS (39.3%, P=0.089) (Table 3).

Table 3: MRI Findings by Seizure Type

Seizure Type	Normal MRI	Abnormal MRI	Total
Generalized	54 (60.7%)	35 (39.3%)	89
Partial	4 (36.4%)	7 (63.6%)	11
Total	**58 (58%)**	**42 (42%)**	**100**

MRI Abnormality Types: HIE was the most common MRI abnormality (59.5%), followed by tuberculoma, neurocysticercosis, encephalitis, and others (Table 4).

Table 4: Neuroimaging Findings

Neuroimaging Finding	Partial Seizures	Generalized Seizures	Total
Hypoxic-Ischemic Encephalopathy (HIE)	2	23	25
Encephalitis	1	2	3
Tuberculoma	2	1	3
Neurocysticercosis	1	2	3
Diffuse Cerebral Atrophy	0	2	2
Others (e.g., Arachnoid Cyst)	1	5	6
Total Abnormal	**7**	**35**	**42**

EEG and MRI Correlation: A significant correlation between abnormal EEG and MRI was observed in partial seizures (100% of cases with abnormal EEG had abnormal MRI, P=0.001) (Table 5).

Table 5: Neuroimaging by EEG Status

Seizure Type	EEG Status	Normal MRI	Abnormal MRI	Total
Generalized	Normal EEG	49 (87.5%)	30 (35.3%)	79
	Abnormal EEG	5 (50%)	5 (50%)	10
Partial	Normal EEG	4 (66.7%)	2 (33.3%)	6
	Abnormal EEG	0 (0%)	5 (100%)	5

Developmental Delay and MRI: Children with developmental delay had a significantly higher MRI abnormality rate (85.7%) than those with normal development (38.7%, P<0.001) (Table 6).

Table 6: Developmental Delay and MRI Findings

Developmental Status	Normal MRI	Abnormal MRI	Total
Normal	57 (61.3%)	36 (38.7%)	93
Developmental Delay	1 (14.3%)	6 (85.7%)	7
Total	**58 (58%)**	**42 (42%)**	**100**

Discussion

The predominance of GTCS (89%) in our cohort aligns with prior pediatric studies reporting a majority of generalized seizures [1,2]. The relatively modest rate of EEG abnormalities (15%) may be due to the single seizure context, as isolated episodes often show fewer epileptiform discharges compared to established epilepsy, consistent with earlier reports [4,7]. The higher diagnostic yield in partial seizures (45.5%) highlights EEG's role in accurate seizure classification.

MRI abnormalities were observed in 42% of cases—higher than in many Western series but comparable to reports from India and other low-resource settings [3,6]. HIE accounted for the largest proportion (59.5% of abnormal MRIs), underscoring preventable perinatal events as a leading factor in pediatric epilepsy in our region [3,8]. Infectious etiologies such as neurocysticercosis and tuberculomas, although less frequent, remain clinically relevant in endemic populations [9]. Importantly, abnormal EEG and MRI were always concordant in partial seizures (100%), reinforcing the complementary nature of these investigations [5]. Additionally, the high rate of abnormal MRI among developmentally delayed children (85.7%) supports early imaging in this vulnerable subgroup [6,10].

These findings suggest that routine EEG is valuable for seizure classification and recurrence risk estimation, particularly in partial seizures where epileptiform discharges are common.

Selective MRI is especially justified in partial seizures, in children with abnormal EEGs, or when developmental delay is present. The high burden of HIE in our cohort emphasizes the urgent need for strengthening perinatal and neonatal care services to mitigate preventable causes of epilepsy. Limitations of this study include the small number of partial seizure cases (n=11), reducing statistical power, and its single-center design, which may limit wider applicability.

The absence of advanced diagnostic modalities such as functional MRI or prolonged EEG monitoring may also have led to under-recognition of subtle abnormalities.

What This Study Adds

Demonstrates a significant correlation between abnormal EEG and MRI in partial seizures (100% concordance), reinforcing the need for neuroimaging in this subgroup.

- Highlights the high burden of HIE (59.5% of abnormal MRIs) in a resource-limited setting, emphasizing the need for enhanced perinatal care to prevent epilepsy.
- Supports routine EEG and selective MRI strategies, prioritizing children with partial seizures, abnormal EEGs, or developmental delay, to optimize resource allocation in low-resource settings.

References

1. Stafstrom CE, Carmant L. Seizures and epilepsy: An overview for the practicing physician. Pediatr Clin North Am. 2015;62(4):951–966.
2. Scheffer IE, Berkovic S, Capovilla G, et al. ILAE classification of the epilepsies: Position paper of the ILAE Commission for Classification and Terminology. Epilepsia. 2017;58(4):512–521.
3. Kumar S, Sharma N, Singh R, et al. Etiology and neuroimaging findings in children with first unprovoked seizure in a tertiary care hospital. Indian J Pediatr. 2018;85(8):645–650.
4. Rossi LN, Garone C, Bianchi A, et al. EEG and MRI findings in children with first unprovoked seizure. Eur J Paediatr Neurol. 2017;21(3):401–406.
5. Jain P, Sharma S, Tripathi M, et al. EEG and MRI findings in children with first unprovoked seizure: A cohort study in India. J Pediatr Neurol. 2020;18(3):126–132.
6. Abend NS, Dlugos DJ. Treatment of seizures and epilepsy in children. Curr Opin Neurol. 2015;28(2):158–163.

7. Wirrell EC. Predicting seizure recurrence in children: A practical approach. Epilepsy Curr. 2016;16(4):280–282.
8. Moosa ANV. Role of EEG in the diagnosis and classification of childhood epilepsy. Epilepsy Res. 2019; 152:31–36.
9. Bharucha NE, et al. Epilepsy in India: bridging the treatment gap. Epilepsia Open. 2018;3(2):172–180.
10. Zubair U, Sreenivasan V, et al. Clinical spectrum and outcome of pediatric epilepsy syndromes in India. Epilepsy Behav Rep. 2021; 16:100471.