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Original Research Article

Neuroimaging in pediatric seizures

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ABSTRACT

Background: Accurate etiological diagnosis of seizures in children is important to begin an effective treatment. MRI is an excellent neuroimaging tool that is highly accurate. It helps in diagnosis, determining the treatment protocol and predicting the outcome. Dedicated studies in paediatric population using MRI brain have been even fewer till date in India. Current study aims to find the common etiology of pediatric seizures on MRI in a developing country like India.
Methods: Hospital based retrospective study. 105 cases in age group between 0 months to 12 years. Seen between 2014 till date included in the study. All cases underwent MRI.
Results: Most common imaging findings were inflammatory granuloma in 10 (9.5%). Other findings were- Hypoxic ischemic encephalopathy (HIE) in 5 (4.7%), cerebral atrophy in 2 (1.9%), focal dysmyelination in 3 (2.8%), calcifying granuloma in 3 (2.8%) and periventricular leucomalacia in 2 (1.9%). Uncommon findings were that of lissencephaly, dysgenesis of corpus callosum, mesial temporal sclerosis, AV malformation, periventricular hemorrhage, schizencephaly, abscess and infarction in one child each (0.9% each). 69 children had no abnormal findings in brain.
Conclusions: The commonest etiology of seizures is inflammatory granuloma. Early recognition of potentially treatable diseases helps in timely treatment and arrest of progression of disease. It is highly recommended to use MRI as primary investigation for seizures. Every effort should be made to provide facility of MRI for management of seizures in all parts of India.

Keywords: Brain MRI, Epilepsy, Neuroimaging, Pediatric seizure

INTRODUCTION

Seizure is an emergency in children. Seizure is a very common cause for hospitalization of children and it results in significant mortality and morbidity. There are very few studies done on neuroimaging in seizures from developing countries like India. Most studies conducted till now have focused on clinical aspect of seizures. Dedicated studies in paediatric population using MRI brain have been even fewer till date in India.[1]

Febrile seizures are the most common cause of acute seizures in children worldwide. These account for the majority of seizures seen in children less than 5 years. In tropical countries like India, acute symptomatic seizures which carry a bad prognosis are more prevalent as compared to febrile seizures.[2] Acute seizures therefore turn out to be an important risk factor for neurological and cognitive impairment in children living in these countries. CNS infections are the main cause for these acute seizures. The incidence is found to be highest among children less than 3 years of age, with a dwindling frequency in higher age groups. Geographical variations determine the common causes in a particular region. Meningitis, viral encephalitis and neurocysticercosis are common causes. These are associated with higher morbidity and mortality with higher rates of recurrent epilepsy.[3]

In this study, we analyzed the prevalence of various aetiologies for seizures detected on MRI. Current study aims to find the common etiology of pediatric seizures on MRI in a developing country like India.[4] Magnetic resonance imaging (MRI) gives precise location and a good idea of the nature of lesions. Therefore it is a good modality that helps both neurophysicians and neurosurgeons for a faster and better diagnosis.

METHODS

It was a Hospital based retrospective study. All cases were sent for imaging. All imaging were performed using Siemens 1.5 Tesla MRI. The protocol consisted of the following scanning sequences (total scan time approximately 25 minutes):

1. Sagittal T1weighted spin echo (SE), with repetition time (TR) = 450ms, echo time (TE) = minimum, slice thickness = 4mm/0mm, matrix = 256 × 192, field of view (FOV) = According to head size, number of excitations (NEX) = 1.

2. Axial T2 weighted fast spin echo (FSE), with TR/TE = 3000/85 ms, echo train length (ETL) = 12, slice thickness = 3mm/0mm, matrix = 256 × 256, FOV = According to head size, NEX = 1.

3. Axial fast fluid attenuated inversion recovery (FLAIR), with TR/TE/TI (inversion time) = 9000/130/2200, slice thickness=3mm/0mm, matrix = 256 × 192, FOV = According to head size, NEX = 1.

4. Axial diffusion weighted echoplanar, b = 1000, with TR/TE = 6000ms/min, slice thickness/gap = 3/0 mm, matrix = 256 × 192, FOV = According to head size, NEX = 1.

5. Axial PD with TE=25, slice thickness=3/0, FOV= according to head size.

6. Axial GRE with TR/TE = 15ms/650; flip angle = 20, slice thickness = 5/0, matrix = 256 × 192, FOV = According to head size, NEX = 1

7. Gadolinium enhancement used in suspected inflammation, tumors/metastases, white matter disorders, neurocutaneous disorders

Sedation was given (as per requirement) to reduce anxiety and movement to avoid motion artefacts. Sedatives/hypnotics at the lowest possible dose were preferred. General anaesthesia (GA) was chosen in selected children- those requiring long duration scans and those with history of failed sedation. The children receiving anaesthesia/ sedation were constantly monitored by an experienced anaesthetic team with appropriate monitoring equipment (including electrocardiography, pulse oximetry, blood pressure, and body temperature assessments. All members of the anaesthetic team were made familiar with MRI-specific safety issues and the requirements of the diagnostic procedure before induction of patient. All present cases were inpatients. The entire imaging was evaluated by an experienced radiologist.

Inclusion criteria

All children with complaints of seizures (including recurrent episodes) in the age group of 1month to 12 years and children admitted including children with developmental delay, cerebral palsy, and mental retardation.

Exclusion criteria

Children with seizures following head injury

Children with seizures following poisoning

RESULTS

105 cases [of which 68 (71.4%) were male] were included in the study. The age groups of patients evaluated were between 0 months to 12 years. All cases underwent MRI. 33 of the patients (31.4 %, n=105) revealed abnormal imaging of significance. The most common imaging findings were inflammatory granuloma in 10 (9.5%). Other findings in order of frequency of occurrence were- Hypoxic ischemic encephalopathy (HIE) in 7 (6.7%), cerebral atrophy in 2 (1.9 %), focal dysmyelination in 3 (2.8%) and calcifying granuloma in 3 (2.8 %). Uncommon findings were that of lissencephaly, dysgenesis of corpus callosum, mesial temporal sclerosis, AV malformation, periventricular hemorrhage, schizencephaly, abscess and infarction in one child each (0.9 % each). 69 children (65.1%, n=105) had no abnormal findings in brain.

Table 1: MRI findings in males (up to 12 years).

Disease	<1 yr	2-5 yrs	6-10 yrs	11-12 yrs
HIE	-	3	2	-
Lissencephaly	-	1	-	-
Persistent septum pellucidum	-	-	-	1
Inflammatory granuloma	-	-	4	2
Dysgenesis corpus callosum	-	-	1	-
Calcifying granuloma	-	-	1	-
Focal dysmyelination	-	1	2	-
Cerebral atrophy	1	-	1	-
AV malformation	-	-	1	-
Close lie schizencephaly	-	-	1	-
Infarction	-	1	-	-
No abnormality found	6	14	12	11
Total	7	20	25	14

Table 2: MRI findings in females (up to 12 years).

Disease	<1 yr	2-5 yrs	6-10 yrs	11-12 yrs
HIE	-	-	2	-
Focal cortical dysplasia	-	-	1	-
Inflammatory lesion(Abscess)	-	-	1	
Inflammatory granuloma	-	-	1	3
Mesial temporal sclerosis	-	-	-	1
Calcifying granulomata	-	2	-	-
Encephalomalacia	-	1	-	-
Periventricular haemorrhage	-	1	-	-
No abnormality found	3	11	6	6
Total	3	15	11	10

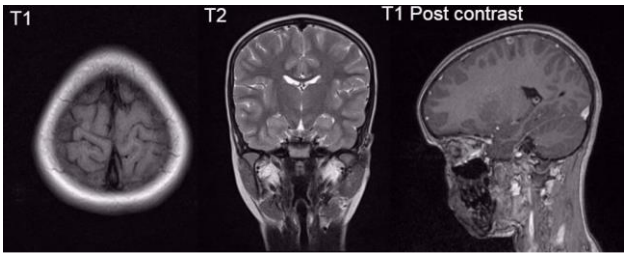

Figure 1: MRI findings in inflammatory granuloma.

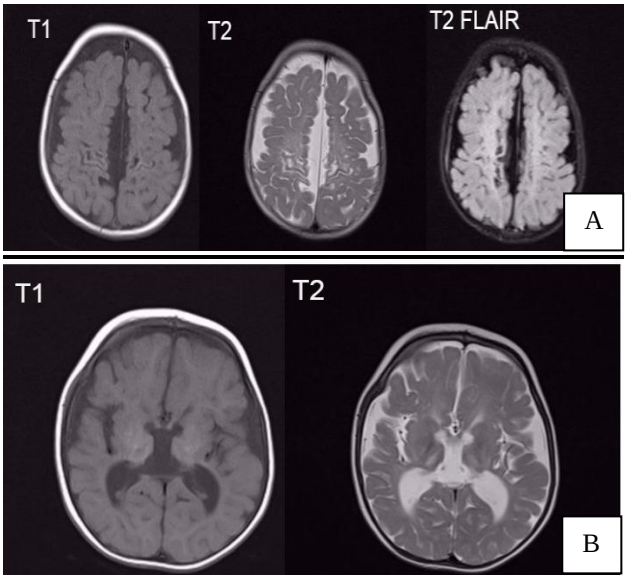

Figure 2 (A) (B): MRI findings in hypoxic ischemic encephalopathy.

DISCUSSION

MRI is a very important modality in management of seizures revealing abnormal pathologies conveniently and non-invasively. Abnormal imaging findings were found in 87 out of 281 children in a study done by Kalnin et al which was a high rate of detection of abnormalities by MRI. In a study conducted by King M on 300 cases with first unprovoked seizures (FUS), found a lesion responsible for seizures in 38 out of 232 cases.[1] It was recommended in the study that imaging should be done in patients with fits to detect lesions with few exceptions in children (those with idiopathic generalized epilepsy).

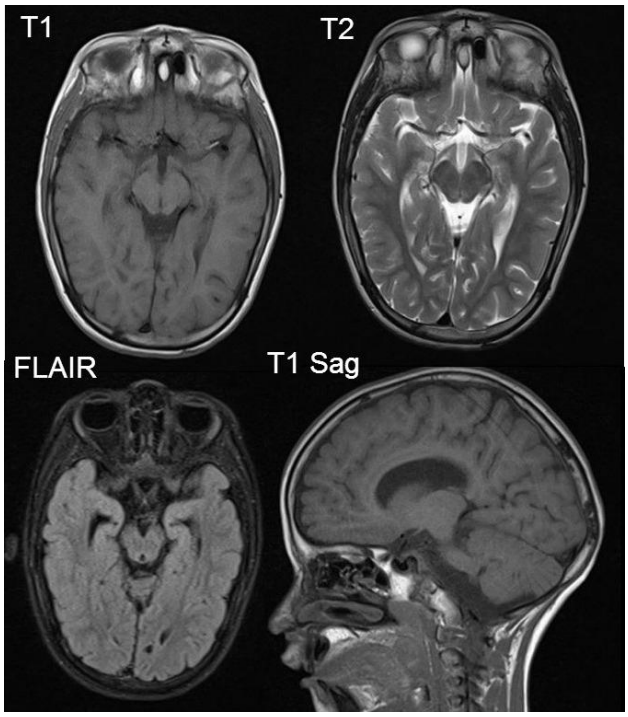

Figure 3: MRI findings in lissencephaly.

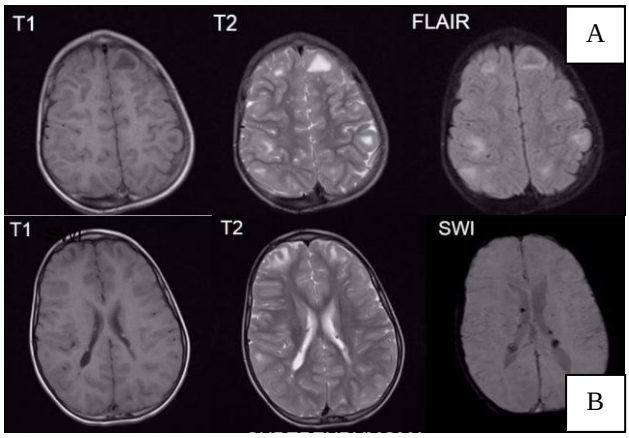

Figure 4(A): MRI findings in tuberous sclerosis; (A) Cortical tubers; (B) Subependymoma.

Pohlmann-Eden et al emphasized and agreed with Mark King that brain MRI is crucial in adults with first epilepsy and children.[2] Researchers recommended brain imaging in FUS; However, not in the emergency room, but imaging in the following days of seizures is necessary. Rauch DA et al pointed out that brain MRI for hospitalized patients for evaluation of new-onset seizures did not bring about any significant changes in treatment

of acute cases and only increased period of hospital stay and incurs financial burden.[3] MRI on an outpatient basis in these patients would be more cost effective.

Berg AT et al, studied 613 children with newly diagnosed epilepsy, out of which 488 (79.6%) underwent some form of neuroimaging.[4] Etiologically relevant abnormalities were found in 62 children (12.7% of those imaged). Doescher JS et al studied 181 children with new onset seizures.[5] MRI brain was done in these children and correlated with EEG findings. Abnormal MRI findings were found in 32.6% (n=59) of the sample. Of the 50 children with a normal EEG, 21 (42%) were found to have an abnormal MRI which was abnormally high frequency in children considered to be normal after EEG.

Bano S et al revealed that finding structural or metabolic abnormalities which need special treatment are the main purpose of imaging in FUS.[6] It was said that CT scan may be used in emergency and peri-operative situations, although the sensitivity is as low as 30%. MRI, however, should be the investigation of choice for seizure disorders. Specialized protocols, wherever available, may be used for accurate localization of lesions and thus, provide better surgical outcomes.

For development of practice parameters for evaluation of first non-febrile seizure in children, Hirtz D et al reviewed available evidence based studies. They recommended that if a neuroimaging study is to be done, MRI is the preferred modality.[7] Emergent neuroimaging should be performed in a child of any age who exhibits a post-ictal focal deficit (Todd's paresis) which is not quickly resolving, or who has not returned to baseline within several hours after the seizure. Non-urgent MRI should be strongly considered in any child with a significant cognitive or motor impairment of unknown etiology, unexplained abnormalities on neurologic examination, a focal seizure with or without secondary generalization, an EEG that does not represent a benign partial epilepsy of childhood or primary generalized epilepsy, or in children less than 1 year of age.

Five hundred children with new-onset afebrile seizures in emergency department of a tertiary care children's hospital were reviewed by Sharma S et al.[8] Ninety-five percent of patients (475/500) had undergone neuroimaging. Clinically significant abnormal neuro-imaging was noted in 8% of patients. Out of these children high risk was considered in presence of a predisposing condition and occurrence of focal seizure if <33 months old. It was found that of the high-risk patients, 26% patients had clinically significant abnormal neuroimaging compared with 2% in the low-risk group.

Udani V, stated that neurocysticercosis is highly endemic in Indian children as a cause of seizures.[9] NCC is responsible for 0.4% of neurological complaints in children. In present study, it was found that inflammatory granulomata were the most common abnormality. Shinnar S et al in a 10 year prospective study on 411 cases, imaging was done in 218 cases (53%) i.e. 159 CT scan and 59 brain MRI.[5,10] Out of these 218 cases, 45 cases (21%) had abnormal findings. Indeed four of these cases needed immediate surgical intervention.

In a study by Kalnin AJ on 281 (age, 6 to 14 years old) patients, he showed a 31% abnormality with at least one brain lesion, of which 12% had two or more lesions.[11] The most common lesions were ventriculomegaly (51%), gliosis (23%), dysplasia or heterotopias in 12%, brain atrophy in 12%, white matter disease in 9% and encephalomalacia in 6%.

IAP expert committee guidelines for diagnosis and management of epilepsy on neuroimaging states that MRI is the imaging modality of choice in children with seizures and recommends high resolution MRI for delineating epileptogenic zone and eloquent cortex in pre-surgical evaluation. However, it is not recommended in benign seizures.

Although a good number of studies have been conducted on adults in our country to establish the common etiological causes of seizure, very few studies have been conducted on children. As we can see that in studies done outside of India, neuroimaging plays an important role in not only establishing the cause of seizure but also deciding treatment. Follow up imaging is helpful in deciding when to stop treatment.

In present study, out of 105 children, neuroimaging revealed about 31.4% abnormal findings of significance which is in agreement with the study conducted by Kalnin et al. The most common cause of seizures was found to be inflammatory granuloma representing neurocysticercosis / tuberculoma, both of which are potentially treatable causes of seizures which would be difficult to diagnose without imaging. Thus, early imaging in these children would help in starting timely treatment and hence, arrest the progress of disease as well as prevent recurrence of seizure. Follow up imaging is recommended in these cases for deciding when to stop treatment.

In present study, however, no case was found that would require immediate surgical intervention which was different from study conducted by Shinnar S.[10] One reason for this could be the limited number of children that were studied. Studies on a larger scale in the future may reveal similar findings.

CONCLUSION

The commonest etiology of seizures is inflammatory granuloma which may represent neurocysticercosis / tuberculoma. It accounted for almost 9.5 % of cases of seizures in present study. Early recognition of these potentially treatable diseases helps in establishing timely treatment with good recovery.

Accurate etiological diagnosis of seizures is very important to begin an effective treatment. MRI is an excellent neuroimaging tool that is highly accurate in diagnosing pathological conditions of the CNS. It helps in diagnosis, determining the treatment protocol and predicting the outcome. In the long run it helps in restricting the period of use of antiepileptic drugs in the management of seizures. Therefore, it is highly recommended to be used as a primary investigation for children presenting with seizures in India.

The only factor that may act as a hurdle from letting MRI become the main investigation in seizures in India are the high costs involved and therefore the socioeconomic status of the patient may have to be taken in to consideration. Also it is not a readily available modality in all parts of the country. So, conventional methods of investigation such as EEG still remain the mainstay of management in remote parts of the country. However, taking into consideration its diagnostic accuracy, every effort should be made to provide facility of MRI to one and all for management of seizures.

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