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Original Research Article

Role of MRI in Evaluation of First Onset Epilepsy: Our Experience of 100 Patients

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ABSTRACT

Background: MRI plays an important role for the accurate diagnosis in patients with epilepsy disorder. Accurate etiology and diagnosis of epilepsy is important for an effective medical or surgical management. MRI is the most sensitive and specific imaging technique for identification of epileptogenic substrates, based on imaging findings. The present study aims to find the spectrum of imaging findings of first onset epilepsy on MRI in developing country.
Material and methods: It is a prospective study, in which 100 cases of age group between 10-80 years were included, between August 2017 to June 2019 in our institute (Maharishi, Markandeshwar Medical College and Hospital) and underwent MRI on machine (1.5 T) PHILIPS ACHEIVA system. MRI dedicated epilepsy protocol was performed to improve sensitivity and specificity to exclude structural abnormalities. Different MRI sequences used in epilepsy protocol were performed.
Results: Out of total 100 patients included in our study, 62 were males and 38 were females. The maximum patients were of 20-30 yrs and followed by 30-40 age groups. The MRI findings were normal in 34 cases and etiology could not be identified on MRI examination, therefore labeled as idiopathic. The most common MRI findings in the present study were of granulomatous etiology, which include neurocysticercosis and tuberculoma in our study, followed by gliosis/infarction and mesial temporal sclerosis. The unusual diagnosis was dysgenesis of corpus callosum, venous angioma, and tuber cinerum hamartoma.
Conclusion: MRI helps in early recognisation of treatable conditions of epilepsy, thus helps in timely management of the disease. MRI is the initial investigation of choice in seizure patients, because of its high diagnostic yield to identify epileptogenic substrates, its multiplanar capability and lack of ionizing radiation.

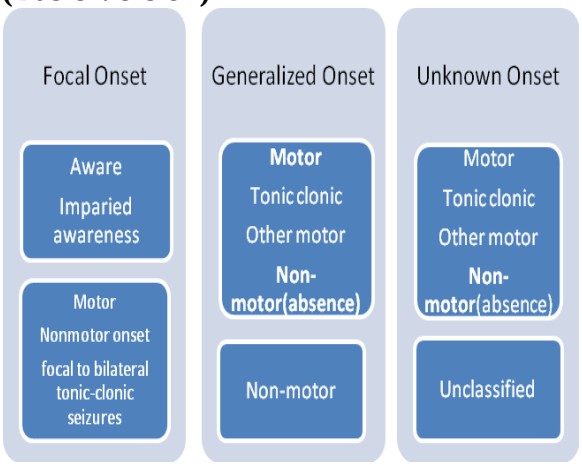
Keywords: Brain MRI, Epilepsy, Neuroimaging, seizure, Magnetic resonance spectroscopy.

INTRODUCTION

In worldwide, the epilepsy is affecting approximately 50 million people and most of them are in developing countries. [1] About 10 million persons with epilepsy are residing in India. [1] According to various studies the overall prevalence of epilepsy in India is 5.59-10 per 1000. [2]

A seizure is defined as a paroxysmal alteration in neurologic function resulting from abnormal excessive neuronal electrical activity and usually a symptom of focal or generalized brain abnormality. Epilepsy is a disorder, characterized by recurrent seizures. Seizures can be classified according to its etiology and origin. According to ILAE 2017 classification, a seizure is classified based on its etiology, and are divided into three types, focal onset, generalized onset and unknown onset. [3]

ILAE 2017 Classification of Seizure (Basic Version) [3]



Relevant seizure history, clinical examination, electroencephalography (EEG) and magnetic resonance imaging (MRI) help the clinician to classify and accurately diagnose epilepsy. Previously, there have been a few studies describing the spectrum of MRI findings in the epilepsy patients belonging to different age groups and also demonstration of underlying identifiable epileptogenic substrates. Focal onset seizures, previously known as complex partial seizures are associated with impaired awareness and most frequently seen at the level of temporal lobe, and the commonest associated structural abnormality is mesial temporal sclerosis (MTS). [4] Mesial temporal sclerosis is best diagnosed by MRI. Mesial temporal sclerosis is the most common cause of intractable epilepsy. [4] The nature of the signs and symptoms in most cases of partial seizures indicates the region of brain involved by the epileptic process.

CT is usually preferred in the emergency setting, for the patients with new onset seizures. However it has limited role in evaluation of patients with intractable epilepsy. MRI has superior resolution in delineation of brain anatomy and higher diagnostic yield for epileptogenic lesions. The advent of high resolution MRI with epilepsy protocol has significantly increased the chances of detecting etiology, resulting in positive clinical impact on the management of these patients.

The present study aims at describing the spectrum of MRI findings of brain seen in our radiology department of a tertiary care hospital in Himachal Pradesh.

AIMS OF STUDY:

1. To evaluate the diagnostic efficacy of a standard MRI and high-resolution sequences with a dedicated epilepsy protocol of the brain with patients of first onset epilepsy.
2. To describe the wide spectrum of imaging findings of epilepsy on MRI.

MATERIAL AND METHODS

In this study, 100 cases of age group between 10- 80 yrs were included, between August 2017 to June 2019 (Maharishi, Markandeshwar Medical College and Hospital) with first clinical presentation of epilepsy who underwent MRI, considering the inclusion and exclusion criteria and results were recorded. Contrast study was performed, if there was suspicion of inflammatory, infectious or neoplastic disorder. Dedicated MRI epilepsy protocol was performed in most of the patients. A dedicated head coil was used with a field of view (22 – 24 cm). A slice thickness of 3 mm was used with an interslice gap of 0.6 mm.

MRI sequences included in our study,

T1W1 isotropic 3D sequence: Superior to look for gray-white matter interface, cortical thickness and abnormal location of gray matter (Heterotopia)

Axial and coronal T2W and FLAIR (perpendicular to temporal lobes): To look for subtle cortical or subcortical hyperintensities.

Axial DWI/ADC: To look for infarction, evident by restricted diffusion.

SWI: To look for calcifications or hemoglobin breakdown.

CET1W: Contrast enhanced images to look for brain tumor, encephalitis, infection or meningitis.

Magnetic resonance spectroscopy: When needed.

Inclusion criteria:
All patients aged 10-80 years presenting with first onset seizures.

Exclusion criteria:
1. Syncopal and hypoglycemic attacks or drug induced seizures.
2. Patients with previous history of neurosurgery.
3. Patients with known contraindications to MRI.

RESULTS AND DISCUSSION

The present study was conducted in a study population of 100 patients in our hospital, who presented with history of generalized and focal seizures and underwent magnetic resonance imaging. In our study, maximum numbers of patients were males. The gender distribution is shown on Figure 1, which includes 62% Males and 38% females. The most common age group of presentation was 10-30 years, depicted on Figure-2. There were 66 patients with abnormal MR findings out of total 100 patients and 34 patients were normal on MRI.

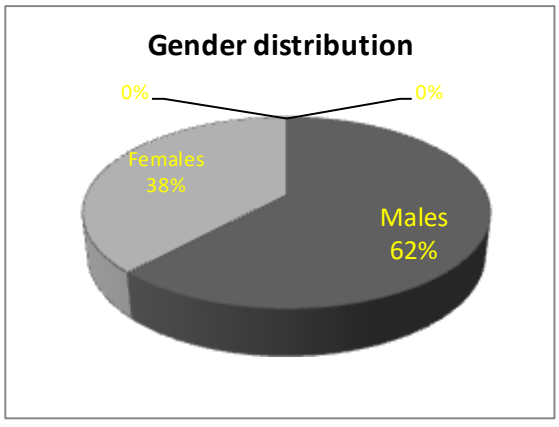


Figure: 1

The most common abnormality in our study was infective granulomas (40.8%), cerebrovascular accidents with gliosis (21.2 %), mesial temporal sclerosis (13.6%), primary and secondary tumours (10.6%), vascular malformations and Post-ictal edema (4.4%), developmental disorders (1.5%) and other causes were 3 % [Table-1]

IMAGING FINDINGS AND AGE DISTRIBUTION

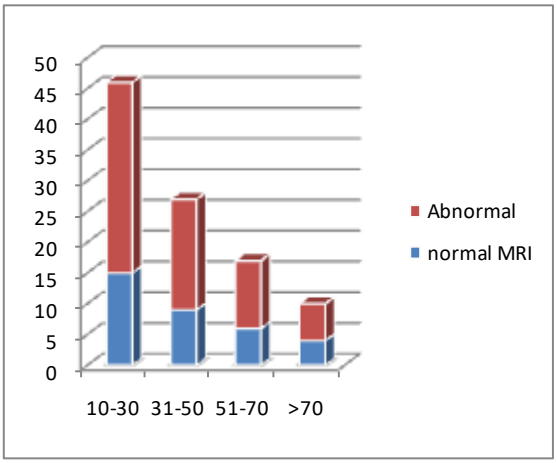


Figure-2

In our study, patients presented with both generalized tonic-clonic and simple/complex partial seizures with percentage of 56.2%, and 16.5% respectively, followed by myoclonic, absence and unclassified types. It was also observed that abnormal MRI findings were more commonly present in absence, complex partial and temporal lobe epilepsy. In present study, CNS infections, chronic infarctions with gliosis and mesial temporal sclerosis were the most common cause of first onset acquired epilepsy.

In CNS infections, neuro-cysticercosis was the most common cause of epilepsy in our study and it is also most commonly seen in young as well as elderly patients. [5] Intracranial cysticercosis evolution occurs through variable MRI stages, which has specific MRI findings and include vesicular stage with CSF signal cyst and internal scolex, colloidal vesicular stage with proteinecous cystic fluid, perifocal vasogenic edema and cyst wall enhancement, granular nodular stage, at which cyst retracts and calcified nodular stage with an involution, resulting in calcified granuloma formation without edema (Figure- 3). Second common CNS infection in our study was tuberculosis, where cause of epilepsy is secondary to raised intracranial pressure, resulting in hydrocephalus, presence of ring enhancing

lesions (tubercuolma) and features of meningitis, which were confirmed on contrast enhanced images (Figure-4). Magnetic resonance spectroscopy sequence (MRS) is a relatively specific sequence for tuberculomas, with diagnostic spectral pattern, involving long chain lipid (range of 0.9 to 1.6ppm peak) and absence of all other normal brain metabolites. MRS sequence was used in most of the ring enhancing lesions to differentiate between intracranial tuberculomas and neurocysticercosis.

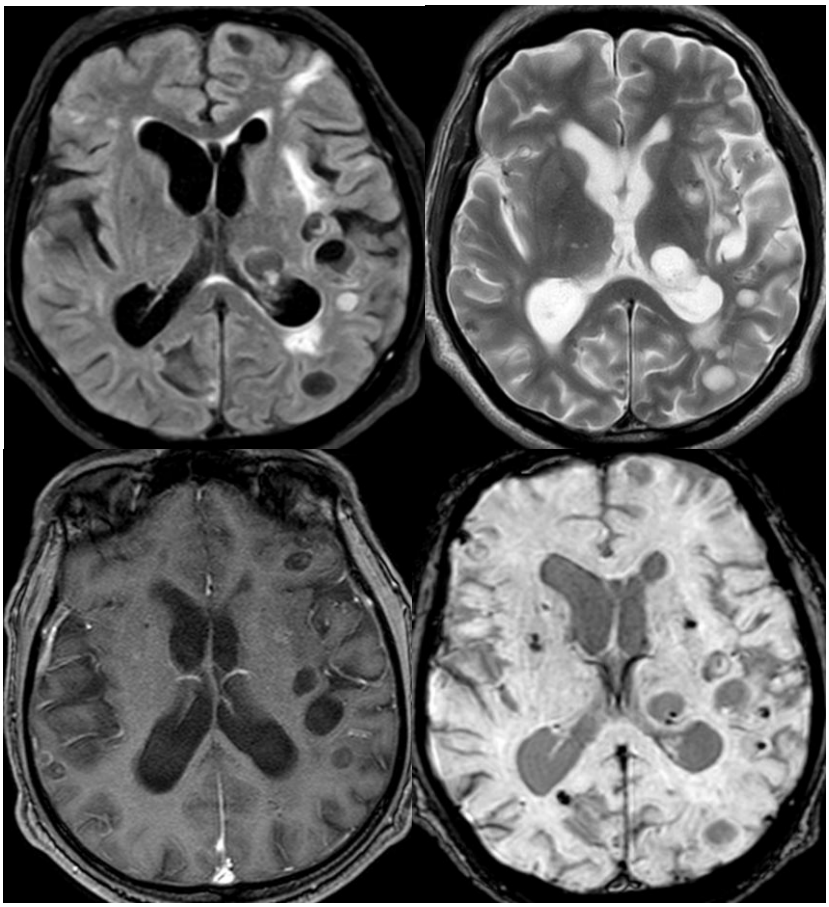
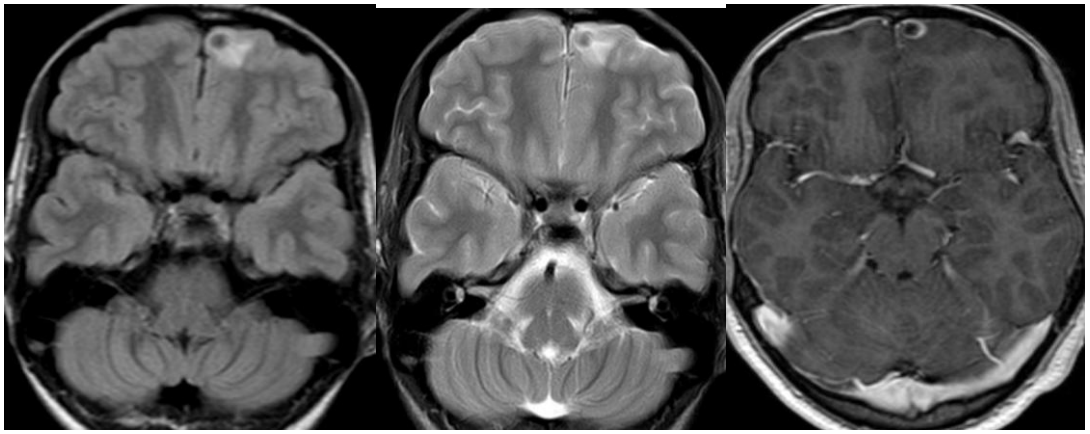


Figure-3: A 24 yr old male with history of seizures.

- Axial T2W and FLAIR demonstrate multiple well-defined hyperintense lesions in both cerebral hemispheres with ring enhancement, eccenteric scolex and multiple areas of perifocal edema. Some of lesions are calcified, seen on SWI images.
- Diagnosis: Neurocysticercosis.



- **Figure-4,** 19 yr old female with history of generalized seizures. MRI Axial T2W and FLAIR images demonstrate vasogenic edema in the left frontal lobe and central T1W and T2W hypointense area, showing ring enhancement on post-contrast images.
- Diagnosis: Tuberculoma

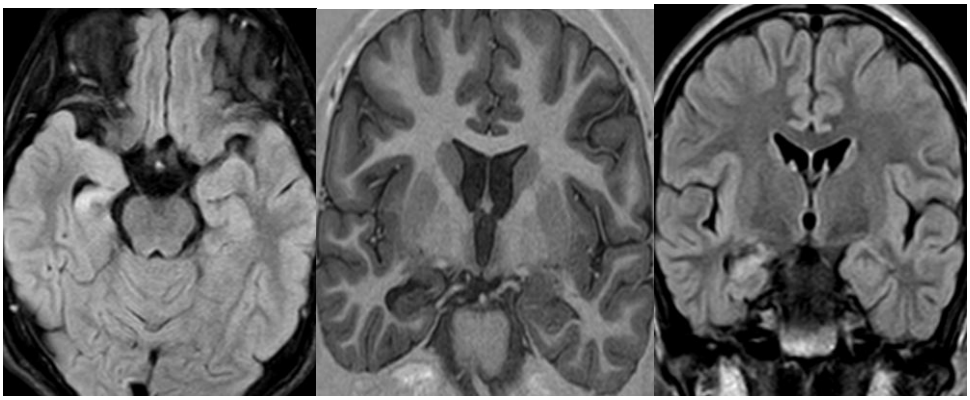


Figure-5: 14 yr old male with history of partial seizures.

- Axial and coronal FLAIR images demonstrate atrophy of the right hippocampus with abnormal hyperintense signal and dilated temporal horn of the right lateral ventricle.
- Diagnosis : Mesial temporal sclerosis

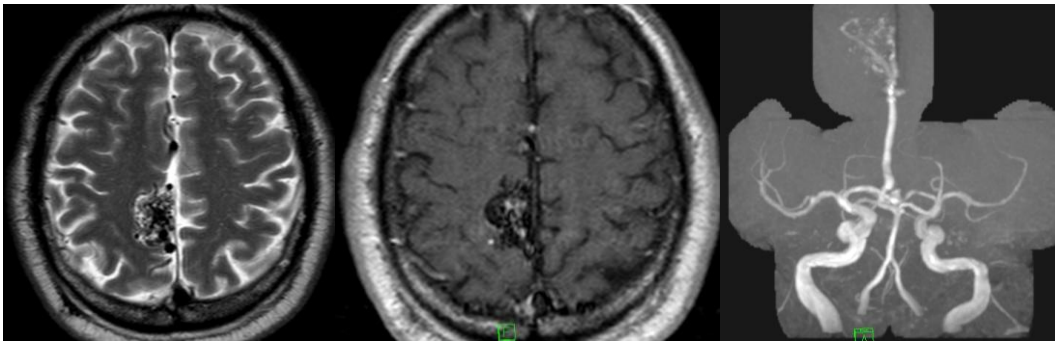


Figure- 6, 33 year old male with clnical history of epilepsy and severe headache had MRI and MRA study. Cluster of serpiginous flow voids on axial T2W and postcontrast axial T1 MRI in the right parafalcine high parietal region with mild contrast enhancement, suggestive of arteriovenous malformation (AVM). AV malformation with a feeding artery from the right anterior cerebral artery, seen on MRA and draining veins into the superior sagittal sinus.

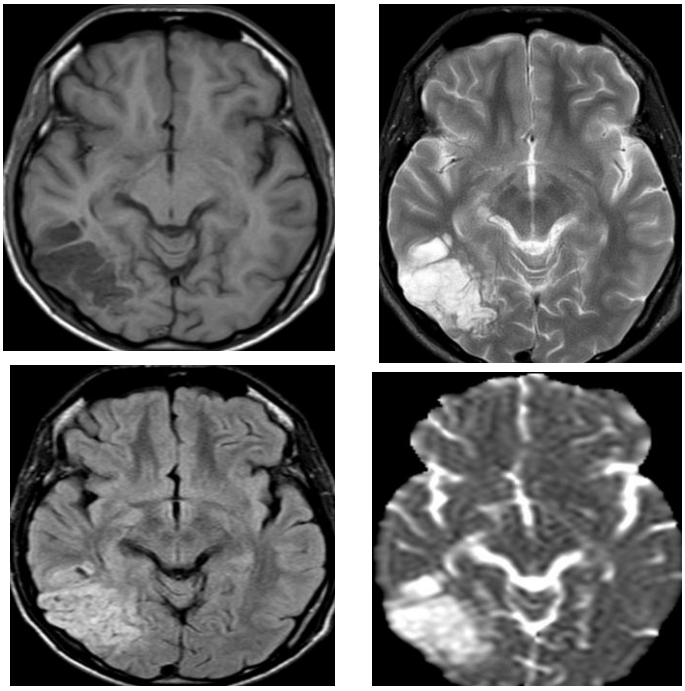


Figure-7: 22 yr old male with history of temporal lobe epilepsy.

- Axial T1W, T2W, FLAIR and ADC images demonstrate cystic space occupying T1W hypointense and T2W hyperintense lesion in the right temporal lobe cortical region with bubbly appearance and without restriction on DWI. No perifocal edema and contrast enhancement seen.
- Diagnosis : Dysembryoplastic neuroepithelial tumor(DNET)

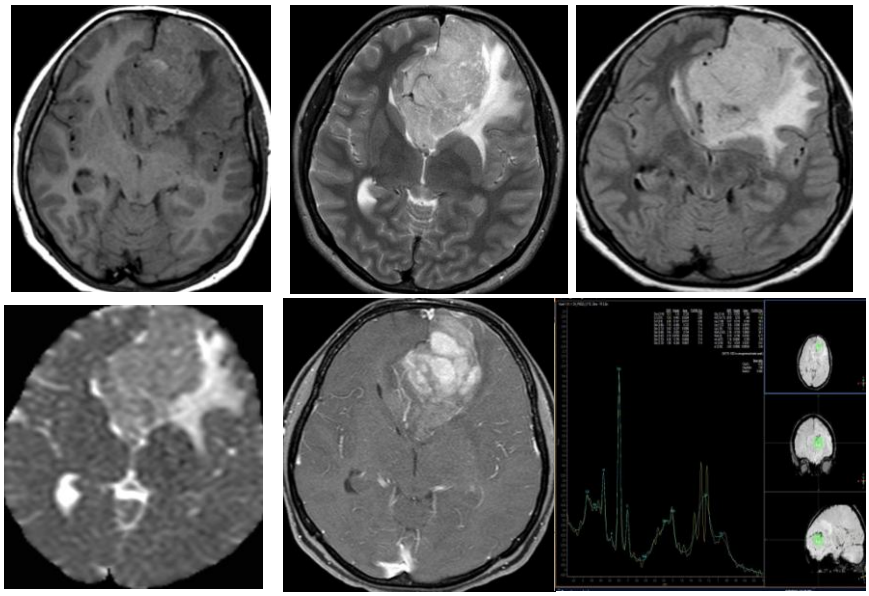


Figure-8: 38 yr old female with history of epilepsy and severe headache.

- Axial T1W, T2W, FLAIR, ADC and post-contrast axial T1W images demonstrate large heterogeneously enhancing occupying T1W hypointense and T2W hyperintense lesion in the left frontal lobe cortical region with restriction and significant white matter edema. MRS shows increased choline peak and reduced NAA.
- Diagnosis : High grade glial tumor

Similarly, a study was performed by Gulati P et al, [6] of 170 children with chronic epilepsy, MRI revealed 64 tuberculomas, 27 cases of cysticercosis and 3 gliomas. Hakami T et al [7] had done study on maximum number of patients (993 patients) and the most common epileptogenic lesion detected in his study as a cause of seizure was gliosis (49%), followed by tumors(15%), cavernomas (9%) and mesial temporal sclerosis(9%).

In our study, 6% patients had transient post-ictal edema, evident by gyral swelling, abnormal T2W and FLAIR hyperintense signal in the cerebral cortex and restricted diffusion, which was resolved on follow-up imaging and no underlying epileptogenic lesion, was demonstrated. Similarly, Kim JA et al [8] had performed a study on eight patients within 3 days of generalized tonic- clonic seizures and found abnormal T2W signal and cortical swelling and restricted diffusion; however, there was complete resolution of T2W abnormal signal on follow up scan on 5 patients, similar to our study.

A study was done in Asia, [9] showed the most frequent cause for epilepsy in elderly is cerebrovascular accidents(30-70%), followed by tumors(10-15%) and metabolic disorders, toxic causes and cerebral hypoxia, account for 10%. In developing countries, prevalence rate for epilepsy in elderly decreases, as compared to those in the first two decades, [9] similar to our study.

Many of our patients with cerebral ischemia and trauma had epilepsy, for which initially CT was performed for the diagnosis. However in a few patients, MRI was advised due to superior resolution and also CT was negative or inconclusive. Cerebrovascular accident is the most common cause of acquired epilepsy in adults in the western world.

In our study, 21.2% patients had acute and chronic stroke MRI findings, out of which approximately 8% patients had acute infarct and 13% cases were of gliosis, as sequelae to prior ischemic or hemorrhagic cerebrovascular accidents and trauma. Similar to the findings observed by Pannang et al study (20%). [10]

Mesial temporal sclerosis was also an important cause of epilepsy in our patients, predominantly in the children, which was not diagnosed on CT study. It is generally considered to be a highly

epileptogenic lesion and causes intractable partial complex epilepsy. In our study, out of total patients, nine children (13.6%), diagnosed with mesial temporal sclerosis, and findings were diagnosed on Coronal oblique SPGR dedicated sequence for hippocampus. The most common findings observed were volume loss of abnormal hippocampus, loss of undulations and hyperintense signal on coronal T2W/FLAIR and SPGR sequences [11] (Figure-5). In advanced cases, ipsilateral limbic system, including mammillary body, fornix and amygdala may be atrophic. [12] Differential of hippocampal hyperintense signal without volume loss are low grade tumors (such as DNET tumor), status epilepticus and encephalitis.

In comparison to conventional T2W sequences, newer, gradient recalled echo (T2W) sequences or Susceptibility weighted imaging (SWI) have improved delineation of calcific foci, hemorrhage and small vascular malformations, such as cavernomas, which could be missed on earlier sequences. In our study, there were two cases of cavernous angioma and one case of arterio-vascular malformation (Figure-6)

PERCENTAGE DISTRIBUTION OF ABNORMAL MRI FINDINGS

Table -1

Abnormal MRI findings	Number of patients	Percentage distribution
Ring enhancing lesions	16	24.2%
Calcified granulomas	11	16.6%
Infarction	14	21.2%
Mesial temporal sclerosis	9	13.6%
Tumors	7	10.6%
Post-ictal edema	3	4.4%
Developmental disorders	1	1.5%
Vascular malformations	3	4.4%
Others	2	3 %

Epilepsy associated tumors are commonly the cause of medically intractable epilepsy. [12] Low grade glioma, meningiomas, Dysembryoplastic neuroepithelial tumor (DNET) (Figure-7), ganglioglioma, metastasis and high grade glioma (Figure-8) were the neoplasms present in our study and observed in 10.6% patients. Surrounding vasogenic edema is usually not present in the low grade tumors.

Developmental disorders, which were diagnosed include polymicrogyria in the frontal lobe and subependymal nodular gray matter heterotopias, it was seen in 1.5% of our patients. To detect subtle gyral pattern abnormalities on MRI, detailed evaluation of cortical anatomy and signal pattern is necessary. Vascular malformations, presented in our study include arteriovenous malformation and cavernoma. Cavernomas have typical MRI characteristic appearance of mixed signal intensity at the center, secondary to variable stages of hemorrhage and peripheral hemosiderin rim, which is better delineated on GRE or SWI imaging.

One patient showed MRI findings of tuberous sclerosis, which showed multiple sup-ependymal nodules and T2W and FLAIR hyperintense cortical lesions in fronto-parietal lobes. Subependymal astrocytoma was also present in the region of foramen of Monroe.

Uncommon diagnosis includes a pediatric patient, who had history of gelastic seizures and precocious puberty and MRI demonstrated tuber cinereum Hamartoma. Another pediatric patient MRI demonstrated findings of Rasmussen's encephalitis, with findings of atrophy of involved cerebral hemisphere and ex-vacuo-dilatation of ipsilateral lateral ventricle and also clinical history of intractable epilepsy.

In recent trends, functional MRI imaging, SPECT and PET and MR spectroscopy will help in localization of seizure focus in the brain and also in patients with refractory seizures for timely surgical management.

CONCLUSION

The present study concludes that MRI plays a significant role in diagnosis of patients presenting with epilepsy to identify epileptogenic lesions/abnormalities. It has ability to detect subtle lesions, their exact location and extent, which are not appreciable on CT study. Focal or complex

seizure patients had higher incidence of abnormal MRI findings, than generalized seizures and timely diagnosis is necessary.

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