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Original Article

Diagnosis of Neurocysticercosis by Computed Tomography: How Much More Do Magnetic Resonance Imaging and Serology, in addition, Contribute?

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Abstract

Background: In the developing world the leading cause of seizures and epilepsy is neurocysticercosis caused by the larvae of *Taenia solium* . Neurocysticercosis is diagnosed by Computed Tomography (CT), Magnetic Resonance Imaging (MRI) or by serological tests on serum or cerebro spinal fluid. We evaluated the role of conventional MRI and serum anti bodies to cysticercal vasicular fluid antigen in patients with seizures diagnosed as neurocysticercosis by CT. ***Methods*:** Plain and gadolinium-enhanced MRI of brain in 51 patients, and ELISA to detect IgG antibodies in the serum to cysticercal vesicular fluid antigen in 44 patients, were performed. ***Results*:** The lesions observed were predominantly Single enhancing CT lesions (SECTL) in 36(70.5%) of the 51 patients studied; they were confined to the brain parenchyma in 50(98%) of the patients. There was no statistically significant difference in the number of lesions detected by CT or MRI in the brain parenchyma. IgG antibodies to cysticercal antigen could be detected in 11(24.8%) of the 44 patients tested by ELISA. **Conclusion**: In the patient population studied, MRI did not contribute much in the diagnosis of neurocysticercosis over CT in terms of number of lesions detected. Serology was found to be useful in the diagnosis of neurocysticercosis in only about a quarter of patients diagnosed by imaging modalities.

Key words: Neurocysticercosis, MRI, CT, Antibodies to cysticercal vesicular fluid antigen.

Introduction

Cysticercosis results when the larva of pork tape worm, *Taenia solium (T. solium)* encysts in tissues. Encystation may take place in the brain, subcutaneous tissue, skeletal muscles, lungs, eyes, liver and occasionally, in the heart[1, 2]. Encystations of *T.solium* larvae in central nervous system, called neurocysticercosis, is the most common parasitic infection of the brain. *T. solium* infections are endemic in many parts of Karnataka and neurocysticercosis is a common cause for seizures[2-5] , as in many parts of the developing world.

With the advent of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), the diagnosis of neurocysticercosis has greatly improved. These techniques demonstrate the topography, the number of lesions, their stage of involution, and the degree of host's inflammatory reaction. As treatment guidelines for neurocysticercosis have been individualized in terms of location of the lesions,their number, and the viability of the parasites within the nervous system, CT and MRI have proved to be the only reliable tools available for the diagnosis and to take therapeutic decisions [6-8]. Among these two imaging modalities, CT is usually preferred as it is comparatively easily available and less expensive. Recently, ELISA test using cyst vesicular fluid antigen has been reported to be highly sensitive and specific [5,9,10].There are very few studies which have evaluated the role of MRI and serology in addition to CT in patients with neurocysticercosis.

In this study from Kolar region of Karnataka state, Southern India, we have evaluated the results

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of conventional MRI in patients presenting with seizures and detected to have neurocysticercosis by CT. We have also associated the radiological findings with the results of ELISA.

Materials and Methods

A total number of 51 patients sequentially presenting with seizures and who were found to have lesions suspicious of neurocysticercosis by CT at R.L.Jalappa Hospital, Kolar, Karnataka state, India, were included in the study between December 2009 and November 2010.

MRI of the brain was performed on all the 51 patients detected to have lesions suspicious of neurocysticercosis by CT. Unenhanced and contrast enhanced CT and MRI were performed using Seimens SOMATOM ESPRIT single slice spiral CT and 0.35T, Siemens, MAGNETOM C MRI. CT brain scan (plain and contrast) was done using 5mm thick axial sections with orbitomeatal line as reference. MR sequences included SE T1Weighted (TR/ TE=428/11ms, TA=6:12 mins) and T2Weighted images (TR/TE=5870/120ms, TA= 7:26 mins), obtained in axial, coronal, and sagittal planes; T2W FLAIR(TR/TE=9580/79ms, TE=79ms, TA = 7:20 mins) in axial plane and post-contrast T1Weighted image in axial, coronal, and sagittal planes. The section thickness was 4mm, the intersection distance was 2mm, a field of view (FOV) of 180-220mm and a matrix of 300 x300. The contrast used for CT scan was Iopromide 62.3 %(ULTRAVIST 300) / Iohexol 64.6 %(OMNIPAQUE 300) and for MRI Gadopentetate dimeglumine (MAGNEVIST) was used. The dose was adjusted according to the weight of the patient (For CT- 1ml/kg body weight & For MRI -0.2ml/kg body weight).

Ring enhancing lesions, single or multiple, with a diameter less than 20mm in CT, with or without eccentrically located scolex, were considered diagnostic of neurocysticercosis. Solitary degenerating cysticercus in MRI was differentiated from tuberculoma by the hyperintense cyst with surrounding hypointense wall in T2 Weighted sequence which is characteristic of neurocysticercosis; tuberculoma in contrast appeared as a hypointense cyst.

Enzyme Linked Immunosorbent Assay (ELISA) was performed on the sera of 44 of the above 51 patients using a commercial ELISA kit (IVD Research Inc., Carlsbad, USA) to detect IgG antibodies against the cysticercus cellulosae cyst fluid [10]. Chi square test was used to find the significance of differences observed in proportions. Findings were considered statistically significant if the p value <0.05.

Results

A total number of 51 patients with age and gender distribution were recuirted in the present study. Among the patients, there were 22(43%) males and 29(57%) females. The age groups between 6 and 30years constituted 38(74.5%) of the patients. Vegetarians accounted for 24(47%) and 27(52%) were non-vegetarians; none of the non-vegetarians ate pork on enquiry.

Site	Number of lesions in brain (%)	
Frontal lobe	252(44.6)	
Parietal lobe	137(24.2)	
Temporal lobe	70(12.4)	515(91.15)
Occipital lobe	56(10)	
cerebellum	11(2)	
Brain stem	7(1.2)	
Basal ganglia	6(1)	29(5.13)
Corpus callosum, Thalamus	5(0.9)	
Intraventricular	1(0.2)	
Subarachnoid space	20(3.5)	21(3.71)
Total	565(100)	

Table :1 – Distribution of Lesions of Neurocysticercosis in the Brain of 51 Patients

CLASSIFICATION	CT	MRI
	No. of lesions detected (%); n=541	No. of lesions detected (%); n= 561
Active (Vesicular)	4(0.74)	5(0.92)
Transitional (colloidal)	494(91.4)	497(92)
Transitional(granular nodular)	6(1.1)	6(1.1)
Inactive (calcified)	36(6.6)	32(5.9)

Table :2 – Number of Lesions & Classification of Neurocysticercosis Lesions in Brain Parenchyma in CT and MRI

TYPE OF LESION	NUMBER OF PATIENTS TESTED	ELISA POSITIVE (%)
Single enhancing CT lesion	28	8 (28.5%)
Multiple enhancing lesion	9	3 (33.3%)
Calcified lesions	7	0 (0%)
Total	44	11(24.8%)

Table :3 – Correlation of Type of Neurocysticercosis Lesion in Patients with Serological Positivity

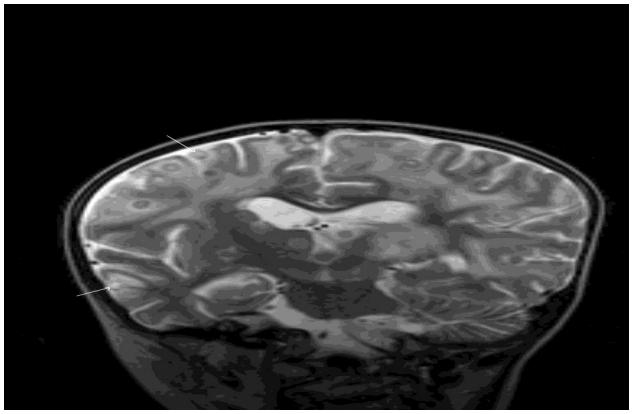
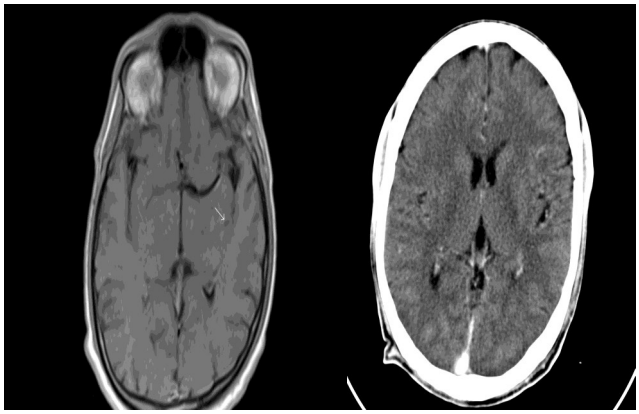


Figure :1 – Neurocysticercosis. Coronal T2W MRI shows brain parenchymal and subarachnoid (white arrows) ring lesions with diffuse cerebral edema. This patient also had ventricular lesions (not shown here).



(a) (b)

Figure :2 a &b– Stage 1 active neurocysticercosis. (a) Axial gadolinium enhanced T1W MRI shows a faintly ring enhancing lesion (white arrow) in the left temporal lobe with no perilesional edema which is not appreciated in the contrast enhanced CT axial scan of the brain at the same level (b).

The regional distribution of 565 lesions in the brains of 51 patients, when results of both CT and MRI are taken together, is shown in table 1.The lesions were confined to the parenchyma of the brain in 50 (98%) of the patients. Frontal lobe was found to house 252(44.6%) of lesions, followed by the distribution in parietal, temporal and occipital lobes in the decreasing order of frequency of lesions detected. Basal ganglia, cerebellum, brain stem, corpus callosum and thalamus accounted for only 29(5.13%) of the lesions. Only one of the patients studied had lesions in the intraventricular region and subarachnoid space in addition to the parenchymal lesions (figure1). The lesions in brain parenchyma were of SECTL variety in 36(70.5%) of the patients.

Seizures were the only clinical finding in 39 (78%) of the patients with parenchymal lesions.

Seizures along with headache and fever was found in 6(12%). Seizures accompanied with headache, vomiting and syncope was found in 5(10%) of the patients. The lone patient with lesions in the intraventricular region and subarachnoid space, in addition to parenchymal lesions, presented with seizures and features of obstructive hydrocephalus.

The number and classification of neurocysticercosis lesions in the brain parenchyma detected by CT and MRI for comparison in presented in table 2. Among the total of 565 lesions detected by both the tests, CT could detect 541 (95.7%) and MRI detected 561 (99.3%) of lesions. The difference in the proportion of lesions detected between the tests was not significant (P value = 0.84,P > 0.05) Thus both MRI and CT were almost equally efficient in detecting parenchymal and intraventricular lesions in the brain. But, 20 lesions in the subarachnoid space were distinctly detected by MRI alone in a single patient; CT could not detect any. Leaving behind the subarachnoid lesions detected only by MRI, there was no substantial difference between the varieties of lesions detected by either of the imaging modalities. However, occasionally individual active lesions were better detected by MRI in comparison to CT (figure 2a & b).

ELISA detected IgG antibodies to cysticercus cellulosae cyst fluid in 11(24.8%) of the 44 patients tested (Table-3). ELISA was positive in 8(28.5%) of 28 patients with SECTL and 3(33.3%) of the 9 patients with multiple (active or transitional) lesions. Taken together 11(29.7%) of the patients with active or transitional lesions were positive by ELISA and all the seven patients who had calcified inactive lesions were negative by ELISA.

Discussion

Neurocysticercosis, related to poverty and poor sanitation, has been reported to be a problem among patients belonging to third and fourth decades of life [(11)]. It is reported to be less common in children and elderly[(12,13)]. In the series reported here, patients in the second and third decades of life accounted for 56.8% of the patients studied and children below 10years accounted for 37.2% of the patients. These findings indicate that in the population in and around Kolar, younger age groups may be more often manifesting neurocysticercosis than in other parts of the country, which, however, needs to be validated by observations on a larger population of patients.

Our study found that 98% of the lesions were confined to the brain parenchyma and only one patient had lesions in the intraventricular region and subarachnoid space in addition to the parenchymal lesions. Earlier radiological studies have

documented similar findings[14,15]. We found 70.5% of the patients had SECTL in the parenchyma of the brain.This type of lesions seems to be peculiar radiological finding in the patients from Indian subcontinent, the reason for which is not clear[4,16,17]. We think that the lower parasite egg load on the raw and improperly cooked vegetables eaten by the population may be responsible for this outcome, as none of our patients ate pork and 47% of the patients were infact vegetarians.

There was no statistically significant difference found in the number of lesions of neurocysticercosis detected by CT and MRI in the present study, which is in agreement with that reported by Suss et al. earlier[15]. However, we found that MRI detected lesions in the subarachnoid space which were not detected by CT at all. Thus, MRI may be useful to detect subarachnoid lesions found in an occasional patient. Our observations, thus show that MRI contributes marginally over CT for the routine diagnosis of neurocysticercosis. We, however, think that MRI has a place in the diagnosis of neurocysticercosis in children; it obviates repeated exposure to radiation, especially, when follow-up scans are required. This assumes importance under circumstances similar to ours, where children constitute more than a third of the patients with neurocysticercosis.

Studies on serology of cysticercosis recommend Enzyme linked Immune electro transfer Blot assay (EITB) to be more sensitive than ELISA. However, ELISA is easily performed and recently a comparison between the results of EITB and the ELISA kit used by us has shown ELISA to have comparable sensitivity and specificity with EITB[10]. Among the 37 patients found to have active or transitional lesions, in our study, 11 (29.7%) patients were seropostitive and 26 (70.3%) patients were seronegative. We also observed that all patients with calcified lesions were negative for serology. Low seropositivity rates have been reported in patients with single lesions, such patients constituted 70.5% in our study population [10].In contrast, though higher rates of positivity have been reported in those with multiple lesions, our study did not support this observation in the small number of patients with multiple lesions. Thus, serology was not found to be useful in diagnosing neurocysticercosis under our conditions unlike the experience in the studies conducted elsewhere[18]. We think that serology can be used as an adjunct to imaging modalities to differentiate tuberculoma mimicking the lesions of neurocysticercosis in an occasional patient, however, this aspect was not addressed in our study[19].Serology can also be used for follow-up; if a positive serological result turns negative on follow-up, it may indicate an active lesion turning inactive[5].

Conclusion

Our study conducted at Kolar, Karnataka state in Southern India, found that neurocysticercosis was more common in children and young adults. The parenchymal cysticercal lesions were the commonest lesions observed. Only one patient had intraventricular and subarachnoid lesions along with parenchymal lesions. SECTL accounted for 70.5% of the parenchymal lesions detected. MRI was found to be superior to CT in detecting subarachnoid lesions and picking up more number of active or transitional lesions. However, MRI contributed marginally for the diagnosis of neurocysticercosis over CT for the routine diagnosis of neurocysticercosis. In the population studied, serology to detect IgG antibodies to cysticercal fluid antigen by ELISA was found to be useful in the diagnosis of neurocysticercosis in only a quarter of the patients.

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