

## A study on EEG findings: An Experience from a Tertiary Care Center of Nepal

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### Abstract

**Introduction:** The electroencephalography (EEG) is the recording of brain's spontaneous electrical activity over a period of time (15-20) minutes recorded from multiple electrodes placed on the scalp. It is used in seizure disorder, organicity, and psychiatric conditions. There is a paucity of literature with regard to the application of EEG in various conditions in our setting.

**Objective:** The current study aims to explore the EEG findings of different cases and their associations in various clinical scenarios.

**Method:** It is a retrospective study on the patients who underwent EEG in the EEG room of Department of Psychiatry at Patan Academy of Health Sciences (PAHS), Nepal for a year. Information was obtained from EEG register and reports. Data were analyzed using IBM SPSS version 23. Frequency distribution was studied and Chi Square test was applied for categorical variables. The only continuous variable studied was the age for which mean, median and standard deviation were computed and the suitable statistical tool was applied after normality testing.

**Result:** Of the total 164 patients studied, mean age was 21.93 years and 51.2% were male. The common reason for EEG referral was to rule out seizure disorder (80.5%), requested mostly from the department of Psychiatry. EEG abnormality was seen in 43.3% with EEG diagnosis of generalized epilepsy in 26.21% and slow wave (46.2%) as the most common EEG finding. Abnormal EEG detection rate was almost similar in both the genders and predominant in those with a clinical diagnosis of seizure disorder (47.88%). The EEG abnormality detection rate was significant in those referred from the Department of Psychiatry and Paediatrics.

**Conclusion:** EEG is a relatively inexpensive and non-invasive test for detection of electrical activity in the brain. Though requested for seizure or related disorders, it can also find its place in organic pathology, monitoring treatment response among others.

**Keywords:** Electroencephalogram, EEG Findings, Seizure, Nepal

### INTRODUCTION

Electroencephalography (EEG) is the recording of electrical activity produced by the firing of neurons within the brain which is recorded for about 20 to 40 minutes from multiple electrodes placed on the scalp. It is one of the tools to assess cerebral function which is based on the work by Hans Berger in the 1930s.<sup>1</sup> The main use of this noninvasive test is in epilepsy to detect seizure activity, a common problem with

estimated worldwide prevalence of 5-30 persons per 1000.<sup>2</sup> The other applications are in the diagnosis of coma, encephalopathy, and brain death.<sup>3</sup> It is also used in sleep studies and monitoring seizure during Electroconvulsive Therapy (ECT). Though gives a measure of cerebral function, the role of EEG in organic conditions is limited with the advent of newer imaging modalities like CT and MRI. The use of this neurophysiological tool has been minimum

in psychiatry despite the known relationship between epilepsy and psychosis and other psychiatric manifestations, especially with the temporal lobe abnormalities.<sup>4</sup> Patients are sent for EEG for various reasons, usually for seizure, pseudo seizure, organicity and psychosis.

There is a paucity of reported literature on EEG findings although many institutes conduct EEG in Nepal now. The current study was conducted in Patan Academy of Health Sciences (PAHS), a tertiary care health sciences center at Lalitpur, Nepal which started its EEG services from 2014. It aims to bridge the current knowledge gap and explore the EEG findings among different cases requested for EEG and their associations.

### **MATERIAL AND METHOD**

This is an analytical retrospective study conducted at the Department of Psychiatry, PAHS of 18month (Ashadh 2072 to Poush 2073). The patients requested for EEG underwent a routine non-sleep deprived EEG using the international standardized 10-20 system of electrode placement. Photic stimulation and hyperventilation methods were used during the EEG recordings where age was not a barrier. All EEGs were done by one technician with the same EEG machine (16 channels RMS digital). All records were reported by the same psychiatrist.

All the patients referred for EEG were considered for the study. Data of 164 patients were taken from EEG register and EEG reports. A structured proforma was used to record the information on the variables like age, sex, probable clinical diagnosis and reasons for referral. EEG findings and EEG diagnosis were tabulated from EEG reports. EEG results were categorized as normal and abnormal. EEG findings were categorized as Localization Related Epilepsy (LRE) and Generalized Epilepsy (GE) for focal epileptiform activity and generalized epileptic activity respectively.

Data were entered in Microsoft Excel (MS Office 2013, Microsoft Corporation, Washington, United States) and analyzed in IBM SPSS v23 for Windows (IBM Statistical Package for Social Sciences, 2015 IBM Corporation, New York, United States). Frequency distribution was studied and Chi Square test was applied for categorical variables to test for associations. The only continuous variable studied was the age

which was categorized in the interval of 10. A suitable measure of central tendency was computed after Shapiro-Wilk normality test. A binary logistic regression was performed to ascertain the effect of age on the likelihood that patients have abnormal EEG. A *p* value of less than 0.05 was considered significant.

### **RESULT**

The demographic characteristics are given in (Table 1). The majority of the patients belonged to the age group 11-20 years, comprising 29.87% (49) of the total study population. The median age was 19 years with an interquartile range of 17.50. Males were slightly more (51.2%) than females. Most of the patients (36%) did not have any clinical diagnosis mentioned at the time of requesting for EEG. Those diagnosed with seizure disorder (31.7%) were the second highest among those referred for EEG evaluation. The reason for referral for EEG was the exclusion of seizure disorder in the majority of cases (80.5%). More than half (58.5%) of the EEGs were requested by the department of Psychiatry and 15.9% of the EEG requests did not contain the details of the referring departments.

Table 2 illustrates the findings of EEG where the abnormality was seen in 43.3% (71). Among them, 26.21% (48) had generalized epilepsy and 14.02% (23) had localization related epilepsy. The most common abnormal pattern in EEG was slow wave (46.2%) and the location was generalized (29.3%) followed by frontal lobe (5.5%).

On further analysis of the patients with abnormalities in EEG, most of them belonged to the age group of 1-10 years with the median age of 14 years. The logistic regression model, used to predict the effect of age on the likelihood that the patients develop abnormal EEG, was statistically significant  $\chi^2(1) = 5.125$ ,  $p = 0.024$ . The model explained 41.0% (Nagelkerke R<sup>2</sup>) of the variance in EEG abnormality and correctly classified 68.9% of cases. Increasing age was associated with a decreased likelihood of having EEG abnormality with odds ratio 0.976 (95% CI 0.954 - 0.998)  $p = 0.030$ . The patients who had abnormal EEG were younger overall (mean age 18.91 years vs 24.24 years).

**Table no. 1: Socio-demographic Profile of Patients with EEG evaluation**

Variable	Categories	Number	%	
Age	<1	2	1.21	
	1-10	38	23.17	
	11-20	49	29.87	
	21-30	41	25	
	31-40	18	10.97	
	41-50	7	4.26	
	51-60	4	2.43	
	61-70	4	2.43	
	71-80	0	0	
	>81	1	0.60	
Gender	Male	84	51.2	
	Female	80	48.8	
Clinical Diagnosis	Not mentioned	59	36.0	
	Seizure Disorder	52	31.7	
	Seizure with Comorbid Psychiatric Illness	15	9.1	
	Organic Pathology	13	7.9	
	Substance Use Disorder	8	4.9	
	Dissociative Disorder	7	4.3	
	Depression	5	3	
	Depression with dissociative disorder	5	3	
	Reason for referral	To rule out Seizure	132	80.5
		Organicity work up	30	18.3
To evaluate treatment response		2	1.2	
Referring department	Psychiatry	96	58.5	
	Paediatrics	30	18.3	
	Not Available	26	15.9	
	Medicine	9	5.5	
	Surgical	3	1.8	

The gender distribution was almost equal with male (49.29%) and female (50.7%). The Chi Square test did not show any statistically significant association between the occurrence of positive EEG result between the two genders ( $\chi(1)=0.185, p = 0.753$ ). The abnormality detection rate was more in seizure disorder (35.21%) and those with comorbid psychiatric disorders (12.67%). Similarly, the cases referred for the exclusion of seizure had EEG abnormality in 74.64% which is statistically insignificant ( $\chi(1)=2.71 p = 0.09$ ) and so are the other reasons of referral for EEG. The referral from Psychiatrists (46.47%) ( $\chi(1)=7.5, p = 0.006$ )

and Pediatricians (33.8%) ( $\chi(1)=20.152, p = 0.000$ ) had abnormal EEG with statistically significant associations. (Tables 3 and 4).

**Table no. 2: Showing EEG Findings of Patients**

Characteristics	Categories	Number	%	
Abnormality	Present	71	43.3	
	Absent	93	56.7	
EEG diagnosis	Normal	93	56.70	
	Generalized epilepsy	48	26.21	
	Localization related epilepsy	23	14.02	
Abnormality Type	Slow wave	43	46.2	
	Spike and Wave	8	4.9	
	Spike wave	8	4.9	
	Slow wave and Spike and Wave	4	2.4	
	Slow wave and Spike wave	3	1.8	
	Sharp wave	1	0.6	
	Sharp wave and Spike wave	2	1.2	
	Slow wave and Sharp wave	2	1.2	
	Abnormality Site	Generalized	48	29.3
		Hemisphere	2	1.2
Frontal		9	5.5	
Fronto temporal		3	1.8	
Fronto parietal		2	1.2	
Occipito frontal		3	1.8	
Temporo parietal		2	1.2	
Paracentral		2	1.2	

**DISCUSSION:**

Since seizure is more common in a younger age in developing countries and EEG is requested mostly for the exclusion of seizure, this might explain the reason for EEG referral for age group distribution in our study.<sup>5,6</sup> Similar finding was reported in various studies.<sup>7-10</sup> Studies suggest male at higher risk for seizure and epilepsy.<sup>5</sup> This explains the higher proportion of male in our study for EEG evaluation which was supported by different studies.<sup>7,10</sup>

**Table no. 3: Distribution Of Abnormal EEG as per Demographics**

Characteristics	Categories	N (%)	Total
Age	<1	2	2
	1-10	28	38
	11-20	15	49
	21-30	12	41
	31-40	5	18
	41-50	1	7
	51-60	4	4
	61-70	2	4
	71-80	0	0
	>81	1	1
Gender	Male	35 (49.29%)	84
	Female	36 (50.70%)	80
Clinical Diagnosis	Not mentioned	23 (32.39%)	59
	Seizure Disorder	25 (35.21%)	52
	Seizure with Comorbid Psychiatric Illness	9 (12.67%)	15
	Organic Pathology	8 (11.26%)	13
	Substance Use Disorder	3 (4.22%)	8
	Dissociative Disorder	1 (1.4%)	7
	Depression	1 (1.4%)	5
	Depression with dissociative disorder	1 (1.4%)	5
Reason for referral	To rule out Seizure	53 (74.64%)	132
	Organicity work up	16 (22.53%)	30
	To evaluate treatment response	2 (2.81%)	2
Referring department	Psychiatry	33 (46.47%)	96
	Paediatrics	24 (33.8%)	30
	Not available	9 (12.67%)	26
	Medicine	4 (5.63%)	9
	Surgical	1 (1.4%)	3

**Table no. 3: Distribution Of Abnormal EEG as per Demographics**

Predictors of abnormal EEG	Test	P value
Age	Logistic Regression	0.030
Gender	Chi Square	0.753
Referring Department	psychiatry	Chi Square 0.007
	pediatrics	Chi Square 0.000
Reason for referral	medicine	Chi Square 1.0
	Rule out seizure	Chi Square 0.099
	Organicity work up	Chi Square 0.229

EEG has been well established as a tool for investigating seizure and epilepsy<sup>6</sup>. Hence, requesting for EEG for patients with seizure disorder with and without psychiatric illness (47.88%) in this study is understandable which is shared by Kwaso .<sup>11</sup>

Compared to our study (43.3%), the study by Shrestha *et al* had more EEG abnormality (58.3%).<sup>7</sup> The major abnormality pattern in EEG in our study and Molokomme was slow waves<sup>10</sup>. However, spike and wave were reported in Chowdhary *et al.* as common EEG pattern.<sup>8</sup>

The majority had EEG abnormality in our study and that of Shrestha *et al.*<sup>7</sup> However, Bhagat *et al* reported normal EEG in the majority which was done among the epileptics.<sup>9</sup> This difference is expected as EEG is a cross sectional record of the brain activity and 50% of patients with epilepsy can have normal EEG, and therefore, does not exclude epilepsy.<sup>12</sup>

The seizures were not classified during the time of referral in the studies. Nevertheless, in our study (as per EEG diagnosis) and that of Bhagat *et al* generalized epilepsy were comparatively more than localized epilepsy.<sup>9</sup> On the contrary, a study from Bangladesh reported more localization related epilepsy than generalized.<sup>8</sup> Studies from different countries have shown the range of patients with generalized seizures as 50–69%, and partial seizures as 31–50%.<sup>13-16</sup> The disparity between the seizure types clinically and as per EEG could be the misdiagnosis of secondary generalized seizure with generalized tonic clonic seizure and lack of adequate information and standardized classification. EEG referral from Psychiatrists reported

abnormality in 40 % of the study population in Bangladesh, 46.47% in our study, 17.6% in the study by O'Sullivan, 11.3% in the study by Lam but only 8.2% in the African study.<sup>1,8,10,17</sup> This disparity could be due to variation in sample size, sample type as well as interpreter variability. Different studies showed few or no positive finding in EEG in psychiatric conditions, including ours.<sup>8,10</sup>

#### CONCLUSION:

EEG is a noninvasive test with its limitations but still can be used for causes other than in the evaluation for seizure. The majority of the epilepsy patients have normal EEG recordings due to its low sensitivity. The diagnosis does not rely exclusively on its reading. Abnormal EEG findings cannot be conclusive to diagnose seizure disorder as it can be normal even in the patient with epilepsy and vice versa. Provocation methods, repeating the routine EEG, video EEG may yield more positive results and thereby help in the management of a patient with epilepsy, psychiatric and organic manifestations. For the prediction of abnormality in EEG, more variables and their association with seizure/organicity need to be looked into.

#### LIMITATIONS:

The clinical details of the patients referred for EEG were not available.

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