ORIGINAL RESEARCH PAPER
Volume-6 | Issue-12 | December-2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 93.98
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

"CLINICOETIOLOGICAL CORRELATION OF CNS INFECTIONS WITH NEUROIMAGING"

Paediatrics

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ABSTRACT

Introduction: CNS infections are life threatening condition which is limited to meninges or brain parenchyma. It could be bacterial, viral, fungal and parasitic. Diagnosis of CNS infection in children with specific pathogen has the utmost importance. Diagnosis is difficult in these patients due to nonspecific clinical feature. When patient with CNS infection admitted, it is hard to distinguish pyogenic and tubercular meningitis. Outcome in these patients depends upon stage of disease, time of diagnosis and proper treatment. Neuroimaging has a very crucial role in visualization of typical lesion in brain and spinal cord. This study planned to correlate clinical and etiological finding of CNS infection with neuroimaging.

Method: This was a prospective observational study carried out in department of paediatrics in SBKS MIRC. All the confirmed cases of CNS infection in children (1 month to 18 years) were subjected to complete neuroimaging study, CT scan (with or without contrast) or MRI Scan.

Result: 61 patients included in study, in which 26.2% with pyogenic infection, 42.6% with tubercular infection, 26.2% viral infection and 4.9% with parasitic infections were found. Total 75% in pyogenic group, 96.2% in tubercular group, 37.2% in viral group respectively had abnormal neuroimaging finding.

Conclusion: Neuroimaging plays very important role in diagnosis of CNS infection specially tubercular and pyogenic. Although, CSF examination remains the gold standard investigation.

KEYWORDS

CNS infections, Meningitis, Encephalitis, Neuroimaging, MRI, CTSCAN, Outcome.

INTRODUCTION

Infection of the central nervous system (CNS) is a life-threatening condition in children. Globally, CNS infections limited to the meninges (meningitis) or with brain parenchyma involvement (encephalitis) are common causes of hospital admissions. The pathogens responsible for these infections may be bacteria, viruses, fungi or parasites. The incidence and etiology of CNS infections vary in time, by geographic region, with age, co-morbidities and vaccination status of the child. Infections of the central nervous system are important because of, i) the endemicity of many of the pathogens, ii) the emerging and re-emerging of new infections, iii) the heavy burden imposed by them on the health care system, iv) the confusing number of pathogens involved, v) the difficulty in arriving at exact microbiological diagnosis and vi) the significant mortality and morbidity rates in the affected patients. These are particularly so in Asia1. The epidemiology of CNS infection in Asia exhibits significant differences from the rest of the world. Although the causes of bacterial meningitis are relatively uniform in many parts of the world; but in some parts of Asia, gram negative bacilli and tubercular bacilli, which are not commonly found to be as important cause of bacterial meningitis elsewhere, assume far greater importance1. However, given the rapidity with which CNS infections may progress and the potentially devastating neurologic complication of undiagnosed disease, accurate and timely diagnosis is of utmost importance.

Almost all agents can cause infection of the central nervous system and the extent of infection ranges from diffuse involvement of the meninges, brain, or spinal cord to localized involvement presenting as a space-occupying lesion. The differential diagnosis of CNS infections in children has been reported to be difficult due to various nonspecific clinical features. The outcome of disease is strongly associated with the stage of disease presentation, with a good cure rate if proper diagnosis and timely treatment are given; otherwise it leads to various proportion of morbidity and mortality.

CNS infections continues to be one of the most serious causes of hospital admissions in children in India. These infections still pose a diagnostic problem. The reason for this is that, partially treated pyogenic and tubercular infection may be indistinguishable. In about one third of children admitted with CNS infection, we initially find ourselves in a diagnostic dilemma as to whether the child has pyogenic or tuberculous meningitis. The diagnosis can often be made in retrospect after assessing the response to therapy and the patients clinical course during the hospital stay. However, valuable time may be lost before the clinical picture becomes distinct.

Infections of the nervous system and adjacent structures leads to often life-threatening conditions. Prognosis mainly depends on rapid identification of the site of inflammation and pathogen in order to initiate effective antimicrobial treatment as early as possible. Whereas analysis of CSF and laboratory analysis remain the gold standard to identify the infectious agent for instance in meningitis, neuroimaging is crucial in clearly depicting inflammatory lesions of brain and spine.
The cornerstone of management of CNS infection in children depends on the rapid diagnosis and prompt treatment. Modern imaging techniques define the anatomic region infected, the evolution of the disease, and help in better management and timely intervention in these patients. Neuroimaging plays a crucial role in the diagnosis and therapeutic decision making in infectious diseases of the nervous system. It is crucial in visualization of typical lesion patterns which not only allows for rapid diagnosis but also subsequent therapeutic decisions and prevention of neurological complication. Particularly recognition of certain atypical imaging features of common CNS infections must be kept in mind to avoid a diagnostic dilemma and delay in appropriate therapy.

This study helps us in understanding clinical presentation of various CNS infections in paediatric population and their imaging findings in paediatric and also ascertains whether, if any, correlation exists

between them for early diagnosis, effective treatment and better outcome of patients.

MATERIALS AND METHODS

Study design: Observational prospective study.
Study site: Study was carried out in Department of Paediatrics of Dhiraj Hospital, Piparia, Vadodara district.

Enrolment period: From 29th feb, 2016 to 30th June 2017.
Inclusion criteria: i) All children in age group of 1 month to 18 years with suspected cases of CNS infections. ii) Parents/guardian who consented for participation in the study.

Exclusion criteria: i) Children <1 month of age. Ii) Children with metabolic disorders, autoimmune, post-traumatic CNS infections. Iii) Children having other neurological disorder along with suspected CNS infections (cerebral palsy, congenital anomalies, etc) which could directly or indirectly affect the neuroimaging findings.

METHOD:

This study included children with central nervous system infection between 1 month to 18 years of age, who got admitted in Dhiraj hospital from 29th Feb 2016 To 30th June 2017.

Written informed consent of parents and Asscent in case of Adolescent was taken before enrolment. The study included children with clinical findings consistent with CNS infections (eg. fever, headache, vomiting, nuchal rigidity, convulsion, impaired consciousness, etc). After initial clinical assessment, blood samples were drawn and a lumbar puncture was performed. Biochemical and cytological examinations of CSF samples were performed, including the measurement of leukocyte count, neutrophil count, glucose level, protein, ADA and LDH levels, CSF culture, gram and ZN staining and thereby CSF analysis was done to diagnose patients as tubercular, bacterial or viral infection. Blood samples were collected at the same time for serum leukocyte count, serum glucose, and blood culture. Staging of tuberculous meningitis was done as per British Medical Council Staging System2. All the patients enrolled in study underwent neuroimaging, plain and contrast enhanced computed tomography (CT SCAN) via Siemens Emoticon 16 slice CT SCAN or Magnetic Resonance Imaging (MRI) via PHILIPS 1.5 TESLA MRI.

Patients information and necessary data were recorded in prestructred proforma (Annexure II). Systat Software used for statistical analysis. The results were expresses in numbers and percentage. Chi-square text was used as and when required to find relationship between two different variables and P value (<0.05) was considered significant.

RESULT AND DISCUSSION

In our study, total 61 patients of CNS infections were enrolled out of which, 16 had pyogenic infection, 26 had tubercular infections and 16 had viral infections and 3 had parasitic infections. Maximum no. of patients 52.46% were belonged to <5 years of age, 29.51% were between 5-10 years and 18.03% were >10 years of age. Males (59.02%) were more than females (40.98%). Malnutrition was present in 70.49%. 90.16% patients belonged to low socio-economic class.

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. Other symptoms were excessive crying, decreased appetite and weakness.

Table 1 shows distribution of clinical signs; in these neck rigidity was present in 28 (45.90%), signs of meningeal irritation in 21 (34.43%), cranial nerve deficit in 8 (13.11%), hemiparesis in 6 (9.84%), crackpot sign in 5 (8.20 %) and quadriparesis in 1 (1.64%) patient respectively. All 18 (29.51% of total) patients <1 year of age had bulging fontanelle.

TABLE – 1 : Distribution of clinical signs

Neck Rigidity	28	45.90%
Signs of meningeal irritation	21	34.43%
Crackpot	5	8.20%
Irritability	17	27.87%
Hemiparesis	6	9.84%
Quadriparesis	1	1.64%

TABLE 2 shows Distribution of normal and abnormal neuroimaging findings according to etiology in study population (n=61); in which Out of total 16 patients in pyogenic group; 12 (75%) had abnormal neuroimaging findings and 4 (25%) patients had normal neuroimaging findings. Out of total 26 patients in tubercular group; 25 (96.2%) had abnormal neuroimaging findings and 1(3.8%) patient had normal neuroimaging finding. Out of total 16 patients in viral group; 6 (37.5%) had abnormal neuroimaging findings and 10 (62.5%) had normal neuroimaging findings. Out of total 3 patients in parasite group; 2 (66.6%) had abnormal neuroimaging findings and 1 (33.3%) had normal neuroimaging findings. P value in pyogenic and tubercular group is significant (<0.05), which suggests *Neuroimaging finding was statistically significant in Pyogenic as well as tubercular CNS infection.*

TABLE – 2 : Distribution of normal and abnormal neuroimaging findings according to etiology in syudy population (n=61)

Etiology	Abnormal Neuroimaging finding	%	Normal Neuroimaging finding	%	Total	p value
Pyogenic	12	75.0%	4	25.0%	16	0.046
Tubercular	25	96.2%	1	3.8%	26	0.000
Viral	6	37.5%	10	62.5%	16	0.317
Parasite	2	66.6%	1	33.3%	3	0.77
Total	45	73.7%	16	26.2%	61	0.000

Distribution of neuroimaging findings:

In the present study, out of 61 patients of CNS infection proven by CSF study and clinical signs and symtoms, 46 patients (75.40%) had abnormal neuroimaging finding and 15 patients (24.5%) had normal neuroimaging finding.

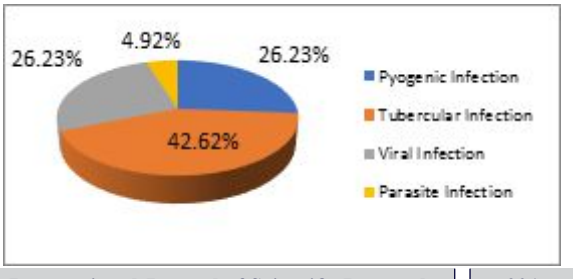
Table 3 shows distribution of neuroimaging findings in these 46 cases of CNS infections; in which meningeal enhancement was present in 36 patients (80%); perilesional oedema was present in 12 patients (26.67%); Tuberculoma was present in 10 patients (22.22%); hydrocephalus was present in 7 patients (15.56%); cerebritis was present in 6 patients (13.33%); infarct was present in 4 patients (8.89%); subdural empyema was present in 2 patients (4.44%); ring enhancing lesion with scolex was present in 2 patients (4.44%); haemorrhage, brain abscess, subdural hygroma was present in 1 patient (2.22%).

TABLE – 3 : Distribution of neuroimaging findings in CNS infections

Neuroi maging Findings	Number	%
Meningeal Enhancement	36	80.00%
Ring Enhancing Lesion with Scolex	2	4.44%
Perilesional Oedema	12	26.67%
Tuberculoma	10	22.22%
Infarct	4	8.89%
Hydrocephalus	7	15.56%
Basal Exudates	4	8.89%
Cerebritis	6	13.33%
Hemorrhage	1	2.22%
Brain Abscess	1	2.22%
Subdural Hygroma	1	2.22%
Subdural Empyema	2	4.44%
normal findings	15	33.33%

Figure 1 shows distribution of patients according to etiology in which; Out of 61 patients, 26 (42.62%) had tubercular infection, 16 (26.23%) had Pyogenic infection, 16 (26.23%) had viral infection and only 3 patients (4.92%) had parasite infection.

Figure – 1



PYOGENIC INFECTION:

In our study maximum no of patients (75%) were under 5 years of age with mean age of 2.94 years. 68.8% patients were male and 31.3 % female with male: female ratio 2:1. 87.5% patients belonged to low socio-economic group.

In study by Ling-yun Guo et al3, a total of 507 patients were studied, median age was 5 months (range 29 days to 15 years). Boys were 64.3% and females were 35.7% with male to female ratio of 1.8:1 which is similar to our study.

In present study, most common presenting symptom in patients with pyogenic infection was fever, which was present in all patients (100%); convulsion (87.50%); irritability (43.75%); vomiting (25%); altered sensorium (25%). Other findings were headache, excessive crying and weakness. In clinical signs, neck rigidity was present in 31.25% patients; signs of meningeal irritation in 25% patients; cranial nerve deficit in 25% patients; hemiparesis in 6.25% patients; crackpot sign in 6.25% patients; bulging fontanelle seen in all 8 (50%) patients < 1 year of age.

In study by B. kuti et al4, In childhood pyogenic meningitis, fever was the most common presenting symptom which was similar to our study. Vomiting and neck stiffness were found as presenting features among older children >5yrs. Irritability was more common in <5 years group. Convulsion was observed in 75.3% children. 51.9% children were unconscious at presentation.

In our study, out of 16 patients, CSF was interpretated in 14 patients as 2 patients had traumatic CSF but clinically they look like pyogenic meningitis. From which we found abnormal neuroimaging study in 12 (75%) patients and normal neuroimaging study in 4 (25%) patients. Most common neuroimaging findings were meningeal enhancement (75%); hydrocephalus (18.75%); infarct (12.50%); subdural empyema (12.50%); perilesional oedema (6.25%); brain abscess (6.25%); and subdural hygroma in (6.25%) patients respectively. Meningeal enhancement and hydrocephalus were predominant features.

In a study by K. gupta et al, neuroimaging findings revealed meningeal enhancement was present in 77.77 %, hydrocephalus in 55.55%, infarct in 22.22%, abscess in 11.11% patients respectively. Similar findings were observed by Oliveria et al and Kioumehr et al.

In present study, total pyogenic meningitis patients discharged were 11 (68.75%) and 5 (31.25%) patients were discharged against medical advice (DAMA). No mortality was noted. Out of total 11 patients discharged, 8 patients had abnormal neuroimaging finding. Mean duration of stay was 20.27 days (S.D 10.73 ± 2) .Out of total patients, 9 (56.25%) patients developed complications i.e. Cranial nerve palsy, hemiparesis, hydrocephalus and subdural empyema, Brain abscess. There was no significant correlation of neuroimaging finding with outcome of patients in reference to discharge and expired.

CNS TUBERCULAR INFECTION:

Out of 61 patients, 26 (42.62%) patients had CNS tubercular infection in our study.

Table 4 shows distribution of study population according to tubercular etiology; In which maximum patients 13 (50%) presented with tubercular meningitis which were <5 year of age followed by tuberculoma in 5 (19.23%) patients which were >10 years of age; tubercular meningitis with tuberculoma in 4 (15.38%) patients; tubercular meningoencephalitis in 3 (11.54%) patients and tubercular meningoencephalitis with tuberculoma in 1 (3.85%) patients respectively.

TABLE – 4 : Distribution of study population according to tubercular etiology:

Tubercular infection	N	%
Tubercular meningitis	13	50.00%
Tubercular meningitis with tuberculoma	4	15.38%
Tubercular meningoencephalitis	3	11.54%
Tubercular meningoencephalitis with tuberculoma	1	3.85%
Tuberculoma	5	19.23%
Total	26	100.00%

In our study 26 patient had tubercular CNS infection. Out of which 14 (53.8%) patients were below the age group of 5 year. In present study, all patients belonged to low socio-economic status. 46.15% patients received BCG vaccination, Malnutrition was present in 53.85%, H/o TB contact present in 5 (19.23%) patients.

In study of A. Israni et al[5] 40 % belonged to low socio-economic status. BCG vaccination was present in 55.3% patients. Mild to moderate malnutrition in 66% patients. Study by A. gunes et al shows history of close TB contact was present in 62 patients (33.5%) and 45 (24.3%) patients had received BCG vaccination.

In present study, Fever was present in all (100%) patients; convulsion (69.23%); altered sensorium (53.85%); vomiting (30.77%); headache (26.92%); decreased appetite (26.92%) and other symptoms were excessive crying, irritability and weakness. Neck rigidity was present in 46.15%; signs of meningeal irritation in 25%; Hemiparesis in 15.38 %; cranial nerve deficit in 7.69% and quadriparesis in 3.85% patients respectively.

In study of A. Israni et al [5], Fever was present in 72.3% patients followed by altered sensorium (57.4%) and seizures (48.9%). Signs of meningeal irritation were present in 66% patients. Hemiparesis in 14.9% cranial nerve palsy in 12.8% and quadriparesis in 8.5 percent respectively. Findings were similar to our study.

In present study; 38.46%, 46.15% and 15.38% presented in stage I, II and III respectively. In which BCG vaccinated seen mostly in stage I and II while unvaccinated seen mostly in stage III.

In our study, 46% were BCG vaccinated, while 54% were unvaccinated. Fever was present in all patients. Meningeal signs were less noted in vaccinated group then unvaccinated group respectively. In neuroimaging findings, meningeal enhancement was seen 75% in vaccinated and 25% in unvaccinated group. Tuberculoma was seen 40% in vaccinated and 60% in unvaccinated group. Hydrocephalus was seen more in unvaccinated group i.e 75% compared to 25% in vaccinated group. However, there was no statistical significant difference between the groups.

In study by R. Kumar et al[6], in a total of 150 children with TBM, 54 (34%) were vaccinated and 96 (64%) unvaccinated. A comparison similar to our study was carried out. It was noted that there was no significant difference between the group except altered sensorium being higher in nonvaccinated group (85%) than (65%) in vaccinated group respectively.

In our study, out of 26 patients, CSF interpretated in 25 patients as 1 patient had traumatic CSF. In this we found abnormal neuroimaging study in 24 (96%) patients and normal neuroimaging study in 1 (4%) patient.

In study by S.a. al-edrus et al[7], on admission only two had normal neuroimaging findings, other 40 patients (95.2%) presented with various neuroimaging findings.

In present study, among various abnormal neuroimaging findings; meningeal enhancement was found in 76.92%; tuberculoma in 38.46%; perilesional oedema in 34.62%; hydrocephalus in 15.38%; basal exudates in 15.38%; infarct in 7.69%; cerebritis in 7.69% patients. Meningeal enhancement was the most common neuroima ging finding. 90% patients of stage I and 100% patients in stage II and III had abnormal neuroimaging findings.

In study by A. Israni et al[5], abnormality of neuroimaging meningeal enhancement was present in 63.8%, hydrocephalus in 33%, periventricular oedema in 44.7%, infarcts in 57.4 % and tuberculoma in 10.6% patients. Findings were similar to our study.

In present study, of the total 26 patients, 9 (34.6%) patients had associated complication. All of these 9 patients had abnormal neuroimaging findings (100%). Amongst which 6 (23.08%) had hydrocephalus; 4 (15.38%) had hemiparesis; 2 (7.69%) had cranial nerve palsy; 1 had quadriparesis (3.85%). 3 patient had multiple complications.

Out of the total 26 patients with tubercular infection, 16 (61.54%) were discharge, 10 patients (38.54%) took DAMA respectively.

VIRAL CNS INFECTION:

Out of 61 patients, 16 patients had CNS viral infection in our study. Amongst viral CNS infections, viral encephalitis was present in 81.25%, viral meningitis in 12.50% and meningoencephalitis in 6.25%. Maximum no of patients was in age group of 5 to 10 years (38.9%) with mean age of 5.1 year. Total number of males in the study were 37.5% and females were 62.5 % with male: female ratio of 0.6: 1.

In study by Vata et al[8] retrospective analysis of children aged 1 to 14 years with viral meningitis were studied. 61.8% patients were males. In study by Junhong ai et al, 261 patients of viral encephalitis and 285 patients of viral meningitis were enrolled. Mean age was 6.39 years (0.42-14.22) which was similar to our study. Male to female ratio was 1.97 in encephalitis and 2.24 in meningitis. In study by Moses et al, 638 children between 2 months to 10 years were studied amongst which 59% were males. In study by Julie Bykowski[9] MD et al, 141 children met inclusion criteria, with an average age of 8.5 years (2 months-19 years). In study by, I-Jen Wang et al, 101 children below 16 years of age with meningoencephalitis and encephalitis were studied. Of these, 8 children were below 1 year, 52 between 1 to 5 years, and 41 were above 5 years (mean, 4.41 ± 3.54 years).

In present study, among clinical symptoms, fever was present in all patients 100%, convulsion in 68.75%, vomiting in 43.75%, headache in 31.25%, altered sensorium in 25%, irritability in 12.50% patients and excessive crying in 6.25% respectively. In clinical signs, neck rigidity was present in 56.25%, signs of meningeal irritation in 25%; bulging fontanelle was present in 18.75% cases; cranial nerve deficit in 12.5% and hemiparesis in 6.25% respectively.

In our study, out of 16 patients, CSF study was done in 15 patients as 1 patient had traumatic CSF and in this we found viral CSF in 12 patients but all were clinically look like viral meningitis. In this we found abnormal neuroimaging study in 3 (25%) patients and normal neuroimaging study in 9 (75%) patients.

In present study, out of 16 patients of viral CNS infection, all patients underwent MRI and only 6 patients (37.5%) had abnormal neuroimaging. Amongst which meningeal enhancement and cerebritis was present in 25% cases; perilesional oedema and haemorrhage 6.25% respectively and rest had normal neuroimaging findings.

In present study, out of 16, 8 patients (50 %) were discharged, 7 (43.75) were DAMA and 1 (6.25%) patient expired. Mean duration of stay of discharged patients was 12.38 days (S.D 7.80 ± 2) .Cranial nerve palsy was present as sequealae in 2 (12.50%) patients discharged. Out of 8 patients discharged, 5 had normal neuroimaging finding and 3 had abnormal neuroimaging finding. The one patient who expired had normal neuroimaging finding.

PARASITE CNS INFECTION:

In our study, only 3 patients had parasite CNS infection. Amongst which 2 patients had neurocysticercosis and 1 had cerebral malaria.

Neurocysticercosis:

In our study, 2 out of 61 patients were diagnosed with neurocys ticercosis. Both patients were >10 years, male and had fever and convulsion at presentation. One patient also had headache. One patient was drowsy at presentation and there were no other clinical signs present in both patients.

In study by PS Mahato et al[10], 40 patients more than 12 years were studied out of which 4 patients had NCC. The presenting complains in NCC were convulsion in all patients (100%), headache in 50 % patients and vomiting and visual complaints in 25% patients. Similar clinical findings were noted by Rashekar and Chacko (n= 93), in which seizures were present in 74% cases. In a study by V. Rajshekhar et al, retrospective analysis of clinical and neuroimaging findings in 25 patients with cysticercus granuloma was done. Out of 25, 19 (76%) were male and 6 (24%) were female. Age range was 8-53 years.

In present study, neuroimaging finding showed ring enhancing lesion with scolex along with perilesional oedema on MRI, suggestive of Neurocysticercosis. Both patients were discharged with no sequealae.

In study by PS Mahato et al[10], neuroimaging showed calcified scolex. Neurological deficit was present in all patients with NCC with cranial nerve deficit most common. In Uttar Pradesh, a study by R. Garg et al, 110 patients were studied with two or more ring enhancing lesions with variable perilesional oedema on neuroimaging. 10 patients out of 110 (9%) were diagnosed Neurocysticercosis (NCC) on basis of CSF ELISA for neurocysticercosis. In a study by V. Rajshekhar et al, all 25 patients showed cysticercus granulomas with well defined margins with oedema.

Cerebral malaria:

One patient in parasite group was >10-year-old male presenting with fever headache and vomiting. Patient was drowsy at presentation with no signs of meningeal irritation. CSF analysis done showed normal picture. Neuroimaging also did not show any abnormal findings. Peripheral smear showed P. falciparum schizonts. Based on clinical and laboratory parameters child was diagnosed as cerebral malaria. Patient was discharged with full recovery with no complication. Mean duration of stay in parasite group was 13 days.

In a study by Anne-Laure Page et al[11], a prospective study was done in children 2 months to 12 years of age suspected of CNS infection. 459 children were enrolled and P. falciparum was found in 36.2% patients of whom 66.8 % were classified as cerebral malaria.

An observational study by Sanjib Mohanty et al[12], in Rourkela, India, studied 11 patients with cerebral malaria. There were 5 adults and 6 paediatric patients. The median (range) age was 12 (5 to 15) years for children and 83.3% were male cases. All patients were comatose at presentation and rapid recovery was seen in all 11 patients. All 11 cases in our series had generalized swelling, cortical thickening in neuroimaging.

CONCLUSION

By our study, we conclude that tubercular meningitis, tubercular meningoencephalitis and pyogenic meningitis mainly below 5 year of age while viral CNS infection present after 5 year of age and parasitic infection present in adolescent age group.

There is male preponderance in pyogenic and tubercular groups and female in viral groups.

There is strong correlation between socioeconomic status and CNS infections with maximum belonging to low socio-economic status because of poor hygiene, illiteracy, poverty, malnutrition.

Clinical signs and symptoms are present more in unvaccinated group however it is not statistically significant. The relatively low incidence of patients with BCG vaccination in STAGE III patients suggests that BCG vaccination might be protective from more severe stages of TBM. Although BCG vaccination does not totally prevent occurrence of Tubercular infection, our results support earlier studies suggesting that children who have been vaccinated with BCG appear to maintain better clinical course during hospital stay and ultimately have better outcome. However, there was no statistical difference in neuroradiological features to explain this finding. In tubercular patients, maximum patients presented to us in Stage II, this may be due to low level of education and limited accessibility to specialized services as most of patients belonged to rural areas. Moreover, late presentation might also be due to rapid progression of disease to severe forms in children.

In our study; we conclude that pyogenic meningitis patients predomin antly present with fever, convulsion, irritability and vomiting. While; fever, altered sensorium and seizure are predominantly present in tubercular meningitis. Viral CNS infection patients mainly present with fever, altered sensorium, vomiting, headache and seizures. Seizure is predominant complaint with neurocysticercosis. Meningeal signs are maximum in tubercular patients and pyogenic patients.

Neuroimaging: Neuroimaging plays an important role in diagnosis of underlying CNS infection. Total 75% in pyogenic group, 96.2 % in tubercular group and 37.5% in viral group respectively had abnormal neuroimaging findings. There was significant statistical correlation between abnormal neuroimaging findings and etiology of CNS infections (in particular reference to pyogenic and tubercular infections because p value in both group are <0.05which is significant). Meningeal enhancement was predominant feature in all three major infectious groups under consideration i.e pyogenic, tubercular, and viral, with 62.50%, 53.85% and 25% respectively. Tuberculoma and basal exudates were specifically present in tubercular patients.

Hydrocephalus was present in both pyogenic and tubercular groups, 18.75% and 15.38% respectively. In patients with CNS tuberculosis, 90% patient in stage I, all patient in stage II and III had abnormal neuroimaging findings.

9 patients in pyogenic and tubercular group and 2 patients in viral group had complication. All patients with complication had abnormal neuroimaging findings. Common complication seen were hydrocephalus, cranial nerve palsy, hemiparesis and quadriparesis. Abnormal MRI findings were seen in viral CNS infections, even if CSF is inconclusive.

Mean duration of stay is maximum in pyogenic infection than other CNS infection explained due to longer course of IV antibiotics i.e. 14-21 days. As, incidence of neurocysticercosis is less in this part of the country, we assume, because of that we had very less patients of neurocysticercosis in our study.

Though our area is endemic for malaria, but only 1 patient in our study was diagnosed with cerebral malaria, that is unusual.

Our study shows, that CSF remains gold standard in diagnosing central nervous system infections. However, neuroimaging plays an important role in diagnosis of the disease and it is well correlated with CSF finding in pyogenic and tubercular CNS infections. Though its relation in prediction of outcome is uncertain, familiarity of various imaging patterns in CNS infections is of key importance to paediatricians and radiologists in timely diagnosis, thereby reducing morbidity and mortality of the potential threatening disease.

Acknowledgement
The authors are thankful to department of Paediatric and Radiology, for providing important information and valuable guidance for publishing this paper. Authors are thankful to management authorities for providing library facilities.

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