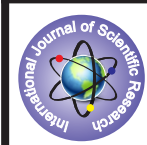


**“MRI IN SIEZURE DISORDER”****Radiology****KEYWORDS:** MRI, seizures.**Dr. Ravleen Kaur**

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**ABSTRACT****Aim:** To study profile of MRI findings in patients with seizure disorder and correlate the MRI findings with clinical type of seizure.**Materials:** It was a prospective study in which 150 patients presenting with seizure disorder were evaluated by MRI.**Result:** Out of 150 patients, 108 (72%) patients showed abnormalities while 42 (28%) patients revealed no abnormality. Neuroinfection formed the major group (31.3%) followed by neoplasms (17.3%), developmental anomalies (14.7%), hypoxic/ischemic encephalopathy (6%) and Rasmussen's encephalitis with vascular malformations forming minority (0.7%). In patients with no gross abnormality, 22.2% patients showed unilateral hippocampal sclerosis. Abnormalities were more common in patients with partial seizures than with generalized/absence seizures.**Conclusion:** MRI not only identifies specific epileptogenic substrates, but also determines specific treatment and predicts prognosis. In this study 72% of patients presenting with seizure disorder showed abnormality on MRI. Hence all patients with seizures should undergo detailed neuroimaging.**Introduction**

A seizure is a paroxysmal alteration in neurologic function resulting from abnormal excessive neuronal electrical activity.<sup>1</sup> Epilepsy is a chronic condition characterized by recurrent seizures unprovoked by an acute systemic or neurologic insult.<sup>2</sup>

The International classification of epilepsies and epileptic syndromes classifies clinical epilepsy into two broad categories, idiopathic (primary) and symptomatic (secondary) disorders.<sup>1</sup> Both primary and secondary epilepsies could be Generalized, Partial (Simple/Complex partial with secondary generalization) or Unclassified seizures (Febrile/Seizure syndromes).<sup>3</sup>

MRI is the most appropriate imaging technique in the initial investigation of patients with seizures. It has increased substantially the ability to detect causes of seizure disorders, to plan medical or surgical therapy and to prognosticate the outcome of disorders and therapy.<sup>4</sup>

Other imaging techniques such as positron emission tomography (PET) and single photon emission computed tomography (SPECT) are reserved for patients with intractable epilepsy when surgery is contemplated.<sup>5</sup>

MRI is unsurpassable in detection of small lesions, differentiation between gray and white matter structures, and in visualization of the hippocampus, all of which are critically important in epilepsy imaging.<sup>6</sup>

**Material and methods:**

The study was conducted in the department of Radiodiagnosis, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, 150 patients presenting with seizure disorder were evaluated by magnetic resonance imaging (MRI). Patients presenting with seizure disorder of all age groups and both sexes were included in the study except patients who were non co-operative, claustrophobic, had cardiac pacemaker/ metallic implant, had history of head injury/ brain surgery and patients with febrile convulsions.

A detailed history of patients, laboratory investigations and EEG findings were recorded. Other investigations like skull/chest radiographs, CT head and relevant biochemical investigations were done wherever required.

**METHOD**

All cases were subjected to routine MRI on 1.5 Tesla 16 channel Achieva (Philips Medical system) MRI with SENSE head coil. Four axial sequences including T1W sequence (TR-542ms, TE-15ms, slice thickness-5mm), T2W sequence (TR-4047ms, TE-100ms, slice thickness-5mm), DW sequence (TR-3678ms, TE-116ms, max b factor 1000) and FFE sequence (TR-636, TE-23, slice thickness-5mm) were taken along with T2 sagittal sequence, FLAIR coronal sequence (TR-11000, TE-140) and thin coronal T2W sequence for hippocampus in all patients. Depending upon conventional MRI findings single voxel spectroscopy/chemical shift imaging, high resolution volumetric imaging, inversion recovery sequence, volumetric and only grey matter sequence were done wherever required. In patients in whom contrast MRI was required, gadolinium based agent was administered in dose of 0.2mmol/kg and contrast enhanced T1W sequence was taken in axial, coronal and sagittal planes. In cases where no gross abnormality was detected on MRI, detailed volumetric and signal characteristic analysis of hippocampus was done to rule out MTS (medial temporal sclerosis). An oblique coronal three dimensional gradient echo sequence (3D-TFE, slice thickness-0.85mm, interslice gap-1.3mm) was obtained perpendicular to the long axis of hippocampus. Cross sectional areas of both hippocampi were measured by tracing hippocampal boundary from hippocampus head to tail manually. The volumes of both hippocampi were calculated by summing each of the cross sectional volumes {cross sectional area x (section thickness + interslice gap)}. MRI findings were recorded, correlated with clinical findings and a provisional diagnosis was made.

**RESULTS**

Majority of the patients were in the age group 21-30 years (24%), followed by 11-20 (21.3%) and 2-10 years (17.3%). Patients of age <1 year and >60 years formed minor group comprising 4.7% and 4%. 83 (55.3%) patients were males and 67 (44.7%) were females. Most

common associated symptom was headache (40%), followed by altered sensorium (20%) and vomiting (16%) while 10.6% patients did not show any other symptoms.

90 (60%) patients had normal CNS examination and 60 (40%) patients showed neurological findings (30 patients had altered sensorium and 10 had developmental delay with 7 having more than one neurological finding).

108 (72%) patients showed abnormalities on MRI and 42 (28%) patients had normal MRI study. Abnormal MRI findings were (Table 1)

#### DISTRIBUTION OF ABNORMAL MRI FINDINGS IN STUDY SUBJECTS

MRI DIAGNOSIS	No. of Patients
<b>NEUROINFECTION</b>	<b>47(31.3%)</b>
NCC	35(23.3%)
TUBERCULOMA	9 (6%)
ABSCCESS	2 (1.3%)
HYDATID	1 (0.7%)
<b>NEOPLASMS</b>	<b>26 (17.3%)</b>
GLIOMA	15 (10%)
MENINGIOMA	8 (5.3%)
METASTASIS	3 (2%)
<b>DEVELOPMENTAL ANOMALIES</b>	<b>22 (14.7%)</b>
MESIAL TEMPORAL SCLEROSIS	12 (8%)
FOCAL CORTICAL DYSPLASIA	4 (2.7%)
TUBEROUS SCLEROSIS	2 (1.3%)
HETEROTOPIA	1 (0.7%)
LEUKODYSTROPHY	1 (0.7%)
SCHIZENCEPHALY	1 (0.7%)
PORENCEPHALY	1 (0.7%)
<b>PRENATAL, PERINATAL &amp; POSTNATAL INSULTS</b>	<b>10 (6.7%)</b>
HIE	9(6%)
RASMUSSEN'S ENCEPHALOPHALITIS	1(0.7%)
<b>VASCULAR MALFORMATIONS</b>	<b>3 (2%)</b>
CAVERNOUS ANGIOMA	2(1.3%)
PIAL ARTERIOVENOUS MALFORMATION	1(0.7%)

Among 108 cases with abnormal MRI, neuroinfection came out to be the leading cause of seizure disorder followed by neoplasms and developmental anomalies. MTS accounted for 8%, cases.

Most common etiology in age < 1 year was HIE. In 2-10 years HIE (23%) and neurocysticercosis (15.4%) were the most common etiologies followed by developmental anomalies and MTS (7.6%). In 11-20 years neurocysticercosis was most common etiology (28.1%) followed by MTS (12.5%). In 21-30 year age group neurocysticercosis was most common etiology (41.7%) followed by MTS (16.6%) and tuberculoma (11.1%). Glioma was the most common etiology in 31-40 years (20.8%) followed by neurocysticercosis (16.6%) and meningioma (12.5%). In age 41-50 years both glioma & tuberculoma were common (30% each) followed by neurocysticercosis (20%). In age 51-60 years glioma and brain metastasis were most common (11.1% each). Age >60 years, the most common etiology was glioma (33.3%) followed by meningioma & neurocysticercosis (16.7% each)

58% of neurocysticercosis and 68.4% of tuberculoma cases were seen in 2nd to 3rd decade. 76.4% of glioma cases were seen in 3rd to 6th decade.

Most common neuroinfection in patients presenting with seizure disorder was neurocysticercosis (74.4%) followed by tuberculoma (19.1%)

Out of the 15 cases of Glioma 3 cases were of low grade glioma (Pilocytic astrocytoma-1, DNET-2) and 12 cases were of high grade tumour (7 anaplastic glioma, 4 glioblastoma multiforme and 1 gliomatosis cerebri). Most common type of brain tumour was glioma, 15 (57.7%) followed by meningioma 8 (30.7%) and metastasis 3 (11.5%).

**MESIAL TEMPORAL SCLEROSIS:** Detailed volumetric and signal analysis of hippocampus was done in 54 patients showing no gross abnormality on MRI. 20 normal control values for hippocampal volume were acquired from 20 control subjects using an identical protocol. Abnormal hippocampal volume values were defined as those outside the range of control values. The mean for normalized R-L hippocampal volume difference in controls was 0.155 (0-0.3cc). All the values which were outside the upper limit of the range were considered abnormal. Using this criteria, 12 (22.2%) out of 54 patients had hippocampal volume difference of more than 0.3cc. They showed relatively small ipsilateral hippocampus with loss of digitations and altered signal intensity on T2W/FLAIR images

The most common seizure type was complex partial seizure (50%) followed by generalized tonic clonic (GTCS) (35.3%). Simple partial 18(12%) & absence seizures 4 (2.7%) formed minority. Most common MRI abnormality found in patients with complex partial seizure was neurocysticercosis (20%), glioma (18.7%) and MTS in 12 (16%) cases. Most common MRI abnormality found in patients presenting with GTCS was neurocysticercosis (13.2%) followed by tuberculoma (7.5%). However it was seen that majority of patients (51%) presenting with GTCS showed normal MRI study. Table 2.

#### DISTRIBUTION OF MRI FINDINGS ACCORDING TO TYPE OF SEIZURE

MRI DIAGNOSIS	Number of patients presenting clinically with a particular type of Seizure				TOTAL
	GTCS/T ONIC/ CLONIC	COM PLEX PARTIAL	SIMP LE PARTIAL	ABSENCE	
NORMAL	27	9	2	4	42
NEUROCYSTICERCOSIS	7	15	13	0	35
TUBERCULOMAS	4	4	1	0	9
ABSCCESS	0	2	0	0	2
BRAIN HYDATID CYST	0	1	0	0	1
GLIOMA	1	14	0	0	15
MENINGIOMA	0	6	2	0	8
METASTASIS	2	1	0	0	3
MTS	0	12	0	0	12
FOCAL CORTICAL DYSPLASIA	0	4	0	0	4
TUBEROUS SCLEROSIS	2	0	0	0	2
HETEROTOPIA	1	0	0	0	1
LEUKODYSTROPHY	1	0	0	0	1
SCHIZENCEPHALY	1	0	0	0	1
PORENCEPHALY	0	1	0	0	1
HIE	7	2	0	0	9
RASMUSSENS ENCEPHALITIS	0	1	0	0	1
CAVERNOUS ANGIOMA	0	3	0	0	3
<b>TOTAL</b>	<b>53 (35.3%)</b>	<b>75 (50%)</b>	<b>18 (12%)</b>	<b>4 (2.7%)</b>	<b>150</b>

## DISCUSSION

Majority of the patients were younger unlike western studies (Sander et al<sup>7</sup>) where many were in older age group. Age distribution was more or less comparable with Verma et al<sup>8</sup>. Discordance with other studies reflects variation in etiological spectrum which differs from region to region.

Rahimian et al<sup>9</sup> reported high number (64%) of normal MRI, while in the present study normal MRI study constituted 28% with 72% showing abnormalities which can be attributed to infections contributing good number of cases in our study resulting in increase percentage of abnormal MRI as compared to their where no such case was diagnosed.

The distribution of various MRI abnormalities differed among various age groups. In the younger age group developmental anomalies and ischemic insults predominated where as majority of cases of neoplasms were found in adult age group. Neuroinfections were noted in all the age groups.

Koirala et al<sup>10</sup> found that in pediatric age group major abnormalities were hippocampal sclerosis and cortical atrophy whereas in adults space occupying lesions (27%), ischemia/infarcts (16.2%) and granulomatous lesions (11%) were common.

FLAIR images were more sensitive in the detection of the scolex, whereas the gadolinium enhanced T1-weighted series identified the highest number of lesions according to Lucato et al<sup>11</sup> who compared all MR sequences.

Liigant et al<sup>12</sup> reported that seizures were more common in tumors involving the frontal, frontoparietal, temporal and frontotemporal lobes, and histologically patients with mixed gliomas, oligodendrogliomas and astrocytomas experienced seizures more frequently. Epilepsy is one of the most common symptoms of intracranial meningiomas according to Lieu AS et al<sup>13</sup>

Kasasbeh A et al<sup>14</sup> evaluated six MRI features of MTS increased hippocampal signal intensity (T2WI), reduced hippocampal size, ipsilateral hippocampal collateral white matter atrophy, enlarged ipsilateral temporal horn, reduced gray-white matter demarcation in temporal lobe, and decreased temporal lobe size. The most prevalent feature of MTS identified on MRI was a reduced hippocampal size as in our study

## CONCLUSION

Partial seizures are associated with very high rate of abnormality detection while patients presenting with primary GTCS, tonic or clonic and absence seizures have relatively lower rate of abnormality. Etiology of seizures varies significantly with age. Infective cause may be the leading cause of seizure depending upon the prevalence. Employing appropriate imaging protocols makes it possible to identify subtle lesions like MTS.

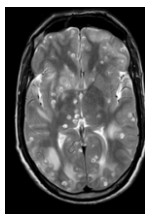


Figure 1- Disseminated NCC

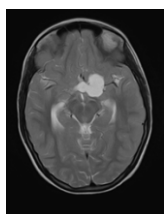


Figure 2 Racemose NCC

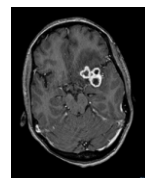


Figure 3- Tuberculomas

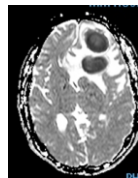


Figure 4-Cerebral abscess

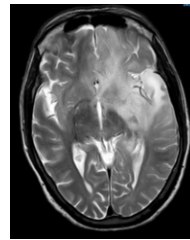


Figure 5- Gliomatosis cerebri



Figure 6- Meningioma

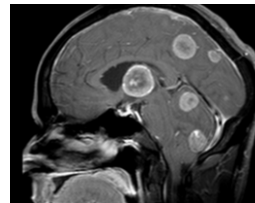


Figure 7 – Metastasis

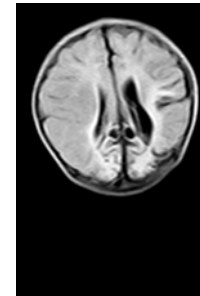


Figure 8- HIE

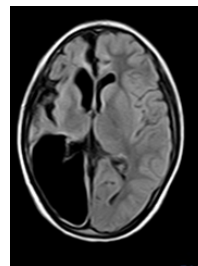


Figure 9 – Rasmussen's encephalitis

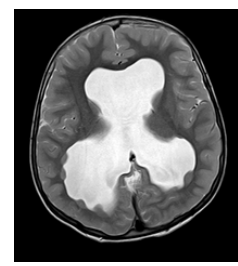


Figure 10- Heterotopia

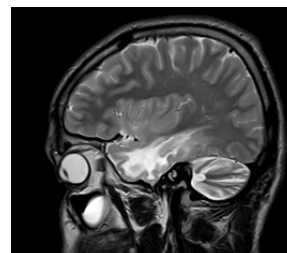


Figure 11- Focal cortical dysplasia

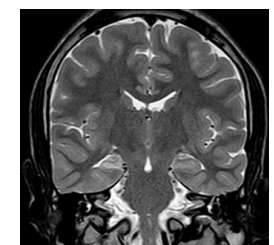


Figure 12- Mesial Temporal sclerosis

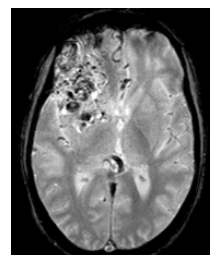


Figure 13- AVM

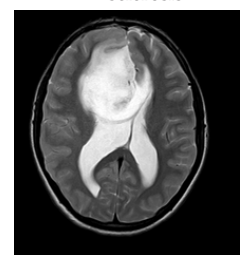
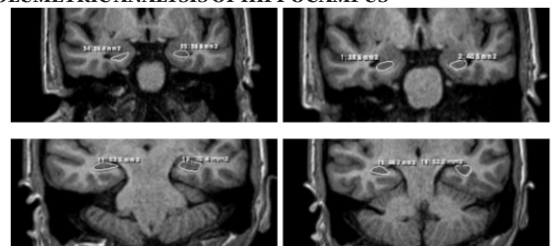
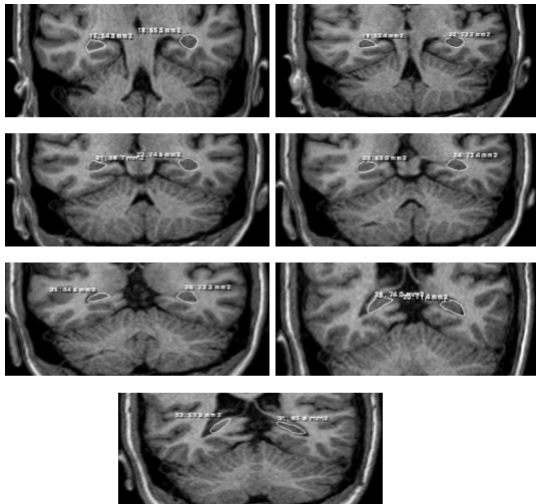


Figure 14- Glioma

## VOLUMETRIC ANALYSIS OF HIPPOCAMPUS





Coronal/Oblique reconstruction images (slice thickness-0.85mm ,interslice gap-1.3mm) obtained from T1W\_3D\_TFE sequence showing technique of volumetric analysis of hippocampus done by tracing hippocampal boundary manually from hippocampal head to tail. The volumes of both hippocampi were calculated by summing each of the crosssectional volumes {cross sectional area x (slice thickness + interslice gap)}.

## References

1. Arora V, Nijjar IBS, Mahajan DS, Chopra R. MRI in seizure disorder-A pictorial essay. *Ind J Radiol Imag* 2005; 15(3):331-40
2. Wilson JF. Searching for epilepsy solutions. *Ann Internal Med*.2004; 141(4):329-32
3. Lowenstein DH. Seizures and epilepsy. In: Longo DL, Kasper DL, Jameson JL, Fauci AS, Hauser SL, Loscalzo J. editors. *Harrisons principles of internal medicine*.18th edition. New York:Mc Graw Hill;2011.P3251-70
4. Elson L So. Role of neuroimaging in the management of seizure disorders. *Mayo Clinic Proceedings*.2002;(77):1251-64
5. Kuzniecky RI, Knowlton RC. Neuroimaging of epilepsy. *Semin Neurol*.2002;22(3)
6. Ulivelli M, Rocchi R, Vatti G, Giannini F, Diandrea P, Batani B et al. CAT and MRI in the study of partial epilepsy: comparison of two methods and correlations with EEG. *Riv Neuro*1991;61(5):161-5
7. Sander JWS, Hart YM, Johnson AL, Shorvon SD. National general practice study of epilepsy: newly diagnosed epileptic seizure in a general population. *Lancet* 1990; 336:1267-71.
8. Verma SR, Sardana V, Gupta PK, Verma SC, Munshi A, Suryavanshi A. Evaluation Of Non Febrile Seizure Disorder On MRI With Correlation With Seizure Type And EEG Records In A Tertiary Care Teaching Hospital. *Int J of Third World Med* 2013; 11(1): 1-12.
9. Rahimian E, Tahsini M, Abolfazli R. Evaluation of MRI findings in 198 cases of focal seizure. *The Internet Journal of Neurology* 2007;8(2):7.
10. Koirala K. Magnetic Resonance Neuroimaging in patient with complains of seizures. *J Nepal Health Res Counc* 2011;9(18):56-60
11. Lucato LT, Guedesa MS, Satoc JR, Bacheschib LA, Machadob LR, Leitia CC. The Role of Conventional MR Imaging Sequences in the Evaluation of Neurocysticercosis: Impact on Characterization of the Scolex and Lesion Burden. *AJNR* 2007;28:1501-4
12. Liigant A, Haldre S, Oun A, Linnamagi U, Saar A, Asser T et al. Seizure disorders in patients with brain tumors. *Eur Neurol* 2001; 45(1):46-51.
13. Lieu AS, Howng SL. Intracranial meningiomas and epilepsy: incidence, prognosis and influencing factors. *Epilepsy Res* 2000; 38(1):45-52
14. Kasasbeh A, Hwang EC, Steger-May K, Bandt SK, Oberhelman A, Limbrick D et al. Association of magnetic resonance imaging identification of mesial temporal sclerosis with pathological diagnosis and surgical outcomes in children following epilepsy surgery. *J Neurosurg Pediatr* 2012;9(5):552-61.