



Original Research Article

Seizure in children: How important is EEG & Neuroimaging?

Sunil Kumar Agarwalla^{1,*}¹Dept. and Pediatrics, MKCG Medical College and Hospital, Berhampur, Odisha, India

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ABSTRACT

Seizure in children are generally indicating a potentially serious underlying systemic or CNS disorders that require thorough clinical examination, investigation and management. It is therefore important to establish accurate diagnosis of seizure and its etiology to manage such patients appropriately.

We carried out this study to evaluate different etiology of seizures and its correlation with abnormal EEG & abnormal neuroimaging in the age group of 2mo to 14 years. 200 children presented with seizure to our department from January 2019 to November 2020 were enrolled in this prospective hospital-based study. Detailed history, clinical examination, investigation with special emphasis to EEG & neuroimaging was done and different correlation was drawn by using SSPS 18.0 statistical analysis. Among 200 cases, 6 to 10yr. age group constituted maximum (49%) number of cases. Male to female ratio is 1.5:1. GTCS is the predominant pattern of seizure (60%) in all age groups. EEG abnormality is found in 45%, mostly in focal seizure type. Neuroimaging abnormality found in 29%. Maximum cases (30%) had infectious etiology. Childhood seizure needs detailed history taking and careful examination. Video recording shown by parents / caregivers really help towards differentiating seizure from seizure mimics. EEG has a role in specific seizure type; Neuroimaging at times helps in diagnosis.

There are few studies that describe neuroimaging [Computed Tomography (CT) and Magnetic Resonance Imaging (MRI)] and Electroencephalogram (EEG) data in children who present with new-onset seizures. The EEG is recommended as a part of the neurodiagnostic evaluation of the child with an apparent first unprovoked seizure.

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1. Introduction

Seizure occurs due to synchronization of electrical waves in the brain. Convulsion denotes to motor seizure. Fits is a layman terminology where as EPILEPSY means mostly generalized seizure of idiopathic aetiology. As per ILAE 2017 seizures are mainly focal, generalized and unclassified type. Seizure disorder includes all variety of seizures like febrile seizure[FS], GEFS+ syndrome, symptomatic seizure due to neuroinfection, metabolic causes like hypoglycemia, hypocalcemia, dyselectrolytemia,

different syndromic seizure like LG syndrome, WEST syndrome, LKS, DRAVET syndrome, benign rolandic epilepsy of childhood and last but not least primary generalized epilepsy[PGE]. EPILEPSY is more common in developing world in comparison to developed world. Till now also among many rural pockets epilepsy is treated as social stigma, thus heading towards naturopathy, mixopathy and non allopathic treatment.¹

Any child presenting with seizure initial job is to confirm whether it is seizure or not? Many times seizure mimics like benign paroxysmal vertigo, syncope, hysteria, cyanotic spell, migraine, suddening Attack, gratification disorder, dystonia, extrapyramidal reaction and different movement

* Corresponding author.

E-mail address: sunil_9910@yahoo.com (S. K. Agarwalla).

disorder do present like seizure. Once it is confirmed to be seizure immediately after ABC management IV assess is to be made. Our main aim is always to abort seizure following seizure protocol irrespective of causality of seizure.

After control of seizure detail history to be taken regarding family history, number of attack, neurodevelopmental status, particular age group, timing of seizure, clinical semiology, provoking factor like fever, sound, photic stimulation or hyperventilation, detail drug history, compliance. All seizure should be managed following syndromic approach.^{2,3}

Neuroinfection like neurocysticercosis and tuberculoma are the important causes of unprovoked seizure in developing country like INDIA where as in developed countries neoplasm, CVA, motor delay and head trauma are common causes.⁴

Neonatal seizure are different category of seizure out of which subtle and multifocal seizure are common. Hypoxic ischemic encephalopathy [HIE] is the commonest cause of seizure in neonates within first day of life. Besides this hypoglycemia, hypocalcemia. Hyponatremia, hypokalemia, neuronal malformations, meningitis, uremia and inborn error of metabolism [IEM] are the important causes of neonatal seizure. Causes of neonatal seizures encompass virtually the entire spectrum of neurologic disorders of infancy, but most neonatal seizures today are due to hypoxic-ischemic brain injury and intracranial hemorrhage.⁵ Phenobarbitone is the drug of choice for seizure management. Levitiracetam is being used nowadays in many neonatal centers in developed world.

Patients may also be grouped not just by type of seizure but by type of epilepsy. This classification system groups patients according to clinical, electrographic, radiographic, and pathologic findings. In the current International Classification,⁶ the partial or focal epilepsies are called "localization-related epilepsies."

EEG being considered as helping tool in diagnosis of syndromic seizure particularly. But always clinical semiology and EEG both along with detail history will pinpoint towards diagnosis. Certain conditions like SSPE, absence seizure, LG syndrome, benign Rolandic epilepsy of childhood, infantile spasm will have typical characteristic findings in EEG. Some times before stopping of AED EEG are of immense help. Misinterpretation of such non-epileptogenic phenomena, or overinterpretation of non-specific EEG abnormalities and spiky/paroxysmal variants of normal cerebral rhythms, are a common reason for over-diagnosis of epilepsy.⁷

As mentioned by Baheti R⁸ partial seizures must be evaluated with EEG as well as CT scan as there are nearly 50% chances of finding some structural cerebral lesion and also because EEG is a useful tool.

In last 2 decades neuroimaging has revolutionized towards diagnosis and management of seizure. Many cases

of idiopathic seizure treated before neuroimaging era might be cases of neurogranuloma as more and more number of cases are coming as Ring Enhancing Lesion (REL) are coming out to be neurogranuloma. Any new onset focal seizure in a otherwise neurodevelopmentally normal child neuroimaging is a must to rule out pathology in the brain. MRI being the modality of choice in ICSOL, Neurodegenerative conditions where as bone, blood and calcification [BBC] are being better visualized in CT imaging. MR angiography can lead to diagnosis of vascular malformation.

MRI is superior to CT imaging in assessing refractory seizure and temporal lobe epilepsy. During follow-up of ICSOL, post surgical patients MRI score over CT imaging.

This study is to evaluate various etiologies of seizures and to study the clinical correlation and importance with EEG and neuroimaging studies. This helps in early intervention and prevention of neurological complications. Early detection and institution of prompt remedial measures so that it resulting favorable prognosis. Our MKCG Medical College, Dept. of pediatrics caters large number of patients from south Odisha and adjoining parts of AP. Lot cases used to present with seizure because of varied etiology. So this study will be of immense help to find out the arena of causes of seizure for early intervention, thus reducing morbidity and mortality.

2. Aim of the study

To study the various etiologies of seizures in patients of age group of 2mo to 14 years presented to MKCG medical college, Berhampur, to find out frequency of abnormal EEG and abnormal neuroimaging in these cases and various correlations among them.

3. Materials and Methods

We conducted a hospital based prospective study in the department of pediatrics, MKCG medical college, Berhampur from January 2019 to November 2020. We included all children of age group 2 mo. to 14 years presented to our department with seizure during the study period. We took neonatal seizure, pseudo seizure, simple febrile seizure and metabolic seizure as exclusion criteria. According to the inclusion and exclusion criteria 200 numbers of cases were included. All patients were subjected to detailed history and clinical examination as per case Proforma. As per need, appropriate investigation was done with special emphasis on EEG, CT scan Brain, and MRI brain.

The collected data were interpreted and analysed using SPSS software (version 18) and described in terms of frequency and percentage in the form of text, tables and pictorial form. Relevant associations were made using chi-square test and different attributes were made and p value

was calculated. P value <0.05 taken as significant.

4. Results & Discussion

The investigation of a seizure disorder depends on many factors, including age of patient, type of seizure, frequency, presence or absence of neurologic findings and constitutional symptoms.⁹

200 cases of seizure cases of 2mo. to 14 years of age were studied, from January 2019 to Nov 2020 in the Department of Pediatrics, M.K.C.G. Medical College and Hospital, Berhampur. Detailed history, physical examinations and investigations (including EEG and neuroimaging) were done in all cases to find out the etiology of seizures and correlation of seizure with etiology, EEG and neuroimaging. Among 200 cases, 6-10 year age group constituted the maximum (98 cases, 49%) followed by 2mo.- 5 year age group (62 cases, 31%) and 11-14 year age group (40 cases, 20%).

Table 1: Generalized vs. Focal seizure semiology

Generalized / Focal	Seizure Semiology	%
Generalized (64%)	GTCS	54
	Tonic	5
	Myoclonic	3
	Absence	2
Focal (36%)	Simple Focal seizure	15
	Complex Focal seizure	21

(Table 1 indicates that GTCS being common type generalized seizure where as complex focal seizure is common type in Focal seizure).

The male groups constituted the majority (120 cases, 60%) than the female group (80 cases, 40%). The male: female ratio is 1.5:1. Regarding seizure pattern, out of 200 cases, 128 cases (64%) presented with generalized seizure and 72 cases (36%) presented with focal seizure. GTCS (54%) is the predominant seizure subtype followed by complex partial seizure (21%), simple partial seizure (15%), tonic seizure (5%), and myoclonic seizure (3%). Absence seizure (2%) was least common type of seizure in our study. Regarding seizure pattern in different age group, GTCS was the predominant seizure type in all age group. EEG was done in 200 cases out of which EEG abnormality was found in 96 cases (48%). Shinnar et al.¹⁰ found EEG abnormality to be present in 42% of patients. Out of 128 cases of generalized seizure, 75 cases (58.5%) had normal EEG and 53 cases (41.5 %) had abnormal EEG. Out of 72 cases of partial seizure, 29 cases (40.3 %) had normal EEG and 43 cases (59.7%) had abnormal EEG. So EEG abnormality was high in partial seizure group than generalized seizure.

(Table 2 shows EEG is abnormal in more number among focal seizure type)

Table 2: EEG correlation among different seizure type

Seizure type	Normal EEG	Abnormal EEG	Total
Generalized	75(58.5%)	53(41.5)	128(100%)
Focal	29(40.3)	43(59.7%)	72(100%)
Total	104(52%)	96(48%)	200(100%)

Neuroimaging (CT/ MRI) done in all cases. Out of 200 cases, 144 cases (72%) had normal neuroimaging and 56 cases (28%) had abnormal neuroimaging.

Out of 128 cases of generalized seizure, 98 cases (76.5%) had normal and 30 cases (23.5%) had abnormal neuroimaging. Out of 72 cases of focal seizure, 46 cases (63.9%) had normal neuroimaging and 26 cases (36.1%) had abnormal neuroimaging. Out of 56 cases of abnormal neuroimaging, 14 cases (25%) had cerebral atrophy, 9 cases (16%) had dilated ventricle, 2 cases (10.7%) each had cerebral abscess, infarction, calcification and tumor, 7 cases (12.6%) had tuberculoma, 16 cases (28.5%) had neurocysticercosis, 2 cases (7.2%) each had porencephalic cyst and corpus callosal agenesis. So neurocysticercosis and cerebral atrophy were most common neurological abnormality.

Table 3: CT/MRI correlation among different seizure type

Test	CT/ MRI Normal	CT/MRI Abnormal	Total
Generalized	98(76.5%)	30(23.5%)	128
Focal	46(63.9%)	26(36.1%)	72
Total	144	56	200

(Table 3 shows more% neuroimaging abnormality in focal seizure type)

Regarding correlation of neuroimaging (CT/MRI) with EEG, Out of 104 cases of normal EEG, 92 cases (88.4%) had normal neuroimaging and 12 cases (11.6%) had abnormal neuroimaging and out of 96 cases of abnormal EEG, 52 cases (54.2%) had normal and 44 cases (45.8%) had abnormal neuroimaging. Thus, neuroimaging abnormality was seen more commonly in those patients who had an abnormal EEG. Regarding correlation of atypical febrile seizure and EEG, out of 52 cases of atypical febrile seizure, abnormal EEG was detected in 7 cases i.e. in 13.4% of cases of atypical febrile seizure had abnormal EEG. Thus probability of finding abnormal EEG in atypical febrile seizure is very less.

Regarding correlation of atypical febrile seizure and neuroimaging (CT/MRI), no neuroimaging abnormality was found in atypical febrile group. Out of 27 cases of ring enhancing lesions [REL] 7 cases (25.9%) had tuberculoma, 16 cases (59.3%) had neurocysticercoma and 2 cases (14.8%) each had cerebral abscess and brain tumor. Thus neurocysticercosis was the leading cause of ring enhancing lesion [REL].

Regarding etiology of different seizure, maximum cause of seizure in children is due to infectious etiology (pyogenic meningitis, viral encephalitis and tubercular meningitis) which constituted 44 cases (22%) followed by atypical febrile seizure (38 cases, 19%) and epilepsy group (36 cases, 18%). Cerebral palsy constituted 8% of cases, epileptic syndromes 6%, tuberculoma 3.5%, neurocysticcoma 8%, congenital hydrocephalus, brain tumor, stroke, cerebral abscess 2% each, porencephalic cyst, tuberous sclerosis, corpus callosal agenesis, SWS in 3% of cases and undiagnosed seizure in 4.5% of cases.

5. Summary

Seizure is common neurological problem in pediatric age group. A careful and detailed history, thorough clinical examination, finding of neurocutaneous markers, sometimes EEG or more advanced testing is required to differentiate it. Majority of seizures begin in childhood and there is male predominance of seizure. Generalized seizure is the predominant seizure type and GTCS is the major seizure subtype in all age group in our study. Epileptiform abnormalities in the EEG support a clinical diagnosis of seizure, help in the diagnosis of specific syndrome. Many epileptic syndromes are diagnosed by EEG only. A normal EEG may not exclude seizure disorder in children. Computed tomography (CT) scans and magnetic resonance imaging (MRI) scans are important adjunct to clinical examination and EEG in the evaluation of seizure. CT scan is more useful in detecting calcifications, neurocysticercosis, tuberculoma, metastatic tumors, abscesses. Normal EEG finding may have abnormal CT/MRI finding. In atypical febrile seizure, the probability of getting abnormal EEG and neuroimaging is very less.

6. Conclusion

Most common cause of ring enhancing lesion (REL) was neurocysticercosis. Major etiological factor of seizures in children are CNS infection, epilepsy, febrile seizure and cerebral palsy. Most of the seizures can be prevented by controlling infection, improving health education, controlling tuberculosis, neurocysticercosis, preventing birth asphyxia. Documentation of clinical semiology, syndromic approach, and targeted intervention will give a path for better management and outcome. Seizures should be adequately treated according to the etiology and should be controlled with antiepileptic drugs [AED] in order to prevent further brain damage. Parents should be counseled for adequate and regular use of antiepileptic drugs and follow up. In this 21st century seizure is no more a social stigma entity. Proper counseling, patient education and appropriate duration of therapy will lead to better compliance thus giving a quality life to idiopathic epileptic and syndromic seizure children.

IN diagnosis and management of seizure in children EEG and Neuroimaging like CT/MRI brain is of paramount importance. Either normal EEG or normal CT/MRI brain or both does not rule out possibility of seizure. Abnormal EEG in partial seizures increases the risk of having abnormal neuroimaging. But normal EEG in partial seizures does not rule out having an abnormal neuroimaging.

Every Child presenting with partial seizures must undergo EEG and imaging study like CT scan, as both collectively help in establishing the etiology of partial seizure and thus serves as a reliable guide for appropriate management.^{11,12}

7. Conflict of Interest

The authors declare that there are no conflicts of interest in this paper.

8. Source of Funding

None.

References

1. Mikati MA, Hani AJ. Seizures in childhood. In: Kleigman R, Stanton B, Schor N, Geme J, Behrman R, editors. Nelson Textbook of Pediatrics. vol. 19. Philadelphia, Saunders; 2011. p. 2013–7.
2. Pohlmann-Eden B, Beghi E, Camfield C, Camfield P. The first seizure and its management in adults and children. *BMJ*. 2006;332(7537):339–42. doi:10.1136/bmj.332.7537.339.
3. Hirtz D, Ashwal S, Berg A, Bettis D, Camfield C, Camfield P, et al. Practice parameter: evaluating a first nonfebrile seizure in children: report of the quality standards subcommittee of the American Academy of Neurology, The Child Neurology Society, and The American Epilepsy Society. *Neurology*. 2000;55(5):616–23.
4. Agarwalla SK, Mishra KP, Momin N. Multifarious Pediatric Seizures: It's Correlation with EEG & Neuroimaging. *JMSCR*. 2020;8(2):85–9.
5. Jin SH, Oslon DM. Etiology of neonatal seizures. *Neo Rev*. 2004;5:327–35. doi:10.1542/neo.5-8-e327.
6. Washimkar SN, Holay MP, Fusey SM. Evaluation of focal seizure by computerized tomography. *JAPI*. 1996;44:959–60.
7. Benbadis SR, Tatum WO. Overinterpretation of EEGs and misdiagnosis of epilepsy. *J Clin Neurophysiol*. 2003;20:42–4.
8. Baheti R, Gupta BR, Baheti R. A study of CT and EEG findings in patients with generalized or partial seizures in Western Rajasthan. *J Indian Acad Clin Med*. 2003;4:25–9.
9. Camfield CS, Camfield PR, Dooly JM. epilepsy after a first unprovoked seizure in child-hood. *Neurology*. 1985;35(11):1657–60. doi:10.1212/wnl.35.11.1657.
10. Shinnar S, Kang H, Berg AT, Goldensohn ES, Hauser WA, Moshé SL, et al. EEG abnormalities in children with a first unprovoked seizure. *Epilepsia*. 1994;35:471–6.
11. Rasool A, Choh SA, Wani NA, Ahmad SM, Iqbal Q. Role of electroencephalogram and neuroimaging in first onset afebrile and complex febrile seizures in children from Kashmir. *J Pediatr Neurosci*. 2012;7(1):9–15. doi:10.4103/1817-1745.97611.
12. Commission on Classification and Terminology of the International League Against Epilepsy. Proposal for classification of epilepsies and epileptic syndromes. *Epilepsia*. 1985;26:268–78.

Author biography

Sunil Kumar Agarwalla, Associate Professor

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