Original Research Article

"A study on role of MRI in the evaluation of ring enhancing lesions in brain with relation to MR Spectroscopy in a tertiary care hospital"

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ABSTRACT:

Background: Magnetic resonance imaging (MRI) has been a reliable diagnostic technique in neuroradiology over the past few years. The ability to distinguish between distinct cerebral lesions is now available thanks to cutting-edge MRI techniques including perfusion, diffusion, and spectroscopy.

OBJECTIVES:

1. By using conventional and advanced MR imaging techniques neoplastic from non-neoplastic brain lesions are differentiated.
2. To study the characteristic imaging findings of various ring enhancing lesions on MRI.
3. By using Conventional MRI, to establish a differential diagnosis of various ring enhancing lesions.
4. To study the role of MR spectroscopy in the evaluation of various ring enhancing lesions in the brain with a single voxel proton MR spectroscopy.

MATERIAL & METHODS: Study Design: A prospective hospital based cross sectional study. **Study area:** Department of Radio diagnosis, in Mamata General Hospital, Khammam. **Study Period:** Jan. 2017 – Dec.2018. **Study population**: Patients referred from Dept. of Neurosurgery, General Medicine to the Dept. of Radio-diagnosis in Mamata General Hospital, Khammam. **Sample size:** study consisted of 60 subjects. **Sampling method:** Simple random technique. **Study tools and Data collection procedure:** All patients referred to the department of Radio diagnosis with clinically suspected cerebral ring enhancing lesions within study period will be subjected for the study. Basic demographic details, clinical data obtained from study subjects will be recorded in a pre-designed proforma. **EQUIPMENT USED**: The evaluation of cases in department of radio diagnosis will be done using Siemens Avanto 1.5 Tesla MRI.

Results: Out of 60 patients evaluated, tuberculomas were seen in 28 (46.6%) of cases. Among the 28 cases (males = 18: females = 10). Single lesions were noted in 9 cases (32.1%) and multiple in 19 cases (67.9%). They were seen as conglomerate lesions which

were hypointense on both T1 and T2. On T1 weighted images15 cases showed an iso to hyperintense ring. 21 cases (75%) showed partial/complete restriction.

CONCLUSION:

From our study it can be concluded that, MRI was the most sensitive modality in the characterization of intracranial ring enhancing lesions. MRI plays a critical role in patient management by suggesting the correct diagnosis based on characteristic imaging findings. MRS helps in characterization of various ring enhancing lesions. However, no lesion can be diagnosed based on the findings of MRS as the sole criteria.

Keywords: Magnetic resonance imaging, Ring enhancing lesions in brain, MR spectroscopy

INTRODUCTION:

Magnetic resonance imaging (MRI) has been a reliable diagnostic technique in neuroradiology over the past few years. The ability to distinguish between distinct cerebral lesions is now available thanks to cutting-edge MRI techniques including perfusion, diffusion, and spectroscopy. One of the most typical neuroimaging abnormalities is several ring-enhancing lesions. These lesions are found using computed tomography and magnetic resonance imaging (MRI), two imaging methods that are widely available. Multiple ring-enhancing lesions in the brain can have a variety of etiologies[1,2].

These lesions show up on neuroimaging studies as hypo- or isodense mass lesions on plain computed tomography. Following contrast injection, the area of hypodensity shows a ring- or homogenous disk-like enhancement. The enhancing lesions typically have different sizes and varying degrees of perifocal vasogenic edoema around them. Ring-enhancing lesions are typically found near the intersection of the grey and white matter, although they can also be found in the sub-cortical region, deep inside the brain parenchyma, or even superficially [3].

A method for differentiating between brain abscesses and non-infectious lesions like primary brain tumours, lymphomas, brain metastases, and tuberculomas is MR spectroscopy. By examining the presence and/or ratio of tissue metabolites like NAA, creatine, choline, and lactate, among others, magnetic resonance spectroscopy (MRS) is able to provide information about the potential scope and nature of changes seen on a typical MRI scan.

We can detect functional metabolic changes thanks to the widespread use of faster MRS applications with higher signal-to-noise ratio (SNR) and spatial resolution, which gives us more information to understand the precise nature of the tumour and the morphological and physiological changes taking place in the surrounding brain parenchyma. Longitudinal investigations have shown that HMRS is helpful in tracking the development of disease and the results of treatment. Moreover, MR spectroscopy has implications for prognosis. [4]

There are many causes and many differential diagnoses for multiple enhancing lesions of the brain according to the size of the lesions. Hence the present study will be undertaken to study the role of MR spectroscopy in the evaluation of various ring enhancing lesions in the brain with a single voxel proton MR spectroscopy.

OBJECTIVES:

1. By using conventional and advanced MR imaging techniques neoplastic from non-neoplastic brain lesions are differentiated.
2. To study the characteristic imaging findings of various ring enhancing lesions on MRI.

3. By using Conventional MRI, to establish a differential diagnosis of various ring enhancing lesions.
4. To study the role of MR spectroscopy in the evaluation of various ring enhancing lesions in the brain with a single voxel proton MR spectroscopy.

MATERIAL & METHODS:

Study Design: A prospective hospital based cross sectional study.

Study area: Department of Radio diagnosis, in Mamata General Hospital, Khammam.

Study Period: Jan. 2017 – Dec.2018.

Study population: Patients referred from Dept. of Neurosurgery, General Medicine to the Dept. of Radio-diagnosis, in Mamata General Hospital, Khammam.

Sample size: study consisted of 60 subjects.

Sampling method: Simple random technique.

Inclusion criteria:

• All cerebral ring enhancing lesions detected on contrast MR studies are taken up retrospectively.
• All patients with incidentally diagnosed ring enhancing lesion by CT.
• Cases of all age groups irrespective of sex.

Exclusion criteria:

• Patient having history of claustrophobia.
• Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreign body in situ.

Ethical consideration: Institutional Ethical committee permission will be taken prior to the commencement of the study.

Study tools and Data collection procedure:

All patients referred to the department of Radio diagnosis with clinically suspected cerebral ring enhancing lesions within study period will be subjected for the study. Basic demographic details, clinical data obtained from study subjects will be recorded in a pre-designed proforma.

EQUIPMENT USED: The evaluation of cases in department of radio diagnosis will be done using Siemens Avanto 1.5 Tesla MRI.

SEQUENCES:

• Conventional spin echo sequences, axial T1, T2 and FLAIR: Coronal T2; Sagittal T1; Post contrast axial, coronal and sagittal; DWI; T2 GRE Single voxel spectroscopy; multi voxel spectroscopy will be performed at TE of 135ms and 35ms, TR at 2000 ms. In single voxel studies, the voxel is placed on the lesion so that it covers the maximum area of the solid tumoral area.
• Spectroscopy will be avoided in small lesions close to the bone.
• Special sequences such as CISS 3D, VENBOLD will be used as and when required.

Statistical analysis:

Data will be analysed using SPSS 21.0 software. Descriptive parameters will be represented as mean with SD or median. Continuous variables will be compared using unpaired t test /Mann Whitney u test. Chi-square or t test will be used to determine significant outcome difference. Categorical data will be represented as frequency with percentage. For all tests a p value of <0.05 will be considered as statistically significant.

OBSERVATIONS & RESULTS:

Total 60 patients presented with various ring enhancing lesions.

Table 1: Incidence of Various Ring Enhancing Lesions

Lesions	No. of Cases(n=60)
Tuberculoma	**28**
Neurocysticercosis	**18**
Abscess	**5**
Metastasis	**7**
Primary Brain Tumour	**1**
Tumefactive Demyelination	**1**

Out of the 60 patients who were evaluated, tuberculomas (47%) were the most common pathology followed by NCC (30%), Abscesses (8%), metastasis (12%), primary brain tumour (2%) and tumefactive demyelination (2%).

Table 2: Age Wise Distribution of Various Ring Enhancing Lesions

Age (In Years)	No. of Cases(n=60)
0-10	6
11-20	13
21-30	19
31-40	6
41-50	3
51-60	8
> 60	5

60 patients were evaluated, whose age group ranged from 4 to 67 years. The highest incidence of REL's were found in 21-30 years age group accounting for 31.6% of cases and least was seen in age group of 41-50 years constituting 5%.

Sixty patients were evaluated of which 37 (62%) were males and 23 (38%) were females.

Out of 60 patients evaluated, Seizures were the most common presenting complaint in 70% of cases. Headache (18%), fever (6.6%), vomiting (15%), ataxia (5%) and motor weakness (6%) were the other presenting complaints.

Table 3: Location of Side of Pathology in Brain in Various Ring Enhancing Lesion

Side of Pathology	Number of Cases(n=60)
Right	23
Left	15
Bilateral	20
Midline	2

Table 4: Male Female Incidence of Ring Enhancing Lesions

Pathology	Males	Females	Total
Tuberculoma	18	10	28
NCC	11	7	18
Abscess	3	2	5
Metastasis	4	3	7
Primary Brain Tumour	1	0	1
Demyelination	0	1	1

Table 5: Number of Ring Enhancing Lesions in a Patient

Number of Lesions	No. of cases
1	21
2-4	24
>4	15

Table 6: Size of Lesion of Various Ring Enhancing Lesions

Size of Lesion (In Cms)	No. of Lesions
< 2	38
2-4	16
>4	6

NOTE: In case of multiple ring enhancing lesions, size of the maximum no. of lesions were considered.

Table 7: DWI in Ring Enhancing Lesions

Diffusion	No. of Cases
Showing Restriction (Complete / Partial)	32
Showing No Restriction	28

Table 8: List of Dominant Metabolite Peaks Noted in Various ring enhancing lesions

Dominant Metabolite Peak	No. cases
Choline	09
Lipid	15
Lactate	16
Reduced NAA	17
Amino Acids	3

MRS could not be performed in 4 patients due to location of the lesion close to the bone.

DISCUSSION:

Magnetic resonance imaging is a noninvasive, multiplanar and highly accurate method with better inherent contrast that demonstrates the lesion accurately. MRI provides an accurate assessment of the brain changes in various ring enhancing lesions, for accurate diagnosis and introduction of immediate treatment.

This was a cross-sectional study done in the Department of Radio-diagnosis and Imaging, Mamata general hospital, Khammam, aimed at studying the MR appearances in various ring enhancing lesions of the brain. In present study of MR imaging of ring enhancing lesions of the brain, 60 patients were evaluated.

60 patients were evaluated, whose age group ranged from 4 to 67 years. The highest incidence of REL's were found in 21-30 years age group accounting for 31.6% of cases and least was seen in age group of 41-50 years constituting 5%. This does not correspond to studies done by Ps Mahato[5] and Jernail Singh Bava[6].The cause could be due to the present study being conducted in a remote area with low hygienic conditions and hence more incidence of infection in a younger age.

Sixty patients were evaluated of which 37 (62%) were males and 23 (38%) were females. About 62% of patients were males and 38% were females which were nearly consistent with the study conducted by Jernail Singh Bava[6] in his study also males were dominant comprising 54% and 46% were females.

Out of 60 patients evaluated, Seizures were the most common presenting complaint in 70% of cases. Headache (18%), fever (6.6%), vomiting (15%), ataxia (5%) and motor weakness (6%) were the other presenting complaints. Our findings were compared with the study conducted by ps mahato[5] in which headache (57.5%) was the most common symptom followed by seizures (52.5%).

Out of the 60 patients who were evaluated, tuberculomas (47%) were the most common pathology followed by NCC (30%), Abscesses (8%), metastasis (12%), primary brain tumour (2%) and tumefactive demyelination (2%). And it correlated with the study conducted by Jernail singh Bava[6] demonstrating that tuberculoma 36% was the most common pathology followed by Ncc 34%. In study conducted by Ps Mahato[5] tuberculoma (58%) was common pathology followed by metastasis. (17.5%). In a study conducted by Schwartz et al[7] 40% cases were gliomas.

Among the 60 patients with RELs noted 23 (38%) were noted on the right side, 15 (25%) were noted on the left side, 20(34%) were seen bilaterally and 2 (3%) in the midline. 60 patients were evaluated - 21(35%) of them presented with a single lesion. 2-5 lesions were noted in 24 (40%) of cases and > 5 RELs were seen in 15(25%) of cases.

60 patients were evaluated - majority 38 (63%) of them showed RELs < 2cm, 16 (27%) of them showed lesions of sizes between 2-4 cm and only in 6 (10%) lesions size is greater than 4 cm. In case of multiple lesions size of the maximum number of lesions which were falling in one category were considered. 60 patients were evaluated - 32 (53%) of patients show diffusion restricting lesions (partial/complete) and 28 (47%) of cases shows no diffusion restriction.

Out of the 60 patients evaluated spectroscopy was possible in only 56 cases and was not performed in 4 cases because of presence of the lesion close to the bone. Choline peak was observed in 09 cases, Lipid in 15 cases, Lactate in 16 cases, reduced NAA peak in 17 cases and amino acids in 3 cases.

MR spectroscopy shows minor metabolite peaks at short mAs [(8)] and dominant metabolite peak at 135 ms. multiple overlapping peaks are noticed in patients having necrotic SOL because central cystic and non-enhancing part of tomour always show significant lactate and lipid peaks along with few creatinine peaks with significant choline peak along periphery of the lesion. In present study, the dominant metabolite peak was considered for making final radiological diagnosis and subtle peaks like raised nonspecific metabolites were not considered while making the statistical data for MRS.

Riley and coworkers[9] concluded that Ring enhancing lesions of the brain remain a diagnostic challenging dilemma including a wide differential diagnosis of neoplastic and non-neoplastic lesions. MRI stands as the main diagnostic imaging modality, using conventional as well as advanced sequences can help in accurate verification and differentiation between these lesions for better diagnostic accuracy.

Out of 60 patients evaluated, tuberculomas were seen in 28 (46.6%) of cases. Among the 28 cases (males = 18: females = 10). Single lesions were noted in 9 cases (32.1%) and multiple in 19 cases (67.9%). They were seen as conglomerate lesions which were hypointense on both T1 and T2. On T1 weighted images15 cases showed an iso to hyperintense ring. 21 cases (75%)showed partial/complete restriction. In general, on contrast, tuberculomas show either a nodular /irregular ring like enhancement. In present study, all cases presented with ring like enhancement. Nodular enhancement was also seen in 2 cases in addition to the ring enhancing lesions.

Subhasis Mukherjee, Runa Das, Shabana Begum (2015) [10] concludes that Conventional neuroimaging like CT scan of the brain with contrast and MRI brain ± contrast alone are insufficient diagnostic tool for a confidant etiological diagnosis of intracranial ring-enhancing

lesions like tuberculoma.

Tae Kyoung Kim and coworkers[11] showed that on T1-weighted images, the granulomas showed a slightly hyperintense rim. On T2-weighted images, the entire portion of the granuloma showed slightly heterogeneous isointensity or hypointensity with small markedly hypointense foci. On postcontrast T1-weighted images, there were single or multiple conglomerate ring enhancements within a tuberculoma in all six patients.

Jayasundar R,Singh VP and coworkers[12] concluded that presence of lipid can be used for differentiating tuberculomas from both non-specific Infective granulomas and NCC. Follow up scan (CT/MRI) was performed in 16 patients which shows resolution of the lesion as well as peri lesional oedema.

Out of 60 patients evaluated neurocysticercosis was seen in 18 (males=11; females=7) cases. 7 patients presented with single lesions whereas 11 patients presented with multiple lesions. All the cases were showing intraparenchymal form of NCC with spinal cysticercosis seen in one case and subarachnoid cysticercosis in 2 cases. Scolex was identified in 8 cases.

In present study, only a single case of intraventricular cysticercosis was found, probably because of the small sample of study. Martinez et al reported intraventricular neurocysticercosis in 22 % of cases.[13] Parenchymal cysticercosis is better identified on MRI than CT in our study as compared to the study done by Suss Ra and coworkers.[14] Features of parenchymal forms of NCC in the present study are similar to the study done by do Amaral LL and co workers[15]

Cho / Cr ratio was less than 1.1 in all NCC and more than 1.2 in all tuberculoma which is similar to the studies performed by Kumar et al and Jayasunder and cco workers [16,17] In present study, seizures was the common symptom and scolex was identified in 8 cases which appeared as hypointense focus on T2WI. Moderate to intense and regular ring enhancement with surrounding perilesional oedema was seen in most of the cases which was similar to study performed by Pandit and coworkers.[18] HR Martinez R Rangel- Guerra and coworkers 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 [13.]

Out of the 60 patients, abscess was found in 5 cases ie,8.3% (males =3; females =2). Single abscess was found in 2 cases whereas the other 3 cases had multiple abscesses. Halmes et al described the appearance of abscesses on MR. We correlated the findings of the present study with those described, and distinguished the peripheral oedema, central necrosis and the characteristic pattern of peripheral enhancement of the abscess capsule.[19] D. Pal and coworkers[20] concluded in their study that the presence of AAs on in vivo ^{1}H-MR spectroscopy is a sensitive marker of pyogenic abscess, but its absence does not rule out a pyogenic etiology. The presence of Ac with or without Suc favors an anaerobic bacterial origin of the abscess; however, this may also be seen in some of the abscesses secondary to facultative anaerobes.

Out of the 60 patients, 7 cases were metastasis (males = 4; females = 3). Multiple lesions were identified in all the 7 cases. All the cases showed high Cho / Cr and Cho / NAA ratios. All 7 cases were hyperintense on T2 with 2 cases showing inversion on FLAIR suggestive of cystic metastasis. Primary was identified in three cases which were breast, lung and prostrate. Thick, irregular type of ring enhancement was noted after contrast administration. Findings of

present study were similar to the study conducted by Vieth RG and coworkers. [21]

Out of the 60 patients, 1 case was tumefactive demyelination was noted in female.the case showed multiple demyelinating lesions,of which one was tumefactive demyelination.ie; it appeared as hypointense on T1W,hyperintense on T2W,FLAIRwith perilesional edema,open ring enhancement on T1+C(open side of ring being towards grey matter).on DWI the lesion showed mild low ADC(suggestive of restricted diffusion).the tumefactive demyelinative lesion on MRS showed significant choline peak with decreased NAA.

Of the 60 patients,1 case of GBM was seen in a male. The lesion was multilobulated located in left parietooccipital region being hypointense on T1W, irregularly hyper intense on T2W. The lesion showed irregular ring like enhancement on T1+C images,few areas of restrictriction on DWI and significant increase choline and decreased NAA on MRS.

Findings of present study were similar to a study conducted by LIA Metwally, SE El-din, O Abdelazizand coworkers,[22] where they concluded that Mi/Cr ratio and Mi is an important predictor for grading of gliomas, wherein the low-grade glioma have a high Mi peak as compared to anaplastic glioma and GBM.

CONCLUSION:

From our study it can be concluded that, MRI was the most sensitive modality in the characterization of intracranial ring enhancing lesions. MRI plays a critical role in patient management by suggesting the correct diagnosis based on characteristic imaging findings. MRS helps in characterization of various ring enhancing lesions. However, no lesion can be diagnosed based on the findings of MRS as the sole criteria. MRS by analyzing the presence and/or ratio of tissue metabolites such as NAA, creatine, choline, and lactate helps in narrowing done the differential diagnosis of ring enhancing lesions.

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