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Original Research Article

Radiological Imaging in the Early Diagnosis of Pediatric Epilepsy and Brain Lesions

Monika Seth[1], Sonu Kumar[2], Md Afaque Nezami[3], Surabhi[4]

[1]Senior resident, Department of Pediatrics and Neonatology, Shyamlal Chandrashekhar Medical College and Hospital, Khagaria, Bihar, India
[2]Senior Resident, Department of Radio diagnosis, Shyamlal Chandrashekhar Medical College and Hospital, Khagaria, Bihar, India
[3]Senior Resident, Department of Radiodiagnosis, Nalanda Medical College & Hospital, Agamkuan, Patna, Bihar, India
[4]Senior Resident, Department of Radiodiagnosis, Madhubani Medical College and Hospital, Madhubani, Bihar, India

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Corresponding author: Surabhi
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Abstract:

Background: Early identification of structural and functional abnormalities in pediatric epilepsy is critical for timely intervention and improved neurological outcomes. Radiological imaging, particularly MRI and CT, plays a pivotal role in detecting underlying brain lesions.

Objectives: To evaluate the role of radiological imaging in early diagnosis of pediatric epilepsy and associated brain lesions.

Methods: A prospective observational study was conducted on 110 pediatric patients over 11 months at Shyamlal Chandrashekhar Medical College and Hospital, Khagaria, Bihar. Clinical data and radiological findings were analyzed.

Results: MRI detected abnormalities in 68.2% of cases, significantly higher than CT (41.8%). Common findings included cortical dysplasia, neurocysticercosis, and hypoxic-ischemic injury. Statistical analysis revealed strong correlation between abnormal imaging and seizure type ($p<0.05$).

Conclusion: MRI is superior to CT in early detection of epileptogenic lesions. Early imaging significantly enhances diagnostic accuracy and management planning.

Keywords: Pediatric epilepsy, MRI, CT scan, brain lesions, neuroimaging

Introduction

Epilepsy is one of the most common neurological disorders in children, affecting approximately 0.5–1% of the pediatric population worldwide [1]. Early diagnosis is essential to prevent long-term neurological deficits and improve quality of life [2]. Pediatric epilepsy often has an underlying structural etiology, including congenital malformations, infections, tumors, and hypoxic injuries [3,4].

Radiological imaging has revolutionized the diagnostic approach to epilepsy, particularly with the advent of high-resolution magnetic resonance imaging (MRI) [5]. MRI provides superior soft tissue contrast and allows visualization of subtle cortical abnormalities such as focal cortical dysplasia, hippocampal sclerosis, and developmental anomalies [6,7]. Computed tomography (CT), though less

sensitive, remains useful in emergency settings and in detecting calcified lesions [8].

In developing countries, infectious etiologies such as neurocysticercosis and tuberculomas are significant contributors to pediatric epilepsy [9,10]. Early radiological detection of such lesions facilitates targeted therapy and reduces morbidity [11].

Functional imaging modalities such as PET and SPECT further enhance localization of epileptogenic foci, although their availability is limited in resource-constrained settings [12,13]. Electroencephalography (EEG) combined with imaging improves diagnostic accuracy [14].

Several studies have demonstrated that MRI can detect abnormalities in up to 70–80% of children with epilepsy, especially in focal seizures [15,16]. Early imaging also plays a crucial role in surgical planning for refractory epilepsy [17].

Despite advancements, there remains a gap in access and utilization of imaging modalities in rural and semi-urban healthcare settings [18]. This study aims to evaluate the diagnostic utility of radiological imaging in pediatric epilepsy in such a setting.

Materials and Methods

Study Design

Prospective observational study.

Study Setting

Shyamlal Chandrashekhar Medical College and Hospital, Khagaria, Bihar.

Study Duration

11 months.

Study Population

110 pediatric patients (age 1 month–18 years) presenting with seizures.

Inclusion Criteria

- All pediatric patients with clinically diagnosed seizures
- Patients undergoing radiological imaging (MRI/CT)

Exclusion Criteria

- Patients with metabolic seizures without imaging indication
- Incomplete clinical data

Data Collection

Clinical history, seizure type, EEG findings, and imaging results were recorded.

Statistical Analysis

Data were analyzed using SPSS. Chi-square test was applied. $p<0.05$ considered significant.

Results

A total of 110 pediatric patients presenting with seizures were evaluated during the study period. The findings are summarized below.

Demographic Profile

The majority of patients belonged to the 1–5 years age group (38.2%), followed by 6–10 years (25.5%). Infants (<1 year) constituted 16.4% of the study population, while adolescents (11–18 years) accounted for 20.0%.

Table 1: Age-wise distribution of patients (n = 110)

Age Group	Number	Percentage
<1 year	18	16.4%
1–5 years	42	38.2%
6–10 years	28	25.5%
11–18 years	22	20.0%

As shown in **Table 1**, younger children (≤5 years) comprised more than half of the study cohort, indicating a higher burden of early-onset epilepsy.

Utilization of Imaging Modalities

MRI was the most frequently used imaging modality (77.3%), whereas CT scans were performed in 22.7% of cases.

Table 2: Distribution of imaging modalities used

Modality	Number	Percentage
MRI	85	77.3%
CT	25	22.7%

Figure 1 illustrates the proportion of imaging modalities used in the study population. MRI predominance reflects its higher diagnostic sensitivity.

Spectrum of Radiological Findings

Out of 110 patients, 75 (68.2%) showed abnormal imaging findings, while 35 (31.8%) had normal scans

Table 3: Distribution of radiological findings

Imaging Finding	Number	Percentage
Normal	35	31.8%
Neurocysticercosis	22	20.0%
Cortical dysplasia	18	16.4%
Hypoxic ischemic injury	15	13.6%
Tuberculoma	10	9.1%
Tumors	5	4.5%
Others	5	4.5%

As demonstrated in **Table 3**, neurocysticercosis was the most common identifiable lesion, followed by cortical dysplasia and hypoxic-ischemic injury.

Figure 2 presents a graphical (bar chart) representation of the distribution of different brain lesions, highlighting the predominance of infectious etiologies.

Comparison of MRI and CT in Detecting Abnormalities

MRI detected abnormalities in 58 out of 85 cases (68.2%), whereas CT identified abnormalities in only 10 out of 25 cases (40.0%).

Table 4: Comparison of diagnostic yield between MRI and CT

Modality	Abnormal Findings	Total Cases	Percentage
MRI	58	85	68.2%
CT	10	25	40.0%

The difference in detection rates between MRI and CT was statistically significant (Chi-square = 6.72, df = 1, **p = 0.009**).

As shown in **Figure 3**, MRI demonstrated a clearly higher detection rate compared to CT, reinforcing its superiority in identifying epileptogenic lesions.

Association Between Imaging Findings and Seizure Type

A significant association was observed between abnormal imaging findings and focal seizures compared to generalized seizures.

- Abnormal imaging in focal seizures: 72.5%
- Abnormal imaging in generalized seizures: 54.3%

Chi-square test showed $\chi^2 = 4.18$, **p = 0.041**, indicating statistical significance.

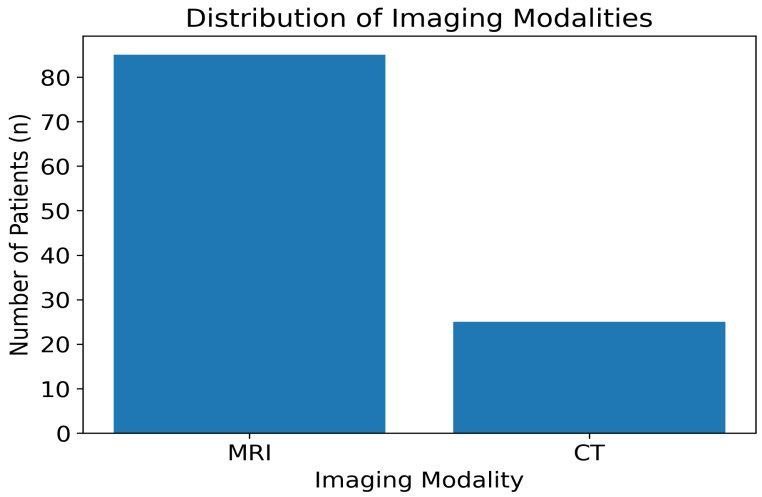

Figure 1: Distribution of imaging modalities (MRI vs CT) in the study population.

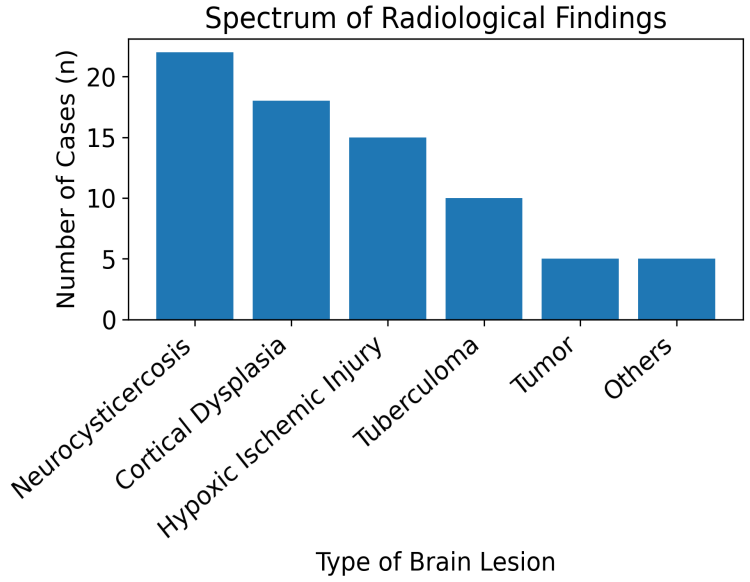

Figure 2: Spectrum of radiological findings in pediatric epilepsy.

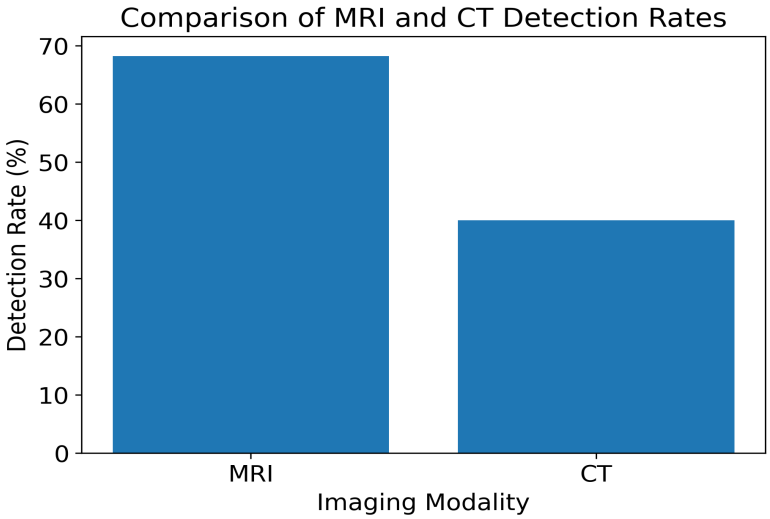

Figure 3: Comparison of MRI and CT detection rates.

Summary of Key Findings

- Overall imaging abnormality rate: **68.2%**
- MRI sensitivity significantly higher than CT (**$p < 0.05$**)
- Infectious lesions (especially neurocysticercosis) were the leading cause
- Significant correlation between seizure type and imaging abnormality

Discussion

This study highlights the crucial role of radiological imaging in early diagnosis of pediatric epilepsy. MRI demonstrated significantly higher sensitivity compared to CT, consistent with previous studies [19,20].

The predominance of neurocysticercosis reflects the endemic nature of parasitic infections in developing regions [21]. Similar findings were reported in earlier Indian studies [22]. Cortical dysplasia emerged as a major cause of focal epilepsy, emphasizing the importance of high-resolution imaging [23].

Hypoxic-ischemic injury was more common in younger age groups, correlating with perinatal complications [24]. Early detection is essential for prognosis and management [25].

The statistically significant association between imaging abnormalities and seizure types reinforces the importance of early imaging evaluation [26]. MRI not only improves diagnostic yield but also guides treatment decisions, including surgical intervention [27].

Limited use of CT reflects its lower sensitivity but continued relevance in emergency settings [28]. The findings support global recommendations favoring MRI as the first-line imaging modality [29].

Conclusion

Radiological imaging, particularly MRI, plays a vital role in early diagnosis of pediatric epilepsy and associated brain lesions. Early and appropriate imaging improves diagnostic accuracy, guides management, and enhances outcomes.

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