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ROLE OF MRI IN EVALUATION OF PAEDIATRIC EPILEPSY

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ABSTRACT

Objectives: Epilepsy is the first most common chronic condition seen by a paediatrician and the second most common neurological condition seen by neurologists. MRI has become the most important imaging modality in paediatric neuroimaging due to lack of radiation exposure and better delineation of pathologies. Our study had described the spectrum of abnormalities in paediatric patients (0-18years) with epilepsy. **Methods:** A prospective study of 50 patients, who presented with history of epilepsy and suspected intracranial abnormalities, underwent MRI of Brain on an elective basis. **Results:** Of the 50 patients, 35 (70%) had abnormal MRI scans and 15 (30%) had normal scans. The final diagnosis were as follows- Malformations of cortical development (12 patients- 24%) of which 4 had focal cortical dysplasia, another 4 had grey matter heterotopia, and one patient each with hemimegalencephaly, lishencephaly, polymicrogyria, and schizencephaly. Perinatal insult (8 patients- 16%), Hippocampal malrotation (8 patients- 16%), Neoplasms (5 patients -10%), Mesial temporal Sclerosis (4 patients- 8%), Infections (4 patients-8%), Neurocutaneous syndromes (2 patients- 4%), Vascular malformation (1 patient- 2%). **Conclusion:** MRI is the imaging modality of choice in patients with paediatric epilepsy for better characterisation and delineation of lesions, aiding in surgical outcomes and also to understand the prognosis of the disease.

KEYWORDS: Paediatric epilepsy, MRI, Brain.

INTRODUCTION

Epilepsy is clinically defined by the International League Against Epilepsy as two or more unprovoked seizures occurring more than 24 hours apart or one unprovoked seizure and the probability of similar seizure or diagnosis of an epilepsy syndrome. It is a common disorder sparing no age, race or ethnic background.

Neuroimaging becomes important and mandatory in the work up for epilepsy in localisation and lateralisation of the seizure focus. MRI has become the most important imaging modality in paediatric neuroimaging due to lack of radiation exposure and better delineation of pathologies. It provides an excellent anatomical overview with good spatial and temporal resolution, allows visualisation of the vascular anatomy and using techniques such as diffusion weighted imaging, perfusion imaging, MR spectroscopy and diffusion tensor imaging, MRI allows quick and exact differentiation between ischemic, hypoxic, inflammatory, oncologic, metabolic and traumatic pathologies.

Advances in technology to localise the epileptic focus using high resolution MRI have significantly improved the success of surgical treatment in patients with epilepsy. MRI has increased our understanding of the underlying disease process as well as revolutionised evaluation and management of epilepsy.

Here we describe a study of 50 paediatric (0-18years) patients presenting with epilepsy evaluated with MRI.

AIMS AND OBJECTIVES

Aim

• To evaluate the spectrum of MRI findings in paediatric patients with epilepsy.

Objectives

- To detect and characterize the lesions causing epilepsy in paediatric age group.
- To detect the frequency of causes responsible for epilepsy in paediatric age group.

MATERIALS AND METHODS

A prospective study was performed on 50 patients referred to Radiology department with a history of epilepsy and suspected intracranial abnormalities during a 2 year period from November 2015 to November 2017. Prior institutional ethics committee clearance was obtained for the study.

Informed consent was obtained from the subjects and their parents/guardians for inclusion of their images in the study.

Inclusion Criteria for the study

• All paediatric patients referred to Radiology Department of our hospital in the age-group of 0-18 years with clinical presentation of epilepsy based on clinical data were included in this study.

Exclusion Criteria for the study

- All patients with contraindications to MRI such as those having pacemakers, aneurysmal clips and cochlear implants.
- Parents or guardians not willing to give consent.

Imaging Protocol

Imaging was done using 3Tesla Philips MRI machine using the following protocol:

- T1,T2 weighted and FLAIR images in axial and coronal planes.
- 3D T1 weighted sequence in sagittal plane.
- ThinT1,T2 weighted and FLAIR sequences in an oblique coronal plane perpendicular to the hippocampus.
- T1 weighted inversion recovery sequence in axial plane.
- Diffusion weighted images in axial plane.

Contrast was used when necessary in a dose of 0.1mmol/kg weight with post contrast Fat suppressed T1 weighted images in axial, coronal and sagittal planes as well as post contrast FLAIR images in axial plane.

RESULTS

This prospective study was performed in the Department of Radiology, at our institute during the period from November 2015 to November 2017, on 50 patients in the age group of 0- 18years with clinical presentation of epilepsy and suspected intracranial pathologies. In this study, imaging features of different pathologies associated with temporal lobe epilepsy are described.

In the present study of 50 patients, maximum number of patients with epilepsy were between 11-15 years of age constituting 44% of all patients.

There was also a predominance of male patients with epilepsy, with a male: female ratio of about 2.1:1.

MRI findings

In the present study, 15 patients revealed an essentially normal brain MRI and were classified as cryptogenic epilepsy, constituting 30% of the total study population. (Table 1).

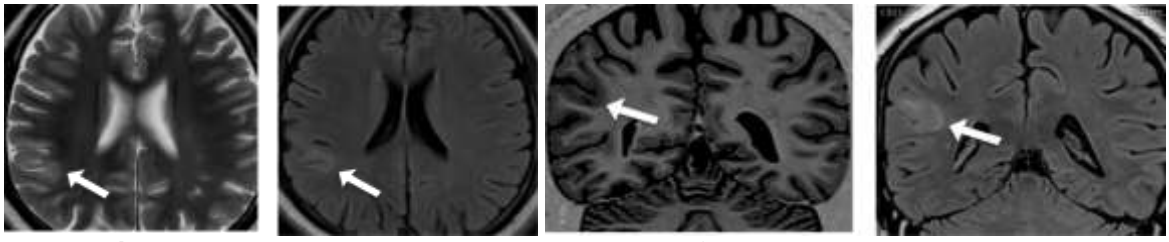
Of the 35 patients with abnormal MRI, 20% (7 patients) had only hippocampal disease, 68.6%(24 patients) had extra-hippocampal pathology and 11.4% (4 patients) had hippocampal as well as extra-hippocampal pathologies. (Table 2)

Table 1: Distribution of patients as per radiological diagnosis.

Radiological Diagnosis	Primary Pathology
Normal	15
Mesial Temporal Sclerosis	4
Malformations Of Cortical Development	12
Neoplasms	5
Vascular Malformations	1
Neurocutaneous Syndromes	2
Infections	4
Perinatal Insult	8
Hippocampal Malrotation	8

Table 2: Distribution as per location of pathology.

Location of Pathology	Number of Patients	Percentage
Hippocampal	7	20%
Extra-Hippocampal	24	68.6%
Both	4	11.4%
Total Abnormal Patients	35	100%



A B C D

Fig 1: (A-D) Focal cortical dysplasia in a 15 year old male. (A) T2 weighted axial (B and D) FLAIR axial and coronal and (C) T1 inversion recovery weighted coronal images showing an area of cortical thickening in the right parietal lobe with indistinct grey-white matter differentiation and hyperintense signal in the subcortical white matter.

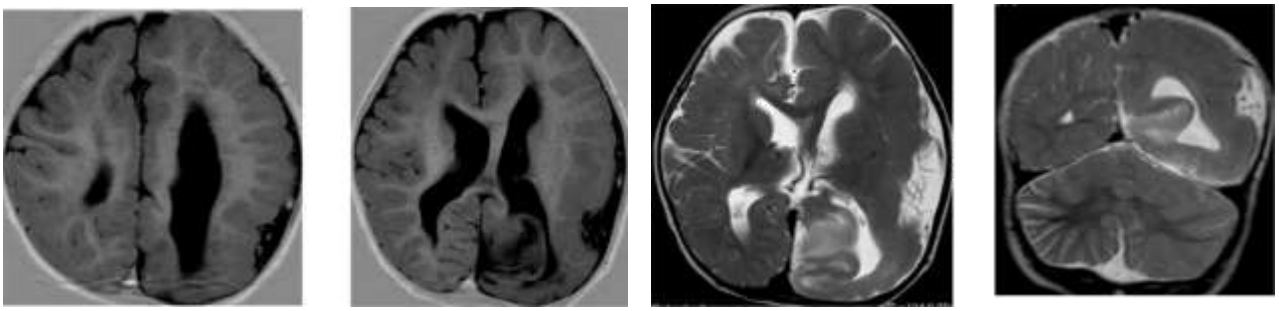


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Fig 2: (A-D) Hemimegalencephaly in a 1 year old female. T1-inversion recovery and T2 weighted images showing an enlarged left cerebral hemisphere with ipsilateral ventriculomegaly, severe involvement of the left occipital lobe and polymicrogyria-pachygyria complex. Also note the dysplastic appearance of the left cerebellar hemisphere with loss of normal fissures.

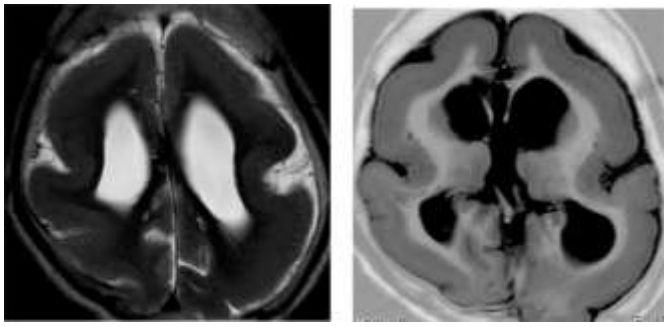

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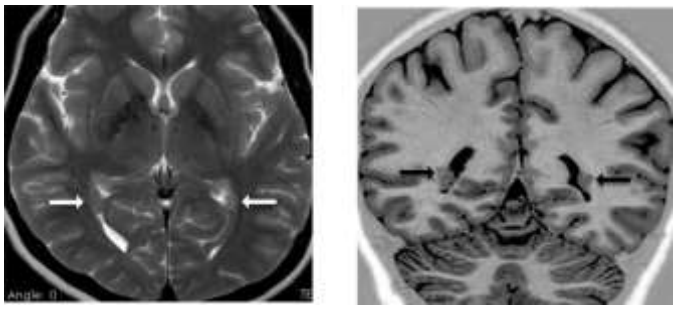
Fig. 3: (A and B) Lissencephaly in a 17 year old male. T2 weighted (A) and T1 inversion recovery (B) sequences showing thickened cortex with shallow sulci suggestive of incomplete lissencephaly.



A B

Fig 4: (A and B) Periventricular Nodular Heterotopia in a 8 year old female. T2 weighted axial (A) and T1 inversion recovery (B) oblique coronal images showing asymmetric focal nodular subependymal grey matter heterotopia along the occipital horns of both lateral ventricles (arrows).

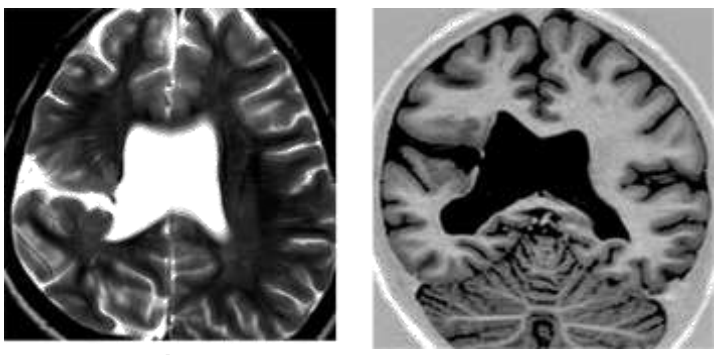


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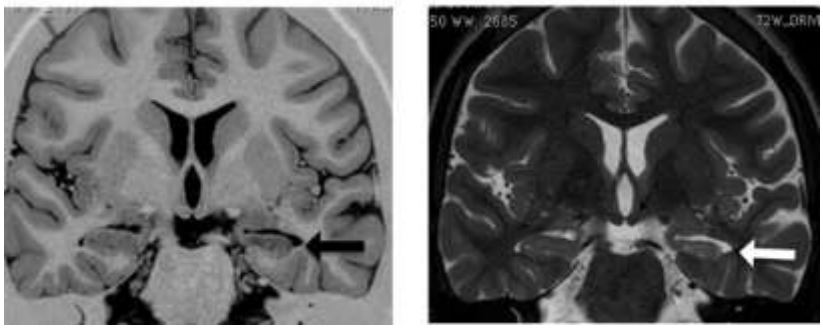
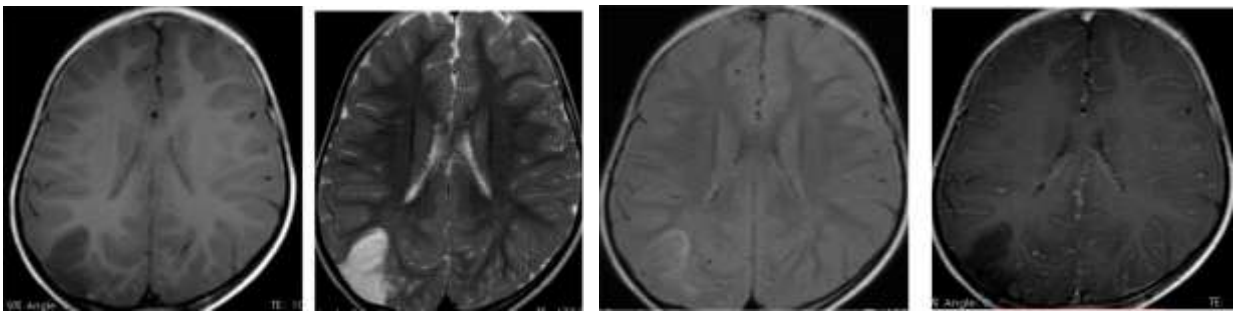
Fig 5: (A and B) Open-lip Schizencephaly in a 15 year old female. (A) T2 weighted axial image showing a CSF filled cleft extending from the right lateral ventricle upto the pial surface. (B)T1 inversion recovery coronal image demonstrates polymicrogyric grey matter lining the CSF cleft. Also note the absent septum pellucidum.



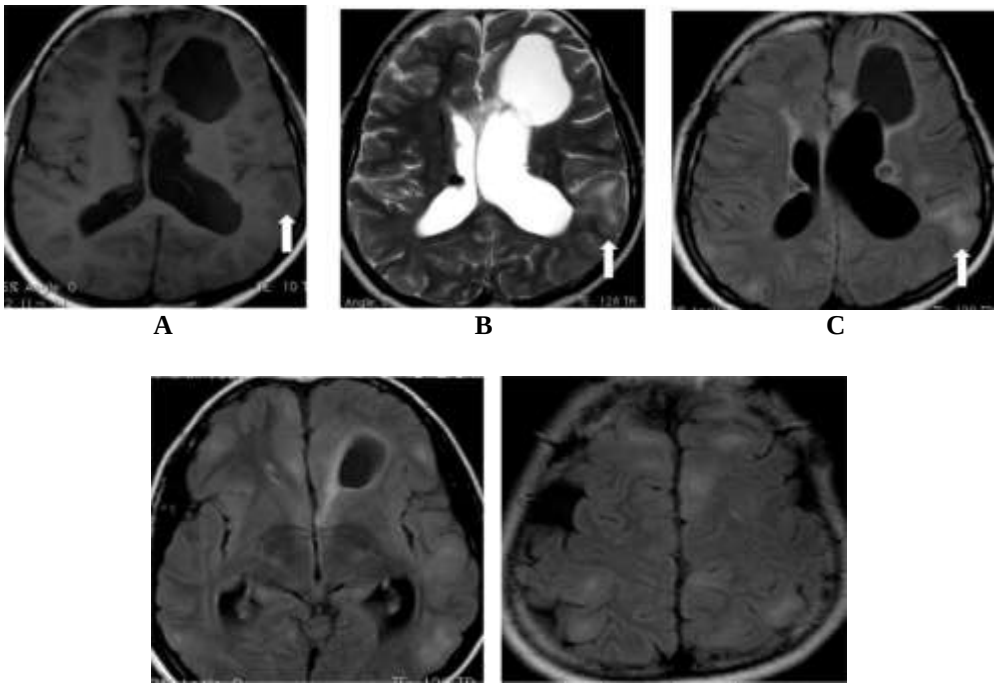
A B

Fig 6: Mesial temporal sclerosis in a 12 year old female. T1 inversion recovery and T2 weighted oblique coronal images showing volume loss of the left hippocampus with increased signal on the T2 weighted images (bold arrow). Also note the loss of interdigitations of left hippocampus, enlarged temporal horn and poor parahippocampal grey-white matter differentiation. There is subtle volume loss of the left mammillary body(dotted arrow).



A B C D

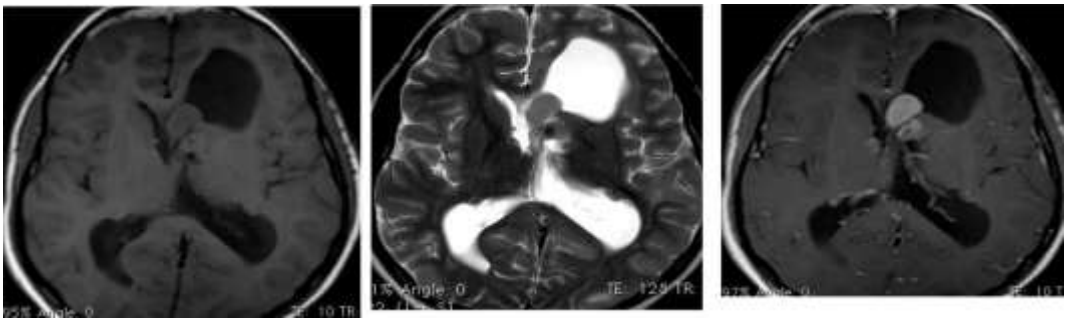
Fig 7: (A-D) Dysembryoplastic neuroepithelial tumour in a 4 year old male. Images showing a multilobulated cystic lesion involving the right posterior parietal cortical-subcortical region appearing hypointense on T1 weighted (A) and hyperintense on T2 weighted (B) with a perilesional hyperintense rim on FLAIR (D) and no postcontrast enhancement (E).



A B C

D E

Fig 8: (A-E) In a known case of Tuberous Sclerosis with past history of surgical excision of SEGA and shunt tube in situ. Notice the expanded gyrus in the left parietal lobe appearing hypointense on T1 weighted (A) and hyperintense on T2 weighted and FLAIR (B & C) images. Also note the multiple cortical tubers involving the cerebrum, appearing hyperintense on FLAIR images (D & E).



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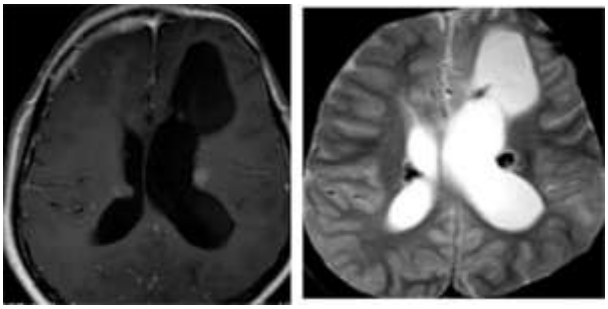
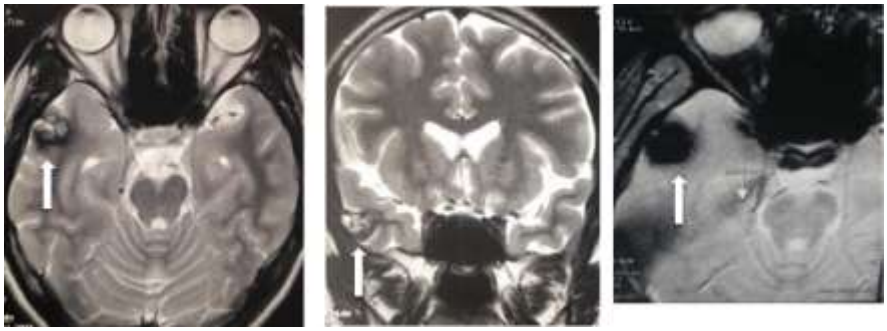


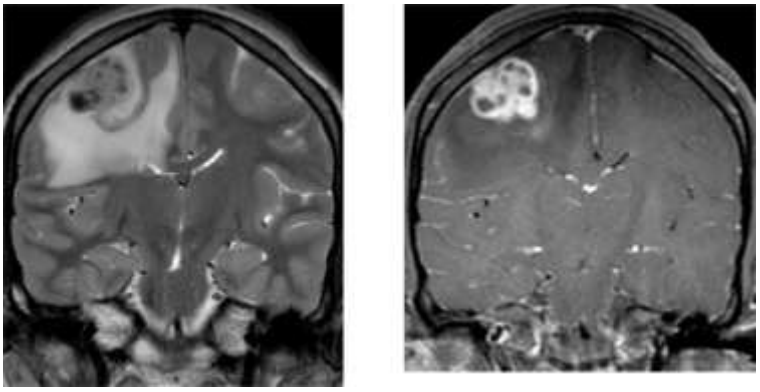
D E

Fig 9: (A-E) Subependymal Nodules in the same patient as fig 17. Notice the mixed signal intensity supendymal nodules (A & B) along the left caudothalamic groove with moderate enhancement (C). Also note few other subependymal nodules along the lateral ventricular walls with evidence of enhnacement (D) and blooming on GRE (E) suggestive of calcification.



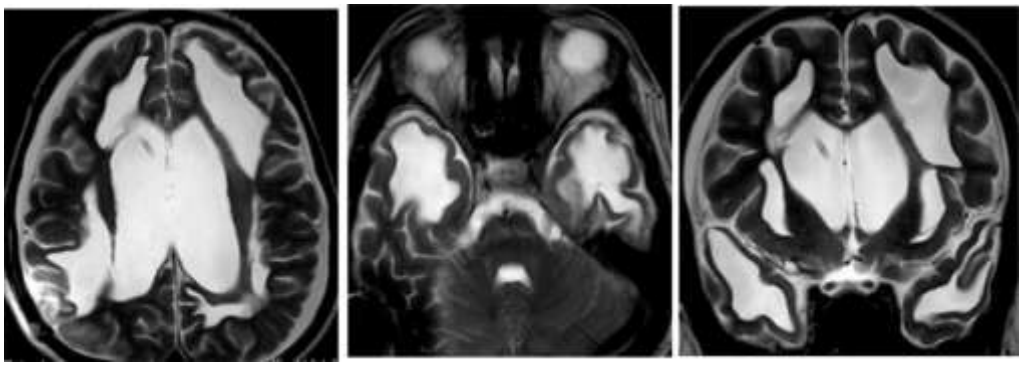
A B C

Fig 10: (A-C) Cerebral cavernous malformation in a 18 year female. MRI showing a cavernoma in the right middle temporal gyrus appearing heterogenously hyperintense on T2 weighted (A &B) images with a hypointense rim, evidence of blooming on GRE (C).



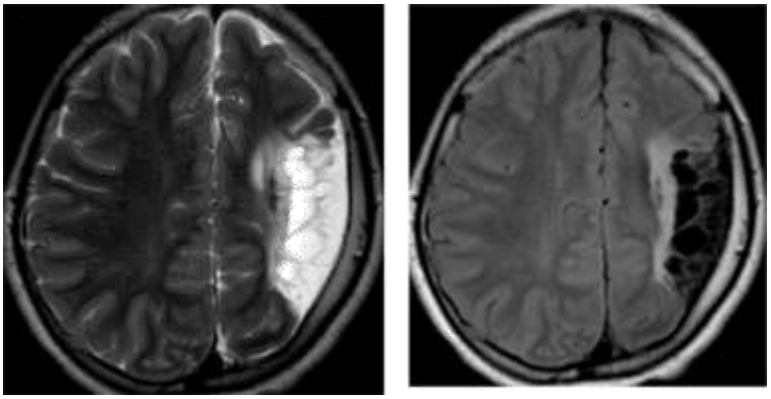
A B

Fig. 11: Intracranial tuberculomas in 17 year old female. MRI showing multiple conglomerate T2 hypointense lesions in the right frontoparietal region with perilesional edema and ring enhancement on post contrast study suggestive of tuberculomas.



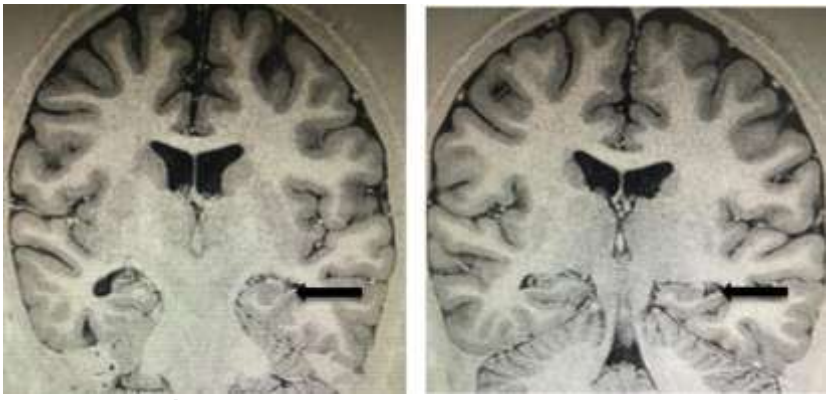
A B C

Fig. 12: (A-C) 15 year old male, known case of congenital CMV infection with past history of tuberculosis and shunt tube in situ for ventriculomegaly. MRI showing diffuse loss of white matter with cystic periventricular changes, also in the anterior temporal lobes alongwith cerebral atrophy and ventriculomegaly.



A B

Fig 13: Perinatal insult in a 8 year old male. MRI showing cystic encephalomalecia in the left middle cerebral artery territory, which is hyperintense on T2 W (A) and suppressed on FLAIR (B) images with a peripheral hyperintense rim.



A B

Fig 14: Hippocampal malrotation in a 13 year old male. MRI showing an abnormal rounded configuration of the left hippocampus with vertically oriented collateral sulcus and ipsilateral low lying fornix. Also note right sided mesial temporal sclerosis.

MRI findings

A. Malformations of cortical development

In the present study, the most common pathology was malformations of cortical development occurring cumulatively in 12 patients constituting 34.2% of all abnormal patients and 24% of all patients. Among the various malformations, focal cortical dysplasia was the most common pathology seen in 4 patients forming 33% of all malformations. (Figure1).[1,2]

The second most common malformation of cortical development was grey-matter heterotopia (Figure 4) occurring in the same frequency as focal cortical dysplasia forming 33% of all malformations. They occurred in isolation in 2 patients and were associated

with posterior periventricular signal abnormality due to hypoxic ischemic insult in 1 patient and dorsal interhemispheric cysts and corpus callosal dysgenesis in 1 patient.[3]

In our study, one case each of other malformations of cortical development, namely hemimegalencephaly (Figure 2), lissencephaly (Figure 3), open-lip schizencephaly (Figure 5) and polymicrogyria were detected. Hemimegalencephaly was seen to affect the left cerebral hemisphere with pachygyria- polymicrogyria complex and severe involvement of the occipital lobe.[4,5,6]

B. Mesial temporal sclerosis

In the present study, mesial temporal sclerosis or hippocampal sclerosis was seen in 4 patients comprising 11.4% of the pathologies. Mesial temporal sclerosis was seen in isolation in 1 patient, with contralateral hippocampal malrotation in 1 patient, with hypoxia ischemic perinatal insult in 1 case and with flattening of the contralateral head of hippocampus in 1 patient likely due to asymmetrical bilateral involvement. MRI appearance of hippocampal volume loss on T1 weighted images and hyperintense T2 signal was highly accurate in diagnosing mesial temporal sclerosis. (Figure 6).[7,8]

C. Neoplasms

In our study, 5 patients were diagnosed with neoplastic pathologies as a causative agent for temporal lobe epilepsy, thus comprising 14.2% of all pathologies.

Of the tumours in our study, ganglioglioma was seen in 2 patients, dysembryoplastic neuroepithelial tumour in 1 patient, high grade oligodendroglioma in 1 patient and low grade glioma of the temporal lobe in 1 patient. MRI along with other MRI techniques such as perfusion imaging, MR spectroscopy, functional MRI and diffusion tensor imaging were helpful in adequate surgical neuronavigation and excision of the tumours. (Figure 7).[9,10]

D. Infections

In the present study, infectious pathologies were noted in 4 patients, comprising 11.4% of all pathologies. Of these infective pathologies, 2 patients had calcified granulomas, one of which had concomitant acute herpes simplex virus encephalitis which on follow-up imaging developed into asymmetric areas of gliosis involving the temporal lobes and causing intractable epilepsy. One patient had conglomerate ring-enhancing tuberculomas with perilesional edema and 1 patient had neonatal CMV infection with characteristic periventricular cystic encephalomalacia and anterior temporal cysts. (Figures 10 and 11).[11,12]

E. Vascular malformations

In our study, temporal lobe cavernous malformation was identified in one patient with epilepsy. The cavernoma was situated in the cortical-subcortical region with a characteristic pop- corn like appearance on T2 weighted and gradient echo images due to hemorrhage. (Figure 9).[13]

F. Perinatal insult

In the present study, 8 patients had MRI findings related to some perinatal insult, comprising 22.8% of the pathologies. The most common perinatal insult was hypoxic ischemic injury causing volume loss of white matter, periventricular signal abnormality and areas of gliosis in varying degrees of severity in all patients. It was associated with mesial temporal sclerosis in 1 patient, hippocampal malrotation in 2 patients, subependymal nodular heterotopia in 1 patient and neonatal cytomegalovirus infection in 1 patient. (Figure 11).[17]

G: Neurocutaneous syndromes

In our study, there were 2 patients with tuberous sclerosis, comprising 5.7% of pathologies. One had all the classical intracranial imaging features consistent with tuberous sclerosis namely cortical tubers, subependymal nodules, radial white matter lines and subependymal giant cell astrocytoma adjacent to the foramen of Monro. However, the other patient only had radial linear white matter abnormalities extending from the ventricles to the cortex, which according to a study by **Iwasaki S et al [19]** is highly characteristic for tuberous sclerosis. T2 weighted and FLAIR images demonstrated the cortical tubers and white matter abnormalities with accuracy and post contrast images were valuable in characterising the subependymal nodules. (Figure 8).[14,15]

H. Hippocampal malrotation

In the present study, incomplete inversion of hippocampus or hippocampal malrotation was detected in 8 patients, comprising 22.8% of pathologies. It was seen in isolation in 4 patients and along with other abnormalities in 4 patients. However, according to recent studies the role of hippocampal malrotation in epilepsy is uncertain as it has been observed in normal subjects as well. Oblique coronal images were highly valuable in the diagnosis of hippocampal malrotation. A rounded hippocampus with a vertically oriented parahippocampal gyrus is likely to suggest the diagnosis. (Figure 13).[18]

DISCUSSION AND CONCLUSION

In this study, imaging characteristics of the spectrum of MRI findings in paediatric patients with epilepsy has been described alongwith the frequency of its occurrence. The study comprised of 50 patients in age group of 0-18 years with clinical diagnosis of epilepsy referred to the Radiology Department.

Intracranial pathologies were most commonly detected in 11-15 year age group with a male predominance.

22% patients with epilepsy had essentially normal MR imaging findings and were classified as cryptogenic epilepsy.

The most common pathology was malformations of cortical development in 32.4% of all abnormal patients and 20.3% of all patients. Among the various malformations, focal cortical dysplasia and grey-matter heterotopia were the most common pathologies occurring with equal frequency of 33% of all malformations.[16]

MRI clearly demonstrated the malformations of cortical development. Added role of 3D and inversion recovery sequences was identified for better delineation of grey-white matter interface and exclusion of partial voluming artefacts.

MRI was helpful in adequate localisation of the lesion, whether hippocampal or extrahippocampal. The diagnosis of mesial temporal sclerosis was confidently made using oblique coronal T1 and T2 weighted sequences.

Also MRI was a valuable imaging modality in differentiating neoplastic, infectious and other pathologies as a causative agent for epilepsy. In patients with neoplastic pathology, neuronavigation techniques alongwith perfusion imaging, diffusion tensor imaging and functional MRI helped to adequately characterise the lesion as well as aided in surgical planning and improved the post-surgical response in patients undergoing surgery.

In our study, MRI was highly diagnostic in patients with perinatal insult either due to hypoxic-ischemic damage or other causes. This helped in prognostication of the disease.

Calcified granulomas were seen in patients with epilepsy, alongwith tuberculomas, herpes encephalitis and CMV infection as other causes. However, infectious pathologies, once considered as the most common pathology in patients with epilepsy was not the case. There is now a shift of spectrum towards cortical malformations than infections in paediatric patients with epilepsy.

In conclusion, MRI is the imaging modality of choice in patients with paediatric epilepsy for better characterisation and delineation of lesions, aiding in surgical outcomes and also to understand the prognosis of the disease.

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