



MRI Evaluation of Seizures in Pediatric Age Group Patients in a Rural Hospital of Central India

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Authors' contributions

This work was carried out in collaboration between both authors. Author NR wrote the protocol and wrote the first draft of the manuscript. Author RD designed the study and guided with the literature searches. Both authors read and approved the final manuscript.

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Study Protocol

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ABSTRACT

Background: Seizures are a common presenting complaint in pediatric patients. There are many underlying causes which may present as seizures in pediatric population, for example: febrile seizures, hypoxic ischemic encephalopathy, congenital malformations, certain neoplasms etc. Magnetic resonance imaging(MRI) plays a fundamental role in evaluation of these causes and is especially of use in identifying the structural lesions presenting as seizures.

Objectives: To assess the role of MRI(1.5 Tesla) in evaluation pediatric seizures and to study spectrum of MRI findings associated with various causes.

Methodology: A prospective study will be conducted at "Acharya Vinoba Bhave Rural Hospital, Sawangi", involving 138 pediatric patients coming to Radiology department.

Results: After statistical analysis, we expect to find effectiveness of MRI in evaluation of pediatric seizures.

Conclusion: In this study we expect to find usefulness of MRI as a diagnostic tool in assessment of pediatric seizures especially in those with structural lesions.

Keywords: Pediatric seizures; MRI; magnetic resonance imaging; pediatric epilepsy.

1. INTRODUCTION

A seizure is a paroxysmal phenomenon because of the brain's irregular, repetitive or synchronous neural activity [1]. "Epilepsy" is a condition characterized by the occurrence of recurrent, unprovoked seizures.

Epilepsy is not a single disease. Rather, it is a heterogeneous group of diseases of diverse etiologies. Among epilepsy, there's a subtype known as drug resistant epilepsy or refractory epilepsy, wherein seizure freedom can't be achieved even after administering of two well tolerated and appropriate anti-epileptic drug schedules. It has been found out that these cases of refractory epilepsy often have structural defect as their underlying cause. Some of the common defects associated with drug resistant etiologies include certain neuro-cutaneous syndromes, calcified lesions, hemorrhagic lesions and few of the metabolic disorders, all of which can be identified on MRI.

During neonatal period, seizures are a common presenting complaint with a study finding it in 1.8 to 3.5 per 1000 live births. Also, they tend to occur more frequently in children who are born underweight and in premature babies. The incidence of epilepsy in developing countries is near 18/1000 population as compared to 2.7-8/1000 population in developed countries [2]. Among Infants, febrile seizures are most common cause [3].

The incidence of seizures is particularly high in children below 3 years of age with a decreasing trend as the age increases. Also, the common causes vary based on geographical region under study. In India, due to poor socio-economic conditions infections form a big subset of causes, While in developed countries febrile seizures and structural malformations are far more common [4].

Seizure's in children account for 1% of all visits to emergency department [5]. Common causes of seizure in children include cortical malformations such as lissencephaly, focal cortical dysplasia etc., neurocutaneous syndromes like neurofibromatosis type 1, sturge weber syndrome etc, trauma, infections, tumours, metabolic and electrolyte disturbances and mesial temporal sclerosis [6].

Currently, the seizures are classified as generalized or focal based on how the initial

onset is and also on the basis of the description the seizure episode. A first episode may be down to an underlying neurological disease or may as well be initial presentation of epilepsy [5].

Initial workup in pediatric population usually involves an electroencephalograph and a neurosonogram. Both of which are cost effective, non-invasive and do not involve any radiation exposure. Computed Tomography(CT) and Magnetic Resonance Imaging(MRI) are the most common neuroimaging modalities used for further workup, with MRI being modality of choice, Computed Tomography though is ideal for evaluating calcific foci but involves considerable radiation exposure.

In recognizing brain pathology related to seizures, MRI is much more useful than CT, and so is the preferred imaging modality [5,6]. Major role of MRI is in identifying structural lesions. MRI provides for much better anatomic resolution when compared to a CT scan, it allows for better visualization of temporal fossa. It so is capable of identifying pathologies such as mesial temporal sclerosis, certain vascular malformations, focal cortical dysplasia and small tumours which may not be picked up on CT [6].

In most of the cases, MRI is a superior imaging modality when compared to CT, However CT is much more readily available and can be used in emergencies. Also, calcifications can be assessed better on CT. Apart from above mentioned scenarios, MRI is a better imaging modality in all situations.

Typically in evaluation of seizures, the sequences should ideally have slice thickness of 3-4mm. Also, much thinner slices i.e 2 mm should be employed when evaluating for focal cortical dysplasias. Much thinner slice sequences are needed in evaluation of focal epilepsy so that minute cortical malformations are not missed. Additionally, these sequences should be taken in axial and coronal planes. Also a coronal oblique sequence should be taken for evaluation of lesions involving the hippocampus.

Contrast is not routinely administered but may be advised if there's suspicion of tumours, infection, inflammatory pathologies and vascular malformations.

Magnetic resonance spectroscopy(MRS) is a technique for analysis of brain metabolite levels such as N-acetylaspartate,

choline, creatine, myo-inositol, glutamine-glutamate-GABA complex, free lipids and lactate. It's a non-invasive technique.

In epilepsy, usually there are aberrations in brain metabolism and hence MR Spectroscopic analysis is informative and can even be diagnostic at times.

MRS has proved to be a useful screening tool for pediatric seizure patients with inborn errors of metabolism and is being used to characterize the mass lesions detected on MRI. MRS has been found to be particularly useful in temporal lobe epilepsy and is valuable in determining prognosis for patients undergoing surgery for epilepsy [6].

1.1 Rationale

Seizures are a common presentation among pediatric patients. Wide variety of diseases may have their initial presentation as a seizure. MRI offers itself as an excellent imaging modality to visualize the extent and type of structural lesion.

1.2 Objectives

- 1) To identify the underlying causes presenting as seizures
- 2) To study spectrum of MRI findings in various causes of seizures.
- 3) To study the role of MRI in evaluation Pediatric seizures
- 4) To study MR Spectroscopic changes in structural lesions.

2. METHODS

2.1 Study Design

Prospective cross – section observational study.

2.2 Settings

Radio-diagnosis department, AVBRH Hospital, Datta Meghe Institute of Medical Sciences, Wardha.

2.3 Subjects

138 pediatric patients with history of seizures presenting to MRI department.

2.4 Sampling Procedure

All pediatric patients referred to the Radio-diagnosis department, AVBRH Hospital, Datta Meghe Institute of Medical Sciences, Wardha with seizures.

2.5 Sample Size

Calculated by formula-

$$N = \frac{Z_{\alpha/2}^2 \cdot P(1 - P)}{d^2}$$

$Z_{\alpha/2}$ = level of significance at 5% i.e. 95% confidence interval = 1.96

P = Prevalence of seizure in pediatric age group = 10% = 0.010

d = Desired error of margin = 5% = 0.05

$$N = \frac{1.96^2 \cdot 0.010(1 - 0.010)}{0.05^2}$$

N =138 = 138 patients needed in the study (Ref – Textbook of Pediatrics by Piyush Gupta)

2.6 Duration of Study

December 2020 – December 2022

2.7 Data Collection Tool

The study will be conducted using GE 1.5 Tesla MRI machine.

2.7.1 Inclusion criterion

1. All Children of ages 0-12 who present with seizures.

2.7.2 Exclusion criterion

1. Children who have been diagnosed with a metabolic disease.
2. Children with a history of psychiatric and mental illness.
3. Children who present with seizure as a result of drug or substance consumption.
4. Children who present with seizure due to temporary electrolyte imbalance.
5. Patient who are not willing to participate in the study.

2.8 Methodology

1. The procedure will be explained to the patient's parents.
2. Written valid consent will be obtained.
3. In case of uncooperative and irritable child, sedation is given by a pediatrician/anesthetist while monitoring vital parameters. The drugs used are:

- Phenergan 0.5 mg/kg/dosage PO [Single dosage not to exceed 25 mg.]
- Triclofos 25mg/kg/dosage PO [Dosage may be increased to 30 to 50 mg/kg per dosage.]
- Midazolam 0.1 mg/kg I.V

2.9 MRI Protocol Consists of

- Axial T1 weighted spin echo: repetition time = 402ms, echo time = 11.1ms, slice thickness = 5mm, matrix = 288 x 192, field of view = According to head size, number of excitations = 2
- Sagittal T1 weighted spin echo: repetition time = 468ms, echo time = 11.2ms, slice thickness = 5mm, matrix = 320 x 160, field of view = According to head size, number of excitations = 2
- Axial T2 weighted fast spin echo: repetition time: 4236ms, echo time: 109ms, echo train length = 12, slice thickness= 5mm, matrix =320 x 256, Field Of View = According to head size, Number of excitations = 2.
- Sagittal T2 weighted spin echo: repetition time = 3652ms, echo time = 108ms, slice thickness = 5mm, matrix = 320 x 256, field of view = According to head size, number of excitations = 2
- Axial FLAIR: repetition time:6777ms, echo time:78.2ms, slice thickness=6mm, matrix = 288 x 160, Field of view=According to head size, Number of excitations = 1.
- Coronal T2 FLAIR: repetition time = 8197ms, echo time = 78.5ms, slice thickness = 4mm, matrix = 288 x 192, field of view = According to head size, number of excitations = 2
- Axial diffusion weighted Imaging: Repetition time:6000, echo time: 79.5, slice thickness = 5mm, matrix = 64 x 138, field of view = According to head size, Number of excitations= 2.
- Axial Proton Density: repetition time=2000ms, echo time: minimum, slice thickness=5mm, matrix: 320 x 192, Field of view=according to head size.
- Axial Gradient recalled echo: repetition time:500ms, echo time: 20 ms ; slice thickness = 5mm, matrix = 288 x 128, Field of View=According to head size, Number of excitations = 1
- Spoiled gradient recalled echo: repetition time:14.3 ms, echo time: 6.3 ms; slice thickness = 3mm, matrix = 256 x 192, Field

of View=According to head size, Number of excitations = 2

- Gadolinium enhancement and MR Spectroscopy will be used in case there is suspicion of metastases, inflammatory disorders, certain tumours, white matter pathologies and neurocutaneous disorders.

2.10 Scope and Implication

MRI(1.5 Tesla) provides for better anatomic resolution of intracranial lesions which underlie a seizure disorder. Using MRI, we can better delineate the morphology, the distribution and the extent of the lesion. Also, the fact that MRI uses non-ionizing radiation gives us an added advantage especially in pediatric patients.

2.11 Expected Outcome

Knowing the advantages of MRI over other imaging modalities, we expect to find MRI along with MRS as imaging modality of choice in evaluation of pediatric seizures.

3. DISCUSSION

A study conducted by Jason Coryell, William D. Gaillard in 2018 [7], on recent diagnosis of epilepsy in 775 children of the age of < 3 years found anomalies in 290 of these children; The anomalies included acquired injury in 97 of these children, cortical growth malformations in 56 children and diffuse brain development disorders in 51 children. Their study found MRI to be of utmost importance in identifying the pathologies.

In another study conducted by Ravinder Sahdev [4] in 2017 on 105 cases in the age group 0 months to 12years, they found:

Distribution of Lesions:

Inflammatory Granuloma	10 (9.5%)
Hypoxic ischemic encephalopathy	5(4.7%)
Focal Demyelination	3(2.8%)
Calcifying granuloma	3(2.8%)
Periventricular Leukomalacia	2(1.9%)

Lissencephaly, dysgenesis of corpus callosum, mesial temporal sclerosis, AV malformation, periventricular hemorrhage, schizencephaly were not common. Abscess and infarction were found in one child each (0.9% each). 69 children had normal findings. Dedicated studies in pediatric

population using MRI brain are very few till date in India. This study aimed to find the common etiology of pediatric seizures on MRI in a developing country like India. The most common etiology according to this study was inflammatory granuloma and the study recommends MRI as primary investigation in seizures.

Aarti Anand et al. [3] conducted an MRI (1.5 Tesla) based study on 95 children in one of Nagpur's tertiary care centres. In their study, they included children under the age of 12 years who presented with epilepsy. They excluded children with history of trauma and those with febrile seizures. Infection was found to be the most common etiology in their analysis i.e. in 25 of the 95 children. Among the infective causes, it was found that tuberculosis was most common, occurring in 7 of the 25 patients.

Distribution according to pathology:

Tuberculosis	7 Patients
Encephalitis	5 Patients
Meningoencephalitis	3 Patients
Pyogenic Abscess	2 Patients
Subdural Empyema	1 Patient
Rasmussen Encephalitis	1 Patient

Their study was found comparable with another study done by Chaurasia et al., Kumar et al. and Gulati et al. wherein they also found infection as the most common cause. The analysis strongly emphasizes on using MRI as imaging modality for evaluation of seizure disorders.

Andrew J. Kalnin, MD et al. [8], performed an analysis on 366 children diagnosed with epilepsy. They used non-contrast MRI(1.5 Tesla) as their modality for study of non-febrile seizures. The commonly detected structural malformations were mesial temporal sclerosis unilateral and bilateral heterotopias, cortical dysplasia, neurocutaneous syndromes and few neoplasms. Their study found MRI to be very useful in demonstrating the extent, the morphology and the distribution of the lesions relating to seizures.

4. CONCLUSION

Following our study, we will have a better understanding of how effective magnetic resonance imaging is in picking up lesions underlying seizures in pediatric children and its correlation with MR Spectroscopy findings.

CONSENT

As per international standard or university standard, patients' written consent will be taken by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical will be taken by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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