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Original Research Article

Electroencephalographic abnormalities and imaging profile of neurocysticercosis: analysis of 60 cases in children

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ABSTRACT

Background: To study the electroencephalographic abnormalities and imaging profile of 60 children suffering from neurocysticercosis at a tertiary care centre over a period of two years.
Methods: A diagnosis of Neurocysticercosis was made mainly on the basis of clinical features, imaging studies and serological tests. Patients were evaluated for different types of abnormalities on electroencephalogram (EEG) of their brains. This study group was subsequently evaluated for nature, type and site of lesion on computed tomographic scan and Magnetic Resonance Imaging of brain.
Results: 28 (57.14%) cases had abnormal EEG finding in which nonspecific background changes was the commonest abnormalities. Solitary lesion (71.66%) were most common type of lesion. Parietal lobe was most common affected lobe followed by frontal lobe (18.6%). Transitional lesion (71.66%) in the form of ring enhancement following contrast administration was the prominent nature of lesion.
Conclusions: Electroencephalographic abnormalities are not directly related to site and type of involvement. Parietal lobe was the most common affected lobe probably due to middle cerebral artery involvement.

Keywords: Electroencephalogram, Imaging, Neurocysticercosis

INTRODUCTION

Neurocysticercosis is the parasitic infestation of human nervous system with tissue cysts of pork tape worm. The World Health Organization (WHO) has estimated that NCC accounts for more than 50,000 deaths per year and is responsible for active epilepsy in a significant number of people. Human NCC is caused by the larval stage (Cysticercous) of the pork tape worm, Taenia solium.[1,2] It affects mainly the adult population but the paediatric infection is well recognized. Most of the cases have been reported from Southeast Asia region including India, Central and Latin America.[2,3] In this study we have assessed electroencephalographic abnormalities associated with Neurocysticercosis as well as changes observed in brain during imaging studies like computed tomographic scan and Magnetic resonance imaging.

METHODS

This observational study was carried out in the department of Paediatric, Patna Medical College and Hospital, Patna, India during the period of September 2006 to August 2008. Children in between the age group of 1year to14 years were enrolled in this study. Ethical clearance was taken from institute ethical committee.

Only those neurological patients were included in this study who had evidence of either active or transitional (ring enhancing lesion) or mixed lesion on Computed

tomography scan (CT-scan) of brain. Detailed history was taken from Children (where possible) or their parents and witnesses regarding the neurological symptoms specially seizures. Patients were evaluated about the neurological manifestation like, focal neurological deficit, headache, vomiting, papilledema and neuropsychiatric presentation. As no separate diagnostic criteria have been laid down for paediatric neurocysticercosis, so modified form of criteria of Del-Brutto et al was followed in this study (Table 1).[4]

Table 1: Diagnostic criteria for human cysticercosis.

Diagnostic criteria for human cysticercosis
Absolute criteria
Demonstration of cysticerci by histologic or microscopic examination of biopsy material
Visualization of the parasite in the eye by fundoscopy
Neuroradiologic demonstration of cystic lesions containing a characteristic scolex
Major criteria
Neuroradiologic lesions suggestive of neurocysticercosis
Demonstration of antibodies to cysticerci in serum by enzyme-linked immunoelectrotransfer blot
Resolution of intracranial cystic lesions spontaneously or after therapy with albendazole or praziquantel alone
Minor criteria
Lesions compatible with neurocysticercosis detected by neuroimaging studies
Clinical manifestations suggestive of neurocysticercosis
Demonstration of antibodies to cysticerci or cysticercal antigen in cerebrospinal fluid by ELISA
Evidence of cysticercosis outside the central nervous system (e.g., cigar-shaped soft tissue calcifications)
Epidemiologic criteria
Residence in a cysticercosis-endemic area
Frequent travel to a cysticercosis-endemic area
Household contact with an individual infected with *Taenia solium*
Definite diagnosis: 1 absolute criterion or two major criteria+minor criterion+one epidemiologic criterion
Probable diagnosis: 1 major+2 minor or 1 major+1 minor+1 epidemiologic criterion or 3 minors+1 epidemiologic criterion

This criterion is a combination of absolute, major, minor and epidemiological components. A total of 60 children were diagnosed as NCC based on these criteria. Patients were divided into lower, middle and upper socioeconomic classes as per modified Kuppuswamy scale. Patients were asked about their food sources, vegetarian and non-vegetarian diets, hand washing practices, consumption of partially or uncooked food or pork in any form and sources of drinking water supply. Serum immunoglobulin IgM and IgG, ELISA against cysticercosis were done both for CSF and serum. CT scan was done in each and every case because this was one of the important inclusion criteria. CT scan was supported by other investigations like magnetic resonance imaging (MRI) and electroencephalogram (EEG). MRI was done in 16 cases only. Stool microscopy for Ova, cysts and parasites and absolute eosinophil count were done in all cases. As Tuberculosis is a very common and close differential diagnosis of NCC in India, so chest X-ray, Mantoux test, sputum examination and gastric lavage for acid fast bacilli (AFB) were also performed to rule out Tuberculosis.

Table 2: Number, type and parenchymal sites of lesion on CT scan of brain.

Type of lesion	No=60 (100%)
Single/ Solitary	43 (71.66%)
Multiple	17 (28.33%)
Site of solitary lesion	No=43 (100%)
Frontal	08 (18.6%)
Parietal	28 (65.11%)
Occipital	02 (4.65%)
Temporal	02 (4.65%)
Cerebellar	03 (6.97%)
Nature of lesion	N=60 (100%)
Active	03 (5%)
Inactive	14 (23.33%)
Transitional	43 (71.66%)

CT-scan of brain was evaluated for number of lesions and disease activity (active, transient or inactive).Number of lesions were counted in CT scan and the disease activity was classified as active(hypodense cyst without enhancement on contrast administration), transitional (appearance of a ring or nodular shadow on contrast enhancement) and inactive(calcified lesions) based on the viability of the parasite as proposed by Caprio et al, MRI brain was done in selected cases (Multiple lesions).[8,9,11] MRI brain was observed for presence of either eccentric scolex within cysts or simple cyst without scolex.

Regression of lesion in CT scan was observed as reduction of size 50% of the original lesion. Persistent of lesion was defined as no reduction in number and reduction in size less than 50% of the original.[9] The size/ diameter of the lesions was measured by the inbuilt ruler provided by the CT scan software and was compared with the old data of the same patient saved in the computer. The data were evaluated in terms of type, size and nature of lesion.

RESULTS

A total number of 60 patients were diagnosed as NCC in which most commonly involved age group was 10-14 years (53.3%). There was no predilection for any sex in this study, as 51.67% cases were male and 48.33% were female. Most of the cases belonged to lower socioeconomic class (81.66%).

Out of the 60 patients who completed the study 71% patients showed solitary lesion while the rest revealed multiple (>2) lesions at different stages of development (Table 2) in the CT scan brain. Amongst the solitary lesions parietal lobe was the most common site of involvement (65.1%) followed by frontal lobe involvement around 08% cases. Seventeen children had multiple lesions in the CT brain. Overall transitional stage lesion was the most common CT finding comprising almost 71.66% cases presenting as ring enhancing lesions, inactive lesion in 23.3% cases. None of the cases revealed ventricular involvement or "starry sky" appearance. Only 16 NCC patients underwent both imaging modalities, MRI picked up more lesions than CT scan. 75% patients have had eccentric scolex within cyst on their MRI brain whereas 25% patients were identified as simple cyst without scolex (Table 3).

Table 3: Nature of lesion on MRI brain.

Nature of lesion on MRI	N=16 (100%)
Eccentric scolex with cyst	12 (75%)
Simple cyst without scolex	04 (25%)

All EEG data were interpreted in conjunction with clinical presentation. In the 60 patients participating until the end epileptic discharge was noted in twelve cases and non-specific abnormality in 16 cases (Table 4). Among epileptic discharge patients, nine patients present with Widespread high frequency interictally epileptiform activity while Three patients showed focal spike wave discharges. Among the non-specific abnormalities focal slow wave activity was observed in four children, focal attenuation in three cases, generalized attenuation in two cases, generalized slowness in five children, triphasic wave in one case and small spike in one patient. However, non-specific abnormalities did not correspond to the location of the lesion in the brain parenchyma.

Table 4: Abnormal electroencephalographic findings.

Abnormal EEG Findings	
Type of abnormalities	N=28 (100%)
Non-specific background, slowing	16 (57.14%)
Epileptic discharge	12 (42.85%)
Type of epileptic discharge	N=12 (42.85%)
Widespread high frequency	09 (32.14%)
Focal spike waves	03 (10.71%)

DISCUSSION

In an endemic area NCC should be considered as first diagnosis when CT brain showing a ring enhancing lesion of less than 2cm and patient present with seizure with no focal neurological deficit and there is no evidence of systemic diseases.[5]

Special precaution was taken to rule out the closest differential diagnosis in this part of the globe i.e. tuberculoma. Tuberculoma were excluded by the following features in CT brain-ring enhancing tuberculoma are more than 20 mm diameter, wall thickness more than 2 mm, presence of midline shift, lack of white dot like scolices, lack of spontaneous disappearance of the tuberculoma.[7,8,9] Moreover, the absence of permanent focal neurodeficit strongly supports the diagnosis of neurocysticercosis.[10,12]

Incidence of a single ring enhancing lesion on imaging was almost 65.11% in our study consistent with most of the other major studies (50-80%).[6,7,11] However, a study from Western Nepal recorded only 41% solitary lesions.[8] Cyst morphology/stage and number did not correlate with different patterns of clinical presentations.

Parietal lobe was the overwhelmingly common site in our series (65% involvement), like the western Nepalese study. Probably cysticercus larva have a tendency to involve middle cerebral artery and its branches so parietal lobe involvement is common.[13]

None of our cases showed extra-parenchymal or extracranial (muscles, ocular tissue etc.) involvement. One possible reason for no extra parenchymal involvement in our study is the over-reliance on CT and limitation of CT in identifying intraventricular, cisternal or soft-tissue involvement. Antoniuk et al and Singhi and Singhi also observed that extra parenchymal neurocysticercosis was rare in paediatric age group.[6,7] However, Basu et al, showed more than 20% extra parenchymal involvement.

Transitional stage cyst was the most common finding in CT in ours (prevalence>70%). Almost similar prevalence was noted in Western Nepal. Antoniuk et al, in a Brazilian study found only 36% transitional stage cysts. We found 23% cases of calcified (inactive) cysts at diagnosis; Brazilian report found 39% cases of inactive stage lesions. One report from Western Nepal observed less than 3% calcified lesions at diagnosis.

In this study, 28 (57.1%) out of 60 patients with seizure showed abnormal EEG discharges at presentation in our cohort of 60 children and only 2 EEGs (5.6% of the total seizure patients) corresponded to the site of lesion (parietal lobe). A major review showed that EEG demonstrated little relation to symptoms and CT lesions in patients with neurocysticercosis.[11] A positive correlation between CT lesions and localizing or lateralizing EEG abnormalities was reported in only 15-30% cases of neurocysticercosis. Correlation between seizure type and EEG abnormalities was reported in 7-20% of patients only.[11]

CONCLUSION

Transitional type is the most common variety of the cyst to be discovered at CT scan. Parietal lobe is the most common location of cyst on CT scan. Transitional cyst

commonly appears as ring enhancing lesion with or without perilesional edema. Solitary cyst is much more common than multiple cysts with not a single case of extra parenchymal type of lesion found in our study. EEG demonstrated little relation to symptoms and CT lesions in patients with neurocysticercosis.

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