Original Research Article

Effectiveness of MRI and its correlation with EEG in patients with seizures

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Abstract

Background: A seizure is defined as an abnormal neurological disorder characterized by alteration in neurologic function due to excessive electrical discharge from the central nervous system. The aim of the study is to assess the changes in Magnetic Resonance Imaging (MRI) brain in patients presenting with seizures. This study is to determine the correlation between Electroencephalogram (EEG) findings and MRI abnormalities in patients presented with seizures. **Materials and Methods:** It is a cross sectional, non-interventional, observational retrospective study in which clinical records and imaging studies of patients, who referred to the Department of radiology, L. G. Hospital, Maninagar, Ahmedabad for MRI examination and EEG of the brain between January 2017 to December 2018 were analyzed retrospectively. **Observations and Results:** Out of 300 patients presented with seizures, 230 (76.6 %) patients were show abnormality in MRI Brain. Etiology according to MRI, in descending order are idiopathic (36.6 %) followed by infections (13.67 %), hippocampal pathology (11.6 %), cortical malformations (4.3%), abnormal white matter hyper intensities (6.66 %), tumors (0.67%) and AVM (3.67%). EEG can identified seizure onset area including hippocampal atrophy, cortical malformation, certain tumors anddual pathology. There were 260 patients (86.67%) with an abnormality on both MRI and EEG. So, abnormal MRI and EEG were concordant in 86% of subjects in this study. There were 40 patients (13.33%) in which both MRI and EEG were normal. The sensitivity (95% Confidence Interval) for MRI is 88.24% and EEG is 66.25%. **Conclusion:** EEG is the preferable investigation for identification and localization of the seizures onset area. However, MRI offers the potential for precise localization of epileptogenic focus. EEG results are not good indicators as compared to MRI for diagnosis of structural causes of seizures.
Key Word: Seizures, MRI (Magnetic Resonance Imaging), EEG (Electroencephalogram)

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INTRODUCTION

A seizure is defined as an abnormal neurological disorder characterized by alteration in neurologic function due to excessive electrical discharge from the central nervous system. Epilepsy is defined as a condition of recurrent seizures and medical intractability as recurrent seizures despite optimal treatment under the direction of a treating consultant over a 2-3-year period.[1] Many imaging modalities for investigating seizures are available like ultrasonography, computerized tomography (CT scan) of brain, MRI of brain, functional MRI, Positron Emission Tomography (PET), Single photon emission computed tomography (SPECT).[2] MRI identifies structural abnormalities that require urgent treatment such as high-grade gliomas and arterio-venous malformations, subtle structural abnormalities such as hippocampal sclerosis and malformations of cortical development. Identification of these conditions has long-term therapeutic and prognostic implications with regard to treatment options, and the possibilities of remission or intractability.[3] EEG is a monitoring method to record the cortical electrical activity of brain by placing the electrodes along the scalp. It is typically a noninvasive electrophysiological method. EEG measures voltage fluctuation resulting from ionic current within the neurons of the brain.[4] EEG is most often used to diagnose seizures, which causes abnormalities in the EEG readings. EEG waveforms are subdivided into bandwidths known as alpha, beta, theta

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and delta to signify the majority of the EEG used in clinical practice.

Delta - > 4 Hz highest amplitude and the slowest waves

Theta - 4-7 Hz normal in young children, drowsiness/arousal in older children

Alpha - 8- 15 Hz posterior regions of the head

Beta - 16- 31 Hz symmetrical distribution in frontal region

Gamma - >32 Hz cognitive or motor function

Mu - 8 -12 Hz synchronous firing of motor neurons in rest state

EEG identifies seizure onset area including hippocampal atrophy, cortical malformation (grey matter and white matter abnormalities), certain tumors and dual pathology.[5] EEG has a potential to provide accurate localization of the site of epileptogenic focus. Epilepsy monitoring is typically done to distinguish epileptic seizures from other types of spells, such as psychogenic non-epileptic seizures, syncope and migraine variants to characterize seizures for the purpose of medical treatment and to localize the region of brain from which a seizure originates for work up of possible seizures surgery.

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:** 300 patients were taken for this study.
- **Study time:** Patients referred to the department of Radio diagnosis, LG hospital, Maninagar, Ahmedabad with seizures for a period from January 2017 to July 2018.

Protocol

MRI: This study has been performed using 1.5T SIEMENS MRI scan machine using head coil. A dedicated head coil is used with a field of view ~ 22 - 24cm. The matrix size used is 512x256. The following sequences are used: T1W, T2W, FLAIR (Axial/coronal/sagittal), Axial DWI/ADC, Axial T2*/ SWI, coronal IR sequence, T1W post contrast sequence in all planes.

EEG: In EEG, the recording is obtained by placing electrodes on the scalp with a conductive gel or paste, usually after preparing the scalp area by abrasion to reduce impedance due to dead skin cells. Digital systems allow the EEG to be reconstructed and displayed with any desired format and to be manipulated for more detailed analysis and also permit computerized techniques to be used to detect certain abnormalities.

Inclusion Criteria

A. All patients referred for MRI and EEG presented with unprovoked seizures/ epilepsy by the treating consultant.

Exclusion Criteria

A. Patients with known contraindications like metallic implant, pacemaker, cochlear implant.
B. Patients presenting with head injury/trauma/drug induced seizures.
C. Syncope and hypoglycemic attacks, pseudo-seizures.

OBSERVATION AND RESULTS

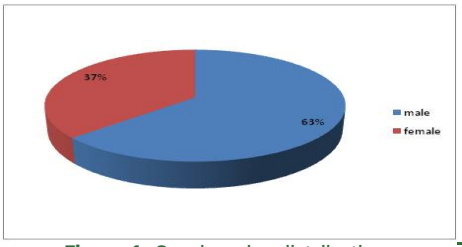

Figure 1: Gender wise distribution

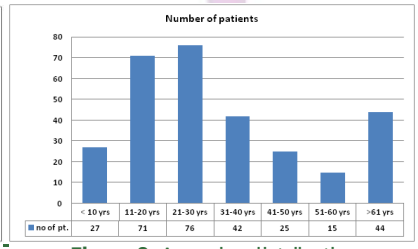

Figure 2: Age wise distribution

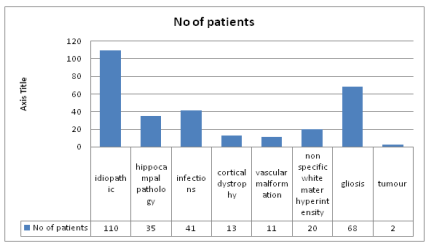

Figure 3: Distribution according to etiology

Table 1: Involvement of different parts of brain in seizures

Lesions	Frontal lobe	Parietal lobe	Temporal lobe	Occipital lobe	Cerebellum	Capsuloganglionic region
Hippocampal Pathology	3	2	24	-	-	6
Cortical malformation	1	8	3	1	-	-
Infections	5	17	8	1	4	6
AVM	2	4	3	-	2	-
Neoplasia	1	1	-	-	-	-
Non specific abnormal white matter hyperintensities	6	11	2	1	-	-

Table 2: Mri and Eeg Corelation

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

Table 2: Sensitivity test

	Positive	Negative	Sensitivity (95% confidence interval)
MRI	230 (76.6%)	70 (23.4%)	88.24 %
EEG	170 (56.6%)	130 (43.4%)	65.22 %

Table 3: Chi-square test for comparison of results of MRI and EEG

Mri	Eeg		Total
	Abnormal	Normal	
Abnormal	150 (50%)	80 (26.6%)	230 (76.6%)
Normal	20 (6.6%)	50 (16.6%)	70 (23.4%)
Total	170 (56.6%)	130 (43.4%)	300 (100%)

Chi-square test value and p value is not significant. There is no relation between MRI and EEG.

In our study, there were total 300 patients, had done both MRI and EEG. Maximum number of patients were seen in age group 21 to 30 years of about 25 % (n=76). Youngest patient was 4 months old and oldest patient was 85 years old. Most seizures are idiopathic (n=110) 36.6%, however, hippocampal pathology (n=35) 11.6% and infections (n=41) 13.6% are common causes of epilepsy. Among epileptic patients with abnormal MRI findings, unilateral hippocampal sclerosis was most common structural lesion comprising 13.9 % followed by granulomatous brain infections like tuberculosis and cysticercosis comprising 11.22 %. Out of 33 patients, 21 patients were diagnosed with tuberculoma and 4 patients having NCC. Out of 300 patients, 170 patients (56.67 %) show epileptogenic abnormality on EEG. Out of 170 patients, 30 patients show hippocampal atrophy- mesial temporal sclerosis. There were 260 patients (86.67%) with an abnormality on both MRI and EEG. There were 40 patients (23.33%) where both MRI and EEG were normal. The sensitivity (95% Confidence Interval) for MRI is 88.24% and EEG is 65.22%. Chi square study is done. The p value is < 0.001 indicates significant difference between MRI and EEG. MRI is better than EEG for the diagnosis of seizures.

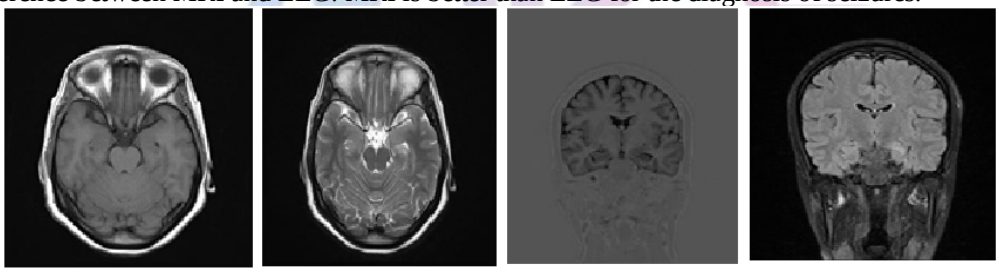

Figure 1: Mesial temporal sclerosis: There is evidence of atrophy involving head and body of left hippocampus. There are hyper intense signals involving hippocampal-para hippocampal regions on left side on T2W and FLAIR images

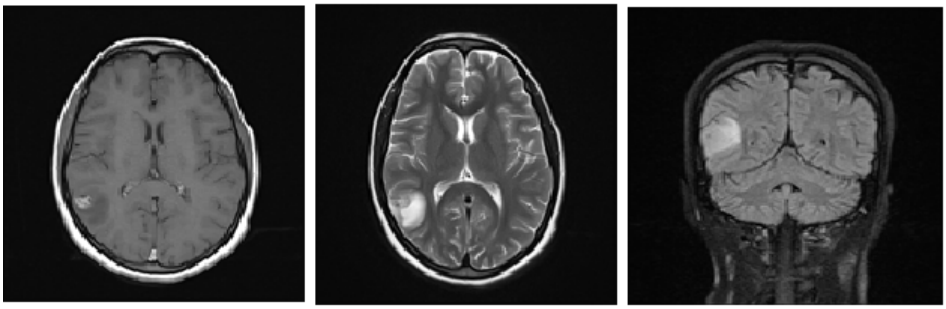

Figure 2: Tuberculoma: The MRI T2W and FLAIR images showing iso /hyper intense lesion and on contrast study nodular peripheral rim enhancement seen

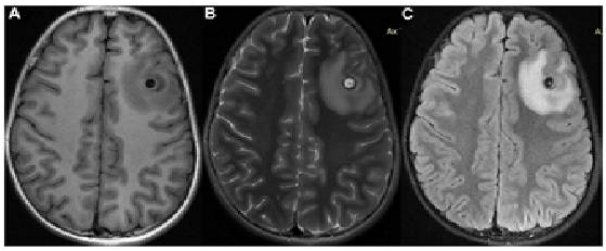

Figure 3: Neurocysticercosis: The MRI T1WI and FLAIR showing hypo intense lesion in left frontal region. The T2WI show hyper intense lesion. Edema surrounding the cysticercosis manifests as acute seizure disorder

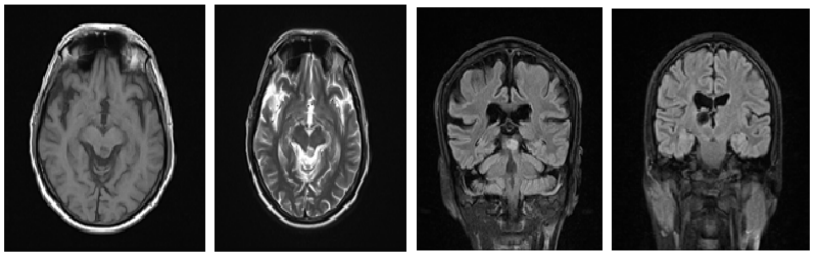

Figure 4: Low grade glioma: There is evidence of heterogeneously hyper intense lesion involving tectum of midbrain on left side on T2W and FLAIR images. The lesion appears iso to hypo intense on T1W images and shows slight tectal expansion. Post contrast images reveal subtle enhancement involving the lesion along posterior aspect

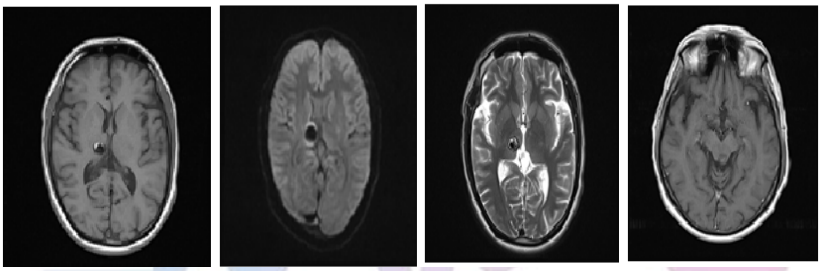

Figure 5: Cavernoma malformation: The lesions show both hypo and hyper intense components on T2W and FLAIR images and iso to hyper intense on T1W images and appear hypo intense on SWI

DISCUSSION

Seizure is a neurological disorder in which persistent, repetitive electrical discharge occurs from brain parenchyma. Gillard *et al.*, 2011 described that MRI helps in characterization of the lesion, progression of the lesion and identify the cerebral and Cerebellar abnormalities.[7] Diffusion tensor imaging (DTI), 3D reconstruction of different imaging modalities is important tools for surgical planning. The purpose of this study is to describe the nature of MRI and EEG abnormalities and to explore any relationship between MRI and EEG findings. Additional to this purpose, study is also used to determine their relevance in the assessment of new-onset seizures. Mesial temporal sclerosis is characterized by pyramidal and granule cell loss in cornu ammonis and dentate gyrus. In MRI, IR sequence, FLAIR and T2W images are important in evaluation of mesial temporal sclerosis (MTS) and shows high signal intensities with hippocampal atrophy. MRI having 97 % sensitivity for MTS. EEG records show rhythmic sharp wave forms and 6 waves / sec based on ictal and inter ictal period. Based on abnormal wave forms exact site location is determine in hippocampus. EEG is a prognostic indicator for surgical treatment.[8] On EEG recording, Focal epileptogenic focus show electrical discharges – spike and sharp wave activity would support the diagnosis of focal seizure disorders like, focal temporal and frontal lobe seizures which depends on the location of seizures. In our study, 24 patients (8%) show abnormal wave form in temporal lobe according to EEG records. However, MRI diagnose hippocampal atrophy / sclerosis in 35 patients (11.6 %) The other most common cause of the seizures are the infections like bacterial, and viral infection causes encephalitis, fungal infection, granulomatous infections like, tuberculosis andcysticercosis. Tuberculosis is the common cause for seizures followed by cysticercosis and rarely with other bacterial infection. On MRI study, the necrotizing caseating solid granulomas appear relatively isointense/hypo intense on T1W images and isointense to hypo intense on T2W images. These lesions show peripheral rim of enhancement on post-contrast T1W

imaging. The neurocysticercosis (NCC) also shows ring enhancing lesion on contrast MRI. It also shows scolex in the vesicular stage of infection. In the inflammatory stage – colloid vesicular stage- provoked by the dying parasite, the cerebral lesions of cysticercus appear as small enhancing rings on MR with variable degree of edema in surrounding brain. The T2, FLAIR and post contrast images better evaluate the stages of the NCC.[9, 10] Focal cortical dysplasia (FCD) is characterized by disorganization of cortical lamination associated with bizarre neurons and cells. MRI demonstrate areas of cortical thickening, focal atrophy, loss of white matter – grey matter differentiation and show high signal intensity on T2 and FLAIR images in MRI. EEG findings are not significant for diagnosis of FCD. [11] Cavernous alformation which involves abnormally configured vessels leads to seizures. Cavernous malformation identify on T2, FLAIR and SWI images.[12] Arterio venous malformation (AVM) is also a type of cerebral vascular malformation shows flow voids, easily seen on T2 weighted images. Complications like hemorrhage and adjacent edema also appreciate on MRI. MR Angiography (MRA) is also useful for diagnosis of AVM.[13] Certain tumors like oligodendroglioma, ganglioglioma, Dysembryoblastic neuroepithelial tumors (DNET) which can occur in any part of brain. DNET is a benign, slowly growing tumor arising from either cortical or deep grey matter. On MRI, FLAIR imaging shows bright rim sign and T2W images shows 'bubbly appearance'. The use of additional imaging planes and of gadolinium contrast is often helpful in further characterization.[14, 15] The EEG discharges in space occupying lesion may be normal, generalized, focal or multifocal. MRI contrast study can easily identify the accurate and specific area of tumor which is useful for surgeon. MRI is better than EEG for demonstration of accurate site, nature and characteristic of the lesion. EEG shows abnormal wave form in generalized tonic-clonic seizures and also in other lesions. However, different waveforms are also seen in normal circadian activity. Seizures are typically infrequent and unpredictable. So, continuous monitoring is required. But, continuous EEG monitoring is not possible. Initial routine inter ictal EEG may be normal in up to 60 % of patients. Thus, EEG cannot establish as the diagnostic indicator of seizures in many patients. Focal electrical discharges are not concordant with structural lesions detected by MRI. Multifocal electrical discharge reveled by EEG correlate with abnormalities detected by MRI is 52 %. Therefore, the lesions detect by EEG in patients with multifocal wave form support the use of MRI in early diagnosis of seizures. In a study by Doescher *et al*., patients with new onset seizure are examined, and demonstrate normal EEG is not a reliable predictor of a normal MRI finding. Hakami T *et al*., show normal EEG finding with positive MRI findings. It indicates that MRI is a good indicator for diagnosis of seizures.[16] Here, the goal of our study is to evaluate the cause of seizures and demonstrate the site of epileptogenic focus which provides further help to treating consultant in management of patients.

LIMITATION OF STUDY

EEG

1. EEG having poor resolution as compared to MRI in various structural lesions causing seizures.
2. EEG is not done in patients with head injury, stroke, toxic states and in encephalopathies.

MRI

The cost of the modality and the patient affordability for MRI continues to be a drawback.

CONCLUSIOSN

EEG is the preferable investigation for identification and localization of the seizures onset area. MRI is the choice of investigation for localization of epileptogenic focus. MRI is the also helpful to diagnose nature of the lesion and tissue characteristic. EEG results are not good indicators as compared to MRI.

REFERENCES

1. Susan T, Herman MD. Single Unprovoked Seizures. Current Treatment Options in Neurology 2004; 6(4): 243-55.
2. Scott N. Atlas. Magnetic Resonance Imaging of the brain and spine. 4th edition, p. 2-14, 307-339.
3. SachinRastogi, Christopher Lee, Noriko Salamon. Neuroimaging in pediatric epilepsy: A multimodality approach. Radio Graphics 2008; 28(2):1079-1095.
4. Niedermeyer E.; da silva F.L. (2004). Electroencephalography: Basic principles, Clinical Applications and Related Fields. ISBN 978-0-7817-5126-1.
5. Chernecky, Cynthia C.; Berger, Barbara J. (2013). Laboratory tests and diagnostic procedures (6th edition). St. Louis, Mo.: Elsevier.
6. Fisher RS *et al*. Epileptic seizures and epilepsy: definitions proposed by the International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE).Epilepsia. 2005; 46(4):470-2.
7. Gaillard WD, Cross JH, Duncan JS, *et al*. Epilepsy imaging study guideline criteria: commentary on diagnostic testing study guidelines and practice parameters. Epilepsia. 2011; 52(9): 1750-1756.
8. Gupta RG. Magnetic resonance imaging of temporal lobe epilepsy. Applied Radiology Dec. 2002; volume 31: No. 12
9. Kuzniecky R. Magnetic resonance spectroscopy in focal epilepsy: P-31 and H-1 spectroscopy. Rev Neurol 1999; 155: 495-498.

10. Zee C, Go J, Kim P, *et al.* Imaging of Neurocysticercosis. NeuroimagClin North Am 2000; 10: 391-407.
11. Bastos AC, Comeau R, Andermann F, *et al*. Diagnosis of subtle focal dysplastic lesions: curvilinear multiplanar reforming from the three dimensional magnetic resonance imaging. Ann Neurol. 1999;46:88-94
12. Geibprasert S *et al*: Radiologic assessment of brain arteriovenous malformations: what clinicians need to know.Radiographics. 30(2):483-501, 2010
13. Roccatagliata L *et al*: Developmental venou anomalies with capillary stain: a subgroup of symptomatic DVAs. Neuroradiology. 54(5):475-80, 2012
14. Thom M *et al*: Long-term epilepsy-associated tumors. Brain Pathol. 22(3):350-79, 2012
15. Chang EF *et al*: Seizure control outcomes after resection of dysembryoplastic neuroepithelial tumor in 50 patients. J NeurosurgPediatr. 5(1):123-30, 2010
16. Hakami T *et al.* MRI – identified pathology in adults with new-onset seizures. Neurology 2013;81(7):920-927
17. The International League Against Epilepsy, Committee for Neuroimaging, Subcommittee for Pediatric. Guidelines for Imaging Infants and Children with Recent-Onset Epilepsy. Epilepsia 2009; 50(9):2147-53.
18. The Commission on classification and terminology of the ILAE. Proposal for revised classification of epilepsy and epileptic syndromes. Epilepsia 1989; 30(4):389-399.
19. Berg AT *et al.* Revised terminology and concepts for organization of seizures and epilepsies: report of the ILAE Commission on Classification and Terminology, 2005-2009. Epilepsia 2010; 51(3):676.
20. Wieser HG, ILAE Commission on Neurosurgery of Epilepsy (2004) ILAE commission report: mesial temporal lobe epilepsy with hippocampal sclerosis. Epilepsia 2004; 45(5):695–714.
21. Bronen RA, Fullbright RR, Spencer DD, *et al.* Refractory epilepsy: comparison of MR imaging CT and histopathological findings in 117 patients. Radiology 1996; 201(6):97-105.
22. Liu RS, Lemieux L, Bell GS, *et al.* The structural consequences of newly diagnosed seizures. Ann Neurol 2002; 52(4):573–580.
23. Price HI, Danziger A. Computed tomography in cranial tuberculosis. AJR 1978; 130(2):769-771.
24. Salgado P, OH Del Brutoo, O.Talamas, MA Zenteno and J. Rodrisuez – Carbajal. Intracranial tuberculoma MR imaging. Neurology 1989; 31(1):299-302.
25. Del Brutto OH. Neurocysticercosis: a review. Scientific World J. 2012:159821.
26. Sanchetee PC, Venkataraman CS, Dhamija RM, Roy AK. Epilepsy as a manifestation of neurocysticercosis. J Assoc Physician India 1991; 39(5):325-8.
27. Hakami T *et al.* MRI – identified pathology in adults with new-onset seizures. Neurology 2013; 81(7):920-927.
28. Betting LE *et al.* MRI reveals structural abnormalities in patients with idiopathic generalized epilepsy. Neurology 2006; 67(1):848.
29. Gilbert DL, Sethuraman G, Kotagal U, Buncher CR. Meta-analysis of EEG test performance shows wide variation among studies. Neurology 2003; 60(3):564.
30. Seneviratne U, Cook M, D'Souza W. The electroencephalogram of idiopathic generalized epilepsy. Epilepsia 2012; 53(5):234.

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