Research Article

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2023.51.008111

Electroencephalography (EEG) Results of Patients Referred for Cognitive and Seizure Disorders and their Association with Brain MRI Findings

Mariwan Husni[1,2,3]*, Hamda Al Neshmi[1], Aldana Zayed[1], Priya Das[1], Abd El Megeid Farag[1] and Fares Zubari[1]

[1]*King Hamad University Hospital (KHUH), Kingdom of Bahrain*

[2]*Professor & Chair Department of Psychiatry, Arabian Gulf University Kingdom of Bahrain*

[3]*Professorial Staff, NOSM University, Ontario, Canada*

***Corresponding author:** Mariwan Husni, Consultant Psychiatrist, King Hamad University Hospital (KHUH), Professor & Chair Department of Psychiatry, Arabian Gulf University (AGU), Kingdom of Bahrain, Professorial Staff, NOSM University, Ontario, Canada

ARTICLE INFO

Received: July 03, 2023

Published: July 12, 2023

Citation: Mariwan Husni, Hamda Al Neshmi, Aldana Zayed, Priya, Abd El Megeid Farag and Fares Zubari. Electroencephalography (EEG) Results of Patients Referred for Cognitive and Seizure Disorders and their Association with Brain MRI Findings. Biomed J Sci & Tech Res 51(3)-2023. BJSTR. MS.ID.008111.

ABSTRACT

Introduction: The electroencephalogram (EEG) is a technique for detecting and recording electrical activity in the brain. It is used to diagnose brain disorders like seizures and cognitive impairments. When appropriate imaging techniques, such as brain magnetic resonance imaging (MRI), are combined with EEG, more information on structural abnormalities and the pathophysiology of the underlying symptoms can be gained. Several studies have found that EEG provides more information and helps predict response to pharmacotherapies and prognosis.

Methods: All patients referred to EEG evaluation in the last 5 years at the King Hamad University Hospital in the Kingdom of Bahrain owing to cognitive difficulties such as confusion and memory problems were included in our study. We chose an age and gender matched group of people who were referred to EEG because of suspected epilepsy. We later compared the EEG results of all participants with available brain MRI results.

Results: Our study Included 80 patients who had been referred for an EEG. Half of the subjects were referred for the test due to cognitive decline results, while the other half were referred for seizure problems. Most subjects had a documented brain MRI. The EEG results revealed abnormality more frequently in participants with cognitive problems, subjects with seizure disorders. The results showed that a higher proportion of older aged patients had abnormal MRI findings. A significant number of abnormal EEG findings were related to the results of brain MRI findings.

Conclusion: EEG is a valuable diagnostic tool for seizure and cognitive disorders. Many individuals with cognitive problems show abnormal EEG findings, which frequently coexist with abnormal brain MRI.

Keywords: Electroencephalogram; EEG; Cognitive Disorders; Seizure Disorders; Epilepsy; Brain MRI

Abbreviations: EEG: Electroencephalogram; IEDs: Interictal Epileptiform Discharges; AD: Alzheimer's Disease; SPECT: Single-Photon Emission Computerized Tomography; PET: Positron Emission Tomography; MRI: Magnetic Resonance Imaging

Introduction

Electroencephalogram (EEG) was introduced in 1929 [1], as a method of detecting and recording electrical activity in the brain. It is used to diagnose brain conditions such as seizures and cognitive disorders. EEG plays a central role in the diagnosis and management of patients with seizure disorder because it is a convenient and relatively inexpensive way to demonstrate the physiological manifestations of abnormal cortical excitability that underlie epilepsy [2]. The characteristic finding of the epileptiform discharge is rarely recorded in healthy, young individuals [3]. EEG recording is critical to localize epileptic zone [4]. Seizures can be either generalized or focal. As detected on surface EEG, generalized seizures begin somewhere inside the brain and rapidly spread bilaterally. The bilateral networks involved in generalized seizures can be subcortical and cortical structures. They do not have to include the entire cortex, as the term "generalized" suggests. The patient's EEG frequently shows generalized spike-wave activity [5]. The diagnosis of this condition is made by clinical history and supported by EEG. Patients can have generalized tonic-clonic seizures but a normal EEG. Interictal Epileptiform Discharges (IEDs) have been observed in around 50% of patients with generalized tonic-clonic seizures, while IEDs can be seen in 1 to 13% of normal individuals, including those with a first-degree relative with generalized epilepsy [2]. Focal epilepsy is a seizure that affects only one region of one hemisphere, and it can start in the subcortical structures. The EEG may reveal focused epileptiform discharges.

Temporal lobe epilepsy is the most prevalent cause of focal IEDs, followed by frontal lobe epilepsy [6]. EEG has also been shown to be a reliable technique in the diagnosis and investigation of cognitive diseases, including dementia. Clinically, these problems are described as a syndrome that results in a loss of attention, memory, executive function, visual-spatial ability, and language [7]. The use of EEG in dementia has sparked a lot of attention. EEG also aids in the differential diagnosis and prognosis of disease development. Dementia is divided into three types: cortical, subcortical, and mixed. The most common type of cortical dementia, Alzheimer's Disease (AD), accounts for over 70% of all dementias [8]. Individuals with subcortical dementia have generally normal EEGs, whereas individuals with cortical dementia have abnormal EEGs [9]. Mixed dementias, including cortical dementias, can also have abnormal EEG characteristics. Furthermore, EEG recordings can provide useful information for predicting treatment efficacy in cognitive disorders [10]. As an in vivo picture of brain regions, imaging technologies such as Magnetic Resonance Imaging (MRI) enable a novel approach to the diagnosis of cognitive disorders [11].

Development of regional metabolic methods (Positron Emission Tomography (PET), Single-Photon Emission Computerized Tomography (SPECT), with ability to map oxygen or glucose consumption and regional blood flow as well as the functional MRI of the brain are thought to have somewhat limited the role of EEG, but it remains a reliable and convenient investigation. There have been attempts to combine MRI, PET and EEG for advanced neuroscience investigations, including its use in dementia [12]. In the early stages of dementia, EEG shows a slowing of the background rhythm with a low frequency (less than 8 Hz). This pattern is sometimes linked with diminished beta (fast waves) activity and intermixed increased theta and delta (slow waves) activity, the amount of which varies according to severity [13]. Where differential diagnosis of cognitive loss offers a barrier to clinicians, EEG can be an incredibly valuable, non-invasive, and very simple diagnostic tool. According to one study, more than one-third of people with persistent epilepsy in rural China have epileptogenic lesions visible on brain MRI, with two-thirds meeting the criterion of pharmacoresistance [14]. As a result, an abnormal MRI scan in persistent epilepsy should serve as a warning sign of pharmacological non-responsiveness. A study in pediatric patients with epilepsy found that a considerable majority of patients (55.86%) had abnormal MRI results [15]; thus, MRI can reveal most structural brain abnormalities in pediatric patients presenting with seizures if used properly.

The use of appropriate imaging modalities in conjunction with EEG has also resulted in increased understanding of the pathophysiology of the underlying symptomatic epilepsies. In clinical practice, the objective for using neuroimaging in epilepsy is to detect specific diseases that require specific therapy, as well as to aid in the formation of syndromic and etiological diagnoses to provide patients and their families with an accurate prognosis [16]. The objectives of our study were to determine whether EEG scans have any added utility in detecting dementia in patients with signs and symptoms of cognitive impairments, and how this compares to diagnosing seizure disorders/epilepsy. We also investigated whether abnormal EEG results in epilepsy and dementia correlate with brain imaging studies (MRI).

Materials and Methods

We included all male and female patients who were referred to EEG examination at the King Hamad University Hospital, Kingdom of Bahrain due to cognitive problems including confusion and memory problems and other cognitive symptoms. We selected an age and gender matched group, who were referred to have EEG for epilepsy and seizure disorders. The comparable group was selected from the register of EEG referrals. For each patient referred for cognitive concerns, we selected the next matching person on the register of the EEG department, who was referred for seizure disorders complaints. Subjects who had history of substance abuse and those who already had an established diagnosis of dementia or epilepsy were excluded. We reviewed all subjects' electronic records to find out if they had imaging studies of Brain including CT scan or MRI. We analyzed the normal and abnormal results of EEG. We performed a regression analysis of age, gender, marital status, and EEG results in those who had a recorded brain imaging study. Statistical Analysis was done using SPSS ver-

sion 25.0. Descriptive statistics were used to compute the frequencies and percentages. Chi-square test was used to compare significant differences between two groups with categorical data. All the statistical tests were 2-tailed, and a p value of <0.05 was considered significant.

Results

The study included a total of 80 participants who had EEG test at King Hamad University Hospital. Males made up 53 (66.3%) of our sample, while females made up 27 (33.7%). The majority of participants (62= 77.5%) were over the age of 50. The average age was 60.03 years (range: 18-84 years, standard deviation: 18.12 years). The youngest participant was 18 years old and was referred for EEG owing to memory issues. There were 53 (66.3) married participants, 21 (26.25%) never married, and the rest (6, 7.5%) were divorced, widowed, or separated. Table 1 contains a summary of the demographic data. The majority (72) of the participants (38 in the cognitive decline group and 34 in the seizure disorders group) obtained a recorded brain MRI. The remaining 8 subjects had no reported brain MRI or CT scans in their electronic medical records. EEG results were abnormal in 23 (57.5%) of the cognitively disordered participants, but normal in 17 (42.5%) of the same group. While 18 (45.0%) of those with seizure disorder symptoms had abnormal EEG findings, and 22 (55.0%) had normal findings. The brain MRI results of the 40 subjects referred to EEG for cognitive symptoms were abnormal in 25 (65.78%), normal in 13 (32.5%), and no brain MRI was recorded in 2 (5%) subjects. While imaging findings were abnormal in 19 (47.5%) of the people referred to EEG for seizure disorders symptoms, normal in 15 (37.5%), and no brain MRI was recorded in 6 (15%) of the participants. Table 1 presents the EEG and brain MRI results in both groups, those referred for EEG due to cognitive disorder symptoms and those referred due to seizure disorder symptoms.

Table 1: Recorded EEG and Brain MRI Results.

Reason for referral	Abnormal EEG results	Normal EEG Results	Missing ECG Results	Abnormal-Brain MRI	Normal Brain MRI	Missing/not recorded Brain MRI
Cognitive Disorders	23 (57.5%)	17 (42.5%)	0 (0%)	25 (62.5%)	13 (32.5%)	2 (5%)
Seizure Disorders	18 (45%)	22 (55.0%)	0 (0%)	19 (47.5%)	15 (37.5%)	6 (15%)

Only 37 subjects had clear documentation of neurological and mental state examinations in their electronic health records. It included 22 (55%) individuals with cognitive disorder symptoms and 15 (37.5%) individuals with seizure disorder symptoms. As shown in Table 2, the Chi-square test results revealed a statistically significant relationship between brain MRI findings and age of the subjects ($\chi 2$ =15.558, df=3, P=0.001) but not with other variables. The Fisher's Exact Test results for EEG data demonstrated a statistically significant association between brain MRI findings and EEG findings (P=0.021), as shown in Table 2. Table 3 summarizes the MRI results in patients with dementia and those with seizures.

Table 2: The association between Brain MRI findings and related factors (n=72).

Characteristic	Imaging Finding		P-value
	Abnormal n (%)	Normal n (%)	
Gender			
Male	29 (60.4)	19 (39.6)	0.864
Female	15 (62.5)	9 (37.5)	
Marital status			
Single	6 (42.9)	8 (57.1)	0.124
Married	31 (66)	16 (34)	
Divorced or widowed	6 (14)	1 (4)	
Age Group			
< 25 Years	1 (2.3)	4 (14.3)	0.001
25-45 Years	2 (4.5)	9 (32.1)	
46-60 Years	9 (20.5)	3 (10.7)	
> 60 Years	32 (72.7)	12 (42.9)	
Finding for EEG			
Normal	16 (47.1)	18 (52.9)	0.021
Abnormal	28 (73.7)	10 (26.3)	

Reason for referral			
Dementia/Cog. Reason	25 (65.8)	13 (34.2)	0.389
Epilepsy/Seizures	19 (55.9)	15 (44.1)	

Table 3: The association between Brain MRI findings and related factors according to reason for referral.

Characteristic	Dementia		P-value	Epilepsy/Seizures		P-value
	Imaging Finding			Imaging Finding		
	Abnormal n (%)	Normal n (%)		Abnormal n (%)	Normal n (%)	
Gender						
Male	16 (64)	9 (36)	0.747	13 (56.5)	10 (43.5)	0.914
Female	9 (69.2)	4 (30.8)		6 (54.4)	5 (45.5)	
Marital status						
Single	5 (55.6)	4 (44.4)	0.340	1 (20)	4 (80)	0.179
Married	17 (70.8)	7 (29.2)		14 (60.9)	9 (39.1)	
Divorced or widowed	3 (100)	0(0)		3 (75)	1 (25)	
Age Group						
< 25 Years	1 (33.3)	2 (66.7)	0.051	0 (0)	2 (100)	0.043
25-45 Years	1 (20)	4 (80)		1 (16.7)	5 (83.3)	
46-60 Years	5 (83.3)	1 (16.7)		4 (66.7)	2 (33.3)	
> 60 Years	18 (75)	6 (25)		14 (70)	6 (30)	
Finding for EEG						
Normal	9 (56.3)	7 (43.8)	0.290	7 (38.9)	11 (61.1)	0.034
Abnormal	16 (72.7)	6 (27.3)		12 (75)	4 (25)	

Discussion

Clinicians refer patients with cognitive decline signs and symptoms, as well as epilepsy and seizure disorders, to EEG. Our data suggest that those referred for cognitive problems are more likely to have abnormal EEG findings than those referred for epilepsy-like issues, but there is no statistical difference in predicting abnormal results based on the reason for referral. We discovered that most individuals referred for EEG studies will also have a brain MRI. The combination of both investigations may have additional value. However, in our study we just examined normal and abnormal results rather than descriptive EEG or brain MRI reports. The regression analysis revealed that abnormal brain MRI has a significant association with abnormal EEG result but the P- value was only 0.48. Investigating a larger sample, possibly in more than one Centre, may help to assess whether more significant values can be achieved. An analysis of the reports, particularly those with similar abnormal results, may reveal more information on the brain disorder's topographic anomaly. It would also be possible to predict who would not respond to medication by ordering brain imaging such as MRI earlier in the disease course, so avoiding the development of chronic epilepsy, as seen in rural China. Furthermore, the practice of including brain MRI for clinical work-up varies across nations and within countries, however research has demonstrated that brain MRI is beneficial in detecting focal lesion epilepsies.

The advancement of imaging and machine learning techniques in MRI investigations, especially those of the brain, will increase lesion visibility and give predictors of clinical epilepsy outcomes [17]. According to some research, neurological examination can detect more than 60% of focal cerebral lesions that do not have obvious focal signs. As a result, for all patients referred for EEG, whether as part of epilepsy or cognitive disorders investigations, a full neurological examination should be performed and recorded [18].

Conclusion

EEG is a valuable diagnostic tool for seizures and cognitive disorders. Most people with cognitive impairment have abnormal EEG findings even before acquiring a brain MRI. Obtaining brain imaging for persons with abnormal EEG may aid in medication response prediction and limit progression to a chronic course.

Limitations

Our study has limitations because it is a retrospective study based on patient electronic records. A large sample of patients from a multicenter study is also required to increase the predictive power and correlation of integrating EEG with imaging.

References

1. Tudor M, Tudor L, Tudor KI (2005) Hans Berger (1873-1941) --povijest elektroencefal ografije [Hans Berger (1873-1941)-the history of electroencephalography]. Acta Med Croatica 59(4): 307-313.
2. Smith SJM (2005) EEG in the diagnosis, classification, and management of patients with epilepsy. Journal of Neurology, Neurosurgery & Psychiatry 76: ii2-ii7.
3. Noachtar S, Rémi J (2009) The role of EEG in epilepsy: a critical review. Epilepsy Behav. 15(1): 22-33.
4. Van Mierlo P, Vorderwülbecke BJ, Staljanssens W, Seeck M, Vulliémoz S (2020) Ictal EEG source localization in focal epilepsy: Review and future perspectives. Clin Neurophysiol 131(11): 2600-2616.
5. Kalaria R, Erkinjuntti T (2006) Small vessel disease and subcortical vascular dementia. J Clin Neurol 2(1): 1-11.
6. Laufs H, Hamandi K, Salek Haddadi A, Kleinschmidt AK, Duncan JS, et al. (2007) Temporal lobe interictal epileptic discharges affect cerebral activity in "default mode" brain regions. Hum Brain Mapp 28(10): 1023-1032.
7. Karantzoulis S, Galvin JE (2011) Distinguishing Alzheimer's disease from other major forms of dementia. Expert Rev Neurother 11(11): 1579-1591.
8. Jelles B, Scheltens P, Van der Flier WM, Jonkman EJ, Da Silva FHL, et al. (2007) Global dynamical analysis of the EEG in Alzheimer's disease: frequency-specific changes of functional interactions. Clinical Neurophysiology 119(4): 837-841.
9. Tsolaki A, Kazis D, Kompatsiaris I, Kosmidou V, Tsolaki M (2014) Electroencephalogram and Alzheimer's disease: Clinical and research approaches. Int J Alzheimers Dis 2014: 349249.
10. Brunnstro H, Gustafson L, Passant U, Elisabet Englund (2009) Prevalence of dementia subtypes: A 30-year retrospective survey of neuropathological reports. Arch Gerontol Geriatrics 49(1): 146-149.
11. Leocadi M, Canu E, Calderaro D, Corbetta D, Filippi M, et al. (2020) An update on magnetic resonance imaging markers in AD. Ther Adv Neurol Disord 13: 1756286420947986.
12. Chen Z, Jamadar SD, Li S, Sforazzini F, Baran J, et al. (2018) From simultaneous to synergistic MR-PET brain imaging: A review of hybrid MR-PET imaging methodologies. Hum Brain Mapp 39(12): 5126-5144.
13. Micanovic C, Pal S (2014) The diagnostic utility of EEG in early-onset dementia: A systematic review of the literature with narrative analysis. J Neural Transm (Vienna) 121(1): 59-69.
14. Davagnanam I, Chen Z, Hoskote C, Ding D, Yang B, et al. (2020) Prevalence of MRI abnormalities in people with epilepsy in rural China. Neurology 95(9): e1236-e1243.
15. Ali A, Akram F, Khan G, Hussain S (2017) Paediatrics Brain Imaging in Epilepsy: Common Presenting Symptoms and Spectrum of Abnormalities Detected On MRI. J Ayub Med Coll Abbottabad 29(2): 215-218.
16. Roy T, Pandit A (2011) Neuroimaging in epilepsy. Ann Indian Acad Neurol 14(2):78-80.
17. Bernasconi A, Bernasconi N (2022) The Role of MRI in the Treatment of Drug-Resistant Focal Epilepsy. Eur Neurol 85(5): 333-341.
18. Anderson NE, Mason DF, Fink JN, Bergin PS, Charleston AJ, et al. (2005) Detection of focal cerebral hemisphere lesions using the neurological examination. Journal of Neurology, Neurosurgery Psychiatry 76: 545-549.

ISSN: 2574-1241

DOI: 10.26717/BJSTR.2023.51.008111

Mariwan Husni. Biomed J Sci & Tech Res