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A COMPREHENSIVE ELECTROENCEPHALOGRAM AUDIT IN A TERTIARY CARE CENTER IN PAKISTAN: DEMOGRAPHIC DISTRIBUTION, REFERRAL INDICATIONS AND FINDINGS

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ABSTRACT

Background and Objective:
Electroencephalography (EEG) is a widely employed non-invasive technique for recording brain electrical activity, pivotal for diagnosing various neurological conditions. The study aims to provide insight into demographic distribution, referral indications, and EEG findings in a tertiary care hospital in Pakistan.

Methods:
A retrospective cross-sectional analysis was conducted involving 2,924 patients who underwent routine EEG evaluations over a three-year period. Data was collected from the EEG records after approval from the ethical review committee. Demographic variables, referral reasons, and EEG findings were recorded and analyzed using descriptive statistics.

Results:
The study revealed a gender distribution of 41.35 % females and 58.65 % males, aligning with broader epidemiological trends. Participants were categorized into different age groups and most of the patients in our study belonged to the five to 18 years of age group. Most common indication was a suspected seizure disorder (78.32 %), followed by subclinical seizures (7.38 %) and medication adjustment (6.81 %). Notably, encephalopathy was the most common abnormal EEG finding (31 %), with temporal epilepsies being predominant within the focal seizure category.

Conclusion:
The descriptive nature of the study contributes novel insights. The study's contribution provides valuable guidance for healthcare professionals, enhancing their comprehension of neurological conditions and refining diagnostic and treatment strategies.

Keywords: Electroencephalogram, encephalopathy, epilepsies, medication adjustment, seizure, temporal.

INTRODUCTION

Electroencephalography (EEG) is a widely used non-invasive method for recording the electrical activity of the brain. By placing electrodes on the scalp, or sometimes using invasive electrodes in specific cases, EEG captures valuable information. It is primarily utilized in the diagnosis and classification of epilepsy. Typically, outpatient EEGs are conducted over a brief period of around 20-30 minutes, often incorporating activation methods such as hyperventilation, photic stimulation, or sleep deprivation to enhance diagnostic accuracy. Electroencephalogram serves as an invaluable tool, not only in identifying abnormal cortical activity associated with seizure disorders but also in diagnosing sleep disorders, stroke, coma, encephalopathies, and cerebral death.[1] Furthermore, it can aid in the evaluation of other neurological conditions like Creutzfeldt Jakob disease and psychogenic non-epileptic seizures (PNES).[2] It also plays a significant role in assessing cognitive decline,

making it essential in the realm of neurodegenerative disorders.[3]

Despite its limitations, routine outpatient EEGs still play a significant role in clinical practice due to their relatively lower cost compared to other investigations. However, these EEGs have certain drawbacks. Firstly, the standard electrode placement may lead to incomplete spatial coverage, omitting smaller cortical regions and deeper structures.[4] Secondly, the short recording duration decreases the likelihood of capturing epileptic discharges. Additionally, capturing sufficient periods of natural sleep during outpatient EEG recordings poses challenges, even though studies suggest that epileptiform discharges are more likely to occur during non-rapid eye movement sleep. Limited data is available regarding the predictors of diagnostic yield in routine outpatient EEG. Understanding these factors could potentially optimize the utility of this frequently employed diagnostic tool.

To date, comprehensive EEG audit data remains sparse both globally and within Pakistan. The aim of this audit is to present the various referral reasons and EEG outcomes across diverse age categories within a tertiary care hospital in Pakistan. The study is the first of its kind, encompassing a substantial number of patients in our department.

METHODS

This retrospective cross-sectional study was conducted at the Neurophysiology lab of the Aga Khan University Hospital over a period of three years from January 2020 to December 2022. The Institutional Review Board reviewed and approved the research protocol. It involved 2924 patients who got their routine EEGs done. These included both inpatients as well as outpatients. Data were taken from EEG registry. The EEGs were done using the internationally standardized 10–20 electrode placement system, with photic stimulation and hyperventilation methods employed during recordings. Clinical neurophysiologists reported all records.

A structured proforma was used to record the information on the variables like gender, age, reasons for referral, and EEG findings. EEG findings were categorized mainly as encephalopathy, focal seizure disorder, focal dysfunction, generalized seizure disorder, status epilepticus, subclinical seizures, epileptic encephalopathy, and periodic lateralized discharges, generalized discharges. The study was approved by the review ethical committee. All statistical analysis was performed using SPSS 23.0 for Windows

RESULTS

Table 1 describes the demographics of the study population.

Table 1: Demographic details of the patients

Characteristics	Groups	No of patient (n=2924)	Percentage (%)
Age (years)	0-1	299	8.02%
	1-5	436	15.28%
	5-18	766	26.84%
	18-50	744	26.07%
	>50	679	23.79%
Gender	Female	1209	41.35
	Male	1715	58.65

The primary indication for EEG referral was a suspected seizure disorder, which was observed in 2,070 patients (78.32% of the sample). This was followed by cases of subclinical seizures (195 patients, 7.38 %), and medication adjustment (180 patients, 6.81 %). Other referral reasons included status epilepticus and altered mentation accounting for 55 (2.08%) and 45 (1.70%) patients, respectively. The least common indication for EEG referral was brain death, noted in five patients (0.19%).

With regards to the EEG findings, the majority exhibited normal findings. Among the cases with abnormal EEG readings, the most prevalent diagnosis was

encephalopathy, identified in 31 % of all the patients. This was followed by focal seizure disorder (14.25%), focal dysfunction (12.11%), and generalized seizure disorder (5.8 %). Subsequently, subclinical seizures were observed in 1.55% of the cases. Notably, 21 patients displayed periodic discharges. Table 2 describes the EEG results in detail.

Table 2: Electroencephalogram results

Serial Number:	Diagnosis	No of patient(n=2924)	Percentage (%)
1	**Normal**	1008	33.89
2	**Encephalopathy**	900	31.06
3	**Focal dysfunction**	351	12.11
4	**Focal seizure disorder**	413	14.25
	1) Temporal	130	4.46
	2) Frontal	68	2.33
	3) Occipital	65	2.22
	4) Parietal	73	2.50
	5) Central	50	1.71
	6) Mixed	89	1.09
5	**Generalized seizure disorder**	168	5.80
6	**Status epilepticus**	9	0.31
7	**Subclinical seizures**	45	1.55
8	**Periodic discharges**		
	1) LPDS	16	0.55
	2) BIPDS	1	0.03
	3) GPDS	4	0.14
	4) CJD	0	0.00
	5) SSPE	1	0.03
9	**Epileptic encephalopathy**	8	0.28

Abbreviations: *BIPDS: bilateral independent periodic discharges; CJD: Creutzfeldt Jakob disease; GPDS: generalized periodic discharges; LPDS: lateralized periodic discharges, SSPE: subacute sclerosing pan encephalitis*

Among those with focal seizure disorder, the majority were identified to have temporal epilepsies, followed by parietal, occipital, frontal, and central epilepsies (Figure 1).

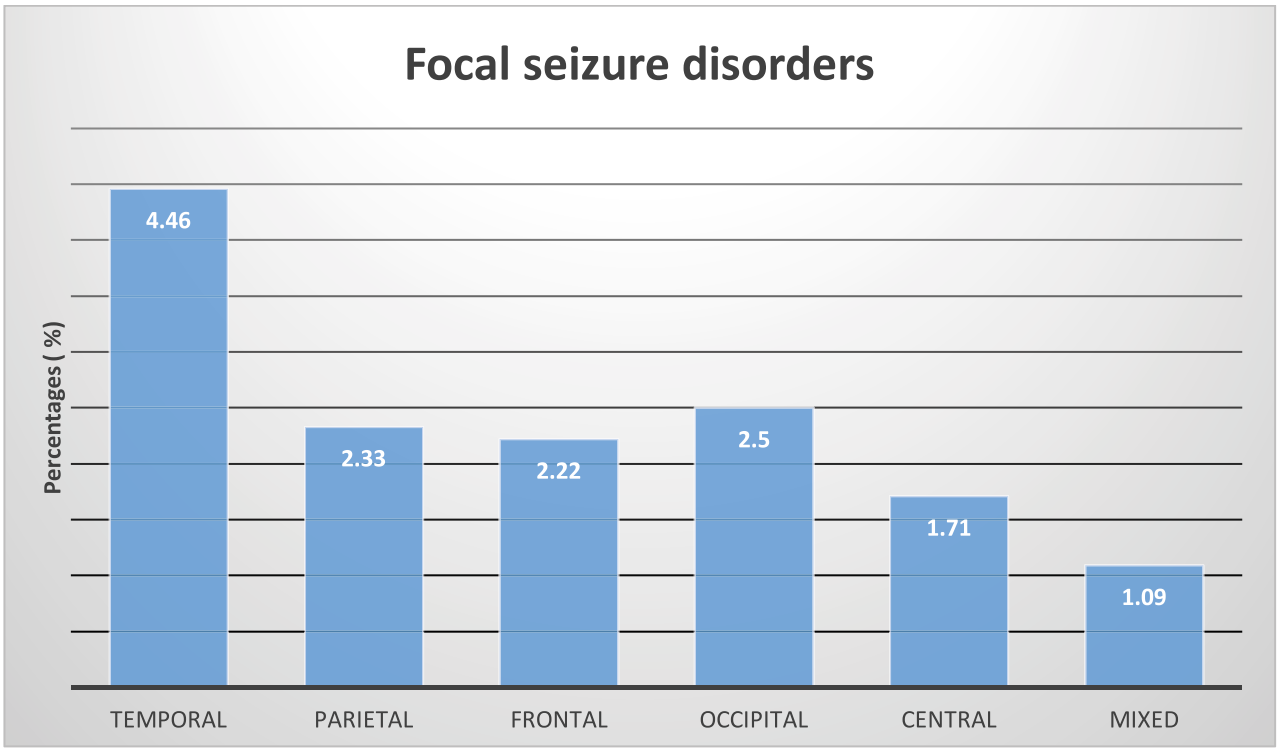

Figure 1: Various regions implicated in focal seizure disorders

DISCUSSION

The results of this comprehensive EEG audit involving 2,924 patients provide valuable insights into the demographic distribution, referral indications, and EEG findings within the studied population. The gender distribution of this cohort, with 41.35 % female and 58.56 % male participants, aligns with the broader epidemiological trends. This finding is consistent with similar EEG audits conducted in Pakistan, where gender ratios within neurology patient cohorts have shown comparable distributions.[5] This observation resonates with the work of Usman S et al.[6] Moreover, the meticulous categorization of patients across distinct age brackets contributes to our study's comprehensiveness, allowing for a nuanced understanding of EEG utilization across different age groups. Most of the patients in our study belonged to the five to 18 years of age group. A similar study conducted in Khyber Pakhtunkhwa, Pakistan, indicated a slightly higher proportion of males, predominantly from urban areas, with a higher prevalence of epilepsy among children aged 11 to 20 years.[7]

Intriguingly, while the most common indication of EEG referral in our study remained suspected seizure disorder, in accordance with findings akin to Khalid et al., there was a noteworthy proportion of cases referred for subclinical seizures, indicating the diagnostic importance of EEG in drowsy patients.[8] Additionally, our research emphasizes EEGs diagnostic significance by identifying focal seizure disorder as the leading abnormal EEG finding, which contrasts with the findings of Usman S et al.[6] These discrepancies emphasize the dynamic nature of EEG utility in a changing clinical landscape.

An epidemiological study focused on epilepsy patients in southern Pakistan showed that 74 % were below the age of 19, with tonic clonic seizures being the most common type.[9] Another study conducted in 2020 has shown that the most common type of seizures were GTCSs. Most of the EEG's were normal like our study results, and the most common abnormal rhythm noted was theta rhythm.[10] It is worth highlighting that, like prior studies, most of the EEGs performed in our study yielded normal results. Yet, it is crucial to recognize that a solitary normal EEG does not definitely rule out an underlying seizure disorder. Intriguingly, our study

unveiled a substantial prevalence of encephalopathy within EEG findings. This observation hints at the cautious approach that physicians adopt in suspecting an underlying seizure disorder, particularly in patients exhibiting drowsy states. These results underscore the complexity of diagnosis and the importance of continuous monitoring in cases where clinical suspicion remains despite initial normal EEG results.

While most previous studies described EEG findings into broad terms like encephalopathy or focal/generalized seizure disorders, a distinct facet of our study lay in the incorporation of specific diagnostic entities such as LPDS, BIPDS, and GPDS. This hasn't been studied much before, and thus adds a fresh understanding to the variety of EEG abnormalities. Additionally, we looked at different types of seizures within the focal seizure category, such as temporal, parietal, occipital, frontal, and central epilepsies. Notably, the preeminence of temporal lobe epilepsies can be attributed to the epileptogenic nature of the temporal lobe.[11]

EEG has a good specificity for the diagnosis of epilepsy but a low sensitivity.[12] So physicians should be careful when asking for EEG tests and use them only when they are strongly suspecting epilepsy.

In summary, this EEG audit's finding aligns with existing research from Pakistan and other regions, emphasizing the universal significance of EEG evaluation in clinical practice. The study's strengths lie in its comprehensive demographic representation and detailed analysis of EEG indications and findings. A major limitation to our study includes a single-center nature of the research. By considering these results alongside global and regional EEG audits, healthcare professionals can enhance their understanding of neurological conditions and tailor diagnostic and treatment approaches accordingly.

CONCLUSION

This study presents a comprehensive analysis of EEG evaluations in a substantial patient cohort, shedding light on demographic characteristics, referral indications, and diverse EEG findings. These findings provide valuable insights into the prevalence of various neurological conditions and contribute to the broader understanding of EEG utilization in clinical practice. The audit serves as a valuable contribution to the field, highlighting the importance of EEG as a diagnostic tool and providing insights that can guide clinical practice and further research in the realm of neurology.

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Dureshahwar Kanwar; data analysis, manuscript writing
Naima Javed; data analysis, manuscript writing
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All the authors approve the final version to be published, and agree to be accountable for all aspects of the work.