Electroencephalogram and Neuroimaging (MRI) Findings in First Episode of Unprovoked Seizures in Children

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ABSTRACT

BACKGROUND

FUS (First Unprovoked Seizure) is defined as the first seizure that is not feverish and that cannot be attributed to an immediate, clear-cut cause, such as an intracranial infection or head injury. Improvements in diagnostic techniques have increased the chances of finding the unknown causes.The most crucial investigative instrument for the diagnosis and treatment of epilepsies is the EEG. Specific epilepsy disorders can be diagnosed with EEG because it can identify focal lesions that are invisible with neuroimaging and have epileptiform signs. Unlike the recommendations for adult patients undergoing neuroimaging, there is not enough data to establish a standard recommendation or guideline for regular neuroimaging for children experiencing their FUS. This study was conducted to delve into the role of neuroimaging (MRI) and EEG combined in the first episode of unprovoked seizures and to establish a correlation, if any, between EEG and MRI findings as well as between clinical features and abnormal EEG and MRI findings.

MATERIALS AND METHODS

This was a prospective descriptive observational study involving 50 children belonging to the age group of 3 months to 18 years admitted with their first episode of seizures. EEG recordings and findings of MRI scans were recorded and the data was analyzed using the SPSS version 21.0 software. Continuous variables were presented as mean+/-SD. Categorical variables were expressed as frequencies and percentages. The Fisher's exact test was used to determine if there is a relationship between two variables. P<0.05 was considered statistically significant.

RESULTS

Generalised seizures were more common (80.8%), and focal seizures were 19.2%. Both generalised (59.5%) and focal (80%) seizures were more common in male children compared to female children, with 40.5% and 20%, respectively. The incidence was higher among the 1–5 year age group (50%). In a majority, 86.5%, the seizures were of <15 minutes duration. The seizures were multiple in a majority of 80.8% of the children. Also, both generalised and focal seizures were more commonly multiple in onset

than single, with 83.3% and 70%, respectively. EEG findings were abnormal in 53.8% of the study population. Focal seizures had more abnormal EEG findings (70%) than generalised seizures. However, the difference was not statistically significant (p-value = 0.3). Only 17.3% of the study population had abnormal MRI findings. Focal seizures had more abnormal MRI findings (30%) than generalised seizures (14.3%). However, the difference was not statistically significant (p value = 0.2). EEG findings were abnormal in 24 of the study population with <15 min of duration and in 4 with >= 15 min of seizure duration. Among those who had abnormal EEG findings, 7 (25%) had a single episode and 21 (75%) had multiple episodes. The findings were abnormal in 24 with a duration <15 min, compared to 4 with a duration >=15 min. This difference had a p-value of 1, which was not statistically significant. MRI findings were abnormal in six cases with multiple episodes and in three cases with a single episode. The p-value was 0.3, which was not significant. In our study, we observed that when EEG was abnormal, there was a higher chance that MRI was also abnormal, with a p-value of 0.002, which is significant.

CONCLUSION

In the present study, generalised seizures were more common. EEG findings were abnormal in a greater number of cases than MRI findings, with focal seizures having more abnormal findings. There was no correlation between abnormal EEG and MRI findings and the duration or number of seizure episodes. When EEG was abnormal, there was a higher chance that MRI was also abnormal, thus indicating the importance of neuroimaging in addition to EEG.

KEY WORDS: FUS (First Unprovoked Seizure), EEG, MRI.

DOI Number: 10.48047/nq.2023.21.7.nq23088 **NeuroQuantology 2023;21(7):989-996**

INTRODUCTION

Seizures are a common neurological problem in the paediatric age group. It occurs in about 10% of children, accounting for approximately 5% of all medical attendances to the emergency department related to seizures. The most common type of childhood seizure is FS (Febrile Seizure). It is also a common cause of paediatric hospital admissions and parental concern. The reported incidence of FSs is up to 14%.Unprovoked seizures, on the other hand, happen to patients older than a month and don't have an immediate cause.

FUS is defined as the first seizure that is not feverish and that cannot be attributed to an immediate, clear-cut cause, such as an intracranial infection or head injury. Improvements in diagnostic techniques have increased the chances of finding the unknown causes.

The most crucial investigative instrument for the diagnosis and treatment of epilepsies is the EEG. Specific epilepsy disorders can be diagnosed with EEG because it can identify focal lesions that are invisible with neuroimaging and have epileptiform signs. AAN and the Child Neurology Society recommend EEG as a standard of care for a child presenting with a first afebrile seizure. It is useful in evaluating the risk of seizure recurrence, determining whether the seizure is focal or generalised, screening for focal abnormalities, determining the need for an MRI, making an epilepsy syndrome classification, guiding treatment with antiepileptics, and aiding in the prognosis. If an EEG discharge is linked to clinical symptoms, it has significant diagnostic and therapeutic implications. Without video records, these signs may, nonetheless, be insignificant and go unnoticed. Video-EEG recordings are very useful for determining absences. These can be brought on by psychogenic or other nonepileptic seizures, especially those associated with the hyperventilation syndrome, as well as focal, myoclonic, or hyperventilation seizures.

Sleep-deprived EEG is helpful if EEG results are negative and clinical suspicion for epilepsy is high. Of the individuals with initially normal EEG readings, 21–35% had abnormalities detected by this test. The first three days following a seizure have the highest yield.

In contrast to the guidelines for obtaining neuroimaging in adult patients, there is insufficient evidence available to make a standard recommendation or guideline for the use of routine neuroimaging in children with FUS. In a few studies that have reviewed the yield of neuroimaging in children with unprovoked seizures, the prevalence of abnormalities ranged from 0 to 21%. The decision to do neuroimaging

should be individualised in FUSs, and an EEG (Electroencephalogram) could be helpful. Clinically significant neuroimaging abnormalities have been reported in 2% of children presenting with the first afebrile seizure without focal features or predisposing conditions. MRI is the preferred method of imaging to avoid radiation exposure and it provides more detailed diagnostic information.

Studies that report EEG and neuroimaging (CT (Computed Tomography) and MRI (Magnetic Resonance Imaging)) data in children who present with new-onset seizures are few. It is advised to include an EEG in the neurodiagnostic examination of a kid who appears to be having an unprovoked seizure for the first time.[1,2] When a kid presents with unprovoked seizures or new-onset afebrile seizures, the usefulness of neuroimaging is unclear.[3] There is not enough data to establish a standard recommendation or guideline for regular neuroimaging for children experiencing their first unprovoked seizure. On the other hand, protocols for getting neuroimaging when an adult patient has a seizure have been released.[3] The frequency of anomalies in children with spontaneous seizures ranged from 0% to 21% in a few studies that examined the neuroimaging yield.[4]

This study was conducted to delve into the role of neuroimaging (MRI) and EEG combined in the first episode of unprovoked seizures and to establish a correlation, if any, between EEG and MRI findings as well as between clinical features and abnormal EEG and MRI findings.

MATERIALS AND METHODS

This was a prospective descriptive observational study conducted between January 2021 and June 2022, involving 50 children belonging to the age group of 3 months to 18 years admitted to the Rainbow Children's Hospital, Vijayawada, with their first episode of seizures. Those with electrolyte abnormalities, seizures caused by toxins, drug overdoses, or post-traumatic seizures were excluded from the study. EEG recordings and findings of MRI scans were recorded, and the data was analysed using the SPSS version 21.0 software. Continuous variables were presented as mean +/- SD. Categorical variables were expressed as frequencies and percentages. The Fisher's exact test was used to determine if there is a relationship between two variables. P<0.05 was considered statistically significant.

RESULTS

Generalised seizures were more common (80.8%), and focal seizures were 19.2%. Male children had a higher incidence of seizures (63.2%) compared to 36.5% among female children. Both generalised (59.5%) and focal (80%) seizures were more common in male children compared to female children, with 40.5% and 20%, respectively. The male-to-female ratio in our study is 1.74:1. The mean age (years) of onset was found to be 3.54 ± 3.75. The incidence was higher in the 1–5 year age group, where it was 50%, then in the 1–year age group, where it was 28.8%, and in the 5+ year age group, where it was 21.2%. The difference was, however, not statistically significant (p-value = 0.4).

In a majority, 86.5%, the seizures were of <15 minutes duration. The seizures were multiple in a majority of 80.8% of the children.Also,both generalised and focal seizures were more commonly multiple in onset than single, with 83.3% and 70% respectively.

EEG Findings	Frequency	Percentage
Normal	24	46.2
Abnormal	28	53.8
Total	52	100.0

Table 1: Distribution of EEG Findings among Study Population

As shown in Table 1, EEG findings were abnormal in 53.8% of the study population.

EEG Findings	Generalised	Focal	Fisher's Exact value	P-Value
Normal	21(50.0)	3(30.0)	1.34	0.3

Abnormal	21(50.0)	7(70.0)		
Total	42(100.0)	10(100.0)		

Table 2: Distribution of EEG Findings with Seizure Types

Focal seizures had more abnormal EEG findings (70%) than generalised seizures.However,the difference was not statistically significant (p-value = 0.3) (Table 2).

MRI Findings	Frequency	Percentage
Normal	43	82.7
Abnormal	9	17.3
Total	52	100.0

Table 3: Distribution of MRI Findings among Study Population

In the present study, only 17.3% of the study population had abnormal MRI findings. (Table 3)

MRI Findings	Generalised	Focal	Fisher's Exact value	P-Value
Normal	36(85.7)	7(70.0)	1.4	0.2
Abnormal	6(14.3)	3(30.0)		
Total	42(100.0)	10(100.0)		

Table 4: Distribution of MRI Findings with Seizure Types

Focal seizures had more abnormal MRI findings (30%) than generalised seizures (14.3%).However, the difference was not statistically significant (p-value = 0.2). (Table 4)

Seizure Duration(min)	EEG Findings		Total	Fisher's Exact Value	P-Value
	Normal	Abnormal			
<15	21	24	45	0.035	1
>=15	3	4	7		
Total	24	28	52		

Table 5: Comparison of EEG Findings with Duration of Seizure

As shown in Table 5, in our study, EEG findings were abnormal in 24 of the study population with <15 min of duration and in 4 with >= 15 min of seizure duration. This difference was statistically not significant, with a p-value of 1.

No. of Episodes	EEG Findings		Total	Fisher's Exact Value	P-Value
	Normal	Abnormal			
Single	3(12.5)	7(25.0)	10	1.34	0.2
Multiple	21(87.5)	21(0)	42		
Total	24(100.0)	28(100.0)	52		

Table 6: Comparison of EEG Findings with Number of Episodes

Among those who hadabnormal EEG findings, 7(25%) had a single episode and 21(75%) had multiple episodes. This difference was statistically not significant (the p-value was 0.2). (Table 6)

Seizure Duration (min)	MRI Findings		Total	Fisher's Exact Value	P-Value
	Normal	Abnormal			
<15	21	24	45	0.04	1
>=15	3	4	7		
Total	24	28	52		

Table 7: Comparison of MRI Findings with Duration of Seizure

MRI findings are as shown inTable 7.The findings were abnormal in 24 with a duration <15min, compared to 4 with a duration >=15 min. This difference had a p-value of 1, which is not statistically significant.

No. of Episodes	MRI Findings		Total	Fisher's Exact Value	P-Value
	Normal	Abnormal			
Single	7	3	10	1.25	0.3
Multiple	36	6	42		
Total	43	9	52		

Table 8: Comparison of MRI Findings with Number of Episodes

MRI findings were abnormal in six cases with multiple episodes and in three cases with a single episode. The p-value was 0.3, which was not significant. (Table 8)

EEG Findings	MRI Findings		Total	Fisher's Exact Value	P-Value
	Normal	Abnormal			
Normal	24	0	24	12.75	**0.002**
Abnormal	19	9	28		
Total	43	9	52		

Table 9: Comparison of EEG and MRI Findings

In our study, we observed that when EEG was abnormal, there wasa higher chance that MRI was also abnormal, with a p-value of 0.002, which was significant.

DISCUSSION

In the present study,male children had a higher incidence of seizures compared to female children.The incidence was higher among the 1-5 year age group.In a majority, the seizures were of <15 minutes duration and were multiple. Also, both generalised and focal seizures were more commonly multiple in onset than single.

These results were in line with a research conducted by GunawanP.TI et al.[5] which found that most boys (61.3%) older than five years old (52.8%) were afflicted by FUS. According to the current study, the majority of the seizures that occurred lasted less than five minutes and were of a more generalised nature.

EEG is useful in seizure type identification, seizure classification, and long-term prognosis prediction. The diagnosis of encephalopathy, subclinical seizures, and metabolic abnormalities can be made with the use of an EEG study. An EEG examination can identify abnormalities related to lateralization or focal epilepsy.

American EEG society recommends EEG be performed after all first non-febrile seizures. However, optimal timing for obtaining an EEG is not clear; an EEG done within 24 hours of the seizure is most likely to show background and epileptiform abnormalities.[6] EEGs performed for new-onset seizures show epileptiform discharge in approximately 18% to 56% of children.[7] In the present study, EEG findings were abnormal in 53.8% of the study population.

In astudy, the prevalence of epileptiform discharges in healthy babies between the ages of 12 and 60 months was 0.76%.[8] 2.9% of 140 children between the ages of 11 and 12 who had no prior history of seizures were found to have epileptiform discharges.[9]

In a study by Shwetha.G et al.[10] overall, 71% of patients with generalised seizures had EEG abnormalities, which was consistent with similar observations made by Al-Sulaiman et al.[11] and Doose et al.[12] in cases of newly diagnosed seizures.

A total of 347 children were assessed for their first unprovoked seizure and observed during follow-up sessions in the research conducted by Shinnar et al.[13] After their first seizure, 38% of the children's EEGs showed abnormalities, the study team discovered. Additionally, they noticed that children with

partial seizures and those older than three years old were more likely to have aberrant EEG readings. Children with abnormal EEGs had the highest chance of recurrence, according to a follow-up study.

The American Academy of Neurology recommends emergent neuroimaging only in children who have postictal focal deficits that are not resolving quickly and who are not returning to baseline within several hours after the seizure. Emergency neuroimaging should be performed in a child with a first afebrile seizure to look for intracranial pathologies needing immediate intervention.[14]

After a first seizure, abnormal neuroimaging has been linked to an increased chance of recurrence.[15] According to the ILAE Subcommittee for Paediatric Neuroimaging recommendation, half of the imaging tests that are done on kids who have localization-related or distant symptomatic seizures or who just started having seizures are not normal. This analysis is based on 18 studies.[16] 8.5% of children with new-onset seizures presenting as status epilepticus in a neuroimaging investigation showed emergent cerebral disease.[17]

In the present study, only 17.3% of the study population had abnormal MRI findings. Similar to our observations, in the Ayoobi-Yazdi et al.[18] study, 16.1% of children had abnormal MRI results, 10.7% of whom had non-specific findings for seizures.

In the Shwetha G et al.[10] study, MRI abnormalities were seen in 7 (10.7%) children, which was consistent with the study done by Sharma et al,[19] where they found that the overall incidence of neuroimaging abnormalities was 8% (26% in high-risk children and 2% in low-risk children), emphasising the need for neuroimaging in only high-risk categories like the presence of predisposing conditions and focal seizures in less than 3 years, whereas well-appearing and low-risk children don't warrant immediate neuroimaging.

According to a research done in Jabalpur by Saini N et al.[20] 66.7% of children had clinically significant neuroimaging abnormalities, with neurocysticercosis being the most frequent abnormality. Neuroimaging was found to be abnormal in 50% of cases of generalised seizures and in 83.8% of cases of partial seizures. According to the study's findings, neuroimaging should be done on every kid experiencing their first afebrile seizure.

According to research by MollaMohammadi M et al.[21] of the 96 children examined, 27.1% had MRI abnormalities, with white matter abnormalities being the main reason. There was no correlation discovered between seizure type, age, or length. Furthermore, no correlation was discovered between focally aberrant EEG and abnormal MRI results. A follow-up revealed that children with abnormal MRIs did not have an increased risk of seizure recurrence. The primary diagnostic method was indicated to be MRI.

The findings of neuroimaging infants under 24 months old who were presenting with new-onset afebrile seizures were examined in a research by D. T. Hsiehet al.[22]An MRI revealed abnormalities in 57.4% of the kids. Among the abnormalities found, cerebral dysgenesis was the most prevalent.

In the present study,focal seizures had more abnormal EEG findings (70%) and MRI findings (30%) than generalised seizures. Given that focal seizures are typically linked to a structural aetiology, aberrant EEG, and neuroimaging abnormalities, Berg AT et al. found that focal seizures had a greater probability of recurrence than generalised seizures. Certain types of seizures, such as myoclonic seizures, epileptic spasms, and normal absences, were not likely to manifest as initial seizures.[23]

52 children were included in the research by Baheti et al.[24] 26 of them were diagnosed with partial seizures, and the other 26 had generalised seizures. In 73% of the partial seizures and 76.9% of the generalised seizures that were reported, EEG abnormalities were seen. The scientists also came to the conclusion that there was a greater likelihood of discovering an abnormal CT scan in situations where there were partial seizures and an abnormal EEG.

A study by DoescherJS et al. in 2014,[25] examined 181 children aged 6-14 who had just started having seizures. The majority of the abnormalities found in the EEGs of 65% of the children under study were localised epileptiform discharges. Of all, 32.6% had a documented abnormal MRI. The two most often reported ones are hippocampal abnormalities and cortical

dysplasia (heterotopias). In 21% of cases, the MRI and EEG were abnormal. The study came to the conclusion that there was no significant correlation between the results of the MRI and the EEGand that abnormalities in the EEG should not be the sole reason to conduct an MRI.

276 youngsters who were selected from Kashmir were investigated using EEG and neuroimaging in a research by Rasool A et al.[26] Of them, 56.2% had an abnormal EEG. 19% of cases had abnormal neuroimaging results. Compared to generalised seizures, localised seizures were more likely to exhibit abnormalities on MRI. The study came to the conclusion that children with focal seizures and abnormal EEG should have neuroimaging, and that the likelihood of abnormal imaging increased with abnormal EEG.

Twenty percent of the 300 patients in the research by King M. A. et al.[27] were youngsters. Fifty-nine of the youngsters under investigation had abnormal EEG readings. Of the overall group tested, 12.6% had epileptogenic lesions detected by MRI, of which 44% were tumours. Patients with BECTS or EEG-confirmed idiopathic generalised epilepsy did not exhibit any substantial MRI abnormalities. The study's conclusions said that all patients, with the exception of those who qualify for idiopathic generalised epilepsy or Rolandic epilepsy, require a thorough clinical evaluation, EEG, and MRI.

Of the 200 children examined, Susan Amirsalari et al.[28] found that 28.5% had aberrant MRI findings, of whom 51.7% had an abnormal neurological assessment and 54.5% exhibited dysmorphic traits. EEG abnormalities were seen in 98% of paediatric epileptic patients. According to the study, children with abnormal physical exams, localised defects, and focused EEG abnormalities should get an MRI. An MRI assessment is also necessary in cases of dysmorphic appearance and a positivefamily history.

CONCLUSION

In the present study, generalised seizures were more common. EEG findings were abnormal in a greater number of cases than MRI findings, with focal seizures having more abnormal findings. There was no correlation between abnormal EEG and MRI findings and the duration or number of seizure episodes. When EEG was abnormal, there was a higher chance that MRI was also abnormal,thus indicating the importance of neuroimaging in addition to EEG.

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