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ORIGINAL ARTICLE

Magnetic Resonance Imaging findings in pediatric patients with epilepsy: a single-center experience from Pakistan

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ABSTRACT

OBJECTIVE: To determine the structural abnormalities on magnetic resonance imaging (MRI) in the epileptic Pakistani pediatric population presenting at tertiary care hospital, Karachi.

METHODS: This cross-sectional descriptive study was done at the CT and MRI Center, Dr Ruth K.M Pfau Civil Hospital Karachi, from February 2019 to January 2020. This study enrolled 173 subjects of either gender between 1-14 years of age with epilepsy who underwent an MRI of the brain. An MRI brain with epilepsy protocol was performed after taking a history from each patient. Abnormalities were reported according to their imaging features, signal intensity, and location.

RESULTS: Of the 173 subjects, 94 (54.3%) were boys and 79 (45.7%) were girls, with mean age of 6.7±3.3 years. Generalized seizures were predominant (n=103; 59.5%), followed by focal seizures (n=57; 33%), and unknown seizure patterns (n=13; 7.5%). MRI findings were unremarkable in 68 (39.3%) cases, predominantly in both generalized (35.84%) and focal (2.31%) epilepsy cases. Structural abnormalities were evident in 105 (60.7%) patients on MRI. Cerebral atrophy was predominant (11.56%), especially in generalized epilepsy cases. Encephalomalacia (6.94%) and ventricular enlargement (6.36%) were observed, with encephalomalacia more prevalent in focal epilepsy and ventricular enlargement in generalized epilepsy. Mesial temporal sclerosis (5.7%) was significant in focal epilepsy cases. The highest prevalence of unremarkable MRI findings was in the 6-10 years' age group (20.2%).

CONCLUSION: MRI detected abnormalities in 60.7% cases of paediatric epilepsy, most commonly cerebral atrophy and encephalomalacia, emphasizing MRI's role in assessing epilepsy-related structural changes and the need for targeted interventions.

KEYWORDS: Epilepsy (MeSH); Magnetic Resonance Imaging (MeSH); MRI (Non-MeSH), Pediatrics (MeSH); Nervous System Malformations (MeSH); Structural abnormalities (Non-MeSH); Cerebral atrophy (Non-MeSH).

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INTRODUCTION

Epilepsy is a chronic medical condition characterized by recurrent seizures unprovoked by an acute systemic or neurologic insult.[1,2] It is a worldwide medical problem that affects approximately 50 million people around the world.[1,3] In Pakistan, it is estimated that the prevalence of epilepsy is approximately 9.99/1000, with the highest prevalence in younger people (<30 years).[3]

Various studies revealed that childhood afebrile seizures are mostly recurrent and drug-resistant, which are more likely associated with abnormal neuroimaging findings.[4,5] Neuroimaging, particularly magnetic resonance imaging (MRI), plays an important role in the proper evaluation and management of children with epilepsy as it localizes and characterizes structural abnormalities like hippocampal sclerosis, tumors, cortical malformations, neurocutaneous syndromes, etc. and assesses the need for surgical resection.[6]

MRI has superior sensitivity and specificity due to its high contrast resolution and multiplanar capability over CT scans for identifying subtle structural abnormalities, temporal lobe pathologies due to beam-hardening artifacts on CT, and a lack of radiation.[1,7] Therefore, the International League against Epilepsy (ILEA) has recommended MRI in all patients with epilepsy for evaluation.[8] So MRI with a special protocol for epilepsy in pediatric epilepsy is highly indicated for the assessment of its etiology, prognosis, and therapeutic approaches.

There is limited literature regarding the MRI findings of structural abnormalities of the central nervous system in Pakistani children with epilepsy. Most studies have focused on MRI findings to identify acute causes of seizures, such as CNS infections, trauma, or brain hemorrhage, for immediate management. So, this study was planned to identify abnormal structural findings of the CNS on MRI in children with epilepsy presenting at a tertiary care hospital of Karachi, Pakistan. These findings could enhance patient management by facilitating targeted therapies, distinguishing between treatable and non-treatable conditions, preventing further seizures through medical or surgical interventions, and enabling more informed prognostic counseling for patients and their families

METHODS

This observational cross-sectional hospital-based study was conducted at the CT and MRI Centre, Dow Medical College, and Dr. Ruth K.M. Pfau Civil Hospital Karachi, Pakistan, from

February 2019 to January 2020. Patients of either gender between 1 and 14 years of age with a history of seizures within six months referred for an MRI of the brain were included. Patients who had a history of recent fever, clinical/laboratory parameters of infective etiology, electrolyte imbalance, dehydration, or recent trauma were excluded from the study.

Sample size was calculated by Openepi Version 3 taking 12.91% of patients with generalized brain atrophy in paediatric epilepsy,[9] 5% confidence interval, and a 95% confidence level. The total calculated sample size was 173. Written informed consent was obtained from each subject, and permission was sought from the Institutional Review Board (IRB-1213/DUHS/Approval/2019/12).

After receiving approval from the Institution Board review, all patients who referred to the CT and MRI Center department fulfilling the inclusion criteria were included in this study. Written informed consent was obtained for the enrollment in this study. The MRI was performed on 1.5-Tesla MR scanner (GE Health Care Signa H D) with paediatric epilepsy protocol. The standardized protocol used which included axial T1-weighted spin echo, axial T2-weighted fast spin echo, coronal oblique fast fluid-attenuation inversion recovery, coronal oblique fast multiplanar inversion recovery, axial diffusion and axial three dimensional spoiled gradient recalled echo. Gadolinium MRI contrast was not part of epilepsy protocol but it was administrated when required for characterization of the lesion as seen on the protocol based images. Uncooperative patients underwent sedation administered by a qualified anesthetist in the MRI room. The MRI findings were localized and documented using the approved proforma.

The collected data were analyzed using SPSS version 23.0. The mean and standard deviation were calculated for quantitative variables like age. Percentage and frequency were calculated for qualitative variables like gender and MRI findings.

RESULTS

Out 173 patients, 94 (54.3%) were boys and 79 (45.7%) were girls. The patients' ages ranged from 1 to 14 years, with 64 individuals (37%) aged 1-5 years, 76 participants (43.9%) aged 6-10 years, and 33 individuals (19.1%) aged 11-14 years.

Generalized seizures were the common seizure pattern seen in 59.5%. Out of 173 patients, MRI examinations revealed unremarkable findings in 68 participants (39.3%), predominantly noted in both generalized (35.84%) and focal (2.31%) epilepsy cases. Conversely, structural or morphological abnormalities were evident in 105 participants (60.7%) on MRI. Cerebral atrophy, with a prevalence of 11.56%, emerged as the predominant MRI finding in the study, particularly among cases of generalized epilepsy. Encephalomalacia (6.94%) and ventricular enlargement (6.36%) also featured prominently, with the former being more prevalent in cases of focal epilepsy (4.63%) and the latter in generalized epilepsy. Ventricular enlargement (6.36%) was particularly observed in cases of generalized epilepsy, while mesial temporal sclerosis (5.7%) emerged as a significant finding in focal epilepsy cases on MRI (Table I).

Table II presents the distribution of MRI findings among different age groups among 173 pediatric epilepsy patients. The highest prevalence of unremarkable MRI findings was observed in the 6-10 years' age group, comprising 20.2% (n = 35) of cases. Cerebral Atrophy, observed in 11.56% (n=20) of the total study participants, showed a relatively even distribution across age groups: 2.89%, 5.2%, and 3.47% in the 1-5 Years, 6-10 Years, and 11-14 Years age groups, respectively. Encephalomalacia was predominantly observed in the 1 to 5 years (2.31%) and 6 to 10 years' age groups (3.47%).

DISCUSSION

In this study, generalized seizures were the most common seizure pattern (59.5%). MRI findings were unremarkable in 39.3% of patients, predominantly in both generalized (35.84%) and focal (2.31%) epilepsy cases. Structural abnormalities were evident in 60.7% of patients on MRI. Cerebral atrophy was predominant (11.56%), especially in generalized epilepsy cases. Other common MRI findings were encephalomalacia (6.94%) and ventricular enlargement (6.36%), with encephalomalacia more prevalent in focal epilepsy and ventricular enlargement in generalized epilepsy. Mesial temporal sclerosis (5.7%) was common in focal epilepsy cases. The highest prevalence of unremarkable MRI findings was in the 6-10 years' age group (20.2%).

Epilepsy is a worldwide neurological problem with long-term physical and psychological debilitation.[7,10] idiopathic, but structural abnormalities are the most common cause of drug-resistant epilepsy seen in about 20% of patients. Here, the role of neuroimaging comes to identify an epileptogenic lesion, which can be managed with early intervention to reduce epilepsy-related morbidity because recurrent seizures can result in further neuronal damage.[4,11]

In this study, the mean age of patients was 6.71±3. years, which is comparable to Mundhe AS, et al.,[12] who showed the mean age of patients was 6.2 years. In the current study, epilepsy is more common in males than females, which corroborates the reports from various studies.[11-14] The reason behind this is not well known, but the possibility of some genetic involvement cannot be excluded; this warrants further research.

Previous studies done in paediatric population of different communities have shown inconsistent incidence of neuroimaging abnormalities.[1,15-18] This may either be due to different MRI protocols and selection criteria, variation in the age and gender of the study population, different genetic and environmental factors, or a combination of these factors.Rehman Z, concluded that most common etiology in children with epilepsy were structural abnormalities,[13] which can be detected via MRI. These abnormalities in turn change the management strategies and patient's prognosis, enhance the surgical treatment, as well as the counseling of child and attendant so clinician should

Table I: MRI findings with type of seizures

MRI Findings	Frequency (Percentage)	Type of Seizures		
		Generalized (n=103)	Focal (n=57)	Unknown (n=13)
Unremarkable	68 (39.3%)	62 (35.84%)	4 (2.31%)	2 (1.16%)
Cerebral Atrophy	20 (11.56 %)	20 (11.56 %)	-	-
Encephalomalacia	12 (6.94%)	-	8 (4.63%)	4 (2.31%)
Ventricular enlargement	11 (6.36%)	11 (6.36%)	-	-
Mesial temporal sclerosis	10 (5.7%)	-	10 (5.7%)	-
Strug Weber syndrome	7 (4.05%)	-	7 (4.05%)	-
Heterotropia	6 (3.47%)	-	6 (3.47%)	-
Porecephalic cyst	6 (3.47%)	-	4 (2.31%)	2 (1.16%)
Arachnoid cyst	6 (3.47%)	-	3 (1.73%)	3 (1.73%)
Tuberous sclerosis	5 (2.89%)	-	4 (2.31%)	1 (0.57%)
Focal cortical dysplasia	5 (2.89%)	-	5 (2.89%)	-
Schizencephaly	4 (2.31%)	4 (2.31%)	-	-
Cortical neoplastic lesions	4 (2.31%)	-	4 (2.31%)	-
Corpus callosum dysgenesis	3 (1.73%)	2 (1.16%)	-	1 (0.57%)
Cerebellar atrophy	3 (1.73%)	3 (1.73%)	-	-
Hemimegalencephaly	2 (1.16%)	-	2 (1.16%)	-
Lissencephaly	1 (0.57%)	1 (0.57%)	-	-
Total	**173 (100%)**	**103 (59.5%)**	**57 (33%)**	**13 (7.5%)**

consider obtaining a structural neuroimaging with MRI.[6,19]

There are limited local studies that were done on neuroimaging findings in paediatric epilepsy in the Pakistani population. In present study, 60.7% patients had abnormal MRI findings, which is in accordance with studies done by Gul P, et al.,[10] (55%), Ali A, et al.,[9] (55.99%) and Khandediya OB, et al.,[11] (62%). Cerebral atrophy was the leading abnormality detected in 11.56% of patients, which was nearer to the findings of the study done by Amirsalari et al[14] (10%) and Azmat et al[9] (12.91%) but higher than those reported by Dirik et al[1] (4.55%). These differences may be due to the different time intervals between the diagnosis of epilepsy and the MRI scan. The second most common finding was encephalomalacia, which constituted 6.94% of patients. Almost similar results have been reported in the literature.[1,20]

Ventricular enlargement was seen in 6.36% patients, which was lower than that found in studies done by Dura T, et al.,[6] and Kalnin AJ, et al.,[15] No significant work was done on the correlation of ventricular size with epilepsy, even though Jackson DC, et al.,[21] also found significant lateral ventricular enlargement in children with new-onset idiopathic generalized epilepsy compared to healthy controls. Mesial temporal sclerosis was observed in 5.87% of patients, which was higher than that found in other studies,[2,9] but much lower than Kalnin AJ, et al.,[15] which may be due to strict study selection criteria or MRI obtained in the later course of the disorder. The other reported abnormalities on MRI in the present study were in different proportions and cannot be compared with other studies conducted due to different demographic data. Most studies also reported meningitis, encephalitis, and tuberculoma in high ratios, but seizures due to infective etiology were not considered in the present study, which focused only on the structural abnormalities that may or may not be rectified by surgical correction or medical therapy.

Few of the neuroimaging findings in current study were non-specific in respect to etiological relationship with epilepsy, which included magna cisterna cyst, arachnoid cysts, choroid plexus cyst, and septum pellucidum, as founded by Samia P, et al.[18] Arachnoid cysts were detected in 3.47% patients but there is controversy regarding the correlation between arachnoid cysts and epilepsy. Arroyo S.[2] also concluded that arachnoid cysts do not reflect the location of seizure focus but are often an incidental finding in patients with epilepsy. Corpus callosum dysgenesis was recorded in 1.73% patients; however, studies found that anomalies of corpus callosum cannot act per se as seizure onset zones but additional mal-development anomalies are noted in patients with epilepsy.[23] However, in some drug-resistant/refractory cases, callosotomy provided benefit in seizure reduction, probably due to decrease in seizure spread through corpus callosum.[23]

Up to 60% of the children with epilepsy had abnormal findings on MRI, so it should be implicated in all paediatric patients with epilepsy in this population. Though the sample size is quite good, there are a few limitations in this study as it is confined to a single region of Pakistan and a single tertiary center. So for generalizability of these abnormalities, further research on a large population and multicenter should be done.

CONCLUSION

Our study highlights the crucial role of MRI in identifying paediatric epilepsy.

Table II: MRI findings with age distribution (n=173)

MRI Findings	Age Distribution (Years)			Frequency (Percentage)
	1-5	6-10	11-14	
Unremarkable	25 (14.5%)	35 (20.2%)	8 (4.6%)	68 (39.3%)
Cerebral Atrophy	5 (2.89%)	9 (5.2%)	6 (3.47%)	20 (11.56 %)
Encephalomalacia	4 (2.31%)	6 (3.47%)	2 (1.16%)	12 (6.94%)
Ventricular enlargement	1 (0.57%)	6 (3.47%)	4 (2.31%)	11 (6.35%)
Mesial temporal sclerosis	-	2 (1.16%)	8 (4.6%)	10 (5.7%)
Strug Weber syndrome	5 (2.89%)	2 (1.16%)	-	7 (4.05%)
Heterotropia	2 (1.16%)	3 (1.73%)	1 (0.57%)	6 (3.47%)
Porecephalic cyst	3 (1.73%)	1 (0.57%)	2 (1.16%)	6 (3.47%)
Arachnoid cyst	2 (1.16%)	3 (1.73%)	1 (0.57%)	6 (3.47%)
Tuberous sclerosis	3 (1.73%)	2 (1.16%)	-	5 (2.89%)
Focal cortical dysplasia	4 (2.31%)	1 (0.57%)	-	5 (2.89%)
Schizencephaly	4 (2.31%)	-	-	4 (2.31%)
Cortical neoplastic lesions	-	3 (1.73%)	1 (0.57%)	4 (2.31%)
Corpus callosum dysgenesis	2 (1.16%)	1 (0.57%)	-	3 (1.73%)
Cerebellar atrophy	1 (0.57%)	2 (1.16%)	-	3 (1.73%)
Hemimegalencephaly	2 (1.16%)	-	-	2 (1.16%)
Lissencephaly	1 (0.57%)	-	-	1 (0.57%)
Total	**64 (37%)**	**76 (43.9%)**	**33 (19.1%)**	**173 (100%)**

Cerebral atrophy, encephalomalacia, and mesial temporal sclerosis were prevalent findings. The study emphasizes the need for integrating MRI into standard practices for early intervention and improved patient outcomes, despite acknowledging limitations such as single-center focus. Overall, this research emphasizes the significance of tailored imaging protocols in guiding effective management strategies for paediatric epilepsy.

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AUTHORS' CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

RS: Concept and study design, acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

SS: Acquisition of data, drafting the manuscript, critical review, approval of the final version to be published

SZ: Acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request