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EFFECTIVENESS OF MRI AND ITS ASSOCIATION WITH EEG IN PATIENTS WITH SEIZURES: A CROSS SECTIONAL STUDY FROM CENTRAL INDIA

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ABSTRACT

Background: A seizure is a neurological condition characterised by changes in neurologic function caused by excessive electrical discharge from the central nervous system.

Aims & objectives: The study's goal is to look at the alterations in the brain on Magnetic Resonance Imaging (MRI) in people who have seizures. The goal of this study is to see if there's a link between EEG findings and MRI abnormalities in people who have seizures.

Materials and Methods: It is a cross-sectional, non-interventional, observational retrospective study in which clinical records and imaging tests of patients who were sent to the Department of Radiology for MRI and EEG of the brain were retrospectively reviewed.

Observations and Results: MRI brain scans revealed abnormalities in 460 (76.6 percent) of the 600 patients who had seizures. Idiopathic (36.6 percent), infections (13.67 percent), hippocampal disease (11.6 percent), cortical malformations (4.3 percent), aberrant white matter hyper intensity (6.66 percent), tumours (0.67 percent), and AVM are the etiologies according to MRI (3.67 percent). Hippocampal atrophy, cortical malformation, certain cancers, and dual disease are all areas where EEG can detect seizure beginning. A total of 520 patients (86.67%) had an abnormality on both the MRI and the EEG. In this investigation, abnormal MRI and EEG were shown to be concordant in 86 percent of the participants. Both the MRI and the EEG were normal in 80 patients (13.33 percent). EEG has a sensitivity of 66.25 percent while MRI has a sensitivity of 88.24 percent (95 percent confidence interval).

Conclusion: For identifying and localising the seizures onset area, EEG is the preferred investigation. MRI, on the other hand, has the capacity to pinpoint the exact location of an epileptogenic focus. When it comes to diagnosing structural causes of seizures, EEG results aren't as good as MRI.

Key Word: Seizures, MRI (Magnetic Resonance Imaging), EEG (Electroencephalogram)

INTRODUCTION

A seizure is a neurological condition characterised by changes in neurologic function caused by excessive electrical discharge from the central nervous system[1]. Epilepsy is described as a condition characterised by recurring seizures, and medical intractability is defined as persistent seizures despite receiving optimal treatment from a treating consultant over a period of two to three years. Ultrasonography, computerised tomography (CT scan) of the brain, magnetic resonance imaging (MRI) of the brain, functional MRI, Positron Emission Tomography (PET), and single photon emission computed tomography are some of the imaging modalities used to investigate seizures (SPECT)[2,3]. MRI detects high-grade gliomas and arterio-venous malformations, as well as modest structural abnormalities including hippocampal sclerosis and cortical development anomalies, which require immediate treatment. The identification of these disorders has long-term therapeutic and prognosis ramifications in terms of therapy options and remission or intractability possibilities[4]. EEG is a monitoring technique that involves putting electrodes around the scalp to capture the cortical electrical activity of the brain. It's a noninvasive electrophysiological technique. The EEG measures the voltage fluctuations caused by ionic current in the brain's neurons. The most common use of EEG is to diagnose seizures, which results in aberrant EEG data[5]. To represent the bulk of EEG used in clinical practise, waveforms are separated into bandwidths known as alpha, beta, theta, and delta. Delta - greatest amplitude and slowest waves, > 4 Hz In young children, theta - 4-7

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Hz is normal; in older children, it indicates drowsiness or arousal. Beta - 16-31 Hz symmetrical distribution in frontal region, Alpha - 8-15 Hz posterior regions of the head >32 Hz gamma - cognitive or motor function In the resting state, motor neurons fire at a rate of 8 to 12 Hz. Hippocampal atrophy, cortical malformation (grey matter and white matter abnormalities), certain cancers, and dual disease are all areas where EEG might detect seizure onset[6-8]. EEG has the potential to pinpoint the epileptogenic focus with pinpoint accuracy. Epilepsy monitoring is usually done to distinguish epileptic seizures from other types of spells like psychogenic non-epileptic seizures, syncope, and migraine variants, as well as to characterise seizures for medical treatment and to localise the region of the brain from which a seizure originates for work up of possible seizures surgery[9-11].

MATERIAL AND METHODS

Source of Data: Hospital based study enrolled after obtaining an informed consent of the patients.

Study type: Retrospective cross sectional study

Sample: Patients having seizures referred for MRI brain and patients who undergo for EEG study.

Sample size: 600 patients were taken for this study.

Study time: Patients referred to the department of Radio diagnosis with seizures.

Protocol

MRI: A 1.5T SIEMENS MRI scan machine with a head coil was used in this study. With a field of view of 22 to 24cm, a dedicated head coil is used. The employed matrix size is 512x256. T1W, T2W, FLAIR (Axial/coronal/sagittal), Axial DWI/ADC, Axial T2*/ SWI, coronal IR sequence, T1W post contrast sequence are all employed in all planes.

EEG: In EEG, the recording is made by applying electrodes to the scalp with a conductive gel or paste, usually following abrasion to remove dead skin cells and minimise impedance. EEG may be reconstructed and shown in any format, as well as altered for more extensive study, using digital technologies. Computerized approaches can also be used to detect certain anomalies.

The treating consultant referred all patients for MRI and EEG because they had unprovoked seizures or epilepsy. Criteria for exclusion: Patients who have known contraindications, such as a metallic implant, a pacemaker, or a cochlear implant Patients who have had a brain injury, trauma, or drug-induced seizures. Pseudo-seizures, syncope, and hypoglycemic attacks

OBSERVATION AND RESULTS

Table 1: Involvement of different parts of brain in seizures

Lesions	Frontal lobe	Parietal lobe	Temporal lobe	Occipital lobe	Cerebellum	Capsuloganglionic region
Hippocampal Pathology	6	4	48	-	-	12
Cortical malformation	2	16	6	2	-	-
Infections	10	34	16	2	8	12
AVM	4	8	6	-	4	-
Neoplasia	2	2	-	-	-	-
Non specific abnormal white matter hyperintensities	12	22	4	2	-	-

Table 2: MRI and EEG Corelation

Test	Findings	
	Abnormal (Positive)	Normal (Negative)
MRI	76.6 %	23.4 %
EEG	56.6 %	43.4 %

Table 3: Sensitivity test

	Positive	Negative	Sensitivity (95% confidence interval)
MRI	460 (76.6%)	140 (23.4%)	88.24 %
EEG	340 (56.6%)	260 (43.4%)	65.22 %

There were 600 patients in our study who had both an MRI and an EEG. A quarter of the patients (n=76) were in the age bracket of 21 to 30 years. The youngest patient was 4 months old, while the oldest was 85. The majority of seizures (n=220) are idiopathic (36.6%), however hippocampal disease (n=70) and infections (n=82) are also common causes of epilepsy. Unilateral hippocampal sclerosis was the most prevalent structural lesion among epileptic patients with aberrant MRI results, accounting for 13.9 percent, followed by granulomatous brain diseases such as TB and cysticercosis, accounting for 11.22 percent. 42 patients were diagnosed with tuberculoma and 8 with NCC out of a total of 66 patients. On EEG, 340 individuals (56.67 percent) demonstrate epileptogenic abnormalities out of 600. 60 patients out of 340 have hippocampal atrophy-mesial temporal sclerosis. A total of 520 patients (86.67%) had an abnormality on both the MRI and the EEG. Both the MRI and the EEG were normal in 80 patients (23.33 percent). EEG has a sensitivity of 65.22 percent while MRI has a sensitivity of 88.24 percent (95 percent confidence interval). The chi square analysis has been completed. The p value of 0.001 suggests that the MRI and EEG have a significant difference. For the diagnosis of seizures, an MRI is preferable than an EEG.

Discussion:

A seizure is a neurological disease in which the brain parenchyma produces a continuous, recurrent electrical discharge. According to Gillard et al., 2011, MRI aids in the characterization of the lesion, its development, and the identification of cerebral and cerebellar abnormalities. Diffusion tensor imaging (DTI), as well as 3D reconstruction of several imaging modalities, are crucial surgical planning tools[12-15]. The goal of this study is to describe the type of MRI and EEG anomalies and to see if there is any correlation between the two. In addition to this, the study will be utilised to see how relevant they are in the assessment of new-onset seizures. Pyramidal and granule cell loss in the cornu ammonis and dentate gyrus are hallmarks of mesial temporal sclerosis. In MRI, the IR sequence, FLAIR, and T2W images are important in evaluating mesial temporal sclerosis (MTS), as they show high signal intensities with hippocampal atrophy and show high signal intensities with MTS. MRI has a sensitivity of 97 percent for MTS. Based on the ictal and inter ictal periods, EEG recordings demonstrate rhythmic sharp wave patterns and 6 waves per second[16]. In the hippocampus, exact site location is determined based on aberrant wave patterns. The electroencephalogram (EEG) is a prognostic indication for surgical treatment. 8 Electrical discharges - spike and sharp wave activity on EEG recording would support the diagnosis of focal seizure disorders such as focal temporal and frontal lobe seizures, depending on the location of seizures. According to EEG records, 48 individuals (8%) in our study had aberrant wave forms in the temporal lobe. MRI, on the other hand, detects hippocampal atrophy / sclerosis in 70 cases (11.6 percent) Diseases such as bacterial and viral encephalitis, fungal infection, and granulomatous infections such as tuberculosis and cysticercosis are other major causes of seizures. Seizures are most commonly caused by tuberculosis, cysticercosis, and, in rare cases, other bacterial infections[17]. On T1W images, the necrotizing caseating solid granulomas look isointense/hypo intense, and on T2W images, they seem isointense to hypo intense. On post-contrast T1W imaging, these lesions have a peripheral rim of enhancement. On contrast MRI, the neurocysticercosis (NCC) displays a ring enhancing lesion. Scolex in the vesicular stage of infection is also visible. The cerebral lesions of cysticercus appear as tiny enhancing rings on MR with varying degrees of edoema in the surrounding brain during the inflammatory stage – colloid vesicular stage – triggered by the dying parasite. The T2, FLAIR, and post contrast pictures provide a more accurate assessment of the NCC phases[18]. Disorganization of cortical lamination is related with strange neurons and cells in focal cortical dysplasia (FCD). T2 and FLAIR scans in MRI show areas of cortical thickness, localised atrophy, lack of white matter – grey matter distinction, and high signal intensity. The EEG findings have no bearing on the diagnosis of FCD. Seizures are caused by cavernous malformations, which are improperly constructed vessels. T2, FLAIR, and SWI scans reveal a cavernous abnormality[19]. AVM (arteriovenous malformation) is a type of cerebral vascular malformation that reveals flow voids on T2

weighted images. On MRI, complications such as bleeding and surrounding edoema are also visible. AVM can also be diagnosed with MR Angiography (MRA). 13 Tumors such as oligodendroglioma, ganglioglioma, and Dysembryoblastic neuroepithelial tumours (DNET) can develop in any area of the brain. DNET is a slow-growing benign tumour that can arise in the cortical or deep grey matter. FLAIR imaging on MRI reveals a bright rim sign, whereas T2W images reveal a 'bubbly look.' Further characterisation is frequently aided by the use of additional imaging planes and gadolinium contrast. In a space-occupying lesion, EEG discharges might be normal, widespread, focal, or multifocal. The MRI contrast study can quickly reveal the precise and particular location of the tumour, which is beneficial to the surgeon. For demonstrating the precise location, nature, and characteristic of the lesion, MRI is superior to EEG. In generalised tonic-clonic seizures, as well as other lesions, EEG exhibits aberrant wave shape. Normal circadian activity, on the other hand, has a variety of waveforms[20]. Seizures are usually rare and unpredictably occur. As a result, constant monitoring is essential. Continuous EEG monitoring, on the other hand, is not possible. In up to 60% of patients, the initial routine interictal EEG may be normal. As a result, in many cases, EEG cannot be used as a diagnostic indicator of seizures. The structural abnormalities observed by MRI are not consistent with focal electrical discharges. The correlation between multifocal electrical discharge revealed by EEG and abnormalities observed by MRI is 52 percent. As a result, lesions detected by EEG in patients with multifocal wave form justify the use of MRI for early seizure diagnosis. Doescher et al. looked at patients with new-onset seizures and found that a normal EEG isn't a reliable predictor of a normal MRI finding. T. Hakami et al. report normal EEG readings in the presence of positive MRI findings. It suggests that MRI is an excellent predictor of seizure diagnosis.

CONCLUSIOSN

For identifying and localising the seizures onset area, EEG is the preferred investigation. For epileptogenic focal localization, MRI is the method of choice. MRI can also be used to determine the type of a lesion and its tissue characteristics. In comparison to MRI, EEG data are not reliable indicators. In numerous structural abnormalities causing seizures, EEG has low resolution when compared to MRI. In patients with a head injury, stroke, toxic conditions, or encephalopathies, EEG is not performed. The expense of the modality, as well as patient affordability, remains a disadvantage.

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