ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Study of Prevalence and Structural Brain Abnormalities Causing Seizure Disorders in the Pediatric Population.

Surendra S Lingawar[1]*, and Yogendra P Sachdev[2].

[1]Radiodiagnosis Resident Doctor, Department of Radiodiagnosis, Dr. Balashaeb Vikhe Patil Rural Medical College, Loni, Ahmednagar, Maharashtra, India.
[2]Professor and Head of Department, Department of Radiodiagnosis, Dr. Balashaeb Vikhe Patil Rural Medical College, Loni, Ahmednagar, Maharashtra, India.

ABSTRACT

Seizure disorders in the pediatric population present significant clinical challenges due to diverse etiologies and impacts on neurodevelopment. This study aimed to determine the prevalence and describe structural brain abnormalities causing seizure disorders in children within a rural setting. A prospective observational study was conducted among 86 pediatric patients below 19 years referred for seizure evaluation. MRI scans were performed using the PHILIPS INGENIA ELITION X 3T MRI machine with an epilepsy/seizure disorder protocol, including various T1W, T2W, FLAIR, DWI, ADC, SWI, and contrast-enhanced sequences. Structural abnormalities were identified in numerous cases, including gliosis with cystic encephalomalacia, hydrocephalus, cortical atrophy, hypoplastic corpus callosum, and cytotoxic lesions of the corpus callosum (CLOCS). Gliosis involved the right fronto-temporal lobe, presenting hypointense with hyperintense rims on FLAIR and hyperintense on T2W images. Hydrocephalus was characterized by ventricular dilation and prominent sulcal spaces. Mesial temporal sclerosis (MTS) was identified in the left hippocampal gyrus with characteristic MRI findings. Structural brain abnormalities are prevalent in pediatric seizure disorders, necessitating comprehensive MRI evaluations for accurate diagnosis and management. Early identification of these abnormalities can guide targeted interventions, improving seizure control and neurodevelopmental outcomes.

Keywords: Pediatric Seizure Disorders, Structural Brain Abnormalities, MRI Evaluation.

https://doi.org/10.33887/rjpbcs/2024.15.4.5

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Seizure disorders in the pediatric population represent a significant clinical challenge due to their diverse etiologies, varying clinical presentations, and potential impact on neurodevelopment [1].

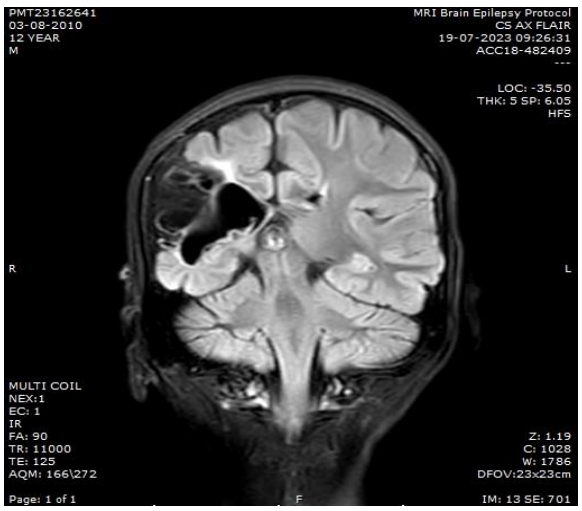
The prevalence of seizure disorders in children is estimated to range from 3 to 5 per 1,000, with the onset commonly occurring in infancy and early childhood. Structural brain abnormalities, including congenital malformations, acquired injuries, and neurodevelopmental anomalies, are critical factors contributing to the pathogenesis of pediatric seizures [2, 3]. These abnormalities can be identified through advanced neuroimaging techniques, which have revolutionized the diagnostic approach and management of these disorders.

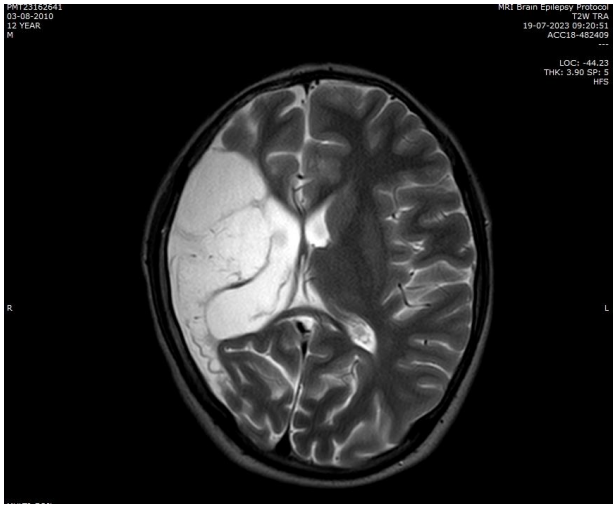
Understanding the prevalence and types of structural brain abnormalities in children with seizures is essential for early diagnosis, appropriate intervention, and improving long-term outcomes. Early detection of structural anomalies can guide targeted therapies, optimize seizure control, and mitigate adverse effects on cognitive and motor development. This study aims to elucidate the prevalence of structural brain abnormalities in pediatric patients with seizure disorders and to characterize the types and distribution of these abnormalities [4]. By providing a comprehensive overview of the underlying structural causes, this research seeks to enhance clinical practices, inform treatment strategies, and contribute to the overall understanding of pediatric seizure disorders.

METHODOLOGY

The study aimed to determine the prevalence and describe the structural brain abnormalities causing seizure disorders in the pediatric population within our rural setting. A prospective observational study was conducted among 86 cases of seizure disorders, including patients below the age of 19 years referred to the department of radiodiagnosis for evaluation of seizure disorders. Complete enumeration of cases within the study interval of one year was carried out. All MRI scans were performed using the PHILIPS INGENIA ELITION X 3T MRI machine following an established epilepsy/seizure disorder protocol. The sequences obtained under the MRI protocol included anatomic axial and sagittal T1W, axial and sagittal T2W, coronal FLAIR, coronal IR (Inversion Recovery) sequence (heavily T1W sequence), axial DWI, axial ADC, and axial SWI sequences. Additionally, gadolinium-based contrast-enhanced T1W sequences in axial, coronal, and sagittal sections, along with delayed axial T1W sequences, were utilized.

RESULTS





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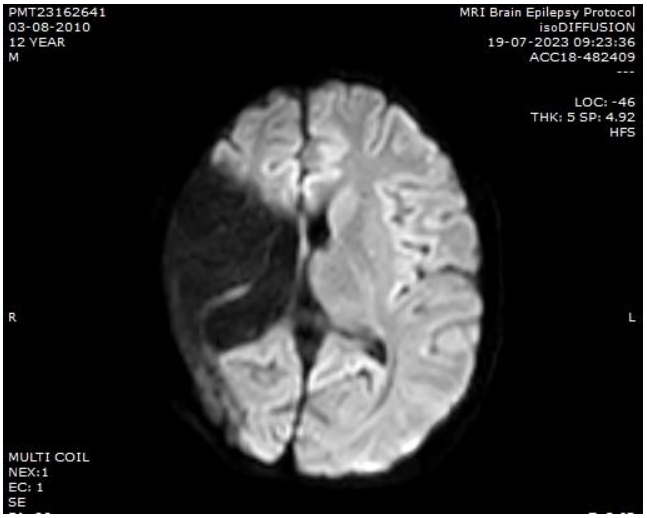
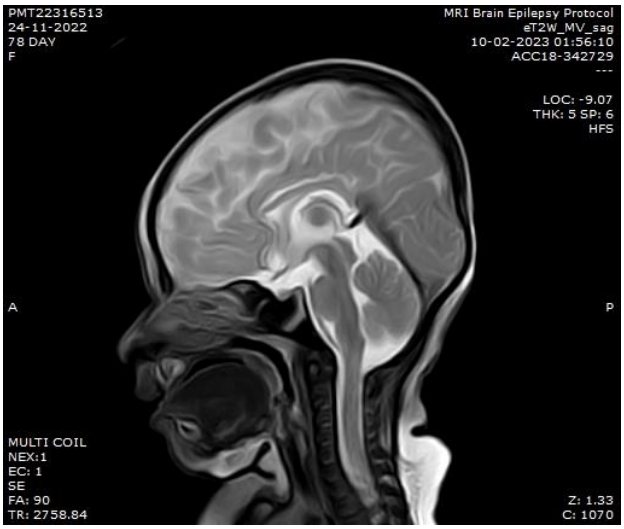
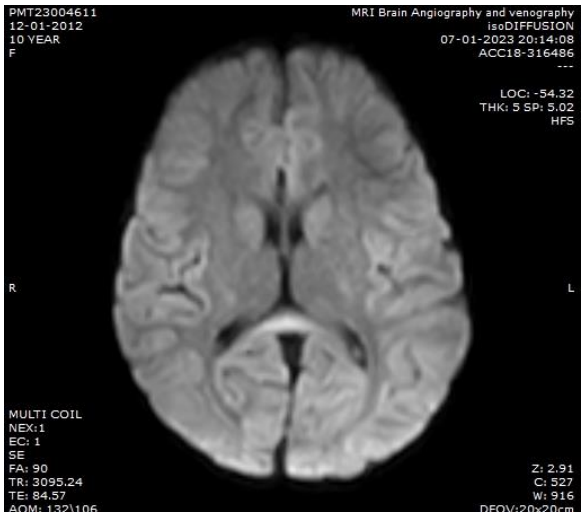
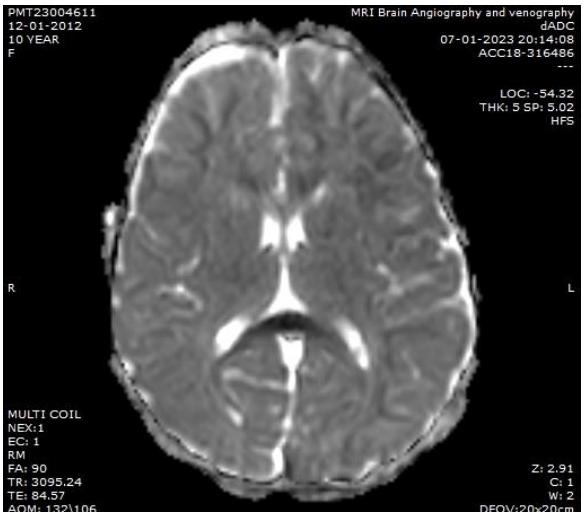


There Area of gliosis with cystic encephalomalacia and exvacuodilatation of of the right lateral ventricle noted involving the right fronto-temporal lobe with right insular cortex, appearing hypointense with hyperintense rim on FLAIR images, hyperintense on T2W images and no Diffusion restriction on DWI images.



There is hypoplastic genu and rostrum of corpus callosum noted.





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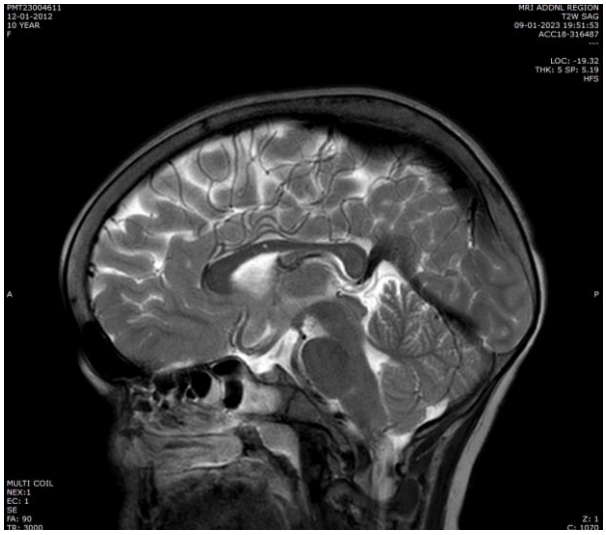
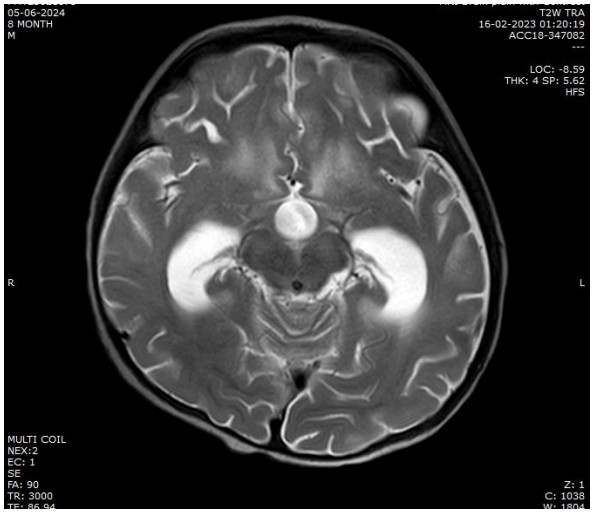
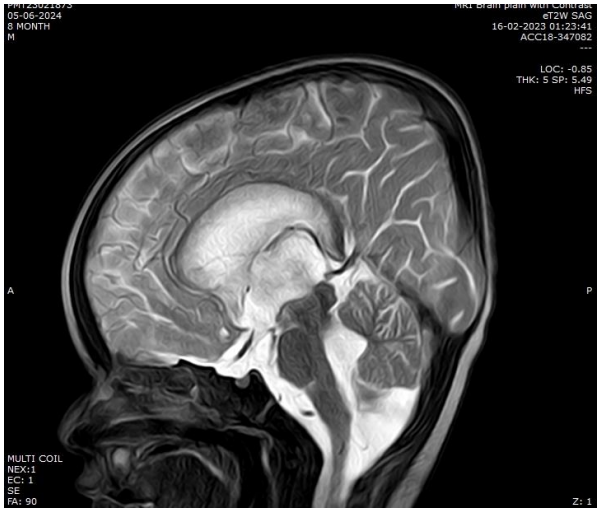
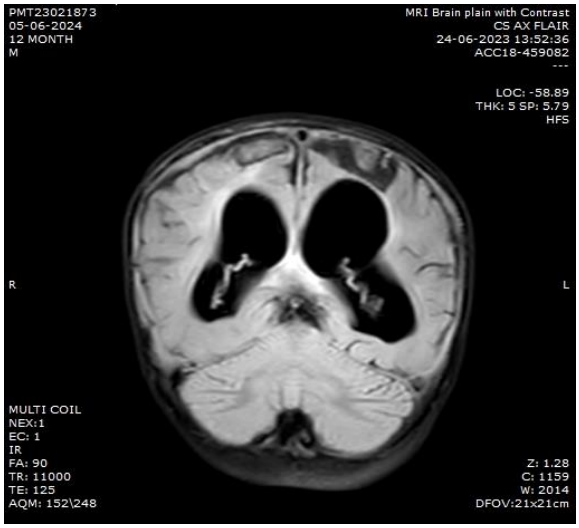


There is e/o area of altered signal intensity noted in the splenium of corpus callosum, showing diffusion restriction on DWI images with low ADC values and appearing hyperintense on T2W images, s/o CLOCS (Cytotoxic Lesion of Corpus Callosum)







There is e/o dilatation of the bilateral lateral ventricles, third ventricle, fourth ventricle with dangling choroid plexus sign noted in bilateral lateral ventricles, s/o Hydrocephalus.

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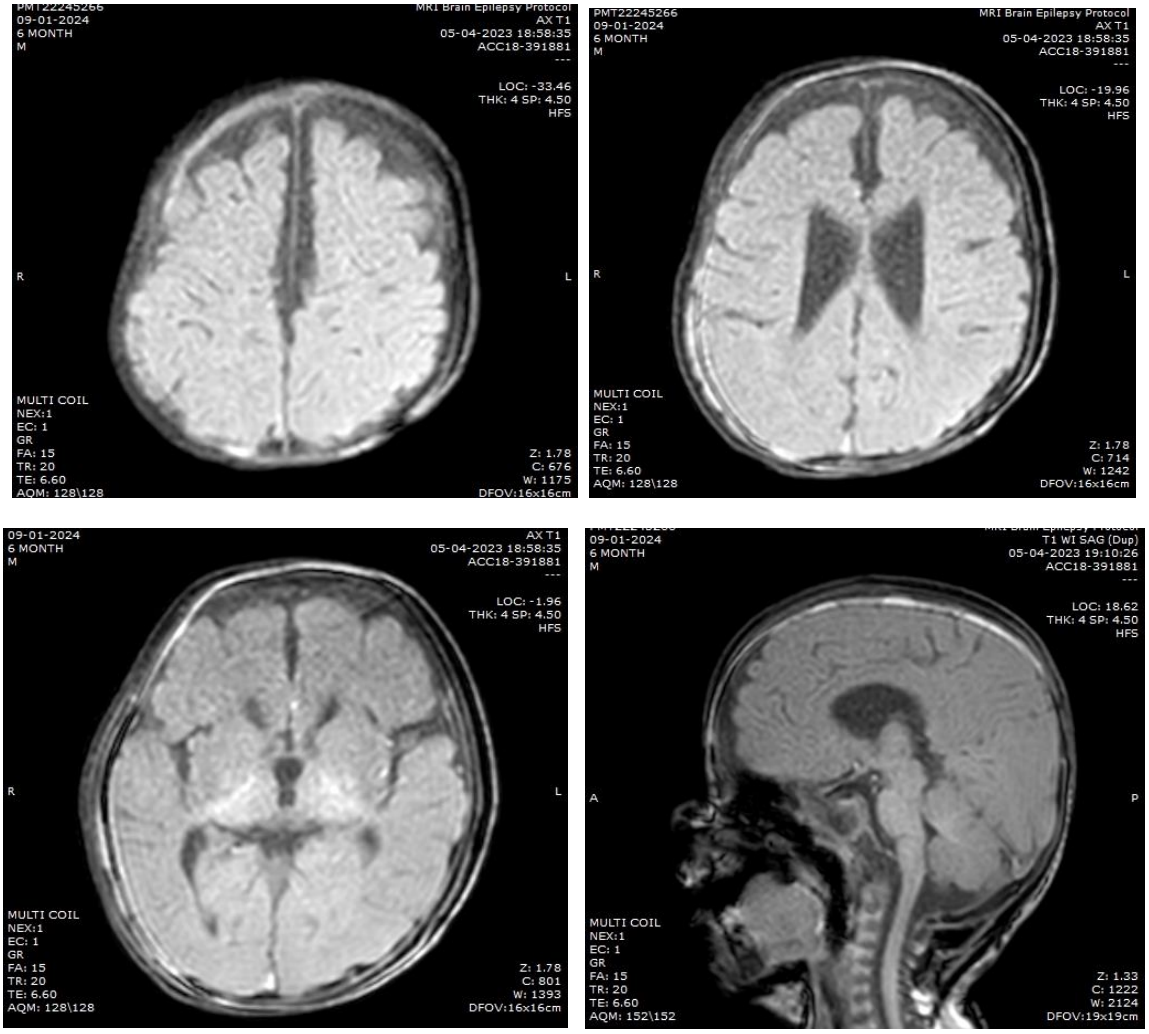

There is e/o prominent sulcal spaces noted in the bilateral frontal lobes, s/o Cortical atrophy with delayed myelination for age.

Table 1: Age and Gender Distribution

	Gender	0-5 Years	6-10 Years	11-15 Years	16-20 Years
Normal	Male	5	3	4	6
	Female	6	4	3	6
Structural Abnormality	Male	4	0	1	0
	Female	3	1	1	1
CLOCs	Male	0	1	0	0
	Female	0	1	0	0
Subdural Hygroma	Male	5	0	0	0
	Female	0	0	0	0
HIE	Male	10	0	0	0
	Female	4	2	1	0
MTS	Male	0	0	0	1
	Female	0	0	0	0
Area of Gliosis	Male	1	2	0	0
	Female	0	0	0	1
Infarcts	Male	0	1	1	0
	Female	1	1	1	1
Others	Male	0	2	1	1
	Female	2	0	1	1

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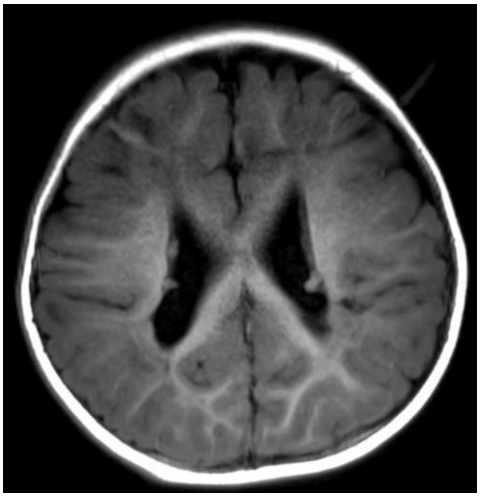
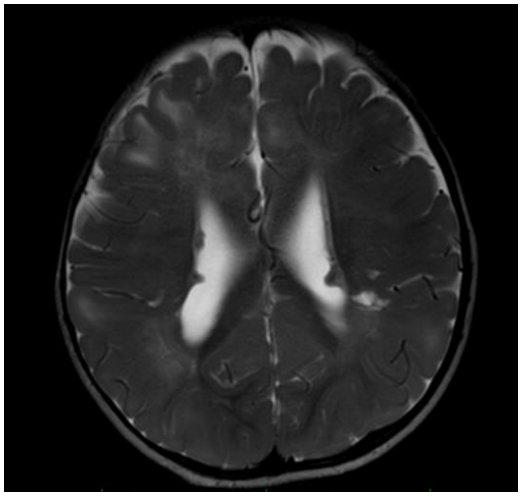
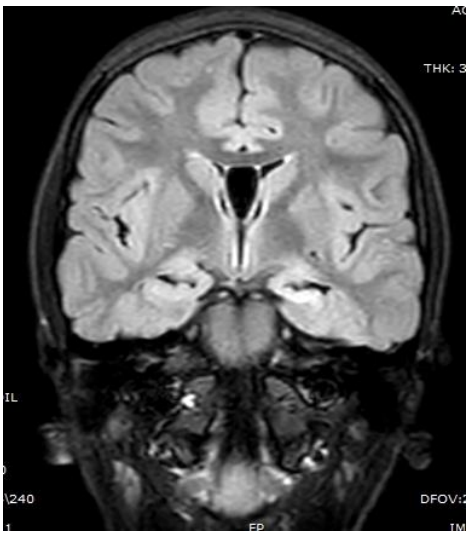
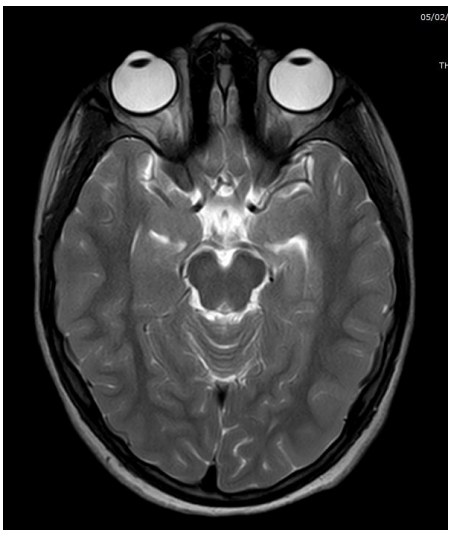
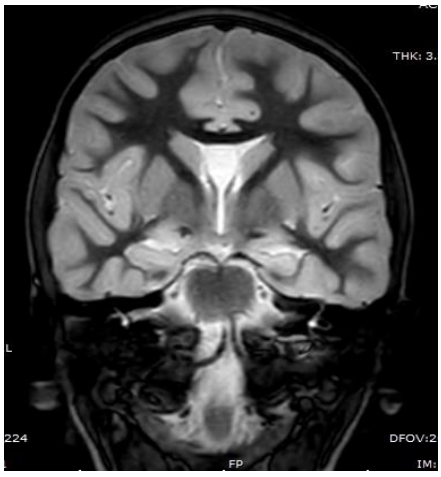



There are multiple patchy areas of altered signal intensities noted in subcortical regions of the right frontal lobe, appearing hypointense on T1W images and hyperintense on T2W images, s/o Cortical tubers. There are multiple subependymal nodules noted along the ventricular walls of bilateral lateral ventricles, appearing hyperintense on T1W images, iso to hypointense on T2W images, s/o Subependymal nodules/ hamartomas.







There is e/o altered signal intensity involving the left hippocampal gyrus, appearing hyperintense on FLAIR images with reduced volume and altered morphology noted. There is mild dilatation of the left temporal horn. Findings s/o Left Mesial temporal sclerosis.

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DISCUSSION

The present study aimed to investigate the prevalence and describe the structural brain abnormalities causing seizure disorders in the pediatric population within a rural setting. The analysis involved 86 pediatric patients with seizure disorders, who underwent comprehensive MRI evaluations using advanced imaging protocols. The findings reveal a diverse range of structural abnormalities, underscoring the complexity and varied etiology of seizure disorders in children [5, 6].

The study identified several types of structural brain abnormalities among the pediatric patients, with gliosis, hydrocephalus, cortical atrophy, and various congenital malformations being predominant. The presence of gliosis with cystic encephalomalacia and ex vacuo dilatation of the right lateral ventricle in the right fronto-temporal lobe, noted in multiple cases, emphasizes the significant role of brain injuries and malformations in the etiology of seizures. These abnormalities are characterized by hypointense regions with hyperintense rims on FLAIR images and hyperintense signals on T2W images, which are indicative of chronic changes post-injury [7, 8].

The detection of hypoplastic genu and rostrum of the corpus callosum, along with cytotoxic lesions of the corpus callosum (CLOCS), highlights the congenital and acquired structural changes contributing to seizure disorders. CLOCS were specifically noted in the splenium of the corpus callosum, presenting with diffusion restriction on DWI images and low ADC values, a hallmark of cytotoxic edema.

Hydrocephalus, observed as the dilatation of bilateral lateral ventricles with the dangling choroid plexus sign, further underscores the role of cerebrospinal fluid dynamics in seizure pathogenesis. This condition, marked by prominent sulcal spaces in the frontal lobes and cortical atrophy, often correlates with developmental delays and seizure activity due to increased intracranial pressure and altered brain structure [9].

Age and Gender Distribution

The age and gender distribution of structural abnormalities provides insights into the demographic characteristics of pediatric seizure disorders. Notably, structural abnormalities were more prevalent in the younger age groups, particularly among males aged 0-5 years. This trend suggests that congenital and early developmental issues are significant contributors to seizure disorders in this demographic. The presence of structural abnormalities decreases with age, reflecting the potential for some children to outgrow certain conditions or the impact of early interventions.

In terms of gender, males showed a higher incidence of structural abnormalities compared to females, particularly in the youngest age group. This finding aligns with existing literature suggesting that males may be more susceptible to certain neurodevelopmental disorders. However, conditions such as subdural hygroma and hypoxic-ischemic encephalopathy (HIE) were also prevalent, with HIE notably affecting both genders but predominantly males in the 0-5 years category.

Specific Structural Findings

The presence of cortical tubers and subependymal nodules in the subcortical regions and ventricular walls, respectively, points towards neurocutaneous syndromes like tuberous sclerosis complex (TSC), which are known to be associated with seizures. These findings, characterized by hypointense signals on T1W images and hyperintense on T2W images, highlight the importance of recognizing these specific syndromes in pediatric patients with seizures for timely diagnosis and management.

Mesial temporal sclerosis (MTS), identified in the left hippocampal gyrus with features like hyperintense signals on FLAIR images and reduced hippocampal volume, is another significant finding. MTS is a well-recognized cause of refractory epilepsy, often necessitating surgical intervention. The presence of MTS underscores the need for detailed imaging in patients with drug-resistant seizures to identify potential candidates for surgical treatment.

Clinical Implications

The findings from this study have important clinical implications. The diverse range of structural abnormalities necessitates a comprehensive and systematic approach to the evaluation of pediatric seizure disorders. Early and accurate identification of these abnormalities through advanced MRI protocols can significantly impact the management and prognosis of affected children. For instance, detecting conditions like MTS or hydrocephalus early can guide appropriate surgical or medical interventions, potentially improving seizure control and neurodevelopmental outcomes.

Moreover, understanding the prevalence and types of structural abnormalities can aid in the development of targeted public health strategies, particularly in rural settings where access to advanced neuroimaging and specialized care may be limited. Establishing protocols for early screening and referral can help mitigate the long-term impact of seizure disorders on pediatric patients.

CONCLUSION

This study underscores the critical role of structural brain abnormalities in pediatric seizure disorders. The findings highlight the importance of advanced neuroimaging in diagnosing and managing these conditions, thereby enhancing clinical outcomes and quality of life for affected children. Future research should focus on longitudinal studies to further elucidate the natural history and progression of these structural abnormalities and their impact on seizure control and neurodevelopment.

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