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Original Research Article

Study of clinicodemographic profile of acute central nervous system infection in children and its correlation with neuroimaging

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ABSTRACT

Background: Infection of central nervous system (CNS) is most common cause of fever associated with signs and symptoms of CNS disease in children. Viral infections of CNS are more common than other infections. Radiology and pathology go together in understanding etiology causing CNS infections which have similar clinical manifestations making specific diagnosis difficult. The present study aims to study the utility of different neuroimaging patterns in diagnosis of acute CNS infection. Aims include: to study utility and pattern of neuroimaging in CNS infection in paediatric age group, and to study socio-demographic and clinical profile of CNS infection in children.
Methods: Prospective observational study in children 1 month-12 years who presented with CNS infection.
Results: Total 58 cases were suspected to have CNS infection, which was more prevalent in 1 month-1 year (27.58%), followed by 5-8 year (24.13%), 1-3 year (22.41), >8 year (20.68%) and 3-5 year (5.17%). Neuroimaging was done in all suspected case (58) of CNS infection in which 30 (51.7%) had abnormal neuroimaging where 3(10%) showed pyogenic meningitis, 7 (23.23%) tubercular meningitis (TBM), 4 (13.13%) tuberculoma, 3 (10%) TBM and tuberculoma, 4 (13.3%) viral meningitis, 1 (3.3%) herpes simplex encephalitis (HSE), 1 (3.3%) COVID encephalitis, 4 (13.3%) acute disseminated encephalomyelitis (ADEM) while 2 (6.66%) brain abscess. Correlation between final diagnosis and neuroimaging was 100% in ADEM, brain abscess, tuberculoma, TB spine, HSV followed by TBM (77.77%), pyogenic meningitis (27.27%) and viral encephalitis (26.66%). Clinically diagnosed acute CNS infection was confirmed in 51.72% and wrong in 48.27%.
Conclusions: CNS infections were more common in less than 5 years age. Approximately 50% patients had abnormal neuroimaging finding. It was found that neuroimaging was more accurate in early diagnosis, categorization of CNS infection and detection of complications with high sensitivity.

Keywords: CNS infection, Neuroimaging, Pediatrics

INTRODUCTION

Infection of the central nervous system (CNS) is the most common cause of fever associated with signs and symptoms of CNS disease in children. Viral infections of the CNS are much more common than bacterial infections, which, in turn, are more common than fungal and parasitic infections.

Radiology and pathology are inseparable at the time of understanding the phenomenon causing nervous system infections. There are a wide range of neuroimaging findings in CNS infections, often with considerable overlap, which makes determination of a specific diagnosis difficult. Correlation with laboratory tests, particularly cerebrospinal fluid (CSF) analysis, is considered to be essential in establishing a definitive diagnosis.[1]

Most patients with CNS infection have similar clinical manifestations. Common symptoms include headache, nausea, vomiting, anorexia, restlessness, altered state of consciousness, and irritability; most of these symptoms are nonspecific.[2] Common signs of CNS infection, in addition to fever, include photophobia, neck pain and rigidity, obtundation, stupor, coma, seizures, and focal neurologic deficits. The severity and constellation of signs are determined by the specific pathogen, the host, and the area of the CNS affected.[2] Infection of the CNS may be diffuse or focal. Meningitis and encephalitis are examples of diffuse infection. Meningitis implies primary involvement of the meninges, whereas encephalitis indicates brain parenchymal involvement. Because these anatomic boundaries are often not distinct, many patients have evidence of both meningeal and parenchymal involvement and should be considered to have meningoencephalitis. Brain abscess is the best example of a focal infection of the CNS.[3]

The diagnosis of diffuse CNS infections depends on examination of CSF obtained by lumbar puncture (LP). Though CSF remains the gold standard for diagnosis of acute CNS infection, role of neuroimaging cannot be denied. Few Indian studies are available which delineate the efficacy and accuracy of neuroimaging in management of patient with acute CNS infection. The present study aims to study the utility of neuroimaging in diagnosis of acute CNS infection and the neuroimaging patterns found in different CNS infection.

METHODS

Study type

This is prospective observational study in children (1 month–12 years old) who presented with CNS infection.

Study place

Ward and pediatric intensive care unit (PICU) of tertiary care hospital- Shardaben General Hospital affiliated to Smt. NHL Medical College, Ahmedabad, Gujarat.

Study period

The period of the study was from June 2020 to November 2021.

Selection criteria

The given inclusion and exclusion criteria was used to select the study subjects.

Inclusion criteria

All children between age of 1 month to 12 years admitted in ward and PICU of tertiary care centre were diagnosed as having CNS infection based on clinical and neuroimaging findings. Neuroimaging was done in all suspected cases of CNS infection.

Exclusion criteria

Patient expired within 24 hour of admission. Those patients who are clinically suspected for acute CNS infection but not affordable for neuro-imaging.

Method

The cases of acute CNS infection were classified based on standard case definition and standard protocol.

Clinical and imaging – computed tomography/magnetic resonance imaging (CT/MRI scan) database review of diagnosed patients having CNS infection based on neuroimaging findings was done.

Detailed history and examination of these children was carried out.

Data was collected in form of detailed proforma with CNS examination as per the design.

Necessary investigation like MRI, lumbar puncture done and patients were managed appropriately according the standard protocol.

Modality of neuroimaging defined based on protocol.

Requested neuro-imaging was done with prior explanation of the radiological investigation and informed written consent of the patient/relatives.

CT was performed on Philips ingenuity core 128 multiline unit with axial, coronal and sagittal reconstructions of desired thickness of acquired data. Contrast enhanced computed tomography (CECT) scans were performed after bolus injection of low osmolalaity non-ionic iodinated contrast material (iohexol 300 mg/ml, dose: 1 ml/kg).

MRI scans were performed on 1.5T GE signa HDe 8 channel unit with acquisition of spin echo T1W, T2W, T2 FLAIR, SWI in desired planes and axial EPI- DWI and ADC maps.

CE MRI was done post IV gadolinium (dose 0.1 mmol/kg) injection with acquisition of TIW scans in three orthogonal planes. Imaging findings were evaluated and tabulated and correlated with the clinical findings and pathological findings (wherever available) subsequently.

Data was entered and appropriate statistical software-statistical package for the social sciences (SPSS) applied.

Ethical consideration

Informed consent was taken in vernacular language.

Table 1: Study clinical case definition.[11]

Criterion	Definition
Age	1 month – 12 years
Fever	≥38°C within 24 hours of hospital admission
Clinical features	At least one of: stiff neck; altered/reduced consciousness (V, P, or U on the AVPU score); <15 on the Glasgow coma score; focal neurological symptoms/signs; convulsions (aged <6 months or ≥6 years: any seizure, *aged 6 months to <6 years: any focal or prolonged seizure, or ≥2 brief generalised seizures); bulging fontanelle if <12 months of age; irritability if <5 years of age; headache; prostration; inability to drink or breast feed, or to remain sitting in a child otherwise able to sit; and petechial or purpuric rash
Laboratory investigation	Neuroimaging

RESULTS

Total 58 cases of less than 12 years old children were suspected to have CNS infection in study period at a tertiary care center.

Table 2: Age and sex group distribution.

Parameters	No. of cases	%
Age group		
1 month-1 year	16	27.58
1 to <3 year	13	22.41
3 to <5 year	3	5.17
5 to <8 year	14	24.13
>8 year	12	20.68
Total	58	100
Sex group		
Male	30	51.72
Female	28	48.27
Total	58	100

Table 3: Presentation.

Symptoms	Yes	%
Fever	45	77.58
Altered sensorium	18	31.03
Seizure	50	86.20
Vomiting	17	29.31
Headache	9	15.51
Cough-cold	8	13.79
Refusal to feed/decrease oral intake	11	18.19
Status epilapticus	30	60
Meningeal signs	34	58.62

In this study, among the 58 cases, fever was present in 45 (77.58%), Altered sensorium in 18 (31.03%), seizures in 50 (86.20%), vomiting was present in 17 (29.31%), headache in 9 (15.51%) and cough-cold in 8 (13.79%) cases. out of 50 cases with seizures 60% had status epilepticus. 34 (58.62%) cases had signs of meningeal irritation while in 24 (41.37%) cases signs were absent. Around half of the patient had meningeal signs because both meningitis and encephalitis are included as part of spectrum of acute CNS infection.

Table 4: Spectrum of acute CNS infection.

Diagnosis	Case	%
Pyogenic meningitis	11	18.96
Enteric encephalitis	3	5.17
CNS TB	16	27.5
TBM	9	
Tuberculoma	4	
TBM+tuberculoma	3	
TB spine	1	1.72
Viral meningoencephalitis	14	24.13
Herpes simplex encephalitis	1	1.72
Dengue encephalitis	5	8.62
COVID encephalitis	1	1.72
ADEM	4	6.89
Brain abscess	2	3.44
Total	58	100

In this study on distributing patients based on clinical and pathological findings, viral infection 14 (24.13%) was most common, followed by acute bacterial/ pyogenic infection 11 (18.96%), tubercular infection 16 (27.5%), dengue encephalitis in 5 (8.62%), enteric encephalitis 3 (5.13%), TB spine and HSE, COVID encephalitis in 1 (1.72%).

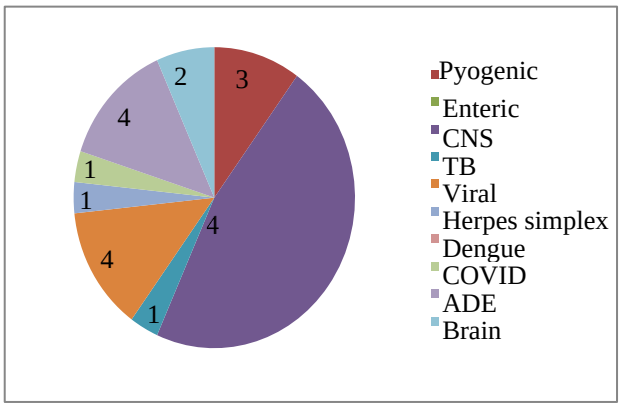

Figure 1: Number of patient with abnormal neuroimaging.

Among the 30 cases with abnormal neuroimaging 3 (10%) showed pyogenic meningitis. In CNS TB: tubercular meningitis present in 7 (23.23%) patient, tuberculoma in 4 (13.13%), TBM and tuberculoma in 3 (10%).

Viral meningitis in 4 (13.3%), HSE in 1 (3.3%), COVID encephalitis in 1(3.3%), ADEM in 4 (13.3%) while 2 patients (6.66%) were found to have brain abscess.

Clinically diagnosed was confirmed in 51.72% (30 case) and was wrong in 48.27% (28 case). There was significant statistical correlation between abnormal neuroimaging findings and etiology of CNS infections. Correlation is significantly more in case of Tuberculous meningitis as compared to pyogenic meningitis ($p<0.05$).

Correlation was 100% in ADEM, brain abscess, tuberculoma, TB spine, HSV followed by TBM 77.77% and followed by pyogenic meningitis (27.27%) and viral encephalitis (26.66%).

Sensitivity was highest in TBM and lower in case of pyogenic meningitis and viral encephalitis, which was comparable to other study.

Table 5: Comparisons of final diagnosis and neuroimaging.

CNS infection	Final diagnosis	Abnormal neuroimaging finding	Correlation
Pyogenic meningitis	11	3	27.27
Enteric encephalitis	3	0	0
CNS TB	16	14	87.5
TBM	9	7	77.77
Tuberculoma	4	4	100
TBM+tuberculoma	3	3	100
TB spine	1	1	100
Viral meningitis	0	0	0
Herpes simplex encephalitis	15	4	26.66
Dengue encephalitis	1	1	100
COVID encephalitis	5	0	0
ADEM	1	1	100
Brain abscess	4	4	100
Total	2	2	100

Table 6: Comparison for sensitivity of neuroimaging in CNS infection.

Sensitivity	Present study	Kumar	Granerod et al	Sharon Tai et al	Zhang (MRI+CSF)	Olivier et al (MRI+CSF)
Tb	88.2	14.2	-	-	24.75	81.3
Pyogenic meningitis	30	88.5	-	89	62.46	-
Viral encephalitis	28.5	26.6	81	-	68.71	68.71

DISCUSSION

This was prospective observational study in children (1 month–12 year old) who presented with CNS infection. This study included 58 children in the age group of 1 month–12 years with a clinical picture suggestive of CNS infection.

Acute CNS infection found to be more prevalent in 1 month to 1 year group (27.58%), followed by 5 to 8 year (24.13%), 1 to <3 year (22.41%), >8 year (20.68%), and 3-5 year (5.17%). The results are comparable with study done at Ananthapuri Hospital and Research Institute, Thiruvananthapuram, India between 2008 and 2020 where 16 patient in the infant (1 month-1 year old) group (25.80%) and 27 patient (43.54%) in the age group 1-5 year.[4]

Among the 58 cases, fever was present in 45 (77.58%), Altered sensorium in 18 (31.03%), seizures in 50 (86.20%), vomiting was present in 17 (29.31%). Thus, fever, altered sensorium and seizures, which is considered to be the triad of symptoms in acute CNS infections, was present in most of the cases.[5] This study was compared with the "clinico-etiological correlation with the neuroimaging study" in Dhiraj Hospital, Vadodra. Fever was the most common presenting symptom and was present in all patients followed by convulsion (73.77%), altered sensorium (36.07%), vomiting (31.15%), irritability 17 (27.87%) and headache (18%) respectively.[6,9]

Out of 50 cases with seizure, 60% had status epilepticus. 34 (58.62%) cases had signs of meningeal irritation. The results are comparable with study done at Ananthapuri Hospital and Research Institute, Thiruvananthapuram, India between 2008 and 2020 were out of 24 patient, 14

patients (58.33%) presented with status epilepticus, and it is the most common symptom.[4,8,12]

Distributing patients based on clinical and pathological findings, viral infection (24.13%) was most common followed by acute bacterial/pyogenic infection (18.96%), tubercular infection 16 (27.5%), dengue encephalitis in (8.62%), TB spine and HSE in (1.72%). This study compared with the imaging of CNS Infections with clinic-pathological correlation, done at Western Uttar Pradesh where tubercular infection (TBM) was most common (41.2%) followed by acute bacterial/ pyogenic infection (36.2%) and viral infection (22.5%).[7,10] Thus, commonest CNS infection encountered in the present study was viral meningitis followed by pyogenic meningitis which was closely followed by gynogenic meningitis.

Out of 58 patient 28 (48.2%) patients had normal neuroimaging study and 30 (51.7%) had abnormal neuroimaging study. Among the cases with abnormal neuroimaging 3 (10%) showed pyogenic meningitis, TBM was present in 7 (23.23%) patients, tuberculoma in 4 (13.13%), TBM and tuberculoma in 3 (10%), viral meningitis in 4 (13.3%), HSE in 1 (3.3%), COVID encephalitis in 1 (3.3%), ADEM in 4 (13.3%) while 2 patients (6.66%) were found to have brain abscess. Thus, out of the patients with abnormal neuroimaging in the present study, maximum number of patients was of CNS tuberculosis, followed by viral meningitis and ADEM. Pyogenic meningitis was found in around 1/10th of the patients.

Clinico-neuroimaging correlation was seen in ADEM, brain abscess (100%), and followed by CNS TB (77.77%), pyogenic meningitis (27.27%), viral meningoencephalitis (26.66%). Thus neuroimaging remain modality of choice for diagnosis of ADEM, brain abscess, TB spine, tuberculoma, HSE. This fact is confirmed in the study .Also correlation was significantly more in TBM as compared to pyogenic meningitis.

Limitation of study

Since this is an observational study, comparison groups are not taken further analytical studies would be more valuable to draw more specific conclusion.

CONCLUSION

It was found that neuro-imaging was accurate in early diagnosis and categorization of CNS infections with high sensitivity in CNS tuberculosis.

Recommendations

In patients presenting with CNS infection, familiarity of various imaging patterns in CNS infections is of key importance to pediatricians and radiologists in timely diagnosis thereby reduce irrational over use of antibiotic and antiviral medication, morbidity and mortality of the potential threatening disease.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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