Original Research Article

A study on clinical profile and correlation between electroencephalogram and neuroimaging in unprovoked seizures in children aged between 2 months to 12 years

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ABSTRACT

Background: Seizure is one of the commonest neurological illnesses in children and is also an important cause of mortality and morbidity in childhood proper diagnosis and management helps in improving the everyday life of children with seizures. The study is conducted to find the clinical profile and correlation of electroencephalogram (EEG) and neuroimaging and their correlation in the unprovoked afebrile seizures in children aged between 2 months and 12 years.

Methods: This is a hospital based prospective observational study conducted for a period of 1 year and total of 63 children were included in the study with unprovoked seizures admitted in pediatric department of government Cuddalore medical college and hospital, Chidambaram. The data regarding their name, age, sex, type of seizure, past history of seizures, treatment history, developmental history, family history and EEG/neuroimaging findings are collected and recorded in a preformed proforma and analysed.

Results: Among the 63 children, majority belonged to 1-5 years age group with male preponderance. About 80% of patient had generalised seizures and 20% had focal seizures. About 90% had abnormal EEG whereas 25.8% had abnormal neuroimaging. Majority of the abnormal neuroimaging is shared by focal seizures group. About 83% of children required single antiepileptic only.

Conclusions: The EEG abnormality occurred equally in both generalised and focal seizures. Higher incidence of neuroimaging abnormality is seen in focal seizures. Idiopathic seizures were the most common etiology. There is a higher correlation between neuroimaging abnormality and EEG changes in focal seizures than generalised seizures. Electroencephalogram and neuroimaging are mandatory in evaluating children with unprovoked seizures.

Keywords: Seizures, Electroencephalogram, Computed tomography and magnetic resonance imaging

INTRODUCTION

Seizure is a transient occurrence of signs and symptoms resulting from abnormal excessive or synchronous neuronal activity in the brain.[1] About 5% of children experience convulsion during the first five years. Approximately 30% of patients who have first episode afebrile seizure later develop epilepsy. Risk is 20% if neurologic examination, EEG and neuroimaging is normal.[2]

A good description of seizure includes mode of onset, details of aura, type of seizures, automatisms, associated behavioural abnormalities and postictal state. An accurate description is more informative than detailed examination and investigation. Several times a child may present with condition that mimic seizures like breath holding, cough syncope, narcolepsy, night terror, tics.

Seizures are a major risk factor for neurological and cognitive impairment and for the development of

epilepsy in children living. In most children with newly diagnosed epilepsy, the long-term prognosis of epilepsy is favourable and in particular, patients with idiopathic etiology will eventually reach remission. The 10-20% will have refractory seizures. Proper diagnosis and management help in improving the everyday life of children with seizures. Though there are lots of investigations available, EEG and neuroimaging (CT/MRI) are the main modalities to investigate children with seizures.

EEG remains an important diagnostic tool in evaluating a patient with epilepsy, it provides evidence for the diagnosis, EEG also assists in classifying the underlying epileptic syndrome and thereby guides for management of seizures.

Neuroimaging (CT/MRI) is central to evaluation of patients with epilepsy; it is used to identify various causes like neurocysticercosis, tuberculosis, space occupying lesions, neuronal migration disorders etc.

There are numerous studies, which have been done correlating EEG and neuroimaging in children presenting with seizures with conflicting results. This study was done to analyze the clinical spectrum and determine the correlation of EEG and neuroimaging in developmentally normal child with unprovoked seizures.

METHODS

This study was done in department of paediatrics, govt Cuddalore medical college and hospital. The study population is paediatric patients (2 months-12 years) who are diagnosed as unprovoked seizures admitted in ward/PICU or attending outpatient department.

Study period

Study carried out for twelve months from (July 2023 to June 2024).

Study design

It was cross sectional-study.

Sample size

Total 63 patients were included in study.

$N=(Z_{1-\alpha})^2 \times P(1-P)/e^2$

$Z_{1-\alpha}=z_{1-0.05}=z_{0.95}=1.96$

P=0.937, Q=0.063 e=margin of error=0.06.[3]

Substituting in the formula, $N=(1.96)^2 \times (0.937 \times 0.063)/0.06 \times 0.06=62.9$

Sampling technique

It was a consecutive sampling

Inclusion criteria

Developmentally normal child aged between 2 months-12 years diagnosed as unprovoked seizures were included.

Exclusion criteria

Patients of age <2 months or >12 years, febrile seizures, head injury and developmental delay child were excluded.

Methodology

Children attending OPD or admitted in ward/PICU to the pediatric department of GCMC, Chidambaram for the complaints of unprovoked seizures aged between 2 months-12 years were examined after duly getting informed consent from the parents.

For each patient, detailed history about age, sex, seizure (type, duration, precipitating factors, no. of episodes) past history of seizure, birth history, family history, developmental history and treatment history will be enquired and recorded in proforma.[4]

Thorough clinical examination will be done and investigations like blood parameters, neuroimaging (CT/MRI) and EEG and other investigations necessary will be done. Etiology will be determined taking into consideration the risk factors (any significant natal or antenatal history, family history), examination findings and investigation reports.

Ethical committee approval

Approved by institutional human ethics committee, government medical college and hospital, Cuddalore district (erstwhile rajah Muthaih medical college) on 21/11/23 ref no. IHEC/1223/2023.The registration number of IEC is EC/NEW/INST/2020/1249.

Analysis

The data entered from the patients were formatted into Microsoft excel sheets to generate master charts, tables and graphs. Data will be analysed using SPSS software. The correlation of neuroimaging and EEG were assessed using chi-square Pearson co-efficient test (p<0.05 was taken as significant).

RESULTS

In our study, seizures occurred most commonly in male children about 61.9% (39/63) and in female children about 38.1% (24/63) (Table 1). The mean age in our study was about 5.4 years with standard deviation of

3.72. Among our study population, 8 children were in <1 year age group, 28 in 1-5 years age group and 27 in >10 years age groups (Table 2).

In our study, generalized seizures were present in 80.9% (51/63) children and focal in 19.1% (12/63) children (Table 3). In age wise category, generalised seizures were common in 1-5 years age group and focal seizures were common in >5 years group.

Family history of seizures was present in 11% (7/63) children in our study population.

EEG was abnormal in 90% (55/61) of children with unprovoked seizures and normal in 10% (6/61) of children (Table 4). The most common EEG abnormality was bilateral generalised epileptiform discharges. On comparing type of seizure and EEG 90% of EEG are abnormal in children with generalized seizure and 91% abnormality with focal seizures (Table 5).

In our study, 25.8% (15/58) of neuroimaging abnormal and normal in 74.2% (43/58) of children (Table 6). Most common neuroimaging abnormality periventricular leukomalacia followed by gliosisic bleed, calcifications, hypoxic changes and tumour. We had 1 case of neurocysticercosis which accounted for about 6.6%. On comparing type of seizure and neuroimaging 22.9% of EEG are abnormal in children with generalized seizure and 40% abnormality with focal seizures (Table 7). Children with normal EEG 33.3% of children had abnormal neuroimaging (2/15) and 13 children with abnormal EEG abnormal neuroimaging that is 27.6%.

The main aim of our study is finding out the correlation between EEG and neuroimaging findings. On comparing them overall, there is only slight agreement between them (kappa-0.034). But comparing them in focal seizures group it was statistically significant with p=0.048 (<0.05) (Table 8) and in generalised seizures it was not statistically significant with p=0.094 (Table 9).

In our study, 84% of children required only 1 antiepileptic and around 16% of children required multiple antiepileptics. Sodium valproate (34) is the preferred drug in generalized seizures followed by levetiracetam (17) and phenytoin (6) is preferred drug in focal seizures (Table 10). In this study, children requiring single antiepileptic was 83.6% in generalised and 85.7% in focal seizures group. In children requiring multiple antiepileptics, abnormal neuroimaging was found in 40% compared to those with abnormal EEG in about 15%.

In our study, 74% (46/63) of children presented as status epilepticus. Among these, 64% of children had seizure duration between 5-30 minutes followed by 25% of children below 5 minutes and 11% had duration above 30 minutes. Inj. phenytoin was most commonly used for treating SE about 47.8% followed by levetiracetam around 26%.

In our study, about 44.5% of children presented as breakthrough seizures and no cause was ascertained in 35.7%, fever/infection in 32.2%, drug withdrawal in 25% and others contributed 7.1%

Postictal symptoms were seen in around 20% of seizures with confusion about 63.6% being most common followed by weakness about 27.2% and headache about 9.2%.

Table 1: Age distribution.

Age (in years)	No. of children	Percentage (%)
<1	8	12.7
1-5	28	44.4
>5	27	42.9

Table 2: Sex distribution.

Sex	Frequency	Percentage (%)
Male	39	61.9
Female	24	38.1
Total	63	100

Table 3: Type of seizures.

Type	Frequency	Percentage (%)
Generalized	51	80.9
Focal	12	19.1

Table 4: EEG findings.

EEG	Frequency	Percentage (%)
Normal	6	10
Abnormal	55	90

Table 5: EEG findings in type of seizures.

EEG findings	Generalized		Focal		Total
	N	%	N	%	
Normal	5	10	1	9	6
Abnormal	45	90	10	91	55
Total	50	100	11	100	61

*P=0.927.

Table 6: Neuroimaging finding.

Neuroimaging	Frequency	Percentage (%)
Normal	43	74.2
Abnormal	15	25.8

Table 7: Neuroimaging findings in types of seizures.

Neuroimaging findings	Generalised		Focal		Total
	N	%	N	%	
Normal	39	81.25	4	40	43
Abnormal	9	18.75	6	60	15
Total	48	100	10	100	58

*P=0.006

Table 8: Correlation between neuroimaging and EEG in focal seizures.

Focal seizures	Neuroimaging normal	Neuroimaging abnormal
EEG normal	4 (100%)	0 (0%)
EEG abnormal	0 (0%)	6 (100%)

*P=0.0048.

Table 9: Correlation between neuroimaging and EEG in generalised seizures.

Generalised seizures	Neuroimaging normal	Neuroimaging abnormal
EEG normal	2 (50%)	2 (50%)
EEG abnormal	37 (84%)	7 (16%)

*P=0.094.

Table 10: Choice of drugs in types of seizures.

Name	Generalised	Focal
Phenytoin	2	4
Levetiracetam	17	0
Sodium valproate	34	6
Carbamazepine	0	2

DISCUSSION

Seizures are one of the most common neurological problems in children. The first episode of seizure is always an anxiety-causing event for parents and it is the health professional's duty to know the best approach and recommendations to use in each case.

Unprovoked seizure is defined as seizure that cannot be explained by an immediate, obvious precipitating cause such as head trauma or intracranial infection.[5]

Out of 63 children studied 39 children were male that is 61.9% and females were 24 that is 38.1%. Male predominance was noted in our study population which is comparable to other studies.[6] The mean age of our study population is 5.4 years.[7,8]

In our study population age group was divided into three subcategories as children between <1 year, 1-5 years and >5 years of age. Children between 1-5 years of age was more in our study group with 44.4 % of the study population, and children >5 years with 31.7%. Comparing this with study done by Pravalika et al which also had 45% in <5 years age group.[9]

Of the 63 children studied generalized seizures were noted in 80.9% (51) and 19.1% (12) presented with focal seizures. In our study population generalized seizures were more predominant than focal seizures. This result was comparable with a study done by Misra et al and Redda et al.[6,10] But other studies it showed equal predominance of both focal and generalized seizures.[11]

Family history is present in 11% of children with afebrile seizures, when compared between seizures, generalized seizure had 18.1% that is 15 children had family history of seizures and 26.7% that is 12 children had positive family history in focal seizures. 11% of family history is less than Redda where they showed 22%.[6]

EEG is a non-invasive, readily available and inexpensive investigation tool, helps in diagnosis of the event, identification of a specific syndrome, and prediction of long-term outcome. It also helps to differentiate a seizure from other events and predicts the risk of recurrence.[5]

In our study, 90% of children had abnormal EEG and 10% of them showed normal EEG. When comparing the abnormal EEG with type of seizures it is observed that child with generalized seizure has 90% abnormality and 91% of focal seizures had EEG abnormality. Most of the studies coincide with our study result. Zajak et al noted EEG abnormalities are more in children with focal seizures, but our study shows there is equal abnormalities noted in both focal and generalized seizures.[8] The most commonly observed EEG abnormality in our study population was B/L Generalized Epileptiform activity.

American academy of neurology recommends emergent neuroimaging only in children who have post ictal focal deficits not resolving quickly and children not returning to baseline within several hours after the seizure. Non emergent imaging studies with MRI should be considered in child with significant cognitive or motor impairment, focal seizures, unexplained neurological examination, age less than 1 year and EEG that doesn't show benign partial epilepsy or generalized epilepsy of childhood.[12]

Neuroimaging abnormality was noted in 15/58 children in our study population, which contributes to 25.8%. And 43/58 children had a normal neuroimaging. When comparing seizure and neuroimaging in our study 11/48 children with generalized seizure had neuroimaging abnormality, which is 22.9% and 4/10 children with focal seizure, had abnormality, which is 40%.

When comparing these results with other study Baheti et al noted 50% neuroimaging abnormality in children with focal seizure and 34.6% of neuroimaging abnormality in children with generalized seizures.[8] Where as Obajiimii et al noted a total 51.5% neuroimaging abnormality and 74.4% abnormality for the children with focal seizures.[13,14]

Commonly observed neuroimaging abnormality in our study population is periventricular leukomalacia which accounted for 26%, others findings like gliosis, bleed, hypoxic changes, tubers, calcifications and tumour, as our study population included both CT and MRI, we could not classify the neuroimaging findings, compared with studies, where they noted ring enhancing lesions more common. We had 1 case of neurocysticercosis, which was 6.6% of our study group, none of the children in our

study group required surgical intervention during the study period.

The main aim of our study was to correlate the EEG and neuroimaging findings, in 63 children of our study population, EEG was abnormal in 55 children and it was normal in 6 children, neuroimaging was abnormal in 15 children in our study population. When comparing both the results of EEG and neuroimaging, children with abnormal EEG 27% that is 13 children had an abnormal neuroimaging which is comparable with other studies.[11] In our study Neuroimaging was normal in 34 (74%) children with an abnormal EEG.

In 6 children with normal EEG, neuroimaging was abnormal in 2 that is 33.5%. This shows that even children with an normal EEG has more chance of getting an abnormal neuroimaging finding. The correlation between neuroimaging and EEG in our study in focal seizures was statistically significant with an p=0.0048 (<0.05 significant). So, neuroimaging should be considered in child with both normal and abnormal EEG.MRI must be considered in children who present with afebrile seizures with no other possible cause because the yield of abnormality in MRI is more than CT and there will also be less exposure to radiation in children.

We followed up our study population for their seizure control with no. of antiepileptics they are on and we observed that 84% children were on single antiepileptics, 12.6% children were on 2 antiepileptics and only 3% children required 3 antiepileptics. Comparing this with the type of seizures, 81% children with generalized seizures and 83% children with focal seizures were on single antiepileptics. Our result with number of anticonvulsants is comparable with Kwan et a1 where 47% with single anticonvulsant and 14% with 2 antiepileptics, but there is no study to compare with type of seizure and their control with anitepilpetics.[15]

The most commonly used anticonvulsants in our study population were valproate (65%) which is followed by levetiracetam with 26% then by phenytoin which was used in 14% of our study population. Less commonly used antiepileptics in our study population is carbamazepine, phenobarbitone and clobazam.

CONCLUSION

The incidence of getting abnormal EEG is similar in both focal and generalised seizures. MRI is the imaging modality of choice due to its better resolution and less radiation exposure. There is better correlation between neuroimaging and EEG in focal seizures compared to generalised seizures. Seizures controlled with single drug, seizures without recurrence, normal neuroimaging and idiopathic seizures are favourable prognostic factors. Hence, we recommend EEG and neuroimaging are mandatory in evaluation and management of unprovoked seizures.

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