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ROLE OF MRI IN EPILEPSY DISORDER IN PEDIATRIC PATIENTS

Radiology

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ABSTRACT

Magnetic Resonance Imaging (MRI) has emerged as a pivotal tool in the evaluation of epilepsy in children. This thesis explores the role of MRI in diagnosing epilepsy in pediatric patients aged 1-12, highlighting its benefits, limitations, and impact on clinical decision making. This was a prospective observational study conducted over a period of 20 months from Nov 2020 to Jun 2022 among all the paediatric patients from 1-12 years with epilepsy. The claustrophobic patients, patients with metallic implants, with trauma, with febrile seizure disorders & with neoplastic disorder were excluded. Total 100 patients enrolled in this study. Mean age was 6.5 years with range from 1-12 years. The gender distribution is relatively balanced, with a slight predominance of male patients. Significant number of patients do not have structural abnormalities & also 70% of children so not had delayed milestone. From this study we conclude that, conventional sequences like T1 and T2 plays most important role in differentiating underlying causes of Epilepsy however special sequences like FLAIR.

KEYWORDS

MRI, Children, Epilepsy

INTRODUCTION:

Magnetic Resonance Imaging (MRI) has emerged as a pivotal tool in the evaluation of epilepsy in children. Unlike other imaging modalities, MRI offers detailed visualization of brain structures exposing patients to ionizing radiation, making it particularly suitable for the pediatric population. MRI's superior contrast resolution allows for the identification of subtle brain abnormalities, including structural lesions, developmental malformations, and other potential causes of epilepsy that may not be detectable with other imaging techniques.

Epilepsy is one of the most common neurological disorders in children, characterized by recurrent seizures resulting from abnormal electrical activity in the brain. It affects approximately 0.5-1% of the pediatric population worldwide, with a significant impact on the physical, cognitive, and psychosocial development of affected children. Early and accurate diagnosis is crucial for effective management and treatment, making advanced imaging techniques an essential component of the diagnostic process.

In children aged 1-12, epilepsy can present with diverse etiologies and manifestations, necessitating a tailored approach to diagnosis and treatment. MRI plays a crucial role in identifying the underlying causes of seizures, guiding treatment decisions, and predicting outcomes. It is particularly valuable in detecting cortical dysplasias, hippocampal sclerosis, and other abnormalities that can be surgically treated to achieve seizure control.

Neuroimaging is recommended by the International League Against Epilepsy (ILAE) for children under the age of 2 unless there is evidence of localization-related epilepsy (in febrile seizures, for example), abnormal neurological examination, usually benign idiopathic epilepsy, or childhood epilepsy that has not responded to the first two antiepileptic medications.

This thesis explores the role of MRI in diagnosing epilepsy in pediatric patients aged 1-12, highlighting its benefits, limitations, and impact on clinical decision-making. Through a comprehensive review of current literature and case studies, this research aims to underscore the importance of MRI in improving the quality of life for children with epilepsy and to suggest potential areas for future research and development in this field. The focus on the 1-12 age group is critical, as early childhood is a period of rapid brain development, and timely intervention can significantly alter the disease trajectory.

METHODOLOGY:

This was a prospective observational study conducted over a period of 20 months from Nov 2020 to Jun 2022 among all the paediatric patients from 1-12 years with epilepsy. The claustrophobic patients, patients with metallic implants, with trauma, with febrile seizure disorders & with neoplastic disorder were excluded. Total 100 patients enrolled in this study.

After obtaining permission from the institution ethics committee & written informed consent from parents after giving proper information of the MRI scan, child with epilepsy enrolled in the study. The patient was screened for ferromagnetic objects. Complete clinical history, birth and vaccination history, family history and past history was noted. The points noted were type of seizure, duration of illness and any associated complaints. Physical examination findings as for evidence of any neurocutaneous stigmata and complete CNS examination findings were noted. Findings of EEG and CT scan if done were documented. Very few cases had EEG documentation which was correlated with imaging findings. For MRI, patient was positioned supine on scanning table, immobilization of the patient's head was achieved and the head coil was applied.

Patients were subjected to MRI scanning. When necessary, adequate sedation was given by the anaesthetist. Magnetic Resonance Imaging was done with Machine, 1.5 & 3 Tesla GE SIGNA MRI SYSTEM, Radiofrequency coil—Sense head coil, excellent resolution, field of view was kept as small as possible (approximately 20 cms), Slice thickness- usually 3-5 mm, Inter-slice gap 1mm and Matrix 256 x256. Conventional MR imaging was performed by taking T1W (TE 8.0 ms, TR 480 ms), T2W (TE 102.9 ms, TR 4780 ms), and FLAIR (TE 92.2 ms, TR 8002 ms) sequences in planes as mentioned below. Post gadolinium (dose 0.1mmol/kg) enhanced MRI was performed in Axial and Sagittal planes in selected cases depending on findings on non-contrast study or clinical suspicion. DWI (TE 83 ms, TR 5025 ms) and GRE (Gradient recalled echo) axial performed in all cases. When required, MR spectroscopy, Venous 3D PCA (Phase Contrast Angiography) and MR angiography including TOF was done. Pulse sequences and imaging planes: T1 Sagittal and Axial Pre and Post contrast. T2 Axial and Coronal. FLAIR Axial. DWI (Diffusion Weighted Imaging) Axial GRE (Gradient Recalled Echo) Axial. T1 Inversion Recovery sequence. In suspected temporal lobe epilepsy additional sequences are: T1angled coronal, T1 3D isotropic acquisition. FLAIR angled coronal, T2 angled coronal, MR Spectroscopy, Venous 3D PCA (Phase Contrast Angiography) and MR angiography including TOF if required. MRI scans were studied with respect to: Number of lesions present., Unilateral or Bilateral, site, signal intensity, any hemorrhage, calcifications, surrounding edema, Mass effect, diffusion restriction, contrast enhancement/enhancing lesion, abnormal meningeal enhancement, atrophy, hydrocephalus, MR spectroscopy findings. Final diagnosis was based on the medical

history, clinical presentation, EEG and CT correlation, follow-up CSF analysis, pathological, surgical findings when available and\ response to medical therapy. Statistical analysis–Data was collected and entered in MS Excel. Data was analysed by using SPSS Version 23.

RESULTS:

Total 100 patients were enrolled in this study, with mean age was 6.5 years with range from 1-12 years. The gender distribution is relatively balanced, with a slight predominance of male patients. Significant number of patients do not have structural abnormalities & also 70% of children so not had delayed milestone. (Table 1)

Patients with Perinatal Asphyxia is strongly associated with Hypoxic ischemic Encephalopathy (18 cases) and Periventricular Leucomalacia (13 cases). Certain MRI diagnoses show strong correlations with specific lesion locations, indicating a clear anatomical basis for the condition. Diagnoses like Tuberous Sclerosis exhibit widespread lesion patterns, highlighting the multifocal nature of these conditions. Hypoxic Ischemic Encephalopathy and Periventricular Leukomalacia are among the most common diagnoses. Our study got conditions like Sturge Weber Syndrome, Metachromatic Leukodystrophy less commonly. (Table 2)

Table 1: Distribution According To Clinico-social Parameter

Clinico-social Parameter		Frequency	Percentage
Gender	Male	54	54%
	Female	46	46%
Lesion Type	Diffuse	61	61%
	Focal	29	29%
	NA	10	10%
Structural Abnormalities	Yes	31	31%
	No	69	69%
Milestone Status	Delayed Milestone	30	30%
	Not delayed	70	70%

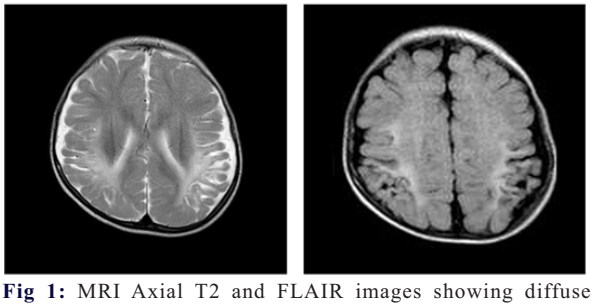

Fig 1: MRI Axial T2 and FLAIR images showing diffuse hyperintensities in periventricular white matter predominantly in parieto-occipital region suggest Periventricular Leukomalacia.

Table 2: Cross Tabulation Of MRI Diagnosis With MRI Findings

MRI Diagnosis	Total No. Of Patients	Delayed Milestone	Microcephaly	No birth issues	Perinatal asphyxia
Hypoxic ischemic Encephalopathy	19	15	0	1	18
Periventricular Leucomalacia	16	10	0	3	13
Normal	8	0	0	5	2
Communicating Hydrocephalous with ooze	7	2	0	7	0
Arachnoid cyst	7	0	2	5	0
Tuberculomas	5	1	0	3	2
Focal Cortical Dysplasia	4	0	0	4	0
Lissencephaly spectrum	4	2	0	4	0
Mesial temporal sclerosis	4	0	0	4	0
Metabollic Encephalopathy	3	0	0	3	0
ArNold Chiary Malformation	3	0	0	3	0
Tuberous Sclerosis	3	1	0	3	0
Metachromatic Leukodystrophy	3	1	0	3	0
Viral Encephalitis	3	1	0	3	0
Leukodystrophy	3	0	0	3	0
Sturge weber syndrome	2	1	0	2	0
Hydrocephalous	2	0	0	2	0
Porencephalic cyst	2	0	1	0	1
Neurocysticercosis	1	0	0	1	0
Microcephaly with simplified Gyral pattern	1	0	1	0	0

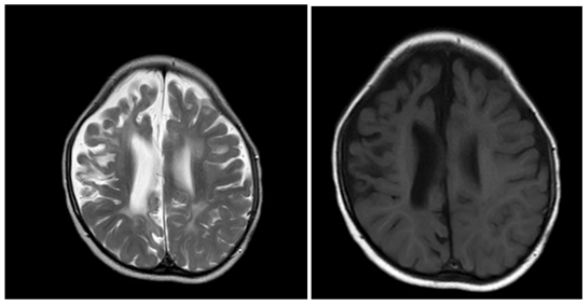

Fig 2: MRI Axial T2 and FLAIR images showing diffuse hyperintensities in periventricular and subcortical white matter predominantly in right fronto-parietal region with associated volume loss and prominent subarachnoid spaces suggest Hypoxic

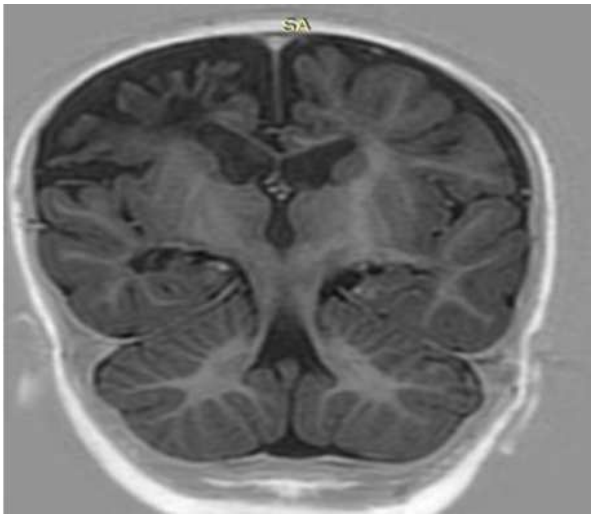

Fig 3: MRI Coronal section of FLAIR IR image depicting the cortical loss and structural comparison with opposite side of the cortex in case of Hypoxic ischemic encephalopathy.

DISCUSSION:

The study includes pediatric patients aged 1 to 12 years with a mean age of 6.5 years. The gender distribution shows a slight male predominance (54% male, 46% female). This balance in gender distribution is important to note, as it suggests that epilepsy in pediatric patients does not show significant gender bias, although slightly more males are affected. The majority of the patients (61%) have diffuse lesions, while 29% have focal lesions, and 10% of the cases do not have specified lesion types. This finding highlights the predominance of diffuse lesions in pediatric epilepsy, which could indicate underlying diffuse brain conditions, such as hypoxic ischemic encephalopathy, which is further supported by the MRI diagnoses. A large proportion of the patients (69%) did not present with structural abnormalities on MRI, while 31% did. This suggests that a significant portion of epilepsy cases in the cohort may be attributed to functional abnormalities, rather than visible structural damage. This aligns with findings in some epilepsy studies, where functional abnormalities (such as electrical disturbances) are present even in the absence of structural brain abnormalities. The most common MRI diagnoses among patients with epilepsy include: Hypoxic ischemic encephalopathy (19%) Periventricular leukomalacia (16%) Communicating hydrocephalus with ooze (7%). The distribution of these diagnoses suggests that brain injuries occurring around the time of birth, such as perinatal asphyxia, play a significant role in pediatric epilepsy. Perinatal asphyxia is strongly associated with conditions like hypoxic ischemic encephalopathy (18 cases) and periventricular.

Diffuse lesions are associated with hypoxic ischemic encephalopathy and periventricular leukomalacia, while focal lesions are linked with conditions like focal cortical dysplasia and tuberous sclerosis. These correlations highlight that different lesion types may be indicative of specific underlying conditions, which can help guide the diagnostic process. Several conditions, such as tuberous sclerosis, exhibit complex lesion patterns that are multifocal. This highlights the need for thorough investigation using MRI to identify multiple lesion locations, which could affect treatment strategies. The analysis reveals a predominance of generalized epilepsy over focal epilepsy in the patient cohort. Generalized epilepsy, characterized by widespread electrical discharges affecting both hemispheres of the brain, is often associated with more severe manifestations. This prevalence may be attributed to various factors, including genetic predispositions, environmental influences, and potentially unidentified neurodevelopmental factors specific to the population under study. Understanding this distribution is crucial for tailoring treatment approaches and allocating resources effectively. The higher incidence of generalized epilepsy suggests a need for healthcare providers to be particularly vigilant in identifying and managing this type. The dataset indicates a significant correlation between adverse birth conditions, particularly perinatal asphyxia, and the development of epilepsy. Perinatal asphyxia, which results in insufficient oxygen supply to the brain around the time of birth, can lead to long-term neurological damage and increase the risk of epilepsy. This finding highlights the importance of monitoring children with such birth histories for early signs of neurological issues and implementing early intervention strategies to mitigate long-term impacts. It also underscores the need for improving perinatal care and preventive measures to reduce the incidence of birth-related neurological conditions that can lead to epilepsy.

Gulati et al. (1991, 1994)[1] and Kuzniecky et al. (1993)[2], which demonstrated that MRI is critical for childhood epilepsy, especially when structural abnormalities are present. Sanghavi et al. (2004)[3] and Barkovich et al. (2005)[4], where MRI was instrumental in identifying congenital CNS malformations. Both studies highlight that congenital malformations are a significant contributor to pediatric epilepsy, emphasizing the need for early MRI-based screening in children with developmental concerns. Rasool et al. (2012)[5] and Kuzniecky et al. (1993)[2] found that MRI and EEG are complementary, with MRI detecting structural lesions and EEG capturing functional abnormalities. Kuzniecky et al. (1993)[2] and Parihar et al. (2012)[6] also found that lesion type and location are critical for determining epilepsy causes. However, they further explored how MRI findings could guide surgical planning, particularly for focal epilepsy, whereas your study focused more on diagnostic patterns. Sanghavi et al. (2004)[3] and Rasool et al. (2012)[5], where birth-related complications and congenital malformations were identified as major contributors to epilepsy. Kuzniecky et al. (1993)[2] found that structural abnormalities, particularly focal cortical dysplasia, were often associated with intractable epilepsy, leading to the recommendation of surgery in severe cases. Parihar et al. (2012)[6] and Gulati et al. (1991)[1], also found that early MRI-based diagnosis improves outcomes in pediatric epilepsy. These studies emphasize early intervention based on MRI findings, aligning closely with your conclusions on the value of early imaging to detect structural anomalies and guide treatment. Chaurasia R, Singh S, Mahur S, Sachan P (2013)[7]: The results demonstrated a broad spectrum of MRI-detected abnormalities in pediatric epilepsy, with common findings including cortical dysplasias, hippocampal sclerosis, and other structural brain anomalies. This study confirmed that imaging plays a critical role in understanding and treating epilepsy in children. Sales LV, Velasco TR (2006)[8]: The study identified temporal lobe epilepsy as a common form of pediatric epilepsy, with neuroimaging showing lesions like hippocampal sclerosis and cortical dysplasia in a significant proportion of cases. Surgical outcomes were favourable in many cases, particularly when MRI helped localize the epileptic focus. Ng YT, McGregor AL, Duane DC, Jahnke HK, Bird CR, Wheless JW (2006)[9]: The study found that mesial temporal sclerosis was a major cause of childhood epilepsy, detectable via MRI. The condition was associated with a history of prolonged febrile seizures and showed favourable outcomes with surgical intervention when diagnosed early.

CONCLUSION:

From this study we conclude that, conventional sequences like T1 and T2 plays most important role in differentiating underlying causes of Epilepsy however special sequences like FLAIR . DWI sequences give additional confirmation for the acute stages of the diseases. Other sequences like Inversion Recovery and Contrast enhanced images give clarity for structural abnormalities and infective etiologies respectively. Special Sequences like GRE are very useful to detect haemorrhages and calcifications. The most common MRI diagnoses are Hypoxic ischemic Encephalopathy and Periventricular Leucomalacia while Structural abnormalities are more frequently found in pa.

Patients diagnosed with congenital abnormalities with conditions such as Focal Cortical Dysplasia. Perinatal asphyxia and certain MRI diagnoses, particularly Hypoxic ischemic Encephalopathy and periventricular leukomalacia, highlights the importance of early intervention and monitoring in newborns with adverse birth histories. This study provides a detailed analysis of the interplay between MRI findings, epilepsy, birth history, and structural abnormalities. MRI with different sequences play essential role in the diagnosis of different causes of epilepsy.

REFERENCES:

1. Gulati P, Jena A, Tripathi RP, Gupta AK. (1991). Magnetic resonance imaging in childhood epilepsy. Indian Pediatrics, 28(7), 761-765.
2. Kuzniecky R, Murro A, King D. (1993). Magnetic resonance imaging in childhood intractable partial epilepsies: Pathological correlations. Epilepsia, 34(4), 681 687. doi:10.1111/j.1528-1157.1993.tb00469.x
3. Sanghavi JP, Rajadhyaksha SB, Uresekar M. (2004). Spectrum of congenital CNS malformations in pediatric epilepsy. Indian Pediatrics, 41(3), 831-838.
4. Barkovich AJ, Kuzniecky RI, Jackson GD, Guerrini R, Dobyns WB. (2005). A developmental and genetic classification for malformations of cortical development. Neurology, 65(12), 1873-1887. doi:10.1212/01.wnl.0000183747.05269.
5. Rasool A, Choch SA, Wani NA, Ahmad SM, Iqbal Q. (2012). Role of EEG and neuroimaging in first onset afebrile and complex febrile seizures in children from Kashmir. Journal of Pediatric Neurosciences, 7(1), 9-15. doi:10.4103/1817-1745.97614
6. Parihar RV, Gupta AK, Saini G, Dev G. (2012). Role of MRI imaging of brain in pediatric patients with partial epilepsies. JK Science, 14(1), 60-64.
7. Chaurasia R, Singh S, Mahur S, Sachan P. Imaging in paediatric epilepsy, Spectrum of abnormalities detected on MRI. J Evolv Med Dent Sci 2013;19(3):3377-87.
8. Sales LV, Velasco TR, Relative frequency, clinical, neuroimaging, and postsurgical features of pediatric temporal lobe epilepsy. 2006; 39(10):1365-72.
9. Ng YT, McGregor AL, Duane DC, Jahnke HK, Bird CR, Wheless JW. Childhood mesial temporal sclerosis. J Child Neurol 2006; 21(6):512-7.