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Prospective study of clinical and investigative profiles of CNS ring enhancing lesions

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Abstract
The present study *"Prospective study of clinical and investigative profiles of ring-enhancing lesions in CNS"* was conducted in the Post doctoral Department of Neurology at S.C.B. medical college & Hospital, Cuttack during the period of between August 2013 – November 2015. Total numbers of Seventy eight patients of CNS Ring enhancing lesions were evaluated. Based on clinical observations and investigations. The numbers of males were more than that of females with overall sex ratio was 1.69:1 (M: F). Majority of patients belongs to third and fourth decade of life (35.9%)). Headache emerged as the most common complaint that the patients presented with (71.79%) followed by seizures in 67.94%.
However in patients of NCC seizures was the most common presentations (86.7%) followed by headache (66.7%). A large number of infectious and non-infectious diseases can cause multiple ring-enhancing lesions of the brain. We reviewed the most common diseases in our setup. The most common etiologies were that of TB, parasitic (especially neurocysticercosis), primary brain tumors and Gliomas and metastases, cerebral abscess. Other rare causes include cerebrovascular stroke.

Keywords: CNS, neurocysticercosis, primary brain tumors, cerebral abscess

Introduction
The advent of computed tomography and Magnetic Resonance Imaging has had a great impact on neurology, primarily because it solves a fundamental limitation of radiography, namely superimposition of imaged structures.
Contrast uptake in the form of "ring-enhancement" on CT brain has been found in diverse conditions with damage to the blood brain barrier [1].
A ring-enhancing lesion in brain imaging is a common feature in the Indian subcontinent. The size, shape, wall thickness of ring-enhancing lesions, the extent of surrounding oedema, and importantly clinical history and age of the patient taken into consideration may help to distinguish the condition [2].
The aetiological spectrum seems to be different from that described in Western literature, with infections like neurocysticercosis and tuberculomas likely to be significant causes of ring-enhancing lesions. With the advent of HIV/ AIDS, toxoplasmosis, fungal infections like cryptococcosis/ histoplasmosis are also increasingly associated with ring enhancement [2-4].
"Ring-enhancement" can be seen in primary brain tumours, metastases, brain abscesses, granulomas, resolving haematomas, and infarcts. Uncommon conditions include thrombosed aneurysms and tumours such as primary CNS lymphomas. Cystic/necrotic neoplastic brain lesions are difficult to differentiate from brain abscess as their imaging features are almost similar and differentiation is of paramount importance because of difference in the subsequent management [5]. In this study, we analyze and evaluate 'ring-enhancing' appearance as a sign in the differential diagnosis of neurological lesions in the brain.

Materials and Methods
The present study "Prospective Study of Clinical and Investigative Profiles of Ring-enhancing Lesions in CNS" was conducted in the Post doctoral Department of Neurology at S.C.B. medical college & Hospital, Cuttack during the period of between August 2013-November 2015.

Selection of Cases

Inclusion Criteria

1. Patients attending OPD and in-patients of Neurology department and other specialities at our hospital.
2. Patients of both sexes above the age of 12 years with single or multiple ring enhancing lesions in CNS imaging were included in the study.

Exclusion Criteria

1. Children below the age of 12 years.
2. Patients with homogeneous nodular enhancements, streaky/ patchy enhancement without definite rim pattern, and were excluded from the study.
3. Patient in whom MRI could not be performed because of having history of claustrophobia, history of metallic implants insertion, cardiac pacemakers and metallic foreign body insitu.

Study Design: Patients admitted in different specialities with single or multiple ring-enhancing lesions found on CNS neuroimaging were analyzed in view of their clinical presentation and investigative profile. All patients underwent routine haematological, biochemical, and serological tests including HIV, VDRL, Chest X-ray and a Mantoux test.

In all cases MRI of Brain with Gadolinium contrast (T1w, T2w, FLAIR, DWI, GRE) was done in our Radiology department. Conventional MR examinations were performed with a 1.5-T imager capable of echo-planar imaging (HDXT). Conventional MR images were obtained with transverse proton density– and T2-weighted sequences (5400/122/2 [TR/TE/excitations]; matrix, 192 x 256; field of view, 24 X 24 cm2; section thickness, 5 mm; section gap, 2.5 mm), transverse T1-weighted sequences (1800/17/ 2; matrix, 192 x 256; field of view, 24 X 24 cm2; section thickness, 5 mm; section gap, 2.5 mm), and transverse contrast-enhanced T1-weighted sequences (0.1 mmol/kg of gadopentetate dimeglumine [Magnevist; Schering, Berlin, Germany]). The contrast-enhanced images were obtained following DW imaging. Isotropic DW images were obtained in the transverse plane by using a single-shot echo-planar spin-echo pulse sequence (4650/78/1; field of view, 24 X 24 cm2; section thickness, 5 mm; section gap, 2.5 mm),with four b values (0, 333, 666, 1000 s/mm2). The total duration of the diffusion-sensitizing gradients was 80 m. To obtain isotropic diffusion weighting, a gradient scheme was used according to Heid and Weber. The maximum diffusion gradient was 26 mT/m. ADC map was obtained in selected patients. The ADC maps were calculated and the ADC value of the cystic or necrotic portion was measured in a region of interest of at least 1 cm2. On visual inspection, the signal intensities of the lesions on the DW images and on the ADC maps were interpreted relative to the contralateral brain parenchyma. GRE image was obtained with (720/20/2 [TR/TE/excitations]; section thickness, 5 mm; section gap, 2.5 mm).

MR Spectroscopy was done in selected cases. Metabolites which were detected in brain tissue include choline (Cho), creatine (Cr), N-acetylaspartate (NAA), lactate, mioinositol (MI), glutamine/glutamate, lipids and amino acids. Brain lesions contain abnormal quantities of these metabolites compared with normal brain tissue.

CSF analysis was done where feasible including cell count, cell type, Gram stain, AFB stain, culture and sensitivity, protein and sugar estimation were done. Special stains like India Ink were done for fungal detection and fungal cultures. CSF –RT PCR for Tuberculosis to be done in selected patients. Analysis for neurocysticercal antigens was done using Cysticheck kits (ELISA technique). A RMS 16 channel EEG machine was used to record EEG's.

Probable etiological diagnoses were based on the presence of supportive findings detected after clinical evaluation and above mentioned battery of investigations. The diagnosis confirmed in few cases whose biopsy and histopathology of the lesion was done and rest of the cases final diagnosis remained probable because the patients histopathological verification was not obtained. Patients were provided appropriate symptomatic treatment (corticosteroids, mannitol, antiepileptic drugs and/or analgesics if required). Appropriate specific treatment according to the suggested diagnosis was provided. Some of the above mentioned laboratory investigations were periodically repeated during hospitalization and on outdoor follow-up to monitor the disease activity on modifying the ongoing treatment.

The Data collected from cases were recorded in a Master chart. Data analysis was done using appropriate statistical tests and graphs.

Table I: Age & Sex Distribution

Age Groups	Total no. of cases (n)=78	Males (49) 62.8%	Females (29)37.2%
12-20	12(15.4%)	7(8.9%)	5(6.4%)
21-30	13(16.7%)	11(14.1%)	2(2.5%)
31-40	28(35.9%)	18(23.07%)	10(12.8%)
41-50	12(15.4%)	5(6.4%)	7(8.9%)
51-60	6(7.7%)	3(3.8%)	3(3.8%)
>60	7(8.9%)	5(6.4%)	2(2.5%)

In the present study, total 78 cases were studied. The age of patients ranged from 12 to 70 years. Out of 78 cases 49(62.8%) were males and 29 (37.2%) were females. The overall sex ratio was 1.69:1 (M:F) (Table 1).

Table 2: Clinical Symptoms At Initial Presentation

Clinical Symptoms	No. Of Cases	Percentage
Constitutional Symptoms	24	30.7%
Fever	32	41.02%
Headache	56	71.79%
Vomiting	44	56.41%
Visual Symptoms	17	21.79%
Seizures	53	67.94%
Unconsciousness	31	39.74%
Focal Neurological Deficit	58	74.35%

Headache emerged as the most common complaint that the patients presented with. Out of total of 78, Fifty-six (71.79%) patients complained of headache. The second most common presenting complaint was that of seizures in 53 (67.94%); vomiting in 44 (56.41%), fever seen in 32 patients (41.02%), patients and loss of consciousness in 47 patients (60.25%).Constitutional disturbances were present in 24 patients (30.7%). Fifty-eight patients (74.35%) had focal neurological deficit (s) at the time of presentation (Table 2).

Table 3: Laboratory Data Of Cns Ring Enhancing Lesions

Chest X Ray	
Normal	61 (79.2%)
Abnormal	17 (21.8%)
Lung Carcinoma	7
Bronchogenic Ca	3
Chest Metastasis	4
Miliary Tuberculosis	9
Pulmonary Cavitary Tb	1
Usg Abdomen	8
Abnormal	4
Hiv Elisa (Positive)	36 (46.15%)
Csf Was Done	49.6
Sugar	123.6
Protein	11.5
Ada	42 (53.84%)
Csf Not Done	1
Afb Stain	1
Indian Ink	1
Malignant Cells	0
Gram Stain	
Csf Pcr Tb	11
Serum Elisa	
Tuberculosis	15
Ncc	18

Mean hemoglobin was 10.5 g/dl and ESR 65 mm at end of first hour. Four patients were HIV positive. Ten patients had evident TB on chest X-ray and 4 cases (5%)had evidence of chest metastases. CSF analysis was done in 45% cases. Average cell count was 86 cells/mm3. Average CSF protein was 123.6 mg/dl. CSF sugar was less than half the matching RBS in 27% cases. Average CSF ADA was 11.5 with 61% patients with ADA >10(Table 3).

Table 4: Numbers & Types of Lesions In Mri

Types of lesion	Number (N=78)	Percentage
Solitary	25	32.05%
Multiple Isolated	49	62.82%
Multiple Coalescent	4	5.12%

Out of total 78 cases solitary ring enhancing lesions found in 25 (32.05%) cases, 53(67.9%)cases had multiple lesions out of them multiple isolated lesions seen in 49 (62.82%) and multiple coalescent lesions in 4 cases(5.12%)(Table 4).

Table 5: Sites of lesions in MRI of brain and spine

Sites of Lesions	(Multiple Lesions) Numbers Of Cases N=53	(Solitary lesions) Numbers Of Cases N=25
Frontal	42	14
Parietal	32	9
Temporal	19	2
Occipital	18	
Brain Stem &Cerebellar	22	
Central Grey Matter	12	
Spinal	0	4
Extra-Axial	1	

Supratentorial most commonly involved than infratentorial. The most common site of involvement both in multiple as well as solitary ring enhancing lesions was frontal lobe in 56 cases (71.79%) followed by parietal lobe in 41 cases (52.56%) and temporal lobe in 21 cases(26.9%)(Table 5).

Table 6: Sizes of Lesions In Mri Of Brain And Spine

Size of Lesions	NO. OF Cases	Percentage
Large Lesions > 4cms	24	30.76%
Medium Lesions 2-4cm	11	14.10%
Small Lesions <2cm	43	55.14%
Mixed Lesions	12	15.39%
Total	78	100%

In our series the small lesions of sizes less than 2 cm were the most common 43 cases (55.14%), followed by large size lesions in 24 cases (30.76%) (Table 6).

Table 7: Types of Ring Enhancement In Mri Of Brain And Spine

Types Of Ring Enhancement	No Of Cases	Percentage
Thin Rim Enhancement	49	62.8%
Dense Ring Enhancement	29	37.2%%
Rings With Eccentric Dots	22	28.21%
Rings With Irregular Margin	23	29.4%
Coalescence Of The Ring Lesions	4	5%
Target Sign	2	2.5%

Thin rim enhancements are the commonest (62.8%) in our case series. Coalescence of the ring lesions were noted in 5% of cases in our study. Target sign (ring enhancement with central calcification) was present in 2.5% of cases in our series. Rings with eccentric dots suggestive of scolex were found in 22(28.21%) of our cases (Table 7).

Table 8: Etiological Diagnosis

Clinical Diagnosis	no. of Cases (n=78)	Percentage
Neurocysticercosis	30	38.46%
Tuberculoma	21	26.92%
Glioma	12	15.38%
Metastasis	8	10.26%
Brain Abscess	4	5.12%
Medulloblastoma	1	1.28%
Cns Toxoplasma	1	1.28%
Resolving Hematoma	1	1.28%

Etiological diagnosis couldn't be ascertained in 7 patients after initial work up. These patients were undergone empirical treatment with Anti- Tubercular drugs and corticosteroid. Out of them one patient did not improve. On subsequent investigations found to have GI Malignancy of undermined primary site and the diagnosis was changed to CNS metastasis. Rest of the cases were included in CNS tuberculoma.

Among 78 patients, 30 patients (38.46%) were diagnosed as NCC, 21 patients (26.92%) as tuberculoma, 13 patients (16.7%) (11 patients as GBM, 1 as Ganglioglioma, 1 as Medulloblastoma) were diagnosed as primary brain tumour, Eight patients (10.26%) were found to have cerebral metastases with evidence of primary focus elsewhere. Four patients (5.12%) had evidence of cerebral abscess. Other lesions comprising of toxoplasmosis and hematoma were seen in one patient each.

So we observed that infective pathology was the most common etiology in patients with ring enhancing lesions of the CNS (Table 8).

Table 9: Etiological Diagnosis cont...

Etiology	Total Cases (N=78)
Malignancy	21 (26.9%)
Non-Malignant Infectious	56(71.8%)
Vascular	1(1.2%)

In our series the most common cause of ring enhancing lesions in CNS was infectious causes in 56 cases (71.8%) followed by non-infectious malignant causes in 21 cases (26.9%). Tuberculosis (TB) and neurocysticercosis (NCC) were the most common infections. Neoplastic etiology was the commonest non-infective etiology. In majority, brain lesions were Primary Brain tumor (predominantly GBM) followed by metastatic lesion in fair number of cases.
This signifies that infections (NCC & Tuberculosis) are the leading cause of ring-enhancing lesions in the Indian setup (Table 9).

Table 10: Clinical presentations of different etiologies

Clinical Diagnosis	Fever	Headache	Vomiting	Visual Symptom	Seizure	Unconsciousness	Fnd (Motor, Sensory Deficit, Ataxia)	Cranial Neuropathy	Papilledma
NCC= 31	4	20	14	4	26	2	17	2	0
Tuberculoma= 20	19	14	10	8	14	12	19	7	4
Glioma=12	01	9	7	2	8	8	12	2	2
Mets=8	04	07	07	3	4	6	6	1	1
Medulo=1	0	1	1	0	0	1	1	1	1
Abscess=4	4	4	4	0	2	1	2		
Toxo=1	1	1	1	1	1	1	0		
Resolving Hematom = 1						0	1		

Seizure was the most common presentations in NCC, where as headache was most common presentations in Brain tumours and abscess. Fever and headache was common in CNS Tuberculosis and brain abscess. Cranial nerves involvements was found mostly in CNS Tuberculosis and in few cases of NCC and Brain tumours (Table 10).

Table 11: Sites of Involvements of Different Etiologies Multiple + (Solitary)

Clinical Diagnosis	Frontal	Parietal	Temporal	Occipital	Central Grey	Cerebellar	Spinal	Extra-axial
NCC= 30	18 +(5)	12 +(2)	12	11	8	8	(2)	0
Tuberculoma= 20	12 +(3)	7+(2)	4+(1)	1	1	8	(2)	1
Glioma= 12	1+(5)	1+(4)	1+(1)	2	0	0	0	0
Mets=08	7+(1)	6	1+(1)	3	3	4	0	0
Medulo=1	0	0	0	0	0	(1)	0	0
Abscess=4	0	2	2	2	0	1	0	
Toxo=1		1						
Resolving Hematoma= 1		(1)						

Table 12: Additional Mri Findings

Clinical Diagnosis	Perifocal Edema	Mass Effect	Hydrocephalous	Meningeal Enhancement
Ncc (30)	22	2	2	3
Tb(21)	18	16	12	20
Glioma(12)	12	10	4	1
Mets (08)	8	6	1	0
Abscess(4)	4	4	1	2
Medulloblastoma (1)	0	1	1	0
Toxo(1)	1	0	0	1
Resolving Hematoma(1)	1	1	0	0
Total	66 (84.61%)	40 (51.2%)	21 (26.92%)	27 (34.61%)

In our study out of different perilesional parenchymal changes includes Surrounding edema in 66 (84.61%), midline shift in 40(51.2%) patients, Hydrocephalus in 21 (26.9%) and Meningeal enhancement in 27(34.61%) patients (Table 12).

Table 13: DWI (ADC value) of different lesions

Adc Value (_× 10^{-3})	Inside Cavity	Rim(Wall)	Edema
Neoplastic Lesions (N=14 Cases)	2.9±1.6	1.09 ± 0.12	1.22± 1.4
Non-Neoplastic Lesions (N= 12 Cases)	0.72 ± 0.9	0.65 ± 0.1	1.43± 0.9
P- Value	<0.001	<0.001	<0.5 (Insignificant)

The ADC map was done in 14 cases of Neoplastic causes and 12 cases of Non-Neoplastic causes (Tuberculomas and Brain abscess) of Ring enhancing lesions. The mean ADC of normal appearing white matter in our study was 0.77± 0.07 x 10^{-3} mm^2/s. The mean ADC value was 2.9±1.6 X10^{-3} mm^2/s inside cavity in neoplastic causes and was 0.72 ± 0.9x10^{-3} mm^2/s in case of non-neoplastic causes which was statistically significant (p<0.001). The mean ADC value

was 1.09 ± 0.12 x 10-3 mm2/second. From wall of ring lesions in neoplastic causes but 0.65 ± 0.1 x 10-3 mm2/second. In Non-Neoplastic lesions which was also statistically significant (p<0.001). The mean ADC value was 1.22± 1.4 x 10-3 mm2/second. From surrounding edema from neoplastic lesions and 1.43± 0.9 x 10-3 mm2/second. In Non-neoplastic lesions which was also statistically insignificant (p<0.05) (Table 13).

Table 14: Mr Spectroscopy Findings of Ring Lesions

		Neoplastic Lesions (n=18)	Tubercular (n= 14)	Pyogenic Abscess (n=3)	NCC N=13
Inside Cavity	Cho/ CrRatio	↑ >6	↑ >1 <2	Normal	
	lipid, lactate	No peak	↑	no lipid peak lactate elevated	no lipid lactate peak, increased cytosolic A.
Wall	Cho/ CrRatio	↑>6	↑ >1 <1.76		
	lipid, lactate peak	No peak	↑	no lipid lactate peak	no lipid lactate peak, increased cytosolic A.
p- value					

MR SPECTROSCOPY was done in 18 cases of neoplastic etiology of ring lesions, 14 cases of Tuberculomas and in 3 pyogenic brain abscess and 13 cases of NCC. Neoplastic lesions shows increased Choline peak with ↑ Cho/ CrRatio >6 without Lipid/Lactate peak with normal NAA, Myoinositol and Cytosolic amino acids both from the wall as well as from cavity. Where as in cases of Tuberculomas increased Lipid/Lactate peak with normal NAA, Myoinositol both from the wall as well as from cavity with slightly increase in choline and Cho/ CrRatio between 1-2. In cases of Pyogenic abscess lactate was mild elevated without any increase in lipid and Cho/cr ratio < 1. In cases of NCC there was peaks of Cytosolic Amino Acids without Lipid/Lactate peak or increased Cho./cr ratio (Table 14).

Discussions

The present study "Prospective Study of Clinical and Investigative Profile of Ring-enhancing Lesions in CNS" was conducted in the Post doctoral Department of Neurology at S.C.B. medical college & Hospital, Cuttack during the period of between August 2013 – November 2015. Total numbers of Seventy eight patients who satisfying the inclusion criteria were selected for the study. All patients after detailed clinical examination and investigations were placed in various subgroups and correlated under several headings.

In Seven patients etiological diagnosis couldn't be ascertained after initial work up. These patients were undergone empirical treatment with Anti- Tubercular drugs and corticosteroid. Out of them one patient did not improve. On subsequent investigations found to have GI Malignancy of undermined primary site and the diagnosis was changed to CNS metastasis. Rest of the cases were included in CNS tuberculoma.

A general discussion of all the study subjects is followed by a discussion of the individual maladies.

Age & Sex Distribution

Among 78 cases studied 49(62.8%) were males and 29(37.2%) were females. The overall M:F ratio was 1.69:1. Majority of patients were in the age group were between 3rd to 4th decades with a mean age of presentations was 35.32yrs.

R K Garg *et al* [1] from Lucknow, India studied 110case of CNS ring enhancing lesion in from 2004-2006. Majority of patients were between 3rd to 4th decade with a mean age of presentation of 33 ± 11yr. The peak age incidence in a study in CMC, Vellore by Rajshekhar V, *et al* [3] in 1997 was between 31-40 years. Another study done in Shri Sayajirao General (SSG) Hospital, Vadodara, Gujarat by Mahoto *et al*[5] also shows majority of patients in their study were in the age group of 31-40 years (27.5%) and M: F ratio was 1.6:1. which was in consistent with our study.

Clinical symptoms at initial presentation

Headache emerged as the most common complaint that the patients presented with. Out of total of 78, Fifty-six (71.79%) patients complained of headache. The second most common presenting complaint was that of seizures in 53 (67.94%). Fifty-eight patients (74.35%) had focal neurological deficits at the time of presentation.

Study on 75 patients with single or multiple ring-enhancing lesions by Rudresh K *et al* [6] from Karnataka, India in 2008 showed Seizure was the commonest presentation (68%) as compared to headache (29%) in their case series. Similarly studies on 753 cases by Sotelo *et al* [8] in 1985 reported epilepsy was the most common presentation (52.4%) followed by headache (43.4%) in their case series. In another series on 203 patients by Del Brutto *et al*. [7] in 1992 reported Seizures may occur in up to 70% of patients in their study and was the most common clinical presentation.

This discordance may be explained due to our small numbers of study populations and probably more subcortical lesions in brain and lesions causing with raised ICT in our study.

However our study was in concordance with studies by R K Garg [1] *et al* from Lucknow, India on 110 cases of CNS ring enhancing lesion found headache in 88%, followed by vomiting in 59%, and seizures in 39% of their case series. Similar concordance was seen with a study done on small population of 40 patients by Mahoto *et al* [8] Gujarat, which also shows Headache as the most common complaint in 57.5% patients followed by seizures in 52.5% of cases. Fever was found in 41.2% of our cases and more predictive of an infective/inflammatory pathology especially with acute pathology such as abscess.

Conclusions

A large number of infectious and non-infectious diseases can cause multiple ring-enhancing lesions of the brain. We reviewed the most common diseases in our setup. The most common etiologies were that of TB, parasitic (especially neurocysticercosis), primary brain tumors and Gliomas and metastases, cerebral abscess. Other rare causes include cerebrovascular stroke.

References

1. Garg RK, Desai P, Kar M, Kar AM. Multiple ring enhancing brain lesions on computed tomography: an Indian perspective. J Neurol Sci. 2008; 266(1, 2):92-6.
2. Kumar N, Narayanaswamy AS, Singh KK. Ring enhancing CT lesions - a diagnostic dilemma. J Assoc Physicians India. 1995; 43(6):391-
3. Rajshekhar V, Chandy MJ. Tuberculomas presenting as isolated intrinsic brain stem masses. Br J Neurosurg. 1997; 11(2):127-33.
4. Enberg GM, Quezada B, Mde L, de Toro VC, Fuenzalida LL. Tuberculous meningitis in adults: review of 53 cases. Rev Chilena Infectol. 2006; 23(2):134-9.
5. Mahato PS, Dabhi AS, Thorat PB. Clinical and Investigative Profile of Ring-enhancing Lesions on Neuroimaging: Mar: Indian Journal of Clinical Practice, 2012; 22(10).
6. Rudresh K, Krishna MV, Karthik, Jomy Sebastin: Clinical and Aetiological Profile of Ring-enhancing Lesions on CT Brain: JIACM. 2008; 9(2):100-2
7. Del Brutto OH, Santibañez R, Noboa CA, Aguirre R, Díaz E, Alarcón TA. Epilepsy due to neurocysticercosis: analysis of 203 patients. Neurology. 1992; 42(2):389-392.
8. Sotelo J, Guerrero V, Rubio F. Neurocysticercosis: a new classification based on active and inactive forms. A study of 753 cases. Arch. Intern. Med. 1985; 145(3):442-445.