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Original Research Article

Study of electroencephalogram characteristics in neurological conditions in pediatric tertiary care hospital

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ABSTRACT

Background: Electroencephalogram (EEG) remains a veritable tool in the diagnostic workup of seizures and childhood epileptic syndromes. EEG has a significant role in substantiating the clinical suspicion of epilepsy, the classification of seizures, and the management of childhood epilepsy.
Methods: This study was retrospective descriptive with convenience sampling where two-years EEG recordings were included and the reporting were reviewed. The desired variables were encrypted and descriptive analysis made via statistical software SPSS version 20.
Results: There was 499 EEG done in a two-year time period where the female children were (n=205, 41.1%) and mean age was 66 months. There were (n=317, 63.5%) children from out of Kathmandu valley. The most common indication for EEG recommendation was seizure without impaired consciousness (69.7%) and least common indication was seizure with impaired consciousness (8.4%). The rate of detection of EEG abnormalities in seizure without impaired consciousness was 43.9% while that in seizure with impaired consciousness was 38.1%. Among the most common EEG abnormality, abnormal sleep EEG record suggestive of generalized epilepsy most of the children had a history of seizure without impaired consciousness (71.4%) and least presented with seizure with impaired consciousness.
Conclusions: The abnormality detection rate of epilepsy was higher in chance if done in early ages. The possibility of findings in EEG are higher with the history of seizures and the perinatal insult as well as birth asphyxia. EEG should be carried out to support the diagnosis of epilepsy in children, and a normal EEG won't be totally excluding epilepsy.

Keywords: EEG, Epileptiform discharge, Generalized epilepsy, Seizure

INTRODUCTION

Electroencephalography (EEG), with information about spatiotemporal patterns of brain electrical activity, is the most efficient tool in the diagnosis of epilepsy, classifying seizures, decision-making regarding initiation and discontinuation of treatment, and drug monitoring even though EEG may also be abnormal in a normal child and normal in a child with clinically diagnosed epilepsy.[1] By increasing the recording time and applying activation procedures, such as hyperventilation, photic stimulation, and sleep deprivation, as well as by repeating the procedure, the diagnostic yield of EEG could be improved. EEG has a significant role in substantiating the clinical suspicion of epilepsy, the classification of seizures, and the management of childhood epilepsy,

even though the diagnosis of epilepsy and epileptic syndrome is largely clinical.

About 4% to 10% of children experience at least one seizure in the first 16 years of life, making seizures, the most common pediatric neurologic disorder.[1,2] There are some factors like organ failure, electrolyte imbalance, medication and medication withdrawal, and hypersensitive encephalopathy which may provoke seizures.[3] Febrile seizure which affects 2-5% of children febrile children between the ages of 6 and 60 months not having an intracranial infection, metabolic disturbance, or history of afebrile seizures, is the most common convulsive disorder in childhood. The ages of patients and the amount of time elapsed between febrile seizures and the performance of EEGs are the key factors causing wide variations ranging from 2% to 86% in reported EEG abnormalities in febrile seizures.[4,5] Epilepsy is a common neurological disorder with characteristic recurrent seizures that affect approximately 1% of the world's population; the majority of them are children and from developing countries.[6,7] The ILAE task force defined six etiologic categories of epilepsy with management implications: structural; genetic; infectious; metabolic; immune and unknown.[8] Status epilepticus (SE) is a life-threatening pediatric medical emergency with an annual incidence of 10 to 73 per 100,000; the majority of which belongs to febrile status epilepticus and affecting the children <2 years most.[9] With prolonged recording time and activation procedures, such as hyperventilation, photic stimulation, and sleep deprivation, the diagnostic yield of EEG can be increased.[10] There is a possibility of misleading impressions for the location of the source of the electrical activity during the propagation of electrical activity along physiological pathways or through volume conduction in extracellular spaces.

An EEG signal is classified into five rhythmic waves with a special range of frequencies, namely, delta (0.1-4 Hz), theta (4-8 Hz), alpha (8-12 Hz), beta (12-30 Hz), and gamma (30-60 Hz) waves. Epileptic seizures in EEG are detected as spikes and sharp waves in the synchronous electrical activity of the neurons.[12] EEG has been used for the prediction of epileptic seizures, characterization of sleep phenomena, encephalopathies or Creutzfeldt-Jakob disease, and monitoring of anesthesia depth with the use of nonlinear techniques to study the slow wave sleep signal.[13] Antiepileptic drugs (AEDs) are effective in only 75% of epilepsy patients and a few respond well to surgery and alternative therapies leaving approximately 20% of epilepsy patients continuing to suffer from recurrent seizures. So, any system to predict in advance the occurrence of seizures can improve the therapeutic treatments and quality of epilepsy life by helping them to adjust their preventive behavior. The underlying etiology of the seizures and specific EEG background patterns are the most reliable early predictors of later neurologic outcomes.[14,15]

This study aimed to find the underlying risk factors for different types of seizures and the associated EEG abnormalities. This will guide the early intervention based on the symptoms and characteristic features of seizure with anticipated EEG abnormalities which was believed in guiding both initiation and discontinuation of appropriate antiepileptic drugs.

METHODS

The Ethical Committee clearance was taken from the IRC of Kanti Children's Hospital. We used the convenience sampling method in this study. The inclusion and exclusion criteria were made.

Those EEG reporting which were done in between January 2019 to December 2021; done with indications; EEG with reporting and desired variables were included in our study while those where EEG was without desired variables; EEG done other than January 2019 to December 2021; EEG done without indications were excluded in our study.

This retrospective descriptive study was done using the secondary data from the ECG section. The interpretation of the EEGs was captured. The desired variables were encrypted like age, sex, address, clinical conditions, EEG reporting. The patient's identity was anonymized. Those EEG records were collected by Microsoft Excel which later transcribed to statistical software IBM SPSS 20.0. The frequency table was prepared and the percentage of the individual variables were calculated. The data were analyzed by using SPSS version 20.

RESULTS

We collected (n=499) EEG from the data section done in a two-year time period who visited the hospital for EEG with some indications where the female children were (n=205, 41.1%) and (n=294, 58.9%) were male. The mean age of children was 66 months. There were (n=250, 50.1%) children below the age of 60 months with mean age of 19.9 months while (n=249, 49.9%) children above 60 months of age and the mean age of the children is 112.7 months. There were (n=317, 63.5%) children from out of Kathmandu valley whereas (n=182, 36.5%) children were from inside Kathmandu valley. The clinical presentation and condition were categorized in the main four groups like seizure with impairment of consciousness (n=42, 8.4%), seizure without impairment of consciousness (n=348, 69.7%), Birth asphyxia with perinatal Insult (n=59, 11.8%) and indication other than seizure (n=50, 10.0%). This is shown in Table 1.

Among the consultations made for EEG, there were (n=210, 42.1%) EEG reports with findings of epileptiform discharges while (n=289, 57.9%) with no abnormalities reported in the EEG. There were (n=59,11.8%) children who underwent EEG for birth asphyxia and perinatal insult and among them (n=30,

50.8%) were with some findings. There were (n=42, 8.4%) children visited for EEG for seizure with impairment of consciousness and among them there were n=16, 38.1%) cases with abnormal recordings. There were (n=348, 69.7%) children who underwent EEG for seizure without impairment of consciousness and among them (n=153, 43.9%) were abnormal EEG recordings of generalized epilepsy and epileptiform discharges. There were (n=50, 10%) children underwent EEG for indications other than seizure and among them (n=11, 22%) EEG were reported with some findings of generalized epilepsy. This is shown in Table 2.

Table 1: Demographics and clinical indications for EEG.

Variables		Frequencies (N, %)	P value
Age (years)	Less than 5	250, 50.1	0.00
	Above 5	249, 49.9	
Sex	Male	294, 58.9	0.12
	Female	205, 41.1	
Distribution	Kathmandu valley	182, 36.5	0.04
	Out of Kathmandu valley	317, 63.5	
Indications for EEG (n=499)	Seizure with impairment of consciousness	42, 8.4	0.01
	Seizure without impairment of consciousness	348, 69.7	
	Birth asphyxia with perinatal insult	59, 11.8	
	Indication other than seizure	50, 10.0	

Table 2: Findings on EEG in different conditions and age groups.

Findings		Chief complaint				P value
		Seizure without impaired consciousness	Seizure with impaired consciousness	Birth asphyxia and perinatal insult	Indication other than seizure	
		(N, %)	(N, %)	(N, %)	(N, %)	
Abnormal EEG recordings	Age less than 5 years	90, 72.6	3, 2.4	25, 20.2	6, 4.8	0.000
	Age more than 5 years	63, 73.3	13, 15.1	5, 5.8	5, 5.8	
	Total	153, 72.9	16, 7.6	30, 14.3	11, 5.2	
Normal EEG recordings	Age less than 5 years	79, 62.7	7, 5.6	20, 15.9	20, 15.9	0.007
	Age more than 5 years	116, 71.2	19, 11.7	9, 5.5	19, 11.9	
	Total	195, 67.5	26, 9.0	29, 10.0	39, 13.5	
Total	Age less than 5 years	169, 67.6	10, 4.0	45, 18.0	26,10.4	0.00
	Age more than 5 years	179, 71.9	32, 12.9	14, 5.6	24, 9.6	
	Total	348, 69.7	42,8.4	59, 11.8	50, 10.0	

Table 3: Characteristics of abnormal EEG recordings in different condition.

Clinical condition of the children for EEG		Abnormal sleep EEG record s/o generalized epilepsy	Abnormal EEG record s/o occipital lobe epilepsy	Abnormal epileptiform discharges in temporal epilepsy	Abnormal epileptiform discharges from frontal lobes	Abnormal epileptiform discharges in parietal region	Other than epileptiform discharges in different lobes	P value
		(N, %)	(N, %)	(N, %)	(N, %)	(N, %)	(N, %)	
Seizure without impaired consciousness	less than 5 years	38, 22.5	5, 3.0	6, 3.6	31, 18.3	3, 1.8	7, 4.1	0.06
	more than 5	17, 9.5	5, 2.8	11, 6.1	21, 11.7	3, 1.7	6, 3.4	

Continued.

Clinical condition of the children for EEG		Abnormal sleep EEG record s/o generalized epilepsy	Abnormal EEG record s/o occipital lobe epilepsy	Abnormal epileptiform discharges in temporal epilepsy	Abnormal epileptiform discharges from frontal lobes	Abnormal epileptiform discharges in parietal region	Other than epileptiform discharges in different lobes	P value
	years							
	Total	55, 15.8	10, 2.9	17, 4.9	52, 14.9	6, 1.7	13, 3.7	
Seizure with impaired consciousness	less than 5 years	2, 20.0	_	0, 0.0	1, 10.0	_	0, 0.0	0.65
	more than 5 years	3, 9.4	_	3, 9.4	6, 18.8	_	1, 3.1	
	Total	5, 11.9	_	3, 7.1	7, 16.7	_	1, 2.4	
Birth asphyxia and perinatal insult	less than 5 years	6, 13.3	4, 8.9	3, 6.7	8, 17.8	-_	4, 8.9	0.50
	more than 5 years	3, 21.4	0, 0.0	0, 0.0	1, 7.1	_-	1, 7.1	
	Total	9, 15.3	4, 6.8	3, 5.1	9, 15.3	_	5, 8.5	
Indication other than seizure	less than 5 years	4, 15.4	1, 3.8	_	1, 3.8	0, 0.0	_	0.56
	more than 5 years	4, 16.7	0, 0.0	_	0, 0.0	1, 4.2	_	
	Total	8, 16.0	1, 2.0	_	1, 2.0	1, 2.0	_	
Total	less than 5 years	50, 20.0	10, 4.0	9, 3.6	41, 16.4	3, 1.2	11, 4.4	0.08
	more than 5 years	27, 10.8	5, 2.0	14, 5.6	28, 11.2	4, 1.6	8, 3.2	
	Total	77, 15.4	15, 3.0	23, 4.6	69, 13.8	7, 1.4	19, 3.8	

There were different types of readings in the EEG which are as according to the elliptical discharges from the different lobes of the brain showing the epilepsy. The EEG reports were mostly divided into the categories as shown in Table 3. The two age groups with the different clinical conditions for EEG were compared with the different EEG readings. We found that among the children with seizure without impaired consciousness, there were (n=38, 22.5%) EEG with abnormal sleep record s/o generalized epilepsy, (n=5, 3.0%) of abnormal EEG record suggestive of (S/O) Occipital lobe epilepsy, (n=6, 3.6%) abnormal sleep records in temporal lobe epilepsy, (n=31, 18.3%) cases of epileptiform discharges from frontal lobe, (n=3, 1.8%) of abnormal epileptiform discharges from the parietal region and (n=7, 4.1%) of other different types of epileptiform discharges in the brain among the children of less than 5 years while (n=17, 9.5%) abnormal sleep record s/o generalized epilepsy, (n=5, 2.8%) abnormal EEG record S/O occipital lobe epilepsy, (n=11, 6.1%) abnormal sleep records in temporal lobe epilepsy, (n=21, 11.7%) epileptiform discharges from frontal lobe, (n=3, 1.7%) abnormal epileptiform discharges from the parietal region, (n=6,

3.4%) other different types of epileptiform discharges in the brain among the children more than 5 years children.

The EEG findings in children with seizure with impaired consciousness; There were (n=2, 20.0%) EEG with abnormal sleep record s/o generalized epilepsy, (n=1, 10.0%) cases of epileptiform discharges from frontal lobe among the children of less than 5 years while (n=3, 9.4%) abnormal sleep record s/o generalized epilepsy, (n=3, 9.4%) abnormal sleep records in temporal lobe epilepsy, (n=6, 18.8%) epileptiform discharges from frontal lobe, (n=1, 3.1%) other different types of epileptiform discharges in the brain among the children more than 5 years children.

The EEG findings with birth asphyxia and perinatal insult; there were (n=4, 15.4%) EEG with abnormal sleep record s/o generalized epilepsy, (n=1, 3.8%) of abnormal EEG record S/O occipital lobe epilepsy, (n=1, 3.8%) cases of epileptiform discharges from frontal lobe among the children of less than 5 years while (n=3, 21.4%) abnormal sleep record s/o generalized epilepsy, (n=11, 6.1%) abnormal sleep records in temporal lobe epilepsy, (n=1, 7.1%) epileptiform discharges from frontal lobe, (n=1, 7.1%) other different types of epileptiform discharges in the brain among the children more than 5 years' children.

The EEG findings with other than seizure; there were (n=4, 15.4%) EEG with abnormal sleep record s/o generalized epilepsy, (n=1, 3.8%) of abnormal EEG record S/O occipital lobe epilepsy, (n=1, 3.8%) cases of epileptiform discharges from frontal lobe in children less than 5 years while (n=4, 16.7%) abnormal sleep record s/o generalized epilepsy, (n=1, 4.2%) abnormal epileptiform discharges from the parietal region among the children more than 5 years' children. This is shown in Table 3.

DISCUSSION

This retrospective study showed only 42.1% of abnormal EEG recording among the 499 EEGs which were done for some neurological conditions. Study done by Owalabi et al also detected abnormal EEG recording in almost half (52.5%) of the children with clinical diagnosis of epilepsy which was in higher percentage of abnormal EEG compared to our study.[16] But the findings from a study done by Wirrell was somehow similar to our study as they had shown an 18-56% chance of observation of abnormal EEG recording in children with new onset seizures.[17]

The rate of abnormal EEG was slightly higher in boys (45.2%) but not statistically significant compared to girls. These findings were way different than the result of study done by Owalabi et al as they had shown 61.5% chance of recording of abnormal EEG in girls, becoming statistically significant when compared to the similar incidence in boys.[16]

The abnormal EEG recording was more prevalent among children <5 years (49.6%) than those with >5 years (34.9%) which was probably of different etiologies and reasons for EEG recordings. Study by Owalabi et al in their study model had set the age categories into neonate, infant, toddler, preschooler, school age and adolescent.[16] They found that 60% detection of abnormal EEG among neonates and 15.2% of abnormal EEG among adolescents and it was statistically significant. They also found the other variables like family history of epilepsy, frequency of epilepsy to be statistically significant for the occurrence of abnormal EEG. Due to limited information on the patient information sheet requested for EEG we could not take the statistically significant variables of Owalabi et al in our study.[16]

The abnormal finding on EEG in children with seizure associated with impaired consciousness and seizure associated with intact consciousness was almost comparable (44.3% vs. 38.1%). There was a higher chance of abnormal EEG findings in children with birth asphyxia and perinatal insult (50.8%) while those with other neurological conditions not having frank seizure had a lower chance of abnormal EEG recordings (22.0%). Among the most common EEG abnormalities, abnormal sleep EEG record suggestive of generalized epilepsy in most of the children had a history of seizure without impaired consciousness (71.4%) and least presented with seizure with impaired consciousness.

Though there were several typical EEG features of genetic generalized epilepsy, the occurrence of atypical features like focal changes should be borne in mind to avoid misdiagnosis. With some EEG features the electroclinical syndromes can also be differentiated into subcategories.[18]

Limitation

The study was done among the secondary data where we could not analyze the different variables and the clinical history where the real EEG findings could be found out and the suggestion for the present practice could have been given. This was kept for further studies in future.

CONCLUSION

The abnormality detection rate of epilepsy is higher in chance if done in early ages. The possibility of findings in EEG are higher with the history of seizures and the perinatal insult as well as birth asphyxia. EEG should be carried out to support the diagnosis of epilepsy in children, and a normal EEG won't be totally excluding epilepsy.

Recommendations

EEG should be carried out to support the diagnosis of epilepsy in children, and a normal EEG won't be totally excluding epilepsy.

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