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# ROLE OF EEG AND MRI BRAIN IN THE DIAGNOSIS OF UNPROVOKED SEIZURES IN CHILDREN IN A TERTIARY CARE CENTRE

**Theetla Priyadarshini, Kokku Pradheep Kumar, Sravanthi CH, Chaitanya Jyothi Ravula**

*Seizure disorders are a major public health problem in a developing country like India. Epilepsy characterized by recurrent unprovoked seizures is a common heterogeneous neurological problem in children that exerts a significant medical, physical, psychological, social, and economic challenge. This study evaluated the importance of the available diagnostic modalities, EEG and MRI, which could influence the management, prognosis and recurrence of unprovoked seizures.*

***The aims and objectives:*** *To determine the role of Electroencephalography and MRI BRAIN in evaluating children presenting with unprovoked seizures.*

***Methodology:*** *The present study was a hospital-based observational study carried out during the period of January 2021 to December 2021 of 70 children who presented with unprovoked seizures to the Department of Paediatrics, Niloufer Hospital, Hyderabad.*

***Results:*** *Among the 70 children who were investigated, EEG showed abnormal findings in 45 (64.29 %) cases. Out of these, the majority of 32 (45.71 %) cases had generalized seizures, and 13 (18.57 %) cases were focal seizures. MRI showed abnormal findings in 30 (42.86 %) cases, and an equal percentage of cases, 15 (21.43 %) of generalized seizures and focal seizures, were having abnormal MRI findings out of the 30 cases with abnormal MRI findings. But, when studied among the individual seizure subtype, a major proportion of focal seizure (68.18 %) cases out of 22 focal seizures had abnormal MRI findings when compared to 31.25 % of generalized seizure cases out of 48 generalized seizure cases with abnormal MRI findings.*

***Conclusion:*** *MRI can identify most of the structural brain abnormalities, and EEG is useful to clearly identify the region of the epileptogenic foci. Therefore, EEG and MRI were useful in identifying a possible cause for unprovoked seizures in children*

***Keywords:*** *unprovoked seizures, seizure disorder, seizures, EEG, MRI*

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## 1. Introduction

Seizures are quite common worldwide, especially among children, and have a wide range of causes. They are the most common and frightening pediatric neurological disorder, with 4–10 % of children experiencing at least one seizure within the first 16 years of life [1]. Epilepsy characterized by recurrent unprovoked seizures is a common heterogeneous neurological problem in children that exerts a significant medical, physical, psychological, social, and economic challenge. Fifty million people have epilepsies globally; more than half of them are children, with a greater number of cases from developing countries [2].

Unprovoked seizures are defined as convulsive episodes occurring in the absence of a potentially responsible clinical condition or beyond the interval estimated for the occurrence of acute symptomatic seizures. They may become cryptogenic, idiopathic, remote symptomatic or progressive symptomatic after an appropriate workup [2].

Approximately 30 % of patients with first unprovoked seizures have later epilepsy [3]. The cumulative risk of recurrence increases over time; most recurrences occur within 1 to 2 years. The recurrence rate is higher in individuals with unprovoked seizures, either remote symptomatic or idiopathic, than in individuals with acute symptomatic seizures. Therefore, proper workup for diagnosis is very important, especially in unprovoked seizures, to reduce the burden of the disease through early intervention. EEG and neuroimaging are the two important diagnostic tools for the diagnosis, classification, plan of treatment, and to assess the risk of recurrence [4]. EEG is recommended as a part of the neurodiagnostic evaluation of a child with an unprovoked seizure. However, the role of neuroimaging in children presenting with new onset unprovoked seizure is not well defined. This study was therefore conducted to evaluate the importance of the available diagnostic modalities, EEG and MRI, which could influence the management, prognosis and recurrence of unprovoked seizures.

The **aims** and objectives of the study were to determine the proportion of unprovoked seizures that can be diagnosed with EEG and MRI BRAIN.

**2. Materials and methods**

The present study was a hospital-based observational study conducted from January 2021 to December 2021 in the Department of Pediatrics, Osmania Medical College, Niloufer Hospital. 70 children (5–10 years) who were admitted to Niloufer Hospital with unprovoked seizures were included in the study after excluding the children who presented with Neonatal seizures, Febrile seizures, Seizures due to metabolic disorders, Seizures with acute aetiologies such as toxins, infections and trauma.

**Bioethics.** Osmania Medical College: number 16101006021D date: 21/6/2015

Prestructured proforma was used to collect data regarding history related to seizures such as onset, type, duration of seizure, number of seizure episodes, aura, precipitating factors, postictal symptoms, other associated symptoms, history relevant prenatal and postnatal events, family history of seizures. The type of seizure was determined as per the *Operational Classification of Seizure Types by the International League Against Epilepsy, 2017.[5]*

A detailed clinical examination of each child was done. Special attention was given to the complete clinical evaluation to rule out acute seizures; the central nervous system was examined in detail for associated neurological deficits. For all children admitted with seizures, investigations such as complete blood counts, Erythrocyte sedimentation rate (ESR), C-Reactive protein (CRP), Blood Glucose, Liver function tests, serum electrolytes, serum calcium, serum magnesium was done to rule out acute seizures due to infections and metabolic disturbances. Whenever acute intracranial infection was suspected, CSF analysis was done. Mantoux test and sputum / gastric aspirate for AFB were done as and when required. These investigations were done to diagnose an acute infectious or metabolic cause for seizures, which, if found, were excluded from the study. EEG and MRI were done for all the cases without an acute cause, which were included in the study. The non-cooperative children were sedated for this purpose.

Analysis was based on simple percentages, proportions, charts and tables. Data analysis was performed using a statistical calculator of the CDC Epi info app and SPSS Version 19. Data is represented in the form of Pie diagrams and bar charts.

The present descriptive statistics summarize data using indexes such as mean and standard deviation and draw conclusions from data using statistical tests such as student's t-test.

**3. Results**

Among the studied cases, 48 (68.57 %±6.8) cases presented with generalized seizures and 22 (31.43 %±3.1) cases presented with focal seizures Majority of cases, 23 (32.85 %±3.2) cases were between the age group of 5–10 years. Male to female ratio was 1.33:1. In all the age groups, the proportion of cases presented with generalized seizures is higher than those presented with focal seizures.

EEG showed abnormal findings in 45 (64.29 %) cases, out of which the proportion of generalized seizure cases, 32 (45.71 %), is more than that of focal seizures 13 (18.57 %). (Table 1). When compared among individual seizure types, 66.67 % of generalized unprovoked seizures and 59.09 % of focal unprovoked seizures showed abnormal EEG findings (Table 2).

Generalized epileptogenic foci are seen in 18 % of the total cases, followed by other abnormal EEG findings (Table 3).

Table 1

Distribution of cases as per EEG report in focal and generalized seizure groups (n=70)

| Type of seizure | Abnormal EEG n (P±Sp, %) | Normal EEG n (P±Sp, %) | Total n (P±Sp, %) |
|---|---|---|---|
| Generalized | 32 (45.72±4.5) | 16 (22.86±2.2) | 48 (68.57±6.8) |
| Focal | 13 (18.57±1.8) | 9 (12.85±1.2) | 22 (31.43±3.1) |
| **Total** | 45 (64.29±6.4) | 25 (35.71±3.5) | 70 (100–10 %) |

Table 2

Distribution of unprovoked individual seizure types based on EEG(n=48)

| EEG | Generalized seizures (n=48) | (P±Sp, %) | Focal seizures(n=22) | (P±Sp, %) |
|---|---|---|---|---|
| Normal | 16 | 33.33±3.3 | 9 | 40.91±4.0 |
| Abnormal | 32 | 66.67±6.6 | 13 | 59.09±5.9 |

Table 3

Distribution of cases based on the type of EEG findings(n=70)

| Epileptogenic foci in EEG | Number of cases, n (P±Sp, %) |
|---|---|
| Generalized Foci | 18 (25.72±2.5) |
| Parieto Temporal | 4 (5.71±0.5) |
| Fronto Central | 7 (10.00±1.0) |
| Fronto Temporal | 3 (4.29±0.4) |
| Temporal | 4 (5.71±0.5) |
| Frontal | 6 (8.57±0.8) |
| Centro Parieto Temporal | 3 (4.29±0.4) |

An equal percentage of cases, 15 (21.43 %), of generalized seizures and focal seizures had abnormal MRI findings out of the 30 cases with abnormal MRI findings (Table 4). When studied among the individual seizure subtype, it showed that more proportion of focal seizures (68.18 %) presented with abnormal MRI findings (Table 5).

Out of the 30 studied cases with abnormal MRI findings cases,15 (21.42 %) showed granuloma with or without perilesional oedema, 5 (7.14 %) cases with Ring enhancing lesions, 4 (5.71 %) cases with cerebral atrophy, 2 (2.81 %) cases each with cystic lesion with

perilesional oedema, T2 hyperintensities in lentiform and dorsomedial thalamus and 1 (1.42 %) case each with Fusiform thickening of the right optic nerve and Multiple NCC.

Table 4

Distribution of cases based on MRI report (n=70)

| Type of Seizure | Abnormal MRI n (P±Sp, %) | Normal MRI n (P±Sp, %)) | Total n (P±Sp, %)) |
|---|---|---|---|
| Generalized | 15 (21.43±2.1) | 33 (47.14±4.7) | 48 (68.57±6.8) |
| Focal | 15 (21.43±2.1) | 07 (10.00±1.0) | 22 (31.43±3.1) |
| Total | 30 (42.86±4.2) | 40 (57.14±5.7) | 70 (100–10) |

Table 5

Distribution Of Generalized Seizure Cases Based on Mri Findings (n=48)

| MRI | Generalized Seizures (n=48) | P±Sp, % | Focal seizures (n=22) | P±Sp, % |
|---|---|---|---|---|
| Normal | 33 | 68.75±6.8 | 7 | 31.81±3.1 |
| Abnormal | 15 | 31.25±3.1 | 15 | 68.18±6.8 |

These are the structural abnormalities detected on MRI. After analysis of these abnormalities, out of the 22 cases with granuloma with or without oedema, ring-enhancing lesions and cystic lesions with perilesional oedema, 20 cases were diagnosed to be as Neurocysticercosis and 2 cases as tuberculoma. Out of these 20 cases of Neurocysticercosis, the majority of cases had lesions in the parietal lobe, followed by the temporal lobe, occipital lobe and frontal lobe. The 2 cases of tuberculoma had lesions in the parietal lobe, and both were associated with perilesional oedema (Table 6).

Table 6

Distribution of unprovoked seizure cases based on MRI findings (n=70)

| MRI Findings | Number of cases (P±Sp, %) |
|---|---|
| Fusiform thickening of the right optic nerve | 1 (1.43±0.14) |
| Granuloma | 15 (21.43±2.1) |
| Ring Enhancing Lesion | 5 (7.14±0.7) |
| Cystic Lesion with Perilesional Edema | 2 (2.86±0.28) |
| Cerebral Atrophy | 4 (5.71±0.57) |
| T2 Hyperintensities in Lentiform & Dorsomedial Thalamus | 2 (2.86±0.28) |
| Multiple NCC | 1 (1.43±0.14) |

**4. Discussion**

Similar studies were done in the last decade to determine the role of EEG and MRI in identifying the cause of unprovoked seizures. In the present study, out of 70 cases, most cases, 48 (68.57 %), presented with generalized seizures, which was like the study done by Momen et al. [6] 20 (62.51 %) and Anand, et al. [6] 63 (66.3 %). A much more predominance of generalized seizures is seen in a study done by Ashok Panagariya et al. [7] 285 (75 %); this may be attributed to the higher sample size of their study.

In the present study, out of 70 cases, 45 (64.28 %) cases had abnormal EEG discharges, which was similar to the study done by N. Narkhede et al. [8] which had 66 (66 %) cases with abnormal EEG out of 100 cases, Momen et al. [6] had 19 (59.37 %) cases with abnormal EGG out of 32 cases, and Owolabi LF et al. [9] had 213 (58.8 %) cases out of 403 cases.

In the present study, 66.66 % of the generalized seizures out of 48 generalized seizure cases had abnormal EEG findings, and 59.09 % of the focal seizures out of 22 focal seizure cases had abnormal EEG patterns. The results were similar but with a lower percentage when compared to the study done by Emmady PD et al. [10]. But a study was done by Emmady PD et al. [9] and Hafeez MK et al. [11] had noticed not much significant difference between the clinical subtypes of cases. Study done by Owolabi LF, et al. [9] 58 % of patients with IGE patients had abnormal EEG. Generalized sharp and wave complexes were the most common findings among those with epileptiform activities. A study conducted by Hafeez MK et al. [11] had 44.44 % of generalized seizures and 47.50 % of focal seizures with abnormal EEG patterns.

The percentage of generalized seizures with abnormal EEG in the present study is more than that of focal seizures. This might be because of the metamorphic pattern of focal seizures in EEG in which, as the seizure ends, rhythmic waves or sequential spikes change to a slow wave pattern that gradually decreases in frequency. [12] Also, this might be because most of the aware focal seizures may not be associated with discernible changes in routine scalp EEG [13], and the present study had 27.27 % focal aware seizures with normal EEG patterns. This might also be because focal and generalized seizure disorders show some overlap of both clinical and electrographic manifestations, and the entity of unihemispheric epilepsies blurs the boundaries further [14].

In the present study, out of 70 cases, 30 (42.48 %) cases showed abnormal imaging findings on MRI. This result is higher than the results of the study done by Samia P et al., [14] 33 % and Sahadev et al., [15] 33 (31.41 %). This discordance may be because of the wide range of age groups up to <60 to >60 yrs in Kushwah et al., [16], which included the most common abnormal structural findings in adults, like cerebral infarcts.

In the present study, the highest proportion of abnormal MRI findings was seen with cases who presented with focal seizures [(15/22), 68.19 %] than with generalized seizures [(15/48), 21.42 %]. This is similar to the study done by Rasool et al. [9].

In the present study, the highest proportion of abnormal MRI findings was seen with cases who presented with focal seizures [(15/22), 68.19 %] than with generalized seizures [(15/48), 21.42 %]. This is similar to the study done by Emmady PD et al. [9].

In the present study, a higher proportion 21.42 % of the structural lesions identified were granuloma, followed by ring-enhancing lesions, which were clinically diagnosed to be Neurocysticercosis in the majority of cases and tuberculoma in 2 cases, which is similar to the study done by Sahadev R et al., [15] which had the highest proportion of granuloma lesions 9.5 % out of their 31.41 % of abnormal MRI findings and 17 % of the cases showed granuloma out the 65 % abnormal MRI finding cases in a study conducted by Kushwah et al., [16] In all the studies mentioned above, most of the granuloma cases were diagnosed to be Neurocysticercosis except in the study done by Kushwah et al. [16], which had more tuberculoma cases. This may be because of the inclusion of patients till old age who are more prone to infection with Tuberculosis, which is more prevalent in developing countries like India.

**Limitations of the present study.** In the present study, EEG was obtained in some cases within 24 hours and in some cases after 24 hours to 3 days due to the clinical instability of the cases. Activation procedures such as hyperventilation, sleep deprivation and photic stimulation were not used during an EEG recording. Though MRI with pediatric seizure protocol had diagnosed many causes of seizures, more recent advances like MR Spectroscopy, Magnetic source imaging could have helped localise the epileptogenic foci when routine MRI is normal.

**Prospects for further research.** Opportunity for further research to be done on the role of MRI in patients with a first seizure. In addition, the epileptogenic potential is known for some lesions but remains poorly understood for others. Further research is needed to determine the epileptogenic nature of such lesions to better predict the risk of future seizures in patients with first-time seizures. Furthermore, research is needed to improve imaging techniques for detecting epileptogenic foci in the relatively large number of patients with new-onset seizures in whom no imaging findings using present technology are present.

## 5. Conclusion

In the present study, the EEG and MRI were found to be useful in identifying a possible cause for unprovoked seizures in children. EEG is useful to clearly identify the region of the epileptogenic foci, not only to diagnose seizures but also to classify them. MRI can identify most of the structural brain abnormalities in pediatric patients presenting with unprovoked seizures and therefore plays a significant role in the diagnosis of children presenting with unprovoked seizures. Hence neuroimaging is of immense value even in generalized seizures besides in focal seizures.

## Conflict of interest

The authors declare that there is no conflict of interest concerning this paper, as well as the published research results, including the financial aspects of conducting the research, obtaining and using its results, as well as any non-financial personal relationships.

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## Data availability

Data will be made available on reasonable request.

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