IMAGING IN PEDIATRIC EPILEPSY: SPECTRUM OF ABNORMALITIES DETECTED ON MRI

Rachna Chaurasia, Shuchi Singh, Sachin Mahur, Pankaj Sachan.

1. Lecturer, Department of Radiology, M.L.B Medical College, Jhansi.
2. Resident, Department of Radiology, M.L.B Medical College, Jhansi
3. Assistant Professor, Department of Radiotherapy, M.L.B Medical College, Jhansi.
4. Resident, Department of Radiology, M.L.B Medical College, Jhansi

CORRESPONDING AUTHOR:
Dr Rachna Chaurasia,
Lecturer,
Department of Radiology,
M.L.B Medical College, Jhansi.
E-mail- dranshulrachna@rediffmail.com

ABSTRACT: OBJECTIVE: To evaluate role of radio-imaging, with emphasis on MRI in comparison to other modalities, in patients of paediatric age group presenting with epilepsy and correlate it with clinical findings in Bundelkhand region. **METHODS:** Prospective data was obtained from evaluation of patients presenting with epilepsy in paediatric OPD and IPD, between 2010 and 2012. A total of 271 patients presenting with epilepsy (> 2 episodes of seizures) were included. CBC, Chest X-ray and CSF analysis were also performed for clinical evaluation as per need. Neurosonogram was done in 41 children below age of 1year (15.1%), Head CT was obtained in 167 (61.7%), MRI in all cases. EEG was done in all cases, except in 5 cases of trauma. Epilepsy provoked by causes such as fever, electrolyte imbalance and dehydration were excluded. **RESULTS:** We observed that generalized seizures were more common presentation, followed by partial seizures, mostly complex. Majority had more than 2 episodes of seizures at the time of presentation. MRI revealed positive findings in 191 cases (70.4%) and CT in 64 cases (38.3%) of 167 done. MRI had positive findings in 35 cases (34.0%) of 103 with normal CT scan. Most common cause of epilepsy in this region was found to be CNS tuberculosis (Tuberculomas, 15.7% & TBM, 14.6%), followed by Neurocysticercosis (11.0%), Encephalitis (7.9%), Demyelination (6.8%), Gliosis with or without Encephalomalacia (6.8%), Periventricular leukomalacia (5.2%), Infarct (4.7%) & porencephaly (3.7%). Rare causes observed were leukodystrophy (7cases), intra-axial bleed (4 case) and extra-axial bleed (5case), heterotopias (4 case), abscess (2case) and Phakomatosis (Tuberous Sclerosis, 1 case). **CONCLUSION:** Since most of the seizures begin in paediatric age-group, which is crucial time for physical, psychosocial & mental growth, it is essential to evaluate the diverse varieties of aetiologies and manage patient accordingly. MRI thus proves to be the best for almost all pathologies, causing epilepsy, except trauma.

INTRODUCTION: Epilepsy is common sparing no age, race or ethnic background. The incidence of epilepsy is 1% [1], making it a common neurological condition. Epilepsy is first most common chronic condition seen by a paediatrician and second most common neurological condition seen by neurologists. It has lot of psychological, social and functional inabilities in children affected and their families.

Epilepsy is often, but not always, the result of an underlying brain disease. Any type of brain disease can cause epilepsy, but not all people with the same brain disease will have epilepsy. In view of the fact that only a proportion of people who have a brain disease experience seizures as a symptom of that disease, it is suspected that those who do have such symptomatic seizures are more vulnerable due to biochemical / neurotransmitter reasons. Instead of terms idiopathic, symptomatic and cryptogenic, the following three terms are and their associated concepts are recommended: Genetic, Structural/Metabolic & unknown [2].

Neuroimaging becomes important and mandatory in the work up for epilepsy in localisation and lateralisation of the seizure focus. The MRI is preferred form of Neuroimaging for children with seizures. MRI has increased our understanding of the underlying disease process as well as revolutionised evaluation and management of epilepsy [3].

For medically refractory epilepsy it is crucial to precisely identify epileptogenic foci that are potentially amenable to surgical resection for possible cure.

To our best of knowledge this is the first study to evaluate role of imaging in epilepsy patients of paediatric age group (0-18year). Also this is the first study to evaluate the role of imaging in GTCS patients in this age group.

METHODS: Prospective data was obtained from evaluation of patients presenting with epilepsy in paediatric OPD and IPD, between 2010 and 2012. A total of 271 patients presenting with epilepsy (> 2 episodes of seizures) were included. CBC, Chest X-ray and CSF analysis were also performed for clinical evaluation as per need. Neuro-sonogram was done in 41 children below age of 1year (15.1%), Head CT was obtained in 167 (61.7%), MRI in all cases. Contrast was given in patients with tumour, suspected vascular malformations, inflammation, and Infectious pathology.

EEG was done in all cases, except in 5 cases of trauma. Epilepsy provoked by causes such as fever, electrolyte imbalance and dehydration were excluded.

RESULTS: TABLE 1: Shows age distribution in this study: **This table shows that maximum number of cases belonged to 13-18 year of age group.**

S.No	Age-group	Total cases	Positive finding	Percentage
01.	0-1 year	49	37	19.4%
02.	1-6 year	58	41	21.5%
03.	7-12 year	75	53	27.7%
04.	13-18 year	89	60	31.4%
		271	191	

TABLE 2: Correlation of MRI & EEG findings: **This table showed that EEG & MRI are complimentary to each other, none alone is sufficient.**

	N=266			
EEG findings	Normal		Positive	
	161 (60.52%)		105 (39.48%)	
MRI findings	Positive	Normal	Positive	Normal
	78 (48.45%)	83 (51.55%)	76 (72.38%)	29 (27.62%)

TABLE 3: Correlation of type of seizure with Positive findings**: This table showed that cases with CPS had more chance of positive finding as compared to GTCS.**

S.No.	Type of seizure	Cases		
		Positive Findings	Normal	Total
01.	GTCS	137 (65.9%)	71(34.1%)	208
02.	CPS	54(85.7%)	9(14.3%))	63

TABLE 4: Causes of epilepsy: **This table shows common causes of epilepsy in order of prevalence.**

S.No.	**Cause**	**No. of cases**	**Percentage**
01.	CNS Tuberculosis a) Tuberculoma b) TBM	58 30 28	30.3% 15.7% 14.6%
02.	Neurocysticercosis	21	11.0%
03.	Encephalitis	15	7.9%
04.	Gliosis with encephalomalacia	13	6.8%
05.	Demyelination	13	6.8%
06.	Periventricular Leukomalacia	10	5.2%
07.	Granuloma	08	4.2%
08.	Infarct a) Arterial b) Venous	09 07 02	4.7% 3.7% 1.0%
09.	Porencephaly	07	3.7%
10.	Leukodystrophy	07	3.7%
11.	Edema	06	3.1%
12.	Trauma	05	2.6%
13.	Bleed (Intra-axial)	04	2.1%
14.	Tumour	04	2.1%
15.	Hetertropias	04	2.1%
16.	ADEM	02	1.0%
17.	Abscess	02	1.0%
18.	Bacterial Meningitis	02	1.0%
19.	Phakomatoses (Tuberous Sclerosis)	01	0.5%
	Total	**191**	

DISCUSSION: Epilepsy is second commonest neurological disorder after headache in India [4].
The role of radio-imaging in partial seizures in children has already been an established fact [5,8,9], but its role in children with generalized seizures particularly in unprovoked seizure is still a debatable point.

Several studies have been done regarding role of radio-imaging in seizure disorder. Most of the studies have been done in general population without discriminating between provoked and unprovoked seizures.

Study regarding role of radio-imaging in first apparent unprovoked generalized seizure in childhood population (0-18years) is not available and its role in such cases still remains a debatable point.

In the present study 271 patients of pediatric age group were studied, who were clinically diagnosed as case of epilepsy, with no provoking factors. Generalized seizure accounted for the majority of our cases (76.8%), which is in agreement with other studies in Africa [6] and India [7], showing preponderance of GTCS of 60-90% [4].

CT scan was done in 167 patients, of 103 with normal CT scan, 35(34.0%) had significant MRI findings which were not seen on CT scan. This difference in diagnostic ability of CT and MRI was shown by previous studies also [8,9]. This could be reasonably explained by multiplanar imaging capability, improved contrast of soft tissue, and high anatomical resolution of MRI over CT. Our finding corresponds with Jackson et al, 2006 [10], that it could be reasonable to forego CT and perform MRI.

We found positive MRI study in 70.4% cases. Resta et al. [11] reported positive MRI in 51.3%, Wang et al. [12] in 41.7% and Chang et al [8] in 48.9%. Our study shows a higher percentage, probably because of strict exclusion criteria's, which shows that patient selection, plays an important role in MR positivity rates.

The present study showed that most of the cases belonged to 13-18 year of age-group and also MRI findings were more in same. But in the incidence and prevalence studies carried out in India, it was higher in first decade of life [4, 7]. This could be explained because these studies were carried out in larger population and at primary level i.e. in rural population, but our study was conducted at tertiary health care centre where patient come usually after taking treatment elsewhere mostly from incompetent people or quacks or traditional methods of tantriks.

In present study Electroencephalogram was done in 266 cases, in which it was positive in 105 cases (39.5%) and normal in 161 cases (60.5%). This was comparable to prior studies [13]. In 105 cases with positive EEG, 76 (72.4%) had abnormal MRI, which was in accordance with previous studies, which showed that MRI abnormalities are usually associated with an abnormal EEG [14]. EEG helps in establishing the diagnosis of seizures, characterizing syndromes, and providing prognosis [15]. Out of 161 patient with normal EEG, 78 (48.4%) had abnormal MRI findings, so though presence of an abnormal EEG in patient could suggest positive MRI finding, but obviously a normal EEG doesn't rule out brain abnormality. This shows that MRI has higher chances of finding epileptogenic focus as compared to EEG alone, it goes in accordance with prior study by Kuzniecky and Knowlton, 2002 [16]. It could be inferred that EEG could be helpful, but not alone.

The most common cause of epilepsy in our study was CNS tuberculosis in this region, being at 30.3%, of which tuberculomas contributed 15.7% [Fig. 1] and tubercular meningitis 14.6%. This was followed shortly by Neurocysticercosis at 11.0% [Fig. 2] and encephalitis at 7.9%. This correlates well with studies done in other tropical countries, where infection still predominate as the most common cause of epilepsy [17]. In the studies conducted in other developing countries like Africa [6] and Nigeria [18] also reported a similar finding. This could be attributed to poor sanitation and low socio-economic status, still at large in the developing countries. The studies in developed countries showed that the most common cause for epilepsy, were cerebral dysgenesis [9], and followed by hypoxic-ischemic lesions, non- accidental injuries, infections, metabolic diseases and tumours [19].

Most of the epidemic encephalitis are caused by arboviruses and demonstrate regional and seasonal variation. Viral encephalitides are found all over the world with specific viruses being common in different geographical regions [20]. In this series we report two cases of ADEM (1.0%) [Fig. 3],it may be distinguished from infective encephalitis by the younger age of the patient, prodromal history of vaccination or infection, absence of fever at the onset of symptoms, and the presence of multifocal neurological signs affecting optic nerves, brain, spinal cord, and peripheral nerve roots [21].

Gliosis with or without encephalomalacia, periventricular leukomalacia (PVL), porencephaly and atrophy are varying response of brain to any type of insult, mostly perinatal or in infancy, but can occur later due to trauma, infection, infarct or haemorrhage. The result of insult during perinatal period depends upon the gestational age of patient, duration and severity of brain insult along with prenatal asphyxia, LBW, prematurity and toxaemia of pregnancy as predisposing factors [22]. Those patients with perinatal insult usually presented with cerebral palsy, intractable seizures and developmental delay. In our present study, 13 (6.8%) cases showed encephalomalacia with (out) gliosis, 10 (5.2%) had PVL [Fig. 4], and 07(3.7%) patient had porencephaly [Fig. 5]. Periventricular leukomalacia, represents toxic injury to premyelinating oligodendrocytes because of cerebral ischemia, reperfusion, or both [22, 23].**Porencephalic cysts** are congenital or acquired cavities within the cerebral hemisphere that usually—although not invariably— communicate directly with the ventricular system. They can be cortical or subcortical, unilateral or bilateral [24]. The location often corresponds to territories supplied by the cerebral arteries.

In the present study White matter disease was seen in 20 patients of which, 13 (6.8%) presented with demyelination and 07 (3.7%) with leukodystrophy [Fig. 6], together making 10.5%. They are proven to be associated with epilepsy by Guissard et al [19] and Hsieh et al [9], but their contribution has not been accounted for by any study. Since white matter does not have a generous blood supply as gray matter and is more susceptible to ischemia (HIE, vasculitis secondary to infection), toxin and other insults [25]. The most common location for the hyperintensities are the subcortical and periventricular white matter, optic radiations, basal ganglia and brain stem, in decreasing order of frequency. The lesions are hyperintense on T2, proton density, and FLAIR images and have well-defined but irregular margins.

Vascular diseases of the neonatal period include haemorrhage, venous thrombosis, and arterial infarctions. Infarct [Fig. 7] contributed to 09 (4.7%) cases in our study, of which 07 (3.7%) were arterial and 02 (1.05) venous. Intra-axial bleed [Fig. 8] was seen in 04 patients (2.1%). There is no prior record of how much they account for epilepsy, but they do cause epilepsy in paediatric age group. In contrast to stroke in adults and older children, neonatal stroke often presents clinically with seizures but not with focal neurological deficiencies [26]. Children can present stroke at any age. The incidence is higher under the age of 2 years and progressively decreases throughout adolescence [27]. We did not find neonates/infants in the present series, probably due to difficulties in performing imaging exams during the acute phase of the disease at this time during the investigation. The common causes of strokes in children are Rheumatic disease, Infectious endocarditis, congenital heart disease, mitral valve prolapse, sickle cell disease, haemolytic uremic syndrome and Antiphospholipid antibody syndrome. In many cases cause could not be determined [28]. In our study three children with infarct had RHD, sickle cell disease and congenital heart

disease. In rest, cause could not be determined. In two cases of intra-axial bleed patient had haemophilia and pancytopenia while in other two cause could not be ascertained.

This study had 06 cases (3.1%) of focal edema in children presenting with epilepsy, which resolved over time, leaving no residual abnormality. In these cases, there was no other abnormality to which epilepsy could be attributed to and hence they were thought to be the causative agents.

We report five cases of head trauma patient who had more than one episode of seizure following traumatic brain injury (TBI). Seizures are usually an indication of a more severe TBI. Seizures that occur shortly after a person suffers a brain injury may further damage the already vulnerable brain [29].

In this study there were four cases (2.1%) of tumours, all of which were infratentorial [Fig. 9], fourth ventricle mass and three of them were causing proximal ventricles dilatation. There is no prior data as to what percentage of epilepsy is contributed by tumours, though there are many studies regarding their implication as causative agent.

We report four cases (2.1%) of brain malformations, namely heterotopias [Fig. 10]. All of them were subcortical in nature and patient presented with epilepsy. Malformations of cerebral cortical development encompass a heterogeneous group of disorders frequently recognized on magnetic resonance images (MRI). These types of disorders are a cause of human epilepsy [30].

In this study we had two (1.0%) case of abscess in children. One of the child had congenital heart disease and other had pneumonia. In one case the abscess had ruptured in the lateral ventricles, causing obstruction and hence proximal dilatation. The clinical course is consistent with that of an expanding intracranial mass lesion. Seizures are the presenting manifestation in at least one-third of cases. Neuroimaging usually confirms the diagnosis by revealing a typically ring-enhancing lesion on contrast CT or MRI [31].

We report one case (0.5%) of phakomatosis that was tuberous sclerosis in 9 year old female, who presented to paediatric OPD with seizures, delayed mental development and skin manifestations. On MRI, scan showed subependymal nodules, cortical tubers and non-specific white matter changes. As many as 90% of patients with tuberous sclerosis have seizures [32], significant proportion of whom are refractory to medical therapy.

BIBLIOGRAPHY:

1. Hauser WA. The prevalence and incidence of convulsive disorders in children. Epilepsia 1994; 35(suppl 2):S1-S6.
2. Epilepsy diagnosis and treatment in infants and children. Consensus in Pediatrics Vol 1. No. 10.
3. Shinnar S, O'Dell C, Mitnick R, Berg AT, Moshe SL. (2001) Neuroimaging abnormalities in children with an apparent first unprovoked seizure. Epilepsy Res 43:261-269.
4. Das SK, Sanyal K: Neuroepidemiology of major neurological disorders in rural Bengal. Neurol India 1996; 14: 47-58.
5. Garg R K, Singh MK, Misra S (2000). Single enhancing CT lesions in Indian patient with seizures. A review. Epilepsy Res 2000; 38: 91-104.
6. Osuntokun BO. Epilepsy in Africa: a review. Trop Geogr Med 1978; 31: 24-31.
7. Sridharan R, Murthy BN. Prevalence and pattern of epilepsy in India. Epilepsia 1999; 40: 631-36.

8. Chang T, Acosta MT, Rosser T, Conry JA, Pearl PL, Weinstein SL, Kolodgie M, Johnson P, Vezina LG, Dubovsky EC, Galliard WD. (2002) Neuroimaging in children during the acute evaluation of new onset seizures. Ann Neurol 52:S134.
9. Hsieh DT, Chang T, Tsuchida TN, Vezina LG, Vanderver A, Siedel J, Brown K, Berl MM, Stephens S, Zeitchick A, Gaillard WD: New onset afebrile seizures in infants- role of Neuroimaging. Neurology 2010; 74:150-156.
10. Jackson N, Ridge CA, Delanty N: Imaging in patient with first seizure. Ir Med J. 2006 Jun; 99(6): 173-5.
11. Resta M, Palma M, Dicuonzo F, Spagnolo P, Specchio LM, Laneve A, Bellomo R, Lauriero F, La Selva L. (1994) Imaging studies in partial epilepsy in children and adolescents. Epilepsia 38:1187-1193.
12. Wang PJ, Liu HM, Fan PC, LeeWT, Young C, Tseng CL, Huang KM, Shen YZ. (1997) MRI in symptomatic /cryptogenic partial epilepsies of infants and children. Zhonghua Min Guo Xiao Er Ke Yi Xue Hui Za Zhi 38:127-136.
13. King MA, Newton MR, Jackson GD, et al. Epileptology of the first-seizure presentation: a clinical, electroencephalographic, and magnetic resonance imaging study of 300 consecutive patients. Lancet 1998; 352:1007–1011.
14. Doescher JS, deGrauw TJ, Musick BS, et al. Magnetic resonance imaging and electroencephalographic findings in a cohort of normal children with newly diagnosed seizures. J Child Neurol 2006; 21:491– 495.
15. Jallon P, Loiseau P, Loiseau J. (2001): Newly diagnosed unprovoked epileptic seizures: presentation at diagnosis in CAROLE study. Coordination Active du Reseau Observatoire Longitudinal de l' Epilepsie. Epilepsia 42:464–475.
16. Kuzniecky RI, Knowlton RC: (2002) Neuroimaging of epilepsy. Semin Neurol 22:279-288.
17. Gupta AK, Sharma R and Sarma D, 2000: Imaging in epilepsy. Indian J Pediatr 2000 Jan; 67 (1suppl):S40-60.
18. Osuntokun BO, Adeuja AOG, Nottidge VA, et al. Prevalence of the epilepsies in Nigerian Africans: a community based study. Epilepsia 1987; 28: 272-9.
19. Guissard G, Damry N, Dan B, Sekhara t, Ziereisen F, Christophe C: Imaging in pediatric epilepsy. Arch Pediatr. 2005 Mar; 12(3): 337-46.
20. Steine I, Budka H, Chaudhuri A, Koskiniemi M, Sainio K, Salonen O and Kennedy PGE. Viral encephalitis: a review of diagnostic methods and guidelines for management. European Journal of Neurology 2005, 12: 331–343.
21. Chaudhuri A, Kennedy PGE. Diagnosis and treatment of viral encephalitis. Postgrad Med J 2002; 78:575–583.
22. Shroff MM, Soares-Fernandes JP, Whyte H, Raybaud C. MR imaging for diagnostic evaluation of encephalopathy in the newborn. RadioGraphics 2010; 30:763–780.
23. Desilva TM, Kinney HC, Borenstein NS, et al. The glutamate transporter EAAT2 is transiently expressed in developing human cerebral white matter. J Comp Neurol 2007;501(6):879–890.
24. Osborn AG. Porencephalic cyst. In: Diagnostic imaging: brain. Salt Lake City, Utah: Amirsys, 2004; I-7-36.

25. Osborn AG. Acquired metabolic, white matter, and degenerative diseases of the brain. Diagnostic Neuroradiology 2009. 748-778.
26. Miller V. Neonatal cerebral infarction. Semin Pediatr Neurol. 2000;7: 278–288.
27. Moura-Ribeiro MVL, Ferreira LS, Montenegro MA, et al. Doença cerebrovascular na infância. Arq Neuropsiquiatr 1999; 57:594-598.
28. Noce TR, Fábio SRC, Neto JIS et al. Cerebral infarct in children aged zero to fifteen years. Arq Neuropsiquiatr 2004;62(1):38-43.
29. Agrawal A, Timothy J, Pandit L, Manju M (2006). "Post-traumatic epilepsy: An overview". Clinical Neurology and Neurosurgery 108 (5): 433–439.
30. Guerrini R, Carrozzo R. Epilepsy and genetic malformations of the cerebral cortex. Am J Med Genet 2001; 106: 160-73.
31. Aminoff MJ, Greenberg DA, Simon RP. Clinical Neurology. Stamford, CT: Appleton & Lange, 1996; 297–298.
32. Guerreiro MM, Andermann F, Andermann E, et al. Surgical treatment of epilepsy in tuberous sclerosis: strategies and results in 18 patients. Neurology 1998; 51:1263–1269.

FIGURE 1: Tuberculoma- Contrast enhanced T1WI axial images shows thick walled ring enhancing lesion with surrounding edema

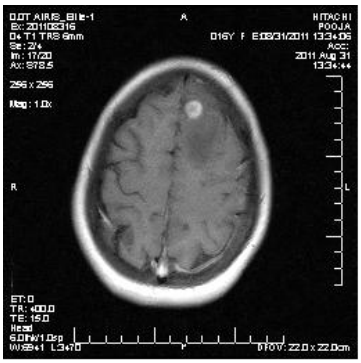

FIG 2: Neurocysticercosis- Contrast enhanced T1WI axial images shows multiple thin walled ring enhancing lesion with mild edema.

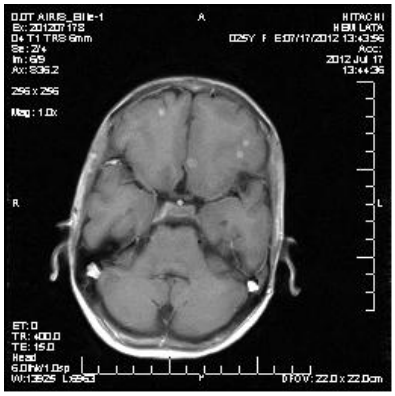

FIG 3: ADEM- FLAIR axial image shows multiple hyperintense foci involving cortex & subcortical white matter.

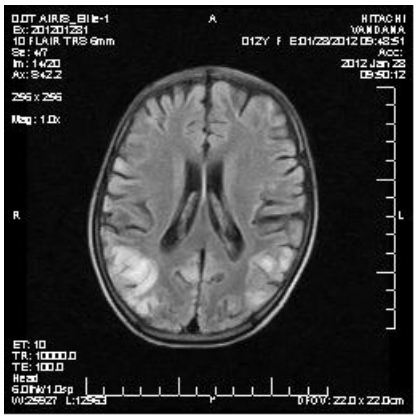

FIG 4: Periventricular Leukomalacia- FLAIR axial image shows dilated occipital horns with irregular walls & confluent hyperintensity in periventricular white matter.

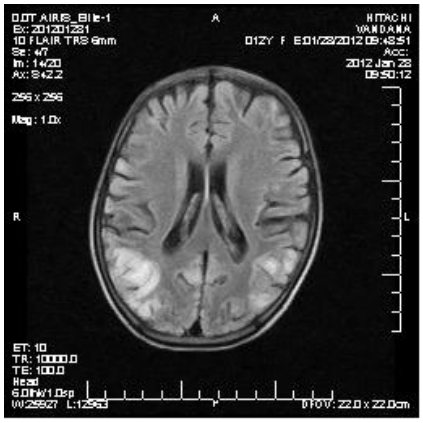

FIG 5: Porencephaly- FLAIR axial image shows large cavities of CSF signal intensity, in left hemisphere, communicating with lateral ventricles.

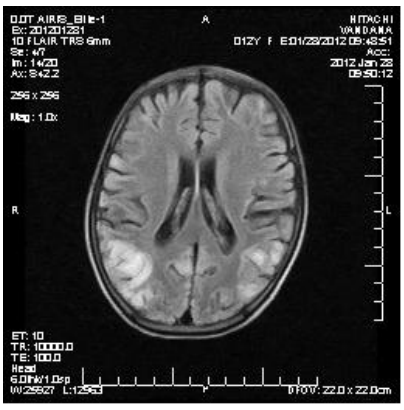

FIG 6: Leukodystrophy- T2WI axial image shows hyperintensity in periventricular white matter, with well-defined but irregular margins.

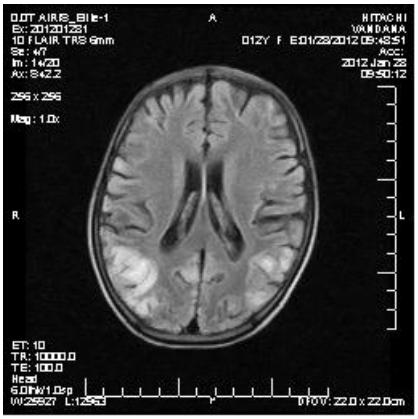

FIG 7: Infarct- FLAIR axial image shows hyperintensity in bilateral thalami, this patient was known case of RHD.

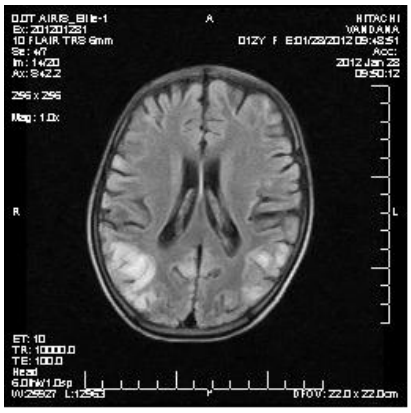

FIG 8: Intra-axial bleed- FLAIR axial image shows hyperintense region in right high parietal area, this patient was known case of hemophilia.

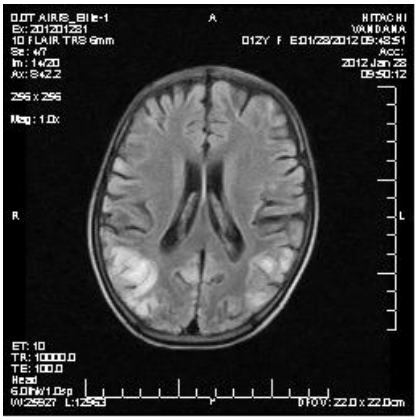

FIG 9: Tumour- FLAIR axial shows lobulated well-defined mass in infratentorial region compressing fourth ventricle.

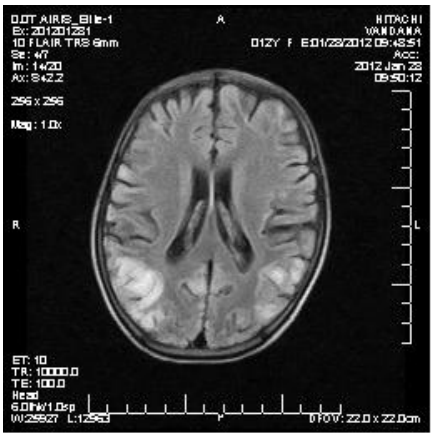

FIG 10: Heterotopias- FLAIR axial image shows focus in subcortical location in right hemisphere with signal intensity similar to grey matter, no enhancement was seen post contrast.