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Neuroimaging and its role in paediatric CNS Disorders

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Abstract

Background: This study may help in establishing coordination between paediatrician and radiologist regarding use of better neuroimaging techniques for particular neurological disorder in children. CNS disorders form a significant proportion of non-communicable disease. The average crude rate of CNS disorder in India is 2394 per 1,00,000 population. Most of the CNS disorders result into long term disability in the form of physical functioning limitation, Cognitive impairment, Behaviour problems, psychosocial limitation. **Aim:** To study neuroimaging findings in various CNS disorder and emphasizes its role in diagnosis. **Methods:** Cross sectional observational study was conducted over period of 1 year in the Paediatric department of a tertiary care hospital. Patients between 1 month - 12 year of age admitted in pediatric ICU / ward or attending pediatric / neuropediatric OPD diagnosed having any CNS disorder were included in study. Patients diagnosed with acute traumatic head injury or febrile seizure were excluded. Demographic data, clinical profile, Neuroimaging results of enrolled patients were noted. CSF examination and EEG were performed in required CNS disorders as per standard protocol and results were noted. **Observations:** It was observed from the study that common CNS disorders found were CNS infection (22%), encephalopathy (18%), congenital malformation (14%) and hydrocephalus (12%). Other disorder found were brain tumor, demyelinating disorder, neurocutaneous disorders and cerebrovascular disorders. **Conclusion:** Availability of neuroimaging has made diagnosis of CNS disorders easy in paediatric population. In emergency conditions CT scan is used but MRI is a feasible and sensitive modality without radiation exposure. Neuroimaging holds extreme value for definitive diagnosis of CNS disorder and also identifying exact anatomical location for further neurosurgical intervention of structural lesions. It also helps in establishing etiology, provides prognostic information and directs treatment

Keywords: Neuroimaging, Pediatric, CNS disorders.

Introduction

The burden of Central Nervous System disorders in children in India is enormous with overall prevalence rate of 1-3% in children < 5 years of age. [(1)] CNS disorders in paediatrics can have a wide range of spectrum from congenital malformation, infections, disorders,

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degenerative diseases, metabolic disorders, space occupying lesions to malignancy. Neuroimaging has a crucial role as a diagnostic as well as prognostic modality in CNS disorders. However, major challenges in paediatric neurology in India are high disease burden, poverty, predominant urban centred child neurology services and prevalent social issues. (2)

Aims And Objective

- To study role of neuroimaging in CNS disorders.
- To observe various neuroimaging findings in CNS disorders.

Material And Methods

This study was Cross sectional observational study conducted in the Paediatric department of a tertiary care hospital. Patients between 1 month - 12 year of age admitted in paediatric ICU / ward or attending paediatric / neuropediatric OPD diagnosed having any CNS disorder were included in study. Patients diagnosed with acute traumatic head injury or febrile seizure were excluded. As per pre-designed proforma a detailed demographic profile and clinical profile were noted. Neuroimaging results were noted. CSF examination and EEG were performed in required CNS disorders as per standard protocol and results were noted. Final diagnosis of CNS disorders with all the details regarding neuroimaging were noted. Data was analysed from filled proforma and appropriate statistical analysis were applied depending up on the distribution of data. Funding is nil and study began after the approval of study protocol by the Institutional Review Board. Written consent was taken from caretakers.

Observation and Discussion

Total 50 patients were enrolled in this study. Out of them, 28 patients were admitted in Paediatric ward / ICU and 22 patients were attending Paediatric / Neuropediatric OPD, diagnosed having CNS disorder.

Table 1: Demographic Details

Demographic Details			
	Frequency	**Percentage**	
Age Distribution			
< 1 year	16	32	
1-5 year	9	18	
5-12 year	25	50	
Gender			
Male	38	76	
Female	12	24	
Socio-Economic Class			
Lower	23	46	
Middle	24	48	
Upper	3	6	
Consanguinity			
Present	9	18	
Absent	41	82	
			n=50

In our study, 50% patients were between 1 month to 5year and 50% between 5 years to 12 years and male to female ratio was 3.16:1.0. Most of the patients in our study were from lower and middle socio-economic class.
Singh et al[3] (2016) and Mogre S.S at el[4] (2021) in their study observed that 50% and 53.5% of the patient were between 6 month to 5 years, and 50% and 46.5% were more than 5 years of age, respectively; which is nearly similar to our study.
Singh et al[3] (2016), Ndubuisi, C. A., et al[5] and Mohamed, I. N., Elseed, M. A., & Hamed, A. A.[6] (2016) observed male to female ratio of 1.38:1 ; 1.2:1. and 2:1. in their study, respectively.

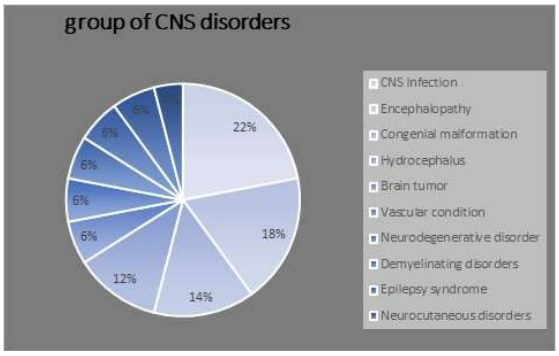

Table 2: Various Group of CNS Disorders

In our study, the most prevalent group of CNS disorders found was CNS infection (27%) followed by encephalopathy (18%) and congenital malformation (14%). Neurocutaneous syndromes were least prevalent in our study. CNS disorders involving spinal cord were found in two patients, diagnosed with acute transverse myelitis and lumber meningomyelocele.
Singh et al (2016) observed CNS infection in 31% of patients, seizure disorders including idiopathic epilepsy, cerebral palsy and unprovoked seizure accounted for 21%, SOL including neurocysticercosis and brain tumor accounted for 21%, febrile seizure accounted for 21% of patients.[3]
Mogre S.S at el (2021) in his study; etiological analysis revealed CNS infection as most common disorder followed by SOL, epilepsy, cerebral palsy.[4]

Table 3: Clinical Presentation of patients at the time of diagnosis

Clinical presentation	Number of patients
Convulsion	26 (52%)
Fever	14 (28%)
Developmental delay	12 (24%)

Paresis/paralysis	10 (20%)
Vomiting	6 (12%)
Altered sensorium	4 (8%)
Head ache	4 (8%)
Ataxia	3 (6%)
Irritability	2 (4%)

Most common clinical presentation was convulsion (52%). Other commonly presenting symptoms were fever (28%), developmental delay (24%) and paresis/ paralysis (20%).
Burton el at 2003 on neurological disorders presenting at a pediatric neurology clinic found that principle clinical presentation most frequently seen was seizures (57%), neuromotor problems (15%) and developmental delay (11%).[7]

Table 4: Neuroimaging Modalities

Neuroimaging method	Total no of patients	Abnormality	Normal
MRI Brain and MRI spine	45	37	6
CT Brain	10	10	0
MR angiography	2	2	0
USG cranium	2	1	1

Table 5: Abnormal MRI findings

Abnormal MRI findings	CNS disorder	Number of patients
Focal Gliosis	Static encephalopathy	4
Cystic encephalomalacia	Static encephalopathy	3
Periventricular Leukomalacia	Static encephalopathy, leukodystrophy	3
Aqueductal stenosis	Non communicating hydrocephalus	3
SOL in posterior fossa	Brain tumor	3
Leptomeningeal Enhancement	Pyogenic meningitis	2
Cortical tubers	Tuberous sclerosis	2
Hypoplasia of corpus callosum with cerebellar tonsillar herniation	Arnold Chiari malformation	2
Abnormal hyperintensity in	Viral encephalitis, autoimmune	2

B/L cerebral hemisphere	Encephalitis	
Infarcts in MCA territory	Acute ischemic stroke	2
Pachygyria B/L cerebral hemisphere	Static encephalopathy	1
Volume loss B/L hemisphere	Static encephalopathy	1
Atrophy at cerebellar area	Static encephalopathy	1
Pachygyria with hypoplasia of anterior callosum with enlarged ventricle	Lissencephaly type I	1
Conglomerated ring enhancing lesion	Pyogenic meningitis	1
Hypoplasia of vermis with corpus callosum agenesis	Dandy walker variant	1
Hypomyelination in B/L cerebral hemisphere	Leukodystrophy	1
Intramedullary Hyperintensity	Acute transverse myelitis	1
Hemi atrophy of cerebral hemisphere with thickening of calvaria	Dyke Davidoff Manson syndrome	1
Small ring enhancing lesion	Tuberculoma	1
Basal meningeal enhancement with focal infarcts with hydrocephalus	Tubercular meningitis	1
Asymmetric hyperintensity in cortical and subcortical area	Subacute sclerosing pan encephalitis	1
Hyperintensity of intraorbital part of optic nerve	Optic neuritis	1

Out of these abnormal imaging most of the patients were diagnosed from these imaging modalities, but few of them required further evaluation with different investigation modalities.

Patients with posterior fossa SOL required histopathology testing of resected SOL and one of them was diagnosed with medulloblastoma and rest two were diagnosed with pilocystic astrocytoma.

Two patients of stroke MRI finding suggestive of infarcts in right MCA territory were further investigated with MR angiography which was suggestive of right MCA stenosis and were diagnosed as Moya Moya disease.

Scott, R. M., & Smith, E. R. (2009) stated that patients with Moya Moya disease are at high risk for stroke. [8]

Bhatia Aashim, and Sumit Pruthi in 2016 found in SSPE neuroimaging finding usually include abnormal T2 hyperintense area mainly at periventricular to subcortical white matter and progressing to diffuse cerebral and cerebellar atrophy[9], which was similar to our study.

Pauline, Leema *at el* stated that the triad characterized by basal meningeal enhancement, hydrocephalus and deep infarcts is highly suggestive of tuberculous meningitis[10], which was similar to present study.

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Total 6: Abnormal CT scan finding

Abnormal CT scan finding	**CNS disorder**	**Diagnostic investigation**	**Number of patients**
Dilated lateral, 3rd and 4th ventricle	Communicating hydrocephalus	-	3
Dilated lateral and 3rd ventricle and normal 4th ventricle (aqueductal stenosis)	Non communicating hydrocephalus	-	3
Hypoplasia of vermis with partial agenesis of corpus callosum	Dandy walker variant	-	1
Hyperdense mass in cerebellum	Medulloblastoma	MRI brain and histopathology	1
Bony defect with hypodense component herniation	Frontal meningoencephalocele	MRI brain	1
Midline shift with multiple hypodense lesions	Brain abscesses	MRI brain	1

Patient underwent CT scan imaging; out of them 3 patients were required further evaluation with MRI or other investigation modality for diagnosis.

Table 7: Normal Imaging in CNS disorders

Normal Imaging in CNS disorders	Diagnostic investigation
Pyogenic meningitis	CSF examination
Acute meningoencephalitis	CSF examination
Myoclonic epilepsy	EEG
left Epilepsia Partialis Continua	EEG
Right focal temporal motor epilepsy	EEG
Landau kleffner syndrome	EEG

In this study normal MRI imaging was found in 6 (13.3%) patients. They were diagnosed with clinical profile and other relevant investigations.
Thomas, Mili, *et a* in 2020 found that 50% of patients with meningitis had normal MRI results. [(11)]

Conclusion

Availability of neuroimaging has made diagnosis of CNS disorders easy in paediatric population. In emergency conditions CT scan is used but MRI is a feasible and sensitive modality without radiation exposure. Neuroimaging holds extreme value for definitive diagnosis of CNS disorder and also identifying exact anatomical location for further neurosurgical intervention of structural lesions. It also helps in establishing etiology, provides prognostic information and directs treatment. The strength of this study is that it assesses different clinical and radiological profile of different CNS disorders in a single clinical setting over a period of time. However, the limitation of this study is its limited sample size, hence making it difficult to comment on a larger group of population. Further clinical studies targeting a larger population with a prospective approach can be conducted.

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