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# EVALUATION OF 3 TESLA MAGNETIC RESONANCE IMAGING FINDINGS OF THE BRAIN IN PAEDIATRIC PATIENTS PRESENTING WITH FIRST UNPROVOKED AFEBRILE SEIZURES

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ABSTRACT

**Background:** Seizures are among the most common neurological presentations in childhood and may result from a broad spectrum of structural, infectious, genetic, immune, metabolic, and unknown causes. Magnetic resonance imaging is a preferred neuroimaging modality because it provides superior soft-tissue contrast, multiplanar imaging, high spatial resolution, and no ionizing radiation.
**Materials and Methods:** This hospital-based cross-sectional observational study included 118 paediatric patients aged day 0 to 14 years who presented for the first time with unprovoked afebrile seizures at a tertiary care hospital in Greater Noida. The study duration was 18 months. All eligible children underwent brain MRI using a 3 Tesla Philips Achieva scanner with an epilepsy-focused imaging protocol. Demographic details, birth history, seizure type, MRI findings, and etiological categories were recorded. Data were summarized as frequencies and percentages.
**Results:** Among 118 children, 77 were male and 41 were female. Term delivery was recorded in 86 children and preterm delivery in 32 children. Generalized-onset seizures were the most common seizure type, observed in 82 children, followed by focal-onset seizures in 34 children and absence seizures in 2 children. MRI brain findings were abnormal in 46 children and normal in 72 children, giving an abnormal MRI yield of 39.0%. The most common abnormal MRI finding was inflammatory granuloma, observed in 13 cases. Hypoxic-ischemic encephalopathy spectrum findings were observed in 12 cases, including encephalomalacia in 8 cases, periventricular leukomalacia in 3 cases.
**Conclusion:** Brain MRI detected abnormalities in 39.0% of paediatric patients presenting with first unprovoked afebrile seizures. Inflammatory granuloma was the most frequent MRI diagnosis, followed by hypoxic-ischemic encephalopathy spectrum changes. 3 Tesla MRI is a valuable non-invasive modality for identifying the spectrum of brain abnormalities in paediatric seizure evaluation.
**Keywords:** Paediatric seizures; Magnetic resonance imaging; 3 Tesla MRI; Afebrile seizures; Inflammatory granuloma; Hypoxic-ischemic encephalopathy.

## INTRODUCTION

A seizure is defined as a transient occurrence of signs or symptoms resulting from abnormal excessive or synchronous neuronal activity in the brain. The International League Against Epilepsy defines epilepsy as the occurrence of two or more unprovoked seizures occurring more than 24 hours apart, one unprovoked seizure with a probability of

further seizures similar to the general recurrence risk, or diagnosis of an epilepsy syndrome.[1]

Seizures in children represent an important neurological presentation and may result from structural, infectious, metabolic, genetic, immune, and unknown causes. Identification of the underlying cause is important for diagnosis, prognostication, treatment planning, and clinical follow-up. Structural neuroimaging is particularly useful in children with recent-onset epilepsy, localization-related seizures, abnormal neurological examination, developmental delay, uncontrolled seizures, or clinically atypical seizure features.[2,3]

Magnetic resonance imaging has become central to epilepsy evaluation because of its high soft-tissue contrast, multiplanar imaging capability, high spatial resolution, and absence of ionizing radiation. MRI is more sensitive than computed tomography for many epileptogenic lesions, including mesial temporal sclerosis, malformations of cortical development, gliosis, small tumors, and subtle structural abnormalities.[3,4] The use of 3 Tesla MRI improves lesion detection compared with 1.5 Tesla imaging in selected epilepsy populations.[5]

The spectrum of MRI abnormalities in paediatric seizure evaluation varies across regions according to age distribution, infectious burden, perinatal factors, socioeconomic factors, access to healthcare, and availability of advanced imaging. Regional data from tertiary care settings are clinically relevant because they may influence diagnostic yield, radiological suspicion, and management planning.

This study evaluated the spectrum and frequency of brain abnormalities detected on 3 Tesla MRI in children presenting with first unprovoked afebrile seizures.

## MATERIALS AND METHODS

**Study design and setting:** This was a hospital-based cross-sectional observational study conducted in the Department of Radiodiagnosis at a tertiary care hospital in Greater Noida.

**Study duration:** The study was conducted over a period of 18 months.

**Study population:** The study population comprised paediatric patients who presented to the outpatient or inpatient departments for MRI brain evaluation of seizures.

**Inclusion criteria**

All children aged day 0 to 14 years presenting for the first time with unprovoked afebrile seizures were included.

**Exclusion criteria**

Patients were excluded if they had simple febrile seizures, a previous history of treatment for seizures, syncopal attacks, hypoglycemic attacks, pseudo-seizures, drug-induced seizures, head injury, or contraindications to MRI.

**Sample size:** The study included 118 cases.

**Sampling method:** All eligible children fulfilling the inclusion criteria during the study period were included.

**Clinical evaluation and data collection:** A detailed history of the seizure event, preictal period, ictal phenomena, and postictal events was recorded. Neurological examination was performed, including assessment for dysmorphism, neurocutaneous markers, focal neurological deficits, and associated comorbid conditions.

**MRI examination:** All children underwent MRI brain using a 3 Tesla epilepsy protocol on a Philips Achieva 3.0 Tesla scanner. Patients were screened before entry into the MRI room for ferromagnetic objects, cardiac pacemakers, aneurysm clips, and other contraindications. Imaging was performed in the supine position using a head coil after appropriate positioning and immobilization of the head.

**MRI protocol:** The MRI seizure protocol included imaging of the entire brain from nasion to inion. The sequences included DWI and ADC mapping with TR/TE 3180/95 ms; axial FLAIR with TR/TE 11000/120 ms, slice thickness 3.5 mm, FOV 230 mm; axial T2-weighted imaging with TR/TE 3000/80 ms, slice thickness 3.5 mm, FOV 230 mm; axial T1-weighted imaging with TR/TE 608/10 ms, slice thickness 3.5 mm, 24 slices, FOV 230 mm; SWI with TR/TE 31/7.7 ms, slice thickness 1 mm, FOV 230 mm, flip angle 17 degrees; coronal T2-weighted imaging with TR/TE 3000/80 ms, slice thickness 3.5 mm, FOV 230 mm; sagittal T2-weighted imaging with TR/TE 3000/80 ms, slice thickness 3.5 mm, FOV 230 mm; oblique coronal T1 inversion recovery with TR/TE 2500/15 ms, slice thickness 3.5 mm, FOV 230 mm; and 3D T1-weighted imaging with TR/TE 27/1.8 ms, slice thickness 3 mm, FOV 230 mm, flip angle 30 degrees.

Depending on non-contrast MRI findings or clinical suspicion, post-gadolinium enhanced MRI was performed in selected patients using T1-weighted and FLAIR sequences in axial and sagittal planes. The gadolinium dose was 0.1 mmol/kg.

**Sedation protocol:** Younger children below 7 years who required sedation were sedated by a dedicated paediatric sedation or anesthesia team. Infants and younger children were sedated using syrup pedicloryl 50 mg/kg before imaging. In children inadequately sedated with pedicloryl, intravenous midazolam 0.1 mg/kg/dose was used under strict paediatric anesthesia supervision and monitoring. Cooperative older children underwent imaging without sedation. Resuscitation equipment and emergency medications were kept readily available during sedation.

**Outcome measures:** The primary outcome was the frequency of abnormal MRI brain findings among paediatric patients presenting with first unprovoked afebrile seizures. Secondary outcomes included the spectrum of MRI diagnoses and etiological classification of MRI abnormalities.

**Statistical analysis:** Data were summarized using frequencies and percentages.

**Ethical considerations:** The study was conducted after approval from the Institutional Ethical Committee.

## RESULTS

**Baseline demographic and birth characteristics:** A total of 118 paediatric patients aged day 0 to 14 years presenting with first unprovoked afebrile seizures were included. The largest age group was 12-14 years, comprising 35 patients, followed by 7-9 years and 10-12 years with 22 patients each. The 4-6-year age group included 20 patients, and the 1-3-year age group included 19 patients. There were 77 male children and 41 female children. Term delivery was recorded in 86 children, while 32 children had a history of preterm delivery.

**Table 1: Baseline demographic and birth characteristics of the study population**

| Characteristic | Category | Frequency | Percentage |
|---|---|---|---|
| Age group | 1-3 years | 19 | 16.1 |
| | 4-6 years | 20 | 16.9 |
| | 7-9 years | 22 | 18.6 |
| | 10-12 years | 22 | 18.6 |
| | 12-14 years | 35 | 29.7 |
| Gender | Male | 77 | 65.3 |
| | Female | 41 | 34.7 |
| Birth history | Term delivery | 86 | 72.9 |
| | Preterm delivery | 32 | 27.1 |
| Total | | 118 | 100.0 |

**Seizure type distribution:** Generalized-onset seizures were the most common seizure type and were observed in 82 patients. Focal-onset seizures were observed in 34 patients, and absence seizures were observed in 2 patients.

**Table 2: Distribution of seizure types among study participants**

| Seizure type | Frequency | Percentage |
|---|---|---|
| Generalized-onset seizure | 82 | 69.5 |
| Focal-onset seizure | 34 | 28.8 |
| Absence seizure | 2 | 1.7 |
| Total | 118 | 100.0 |

**MRI diagnostic yield:** MRI brain findings were normal in 72 patients and abnormal in 46 patients. The abnormal MRI diagnostic yield was 39.0%.

**Table 3: MRI diagnostic status among study participants**

| MRI diagnosis | Frequency | Percentage |
|---|---|---|
| Normal | 72 | 61.0 |
| Abnormal | 46 | 39.0 |
| Total | 118 | 100.0 |

**MRI findings according to age group and seizure type:** Among 46 patients with abnormal MRI findings, the largest proportion belonged to the 12-14-year age group. Generalized-onset seizures were the most common seizure type among patients with abnormal MRI findings and were observed in 33 of 46 patients.

**Table 4: Distribution of MRI diagnostic status according to age group and seizure type**

| Variable | Category | Normal MRI, n (%) | Abnormal MRI, n (%) | Total |
|---|---|---|---|---|
| Age group | 1-3 years | 12 (16.7) | 7 (15.2) | 19 |
| | 4-6 years | 13 (18.1) | 7 (15.2) | 20 |
| | 7-9 years | 13 (18.1) | 9 (19.6) | 22 |
| | 10-12 years | 14 (19.4) | 8 (17.4) | 22 |
| | 12-14 years | 20 (27.8) | 15 (32.6) | 35 |
| Seizure type | Generalized-onset seizure | 49 (68.1) | 33 (71.7) | 82 |
| | Focal-onset seizure | 22 (30.6) | 12 (26.1) | 34 |
| | Absence seizure | 1 (1.4) | 1 (2.2) | 2 |
| Total | | 72 (100.0) | 46 (100.0) | 118 |

**Spectrum of MRI brain findings:** Inflammatory granuloma was the most common abnormal MRI finding and was observed in 13 patients. Hypoxic-ischemic encephalopathy spectrum findings were observed in 12 patients, including encephalomalacia in 8 patients, periventricular leukomalacia in 3 patients, and diffuse brain edema in 1 patient. Tuberous sclerosis, partial agenesis of the corpus callosum, and diffuse cerebral atrophy were each observed in 3 patients. Non-specific T2/FLAIR hyperintense areas, mesial temporal sclerosis, and subependymal grey matter heterotopias were each

observed in 2 patients. Low-grade tumor, ADEM, meningoencephalocele, demyelination, and communicating hydrocephalus were each observed in 1 patient.

**Table 5: Spectrum of MRI brain findings in paediatric patients presenting with seizures**

| MRI brain diagnosis | Frequency | Percentage |
|---|---|---|
| Normal study | 72 | 61.0 |
| Inflammatory granuloma | 13 | 11.0 |
| Encephalomalacia | 8 | 6.7 |
| Periventricular leukomalacia | 3 | 2.5 |
| Diffuse brain edema | 1 | 0.8 |
| Tuberous sclerosis | 3 | 2.5 |
| Partial agenesis of the corpus callosum | 3 | 2.5 |
| Diffuse cerebral atrophy | 3 | 2.5 |
| Non-specific T2/FLAIR hyperintense areas | 2 | 1.6 |
| Mesial temporal sclerosis | 2 | 1.6 |
| Subependymal grey matter heterotopias | 2 | 1.6 |
| Low-grade tumor, DNET/Gangliocytoma | 1 | 0.8 |
| ADEM | 1 | 0.8 |
| Meningoencephalocele | 1 | 0.8 |
| Demyelination | 1 | 0.8 |
| Communicating hydrocephalus | 1 | 0.8 |
| Other/unspecified abnormal MRI finding | 1 | 0.8 |
| Total | 118 | 100.0 |

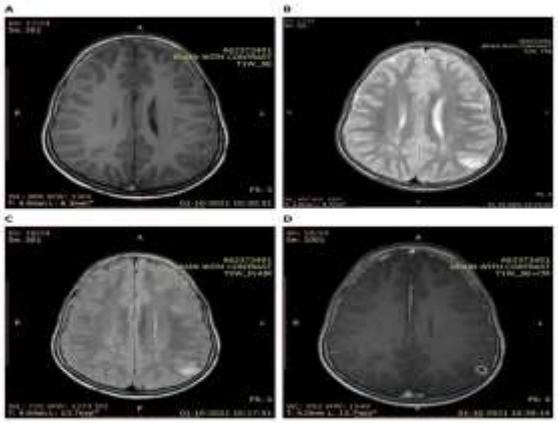

**Figure 1: MRI findings of inflammatory granuloma.**

A 12-year-old male child with abnormal body movements followed by loss of consciousness. (A)Axial T1-weighted image shows a well-defined hypointense lesion in the left occipital lobe. (B)Axial T2-weighted image shows a hyperintense lesion with surrounding edema. (C)FLAIR images demonstrate partial suppression with mild perilesional edema. (D)Post-contrast T1-weighted image shows ring enhancement, suggestive of inflammatory granuloma.

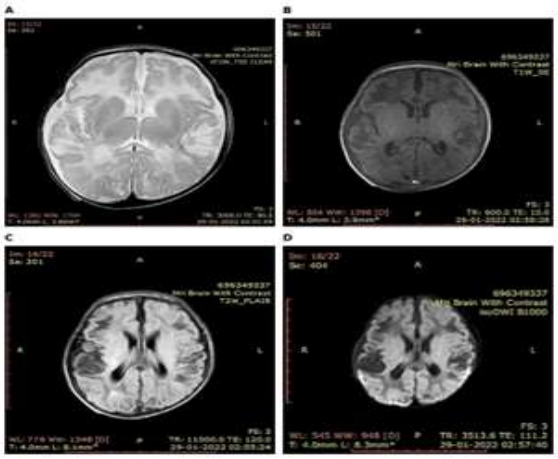

**Figure 2. MRI findings of hypoxic-ischemic encephalopathy.**

A 1-year-old child with multiple episodes of abnormal body movements since birth. (A-D)Axial T2-weighted , T1-weighted ,FLAIR and DWI images show diffuse cerebral atrophy with encephalomalacia involving bilateral frontal and temporal lobes, prominent gyri, sulci, and lateral ventricles, with paucity of bilateral parieto-occipital white matter.

**Figure 3: Representative MRI findings of meningoencephalocele.**

A 13-year-old male child with bilateral limb stiffening and abnormal body movements. (A,B) T2-weighted axial and coronal STIR images show herniation of meninges with right temporal lobe parenchyma through the foramen ovale into the right masticator space, suggestive of meningoencephalocele.

**Figure 4. Representative MRI findings of partial agenesis of the corpus callosum with subependymal heterotopias.**

A 4-year-old male child with abnormal body movements and limb stiffening.(A)Sagittal T2-weighted image shows poorly developed rostrum and splenium of the corpus callosum. (B) Coronal T1 inversion recovery image shows multiple subependymal nodules along the floor of the lateral ventricles following grey matter signal intensity, suggestive of subependymal heterotopias.

Etiological classification of abnormal MRI findings

Among patients with abnormal MRI findings, structural abnormalities were the most common etiological category, accounting for 20 cases. Infectious etiology was seen in 13 cases, genetic etiology in 9 cases, unknown etiology in 3 cases, and immune etiology in 1 case. No metabolic etiology was recorded.

**Table 6: Etiological classification of abnormal MRI findings**

| Etiological category | Frequency | Percentage among abnormal MRI findings |
|---|---|---|
| Structural | 20 | 43.0 |
| Infectious | 13 | 28.0 |
| Genetic | 9 | 20.0 |
| Unknown | 3 | 7.0 |
| Immune | 1 | 2.0 |
| Metabolic | 0 | 0.0 |
| Total | 46 | 100.0 |

## DISCUSSION

This hospital-based cross-sectional study evaluated 118 paediatric patients presenting with first unprovoked afebrile seizures using 3 Tesla MRI brain imaging. MRI abnormalities were detected in 46 children, giving a diagnostic yield of 39.0%. The most common seizure type was generalized-onset seizure. The most frequent abnormal MRI diagnosis was inflammatory granuloma, followed by hypoxic-ischemic encephalopathy spectrum changes. Structural abnormalities formed the largest etiological category among abnormal MRI findings. These findings support the role of MRI as a clinically useful modality in the evaluation of children with seizures, particularly because MRI can identify structural and potentially treatable abnormalities that may not be evident on clinical assessment alone.

The abnormal MRI yield of 39.0% in this study is comparable with several paediatric seizure imaging studies. Sharma et al. evaluated children with new-onset afebrile seizures and reported abnormal neuroimaging in a smaller proportion of cases.6 Kalnin et al. reported MRI abnormalities in 31% of children with a first recognized seizure.[7] Hsieh et al. reported a higher yield in infants with new-onset afebrile seizures, reflecting the higher prevalence of cerebral dysgenesis and early-life structural abnormalities in that age group.[8]

Inflammatory granuloma was the most common abnormal MRI finding in this study. Similar findings have been reported in Indian paediatric seizure imaging studies. Sahdev et al. identified inflammatory granuloma as a leading imaging abnormality in children with seizures.[9] Mathur et al. also reported inflammatory granuloma among the most common MRI abnormalities in paediatric seizure evaluation.[10] Mundhe and Kombade observed infectious etiology as a major contributor to MRI abnormalities in paediatric epilepsy at a tertiary hospital.[11]

Hypoxic-ischemic encephalopathy spectrum changes were the second most common group of abnormalities in this study. Encephalomalacia was observed in 8 cases. Comparable findings have been described by Alam-Eldeen and Hasan and by Samia et al., who reported encephalomalacia among MRI abnormalities in paediatric epilepsy cohorts.[12,13]

Tuberous sclerosis was observed in 3 cases. Similar proportions have been described in paediatric seizure imaging studies by Khandediya et al. and Sharma et al.[6,14] Mesial temporal sclerosis was observed in 2 cases, comparable with observations reported by Raj and Dhande and by Ali et al.[15,16] Subependymal grey matter heterotopias were observed in 2 cases, similar to findings reported by Chaurasia et al., Dirik and Sanlidag, and Minh Xuan et al.[17-19]

The findings indicate that a substantial proportion of children presenting with first unprovoked afebrile seizures have identifiable MRI abnormalities. The predominance of inflammatory granuloma reflects the importance of regional infectious and inflammatory etiologies in paediatric seizure evaluation. Detection of structural lesions such as mesial temporal sclerosis, corpus callosum abnormalities, heterotopias, low-grade tumor, and meningoencephalocele may influence clinical management, follow-up planning, and referral decisions.

The use of a 3 Tesla MRI epilepsy protocol may improve visualization of subtle structural abnormalities. In paediatric patients, the absence of ionizing radiation further supports MRI as an important imaging modality when clinically indicated.

**Strengths and Limitations**

The strengths of this study include the use of 3 Tesla MRI in a defined paediatric population presenting with first unprovoked afebrile seizures, application of an epilepsy-focused MRI protocol, and evaluation of a broad spectrum of MRI diagnoses.

The limitations include the single-center hospital-based design, absence of long-term clinical outcome correlation, and limited electroencephalographic correlation analysis.

## CONCLUSION

3 Tesla MRI detected brain abnormalities in 39.0% of pediatric patients presenting with first unprovoked afebrile seizures. Inflammatory granuloma was the most common abnormal MRI finding, followed by hypoxic-ischemic encephalopathy spectrum changes. Structural abnormalities represented the most frequent etiological category among abnormal MRI findings. MRI brain imaging is a useful non-invasive tool for identifying brain abnormalities in children presenting with seizures.

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