

ROLE OF MAGNETIC RESONANCE IMAGING BRAIN IN EVALUATION OF SEIZURES

Athira Dinesh¹, Nita Hubert², Sara Ammu Chacko³, Manju Annie Rajan⁴, Subramanya Uppunda⁵, Ajith Mohanan Nair⁶

HOW TO CITE THIS ARTICLE:

Athira Dinesh, Nita Hubert, Sara Ammu Chacko, Manju Annie Rajan, Subramanya Uppunda, Ajith Mohanan Nair. "Role of Magnetic Resonance Imaging Brain in Evaluation of Seizures". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 78, September 28; Page: 13654-13670, DOI: 10.14260/jemds/2015/1952

ABSTRACT: BACKGROUND AND OBJECTIVES: In patients with seizures a dedicated MRI protocol is a useful tool in the detection of an epileptogenic focus, including congenital, neoplastic and degenerative. Resection of these lesions can lead to seizure freedom in most patients. In this context, a prospective study was conducted to evaluate the etiology of seizures using MRI brain. **METHODOLOGY:** 120 patients presenting with seizures, above the age of 2years, referred to the Department of Radio-diagnosis were included in this study. **RESULTS:** In this study, the MR examination revealed pathological findings in 32.50% (39) out of 120 patients which includes: mesial temporal sclerosis-14.2% (17), cerebral infarct with gliosis-6.6% (8), meningioma-2.5% (3), hypoxic ischemic encephalopathy-1.6% (2), cortical dysplasia-1.6% (2), tuberous sclerosis-11.6% (2), nodular heterotopias-0.83% (1), neurocysticercosis-0.83% (1%), metastasis-0.83% (1), Dyke Davidoff Maison syndrome-0.83% (1) and Arnold Chiari Malformation 0.83% (1). **CONCLUSION:** This study concludes that MR imaging plays a pivotal role in the evaluation of patients with seizures using a dedicated MRI seizure protocol to confirm or rule out any organic or developmental lesions. The most common abnormality seen in this study was mesial temporal sclerosis.

KEYWORDS: magnetic resonance imaging, brain, seizure etiology, mesial temporal sclerosis.

INTRODUCTION: Seizure is a distinct clinical episode characterized by a transient disturbance in mentation and/or abnormal movements resulting from excess electrical brain activity. Seizures result from the loss of normal balance of neuronal excitation and inhibition causing relative neuronal hyperexcitability. Epilepsy is a chronic condition characterized by recurrent seizures unprovoked by an acute systemic or neurologic insult.

Most of the patients suffering from seizure disorder, have good control of this disease with the use of antiepileptic drugs. However up to 20% of patients continue to have seizures despite the best medical treatment. Most of these patients with intractable epilepsy have seizures that are focal and can be potentially treated. Neurosurgery is most often considered in medically refractory epilepsy when removal or isolation of epileptogenic region is possible without any neurologic deficit.

Using a dedicated MRI protocol, it is possible to detect an epileptogenic lesion in 80% of these patients. MR imaging has emerged as the most diagnostically valuable tool for preoperative localization of epileptogenic focus because of its excellent soft tissue contrast, allowing for detailed depiction of anatomy, capacity for multiplanar imaging and freedom from harmful radiations.

MR gives more precise localization and histological nature of lesions. This is of immense help to both clinicians as well as neurosurgeons in their attempt to achieve a faster and more accurate method of discovering the nature of the pathologies. MR imaging also helps to depict topographic relationships between epileptogenic lesion and the eloquent regions of brain.² The following study has been undertaken to study the etiology and spectrum of MRI findings in patients with seizures.

ORIGINAL ARTICLE

MATERIALS AND METHODS: Prospective study of 120 patients with history of seizures as per the criteria laid down by the ILAE 1981. The duration of the study was from December 2012 to June 2014.

MRI brain was performed using a dedicated seizure protocol, using MRI unit-1.5 T Siemens Magnetom Avanto Tim (32x8). MRI protocol includes the entire brain from nasion to inion, conventional routine 5mm slice thickness, T1, T2 and FLAIR axial sequences, 1.5 mm slice thickness coronal oblique. Inversion recovery and SPGR images, 1.5mm slice thickness are acquired as a 3 dimensional volume. Protocol also includes coronal and axial FLAIR sequences with 2-3 mm slice thickness & 1 mm inter slice gap. A conventional thin slice, T2 weighted axial and coronal sequences were also obtained. Magnetic resonance spectroscopy & Diffusion weighted imaging were also used. Gadobenate dimeglumine, MR contrast agent was used if a tumour or vascular malformation was suspected. It was also used in new-onset epilepsy and neurocutaneous syndromes to visualize leptomeningeal angiomas. Dosage used as 0.1 mg/kg wt.

Inclusion Criteria: All patients above 2 years with history of seizures.

Exclusion Criteria: Children below 2 years of age, Alcohol dependent seizure, Psychogenic non-epileptic seizures, Factitious disorder, Malingering, Trauma & Drug induced seizures, Absolute & relative contra- indications for MRI.

Data was tabulated using MS excel sheet and analyzed using SPSS version 20. Qualitative variables expressed as percentages and analyzed using Chi-square test. Quantitative variables expressed as mean with standard deviation.

Fig. 1a: Right Mesial Temporal Sclerosis (MTS) - Coronal FLAIR images - hippocampal hyperintensity, collateral white matter atrophy, prominence of collateral sulcus, atrophy of temporal lobe and prominence of ipsilateral temporal horn.

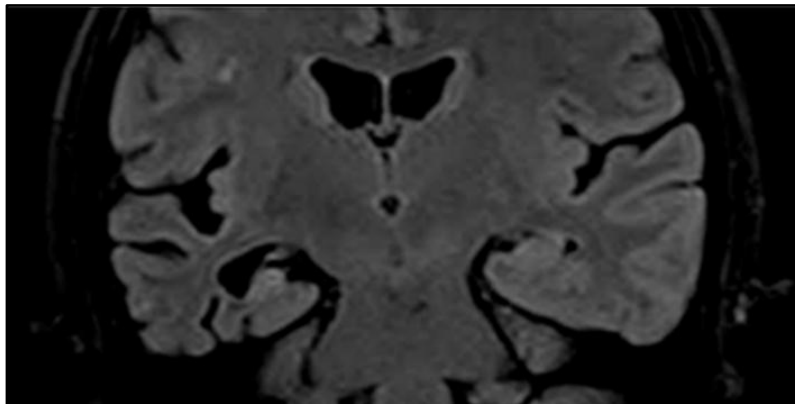


Fig 1a

ORIGINAL ARTICLE

Fig. 1b: Right MTS - Coronal Inversion Recovery sequence showing atrophy of ipsilateral fornix, loss of hippocampal architecture, collateral matter atrophy with prominent collateral sulcus, atrophy of temporal lobe and prominence of ipsilateral temporal horn.

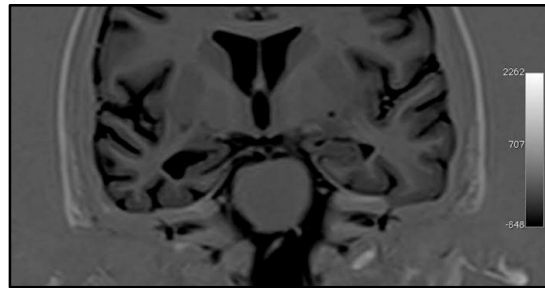


Fig. 1b

Fig. 2a: Tuberos Sclerosis – Axial T2W MR - T2 hyperintense multiple cortical/sub cortical tubers beneath the expanded gyri.

Fig. 2b: Tuberos Sclerosis – Axial FLAIR MR - focal lacunae like cysts in the right parasagittal region & multiple T2 hyperintense cortical/sub cortical tubers beneath the expanded gyri.

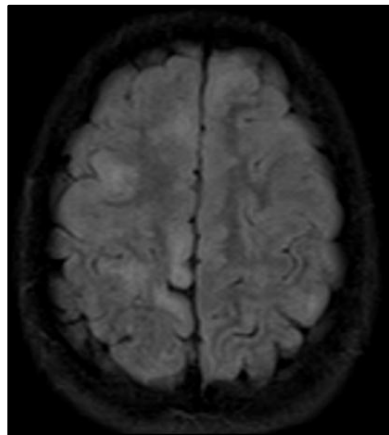


Fig. 2a

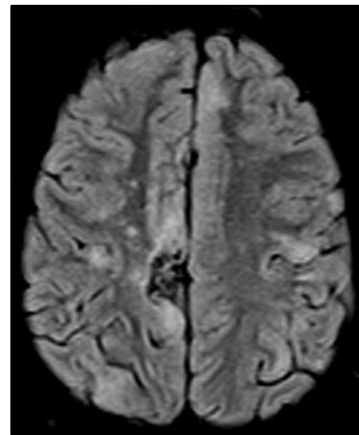


Fig. 2b

Fig. 2c: Tuberos Sclerosis – T2W axial MR showing multiple hypointense subependymal nodules & band like white matter hyperintensities adjacent the body of lateral ventricle.

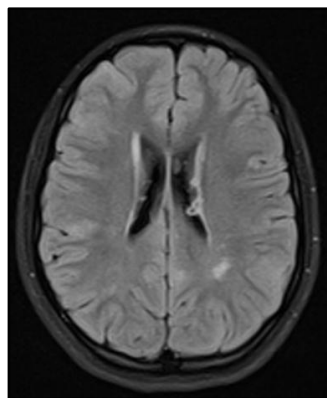


Fig. 2c

ORIGINAL ARTICLE

Fig. 3: Focal Cortical “Dysplasia-Coronal” FLAIR MR shows focal cortical/sub-cortical hyperintensity.

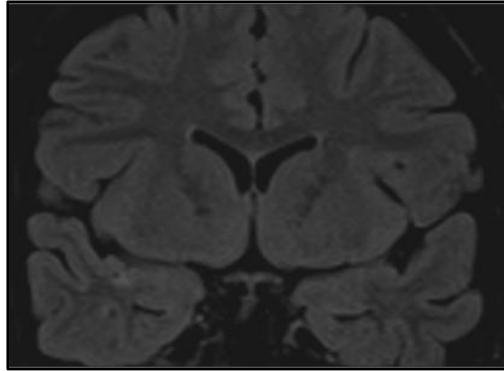


Fig. 3

Fig. 4: Dyke Davidoff Maisson Syndrome - FLAIR axial MR - left sided hemiatrophy, hypoplasia of left thalamus & lentiform nucleus with white matter hyperintensity with dilatation of ipsilateral lateral ventricle.

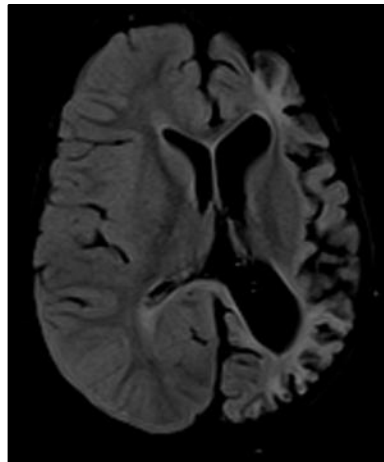


Fig. 4

Fig. 5: Metastasis from Bronchogenic Carcinoma – Axial T1 Post contrast MR - an enhancing lesion in the left precentral gyrus with surrounding perilesional edema and mass effect.

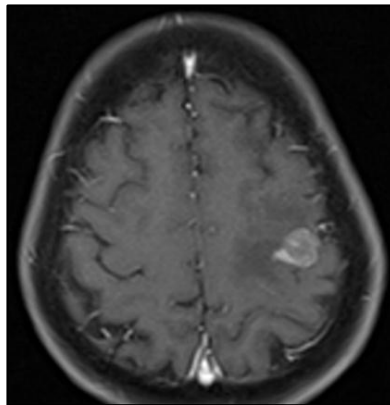


Fig. 5

ORIGINAL ARTICLE

Fig. 6a & 6b: T1 Axial and FLAIR coronal MR images showing left convexity meningioma with perilesional edema causing midline shift and subfalcine herniation.

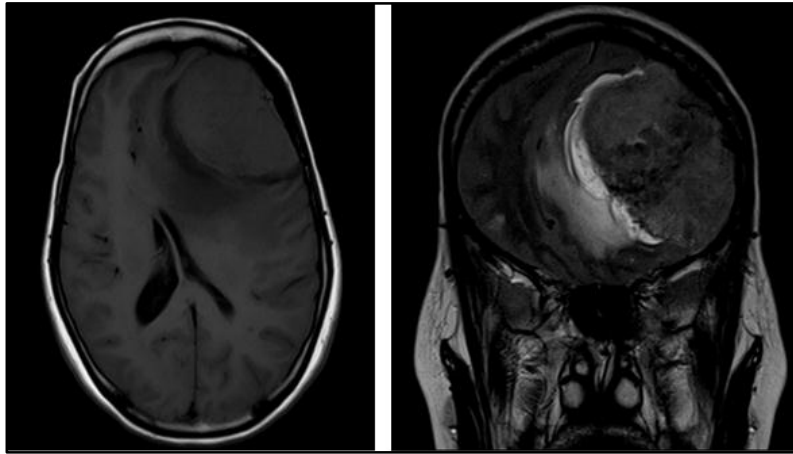


Fig. 6a & 6b

Fig. 7: Meningioma-Sagittal T1 post contrast MR shows Falcine meningioma with invasion of with Superior sagittal sinus and significant perilesional edema and mss effect.

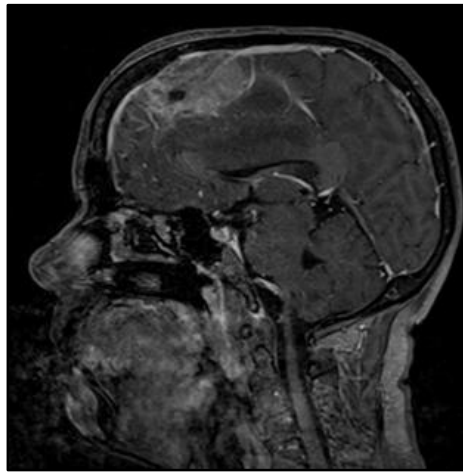


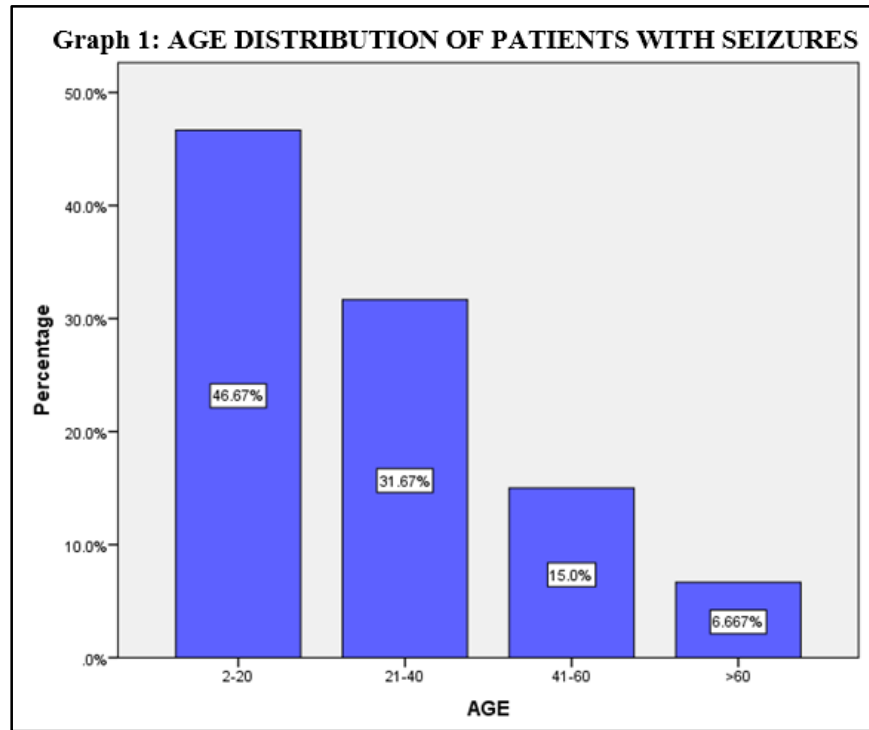
Fig. 7

OBSERVATION AND RESULTS:

Age Group (In Years)	Number	Percentage (%)
2 -20	56	46.7
21-40	38	31.7
41-60	18	15.0
>60	8	6.7
Total	120	100.0

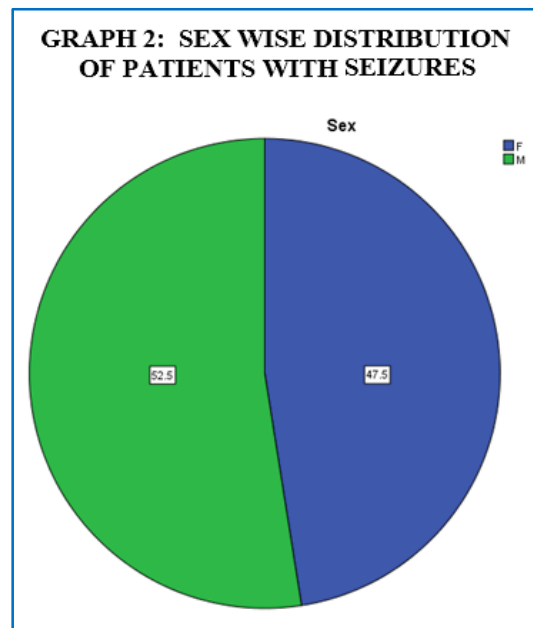
Table 1: Age Distribution of Patients with Seizures

ORIGINAL ARTICLE



GENDER	Number	Percentage (%)
F	57	47.5
M	63	52.5
Total	120	100.0

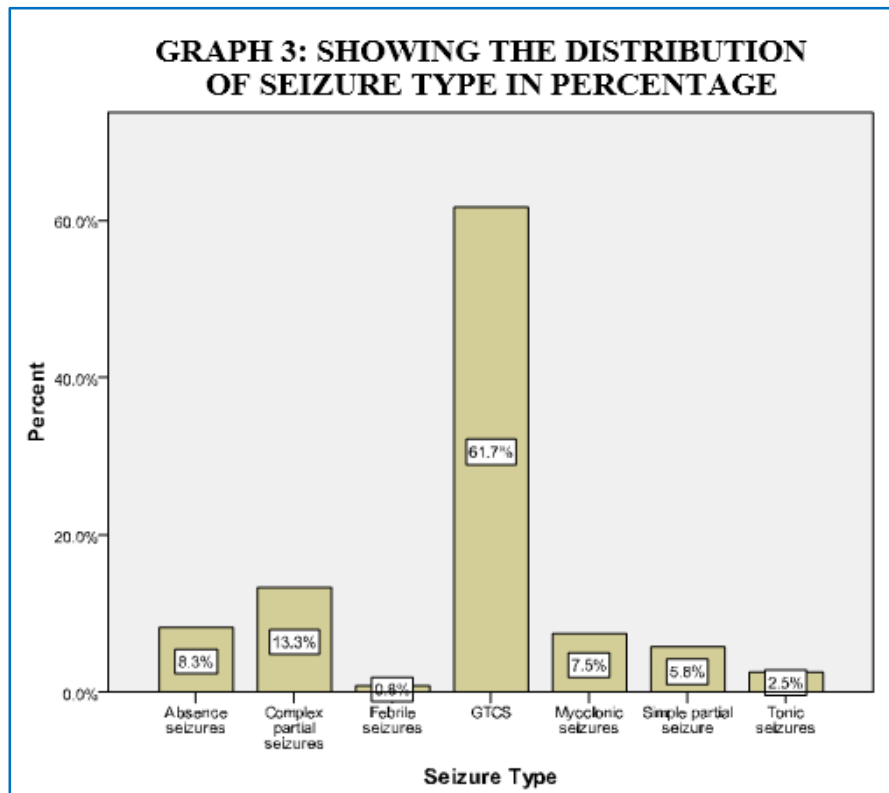
Table 2: Sex Distribution of Patients with Seizures



ORIGINAL ARTICLE

Seizure Type	No. of Cases	Percentage (%)
Absence seizures	10	8.3
Complex partial seizures	16	13.3
Febrile seizures	1	.8
GTCS	74	61.7
Myoclonic seizures	9	7.5
Simple partial seizure	7	5.8
Tonic seizures	3	2.5
Total	120	100.0

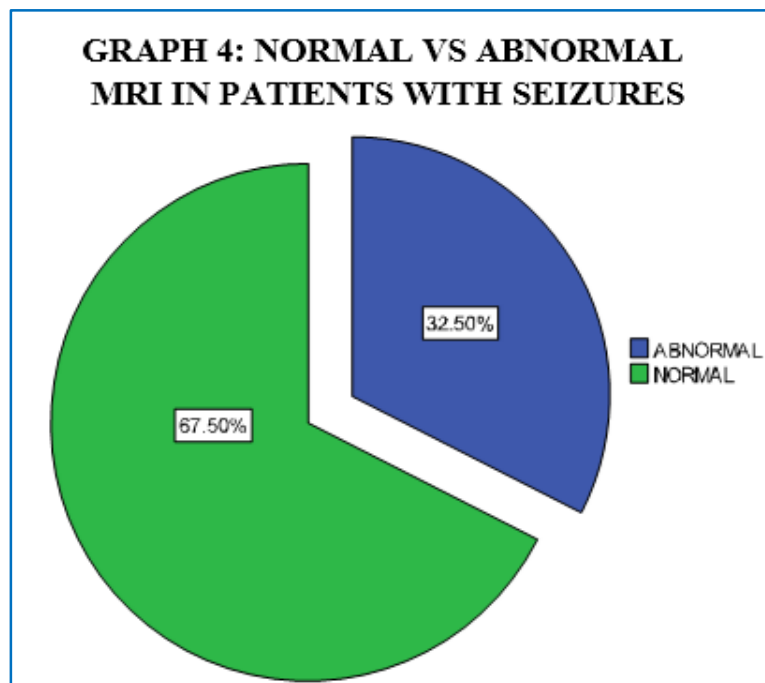
Table 3: Distribution of Patients Based on Seizure Type



MRI	Number	Percentage%
Abnormal	39	32.5
Normal	81	67.5
Total	120	100

Table 4: Distribution of Normal and Abnormal MRI in Patients Presenting with Seizures

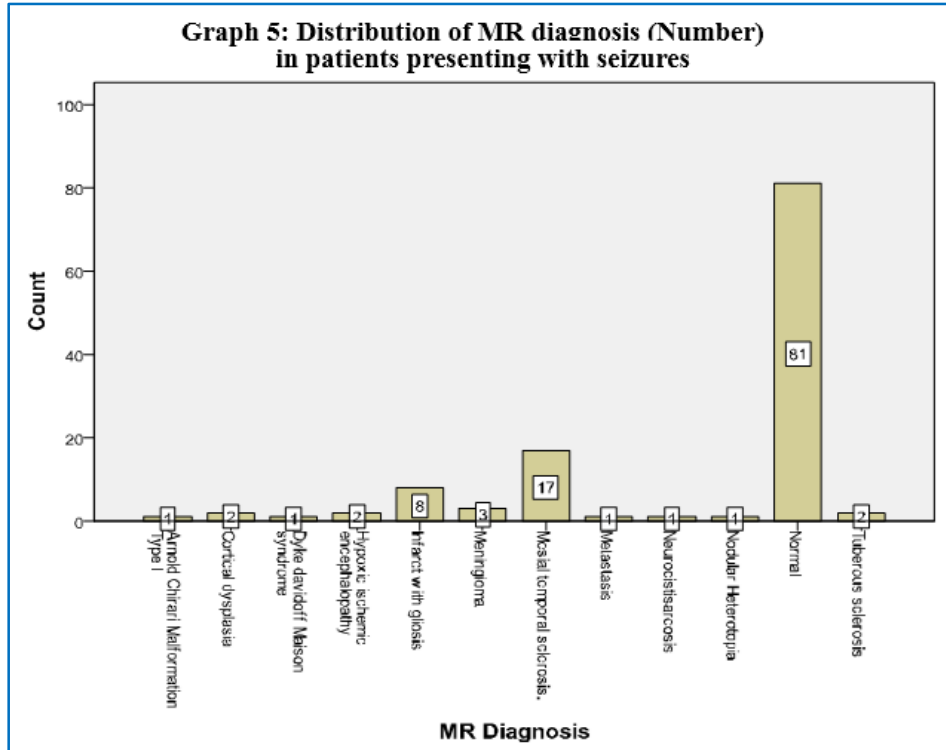
ORIGINAL ARTICLE



MRI DIAGNOSIS	Number	Percentage (%)
Arnold <u>Chirari</u> Malformation Type I	1	0.8
Cortical dysplasia	2	1.7
Dyke <u>Davidoff</u> <u>Maison</u> syndrome	1	0.8
Hypoxic ischemic encephalopathy	2	1.7
Infarct with gliosis	8	6.7
Meningioma	3	2.5
Mesial temporal sclerosis.	17	14.2
Metastasis	1	0.8
<u>Neurocistisarcosis</u>	1	0.8
Nodular Heterotopia	1	0.8
Normal	81	67.5
Tuberous sclerosis	2	1.7
Total	120	100.0

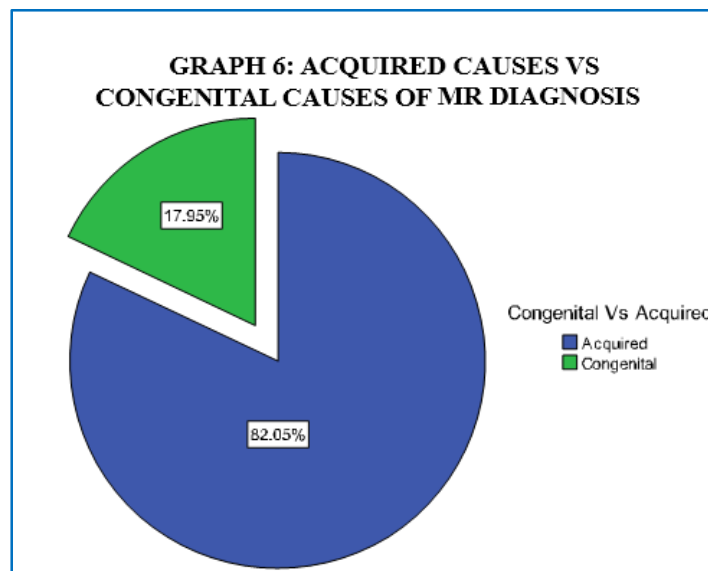
Table 5: MRI Diagnosis in Patients with Seizures

ORIGINAL ARTICLE

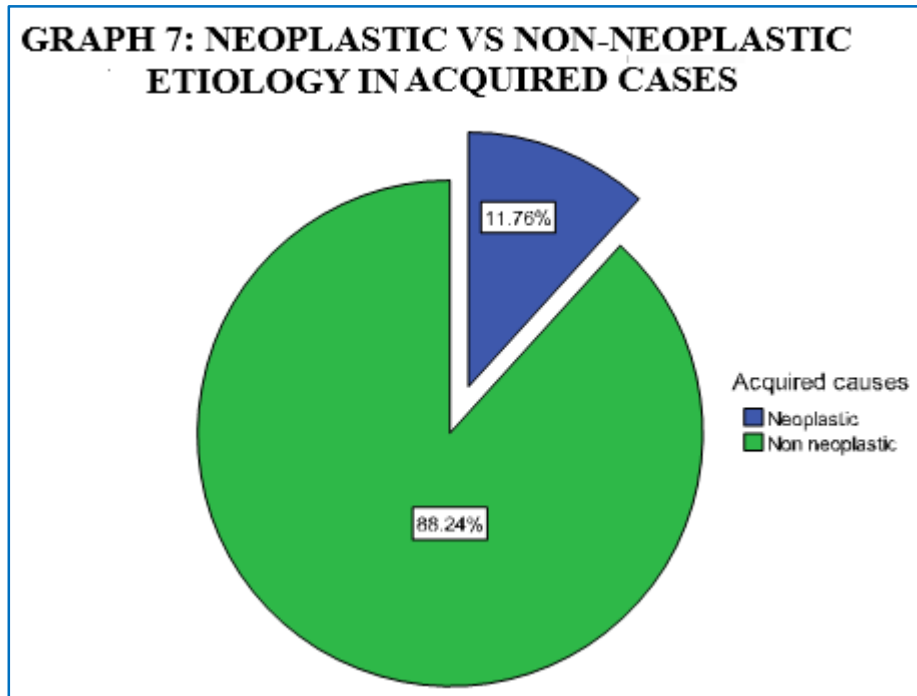


ETIOLOGY	No of cases	Percentage
Acquired	32	82.1
Congenital	7	17.9
Total	39	100.0

Table 6: Congenital V/s Acquired Etiology Of Seizures

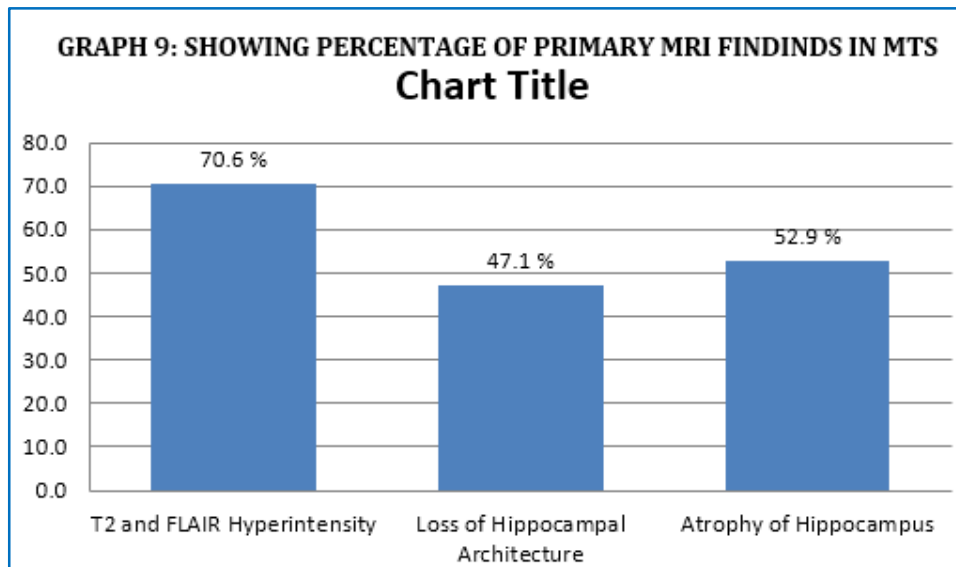


ORIGINAL ARTICLE

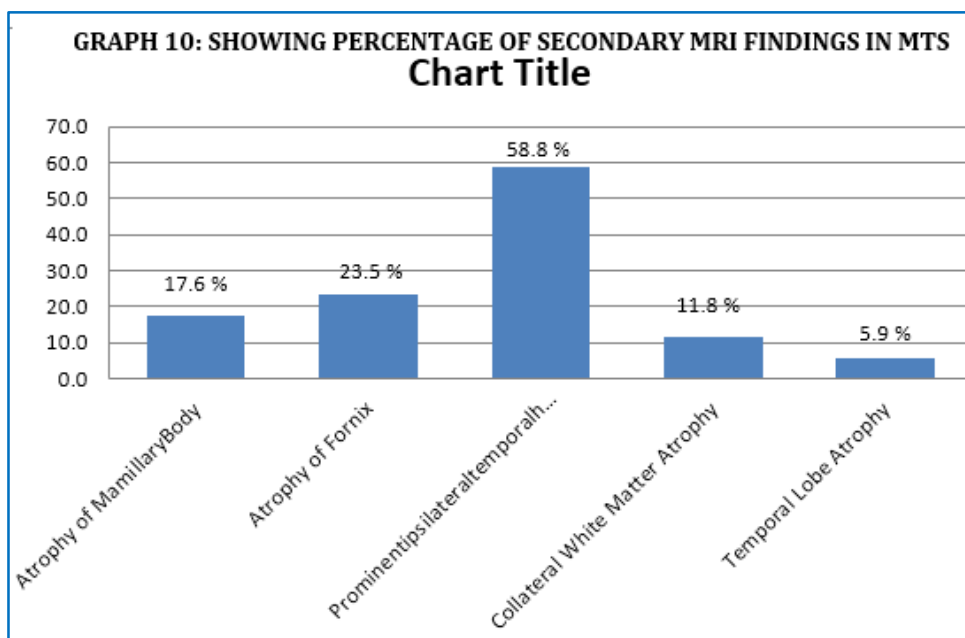


MR Diagnosis	Number	Percentage %
Mesial <u>temoral</u> sclerosis	17	43.6
Others	22	56.4
Total	39	100.0

Table 7: Mesial Temporal Sclerosis Vs Other MR Diagnosis



ORIGINAL ARTICLE



DISCUSSION: Patients presenting with seizures can have wide range of MR imaging abnormalities depending upon the etiology. MRI can reliably identify and localize the intracranial abnormality so that further management can be planned accordingly.

In this study of 120 patients presenting with seizures, age ranged from 2 to 80 years with the median age of 21 years. Of these 63(52.5%) were males & 57(47.5%) were females. There is no significant association between the age-sex distributions of patients with seizures:

- In the age group 2-20 years the total % of patients with seizures 46.7%
- In the age group 21-40 years the total % of patients with seizures 31.7%.
- In the age group 41-60 years the total % of patients with seizures 15%.
- In the age group >60 years the total % of patients with seizures 6.7%.

Distribution of Patients Based on Seizure Type: In this study population, predominant number of patients presented with generalized tonic clonic seizures, which accounted for 61.7% (74 patients). Of the remaining 32.3%, temporal lobe seizures accounted for 27.4% (Absence seizures-8.3%; Complex partial seizures-13.3%; Simple partial seizure-5.8%- i.e. total 33 patients). Rest of the patients presented with febrile seizures, myoclonic and tonic seizures (Febrile seizures-0.8% -1 case; Myoclonic seizures-7.5%-9 cases & Tonic seizures-2.5% - 3 cases).

Seizure Type	Distribution of seizure type in percentage (%)
Generalised tonic clonic seizure	61.7
Complex partial seizure	13.3
Simple partial seizure	5.8
Absence seizure	8.3
Myoclonic seizure	7.5

Table 8: Showing the Distribution of Seizure Type

ORIGINAL ARTICLE

Sex Distribution in MRI abnormal Cases: The MR examination revealed pathological findings in 39 (32.50%) & normal study in 81(67.50%) out of 120 patients.

Out of the total abnormal 32.50%, 43.58% are males & 56.41% are females.

MRI Positivity: In the present study, the MR examination revealed pathological findings in (32.50%) 39 out of 120 patients which includes: mesial temporal sclerosis-14.2% (17), cerebral infarct with gliosis-6.6% (8), meningioma-2.5% (3), hypoxic ischemic encephalopathy-1.6% (2), cortical dysplasia -1.6% (2), tuberous sclerosis-11.6% (2), nodular heterotopias-0.83% (1), Neurocysticercosis-0.83% (1), metastasis-0.83% (1), Dyke Davidoff Maison syndrome-0.83% (1), Arnold Chiari Malformation 0.83% - (1).

Etiology of epilepsy cases.	Distribution of etiology of epilepsy cases.(%)
Unknown	67.5
Neurodegenerative diseases	14.2
Stroke	6.6
Tumor	3.3
Infection	0.83
Congenital	5.8

Table 9: Shows the Distribution of Aetiology of Seizures

Congenital Vs Acquired Causes of Seizures: According to the present study, 82.1% is acquired & 17.9% is congenital.

Acquired causes (Total 32cases) includes Mesial temporal sclerosis (17 cases), hypoxic ischemic encephalopathy (2 cases), neurocysticercosis (1 case), cerebral infarct with gliosis (8 cases), metastasis (1 case) & meningioma (3cases).

Congenital (7 cases) causes includes Arnold Chiari Malformation (1 cases), cortical dysplasia (2cases), Dyke Davidoff Maison syndrome (1 case), Nodular heterotopia (1 case) & tuberous sclerosis (1 case).

In Acquired Cases: Neoplastic Vs Non-Neoplastic: 11.76% are neoplastic & 88.24% are non-neoplastic lesions. Neoplastic lesions (4 cases) which includes Meningioma (3 cases) & metastasis (1 case).

Mesial Temporal Sclerosis Vs Other Diagnosis: 17 out of the 39 cases with positive MRI findings (43.6%) showed features of Mesial Temporal Sclerosis.

Age-Sex distribution of MTS: 11 out of these 17 cases were females of which 9 (81%) belonged to the age group 16-30years and 2 were in the 31-45years age group. 6 cases were males of which 4 cases (66.7%) were in the age groups 16-30years.

Types of seizure in patients with MRI diagnosis of MTS: In cases with MRI features of MTS (17 cases), 76.5% (13 cases) had complex/simple partial seizures or absence seizures. However, 23.5% (4 cases) had GTCS.

Here, 58.82% (10 cases) shows complex partial seizures, 11.76%(2 cases) simple partial seizures , 5.9%(1 case) absence seizures & 23.53%(4 cases) are cases are GTCS.

ORIGINAL ARTICLE

Hence, out of the total 17 cases with MR diagnosis of MTS, complex partial seizures was the most common presenting feature in this study.

MRI findings in 17 cases with MTS (Figures 1a & 1b): Primary findings of MTS:

MRI findings:	Present study
Abnormal T2 signal in the hippocampus in	12 (70.6%)
Visually assessed hippocampal atrophy	9 or 52.9%

Table 10: Primary MR findings MTS

MRI findings:	Present study - out of 17 MRI positive cases of MTS:
Smaller mammillary body	3 cases or 17.6%
Temporal horn dilatation	10 cases or 50.8%
Collateral white matter atrophy	2 cases or 11.8%
Disruption of the internal architecture of the hippocampus	8 cases or 47.1%
Temporal lobe atrophy	1 case or 5.9%
Smaller fornix	4 cases or 23.5%

Table 11: Secondary MR findings of MTS

If there are no primary MR findings, the patient has less than a 50% likelihood of becoming seizure free after surgery. Although these yields are impressive, they are selective.

Some patients with MTS have either absent or equivocal primary MR findings of MTS. The use of secondary MR features can help improve the sensitivity and positive predictive value in this group of patients, especially when used in conjunction with other localizing techniques.

According to Richard Bronen, et al, the hallmark of mesial temporal sclerosis on MR imaging is an atrophic hippocampus associated with hyperintense signal. Patients with these primary MR findings have a 70% to 90% probability of being free of seizures after temporal lobectomy.

One of the limitations of my study was that I was able to perform DWI only in few cases as majority of the patients were claustrophobic and was unable to lie inside the MRI machine for prolonged time.

Cerebral Infarcts with Gliosis: 8 patients (6.6%) revealed cerebral infarction on MRI study. Two patients revealed acute infarct in parieto-occipital lobes diagnosed based on diffusion restriction with mild swelling with effacement of adjacent sulci.

Chronic ischemic changes with gliosis in left fronto-parietal lobe noted in one patient and one patient showed cystic encephalomalacia changes in right parieto-occipital lobe.

Four patients showed tiny chronic ischemic lesions in deep white matter with bilateral periventricular hyperintense lesions on T2 and FLAIR with no restriction on diffusion sequences.

Meningioma: 3 cases (2.5%) revealed MRI features of meningioma. One of the case showed falcine meningioma (Fig: 7) with invasion of superior sagittal sinus causing thrombosis, significant

ORIGINAL ARTICLE

perilesional oedema and mass effect. Two other cases (Fig: 6a & 6b) showed left fronto parietal convexity meningioma and left anterior frontal convexity meningioma respectively.

According to Lieu AS1, Howng SL et al., in a retrospective study of a 222 surgically treated meningiomas, it was found that 26.6% of the patients presented epilepsy as their initial symptom. In this group, surgical excision of the intracranial meningiomas stopped the epilepsy in about 62.7% of the patients.

Tuberous Sclerosis: Two patients with clinical diagnosis of tuberous sclerosis (Figures 2a,2b & 2c) underwent MR neuroimaging. Axial T2W and FLAIR MR showed multiple hyperintense cortical/subcortical tubers beneath the expanded gyri, suggestive of cortical/subcortical tubers. T2W & FLAIR axial MR also showed multiple hypointense subependymal nodules & band like white matter hyperintensities adjacent the body of lateral ventricle.

One patient showed focal lacunae like cysts in the right parasagittal region in axial FLAIR MR images. also showed. No mass effect or perilesional edema.

Katarzyna Kotulska, et al., retrospectively reviewed thirty-three children with TSC who underwent excisional epilepsy surgery at Miami Children's Hospital to study the predictors of seizure-free outcome after epilepsy surgery for pediatric tuberous sclerosis complex.

Focal Cortical Dysplasia: In the present study, there are two cases (1.6%) (Figure 9) showing MR features of cortical dysplasia who presented with epileptic seizures episodes. Coronal FLAIR MR showed, focal cortical/sub-cortical hyperintensities.

Nadia Colombo et al., reviewed the MR data of 49 patients treated surgically for intractable partial epilepsy, who received a histologic diagnosis of Focal cortical dysplasia (FCD). The study concluded that a provisional MR diagnosis is important for presurgical investigations and surgical planning and may have prognostic implications.

Hypoxic Ischemic Encephalopathy (HIE): Two children who presented with epilepsy showed features of hypoxic ischemic encephalopathy on MR imaging, with increased signal intensity in the ventrolateral thalamic and perirolandic cortex bilaterally with low signal intensity on corresponding apparent diffusion coefficient(ADC) maps.

Nodular Heterotopia: One of the patients showed MRI appearance of Subependymal heterotopia (SEH). Round to ovoid subependymal nodules, located beneath the ependymal lining of the lateral ventricles and protruding mildly into its lumen, resulting in an irregular ventricular outline. The number and size of heterotopia varied from small nodules to a thick layer of coalescent nodules of gray matter lining the lateral ventricles. The nodules were isointense to the cortical gray matter on all MRI sequence.

Ragab H Donko et al., studied 20 patients with ages ranged from 9 months to 39 years. All patients suffered from epileptic seizures. According to the location of heterotopia, patients were classified into three groups: subependymal, sub-cortical and band heterotopia. It was concluded from the study that MRI was useful in diagnosing and differentiating between various types of gray matter heterotopia, and its extent is useful for management planning and predicting prognosis.

ORIGINAL ARTICLE

Arnold Chiari Malformation- Type 1: MRI brain of a 53 year old lady, who presented with history of seizures, showed peg like descent of the cerebellar tonsils ~9mm, favouring the diagnosis of Arnold Chiari Malformation Type 1. There was no evidence of associated brainstem compression/syrinx.

According to Granata T1, Valentini LG, in patients with Chiari malformation type 1 (CMI), epileptic seizures are occasionally reported both in symptomatic patients candidate to surgery and in patients without symptoms of tonsillar displacement. In both groups of patients, the course of epilepsy is almost invariably favorable, with a few seizures easily controlled by treatment.

Dyke Davidoff Maison Syndrome: In present study, the T2W & FLAIR axial MR shows left sided hemiatrophy, hypoplasia of the left thalamus & lentiform nucleus with white matter hyperintensity with midline shift to left and dilatation of ipsilateral lateral ventricle in a 7 year old boy (figure 4) with seizures, features favoring the diagnosis of Dyke Davidoff Maison syndrome.

Neurocysticercosis: MRI brain of one patient showed evidence of neurocysticercosis (NCC). It showed features of parenchymal form of NCC, with few ring enhancing lesions in cerebral hemispheres. Lesions showed T1 hypointensity and T2 hyperintensity contents. Few lesions showed perilesional edema. Most of lesions seen in parietal lobe and some show cystic signals. TR Velasco et al, evaluated 512 patients of intractable epilepsy and concluded that isolated NCC was found in eight patients (1.56%).

Metastasis: 62 year old lady, a known case of Bronchogenic Carcinoma, presented with history of a single episode of seizure. Following this the case was evaluated with CT and MRI brain. On MRI (Figures 5), there was the lesion, which was hypointense on T1W, hyperintense on T2W images with surrounding perilesional edema, mass effect & post contrast enhancement. These features were favoring brain metastasis, in view of the primary lung carcinoma.

Earnest F 4th et al., assessed the accuracy of screening magnetic resonance (MR) imaging in identifying occult metastases, and to determine the effectiveness of a high dose of MR contrast material. Twenty-nine patients suspected of having non-small cell lung cancer (NSCLC) localized to the lung or regional nodes underwent preoperative MR imaging with contrast material enhancement for detection of brain metastasis.

CONCLUSION: Assessment of the patient presenting with seizures, is a common problem in clinical practice. MR imaging plays a pivotal role in the evaluation of patients with seizures.

Accurate diagnosis of the cause of seizure is crucial for finding an effective treatment. MRI has been shown to be highly sensitive and specific in identifying the underlying pathology in seizures. With its high spatial resolution, excellent inherent soft tissue contrast, multi-planar imaging capability and lack of ionizing radiation, MR imaging has emerged as a versatile tool in the evaluation of patients with seizures.

MR imaging not only identifies specific epileptogenic substrates, but also determines specific treatment and predicts prognosis. Employing appropriate imaging protocols and reviewing the images in a systemic manner helps in the identification of subtle epileptogenic structural abnormalities.

ORIGINAL ARTICLE

This study was carried out in 120 patients presenting with seizures who underwent magnetic resonance imaging to evaluate the spectrum of findings, various etiologic factors for seizures, and the most common imaging abnormality.

In our study Mesial temporal sclerosis (17%), cerebral infarct with gliosis (8%), meningioma (3%), hypoxic ischemic encephalopathy (2%), cortical dysplasia(2%), tuberous sclerosis (2%) constitute the main etiological factors other being nodular heterotopia (1%), NCC (1%), metastasis (1%), Dyke Davidoff Maison syndrome(1%), Arnold Chiari Malformation (1%).

The most common abnormality seen in this study was Mesial temporal sclerosis. The three primary findings of MTS seen on MRI were hyperintensity on T2W & FLAIR images (70.6%), loss of hippocampal architecture (47.1%) and small atrophic unilateral hippocampus (52.9%).

MR imaging is superior neuroimaging with no radiation exposure and could be the first investigation of choice in epileptic syndrome, acute cerebrovascular disease with seizure, developmental cortical malformations, and vascular malformations. Its ability in identifying subtle lesions, location, extent of the lesions and amount of findings are excellent.

Hence we conclude that MRI brain with dedicated seizure protocol plays a significant role in patients presenting with seizures, to confirm or rule out any organic or developmental lesions.

REFERENCES:

1. Edelman, Hesselink, Zlatkin, Crues et al. *Clinical Magnetic Resonance Imaging*; 3rd edn., .p. 1366-1397.
2. Sander JWAS, Hart YM, Johnson AL, Shorvon SD. National general practice study of epilepsy: Newly diagnosed epileptic seizures in a general population. *Lancet* 1990; 336: 1267-71.
3. Scott N. *Atlas. Magnetic Resonance Imaging of the brain and spine*. 4th edn., .p. 2-14,308-342
4. Bronen RA, Cheung G, Charles JT, et al: Imaging findings in hippocampal sclerosis: Correlation with pathology. *Am J Neuroradiol* 12:933-940, 1991.
5. Lieu AS, Howng SL, et al. Intracranial meningiomas and epilepsy: incidence, prognosis and influencing factors. Volume 38, Issue 1, Pages 45–52, December 3, 2000.
6. Katarzyna Kotulska, Elżbieta Jurkiewicz, Dorota Domańska-Pakieła, Wiesława Grajkowska, Marek Mandra, Julita Borkowska, Sergiusz Józwiak, *Epilepsy in newborns with tuberous sclerosis complex*, *European Journal of Paediatric Neurology*, 2014,18, 6, 714
7. Nadia Colombo, Laura Tassi, Carlo Galli, Alberto Citterio, Giorgio Lo Russo, Giuseppe Scialfa, and Roberto Spreafico. Focal Cortical Dysplasias: MR Imaging, Histopathologic, and Clinical Correlations in Surgically Treated Patients with Epilepsy. *AJNR Am J Neuroradiol* 24: 724–733, April 2003.
8. Donkol RH, Moghazy KM, Abolenin A. Assessment of gray matter heterotopia by magnetic resonance imaging. *World J Radiol* 2012; 4(3): 90-96.
9. Granata T1, Valentini LG. Epilepsy in type 1 Chiari malformation *Neurol Sci*. 2011 Dec; 32 Suppl 3:S303-6. doi: 10.1007/s10072-011-0697-y
10. T R Velasco, P A Zanello, C L Dalmagro, D Araújo, Jr, A C Santos, M M Bianchin V Alexandre, Jr, R Walz, J A Assirati, C G Carlotti, O M Takayanagui, A C Sakamoto, J P Leite. Calcified cysticercotic lesions and intractable epilepsy: a cross sectional study of 512 patients. *J Neurol Neurosurg Psychiatry* 2006; 77: 485-488.

ORIGINAL ARTICLE

11. Franklin Earnest IV, Jay H. Ryu, MD Gary M. Miller, Patrick H. Luetmer, Lee A. Forstrom, Omer L. Burnett, Charles M. Rowland, Stephen J. Swensen, David E. Midthun, Suspected Non-Small Cell Lung Cancer: Incidence of Occult Brain and Skeletal Metastases and Effectiveness of Imaging for Detection. RSNA, 1999; 211:137-145.

AUTHORS:

1. Athira Dinesh
2. Nita Hubert
3. Sara Ammu Chacko
4. Manju Annie Rajan
5. Subramanya Uppunda
6. Ajith Mohanan Nair

PARTICULARS OF CONTRIBUTORS:

1. Junior Resident, Department of Radiology, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram.
2. Associate Professor, Department of Radiology, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram.
3. Professor and HOD, Department of Radiology, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram.

FINANCIAL OR OTHER

COMPETING INTERESTS: None

4. Assistant Professor, Department of Radiology, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram
5. Assistant Professor, Department of Radiology, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram.
6. Assistant Professor, Department of Neurology, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Athira Dinesh,
Illikkatt House,
Edappally - P. O,
Kochi-682024.
E-mail: athirad@gmail.com

Date of Submission: 10/09/2015.
Date of Peer Review: 11/09/2015.
Date of Acceptance: 21/09/2015.
Date of Publishing: 28/09/2015.