Research Article

Occurrence of neurocysticercosis in patients presenting with seizure and its radiological evaluation

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Received: May 27, 2018; **Accepted:** April 25, 2018

ABSTRACT

Background: Neurocysticercosis (NCC) is a major parasitic disease affecting endemic areas worldwide. It spreads through fecal–oral route. It causes lesion in the central nervous system which has different evolving stages and can be asymptomatic or clinically evident. Imaging studies play an important role in the diagnosis of the disease and its appropriate control since it is the most common treatable cause of the seizure. **Objective:** The objective of the study was to evaluate the occurrence of NCC in patients presenting with seizures and to carry out its radiological evaluation. **Materials and Methods:** A total of 100 patients presenting with recent onset seizures were recruited from pediatric department of a local major tertiary care teaching hospital during the period 2016–2017. Brain imaging was performed in all the above cases. **Results:** The recruited patients presented with generalized, simple partial, and focal seizures (68%, 21%, and 11%, respectively). NCC was diagnosed in 37 of 100 (37.0%) seizure cases based on imaging characteristics. There were 13% cases in whom, magnetic resonance imaging showed calcified NCC/granuloma suggestive of NCC. In 24% cases, scolex suggestive of NCC was seen. **Conclusion:** The findings of the present study showed that NCC still is a major diagnosis among children presenting with the seizure from this endemic area. Neuroimaging was a useful tool in diagnosis and characterization of NCC. The study highlighted the need to create awareness regarding maintenance of hygiene and cleanliness

KEY WORDS: Neurocysticercosis; Seizure; Radiological Evaluation

INTRODUCTION

Seizure (from Latin word sacire, "to take possession of") is a paroxysmal event due to abnormal excessive synchronous neuronal discharge activity in the brain. It is defined as an episode of neurological dysfunction caused by abnormal neuronal activity that results in a sudden change in motor activity that results in a sudden change in motor activity, behavior, and sensory perception.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/ijmsph.2018.0307525042018	

It is a commonly encountered and one of the important causes for hospital admission of children in underdeveloped and developing countries and generally affects the children at young age.[1,2] It has been reported that nearly 4–10% of children experience seizure by the age of 16 years. Nearly 20% of children with unprovoked seizures may develop epilepsy.[3]

Seizures in children can be caused by a number of causes. It can be caused by infections; it may result from birth asphyxia or can be attributed to metabolic causes among neonates. On the other hand, febrile convulsions can be attributed to bacterial (meningitis), viral (encephalitis), parasitic (neurocysticercosis [NCC] and cerebral malaria), or epileptic (symptomatic, cryptogenic, and idiopathic) etiologies resulting in acute seizures in children.[4-9]

In the recent years, NCC has been recognized as one of the major diagnoses among patients with seizures in both adult and pediatric age groups.[10-13] In some recent studies in children, its occurrence in seizure affected children has been reported to be as high as 40%.[11,13] The increasing occurrence of NCC in childhood seizures in recent years might be attributable to the emergence of more sensitive imaging and immunological tests.[14]

NCC also termed as intracerebral cysticercosis is common parasitic (zoonotic=animal borne) infection that affects the nervous system which manifests as a seizure disorder.[15,16] NCC is a global problem with endemic areas spread throughout the world. The most affected endemic areas in different continents include parts of South America, Eastern Europe, the Indian subcontinent, South East Asia, and Sub-Saharan Africa.[16] Reports from north India link NCC as one of the most prominent etiologies behind focal seizures in children.[17]

NCC is resulted following infestation of the central nervous system (CNS) with encysted larvae of *Taenia solium*. One must understand that taeniasis and NCC are two different clinical entities caused by the same parasite, i.e., *T. solium*. Taeniasis is an intestinal infection of *T. solium* with undercooked pork infected with cysticerci as the major identified source. Cysticerci can remain asymptomatic within host tissue for a prolonged period which may spread over the years primarily due to an excellent resistance-mechanism to evade host response. In favorable conditions, larva penetrates the intestinal mucosa and migrates throughout the body to produce human cysticercosis. These cysts can be located in almost all human tissues; however, on attaining maturity, these cysts are more commonly found in CNS. Subcutaneous tissue, skeletal muscles and the visual system (primarily eyes) are the other most commonly affected locations frequented by the cysts. The relocation of cysts from one place to another takes place with high blood flow especially the gray-white matter junction.[2]

In *T. solium* pigs act as the intermediate host in which the larval stage or cysticercus cellulosae develops. Definitive hosts acquire the disease after ingesting undercooked infected pork meat, while cysticercosis is produced after swine consume infected human feces that contain tapeworm gravid proglottids full of eggs. In addition, accidental ingestion of these eggs can cause human NCC, a public health problem in many developing countries including India and emerging infectious disease in some developed ones.[18,19]

A confirmed diagnosis of NCC in seizure patients is the key to determine the course of treatment. Scientific bodies like American Academy of Neurology have recommended cysticidal therapy for treatment of seizures. Cysticidal therapy is a proven effective measure to reduce seizure frequency and in long-term helps in resolution of the lesions altogether.[20]

Clinical profile of NCC includes seizures as one of the important features with headache, vomiting, and other neurological signs and symptoms. Pathologically, it is difficult to be performed, and serological tests often have low sensitivity[21] despite being reported for high specificity.[22] Neuroimaging is the preferred modality for NCC diagnosis. Computed tomography, magnetic resonance imaging (MRI), and proton magnetic resonance spectroscopy are some of the neuroimaging modalities commonly used for diagnosis.[2]

In view of the relationship of NCC with childhood seizures, the present study was carried out with the purpose to evaluate the occurrence of NCC in patients presenting with seizures, and to carry out its radiological evaluation.

Aims and Objectives

The aims of the study were to evaluate the occurrence of NCC in patients presenting with seizures and to carry out its radiological evaluation.

MATERIALS AND METHODS

The study was conducted in patients with seizure admitted to the Department of Pediatrics, TMMRC, Moradabad.

Ethical approval for the study was obtained from the Institutional Ethical Review Committee.

Study Design

This was a descriptive cross-sectional hospital-based prospective study.

Sample Size

The sample size was 100.

Inclusion criteria

The following criteria were included in this study:
1. Patients between age group 18 months and 18 years.
2. Patients presenting with seizure attending outpatient department (OPD) or admitted in ward/psychiatric intensive care unit.

Exclusion criteria

The following criteria were excluded from the study:
1. Known seizure disorders on treatment.
2. Known case of NCC on treatment.
3. Pseudoseizures such as hyperventilation, transient ischemic attacks, delusions, and electrolyte disturbances.
4. Febrile convulsion.

Method of Collection of Data

All consecutive **c**hildren between 18 months and 18 years reporting to pediatric OPD/inpatient department of a tertiary care hospital, with seizure were enrolled in the study, after

obtaining informed consent from the parents/attendants. Demographic information was obtained from all the parents. Type of seizure was noted, details regarding the family history of seizure and dietary preferences were noted. The patient's consciousness status was noted in terms of Glasgow Coma Scale. After obtaining the information, a thorough clinical evaluation was carried out, including detail neurological assessment to look for any neurological deficit. All the patients underwent necessary lab investigations such as blood sugar, electrolytes, and cerebrospinal fluid examination if indicated. Neuroimaging was done by MRI using 1.5 Tesla Magnetom Avanto Siemens MRI machine.

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences version 21.0. The values were represented in number (%) and mean ± standard deviation. Chi-square test had been used to assess variables and $P < 0.001$ was considered statistically significant.

RESULTS

The present study was carried out with an aim to evaluate the occurrence of NCC in patients presenting with seizures and to carry out its radiological evaluation. For this purpose, a total of 100 consecutive cases presenting with seizures falling in sampling frame were enrolled in the study Table 1 show the general profile of the patients enrolled in the study.

Age of patients ranged from 2 to 18 years. There were 23% cases aged 2–5 years, 24% aged 6–9 years, 22% aged 10–12 years, and 31% aged >12 years. Mean age of patients was 9.61±4.58 years.

Majority of patients were males (72%). There were 28% females. Male to female ratio was 2.57.

Majority of patients were Hindus (55%). There were 45% Muslims.

Majority of cases had generalized tonic-clonic seizures (GTCS) (68%) followed by those having partial (n = 21%) and focal (11%) seizures. There was one case each having myoclonic and tonic seizures.

Family history was positive in 5 cases. A total of 55% patients were non-vegetarian.

MRI findings did not show any abnormality in 21% cases. There were 13% cases in whom, MRI showed calcified NCC/granuloma suggestive of NCC. In 24% cases, scolex suggestive of NCC was seen. A total of 4% cases were diagnosed as meningitis/leptomeningitis, and 3% were diagnosed as meningoencephalitis. Other findings were seen in 22% cases - these included arachnoid cyst, basal ganglia edema, benign cerebellar tonsillar ectopia, calcified granuloma suggestive of ependymal cyst/choroid plexus cyst, choroid plexus cyst, confluent hyperintensity, cyst, diffuse cerebral atrophy, diffuse meningeal enhancement, gliotic changes, hyperintensities, ischemic patches suggestive of cerebral malaria, mesial temporal sclerosis, mild PVL, old infarct with gliosis, pachygyria, pansinusitis, postictal edema/ischemic changes, and viral encephalitis in one case each, and prominent CSF space in two cases, respectively.

Among cases having unilateral involvement, right side was more commonly involved (n = 26; 32.9%) as compared to the left side (n = 19; 24.1%). Bilateral involvement was seen in 7 (8.9%) cases. In 27 (34.2%) the side could not be specified.

Parietal (16.5%), frontal (15.2%), and frontoparietal (10.1%) locations were most commonly involved followed by occipitoparietal (6.3%), fronto-occipital (3.8%), cerebellar (2.5%), temporal (2.5%), and occipital (2.5%) locations.

Table 1: General profile of patients enrolled in the study

Variable	Number and percentage
Age (years)	
2–5	23
6–9	24
10–12	22
>12	31
Mean age±SD (range) in years	9.61±4.58 (2–18)
Gender	
Male	72
Female	28
Religion	
Hindu	55
Muslim	45

SD: Standard deviation

Table 2: Distribution of cases according to the type of seizure

Type of Seizure	Number and percentage
Focal	11
Generalized tonic-clonic	66
Partial	21
Others (Tonic-1, Myoclonic-1)	2

Table 3: Family history and dietary preferences

Variable	Number and percentage
Family history	
Negative	95
Positive	5
Dietary preference	
Vegetarian	45
Non-vegetarian	55

Table 4: MRI findings

Finding	Number and percentage
Normal findings	21
Calcified NCC/granuloma	13
NCC scolex	24
Meningitis/leptomeningitis	4
Meningoencephalitis	3
Others	22

NCC: Neurocysticercosis, MRI: Magnetic resonance imaging

Table 5: MRI findings side, location, and number of lesions (*n*=79)

Finding	*n* (%)
Side	
Left	19 (24.1)
Right	26 (32.9)
Bilateral	7 (8.9
Unspecific	27 (34.2)
Location	
Parietal	13 (16.5)
Frontal	12 (15.2)
Frontoparietal	8 (10.1)
Occipitoparietal	5 (6.3)
Fronto-occipital	3 (3.8)
Cerebellar	2 (2.5)
Temporal	2 (2.5)
Occipital	2 (2.5)
Frontoparietotemporal	1 (1.3)
Occipitotemporal	1 (1.3)
Basal ganglia	1 (1.3)
Temporoparietal	1 (1.3)
Unspecified	27 (34.2)
Number of lesions (n=45)	
1	27 (60.0)
2	9 (20.0)
3 or more	9 (20.0)

MRI: Magnetic resonance imaging

There was one case each having frontoparietotemporal, occipitotemporal, basal ganglia, and temporoparietal involvement.

Lesions could be located in 45 cases. Among these majority (60%) were single lesions while 9 (20%) cases had two lesions. Three or more lesions were seen in remaining 9 (20%) cases.

DISCUSSION

On the basis of findings of a present study conducted on 100 children presenting with seizures, the following clinico-radiological profile of seizure patients was revealed that age of patients ranged from 2 to 18 years. Maximum were aged above 12 years (31%). Mean age of patients was 9.61 ± 4.58 years. Majority were males (72%). Male to female ratio was 2.57. GTCS was the most common type (68%) followed by partial (n = 21%) and focal (11%) seizures. Family history was positive in 5 cases. A total of 55% patients were non-vegetarian. MRI scan was normal in 21% cases, were suggestive of NCC in 37%, meningitis/leptomeningitis in 4%, meningoencephalitis in 3%, and others in 22%. Among 79 cases with positive MRI findings, the right side was more commonly involved (n = 26; 32.9%) as compared to the left side (n = 19; 24.1%). Bilateral involvement was seen in 7 (8.9%) cases. In 27 (34.2%) the side could not be specified. Parietal (16.5%), frontal (15.2%), and frontoparietal (10.1%) locations were most commonly involved. Lesions could be located in 45 cases. Among these majority (60%) were single lesions while 9 (20%) cases had two lesions. Three or more lesions were seen in remaining 9 (20%) cases

The positivity rate for NCC in different contemporary series has varied substantially. Sahu *et al.*[11] in their study found positivity rate of 37.7% which is similar to ours (38%). Chaudhary *et al.*[13] reported this rate to be 42.9%, which is slightly higher than that observed in the present study. Kumar *et al.,*[21] on the other hand, found positivity rate of 71% which is much higher than that observed in present study while Rao *et al.*[12] reported the NCC positivity rate of 16.9%. Variability in NCC rate in different studies might be dependent on the sampling frame, endemicity, and profile of the study population being studied.

As far as the profile of study population is concerned, the present study was carried out in children aged 2–18 years having a mean age of 9.61 ± 4.58 years and a male-female ratio of 2.57 with the majority being Hindus (55%). Compared to the present study, Basu *et al.*[9] although included children aged 11 months to 15 years in their study found their mean age to be 10.8 years which are higher than the present study. Bhattacharjee *et al.,*[22] on the other hand, had included children aged 1–13 years in their study and reported their mean age as 8.47 years. Most of the other studies had limited the age range of children to 15 years only,[11] however, Pandit *et al.*[23] in their study extended the maximum age to 16 years yet reported the mean age of patients as 8.68 years. The age variability in different studies generally depends on the hospital policy that determines the upper level of age of patients that are admitted/frequented at the pediatric population. In our institution, all the children (aged to 12 years), as well as adolescents (aged 13–18 years), are referred to the pediatric department. However, despite extending this age range, we did not find much difference in the mean age of the study population thus showing that extension of upper age does not have an impact on the central tendency of the study population and as such till 18 years of age, the seizure frequency does not show a phenomenal change.

As for the gender ratio, the present study was predominated by males (72%). However, extreme variability is seen in gender profile in different studies. Bhattacharjee *et al.*[22] and Pandit *et al*.[23] in their study had predominance of females (58% and 52%), while Sahu *et al.*[11] similar to our study had a dominance of males (77%) Kumar *et al.*[21] also reported a dominance of males (55.8%). These findings, in general, suggest that gender-related differences in different studies are incidental and do not indicate any gender associated risk of seizures.

As far as religion proportion is concerned, most of the studies do not report on it. In the present study, the religion proportion was in accordance with the population proportions in our study area. However, religion was recorded as a variable to assess whether Muslims, in whom pork is prohibited as food, have a lower risk of NCC which is the most common source of transmission to human beings.[24]

In the present study, the majority of cases had GTCS (66%). The spectrum of the type of seizures has shown a variability in different series. Basu *et al.*[9] who presented the profile of 124 children with NCC only reported the simple partial seizures to be the most common seizure type, however, Bhattacharjee *et al.*[22] who also reported the profile of 38 children with NCC, similar to our study found GTCS to be most common (55.3%). Similarly, Chaudhary *et al.*[13] also reported dominance of GCTS (82.1%) in their study. On the other hand, Sahu *et al.*[11] who similar to our study included children with seizures as the study population reported generalized seizures (49.2%) to be the most common type of seizure. Dominance of generalized seizures among seizure patients was also reported by Pappala *et al.,*[10] in their study (55%), and Pandit *et al*.[23] (76%). The findings suggest that the spectrum of seizures might vary in different case series and this might either be incidental or dependent on the underlying etiology.

In the present study, a total of 5 cases had a positive family history of NCC, thus indicating the relevance of endemicity. Majority were non-vegetarian (55%). This finding is similar to the observation of Kumar *et al.*[21] who in a study of 120 cases of NCC reported dominance of non-vegetarians (64.2%), however, Pandit *et al.*[23] in their study of 50 cases of NCC had only 32% non-vegetarians. These findings suggest that non-vegetarian diet necessarily need not be the source of transmission of NCC.

In the present study, MRI positivity rate was 37%. A total of 13 cases were identified as calcified NCC/granuloma, and 24 had evidence of NCC scolex. Neuroimaging has been considered to be the most popular and established method of establishing NCC. MRI provides useful information regarding the laterality, location, and number of lesions responsible for seizure activity due to NCC. Neuroimaging findings were predominantly unilateral, 57% had maximum involvement of frontal lobe and parietal lobes (28%) either alone or in combination and showed lesions in 45% - of these 27 (60%) were single lesions. Similar to our findings among seizure patients dominance of single lesion (62.3%) was also reported by Sahu *et al.*[11] in their study. However, Pappala *et al*.[10] showed parietal lobe involvement to be most commonly involved (38.1%). Rao *et al.*[12] too in their study showed the dominance of single lesion (78.2%) to be more common than multiple lesions.

As far as the relatively significantly higher age of patients with NCC diagnosis is concerned, it might be attributable to the age when a child starts to experiment on his/her own regarding dietary practices. A lower prevalence of NCC among Muslims as compared to Hindus might be attributable due to the prohibition of pork in their religion.

One of the most important findings was that in the present study, neuroimaging was a dominant mode of confirming NCC etiology.

The findings of present study thus confirm that NCC is an important etiology of seizures especially in endemic areas like ours. The findings also showed that neuroimaging is a useful diagnostic modality and should be carried out in all the cases to confirm the diagnosis. The findings of the present study are thus in agreement with the previous studies that have laid emphasis on neuroimaging assessment. Keeping in view of a high proportion of NCC related seizures in our study, it is essential that awareness campaigns regarding prevention and protection and mass level dewormification campaigns should be initiated at the earliest.

CONCLUSION

The findings of the present study showed that NCC still is a major diagnosis among children presenting with the seizure from this endemic area. Neuroimaging was a useful tool in diagnosis and characterization of NCC. The study highlighted the need to create awareness regarding maintenance of hygiene and cleanliness.

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How to cite this article: Malhotra K, Srivastava A, Sharma U, Bhattacharjee P. Occurrence of neurocysticercosis in patients presenting with seizure and its radiological evaluation. Int J Med Sci Public Health 2018;7(8):605-610.

Source of Support: Nil,**Conflict of Interest:** None declared.