

Magnetic Resonance Imaging Brain and Electroencephalogram (EEG) in the Evaluation of New-Onset Seizures in a Tertiary Care Centre of Nepal

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Abstract

Introduction: Seizure is a common neurological condition with multiple etiological factors. This study aims to evaluate the role of magnetic resonance imaging (MRI) Brain and electroencephalography (EEG) in the diagnosis of new-onset seizures in the Nepalese population.

Methods: A total of 106 patients aged between 7 to 85 years of age with first onset seizure, who underwent MRI and EEG were enrolled in the study.

The sensitivity of MRI and EEG for the diagnosis of seizure when used in combination was compared with that of MRI or EEG alone.

Results: Out of 106 patients, 58.5% (n=62) were males and 41.5% (n=44) were females. In 52.8% (n= 56) of the patients, there was epileptogenic lesion in MRI, and 39.6% (n=42) of the patients had an abnormal EEG. The combination of MRI with EEG was significantly better than either MRI or EEG alone in the diagnosis of seizures (p <0.001).

Conclusion: MRI and EEG are frequently used for the evaluation of seizures. MRI Brain when used in combination with EEG significantly improves the diagnostic accuracy of seizures.

Introduction

Seizure is a paroxysmal alteration of the neurologic function caused by an excessive, hyper synchronous discharge of the neurons in the brain resulting in acute changes in the clinical state of the person. Seizure is the common manifestation of several disease conditions, such as central nervous system infections, biochemical abnormalities, genetic conditions, adverse drug effects, and intracranial mass lesions.¹ Epilepsy is a disorder characterized by two or more unprovoked seizures occurring at least 24 hours apart, or one unprovoked seizure and a possibility of further seizures of at least 60% after two unprovoked seizures, occurring over the next 10 years.²

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The prevalence of epilepsy in Nepal is approximately 7.3 per 1000 population.³ Nepal has a huge geographical diversity and the majority of the people, especially those living in rural areas, have limited access to healthcare facilities. Neurocysticercosis with calcified lesions is the most common cause for epilepsy in Nepal, which accounts for almost 17% of all the cases in the country.⁴

MRI of brain with dedicated epilepsy sequences is the investigation of choice in patients with epilepsy.⁵ In recent years, there has been a significant improvement in neuroimaging, its post-processing techniques, and the availability of trained staff. The identification of structural and functional causes of epilepsy has become more accurate.⁶ EEG is a non-invasive, cost-effective, and bedside procedure that has an established role in the diagnosis, classification, and management of epilepsy.^{7, 8} The purpose of this study was to compare the effectiveness of MRI and EEG in the diagnosis of first-onset seizures, when used alone and when used in combination,.

Methods

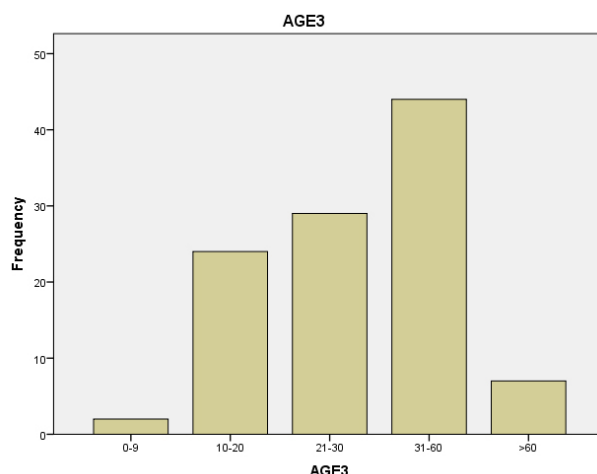
It is a retrospective study performed in all patients with first-onset seizure presenting to Neurology departments of Nepal Medicit Hospital, Lalitpur from June 2019 to May 2021. MRI and EEG were performed after the seizure episodes. The patients were classified into different age groups child, adolescents, adults and seniors adults (WHO classification). The imaging of the patient was further sub-grouped into structural and non-structural causes. The seizure was defined relative to the symptoms and signs of the patient and was classified using the International League Against Epilepsy (ILEA) classification.⁹ The sample size was estimated assuming the proportion of individuals with MRI positivity of 80%, with absolute precision of 10% and desired confidence interval of 95%. The required sample size was determined to be 96, using the formula $n = t^2 \times p(1-p)/m^2$ where, n= required sample size, t=confidence interval at 95% (standard value 1.96), p= estimated prevalence of positive result, and m= estimated precision. Patients with non-epileptic seizure, known seizure disorder, and contraindication to performing MRI were excluded from the study.

The patients' data was entered into Microsoft Excel sheet (Microsoft Office 2019, USA) and analysed using SPSS version 20 (IBM SPSS, USA). Descriptive statistical analysis was done and if required, the data were tabulated with appropriate means. The sensitivity and specificity of the test were calculated separately as well as in combination. All the qualitative variables were expressed in terms of proportion. Chi-square test of significance ($p < 0.05$) was used to test for the difference in proportion. The correlation between MRI brain and EEG were studied.

Result

A total of 106 patients with new-onset seizure were included in this study. The patients were either admitted to the hospital or had visited the out-patient's department during the study period. The mean age of the patients was 31.97 ± 15.44 years. Among them, 58.5% (n=62) and 41.5% (n=44) were males and females respectively. The majority of the patient belonged to the adult population as shown in Figure 1.

Figure 1: Age distribution of the patients



The majority of the patients had a generalized tonic-clonic seizure (GTCS) (Figure 2).

Figure 2: The frequency of different types of seizure

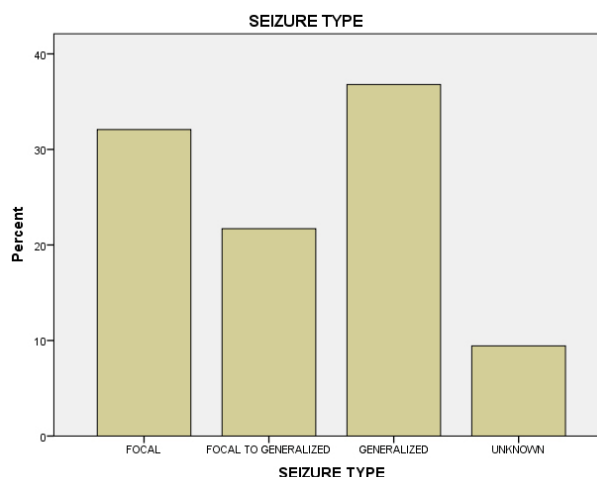


Table 1: MRI and EEG reporting in epilepsy patient

Monitoring Modality		Frequency (%)
MRI findings	Abnormal	56 (52.8)
	Normal	50 (47.2)
EEG findings	Abnormal	42 (39.6)
	Normal	64 (60.4)

Table 2: Sensitivity of MRI and EEG

	Positive	Negative	Sensitivity (95% Confidence Interval)
MRI	56	50	52.83% (0.429-0.626)
EEG	42	64	39.6% (0.303-0.496)
MRI + EEG	75	31	70.75% (0.611-0.792)

MRI	EEG		Total	P-value
	Abnormal	Normal		
Abnormal	23 (54.8%)	33 (51.6%)	56	0.071
Normal	19 (38%)	31 (62%)	50	
Total	42 (39.6%)	64 (60.3%)	106	

Table 3: Comparison of MRI and EEG

Table 4: Comparison of MRI and EEG combined with EEG alone

		EEG and MRI		Total	P-value
		Abnormal	Normal		
EEG	Abnormal	42	0	42	<0.001
	Normal	33	31	31	
Total		75	31	106	

Table 5: Comparison of MRI and EEG combined with MRI alone

		EEG and MRI		Total	P-value
		Abnormal	Normal		
EEG	Abnormal	56	0	56	<0.001
	Normal	19	31	31	
Total		75	31	106	

Discussion:

About 5% of the general population will experience one unprovoked seizure during their lifetime 10, less than half of these will develop epilepsy 11. Various investigations are available for detection of the structural and the functional abnormalities of a seizure which include EEG, cerebral structural imaging (MRI and magnetic resonance spectroscopy), magnetoencephalography (MEG) and cerebral function imaging (SPECT and PET). The limitations of each test in localizing the seizure focus must be recognized. Not all tests will show localizing abnormalities and the foci determined by different tests may be unrelated. The clinical history of the patient is extremely important in the evaluation of a patient with seizure and epilepsy. In out-of-hospital seizures, a video-recording of the episode of the seizure, if available, is helpful to make a clinical diagnosis. Seizures are broadly classified as focal, focal with generalized, or unknown. The common causes of seizures are different in patients of different age groups.12

In our study, a total of 106 patients underwent MRI of the brain for evaluation of seizures, among whom 56 (52.83%) patients had imaging findings like infarction, neurocysticercosis, calcified granuloma, or tumor. MRI provides optimal information for finding out temporal lobe (mesial temporal lobe) and frontal lobe lesions, which are the usual cause of the focal seizure with impaired awareness. MRI provides additional information on structural lesions, like primary or metastatic tumour, infection, inflammation, acute infarct or hemorrhage.13 MRI is an important step in the evaluation of seizure; however, in some patients, CT scan of the head may provide rapid radiological diagnosis.

The patients in the study were subjected to EEG examination. If the patients did not have any contraindication, they were subjected to the EEG lab for at least 30 min and provocation factors like hyperventilation and photosensitivity were tested in

each case. EEG is one of the important tools in the diagnosing and analysis of seizures. It represents the electrical activity produced by perpendicular neurons to the brain surface. For the detection of seizure, neurons in at least an area of 6 square cm need to be electrically hyperactive. Internationally recognized system for EEG is the 10–20 system; the 10- 20 system refers the distance of electrode placements in the scalp from each other 10 % or 20% forth back and right-left distance.14 .15

Interictal EEG is a safe, cheap and widely available tool for evaluation of the seizure. With the advent of modern neuroimaging and prolonged video-EEG monitoring, interictal EEG recording remains an important in diagnosis and prognostication of patient with seizure. EEG abnormalities have been consistently associated with a higher risk of patients had recurrence 16 -19

In our study, 40% of the EEG abnormalities. The abnormal al EEG refers to the presence of spikes or spikes with slow waves. The presence of spikes or spikes with slow waves predicts the seizure. The EEG also helps to localize ad classify the type of seizure as either localized or generalized. In patients with first-onset seizures, Gilbert et al showed a wide variation of EEG findings in the detection of seizures.20

A large portion of patients has no EEG changes or structural abnormalities. In patients, without abnormalities on EEG or neuroimaging, incorporating both EEG and MRI brain together can help in diagnosis and also to localized seizure focus helping surgical treatment in drug resistant cases. MRI and EEG are important modalities in the investigation of seizures. They can be used alone or in combination for the evaluation of seizures. In this study, all the patients had undergone at least 30 min of EEG and MRI of the brain. The combination of MRI and EEG provided significantly better diagnostic yield compared with either modality when used alone. Similar results were found in a study done by Mohan B et al. 21

The presence of an MRI abnormality concordant with the ictal onset in EEG is independently predictive of excellent postsurgical seizure control in such patient. 22

This study reinforces the need to upgrade the services of MRI and EEG in other parts of the country in the evaluation of seizures.

Conclusion

The limitation of the study is that it is a single-center study. Seizure and epilepsy are common neurological conditions. There are different causes of seizures in patients of different age groups. Magnetic resonance imaging is important to find out different the structural causes associated with seizures. However, when MRI and EEG are used together, the detection of seizure activity is improved compared with when either modality is used in isolation.

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