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Neurocysticercosis in South Asian Adult Population: An Imaging Based Prospective Study

Dr Jitender Singh

MD DNB, JNMC AMU Aligarh, Uttar Pradesh, India

Abstract: ***Neurocysticercosis (NCC) has become an important emerging infection in the industrialized world due to increased travel and immigration of people from endemic areas. About 40 million of the 50 people with epilepsy in the world reside in the developing world where epilepsy continues to be a highly stigmatizing condition [135]. In most developing countries, 10% of acute neurological cases are patients with NCC. The study compares the efficacy of various imaging modalities - Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) in diagnosing NCC. We conclude that both MRI and CT scan plays a key role in establishing the cause of ring enhancing lesion like NCC and its extent of involvement. In NCC if available and feasible, MRI must be undertaken. Moreover routine MRI examination should be coupled with MRS for cases with suspected intracranial ring enhancing lesions like NCC as it could increase the diagnostic accuracy. But this is an exorbitant and not easily available tool putting it out of the reach of most patients in developing countries who are the ones who suffer from this disease. Hence contrast enhanced CT scan remains the imaging modality of choice for NCC in developing countries.***

Keywords: Neurocysticercosis, NCC, CT Scan, Magnetic Resonance Imaging, MRI, Magnetic Resonance Spectroscopy, MRS

1. Introduction

Ring enhancing lesion in brain imaging is a frequently encountered feature in Indian sub-continent and is commonly encountered neurological abnormalities. In a developing country like ours, the etiological spectrum seems to be different from the western world. Widely available imaging techniques, computed tomography (CT) and magnetic resonance imaging (MRI) is used to detect these lesions. A wide range of etiologies may present as intracranial multiple or single ring-enhancing lesions (**1).**

Cysticercosis is most common parasitic infection of the human central nervous system and is common etiological factor of seizure worldwide. The causative agent in cysticercosis is the pork tape worm, Taenia solium. Humans become infected with cysts by accidental ingestion of T. solium infective eggs by fecal-oral contamination (***Hector et al., 2002*****) (2).** Seizures are the most common clinical manifestation of neurocysticercosis and may represent the primary or sole manifestation of the disease in almost 70% of patients **(3)**. Headache is common among patients with neurocysticercosis. (***Rajshekhar et al, 2000*****) (4).**. The cyst then involutes, degenerates and often calcifies. The location of involvement in the brain can be meningo-basal, parenchymal, intraventricular or the combination of the sites. However parenchymal disease is quiet common.

Before the introduction of modern neuroimaging diagnostic techniques, knowledge of the natural history of cysticercosis was limited and largely based on cases diagnosed either by the presence of subcutaneous nodules, plain X-rays showing calcifications in the brain or soft tissues, surgery of cases with intracranial hypertension, or from necropsy data. During the last two decades, the introduction of CT and later MRI permitted the identification of mild cases with only a few parenchymal cysts **(*Estanol et al, 1986*) (5).**Later, studies in India showed that a vast majority of single enhancing lesions, until then attributed to TB, were in fact degenerating cysticerci **(*Chandy et al, 1991*) (6).**

Imaging findings in each stage reflect underlying changes in the disease process and host response**.** The recent imaging methods provides evidence on the number and topography of lesions, their stage of involution, and the degree of inflammatory reaction of the host against the cysticerci **(*Garcia and Del Brutto, 2003*) (7)**. Parenchymal disease has been classified into following four stages (**8, 12).**

Vesicular Stage

Cysts are commonly seen at the gray white junction, however they can also seen in the basal ganglia, cerebellum, and brainstem. The cyst wall is thin and smooth, and a 2 to 4-mm scolex is identified within the cyst. There is no evidence of any edema surrounds the cyst.

CT shows a nonenhancing or mildly enhancing cyst wall containing a small scolex and CSF-attenuation cystic fluid. A low-signal-intensity cyst cavity containing a nodule that is isointense or hyperintense relative to white matter is seen on T1-weighted MR images. On T2-weighted MR images the scolex can be isointense or hyperintense and can be obscured by high signal intensity of cystic fluid. The scolex is better seen on proton density-weighted images as signal to noise ratio is high and high contrast enhancement is there.

Colloidal Vesicular Stage

As the larva dies leakage of cyst material results in host's immune response results in a fibrous capsule to form with surrounding perilesional parenchymal edema. The severity of this inflammatory response varies widely and depends on the host's immunity to infestation.

A diffuse encephalitis/cerebritis may occur, especially in children and after use of the oral antihelmintic agents' praziquantel or albendazole, and usually requires requiring large doses of corticosteroids to control brain edema.

CT depicts ring-enhancing cystic lesions usually with hyperdense fluid content and surrounding edema. On T1 –weighted MR images cyst appears hyperintense to CSF because of proteinaceous fluid and accumulated debris within the cystic. T2- weighted MR images show a hyperintense cyst surrounded by hyperintense parenchymal edema.

Granular Nodular Stage

In this stage, the cyst retracts and forms a granulomatous nodule that will calcify later on. CT reveals an enhancing nodule with calcified scolex and mild surrounding edema. MR images show a thick enhancing ring or nodule with or without surrounding edema. Usually at this stage it simulates tuberculoma or metastatic nodule.

Nodular Calcified Stage

In this stage the granulomatous lesion completely calcified with no perilesional edema. On CT the lesion appears as single or multiple calcified nodules. These nodules are hypointense on all MR imaging sequences.

Cisternal Cysticercosis

In cisternal cysticercosis involvement of subarachnoid spaces and adjacent meninges will occur. Cisternal cysticercosis are very rare and occur in association with parenchymal cysticercosis. Sometimes Cysts within the cistems may manifest as space-occupying lesions and causes cause obstructive hydrocephalus. The Racemose form that occurs in the subarachnoid spaces and may simulate a low-density tumor in the sellar region or cerebellopontine angle cistern region. The subarachnoid cysts usually lack a scolex **(9).**

lntraventricular Cysticercosis

Intraventricular cysticercosis often leads to intraventicular obstruction hydrocephalus and ventriculitis (**27**). On MR imaging, the presence of scolex, subependymal reaction, and cyst wall are readily apparent, indicating the intraventricular larva.

MR Spectroscopy

MRS findings of cysticercosis include a combination of elevated levels of lactate, alanine, succinate and choline and reduced levels of NAA and Creatine with no lipid peak (**10).**

Identification of the scolex is essential for making a definitive diagnosis of neurocysticercosis (NCC). This scolex may be missed on routine sequences but a 3D sequence like CISS will demonstrate it. The cyst wall and scolex are well visualized on CISS and CT scan.The increased sensitivity of the CISS sequence is due to its higher contrast to noise ratio and may also be related to accentuation of the T2 value between the cystic fluid and the surrounding CSF. Although the presence of scolex is considered to be pathognomonic for cysticercosis, it has never been rigorously tested (***Zee et al, 2000***) **(11).**

Cysticercotic encephalitis is a rare form of the disease in which patients have numerous inflamed cysticerci, leading to diffuse, severe cerebral edema (***Kramer et al, 1989***) **(13).**

MODIFIED DIAGNOSTIC CRITERIA FOR NEUROCYSTICERCOSIS (Del Brutto et al., 2001) (14)

Absolute

- Histologic demonstration of the parasite
- Multiple cystic lesions with or without the scolex

Major

- Presence of characteristic picture
- Positive serum EITB
- Aggravation of existing symptom or appearance of new symptoms following
- antiparasitic treatment
- Cysticercosis outside the CNS

Diagnosis with Caution

- Old patient
- HIV – infected patients
- Patients with pre existing tuberculosis and malignancy
- Patients with grossly abnormal neurological examination

Definitive

- Presence of one absolute criterion
- Presence of two major and one minor criteria

Probable

- Presence of one major plus two minor criteria
- Three minor criteria

Sethi et al. in 1985 made the fortuitous discovery that Solitary cerebral cysticercus granuloma lesions resolved spontaneously and labeled them "appearing and disappearing abnormalities **(15).**

Rajshekhar V, Chandy MJ (1996) compared the relative yield of a thin-slice contrast-enhanced CT and MRI in the visualization of SCCG and concluded that if the CT examination is properly performed with adequate contrast injection; both modalities have almost equal sensitivity **(16).**

Rajshekhar V, Chandy MJ (1997) published a set of diagnostic criteria for SCCG, which included clinical and

CT features. These criteria were validated in a prospective study and found to have a sensitivity of 99.5% and specificity of 98.9%.They compared the clinical and CT data from six consecutive patients with histologically proven small solitary tuberculomas and 25 consecutive patients with histologically proven solitary cysticercus granulomas. Based on the clinical finding (evidence of raised intracranial tension and a progressive neurological deficit) and CT criteria (size, shape, and association with a midline shift), it is possible to separate these two entities in a majority of patients with seizures and with a single small lesion on CT **(17).**

Garg RK, Nag D. Single (1998) studied 101 such patients who had single CT lesions and in their study they recorded that the initial non-contrast enhanced CT scan revealed focal hypodensity due to cerebral oedema in 49 patients. In an additional 17 patients he observed complete cysticercal larvae (cyst with scolex). In the rest of the patients, plain CT scans were normal. After contrast administration, the majority revealed a ring/disc enhancing lesion; half of them had an enhancing eccentric dot representing a scolex (**18).**

Chandy MJ, Rajshekhar V, Ghosh S (1991) in their study noted that excision biopsy and histopathological analysis of single small CT lesions showed that 12 out of 15 patients had evidence of cysticercus or its parts. None of the patients were found to have neoplasm or tuberculosis (**19).**

Yodnopaklow P et al (2000) in their study evaluated 1, 000 patients with various seizure disorders, of whom approximately 10% had seizure and a solitary lesion. Roughly 80% of patients had lesions more than 20 mm and were excluded. On follow-up of these excluded patients (> 20 mm), only 1 had spontaneous resolution while the rest had persistent lesion on CT. Of the remaining 20% included in the study, 90% had complete resolution by 6 months. Of the two patients with persistent lesions, one underwent excision biopsy which revealed eosinophilic granuloma. The other patient refused biopsy, anti-tubercular treatment was prescribed and lesion resolved after 4 months. This study externally validated the previously described criteria and calculated the sensitivity and specificity as 95 and 97 per cent respectively with a negative predictive value of 98 per cent (**20).**

Desai and Bhatia (1990) observed differences in the MRI picture of tuberculoma and cysticercosis. On T2 weighted sequences, tuberculomas were seen to lose signal intensity, while the intensity of cysticerci increased from first to second echoes (**21).**

Chandy and Rajshekhar et al (1991) reported that amongst 31 consecutive cases of ring enhancing lesions (25 of them were cysticerci and 6 tuberculomas), all cysticercus granulomas were less than 20 mm in size. In comparison to all tuberculomas which were greater than 20 mm in size. Moreover, 96% of cysticerci had a regular outline with no mass effect or midline shift, contrasting 5 out of 6 tuberculomas which were irregular in outline and 4 of 6 had evidence of midline shift on CT.Presence of calcification, and perifocal edema was seen in both, and was not a differentiating feature **(22).**

Pretell EJ, Martinot C Jr, Garcia HH et al (2005) studied ten patients with SELs caused by neurocysticercosis (n=6) or tuberculosis (n=4) were examined by proton magnetic resonance spectroscopy. Tuberculomas had a high peak of lipids, more choline, and less N-acetylaspartate and creatine. The choline/creatine ratio was greater than 1 in all tuberculomas but in none of the cysticerci **(23).**

Souza Ad et al (2013) concluded that contrast CT was nearly as sensitive as MRI in detecting solitary cerebral cysticerci. Thus, in highly resource limited settings contrast CT may be sufficient for the diagnosis and management of neurocysticercosis **(24).**

Amaral L, Maschietto M, Maschietto R et al (2003) retrospectively analysed 172 cases of neurocysticercosis studied by MR over a period of 13 years. They concluded that MR imaging is a sensitive and specific method in the analysis of different forms of unusual manifestations of neurocysticercosis, which should appear in the differential diagnosis of parenchymal, ventricular, spinal, cisternal, and orbital lesions (**25)**.

Chang KH, Han MH reviewed MRI finding of parasitic disease of the central nervous system (CNS) in 1998, with emphasis on neurocysticercosis which is by far the most common CNS parasitic infection worldwide. They concluded that MRI is superior to CT in the evaluation of most CNS parasitic infections and is nearly diagnostic, particularly in endemic areas. Contrast enhanced studies is essential not only for specific diagnosis of the disease, but also for the assessment of the inflammatory activity (**26)**.

HR Martinez R Rangel- Guerra, G Elizondo et al reviewed the MR findings in 56 patients with neurocysticercosis (NCC) in 1989, MR finding were correlated with other neuroradiological finding in 40 cases with histopathological studies in 15 surgically treated patients, and with autopsy finding in one case. They concluded that MR is sensitive in diagnosing active NCC and may be useful in evaluating the degenerative changes in parasite that occur as a result of natural degeneration, host response or medical therapy (**27).**

2. Methodology

Source of Data:

The main sources of data for the study are patients from indoor and outdoor patients departments of Jawaharlal Nehru Medical College and hospital, Aligarh Muslim University, Aligarh, particularly the department of medicine and neurosurgery.

Method of Collection of Data:

All patients referred to the department of Radiodiagnosis with history of neurological complaints with known and suspected intracranial lesions will be considered for the study in the Department of Radiodiagnosis over a period of 2 years from November 2013 to November 2015.

A detailed clinical history was noted in all patients with neuroimaging suggestive of ring-enhancing lesions. Detailed past, family and personal history was also taken in all patients. A thorough general and systemic examination, especially evaluation of neurological status was done in view of different etiologies for such a presentation.

Laboratory tests evaluated which included a complete blood count with erythrocyte sedimentation rate (ESR), electrolytes and routine biochemical tests. Specific laboratory tests for establishing etiology were performed like screening for HIV-1 and 2, blood cultures, sputum examination and culture. CSF analysis for protein, sugar, cell count and morphology. CSF ADA, IgM toxoplasmosis antibodies, as when indicated or available.

Imaging studies done included computed tomography (CT) brain with contrast and magnetic Resonance imaging (MRI) brain with contrast as indicated. Ancillary investigations like X-ray Chest and CT scan of chest, abdomen USG of abdomen, were evaluated whenever the clinical situation demanded.

Probable etiological diagnoses were based on the presence of supportive findings detected after Clinical evaluation and battery of investigations. The diagnosis remained probable because in many patients did not have histopathological verification. Patients were provided appropriate symptomatic treatment. Appropriate specific treatment according to the suggested diagnosis was provided by the clinician. Patients were followed for resolution of clinical symptoms for maximum 6-8weeks and follow up scan was done as clinically indicated. Size of the lesion, edema, calcification or disappearance of lesion was noted in the follow up scan.

Inclusion Criteria

- Patients of all age group except paediatric age group.
- Both sexes
- Patient referred to department of radiodiagnosis with neurological complains and whose imaging study revealed ring enhancing lesions are taken up.

Exclusion Criteria:

The study will exclude

- Known allergy to contrast materials.
- Deranged Renal Function Test (serum creatinine level >2.5mg/100ml of blood).
- Post operative cases.
- Patient having history of claustrophobia.
- Patient having history of metallic implants insertion, cardiac pacemakers and Metallic foreign body in situ.

Prior to imaging an informed consent was obtained, followed by a detailed enquiry regarding the possibility of any contraindications to Imaging such as cardiac pacemaker, metallic clips and stents, prosthesis, rod, aneurysmal clips, or contrast reaction etc.

Equipment and Technique Used

CT scan (SIEMENS SOMATOM EMOTION 16 slice) and MRI on 1.5T MR Scanner (MAGNETOM AVANTO, SIEMENS) were used for the study.

Imaging Techniques

Patients were examined in supine position with proper positioning and immobilization of the body. Standard surface coil was used in case of MRI.

CT scan

Topograph was performed first followed by scan with axial ~5mm sections thickness at 130KV, 270mAs.*Optiscan*^{TM} *(Iohexol)* contrast injection was administered (IV route) in the dose of 1-2ml/kg was given as indicated and post contrast scan were obtained and further recon and reformed and delayed or plain scan were taken as and when required.

MR Imaging

On MRI Conventional spin echo sequences, axial T1 (TE-11, TR-546ms), T2 (TE-96, TR-4000ms) and FLAIR (TE-110, TR-9120ms); Sagittal T1; Post contrast axial, coronal and sagittal; DWI and GRE/SWI sequences. *Optimark*^{TM} *(Gadoversetamide)* contrast injection was administered (IV route) in the dose of 0.1-0.3mmol/kg was given as indicated and post contrast fat saturated T1-weighted images were obtained. Coronal, axial and sagittal images were obtained in various sequences as mentioned above as per the clinical indication. In-Vivo 2D proton MR spectroscopy was performed using chemical shift imaging with intermediate TE (time to echo) of 135 ms and TR (time of repetition) of 1500 ms.

The voxel was placed on the lesion so that it covers the maximum area of the lesion. We used T1 post contrast sequence as localization sequence. If necessary Spectroscopy was avoided in small lesions close to the bone.

Special sequences such as CISS 3D, and MTC were used as and when required.

Findings were noted with references to the following for presence of any ring enhancing lesion:

1. Size of the lesion.
2. Location of the lesion

3. CT attenuation and signal intensity characteristic: compared to the normal neuroparenchyma on different sequences.
4. Contrast enhancements
5. Hemorrhage /calcification

On MR spectroscopy ratios of CHO/CR, CHO/NAA and NAA/CR was obtained and compared.

Final diagnosis was made by correlating the imaging finding and available clinical data of the patient. The radiological diagnosis was correlated with the provisional clinical diagnosis based upon the clinical outcome of the patient and the histopathological analysis whenever available and the results thus obtained were statistically analyzed.

Statistical analysis

Statistical presentation and analysis of the present study was conducted using arithmetic mean, percentage and standard deviation. Student t- test was used to determine the significance between two groups. Unpaired two tail t-test was used for explore parameter relationships and comparison among different variables in quantitative data of two groups. Parameter values were expressed as mean and standard deviation (SD). P- Values of less than 0.05 were considered statistically significant. Statistical analysis was performed using MS Excel 2010 and IBM SPSS statistical software package.

The study was approved by the local ethics committee at our institution, patient consent was obtained from all study subjects and their data were kept in a secure electronic file in an anonymous manner to insure patient confidentiality.

3. Observation and Results

This prospective study was conducted on 80 patients suspected having intracranial ring enhancing lesion between November 2013 and November 2015 in the Department of Radiodiagnosis, in coordination with the Department of neurosurgery in Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh.

The age distribution of the patients was relatively wide, ranging from 5-70 years. (Table 1) The maximum numbers of cases were seen in the second-third decade of life.

- Ring enhancing lesions were common in younger age group.
- First peak was noted in age group 11-30 years followed by 41-50 years age group.
- Neurocysticercosis is seen involving the younger age group.

All suspected patients underwent neuroimaging as per scanned protocol and the various causes of ring enhancing lesions are summarized in column chart 1.

- Of total 80 patients % underwent MRI, % CT and remaining % cases subjected to both CT and MRI.
- All lesions are more common in males compared to females except metastasis where frequency of lesion is slightly more common in female.
- The overall male to female ratio is~ 3:2 in our study.

All patients who had ring enhancing lesion on MR imaging underwent MR spectroscopy as per scanned protocol and the metabolite ratios of different ring enhancing lesions are summarized in table 5 and chart 3.

- There is slight Male preponderance in cases of NCC.
- Seizure is most common complain seen in the cases followed by headache and weakness.
- Behavioural change was noted in 5 patients who had numerous lesion in brain.

On neuroimaging the NCC lesions have also been categorized on the basis on laterality, location, size and number and described in table and chart.

- The involvement of both side of brain is fairly equal and Right to left ratio is almost 1:1
- 49% had located in the parietal lobe followed by occipital lobe.
- It is noted that above table is only for lesion in single lobe.
- In present study ~74% of cases the size of the lesion is <1cm.
- Predominately single lesion is noted in cases of NCC.
- ~62% patients had solitary lesion.
- 2 cases disseminated NCC was noted
- 2 cases of Cisternal NCC were also noted.

MR spectroscopy metabolite ratio of different patients who had NCC as ring enhancing lesions on MRI has been summarized in Table 6.

- 52 (89%) cases have CHO/NAA ratio less than 1.5.
- Only 4 patient had NAA/CR ratio >1.5.

Follow up scan characteristic of different patients had NCC as ring enhancing lesion on MRI or CT have been summarized in Table 7 and Chart 4

- There were 40 patients whom repeat CT/MRI scan was done after treatment.
- No increase in size of any lesion is noted.
- All lesions showed reduction of edema of variable degree and out of which 45% cases showed only reduction in edema only.
- Post contrast sequence followed by T2 and SWI are best sequence to visualised suspected solitary lesion of NCC.

4. Discussion

In present study, 60 cases of NCC were detected on the MRI of which 34 underwent both CT and MRI, and 20 cases on CT alone.

Age and sex distribution:

In present study, maximum number of patients of NCC, 18 (i.e.43%) patients were encountered in the age group of 15 to 20 years followed 10 (24.05%) in 20 to 30 years. The mean age of patients was 28 years and median was 25 years with male to female ratio about 2:1 (males=29; females=13) in cases of NCC. In a similar study by ***Singhi P et al, 2003 (35),*** the mean age of patients was 29.1 years which slightly higher compared to our study.

Seizure was the most common clinical presentation was seen in 31 (74%) patients for which patient underwent imaging. Of the patients who presented with seizures 55% patients presented with generalized tonic-clonic seizures and no patient presented with status epilepticus. The second most common symptom was headache seen in 7 patients (17%). Other presenting symptoms included abnormal behavior in 5% of cases. Some patients had a combination of two or more symptoms; however, we considered only the single chiefs complain. ***Patil TB et al, 2012 (36)*** also noted seizure as the most common complain in their study on NCC, however, thenumber of patients was varied.

NeuroImaging:

In present study twenty-six (i.e.62%) patients had single lesion and 19% patients had more than 4 lesions. The lesion were seen more commonly at a grey-white junction in the supratentorial location (90%) with fairly equal distribution in the both right and left side/ lobes 45% and 42.5% cases respectively with 12.5% cases showed lesions in the both lobes. The parietal lobe is most common site (49%) cases followed by occipital lobe 26% cases. 74%cases have a size less than 1cm and only 5% cases had a size greater than 2cm. All the cases were showing intraparenchymal forms of NCC with subarachnoid/cisternal cysticercosis seen in 2 cases and 5% cases had an extracranial lesion. ***Baranwal et al, 1998 (37) and Singhi et al, 2003 (35)*** reported parietal lobe involvement in 41% and 57.3% patients, respectively in their study which most common site of NCC in supratentorial location, similar finding was noted in our study. Most of the studies in India deal with single lesion neurocysticercosis. The singlelesion was present in 76% and multiple lesions in 24% patients in a study by ***Singhi et al, 2003 (35)*** and ***Rajshekhar V et al, 1997 (17)*** reported single lesion in 60.88% and multiple lesions in 39.13% patients. Whereas most of the Latin American studies show that multiple lesion neurocysticercosis is common in that part of the world; Most of the Indian studies show that single lesion neurocysticercosis is the more common form of the disease in India.

Present study showed that single lesion neurocysticercosis is more common than multiple lesions, which is in agreement with most other Indian studies.

The visualization of a scolex confirms the diagnosis of neurocysticercosis. However, it was not seen in all the cases. It could be visualized in only 63% patients higher than the previous study by ***Garg RK, 1998 (18)***. On CT, scan scolex appears hyperdense eccentric enhancing nodule within the cystic lesion and on MRI it appears as hypointense focus on T2WI which is better visualized on CISS sequence performed in 10% of cases.

NCC lesion appears hypodense on plain CT scan in 76% and hyperdense on 23% cases.On MR imaging all the lesions were hypo to isointense on T1 weighted images and 63% (out of 60) cases were hyperintense on T2 with hypointense rim compare to brain parenchyma and 40% cases showed inversion on FLAIR suggesting the fluid content of lesion. The most common stage of the presentation of NCC was colloidal. This can be explained by the fact that in the colloidal stage, there is degeneration of cyst wall and active inflammation leading to symptoms. Therefore the lesion showed intense ring enhancement with surrounding perilesional edema was seen in all cases suggestive of active lesions with 4 cases showed nodular or disc-like enhancement along with ring enhancement. Features of parenchymal forms of NCC in our study are similar to the study done by ***Garg RK, 1998 (18)***.In present study SWI played a significant role in identifying calcified lesions which were seen in 37.5 %.

We did not find a any case of intraventricular cysticercosis concurrent with parenchymal ring lesion because we excluded the only intraventricularcysticercosis from our study whereas ***Martinez et al, 1989 (27)*** reported intraventricular neurocysticercosis in 22 % of cases. Parenchymal cysticercosis is better identified on MRI than CT in present study as compared to the study done by ***Rajashekhar V et al, 1997 (17).***

MRS showed Choline peak in 37% case (out of 27 on which MRS was performed) and 37% percentage of cases showed reduced NAA peak. Lactate peak is seen in the 44.4% case (out of 27) and no lesion shows lipid peak in any of the cases diagnosed as NCC.

The ratio of CHO/CR, CHO/NAA, and NAA/CR is less than 1.5 in 81%, 89%, and 96% cases respectively. These ratios fairly correlating with a study done by ***Kumar A et al, 2003 (28)*** and slight discordance with a study done by ***Jayasunder et al, 1999 (29),*** they noted that CHO/CR <1 in all NCC patients (n=10).

The mean and standard deviation of Ratios of CHO/CR, CHO/NAA, and NAA/CR is 1.23±0.32, 1.12±0.43 and 1.21±0.34 respectively in present study.

Follow up:

Clinical outcome was assessed on the basis of recurrence of seizures or presenting complain of the patients. All patients followed-up for at least one month, out of which, 20 (47%) continued to follow and imaging was done. Of the 20 patients who were followed-up, 80% patients showed no recurrence of presenting symptoms in the month of treatment.

Radiological outcome

Repeat scan was performed in only 20 cases, all cases showed reduction in edema, out of which 35% (i.e. 7 cases) cases also showed reduction in the size of the lesion, 5% cases shows calcification and 15% patients showed completely resolved or healing lesions when compared with their previous scan. These results are not in agreement with ***Baranwal et al, 1998 (37)*** who noted resolution in 64% of cases. There was no mortality observed over the study period. However, there is no uniformity in the timing of scans and time period ranges from 2 months to 9 months with a mean duration of 10 weeks.*No increase in the size of any lesion is noted* similar ***to Patil TB et al, 2012 (36).***

5. Conclusion

- We conclude that all cases of young and adult onset epilepsy in our countries should be investigated for neurocysticercosis
- In cases of NCC CECT scan was nearly as sensitive as MRI, and thus in highly resource limited settings, it should be considered as a investigation of choice.
- We recommend that MR spectroscopy should be a part of the routine MR examination for cases with suspected intracranial ring lesion as it could increase the imaging diagnostic efficiency.

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