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# Role of MRI in Evaluation of Epilepsy

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**Abstract:** ***Introduction: Epilepsy is a brain disorder marked by repeated and spontaneous seizures. A seizure occurs when there is a sudden disruption in normal brain function due to abnormal, excessive electrical activity in the neurons. The frequency of epilepsy rises with age and can significantly impact a person's quality of life and ability to function within society. The diagnosis of epilepsy relies on a combination of clinical evaluation, electroencephalography (EEG), and neuroimaging. Magnetic resonance imaging (MRI) is currently the primary method used to detect brain abnormalities in epilepsy patients. Methodology: The study was conducted on 60 patients in Department of Radiodiagnosis RDGMC, Ujjain who presented with epilepsy and were examined using GE signa architect 3.0 Tesla MRI machine after taking proper consent. Epilepsy protocol was done in every patient to increase sensitivity and specificity to diagnose structural abnormalities. Results: Out of 60 patients, MRI findings were normal in 33 patients and etiology could not be identified on MRI. Maximum patients were in the age group of 0 - 10 years. Most common findings in our study includes infections, gliosis and intra and extra axial space occupying lesions. Tuberculoma among infections is the most common finding. Conclusion: The present study was an observational study and it concludes that MRI is the initial investigation of choice in patients with epilepsy with its excellent soft tissue contrast, multiplanar imaging capability, high spatial resolution and lack of ionizing radiation potentially improving patient outcomes.***

**Keywords:** Magnetic Resonance Imaging (MRI), Epilepsy, Seizure, Brain abnormalities, MRI diagnosis

## 1. Introduction

An epileptic seizure is a temporary occurrence that results from abnormal or excessive electrical activity in the brain, leading to distinct symptoms. Epilepsy, however, refers to a chronic condition characterized by a recurring tendency to experience seizures, along with its associated effects on neurobiology, cognition, psychology, and social well - being. The nature of these seizures can vary depending on how the abnormal brain activity is distributed. While many factors influence the occurrence of seizures, about 5 - 10% of people will experience at least one seizure in their lifetime, with the highest rates seen in early childhood and late adulthood.

It's crucial to distinguish between "seizure" and "epilepsy. " A seizure refers to a single episode of unusual brain activity, while epilepsy describes a condition in which a person is at risk for recurrent seizures due to an ongoing underlying cause. Epilepsy is marked by the continuous likelihood of seizures and is linked to various neurobiological, cognitive, psychological, and social challenges. It is a common neurological disorder that significantly impacts individuals, families, and healthcare systems.

Epilepsy affects roughly 50 million people worldwide, making it one of the most common neurological disorders. In developed nations, the incidence of epilepsy is between 24 and 53 cases per 100, 000 person - years. However, in developing countries, the reported prevalence can differ significantly due to factors such as variations in diagnostic practices, survey methods, and the regional occurrence of parasitic infections that may raise the risk of epilepsy, with prevalence reaching as high as 57 cases per 1, 000 people.

Seizures are sudden, abnormal events that arise from the electrical activity of the cerebral cortex. They occur when there's an abrupt disruption in the balance between excitatory and inhibitory forces, leading to overall increased excitation in the neural network. This heightened excitation can result from either decreased inhibition or increased excitation.1

Before the introduction of cross - sectional imaging, the assessment and categorization of seizure patients relied on EEG data and clinical observations. While electroencephalography (EEG) remains the gold standard for confirming the presence of epilepsy by detecting abnormal electrical activity, relying solely on EEG and clinical observations to classify seizures can lead to misdiagnosis, especially in patients with partial seizures that quickly progress to generalized seizures. Given that surgical cure rates can reach 65% to 70% for patients with partial seizures linked to structural abnormalities, such misclassification is unacceptable.3

Among the various brain imaging techniques, magnetic resonance imaging (MRI) is the primary method used to identify brain abnormalities in patients with epilepsy. It is non - invasive, painless, and free from ionizing radiation risks [2]. However, it is more costly compared to other imaging methods and electrophysiological procedures. The diagnosis of epilepsy typically involves a combination of clinical assessment, electroencephalography (EEG), and neuroimaging.

## 2. Literature Survey

Wieshmann UC carried out an observational study to explore how neuroimaging is used in clinical practice and to assess the prevalence of structural abnormalities in individuals with epilepsy [4]. The study, which involved 919 patients, found that more than half of those with localization - related epilepsy had identifiable abnormalities, while roughly 20% of patients with a single seizure or epilepsy in remission also exhibited abnormalities. Interestingly, approximately 30% of

participants were excluded due to the lack of CT or MRI scans, prompting the author to propose that the true prevalence of abnormalities could be higher than what was reported.

In a comprehensive review by Kuzniecky et al., it was concluded that the role of CT scans is diminishing, with MRI emerging as the most sensitive technique for identifying cortical malformations, mesial temporal sclerosis, and tumours [5]. The review highlighted that MRI should be the initial neuroimaging method for assessing patients with epilepsy.

In a study by Kodama K, 45 patients with suspected temporal lobe epilepsy underwent both CT imaging and MRI.6 The study concluded that MRI was superior in identifying structural lesions in temporal lobe epilepsies. The study also revealed that patients with unilateral structural lesions had significantly more number of lateralized epilepsy. The MRI findings also significantly correlated with EEG findings.

## 3. Methodology and Approach

This study is carried out at R. D. Gardi Medical College and C. R. Gardi Hospital, Ujjain M. P. subject to approval by ethical committee, in the department of Radiodiagnosis.

**Sources of Data**
All patients suffering from epilepsy referred for MRI evaluation to the department of Radiodiagnosis at RDGMC Ujjain. Before subjecting the patients for MRI evaluation, patient details and detailed clinical history will be taken.

**Sample Size**
During my study duration, study population is finite approximate 60 cases will be reported. So, we include all cases who will reported in my study center during one year duration.

**Inclusion Criteria**
All patients aged 1 month to 60 years suffering from epilepsy referred to the department of Radiodiagnosis for MRI evaluation.

**Exclusion Criteria**
- Patient's /or patient's relatives not giving consent
- Patient with history of claustrophobia
- Study participant with contraindications to MRI investigation (Patients with Aneurysmal clips, cardiac pacemaker, Implanted cardiac defibrillator).

**Case Definition for Study Purpose [7]**
- At least two unprovoked (or reflex) seizures occurring>24 h apart.
- One unprovoked (or reflex) seizure and a probability of further seizures similar to the general recurrence risk (at least 60%) after two unprovoked seizures, occurring over the next 10 years.
- Diagnosis of an epilepsy syndrome.

According to the "International League against Epilepsy Guidelines for Neuro - imaging in Epilepsy Patients (1997)," which suggests using a dedicated epilepsy protocol MRI for all patients with new - onset seizures or newly diagnosed epilepsy in non - emergency situations, the study group underwent imaging using the EPILEPSY PROTOCOL. This protocol includes the following sequences: T2 Axial Fast Spin Echo (FSE), Fluid Attenuated Inversion Recovery (FLAIR) – Axial, Diffusion Weighted Imaging (DWI), T1 Inversion Recovery (IR) Sequence – Axial, T1 Inversion Recovery (IR) Coronal Oblique – 1.5 mm Slices, T2 Coronal Oblique – 1.5 mm Slices, T1 Spoiled Gradient Recalled Echo – Sagittal, and 3D Magnetization Prepared Rapid Gradient Echo (MPRAGE). MRI scans were reviewed, and the findings were documented in a standardized proforma.

## 4. Observation and Results

A total of 60 patients who fulfilled the inclusion criteria were included in the study. The age range of patients was from 1month to 60 years with male predominance (56.6%) which correlates with study done by Sanghvi JP et al [8]. There were 27 patients with abnormal MR findings out of total 60 patients and 33 patients were normal on MRI. In our study patients presented with both generalized and focal seizures. Generalized seizure was more common 39 patients (65%) than focal seizures 18 patients (30%) which correlates with study done by Rasool A et al [9].5% of the patients have unknown seizure onset. Patients with focal lesions have significantly higher incidence of focal onset of seizures and patients with multifocal / generalised lesions have higher incidence of generalised onset of seizures. MRI findings were present in 83.3% of patients (15 out of 18) with focal seizure onset and 30.7% of patients (12 out of 39) with generalized seizure onset. It was observed that abnormal MRI findings were more commonly seen in absence, partial and temporal lobe epilepsy. Maximum patients were in the 1st decade followed by 2nd decade.86.6% patients were below 40 years. In studies done by Murlidhara et al (64%), Hirani et al (54%), highest proportion of patients were also aged < 40 years.1[0, 11]

The common abnormalities in our study were infections (22.2%), gliosis (22.2%), mass (22.2 %), mesial temporal sclerosis (7.4%), periventricular leukomalacia (14.8%) and congenital (11.2 %). Among infections tuberculoma is the most common abnormality. In our study gliotic changes which occur as a consequence of infarction, trauma, infection is also among the most common cause of recurrent seizures. In MRI, gliotic areas follow cerebrospinal fluid signal intensity on all pulse sequences. In our study out of 2 patients with mesial temporal sclerosis, hippocampal atrophy and temporal horn dilatation is seen in 100% of patients.

EEG findings were available for 44 patients out of which 18 patients have generalized EEG findings and 11 patients had focal EEG findings. Out of 11 patients with focal EEG findings 10 patients had focal structural abnormality on MRI. Association between MRI findings and EEG findings were analysed. There was significant association between focal changes in MRI and focal EEG abnormalities. Similarly multifocal / generalised MRI findings were associated with multifocal / generalised EEG abnormalities.

**Table 1:** Findings on Magnetic Resonance Imaging

| MRI Features | Frequency | Percent |
|---|---|---|
| Normal magnetic resonance imaging | 33 | 55% |
| Magnetic resonance imaging with findings | 27 | 45% |
| Total | 60 | 100 |

**Table 2:** Age Wise Distribution

| Age Group | No. of Patients | Percentage Distribution |
|---|---|---|
| 0 - 10 Years | 16 | 26.60% |
| 11 - 20 Years | 15 | 25.00% |
| 21 - 30 Years | 15 | 25.00% |
| 31 - 40 Years | 6 | 10.00% |
| 41 - 50 Years | 4 | 6.70% |
| 51 - 60 Years | 4 | 6.70% |
| Total | 60 | 100 |

**Table 3:** Gender Wise Distribution

| MRI Features | Male | Female |
|---|---|---|
| MRI with findings | 18 | 9 |
| Normal MRI | 16 | 17 |
| Total | 34 | 26 |

**Table 4:** Finding in Patients with Focal and Generalized Seizures

| MRI Features | Focal Seizure | Generalized Seizure | Unknown Onset |
|---|---|---|---|
| MRI with findings | 15 | 12 | 0 |
| MRI without findings | 3 | 27 | 3 |
| Total | 18 | 39 | 3 |

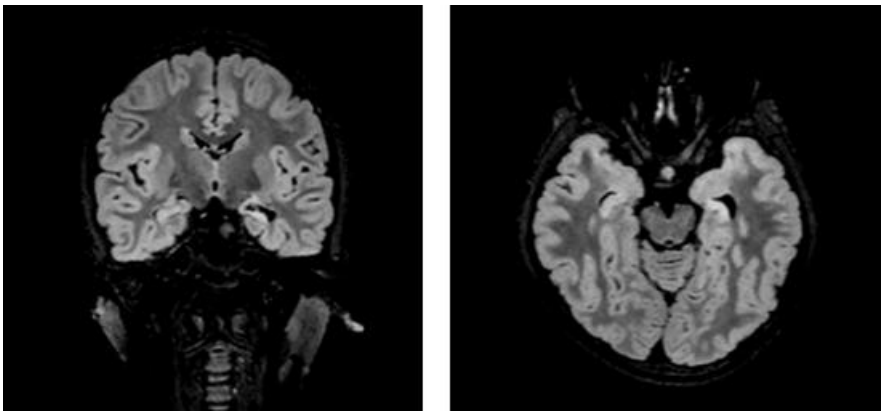
**Table 5:** Epileptogenic Lesion

| Epileptogenic Lesion | No. of Patients | % |
|---|---|---|
| Mesial Temporal Sclerosis | 2 | 7.40% |
| Gliosis | 6 | 22.20% |
| Infectious etiology | 6 | 22.20% |
| Mass lesion | 6 | 22.20% |
| Periventricular Leukomalacia | 4 | 14.80% |
| Congenital | 3 | 11.20% |
| Total | 27 | 100% |

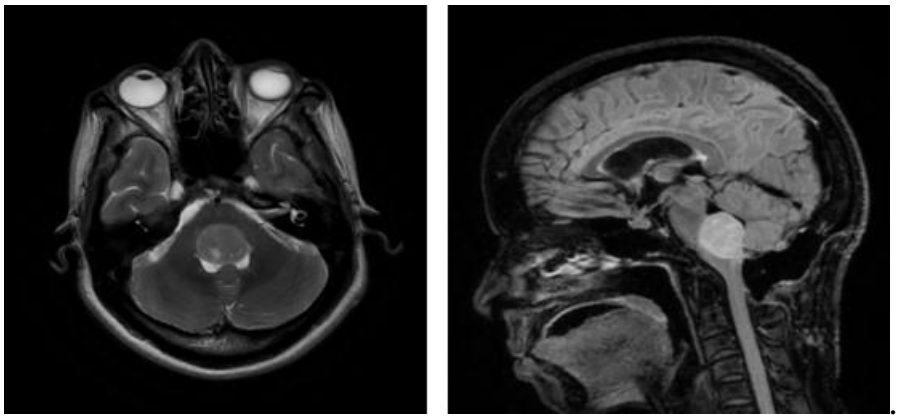
**Table 6:** EEG Findings

| | Focal EEG findings | Multifocal/Generalised EEG abnormalities | Total |
|---|---|---|---|
| Focal lesion in MRI | 10 | 1 | 11 |
| Multifocal/Generalised Lesion in MRI | 0 | 7 | 7 |
| Total | 10 | 8 | 18 |

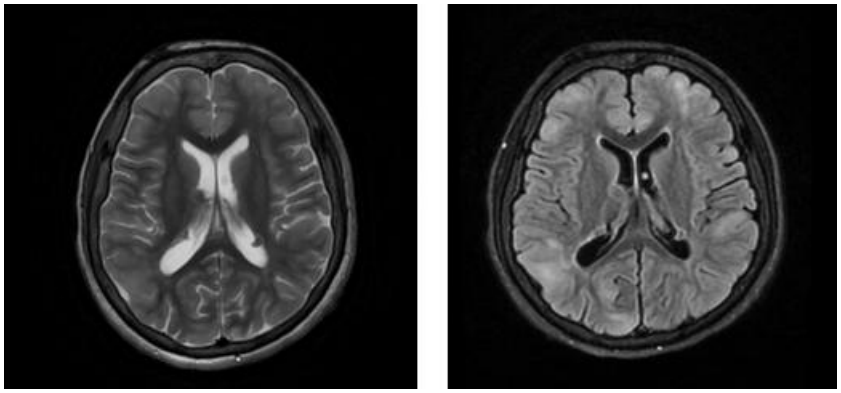
## 5. Cases



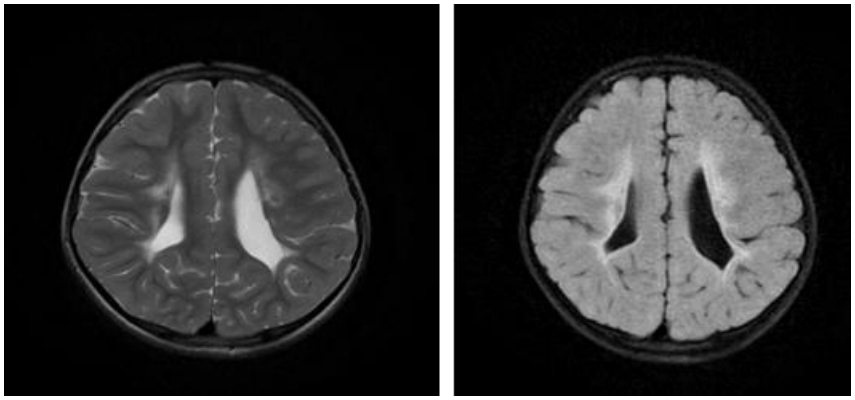
**Case 1:** Mesial Temporal Sclerosis
Hyperintensity in medial part of temporal lobe in hippocampal region with volume loss and dilated temporal horn of left lateral ventricle.



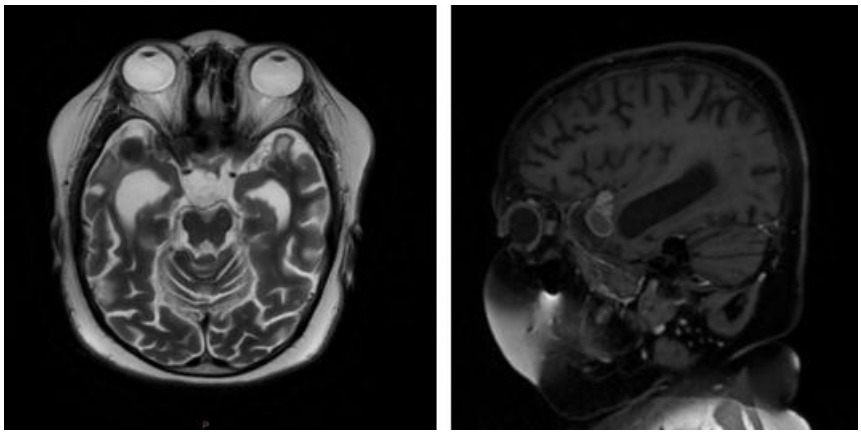
**Case 2:** Pontine Glioma
Rounded mass lesion in posterior aspect of pons in subependymal location.



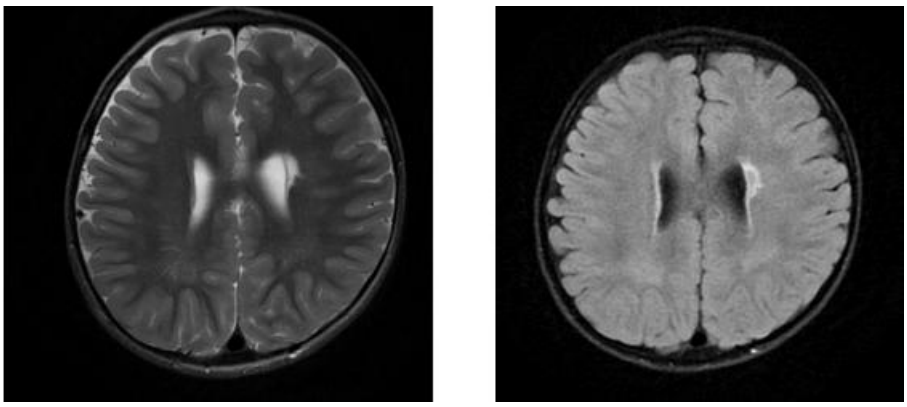
**Case 3:** Tuberous Sclerosis
Multiple lesions hyperintense on T2W/FLAIR sequence in cortex and white matter with subependymal nodules.



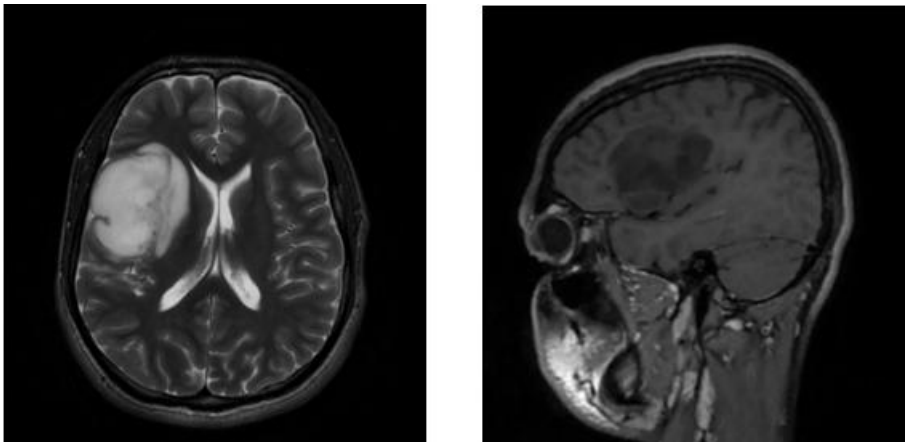
**Case 4:** Periventricular Leukomalacia
Hyperintensity on T2W/FLAIR sequence in periventricular deep white matter with altered shape of ventricles.



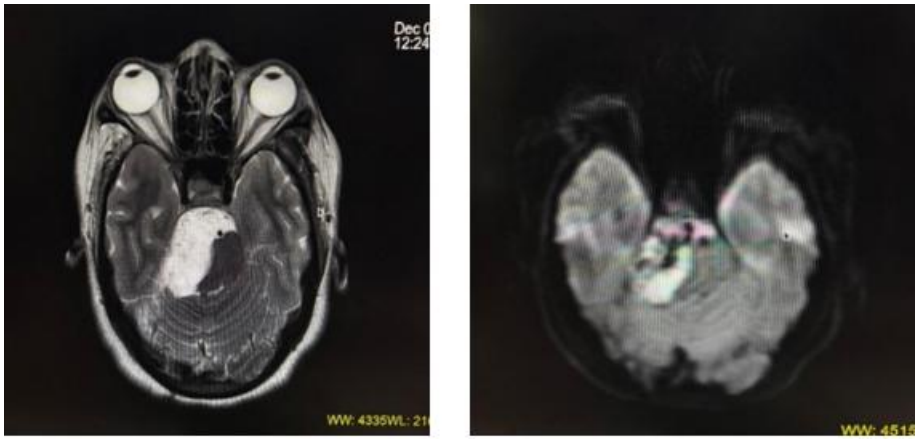
**Case 5:** Tuberculoma
Lesion with surrounding edema and post contrast ring enhancement is seen in anterior part of right temporal lobe.



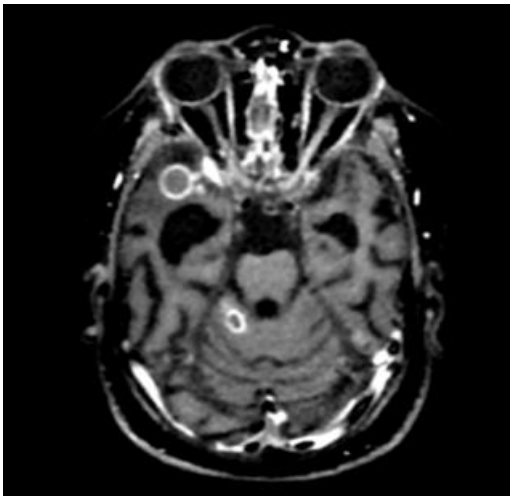
**Case 6:** Gliosis
Lesion hyperintense on T2W/FLAIR sequence in left paraventricular region with volume loss.



**Case 7:** Glioma
Intra axial mass lesion in right insular cortex and external capsule and perisylvian frontal region involving cortex and white matter.



**Case 8:** Epidermoid Cyst
Lesion hyperintense on T2W image showing diffusion restriction seen in right Cerebro - pontine angle causing compression of pons.



**Case 9:** Neurocysticercosis

**Case 10:** Brain Abscess

## 6. Conclusion

MRI is the preferred diagnostic tool for patients with seizure disorders. Its effectiveness in detecting abnormalities depends on the underlying causes of seizures as well as the MRI techniques used and the experience of the interpreting physician. This study concludes that MRI should be considered in the initial evaluation of patients with epilepsy for accurate diagnosis of the cause and for determining the

appropriate treatment. With its high spatial resolution, excellent soft tissue contrast, ability to produce multiplanar images, and the absence of ionizing radiation, MRI has become a valuable tool in assessing patients with seizure disorders. Future scope includes advanced imaging techniques like diffusion tensor imaging (DTI) and functional MRI (fMRI) in evaluating epilepsy.

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