



## ROLE OF MAGNETIC RESONANCE IMAGING IN EVALUATION OF PARTIAL SEIZURES

### Radiology

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### ABSTRACT

**Aims and objectives:** To evaluate the role of Magnetic resonance imaging (MRI) in partial seizures and to correlate the MRI findings with EEG (Electroencephalogram)

**Materials and methods:** The study was conducted in a tertiary care hospital attached with a teaching institute over a 2 year period. 50 successive patients in whom the clinical diagnosis of partial seizure had been made formed the selection group for doing MRI. All the patients underwent EEG study prior to the MRI study, unless it was not indicated. The EEG and magnetic resonance imaging findings were correlated with postoperative histopathological findings in cases where required.

**Results:** The study revealed that the role of imaging in the evaluation of partial seizure is to localize the origin of a focal seizure and identify its cause. Magnetic Resonance Spectroscopy and intravenous contrast administration helps in better characterization of the lesions and thus improves the reliability and confidence of diagnosis in lesions with non-specific appearances.

**Conclusion:** MRI should be the imaging study of choice for the assessment of all patients with partial seizures irrespective of the EEG findings.

### KEYWORDS

Magnetic resonance imaging, Partial seizures, Magnetic resonance spectroscopy.

### Introduction

Partial seizures are those in which electrographic activity commences in a part (focus) of the cerebrum (1,2). They are subdivided into simple partial seizures, where there is no alteration of consciousness, complete partial seizures, where consciousness is altered or lost, and partial seizures evolving to secondarily generalized seizures. EEG has been extensively used for the classification of seizures and the localization of the anatomical area of epileptic focus within the brain. It shows functional (epileptiform) changes to support clinical diagnosis of epilepsy and gives clues regarding partial or generalized seizure onset. But in clinical practice, the EEG is not specific or sensitive at diagnosing the presence or absence of underlying structural cerebral lesions (3).

Since its development, MR imaging has revolutionized the evaluation of epilepsy. It has helped to localize the origin of a focal seizure and identify its cause. This information is not only important in the treatment and prognosis of affected patients, but also vital to those with surgically treatable epilepsy. Surgical treatment of certain disorders such as tumours, vascular malformations or hippocampal sclerosis can eliminate seizure activity. Because the type of surgery and the outcome depend on the cause and location of the epileptogenic source, MR Imaging has become a critical component of the preoperative evaluation (3, 4).

The purpose of this study was to study the role of MR Imaging in evaluation of partial seizures.

### Aims and objectives

To evaluate the role of MR Imaging in partial seizures and to demonstrate the MR Imaging characteristics of various etiologies causing partial seizures. To correlate the MRI findings with EEG and postoperative findings wherever available.

### Materials and methods

The study was conducted in a tertiary hospital attached with a teaching institute over a 2 year period. This prospective study was carried out in 50 consecutive patients who attended the out patient department or were admitted in the hospital, in whom the clinical diagnosis of partial seizure had been made by at least two neurologists. The age group varied from 6 months to 54 years.

The initial evaluation included detailed history of the present and past, general and systemic examination, relevant laboratory and

biochemical tests. 37 Patients underwent an EEG examination. In the remaining, EEG was not resorted to because of the clinical condition of the patient or due to obvious diagnoses such as intracranial neoplastic lesions detected in MRI.

The patients underwent MR imaging in Symphony Maestro 1.5 T MR scanner from Siemens Ltd. The examination was performed with a dedicated head coil. Uncooperative patients and small children were evaluated under sedation or general anesthesia.

All the patients were evaluated with the following sequences: T1 weighted volumetric acquisition followed by sagittal and axial reconstructions, T2 weighted axial, FLAIR axial, gradient echo axial, and FLAIR coronal sequences. Further evaluation with single voxel MR spectroscopy, gadolinium enhanced T1 weighted images, and diffusion weighted images with ADC mapping was done in cases with specific findings to further characterize the lesions and corroborate the findings observed in routine sequences.

All abnormal patients were followed up by clinical examination, response to medical or surgical treatment, histopathology or by follow up scans.

### Results

In our study, maximum referrals for MR imaging for partial seizures was in the age group of 31-40 years (13 patients). The youngest patient was 6 months of age and the oldest was 54 years of age. The mean age of the patients was 25.08 years. Out of 50 patients, 31 patients were males and 19 were females.

All the patients presented with documented history of partial seizures. Clinically maximum number of patients (n=25) presented with complex partial seizures. Simple partial seizures accounted for 19 patients and 6 patients had partial seizures with secondary generalisation.

Other than the history of seizures, 4 patients had right sided hemiparesis (of which one was aphasic), 3 patients had altered sensorium, 1 had decreased vision in left eye, 2 had poor scholastic performance in school, 6 patients complained of generalized headache and one patient gave history of headache in the occipital region. A 6-month-old child had features consistent with floppy child.

Of the 50 patients studied in our series, 38 patients had abnormal MRI

findings (Table 1). A total of 13 patients had granulomatous lesions in brain parenchyma. There were 6 patients of tuberculomas (Fig 1) and 5 patients of neurocysticercosis in varying stages of evolution. 2 patients had imaging features of calcified granulomas. There were 6 cases of tumours and 4 cases of mesial temporal sclerosis (Fig 2). In addition to the above, 6 patients had gliotic changes and 3 patients had infarcts. Significantly, MRI revealed abnormal findings in all the patients (n=10) in the age group of 21-30 years. Rest of the findings is given in Table 2.

**Table 1: Types of seizures**

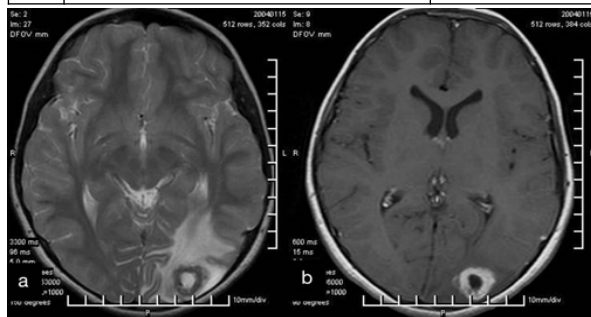
Type of seizure	No. of patients	Abnormal MRI findings	Normal MRI findings
Simple Partial seizures	19	15	4
Complex partial seizures	25	18	7
Partial seizures with secondary generalisation	6	5	1

Out of 37 patients who underwent EEG studies, 11 showed abnormalities and the rest (26) were essentially normal. EEG correctly localized the epileptogenic foci in 7 patients, which correlated with the MRI findings. In 2 patients EEG showed non-specific findings and could not localize epileptogenic foci, whereas MRI findings could explain the focal seizures. In 2 other patients MRI findings were essentially normal, whereas EEG could localize epileptogenic foci. In 3 patients, MRI revealed findings that could not explain the focal seizures.

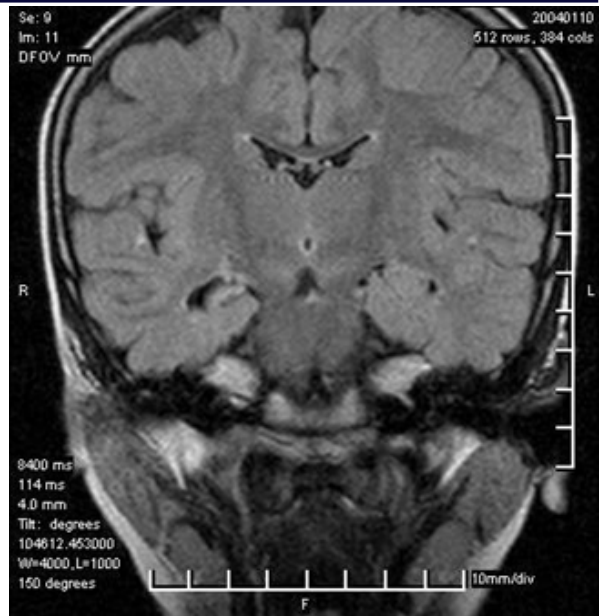
Single voxel MR spectroscopy was done in 17 patients after routine MR imaging. 4 patients (8%) with complex partial seizures had MR imaging features suggestive of mesial temporal sclerosis. Single voxel MR spectroscopy of the hippocampal region on the affected side revealed mild reduction in NAA with raised choline peak and reversal of NAA to choline ratio. 6 patients (12%) had intracranial neoplastic lesions. Single voxel spectroscopy in the region of altered signal in the routine sequences showed significantly elevated choline levels with reduced NAA peak in all these patients.

**Table 2: MR Imaging Findings**

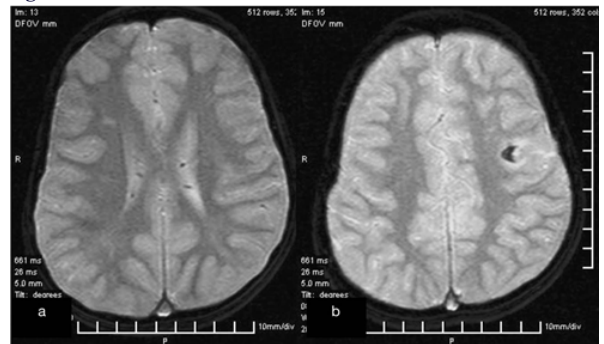
S. No.	FINDINGS	No. OF CASES
1	Normal	12
2	Tuberculoma	6
3	Neurocysticercosis	5
4	Tuberculoma / Neurocysticercosis	2
5	Mesial Temporal Sclerosis (MTS)	4
6	Tumours	6
7	Gliosis	6
8	Infarcts	2
9	Demyelinating Disorder	1
10	Arachnoid cyst	1
11	Cerebral Abscess	1
12	Central Pontine Myelinolysis+Cortical Infarct	1
13	Subarachnoid Haemorrhage	1
14	Tuberous Sclerosis	1
15	Lipoma of corpus callosum	1
	<b>Total</b>	<b>50</b>



**Fig 1a & b: Tuberculoma. 1a: T2WI- Lesion showing central hyperintensity with a well defined peripheral hypointense wall with perilesional oedema seen as hyperintensity surrounding the lesion. 1b: Post-contrast T1WI- Multiple well defined coalescent ring enhancing lesions in the left occipital lobe**



**Fig 2: Mesial Temporal Sclerosis. FLAIR Coronal image- Focal hyperintensity associated with significant volume loss of the right hippocampal gyrus with dilatation of the temporal horn of the right lateral ventricle.**



**Image 3a/3b: Tuberous sclerosis. Gradient echo MR images- Periventricular and subcortical hypointense areas, consistent with calcific foci.**

Gadolinium based intravenous contrast enhanced sequences were acquired in 27 patients after routine sequences, which showed ring like, disc like and irregular patchy enhancement patterns. A total of 17 patients showed contrast enhancement of various patterns. In 4 patients new lesions were detected in contrast enhanced scans which were not seen in precontrast sequences. Presence or absence of contrast enhancement, patterns of enhancement, detection of new lesions in contrast enhanced images, all helped in reaching a fairly accurate diagnosis or narrowing down the differential diagnoses in these patients.

In 5 patients 2D & 3D TOF acquisition of intracranial vessels followed by MIP reconstruction of these images in various orientations (MR angiography) showed positive findings in MR angiography, which could corroborate the other imaging findings in routine sequences and gave a clue towards the possible etiology.

In 3 patients diffusion weighted images with ADC mapping was undertaken to further characterize the findings in routine sequences. 1 was a case of arachnoid cyst and the other 2 were acute cortical infarct and cerebral abscess. Both the latter cases showed areas of restricted diffusion.

**Discussion**

The main purpose of neuroimaging in epilepsy patients is not only to identify underlying structural abnormalities that require specific treatment but also to aid in formulating a syndromic or aetiological diagnosis. This information is important in the treatment and prognosis of affected patients, but is vital to those with surgically

treatable epilepsy. Investigations of epileptic foci in humans have been limited till now by the low spatial or temporal resolution of the diagnostic tools available.

Modern MRI frequently reveals the structural basis of seizures like indolent gliomas, dysembryoplastic neuroepitheliomas and disorders of neuronal migration. The finding of a discrete structural abnormality is of great importance when surgical treatment is being considered. Similarly, finding of a diffuse abnormality, such as widespread cortical dysplasia, argues against surgical therapy being likely to effect seizure control. MRI is invaluable in detecting the extent of surgical resection and whether pathological tissue remains or not (3).

With recent advances in techniques, MR imaging now routinely detects undetectable subtle structural abnormalities. MR imaging with its higher sensitivity, better spatial resolution, excellent soft tissue contrast, multiplanar imaging capability and lack of ionizing radiation has emerged as primary modality of choice in the evaluation of patients with epilepsy.

In our study of 50 patients having partial seizures, abnormal findings were encountered in 38 (76%) patients. Li et al, in 341 patients with chronic partial seizures could demonstrate abnormal findings in 254 (74%) patients using 1.5 T scanner (5, 6).

Out of the fifty patients, 13 patients (26%) had intracranial granulomatous lesions. Infective lesions such as tuberculomas and neurocysticercosis were frequently seen in our study (11 cases). Even though the majority of studies in developed western countries reveal these infective causes as rare conditions in partial seizures cases, many of the studies done in developing countries including India show them as major causes. In a study reported by Wadia et al from Pune, in 150 cases of simple partial epilepsy, commonest lesions found was ring or disc enhancing lesions and more than one third of these were tuberculomas (7). In a study published by Kumar et al, which included 510 cases of partial seizures from Pune and Calcutta, CNS infections constituted the commonest cause. In their study, 68 cases were tuberculomas and 56 cases were neurocysticercosis (8). Chandy et al, reported neurocysticercosis as the commonest cause for epilepsy in a study done in South India with similar reports from other countries as well (9–11).

The noncaseating tuberculoma is seen as an iso- to hypointense lesion on T1-weighted images and as a variable signal intensity lesion on T2-weighted images, with surrounding oedema. The granulomas enhanced homogeneously after contrast administration. Caseating granulomas were hypo- to isointense on T1-weighted images and hypointense to brain parenchyma on T2-weighted images, and showed enhancement in a ring like manner. Conglomerates of such lesions were seen in one of our patient.

Neurocysticercosis in its various stages of evolution were seen in this study. In the parenchymal vesicular stage, they were visualized as thin-walled non-enhancing cystic lesions isointense to CSF on all pulse sequences with an eccentrically located scolex within. In the colloidal vesicular stage, the cyst wall was thicker and it showed enhancement after contrast administration. Surrounding parenchymal oedema was appreciable in this stage. In the granular nodular stage, the residual cyst was typically isointense to brain on T1-weighted image and iso- to hypointense on T2 weighted image. The nodular calcified stage was visualized as signal voids on gradient echo images as a result of susceptibility artifacts. These correlated with the well established appearances of neurocysticercosis in various stages of evolution (12,13).

In our series 6 patients (12%) showed findings suggestive of gliotic changes. MR imaging findings of gliosis were nonspecific, consisting of hyperintense changes on long TR sequences and hypointense signal on T1-weighted images, which in 2 cases were associated with varying degrees of volume loss, encephalomalacia, sulcal widening and ventricular enlargement. Bronen et al reported gliosis in 16% cases with intractable epilepsy out of 165 patients who underwent resective surgery (12).

In our study 6 patients (12%) had intracranial neoplastic lesions. Li et al, in 341 patients with chronic partial seizures could demonstrate neoplastic lesions in 12% patients using 1.5 T scanner in a tertiary referral unit (5). Various neoplasms were found in patients with partial

seizures in our series. All of them were found to be various types of gliomas after histopathological examination. 3 were Glioblastomas, 2 were Oligodendrogliomas and 1 was low-grade (WHO grade 1) glioma.

They were hypointense on T1-weighted images and hyperintense on T2-weighted images. They had significant perilesional hyperintensity in T2-weighted and FLAIR images suggestive of oedema. In all of these patients additional contrast enhanced T1 weighted sequences and single voxel MR spectroscopy from the region of interest were obtained. They helped in delineating and characterising the lesions better.

In our study there were 4 patients (8%) with complex partial seizures who had MR imaging features suggestive of mesial temporal sclerosis. The MR imaging in these patients showed evidence of atrophy of unilateral hippocampus with increased signal intensities on T2 weighted and FLAIR images. Single voxel MR spectroscopy of the hippocampal region on the affected side revealed mild reduction in NAA with raised choline peak and reversal of NAA to choline ratio. There was dilatation of the temporal horn of the lateral ventricle on the ipsilateral side in all these patients. These findings correlate well with earlier studies by Brooks et al, Berkovic et al, Coste et al and Heinz et al (14,15).

Gadolinium based intravenous contrast enhanced sequences were acquired in 27 patients after routine sequences in our study. A total of 17 patients showed contrast enhancement of various patterns. These findings correlate well with most of the earlier studies by various authors to ascertain the requirement of contrast enhanced sequences in patients of partial seizures. Thomas et al concluded after studying 20 paediatric patients that the contrast Gd-DTPA is useful in delineating the presence, extent, and number of certain lesions in the CNS in children (16). Allen et al designed a blinded prospective study involving children as well as adults who were referred for routine cranial MRI. The authors concluded that Gd-DTPA should probably be used routinely for cranial MRI in most patients, except perhaps, children and young adults with normal pre-contrast images (17).

Single voxel MR spectroscopy was done in 17 patients after routine images showed various findings. Kim Vuori et al assessed eighteen patients with seizures and a cortical brain lesion on MR images with proton MR spectroscopy. Their results showed that loss of NAA and increase of Choline were more pronounced in low-grade gliomas than in focal cortical developmental malformations (FCDM) (18). These were found in our patients also. MR spectroscopy provided valuable information in all our patients who underwent this sequence, and helped in corroborating the findings of routine sequences.

In 2 patients MR imaging showed incidental findings which could not explain the partial seizures they had. One patient had lipoma of corpus callosum and the other had an arachnoid cyst in the middle cranial fossa near anterior temporal lobe.

In 2 patients EEG showed non-specific findings and could not localize epileptogenic foci compared to the MRI findings which could explain the focal seizures. In 2 other patients MRI findings were essentially normal, whereas EEG could localize epileptogenic foci. Reason could be too tiny / microscopic epileptogenic focus beyond the resolution of MRI or a generalized metabolic disease starting sometimes as partial seizures with secondary generalization.

The MR findings observed in the rest of the patients were cortical infarct (2 patients), tuberous sclerosis (Fig 3), subarachnoid haemorrhage, central pontine myelinolysis with cortical infarct, cerebral abscess, and demyelinating disorder (1 patient each). The diverse nature of aetiological agents in our series is probably due to the fact that our hospital is a tertiary care referral center. However we did not have any patient with arterio-venous malformation, as seen in most of the western studies, probably due to the small study population.

### Conclusion

The role of imaging in the evaluation of partial seizure is to localize the origin of a focal seizure. This information is not only important in the treatment and prognosis of affected patients, but also vital to those with surgically treatable epilepsy. Magnetic Resonance Spectroscopy and intravenous contrast administration helps in better characterization of lesions and thus improves the reliability and confidence of diagnosis in

lesions with non-specific appearances. Specificity and sensitivity of EEG for diagnosing the presence or absence of underlying structural cerebral lesions in case of partial seizures is low. MRI should be the imaging study of choice for the assessment of all patients with partial seizures irrespective of the EEG findings.

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