

ORIGINAL ARTICLE

MRI Evaluation of Seizures in Paediatrics Age Group Patients in A Rural Hospital of Central India

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ABSTRACT

Seizure is abnormal irregular synchronous activity in brain while epilepsy is condition characterized by repetitive unprovoked seizures. Magnetic Resonance Imaging(MRI) is the imaging modality of choice in evaluation of paediatric seizures. The study aims to assess the role of MRI in identification of various etiologies and to study the spectrum of imaging appearances of different etiologies on MRI. We studied 138 patients presenting with history of seizures in the age group of 0 to 12 years over a period of two years at a tertiary hospital in central India using GE 1.5 Tesla MRI machine. Overall, Hypoxic ischemic encephalopathy (HIE) was the most common etiology for seizures, followed by CNS infections and developmental malformations. Among HIE, majority of cases were seen in the age group of 0 to 3 years. There was positive association of HIE with history of perinatal insult ($p < 0.00001$) and preterm birth ($p < 0.0001$). MRI plays a significant role in evaluation of paediatric seizures, with identification and delineation of severity of wide variety of etiologies, thus helping in further management and treatment plan of patients.

Keywords: Magnetic Resonance Imaging, MRI, Paediatric seizures, Epilepsy

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INTRODUCTION

A seizure is defined as abnormal electrical activity characterized by repetitive, irregular and synchronous neuronal activity. Epilepsy is a chronic condition characterized by repetitive unprovoked seizures. The underlying pathology in seizures is down to excessive neuronal activity often secondary to pathology affecting inhibitory and/or excitatory pathways of the brain. (1)

Epilepsy in itself can't be regarded as a single entity, instead it's a result of wide variety of diverse etiologies involving infections, congenital anomalies, developmental abnormalities and tumours. In neonatal period, seizures are a common manifestation of underlying disease.

One of the studies found their incidence in neonatal period to be 1.8 to 3.5 per 1000 livebirths. Also, various studies have found seizures and epilepsy to have higher incidence in childhood. In developing countries, incidence of epilepsy is 18/1000 population while in developed countries the incidence is projected to be around 2.7-8/1000 population. (2)

Prevalence of seizures is maximum in neonates with febrile seizures being the most common cause in infancy (3). However, in developing countries like India, studies have linked Central Nervous System (CNS) infections to be the most common cause of seizures in paediatric age group. Among CNS infections tuberculomas and neurocysticercosis formed the main bulk of underlying pathology. (4)

Other common causes of seizures in paediatric age group include hypoxic ischemic encephalopathy, hypoglycemic encephalopathy, cortical malformations like focal cortical dysplasia, schizencephaly, lissencephaly etc, neuromigrational disorders such as grey matter heterotopias, certain neurocutaneous syndromes like neurofibromatosis, sturge webersyndrome, neoplasms like dysembryoblastic neuroepithelial tumour (DNET) and trauma.(1)

With regards to investigative modalities available for evaluation of seizures, Electroencephalogram (EEG) and neurosonogram tend to be the initial investigations in neonates as they are non-invasive and non-ionizing, magnetic resonance imaging is the modality of choice for evaluation of seizures and paediatric epilepsy, with magnetic resonance imaging the neuroanatomy can be depicted in explicit detail with excellent grey-white matter delineation. Also, it allows for much better visualization of the temporal fossa and in identification and characterization of focal brain lesions. The added advantage is that its non-invasive and non-ionizing which is especially important in paediatric age group.

Computed tomography is also helpful in minority of conditions such as in conditions causing intracranial haemorrhage and in evaluation of lesions with calcifications. The advantage of computed tomography is that it is fast and less expensive, but the disadvantages often tend to outweigh the advantages as there is risk of ionizing radiation and often certain subtle pathologies like focal cortical dysplasia or neuromigrational disorders cannot be well visualised. (5)

A large chunk of studies conducted in India have focused on the clinical aspects and evaluation of paediatric seizures, however dedicated studies evaluating the role of magnetic resonance imaging in paediatric seizure workup is sparse.

Hence, our study was done to understand the role and the benefits of Magnetic resonance imaging in delineating the underlying pathologies and understanding wide variety of imaging appearances of different etiologies.

Objective:

- To identify potential cause for seizures in paediatric age group using magnetic resonance imaging.
- To study association of hypoxic ischemic encephalopathy with perinatal insult and preterm births.
- To study various imaging patterns associated with hypoxic ischemic encephalopathy.
- To study association of congenital malformations with preterm birth.

MATERIALS AND METHODS:

Setting: Radio-diagnosis department, AVBRH Hospital, Datta Meghe Institute of Higher education, and Research, Wardha.

Research design: Prospective cross – section observational study

Subjects: 138 paediatric patients presenting to the MRI department with history of seizures will be taken for study.

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

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 paediatric age group = 10% = 0.10

d = Desired error of margin = 5% = 0.05

$$N = \frac{1.96^2 \cdot 0.10(1 - 0.10)}{0.05^2}$$

N = 138 = 138 patients needed in the study

(Ref – Textbook of Paediatrics by Piyush Gupta)

Duration of study: December 2020- December 2022

Data collection tool:

The study was conducted using GE 1.5 Tesla MRI machine.

Inclusion criterion:

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

Exclusion criterion:

Children who have been diagnosed with a metabolic disease.

Children with a history of psychiatric and mental illness.
 Children who present with seizure as a result of drug or substance consumption.
 Children who present with seizure due to temporary electrolyte imbalance.
 Patient who are not willing to participate in the study.

Methodology:

- The procedure was explained to the patient's parents.
- Written valid consent was obtained.
- In case of uncooperative and irritable child, sedation was given by a paediatrician/anaesthetist 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

MRI Protocol consists of:

- Axial T1, Sagittal T1, Axial T2, Sagittal T2, Axial FLAIR, Coronal T2 FLAIR, Axial Diffusion Weighted Image, Axial Proton Density, Axial Gradient recalled echo, Spoiled gradient recalled echo, 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.

Data collection tool and statistical analysis: Data was analyzed on the basis of statistical analysis by using ANNOVA test (SPSS for window version 16 and EpiInfo version 6) When $p < 0.05$ will be considered as the level of statistical significance.

RESULTS

The study was conducted on 138 paediatric patients in the age group of 0 to 12 years and following results were obtained:

- Majority of patients were male – 76 patients (70%), while females constituted – 30 patients (30%)
- With respect to age distribution, majority of patients were in the age group of 0 to 3 years- 66 patients (48%) followed by 4 to 6 years – 29 patients (21%).
- Majority of patients presented with Generalized tonic clonic seizure (GTCS) type of seizure – 103 patients (73%), while 35 patients (25%) presented with partial seizure.
- Out of 138 patients, majority of them were term patients – 100 (72%) while 38 patients (28%) were preterm.
- Based on mode of delivery, majority of patients were delivered by vaginal route – 95 patients (69%) while 43 patients (31%) were delivered by C-section.
- With respect to distribution obtained based on MRI findings, out of 138 patient, abnormal findings were obtained in 86 patients (62%) while normal findings were obtained in 52 cases (38%)
- Among the abnormal MRI findings (Table 1), most of the cases were of hypoxic ischaemic encephalopathy (HIE) – 24 patients (27.9%) followed by infection – 22 patients (25.5%), congenital malformation – 22 patients (25.5%) and tumour – 8 patients (9.3%)

TABLE 1: DISTRIBUTION BASED ON ABNORMAL MRI FINDINGS (n=86)

TYPE OF ABNORMAL MRI FINDINGS	BASED ON MRI FINDINGS (%)
HYPOXIC ISCHEMIC ENCEPHALOPATHY (HIE)	24 (27.9%)
CONGENITAL MALFORMATION	22 (25.5%)
INFECTION	22 (25.5%)
TUMOUR	8 (9.3%)
INFARCT	4 (4.6%)
DEMYELINATING	3 (3.4%)
TRAUMA	2 (2.3%)
MESIAL TEMPORAL SCLEROSIS	1 (1.1%)

- In patients with findings of HIE, majority of the cases were in the age group of 0 to 3 years – 15 patients (62.5%).
- In patients with HIE, a correlation was done between presence of findings of HIE with history of perinatal insult and also with preterm births. Out of 24 cases of HIE, 23 patients had history of perinatal insult and the p-value obtained was < 0.0001 i.e., statistically significant. (Table 2)

TABLE 2: ASSOCIATION OF HIE WITH PERINATAL INSULT

H/O PERINATAL INSULT	FINDINGS OF HIE	OTHER MRI FINDINGS/NORMAL
YES	23	9
NO	1	105
χ^2 : 86.07 P - Value <0.00001		

o Also, correlation was done for patients presenting with findings of HIE and preterm births (Table 3), out of 24 patients, 17 patients had history of preterm birth and the p-value obtained was <0.0001 i.e., statistically significant.

TABLE 3: ASSOCIATION OF HIE WITH PRETERM BIRTH

H/O PRETERM BIRTH	FINDINGS OF HIE	OTHER MRI FINDINGS/NORMAL
YES	17	21
NO	7	93
χ^2 : 27.2 P - Value <0.0001		

o In patients of HIE, imaging patterns were analysed and three common imaging patterns were identified (Table 4) i.e. involvement of periventricular white matter, Subcortical and Periventricular white matter and involvement of bilateral basal ganglia, thalamus and cerebral lobes, Out of 7 term patients with HIE involvement of bilateral basal ganglia, thalamus and cerebral lobes was seen in all 7 cases (100%), while in case of preterm patients, 12 cases showed involvement of both periventricular and subcortical white matter while 5 cases showed periventricular white matter involvement.

TABLE 4: DISTRIBUTION BASED ON IMAGING PATTERNS IN HYPOXIC ISCHEMIC ENCEPHALOPATHY (n=24)

	ONLY PERIVENTRICULAR WHITE MATTER INVOLVEMENT	PERIVENTRICULAR +SUBCORTICAL WHITE MATTER INVOLVEMENT	BASAL GANGLIA, THALAMUS, AND CEREBRAL CORTEX INVOLVEMENT
TERM PATIENTS	-	-	7(29.1%)
PRETERM PATIENTS	5(20.8%)	12(50%)	-

- o Among patients with findings of infection, majority of the cases were of tuberculoma - 7 patients (31.8%) followed by viral encephalitis - 6 patients (27.2%), meningitis - 4 patients (18.1%), cerebral abscess - 4 patients (18.1%) and neurocysticercosis - 1 patient (4.5%).
- o Among patients with findings of congenital malformation, majority of them had congenital aqueductal stenosis - 8 patients (36%), followed by dandy walker malformation in 6 patients (29%), hypoplasia of corpus callosum - 2 patients (9%), Type 2 Arnold Chiari Malformation - 2 patients (9%), rest of the cases were of focal cortical dysplasia, rhomboencephalosynapsis, septo-optic dysplasia and open lip schizencephaly constituting 1 case each.
- o Among 8 cases of tumours, 3 cases were of pilocytic astrocytoma (37.5%) followed by medulloblastoma - 2 cases (25%) and 1 case each (12.5%) of brain stem glioma, diffuse fibrillary astrocytoma and dysembryoplastic neuroepithelial tumour.
- o In patients with congenital malformations, association was seen between findings of congenital malformations and preterm birth with history of preterm births in 15 patients and a p-value of <0.00001 i.e. statistically significant. (Table 5)

TABLE 5: ASSOCIATION OF CONGENITAL MALFORMATION WITH PRETERM BIRTH

HISTORY OF PRETERM BIRTH	PRESENCE OF CONGENITAL MALFORMATION	ABSENCE OF CONGENITAL MALFORMATION
YES	15	23
NO	7	93
χ^2 : 21.6 P - Value: <0.00001		

DISCUSSION

We did study on 138 pediatric patients presenting to department of radiodiagnosis with clinical presentation of seizures.

DISTRIBUTION BASED ON GENDER DISTRIBUTION:

In our study majority of the patients were male (70%), while females constituted 30% of the total sample size.

Our findings were in accordance with study done by Miyan Tambe et al. (2) who in their study found majority of patients as male (61.3%) while females constituted 38.6% of patients.

DISTRIBUTION BASED ON AGE DISTRIBUTION

In our study, majority of the patients were of age group of 0 to 3 years of age (66%) followed by patients in age group of 4-6 years (21%).

Our findings were in accordance with study done by Miyan Tambe et al. (2) who in their study found majority of the paediatric patients with seizures presented under 3 years of age.

DISTRIBUTION BASED ON TYPE OF SEIZURE

In our study, majority of patients had Generalized tonic-clonic seizure (75%) while only 25% of the patients had partial seizure.

Our findings were in accordance with study done by Umapet al. (6) who in their study found majority of the paediatric patients presenting with seizure to have generalized tonic clonic type of seizure (68%) while only 32% presented with partial seizure.

Our findings were also in accordance with another study done by Anand et al. (3) who in their study found GTCS in 66.3 % of the patients while 33.7% of their patients had partial seizures.

DISTRIBUTION BASED ON PRESENCE/ABSENCE OF ABNORMAL MRI FINDINGS

In our study, out of total 138 patients 62% showed abnormal findings on MRI while 38% had normal findings on MRI.

Our findings are in accordance with study done by Anand et al. (3) and Umapet al. (6) who in their studies found majority of the patients with paediatric seizures showed abnormal findings on MRI i.e., 88.4 % and 89% respectively.

DISTRIBUTION BASED ON TIME OF DELIVERY

In our study, majority of the patients had term deliveries (72%) while only 28% of the patients had preterm delivery.

Our findings are in accordance with study done by Mathur M et al. (7) who in their study found 74% patients had term delivery while 26% patients had preterm delivery.

DISTRIBUTION BASED ON MODE OF DELIVERY

In our study, majority of the patients were delivered by vaginal route (69%) while 31% were born by C-section.

Our findings are in accordance with study done by Mathur M et al. (7) who in their study found 62% of the patients were delivered by vaginal route while 38% of the patients were delivered by C-section.

DISTRIBUTION BASED ON ETIOLOGY OF ABNORMAL MRI FINDINGS

Majority of the patients with abnormal MRI findings were found to have hypoxic ischemic encephalopathy i.e., 27.9% followed by congenital malformation (25.5%) and Infection (25.5%).

Our findings are in accordance with study done by Umapet al. (6) who in their study found hypoxic ischemic encephalopathy (31.5%) as the most common cause followed by infections (25.8%) and congenital malformation (13.5%).

Our findings were also similar to studies done by Sahdev R et al. (4) however in their study most common etiology was found to be infection followed by hypoxic ischemic encephalopathy.

Similar findings were also observed by study done by Mathur M. et al. (7) wherein infection followed by hypoxic ischemic encephalopathy was found to be the commonest cause.

DISTRIBUTION OF HIE FINDING ACCORDING TO AGE GROUP

In our study, majority of the cases with finding of HIE were in the age group of 0 to 3 years i.e., 62.5% and among them majority of the patients were neonates (66.6%).

Our study is in accordance with study done by Umapet al. (6) and Miyan Tambe et al. (2) where in majority of the cases were in age group of 0 to 3 years and among them majority of them were neonates.

ASSOCIATION OF HIE WITH PERINATAL INSULT

In our study, we found that majority of patients with finding of HIE on MRI had history of perinatal insult with a P- Value of <0.00001 (statistically significant).

Our findings were in compliance with study done by Mathur et al. (7) wherein they compared findings of HIE on MRI with history of perinatal insult, their study had a p-value of <0.004 (statistically significant)

ASSOCIATION OF HIE WITH PRETERM BIRTHS

In our study, out of all the patients who had findings of HIE on MRI majority of them had a history of preterm birth and the p-value for the same was found to be <0.0001 (statistically significant).

Our findings were in compliance with studies done by Chalak, Lina F., *et al.*, Schmidt *et al.* and Salhab *et al.* (8) Their studies found higher association of HIE with preterm births.

DISTRIBUTION BASED ON FINDINGS OF INFECTION

In our study, majority of cases with MRI findings of infection were of Tuberculoma i.e., 31.8% of the cases followed by findings of viral encephalitis and meningitis.

Our findings are in compliance with studies done by Anand *et al* (3), Mathur *et al.* (7), Sahdev R *et al.* (4) and Umap *et al* (6), In their studies tuberculoma was found to be the commonest MRI finding among infectious causes.

However, in studies done by Mathur *et al.* (7) and Umap *et al* (6) the second most common infectious cause identified was neurocysticercosis at 40% and 26%, This was not the case in our study with only 4.5 % of cases representing neurocysticercosis in our study.

Cases:

Tuberculoma

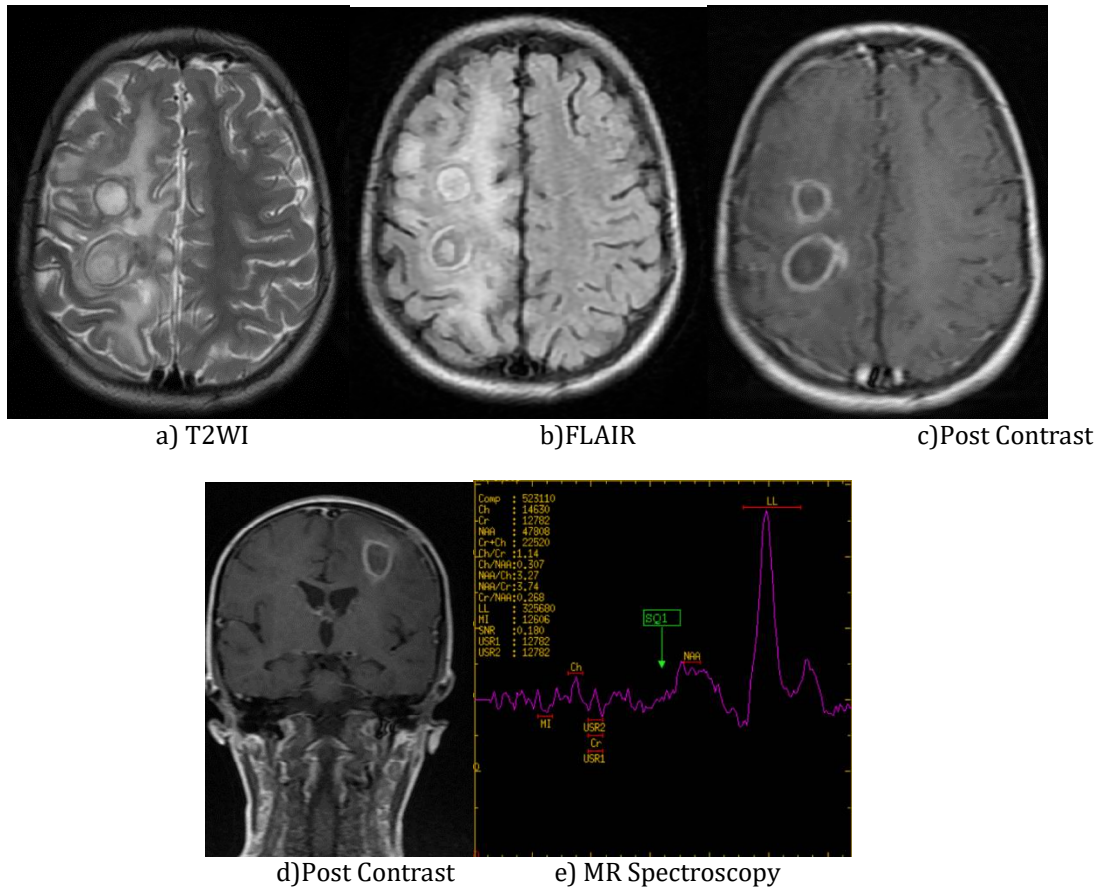


Fig 1: Image Description: Multiple ring enhancing lesions in a known case of pulmonary tuberculosis appearing heterogeneously hyperintense on T2WI/FLAIR showing peripheral ring enhancement, On MR Spectroscopy there is prominent lipid lactate peak with decreased NAA, Creatine and choline.

Key: T2WI: T2 Weighted Imaging, T1WI: T1Weighted Imaging FLAIR: Fluid attenuated inversion recovery, DWI: Diffusion weighted imaging, ADC: Apparent diffusion coefficient.

DISTRIBUTION BASED ON FINDINGS OF CONGENITAL MALFORMATIONS

In our study, congenital aqueductal stenosis was the most common finding observed representing 36 % of all cases followed by Dandy Walker malformation (29%) and hypoplasia of corpus callosum (9%).

Our study was in accordance with findings observed by Omidiji, Olubukola Abeni Titilayo, *et al.* (9) and study done by Hadžagić-Ćatibušić, Feriha, *et al.* (10) wherein congenital aqueductal stenosis was common finding observed in patients presenting with seizures i.e., in 32% and 26.8% of cases.

In study done by Hadžagić-Ćatibušić, Feriha, *et al.* (10), dandy walker malformation and hypoplasia of corpus callosum attributed to 4.7 % and 7.9% of all cases, while in our study their proportion was higher.

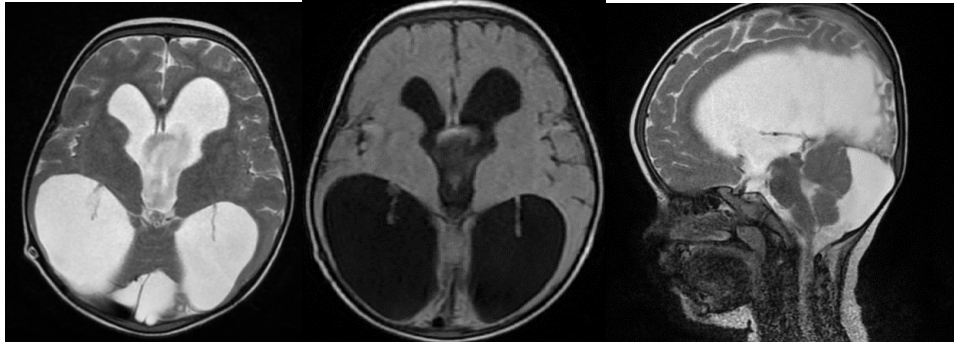
ASSOCIATION OF CONGENITAL MALFORMATIONS WITH PRETERM BIRTH

In our study, majority of paediatric patients with findings of congenital malformation had history of preterm births with p value of <0.00001 (statistically significant).

Our findings are in accordance with study done by Kase, Jordan S. et al (11) wherein there was positive correlation between presence of congenital anomalies and preterm births with p value 0.002 and they concluded that presence of congenital malformation increase likelihood of preterm births.

Cases:

Congenital Aqueductal Stenosis



a) Axial T2WI b) Axial FLAIR c) Sagittal T2WI

Fig2: Bilateral lateral and third ventricle with normal appearing fourth ventricle causing parenchymal thinning.

Key: T2WI: T2 Weighted Image, FLAIR: Fluid attenuated inversion recovery.

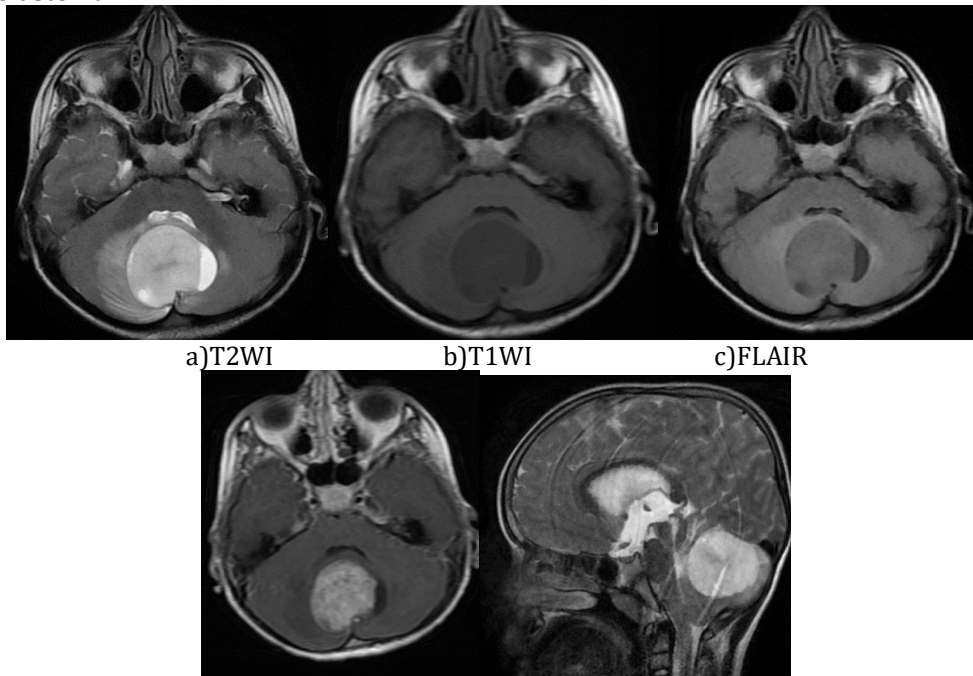
DISTRIBUTION BASED ON FINDINGS OF TUMOURS

In our study, we found juvenile pilocytic astrocytoma (low grade glioma) as the most common tumour accounting for 37.5% of all tumour cases followed by medulloblastoma accounting for 25% of all tumour cases, brainstem glioma, diffuse fibrillary astrocytoma and dysembryoplastic neuroepithelial tumours formed a smaller subset of tumour cases.

Our findings are in compliance with research done by Metzger, Sarah, et al. (12) where they found low grade glioma as the most common tumour accounting for 36% of the cases, in their study medulloblastoma accounted for 11% of all cases.

Cases:

Medulloblastoma



a)T2WI b)T1WI c)FLAIR

d) Post Contrast e)Sagittal T2WI

Fig3: Heterogeneously enhancing mass lesion in the region of fourth ventricle appearing heterogeneously hyperintense on T2WI/FLAIR causing mass effect over fourth ventricle and cerebellum with obstructive hydrocephalus.

Key: T2WI: T2 Weighted Imaging, T1WI: T1Weighted Imaging FLAIR: Fluid attenuated inversion recovery, DWI: Diffusion weighted imaging, ADC: Apparent diffusion coefficient.

DISTRIBUTION BASED ON IMAGING PATTERNS IN HYPOXIC ISCHEMIC ENCEPHALOPATHY

In our study, we observed in preterm patients there was isolated periventricular involvement in 20.8% of cases of HIE, involvement of periventricular and subcortical white matter involvement in 50% of cases of HIE, these areas showed T2WI/FLAIR hyperintensities with DWI restriction in acute cases, while in term patients there was involvement of basal ganglia, thalamus and/or cerebral gray and white matter in 29.1% of cases.

Our study findings are in compliance with study done by A.Cabaj et al. (13) who in their study identified three imaging patterns of Hypoxic Ischemic Encephalopathy i.e. periventricular leukomalacia, basal ganglia/thalamic involvement and findings of multicystic encephalomalacia. In their study, they found involvement of periventricular and subcortical white matter in preterm patients while involvement of basal ganglia, thalamus and cerebral cortex involvement in term patients.

Cases:

Hypoxic ischemic encephalopathy in preterm child.

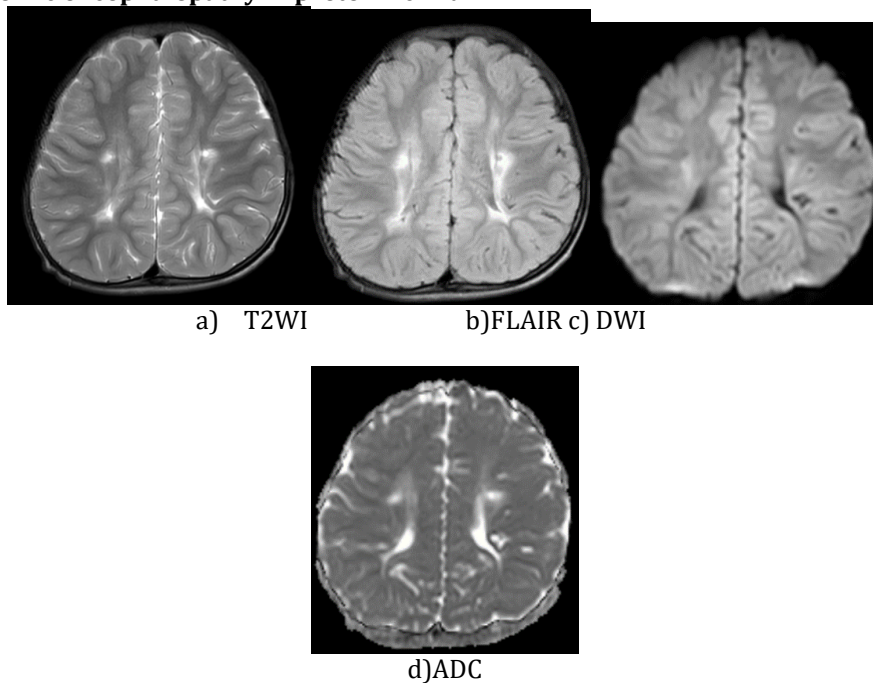
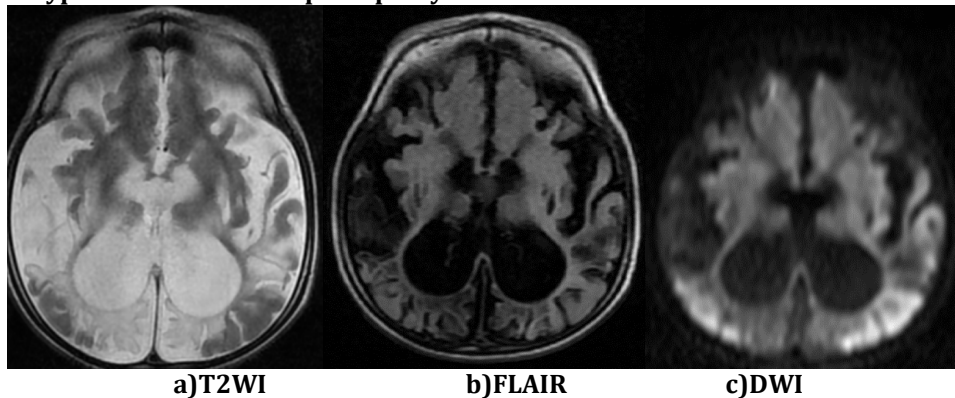
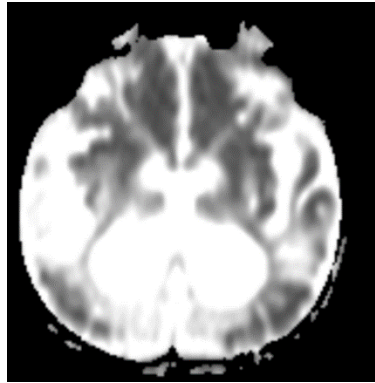


Fig4: Case of hypoxic encephalopathy, patient had history of preterm birth with history of birth asphyxia and NICU stay; There are bilateral T2WI/FLAIR hyperintensities in periventricular and subcortical white matter with no restriction on DWI.

Key: T2WI: T2 Weighted Imaging, FLAIR: Fluid attenuated inversion recovery, DWI: Diffusion weighted imaging, ADC: Apparent diffusion coefficient.

Multicystic Hypoxic Ischemic Encephalopathy in a term child





d) ADC

Fig 5: Term infant with history of birth asphyxia, Diffuse encephalomalacic changes seen in bilateral parieto-temporal lobes appearing hyperintense on T2WI, hypointense on FLAIR, areas of diffusion restriction seen in bilateral occipital region suggestive of acute infarction.

Key: T2WI: T2 Weighted Imaging, FLAIR: Fluid attenuated inversion recovery, DWI: Diffusion weighted imaging, ADC: Apparent diffusion coefficient.

CONCLUSION

MRI plays a significant role in evaluation of pediatric seizures, with identification and delineation of severity of wide variety of etiologies, thus helping in further management and treatment plan of patients. With magnetic resonance imaging the neuroanatomy can be depicted in explicit detail with excellent grey-white matter delineation. Also, it allows for much better identification and characterization of focal brain lesions. The added advantage is that its non-invasive and non-ionizing which is especially important in pediatric age group.

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None

CONFLICT OF INTEREST:

Nil

ETHICAL STATEMENT: Nil

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