VOLUME - 12, ISSUE - 05, MAY - 2023 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Pediatrics

TO CORRELATE CLINICAL FEATURES WITH EEG FINDINGS AND NEUROIMAGING (MRI) ABNORMALITIES IN CHILDREN WITH SEIZURE DISORDER

Dr. Anuj Shamsher Sethi	MD, Assistant Professor, Department of Pediatrics, M.L.B. Medical College, Jhansi (U.P.)
Dr. Jitendra Kumar Singh	MD, Senior Resident, Department of Pediatrics, M.L.B. Medical College, Jhansi (U.P.)
Dr. Om Shankar Chaurasia	MD, Professor and Head Department of Pediatrics, M.L.B. Medical College, Jhansi (U.P.)
Dr. R.S. Sethi	MD, DCH, Professor and Former Head, Department of Pediatrics, M.L.B. Medical College, Jhansi (U.P.)

ABSTRACT

Objectives: To evaluate the findings of EEG and MRI in childhood seizure disorder, and to determine correlation between clinical features, EEG findings and neuroimaging (MRI) abnormalities in children with seizure disorder. **Methods:** The present study was carried out in the department of Pediatrics in active collaboration with department of Radiodiagnosis, Maharani Laxmi Bai Medical College, Jhansi over a period of one year from june 2019 to june 2020. Children of 1 month to 15 years of age attending in OPD for follow up or admitted in pediatric wards were selected for this study. All patients underwent EEG and MRI. Our study group comprised of 70 cases of epilepsy, Among which 45 were male and 25 were female. The correlation between MRI and EEG abnormal findings was analyzed using chi-square test. **Result:** Out of 70 cases, 45 cases were male and 25 cases were female. 52.85% cases had generalized seizure and 47.14% cases had partial seizure. Out of 70 cases, 50 cases had structural lesions, 4 cases had metabolic problem, 9 cases had fever and 7 cases had idiopathic etiology. 57.14% cases had abnormal MRI findings. MRI abnormality present was ventricular abnormalities (22.85%), white matter lesion (14.28%), brain stem and cerebellar abnormalities (11.42%), cortical lesion (grey matter) (8.57%), deep grey matter (7.14%) and miscellaneous (2.85%). Out of 70 cases 44 cases had EEG abnormality. Out of 70 cases, 13 had normal MRI with normal EEG, 17 had normal MRI with abnormal EEG, 13 had abnormal MRI with normal EEG and 27 had abnormal MRI with abnormal EEG. The correlation between abnormal EEG and abnormal MRI was statistically not significant (p=0.35). **Conclusion:** Our study reveals that both EEG and MRI are important tools in diagnosis of epilepsy in children and MRI is specially important to diagnose structural lesions in symptomatic epilepsy. In our study no significant correlation was found between abnormal EEG and abnormal MRI findings.

KEYWORDS : Csorrelation between EEG and MRI, seizure disorder in children, MRI, EEG

INTRODUCTION

Seizure disorder is one of the most common treatable neurological disorders of the Brain **(WHO, 2005)**[1]. Seizure disorder is a general term that is usually used to include any one of several disorders including epilepsy, febrile seizures, and possibly single seizures and seizures secondary to metabolic, infectious or other etiologies. Seizures are symptoms caused by abnormal discharges in neurons in the central nervous system. Approximately 5% to 10% of children have a seizure episode during the first 2 decades of life. The lifetime prevalence rate of epilepsy is 1% [2].

Epilepsy is disorder of the brain characterized by an enduring predisposition to generate epileptic seizures, and by the neurobiological, cognitive, psychological, and social consequences of this condition. Epilepsy is one of the most common neurological condition affecting approximately 50 million people worldwide. The World Health Organization (WHO) defines epilepsy as a neurological condition characterized by the occurrence of two or more unprovoked seizures. Approximately 30% of patients who have first afebrile seizure have later epilepsy; the risk is approximately 20% if neurologic examination, EEG, and neuroimaging are normal. Approximately 4-10% of children experience at least one seizure in the first 16 years of life. The cumulative lifetime incidence of epilepsy is 3%, and more than half of the cases start in childhood. The annual prevalence is 0.5-1%[3]. The essential diagnostic evaluation for an unprovoked seizure remains a source of debate.

EEG and Neuroimaging are two usual ways to use for this purpose. The goal of the diagnostic assessment is to prepare evidence that helps establish or disprove the diagnosis of epilepsy and to determine the cause of epilepsy to classify the epileptic syndrome. EEG helps determine seizure type and epilepsy syndrome, and thereby choice of antiepileptic medication and prediction of prognosis. EEG findings contribute in terms of whether the seizure disorder is focal or generalised, idiopathic or symptomatic, or part of aspecific epilepsy syndrome.

Imaging is recommended when localization-related epilepsy is known or suspected, when the epilepsy classification is in doubt, or when an epilepsy syndrome with remote symptomatic cause is suspected. The basic role of radiological imaging in epilepsy is to define any structural anomalies or pathologies and to aid in the patient treatment protocol. MRI is considered the imaging modality of choice because of superior anatomic resolution and characterization of pathologic processes, versatility, and lack of radiation. The sensitivity of MRI in identifying epileptogenic foci in patients with medically refractory patients has been reported to be more than 80% **(Bano S et al, 2011)**[4].

Neuroimaging specially computed tomography (CT) scan also has a critical role in the evaluation of patients with seizure for overruling the life-threatening causes. MRI is the one of best neuroimaging study for the assessment of a child with seizures. MRI is more sensitive than CT scan for identifying brain abnormality and dysplastic lesions especially in the hippocampus, a common site of seizure onset **(Hsieh DT et al, 2010)**[5]. Considerable MRI abnormalities in children with epilepsy are present in 16-21% and the most frequent structural abnormality are congenital impairments,

neurocutaneous syndromes, malignancy, and evidence of encephalopathy due to trauma, infection or asphyxia insult **(Arthur TM et al, 2008; Berg AT et al, 2009; Shinnar S et al, 2001)**[6-8]. Furthermore, all MRI abnormal findings are not related to epileptic seizures. white matter Punctuate foci of T2 signal change, some cystic lesions (choroidal fissure cysts, arachnoid cysts), lacunar infarctions, diffuse atrophy, ventricular asymmetry and isolated venous anomalies (i.e. those not correlated with arteriovenous malformation or cavernous angioma) are not recognized to be cause of epilepsy, and must be assigned incidental to a seizure diagnosis **(Vattipally VR et al, 2004)**[9].

AIMS AND OBJECTIVES

1. To evaluate the findings of EEG in childhood seizures disorder.
2. To evaluate the role of MRI in diagnosis and management of childhood seizure disorder.
3. To determine correlation between clinical features, EEG findings and neuroimaging (MRI) abnormalities in children with seizure disorder

MATERIAL AND METHODS:

The present study was carried out in the department of Pediatrics in active collaboration with department of Radiodiagnosis, Maharani Laxmi Bai Medical College, Jhansi over a period of one year from june 2019 to june 2020. Children of 1 month to 15 years of age attending in OPD for follow up or admitted in pediatric wards were selected for this study.

A written informed consent of the parents of the subjects was taken prior to participation.

Study group:

Our study group comprised of 70 cases of epilepsy, age group between one month to 15 years. Among the study groups 45 were male and 25 were female.

Inclusion criteria:

1. All cases of epilepsy aged between one month and 15 years.
2. Cases of febrile seizure, atypical febrile seizure, idiopathic seizure (Cryptogenic seizure), seizure because of metabolic, infective and anatomic structural defect will be taken.

Exclusion criteria:

1. Neonatal seizures (less than 1 month for the present study) because they have various possible etiologies for seizures.
2. Parents /Patients who refused to consent for inclusion in the study.
3. Children with seizures following head injury.
4. Children with seizures following poisoning

A surface EEG was performed for all of the patients and any abnormalities found was noted. Following characteristics was taken into consideration while doing EEG-

- Hyperventilation,
- Photic stimulation (with a strobe light),
- Eye closure,
- Mental activity,
- Sleep and sleep deprivation.
- During (inpatient) epilepsy monitoring, a patient's typical seizure medications was withdrawn.

The EEG was interpreted via single pediatric Neurologist. MRI Brain was done using 0.3 tesla machine in the department of Radiodiagnosis, MLB Medical College, Jhansi. The films were reported independently by radiologist who had extensive epilepsy imaging experience.

Sedation was given (as per requirement) to reduce anxiety and movement to avoid motion artefacts. Sedatives/hypnotics at the lowest possible dose was preferred. General anaesthesia (GA) was chosen in selected children- those requiring long duration scans and those with history of failed sedation. The children receiving anaesthesia/ sedation were constantly monitored by an experienced anaesthetic team with appropriate monitoring equipment (including electrocardiography, pulse oximetry, blood pressure, and body temperature assessments). All members of the anaesthetic team were familiar with MRI-specific safety issues and the requirements of the diagnostic procedure before induction of patient.

Data analysis:

Statistical analyses were conducted using SPSS version 26. The pattern of seizure distribution and correlation between seizure pattern and neuroimaging findings were analyzed. Comparison across levels of categorical independents variables was done using student "t" and ^{2} (Chi-square) test. The P - values less than or equal to 0.05 ($P \leq 0.05$) were treated as statistically significant.

RESULTS

Out of 70 cases, 45 cases were male and 25 cases were female. Ratio of male:female was 1.8:1. Out of 45 male cases, 30 had generalized seizures and 15 had partial seizures. Out of 25 female cases 7 had generalized seizures and 18 had partial seizures.

Out of 70 cases, 50 cases had structural lesions, 4 cases had metabolic problem, 9 cases had fever and 7 cases had idiopathic etiology. MRI abnormality was present in 33 cases of structural lesion, 2 cases of metabolic problem, 3 cases of febrile illness and 2 cases of idiopathic etiology. There was significant correlation between structural etiology and MRI abnormality ($p=0.0179$) ($t= 0.4147$)

Structural lesions present were neurocysticercosis (12), meningitis (10), encephalitis (9), cortical malformation (7), tuberculoma (5), stroke (4) and neurocutaneous syndrome (3). Out of 70 cases in our study group 24.28% had complaints of fever, 55.71% had loss of consciousness, 14.28% had focal deficit, 14.28% had meningeal sign, 15.71% had developemental delay, 4.28% had neurocutaneous marker, 52.85% had generalized seizure, and 47.14% had partial seizure on presentation.

Table 1: EEG changes

EEG changes	Number of patients	Percentage
Generalized epileptiform discharge	25	56.81%
Focal	17	38.63%
Hypsarrhythmia	2	4.54%
Total	44	100%

Out of 70 cases 44 had EEG abnormality. 56.81% cases had generalized epileptiform discharge, 38.63% had focal epileptiform discharge and 4.54% had hypsarrhythmia.

Table 2: Distribution of MRI abnormalities on basis of anatomical structures involved

MRI abnormality	Number of patients	Percentage
Ventricles	16	22.85%
White matter lesion	10	14.28%
Brain stem and cerebellum	8	11.42%
Cortical lesion (grey matter)	6	8.57%
Deep grey matter(basal ganglia,thalamus)	5	7.14%
Miscellaneous	2	2.85%

MRI abnormality present was ventricular abnormalities (22.85%), white matter lesion (14.28%), brain stem and cerebellar abnormalities (11.42%), cortical lesion (grey matter) (8.57%), deep grey matter (7.14%) and miscellaneous (2.85%).

Out of 70 cases 42 cases were in 0-5 years age group, 17 in 6-11 years and 11 were in 12-15 years age group. MRI abnormalities were in 0-5 years (28 cases), 6-11 years (8 cases) and 12-15 years (4 cases). The correlation between age of onset of seizure and abnormal MRI was not significant. (p=0.1224) (t=0.365). It is evident from the table that maximum abnormality in MRI were observed in children between 0-5 years age group(40%), while 11.42% MRI abnormailty were present in children between 6-11 years age group and least (5.71%) MRI abnormality were present in children between 12-15 years age group.

Out of 70 cases 42 were in 0-5 years age group, 17 were in 6-11 years age group and 11 were in 12-15 years age group. EEG abnormality was present in 26 cases (0-5 years), 12 cases (6-11 years) and 6 cases (12-15 years). Correlation between age of onset and EEG abnormality was statistically not significant (p=0.67) (t=1.6665). Out of 70 cases 5 cases have positive family history of seizure. Out of 5 cases 3 have abnormal EEG findings and the correlation was statistically not significant. (p=0.89)

Table 3: Correlation between types of seizure and abnormal EEG

	EEG		Total (70)
	Normal	Abnormal	
Partial	15	18	33 (47.14%)
Generalized	11	26	37 (52.85%)

Out of 70 cases 33 cases (47.14%) had partial seizure and 37 cases (52.85%) had generalized seizure episode. In our study generalized seizure were observed more than the partial seizure. Out of 33 cases of partial seizure 18 had abnormal EEG and out of 37 cases of generalized seizure 26 had abnormal EEG. The correlation between seizure type and abnormal EEG was not significant (p=0.17).

Out of 70 cases, 12 had developmental delay, 3 had behavioural issue, 2 had academic difficulty and 53 had no co-morbidity. Correlation between developmental delay and abnormal EEG was significant (p=0.02) (t=0.023)

Table 4: Correlation between abnormal EEG and abnormal MRI

MRI	EEG	
	Normal	Abnormal
Normal	13(18.57%)	17(24.28%)
Abnormal	13(18.57%)	27(38.57%)
Total (70)	26(37.14%)	44(62.85%)

Out of 70 cases, 13 had normal MRI with normal EEG, 17 had normal MRI with abnormal EEG, 13 had abnormal MRI with normal EEG and 27 had abnormal MRI with abnormal EEG.

The correlation between abnormal EEG and abnormal MRI was statistically not significant. (p=0.35). Out of 70 cases, 22 cases were on monotherapy and 48 cases were on polytherapy. Out of 22 cases on monotherapy 5 had abnormal EEG and out of 48 cases on polytherapy 39 had abnormal EEG. The correlation was statistically significant. (p=<0.00001) (t=0.046).

DISCUSSION

Seizure is a transient occurrence of signs and or symptoms resulting from abnormal excessive or synchronus neuronal activity in the brain. Epileptic seizure displays the clinical manifestation of excessive, abnormal, unprovoked, synchronus discharges of neuron residing primarily in the brain cortex. Seizure disorder is one of the most common treatable neurological disorder of brain.

Very few studies have been conducted to evaluate utility of EEG and neuroimaging (MRI) in seizure disorder in clinical practice.

The present study was carried out to correlate the Clinical features, with EEG findings and MRI abnormalities in 70 children age group between 1 month to 15 years with seizure disorder, over a period of one year from June 2019 to June 2020, in active collaboration with department of radio diagnosis of Maharani Laxmi Bai Medical College, Jhansi.

In our study, out of 70 cases 45 cases (64.29%) were male and 25 cases (35.71%) were female. Our study is comparable to the previous study conducted by Doescher et al (2006)[10] in which out of 181 cases 50.27% were males and 49.72% were females. In the study conducted by S Amirsalari et al (2011)[11] out of 200 cases, 115 (57.7%) were boys and 85 (42.5%) were girls. In a similar study conducted by Mohan b et al (2018)[12] the number of male patients were 77 (69%) and female patients were 35 (31%). Similarly Ngo Minh xuan et al (2020)[13] reported 51.8% boys and 48.2% girls.

The most common etiology causing seizure disorder in children was structural lesion in our study (71.42%). Most common structural abnormality was ring enhancing lesion (24.28%). Of these 17.14% children had neurocysticercosis and 7.14% children had tuberculomas. The correlation between structural lesion and abnormal MRI finding was statistically significant (p=0.0179).

In study conducted by Nilima N et al (2017)[14] most common MRI abnormality was structural lesion (59%), out of which most common was ring enhancing lesion (19%). Of these, 12(12%) children had neurocysticercosis and 7(7%) children had tuberculoma. According to Nilima N et al(2017)[14], there was a significant statistical association between MRI abnormality and structural lesion (p<0.05).

In our study, 44 cases (62.85%) had abnormal EEG, 25 cases (56.81%) had generalized epileptiform discharge, 17 (38.63%) cases had focal epileptiform discharge and 2 (4.54%) cases had hypsarrhythmia on EEG. Previously study done by Nilima N et al (2017)[14] 66% children had abnormal EEG. Out of 100 children enrolled, 35% had generalized epileptiform discharges, 29% had focal epileptiform discharges while 2% had EEG suggestive of hypsarrythmia.

However on the contrary, Doescher et al (2006)[10] and Ngo Minh xuan et al (2020)[13] in their studies, reported focal epileptiform discharges were more common. In study done by Doescher et al[10], in 119 children epileptiform activity was seen. Out of 119 children,in 89 children (74.8%) there was focal epileptiform discharge.

In study done by Ngo Minh xuan et al (2020)[13], most common EEG abnormality was focal epileptiform discharges which was found in 75.9% of cases. In our study 57.14% cases had MRI abnormality. 22.85% cases had ventricular abnormalities, 14.28% cases had white matter lesion, 11.42% cases had brain stem and cerebellar abnormalities, 8.57% cases had cortical lesion (grey matter), 7.14% cases had deep grey matter abnormalities and 2.85% cases had miscellaneous findings on MRI. Studies done previously by J.S. Doescher (2006)[10], S Amirsalari et al (2011)[11] and Ngo Minh Xuan (2020)[13] had reported similar findings, which is comparable to our study.

In the study conducted by Doescher et al (2006)[10], MRI abnormalities were present in 32.6% cases.

S amirsalari et al (2011)[11] and Nilima et al (2017)[14] reported abnormal MRI finding in 28% and 59% patients respectively. Similarly in study conducted by Ngo Minh xuan (2020)[13] in 34.8% children MRI abnormalities were present.

Abnormal MRI findings were observed more in our study as compared to other studies. This is probably due to more number of structural lesion in our study.

The age of onset of seizure in our study ranged from 2 month to 15 years with mean age of onset of seizure 5.5 years. No significant correlation was found between age of onset of seizure and MRI abnormality in our study (p=0.122). Similar study done by Nilima N et al, (2017)[14] which is comparable to our study (p>0.05).

In our study there was no significant correlation between age of onset of epilepsy and EEG abnormality (p=0.67) which is comparable to previous study (Nilima N et al)[14] (p>0.05).

In our study out of 70 cases 5 cases had positive family history of seizure disorder,out of which 3 cases had abnormal EEG findings. The correlation between positive family history of seizure disorder with abnormal EEG was statistically not significant (p=0.89). Previous study which is comparable to our study was done by Nilima N et al (2017)[14] (p>0.05).

In our study, generalized seizures (52.8%) were more common as compared to partial seizures (47.1%). Our study is comparable to the results of various studies done previously by S.Shinnar et al,(1994)[15] , Sameer et al (2017)[16] and Mohan B et al (2018)[12]. In study conducted by Shashibala Yadav et al (2018)[17], most common type of seizures were found to be generalized seizures (60%). Which is comparable to our study. On contrary in studies done by Doescher et al (2006)[10], S Amirsalari et al (2011)[11], Nilima N et al (2017)[14] and Chan et al (2010)[18], partial seizures were more common than generalized seizures.

In study conducted by Doescher et al (2006)[10], 110 children had partial seizure and 70 children had generalized seizure.

In study conducted by S Amirsalari et al (2011)[11], 77.6% of female patients and 56.5% of male patients had focal seizure.

In study conducted by Nilima N et al (2017)[14], out of 100 children, 43 children had focal seizure and 42 had generalized seizure.

In our study no significant correlation was found between types of seizure and abnormal EEG (p=0.17), which is comparable to previous study done by Nilima N et al (2017)[14] (p>0.05).

On contrary to this study done by S.Shinnar et al (1994)[15], abnormal EEG were more common in children with partial seizure (56%) than in children with generalized seizures (35%). The association between partial seizures and an abnormal EEG was statistically significant (p<0.001).

In our study a significant correlation was found between partial seizure and MRI abnormality (p=0.045). Study done by sameer et al (2017)[16], in partial seizure 62.3% cases had abnormal MRI findings, in case of generalized seizures 26.3% had abnormal MRI and in other seizure types (unclassified) 63% cases had abnormal MRI findings. This difference was statistically significant (p=0.003).

On contrary to our study, studies done by Resta et al, (1994)[19], S Amirsalari et al (2011)[11], Rasool et al (2012)[20], Nilima et al (2017)[14] had found no significant correlation between types of seizure and abnormal MRI (p>0.05). In study done by Resta et al (1994)[19], they tried to correlate between partial seizure with abnormal MRI. Out of 109 cases 57 cases had abnormal MRI findings and 52 cases had normal MRI findings and the association was statistically not significant (p=0.16).

In study done by Rasool et al (2012)[20] abnormal MRI was present in 27% cases of partial seizure, 15.8 % cases of generalized seizure, 10% of complex febrile and 50% of undetermined cases. These observation were statistically insignificant (p>0.05).

In our study, when correlation was made between abnormal EEG and co-morbidities, it was found that history of developemental delay (17.14%) had a significant correlation with abnormal EEG (p=0.02), whereas there was no statistically significant correlation between behavioural issue (4.28%), academic difficulties (2.85%) and abnormal EEG. Abnormal EEG was also noticed in patients who had no co-morbidity (75.71%) but it was not statistically significant.

In study conducted by Nilima N et al (2017)[14], 14% children had developmental delay and the correlation with abnormal EEG was statistically significant with a p-value 0.03.

In our study, out of 70 cases 13 cases(18.57%) had normal EEG with normal MRI, 17 cases(24.28%) had abnormal EEG with Normal MRI, 13 cases(18.57%) had normal EEG with abnormal MRI and 27 cases(38.57%) had abnormal EEG with abnormal MRI. No statistically significant correlation was found between abnormal EEG and abnormal MRI (p=0.35). This study is comparable to previous study by Doescher et al (2006)[10], Nilima N et al (2017)[14], Mohan B et al (2018)[12] and Ngo Minh Xuan et al (2020)[13].

In study done by Doescher et al (2006)[10], it was observed that EEG and MRI were both abnormal in 38 children, 29 children had normal EEG and normal MRI, in 21 cases had normal EEG with abnormal MRI. According to their study the association between EEG and MRI findings were not significant (p=0.09).

In study conducted by Nilima N et al (2017)[14], MRI abnormality was found in 63.3% of children with abnormal EEG and 50% of children with normal EEG and the difference was not significant (p=0.272). In their study they found that normal EEG did not reliably predict a normal MRI and normal results on EEG should not be used to place a patient in a low-risk group that does not need an MRI for a complete evaluation.

In a similar study done by Mohan B et al (2018)[12] 13% cases had abnormal EEG and MRI, In 33.1% cases EEG and MRI were normal. 31% cases had normal EEG with abnormal MRI. No significant association was found.

In study conducted by Ngo Minh xuan et al (2020)[13], there was no significant association between MRI and EEG findings (p=0.17)

Contrary to our study, significant correlation was found between abnormal EEG and abnormal MRI in previous study done by Rasool et al (2012)[20], Mehmet et al (2018)[21].

In study done by Rasool et al (2012)[20], out of 155 cases with abnormal EEG findings, 30 cases(19.4%) had abnormal MRI findings too. The correlation between abnormal EEG and abnormal MRI was statistically significant (p=0.005).

In study conducted by Mehmet et al (2018)[21], 2.3% cases had normal MRI with normal EEG, 56.3% cases had normal MRI with abnormal EEG, 2.3% cases had abnormal MRI with normal EEG and 39.2% cases had abnormal MRI with abnormal EEG. The correlation between abnormal MRI and abnormal EEG was statistically significant (p=0.007).

In our study, out of 70 cases, 22 cases were on monotherapy in which 5 had abnormal EEG and 48 cases were on polytherapy in which 39 cases had abnormal EEG. The correlation was statistically significant ($p<0.00001$). Patients on poly therapy had more EEG abnormal findings. This study is comparable to previous study by Nilima N et al (2017)[14].

In study by Nilima et al (2017)[14], EEG abnormality was found in 57.8% children on monotherapy and 80.6% on polytherapy. The correlation was statistically significant ($p=.037$).

CONCLUSION

A normal EEG does not rule out the presence of any pathology, including tumor formation. Thus EEG findings are not a good predictor of MRI results.

Although EEG and MRI are the vital diagnostic tool for accurate diagnosis of epilepsy along with a careful history and clinical examination, our findings did not show the correlation between EEG and MRI findings. This study shows that EEG results are not good indicators of MRI results and they should not be used as the only criterion for ordering MRI. Our study reveals that both EEG and MRI are important tools in diagnosis of epilepsy in children and MRI is specially important to diagnose structural lesions in symptomatic epilepsy. In our study no significant correlation was found between abnormal EEG and abnormal MRI findings

REFERENCES:

1. Atlas: Epilepsy Care in theWorld. Programme for Neurological Diseases and. Neuroscience, Department of Mental Health and Substance Abuse, World Health Organization; 2005.
2. Wyllie E. Epidemiologic aspect of Epilepsy. In : Cascino G and Goodkin P Wyllie's treatment of epilepsy and principles and practice. *Philadelphia: Lippincott Williams and Wilkins*. 2011. 5th edi. P1-10.
3. Nelson Text book of Pediatrics
4. Bano S, Yadav SN, Chaudhary V, Garga UC. Neuroimaging in epilepsy. J PediatrNeurosci 2011 Jan;6(1):19-26.
5. Hsieh DT, Chang T, Tsuchida TN, Vezina LG, Vanderver A, Siedel J, Brown K, Berl MM, Stephens S, Zeitchick A, Gaillard WD. New-onset afebrile seizures in infants: role of neuroimaging. Neurology 2010;74(2):150-6.
6. Arthur TM, deGrauw TJ, Johnson CS, Perkins SM, Kalnin A, Austin JK, Dunn DW. Seizure recurrence risk following a first seizure in neurologically normal children. Epilepsia 2008;49(11):1950-4.
7. Berg AT, Mathern GW, Bronen RA, Fulbright RK, DiMario F, Testa FM, Levy SR. Frequency, prognosis and surgical treatment of structural abnormalities seen with magnetic resonance imaging in childhood epilepsy. Brain 2009;132(Pt 10):2785-97.
8. Shinnar S, O'Dell C, Mitnick R, Berg AT, Moshe SL. Neuroimaging abnormalities in children with an apparent first unprovoked seizure. Epilepsy Res 2001;43(4261-9.
9. Vattipally VR, Bronen RA. MR imaging of epilepsy: strategies for successful interpretation. Neuroimaging Clin N Am 2004;14(3):349- 72.
10. Jason S Doescher 1, Ton J deGrauw, Beverly S Musick, David W Dunn, Andrew J Kalnin, John C Egelhoff, Anna Weber Byars, Vincent P Mathews, Joan K Austin.Magnetic resonance imaging (MRI) and electroencephalographic (EEG) findings in a cohort of normal children with newly diagnosed seizures.J Child Neurol . 2006 Jun;21(6):491-5.
11. Amirsalarl S, Saburi A, Nadi R, Torkaman M, Beiraghdar F, Afsharpayman S, Ghazavi Y. Magnetic resonance imaging findings in epileptic children and Its relation to clinical and demographic findings. Acta Med Iran. 2012;50(437-42.
12. Mohan B.1 , Ranoji Mane2 , Karthik G A3 , Vimal Raj4 , Parthasarathy5 , Venkatramana Bhat6.Utility of Magnetic Resonance Imaging (MRI) and It's Comparison with Electroencephalogram (EEG) in First Onset Seizures in Children.International Journal of Contemporary Medicine Surgery and Radiology. 2018;3(2):B4-B7
13. Ngo Minh Xuan 1, Tran Thi Khanh Tuong 2, Huynh Quang Huy 3, Nguyen Huu Son 4.Magnetic Resonance Imaging Findings and Their Association with Electroencephalogram Data in Children with Partial Epilepsy.Cureus . 2020 May 2;12(5):e7922. doi: 10.7759/cureus.7922.
14. Dr Nilima Narkhede,, Dr Tushar Maniar, Dr N.C.Joshi, Dr Shilpa Kulkarni : Correlating Clinical Features with EEG findings and Neuroimaging (MRI) abnormalities in Children with Seizure disorder. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861Nolume 16, Issue 10 Ver. V (Oct. 2017), PP 01-04.
15. S Shinnar 1, H Kang, A T Berg, E S Goldensohn, W A Hauser, S L Moshé.EEG abnormalities in children with a first unprovoked seizure.Epilepsia . May-Jun 1994; 35(3):471-6. doi: 10.1111/j.1528-1157.1994.tb02464.x.
16. Dr.SameerR. Verma , Dr.VandanaSardana.Evaluation of Non Febrile Seizure Disorder on Mri with Correlation with Seizure Type And EEG Records in Children..IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 6 Ver. X (June. 2017), PP 13-16
17. Dr. Shashibala J Yadav, Dr. Anu Sharma.Neuroimaging Abnormalities in Children Presenting With First Onset Apparent Unprovoked Seizures. February 2018International Journal Of Medical Science And Clinical Invention 5(2):3507-3512
18. Chan D1, Phuah HK, Ng YL, Choong CT, Lim KW, Goh WH.Pediatric epilepsy and first afebrile seizure in Singapore: epidemiology and investigation yield at presentation.J Child Neurol. 2010;25(10):1216-22
19. Resta M, Palma M, Dicuonzo F, Spagnolo P, Specchio LM, Laneve A, Bellomo R, Lauriero F, La Selva L. (1994) Imaging studies in partial epilepsy in children and adolescents. Epilepsia 35:1187–1193.
20. Akhter Rasool, Suhil A. Choh, Nisar A. Wani, S. Mushtaq Ahmad, and Qazi Iqbal.Role of electroencephalogram and neuroimaging in first onset afebrile and complex febrile seizures in children from Kashmir.J Pediatr Neurosci. 2012 Jan-Apr; 7(1): 9–15.
21. Mehmet Alp Dirik1 and Burcin Sanlidag2.Magnetic resonance imaging findings in newly diagnosed epileptic children.Pak J Med Sci. 2018 Mar-Apr; 34(2): 424–428.