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RESEARCH PAPER

Comparative study of CNS tuberculoma and Neuro-cysticercosis with CT and MRI

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ABSTRACT

Background and aims*: CNS infections are usually diagnosed by clinical assessment and laboratory investigations, particularly cerebrospinal fluid (CSF) analysis, combined with radiologic findings. Radiology plays a vital role by providing the differential diagnosis and occasionally identifying a particular entity with a characteristic appearance. Imaging is also crucial for identifying disease complications and assessing response to treatment.* ***Material and methods****: Cases are referred to the Radiology department based on clinical signs and symptoms. Contrast-enhanced Computed Tomography (CT) & Magnetic Resonance Imaging (MRI) of the brain were done routinely. Written consent was taken in all cases for the contrast study. Additional sequences like Magnetic Resonance Spectroscopy (MRS), Diffusion-Weighted Imaging (DWI), and Susceptibility Weighted Imaging (SWI) characteristics of the lesions were evaluated.* ***Results****: Our study group comprised 50 cases of CNS infection. Males are more commonly affected than females. Neurocysticercosis (NCC) was the most common (60%), followed by tuberculosis. Headache (90%) and vomiting (80%) were the common presenting symptoms. Tuberculoma lesions mainly were between 1-3 cm in size. 60% of cases showed multiplicity. 78% of the NCC cases showed multiple lesions, with perilesional oedema present in 74% of the cases. Mass effect was not a predominant finding in NCC cases. The T2 intensity of lesion varied between hyperintensity and heterointensity, with most cases (75%) being T2 hyperintensity.* ***Conclusion****: Our study found MRI superior to CT in diagnosing and characterizing tuberculoma and NCC lesions.*

Keywords: *CNS Infection; diffusion-weighted imaging; magnetic resonance spectroscopy.*

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INTRODUCTION

Intracranial infections are usually diagnosed by clinical assessment and laboratory investigations, particularly cerebrospinal fluid (CSF) analysis, combined with radiologic findings. Radiological modalities play an essential role by providing the differential diagnosis and occasionally identifying a particular entity with a characteristic appearance. Imaging is also crucial for identifying disease complications and assessing response to treatment. In developing countries like India and other south Asian countries incidence of CNS infection is high.[1] Hence, early and accurate diagnoses are the key to managing such diseases, which are readily treatable and timely treatment can reduce morbidity and mortality.

Among Radiological modalities, CT and MRI are the most used modalities for the evaluation of tuberculoma and NCC.[2] The first diagnostic modality is a CT scan, widely available to assess suspected CNS infections. CT helps identify the inflammatory granuloma cases, measures the disease extent and associated complications, if any, and helps monitor treatment.[3] MRI is considered superior to CT whenever there are any diagnostic dilemmas in differentiation between TB and NCC, as well as from other neoplastic diseases. Advances in MR sequences like spectroscopy and diffusion-weighted imaging have proved to be problem-solving tools in many confusing situations.

The present research aims to diagnose inflammatory granulomas and identify whether it is tuberculoma or NCC based on CT and MRI findings and study and compare their CT and MRI imaging findings.

MATERIAL AND METHODS

The study was conducted in the Radiology Dept. of Gauhati Medical College and Hospital, Guwahati, from September 2020 to October 2021. Clinically suspected cases of inflammatory granuloma referred to the Radiology department were included in the study (50 cases). Relevant history was taken, with the history of treatment received, if any. Any allergy or previous contrast reaction history was documented, and creatinine levels were checked in all patients for contrast study.

CT Imaging: The machine used is PHILIPS (256 SLICE CT) scanner.

Positioning & Scanning:

All patients were scanned in the supine position. Axial plain scans were taken, and a contrast study was done on all patients. For the contrast study, patients were instructed to be on an empty stomach for at least 6 hrs. **Table 1** shows the site involvement of the diseases, CT imaging features, contrast enhancement pattern & complications.

MR Imaging: SIEMENS TIM AVANTO, a 1.5 Tesla machine, was used. H/o claustrophobia, any metallic implants and renal function status were enquired about before MR imaging.

Positioning: All cases were supine, placing the head in the head coil. Comfortable positioning was ascertained to reduce any movement artefacts.

Table 1 CT Appearances of Tuberculoma, NCC and JE

Disease	Location	CT appearances	Contrast Enhancement	Complications
Tuberculoma	Grey, white junction	Hypo to the isodense nodular lesion	Nodular or peripheral enhancement	Meningitis++, hydrocephalus++ Abscesses ++ Infarcts +
NCC	CSF spaces, grey-white junction, intraventricular	Hypo to the isodense nodular or cystic lesion	Nodular or peripheral enhancement	Hydrocephalus +/-
Japanese encephalitis	Ventral thalami, midbrain, cerebral peduncles	Ill-defined hypodensity in involved areas	+/-Patchy enhancement	Haemorrhagic encephalitis, cerebral oedema

Table 2 MRI Appearances of Tuberculoma, NCC and JE

Lesions	T1WI	T2WI	DWI	MRS	Contrast Enhancement	Complications
Tuberculoma	Hypointense with +/- faint peripheral hyperintensity	Hypo to hyperdense depending on the stage	++ depends on the stage	Increased lipid lactate, Choline, reduced NAA	Nodular or peripheral enhancement	Meningitis ++, hydrocephalus++ Abscesses ++ Infarcts ++
NCC	Hypointense	Hypo to hyperintense	—	Increased lactate alanine, succinate & Choline & reduced NAA, creatine	Nodular or peripheral enhancement	Hydrocephalus +/-
JE	Hypointensity in involved areas	Hyperintensity in involved areas	variable	Reduced NAA, increasing lipid lactate	+/-Patchy enhancement	Hemorrhagic encephalitis, cerebral oedema

MR Protocol: Plain with post-Gadolinium examinations of the brain were performed in all patients in axial, coronal, and sagittal planes along with FLAIR, DWI, SWI and MRS studies.

Table 2 shows the MRI appearances of tuberculoma, NCC and JE, contrast enhancement pattern & complications.

Statistical analysis: Data were presented as Mean SD (Min-Max) for continuous data and as Number(%) for categorical measurements. Chi-square/ Fisher Exact test has been used to find the significance between two or more groups. Significance is assessed at a 5% level of significance. Diagnostic statistics, viz. Sensitivity, Specificity, PPV, NPV and Accuracy have been computed to find the correlation between CT and MR findings. Microsoft excel, SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment Ver.2.11.1 were used for the presentation and analysis of the data.

RESULTS

33(66%) were male, and 17(34%) were female out of the 50 case studies. Most cases were in the 30-40 years of life followed by 20-30 years (**Table 3**).

Table 3 Age-wise distribution of the patients

Age groups	No. of cases	Percentage
10-20	3	6
20-30	11	22
30-40	14	28
41-50	10	20
51-60	7	14
61-70	5	10

The most common presenting symptom was headache (90%), vomiting (80%) and fever (66%). Neurological deficit was recorded in 58% of the patients (**Figure 1**).

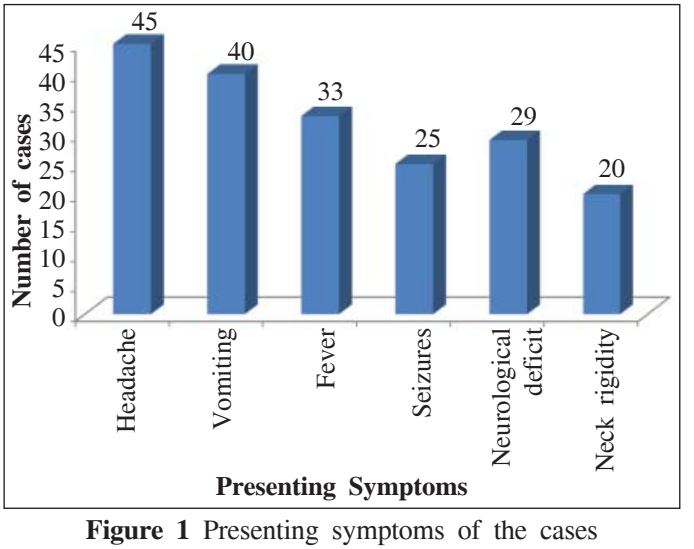

Figure 1 Presenting symptoms of the cases

Our study revealed NCC as the commonest of inflammatory granulomas, followed by tuberculosis. Superimposed JE infection was found in 3 cases of NCC (**Table 4**).

Table 4 Frequency of the diseases

Lesions	No of cases	Percentage
Tuberculoma	20	40%
NCC	30	60%
JE + NCC	3	

Imaging features of NCC: The appearance of most NCC was small (<1cm), with T2 hyperintense lesions with multiple lesions at various stages being common in one patient. In a contrast study, thin rim enhancement was found with perilesional oedema, but no mass effect was usually present. No significant midline shift (>3mm) was observed in any of the cases, and calcification was present in 7 cases (**Table 5**).

Table 5 Imaging features of the NCC cases

FEATURE	Sub-categories	Number(%)
NE CT findings	Hypodense	18(60%)
	Isodense	6(20%)
	hyperdense	6(20%)
T1 intensity	Hypointense	15(50%)
	Iso-hypointense	10(33%)
	Isointense	5(17%)
T2 intensity	Hypointense	6(20%)
	Heterointense	2(6.6%)
	Hyperintense	4(13.4%)
	Hyperintense with hypointense rim	6(20%)
	Hyperintense with hypointense nodules	3(10%)
	Hyperintense with nodule and rim	9(30%)
Number	Single	7(22%)
	Multiple	23(78%)
Conglomeration	Present	4(12%)
Significant midline shift (>3mm)	Present	0
Perilesional oedema	Present	22(74.0%)
Size of largest lesion (cm)	<1	28(93.0%)
	1-3	2(7.0%)
Post contrast enhancement	No enhancement	10(33.0%)
	Thin regular ring	11(37.0%)
	Thick irregular ring	-
	Nodular	9(30.0%)
Complications	Present	0
Other features	Calcification	7(23.0%)

Imaging features of Tuberculoma: CT-imaging features of the 20 cases show appearances of most lesions of 1-3 cm. Multiple lesions were observed in 60% of the cases. Significant midline shift (>3mm) was observed in 20% of the cases, and 3 showed calcification. Complications including infarcts, hydrocephalus and abscess were found in 35% of cases (**Table 6**).

Table 6 Imaging characteristics of tuberculoma in the study sample

Feature	Sub-categories	Number(%)
CT findings	Hypodense	10(50%)
	Isodense	3(15%)
	Mixed	7(35%)
T1 intensity	Hypointense	2(10%)
	Isointense	4(20%)
	Iso-hypointense	6(30%)
	Hypointense with hyperintense rim	7(35%)
	Iso-hyperintense	1(5%)
T2 intensity	Hypointense	6(30%)
	Hypointense with hyperintense rim	2(10%)
	Iso-hypointense	2(10%)
	Hyperintense with hypointense rim	2(10%)
Number	Single	8(40%)
	Multiple	12(60%)
Conglomeration	Present	3(15%)
Significant midline shift (>3mm)	Present	4(20%)
Perilesional oedema	Present	20(100%)
Size of largest lesion (cm)	1-3	15(75%)
	>3	5(25%)
Post-contrast enhancement	Thin regular ring	14(70%)
	Thick irregular ring	2(10%)
	Nodular+thin regular	4(20%)
Calcification	Present	3(15%)
Complications	Infarcts	1(5%)
	Hydrocephalus	3(15%)
	Abscess	3(15%)

Representative cases: b

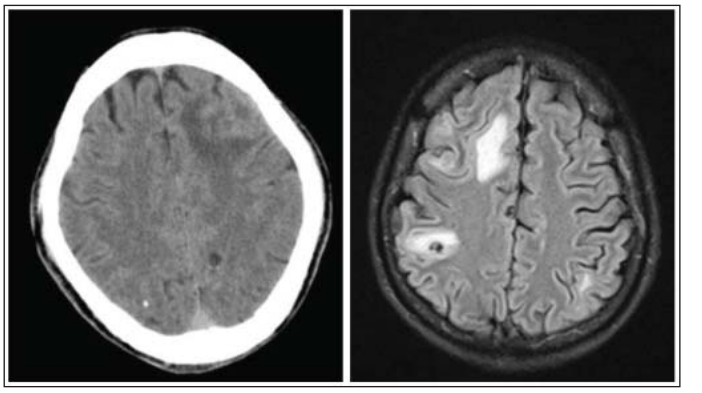

Figure 2 NECT and FLAIR MRI images showing NCC at the vesicular stage and calcified stage with oedema.

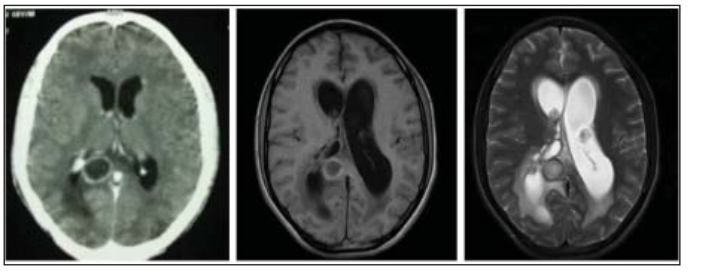

Figure 3 CECT image showing rim enhancing tuberculoma in splenium with corresponding T1W and T2W MRI images

DISCUSSION

The presenting age of the cases was mostly in the 30-40 age group. This age pattern is like other studies.[4,5] Presenting symptoms like headache, vomiting and fever were predominant in our study, which correlates well with another study.[6]

Most tuberculoma lesions were 1-3 cm in size (75%). Multiplicity was seen in 60% of cases, similar to another study.[6] Tuberculomas (85%) were primarily supratentorial, frontal and parietal lobes involved in 80% of cases, similar to a study.[7] Tuberculomas were seen in caseating granuloma, caseating granuloma with liquefactive necrosis and calcified stages. On conventional MR imaging, 70% of cases belonging to caseating granuloma and with liquefactive necrosis stages were either isointense or iso-hypointense to grey matter on T1 WI. A hyperintense rim was noted in 32% of cases, agreeing with another study.[8] Specific MRI finding of tuberculoma was T2 hypointense character with MRS at 135 ms (70%) and a well-defined lipid peak at 1.3 ppm (75%). Tubercular lesions on calcified stages showed susceptibility artefacts on SWI sequences.

Most of the tubercular abscesses showed diffusion restriction. In the post-contrast study, 13 cases (67%) had thin regular, and 2 cases (10%) had thick irregular ring enhancement,

while 5 cases (25%) had homogeneous nodular enhancement with associated rim enhancement. The nodular enhancing lesion was T2 hyperintense. The pattern of contrast enhancement and T2 intensity was like other studies.[9,10]

DWI studied twelve tuberculomas; 4/12(33%) cases showed increasing hyperintensity with increasing b values and hypointense on ADC maps. This is a pattern associated with restricted diffusion.

A well-defined lipid peak at 1.3 ppm was specific for tuberculoma. The spectral pattern of tuberculomas is consistent with a similar study.[8]

Among 30(60%) cases of neurocysticercosis, the diversity of lesions was present in 78% of the cases, with perilesional oedema in 74%. Still, no mass effect was noted in any case. On NECT, the lesions appeared as hypodense (60%), isodense (20%) and hyperdense calcified lesions. On T1 WI, 50% of cases were hypointense: 33% of cases were iso-hypointense, and 17% of cases were isointense to grey matter. The T2 intensity of lesion varied between hyperintensity and heterointensity, with most cases (75%) being T2 hyperintensity. The T2 hypointense lesions were calcified on CT.

Most lesions (9) were in the granular nodular stage, 3 were in the vesicular stage (10%), and 10 were in various stages, including calcified lesions. Colloid vesicular and granular NCC together accounted for almost 50% of cases in our study, and these cases are considered active and need treatment.

Perilesional oedema was present in 22/30(74%) of NCC, which were in colloid vesicular and granular stages. Perilesional edema was absent in vesicular and calcified stage of NCC. The findings are similar to another study.[11] Post-contrast enhancement was present in 20 patients, among whom all (100%) had perilesional oedema. The lesions in the vesicular stage showed no perilesional oedema. In 3 cases, an eccentric hyperintense scolex could be identified, which is considered confirmatory for NCC in the vesicular stage. This suggests that contrast enhancement seems to occur when there is surrounding oedema.[11]

Eleven cases had DWI study, of whom 9(73%) had equal hyperintensity on all b values with mixed intensity on ADC maps lesion. These cases were in the colloid vesicular or granular stage. Of the 30 cases of NCC, only 20 cases had a visible spectrum on MRS. NAA was decreased in 50% of cases, Choline was decreased in 5 cases, and creatine decreased in all 20(100%) cases. Lactate and cytosolic a.a. resonances were present in 6 and 5 patients, respectively.

Pre-contrast MR imaging provides enough information to diagnose neurocysticercosis in most patients. The small size of the lesion and relatively more minor perilesional oedema favour a diagnosis of NCC. The presence of a T2 hypointense rim, nodule or both together had a high sensitivity rate (82%) for NCC. Cases with perilesional oedema in pre-contrast images were valuable to be studied with contrast imaging.

The absence of mass effect was a consistent sign of NCC, which correlates with another study.[12] The Number and stages of cases were better identified with MRI than CT scan.

The cases of NCC with JE T2WI and FLAIR images showed increased signal intensities in bilateral thalami (100%), substantia nigra (66%), basal ganglia (33%) and dorsal pons (33%) with diffusion restriction in 2 cases which correlated well with another study by Siu, et al.[13]

In doubtful cases where the precise radiological diagnosis was not possible to differentiate between tuberculoma and NCC, cases with small size, minor perilesional oedema and absence of mass effect were treated with antiparasitic therapy. Healing with calcification was observed, and therapeutic response confirmed the diagnosis of NCC. The cases with larger lesion size, more perilesional oedema and mass effect were given anti-tubercular therapy and followed up at three monthly intervals up to 12 months, and response to treatment was observed. Ultimately healing by calcification was observed. In none of the cases a biopsy was performed for diagnostic purposes. None of the patients was willing to undergo the surgical procedure, and referring departments relied on radiological and serological findings. Serological tests were performed in all suspected cases of NCC and found to be positive in all the active cases of NCC.

CONCLUSION

When diagnosed early, CNS infection, especially tuberculoma and NCC, can be managed successfully with advanced antimicrobials without any residual. For diagnosis, along with clinical and pathological studies, imaging by CT and MRI play an essential role.

Due to broader availability and cost-effectiveness, CT is always the first modality used to evaluate suspected inflammatory granuloma cases. However, MRI proves to be better in cases with a diagnostic dilemma in differentiating between various infectious causes and neoplastic etiologies. Advanced MRI sequences like MR spectroscopy, Perfusion imaging & diffusion-weighted imaging, and MRI proves to be better at evaluating CNS infections than CT.

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