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Research Article

ROLE OF MRI IN EVALUATION OF RING ENHANCING LESIONS IN BRAIN IN CORRELATION WITH MR SPECTROSCOPY

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ABSTRACT

Multiple ring-enhancing lesions are one of the most commonly encountered neuro imaging abnormalities. Widely available imaging techniques, computed tomography and magnetic resonance imaging (MRI) are used to detect these lesions. Objective was to study the characteristic imaging findings in various ring enhancing lesions and the role of MR spectroscopy in its evaluation. It is a retrospective study conducted on 50 patients at Bapuji hospital, Davangere from Nov 2009 to Nov 2011 over a period of 2 years. Out of the 50 patients evaluated, 22 cases were tuberculomas, 16 were NCC, 5 abscesses, 5metastasis, 1case of pilocyticastrocytoma and 1 case of tumefactive demyelination. MRI is the most sensitive modality in the characterization of intracranial ring enhancing lesions-RELS. It shows characteristic imaging findings which helps in differentiating the various RELs. MRI plays a critical role in patient management by suggesting the correct diagnosis based on characteristic imaging findings.

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INTRODUCTION

Multiple ring-enhancing lesions are one of the most commonly encountered neuroimaging abnormalities. Widely available imaging techniques, computed tomography and magnetic resonance imaging (MRI) are used to detect these lesions. A wide range of etiologies may present as cerebral multiple ring-enhancing lesions^{1,2}.

MRI's clinical advantage in early detection of disease is visually demonstrated as unmistakable contrast between gray and white matter and tumor ischaemia/infarct, edema, MS plaques, infection/abscess and hemorrhage. MR spectroscopy is a potential tool for differential diagnosis between brain abscesses and non-infectious lesions such as primary brain tumor, lymphoma, brain metastasis, and tuberculoma. Magnetic resonance spectroscopy (MRS) provides information about the possible extent and nature of changes on a routine MRI scan by analyzing the presence and/or ratio of tissue metabolites such as NAA, creatine, choline, and lactate etc.

Widespread usage of faster MRS applications with higher signal-to-noise ratio (SNR) and spatial resolution, allows us to detect functional metabolic changes, which provides more data to understand the exact nature of the tumour

and the morphological and physiological changes occurring in the surrounding brain parenchyma. Longitudinal studies have demonstrated that HMRS is useful in monitoring disease progression and treatment effects. MR spectroscopy also has a prognostic implication.³

Objectives of the Study

- To differentiate neoplastic from non-neoplastic brain lesions using conventional and advanced MR imaging techniques.
- To study the characteristic imaging findings of various ring enhancing lesions on MRI.
- To establish a differential diagnosis of the various ring enhancing lesions on conventional MRI.
- 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.

MATERIALS AND METHOD

Source and Method of Collection of Data

It is a retrospective study conducted on 50 patients admitted in Bapuji hospital and Chigateri general hospital, attached to JJM Medical College, Davangere, Karnataka between June 2015 to

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December 2016. All the 50 patients were subjected to MRI on Philips MRI ACHIEVA of 1.5 tesla field strength. 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 was performed at TE of 144. The voxel is placed on the lesion so that it covers the maximum area of the lesion in a single voxel. We used PRESS and T1 post contrast sequence as localization sequence with 5 mm thickness. Spectroscopy was avoided in small lesions close to the bone. Special sequences such as CISS 3D, VEBOLD were used as and when required.

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.

Statistical analysis

Statistical analysis was performed using percentages and proportions.

RESULTS

Total 50 patients presented with various ring enhancing lesions.

Table 1 Incidence of Various Ring Enhancing Lesions

Lesions	No. of Cases
Neurocysticercosis	16
Tuberculoma	22
Abscess	5
Metastasis	5
Primary Brain Tumour	1
Tumefactive Demyelination	1

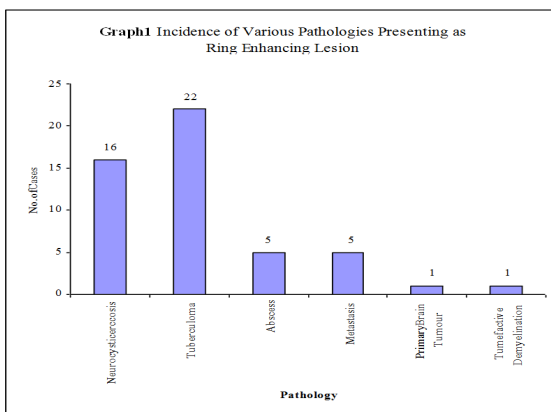


Table 2 Clinical Symptoms Presented by a Patient with Various Ring Enhancing Lesions

Symptom	No. of Cases
Seizures	42
Headache	11
Vomiting	9
Weakness	3
Fever	4
Ataxia	3

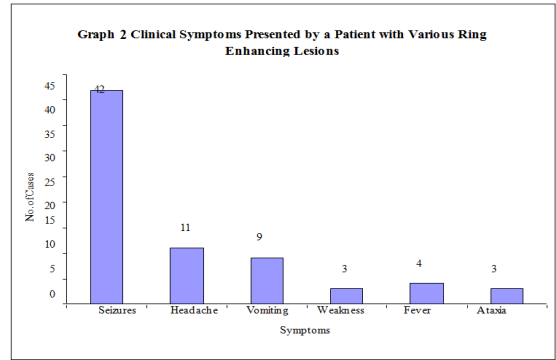


Table 3 Male Female Incidence of Ring Enhancing Lesions

Pathology	Males	Females	Total
Tuberculoma	15	7	22
NCC	10	6	16
Abscess	3	2	5
Metastasis	2	3	5
Primary Brain Tumour	0	1	1
Demyelination	1	0	1

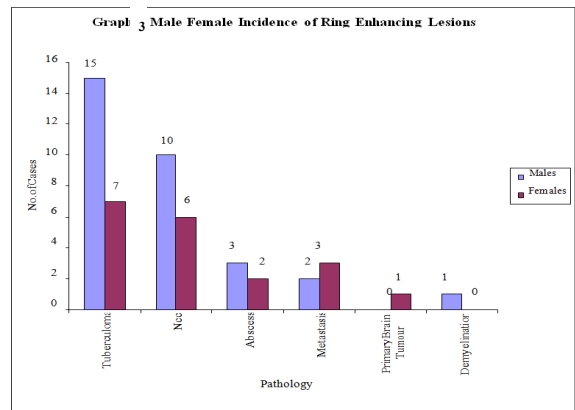


Table 4 Number of Ring Enhancing Lesions in a Patient

Number of Lesions	Number of Cases
1	17
2-4	21
>4	12

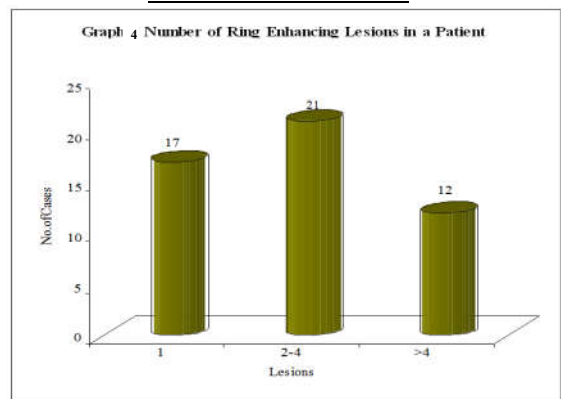
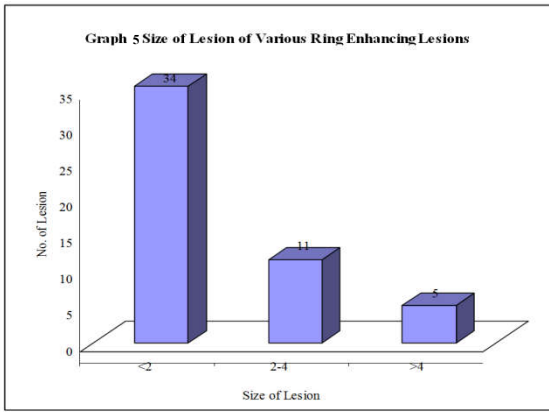


Table 5 Size of Lesion of Various Ring Enhancing Lesions

Size of Lesion (In Cms)	Number of Lesions
<2	34
2-4	11
>4	5



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

Table 6 DWI in Ring Enhancing Lesions

Diffusion	Number of Cases
Showing Restriction (Complete / Partial)	27
Showing No Restriction	23

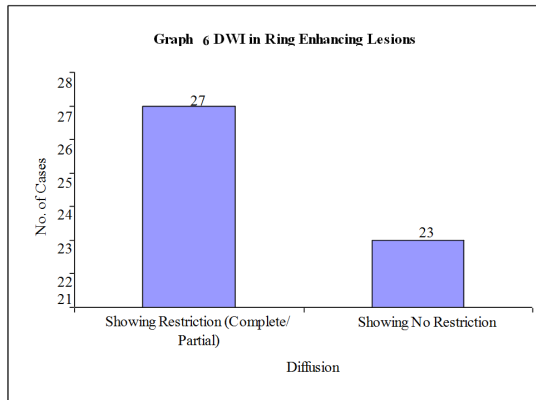
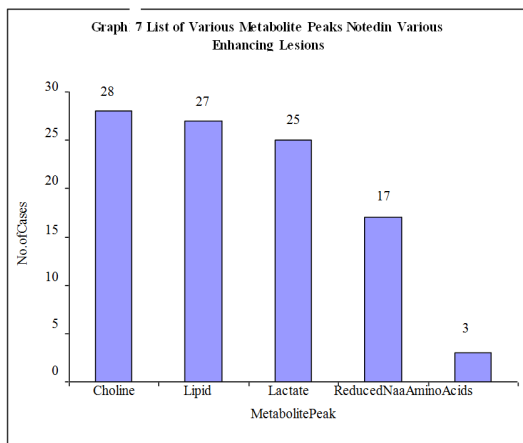


Table 7 List of Various Metabolite Peaks Noted in Various Enhancing Lesions

Metabolite Peak	Number of Cases
Choline	28
Lipid	27
Lactate	25
Reduced NAA	17
Amino Acids	3



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

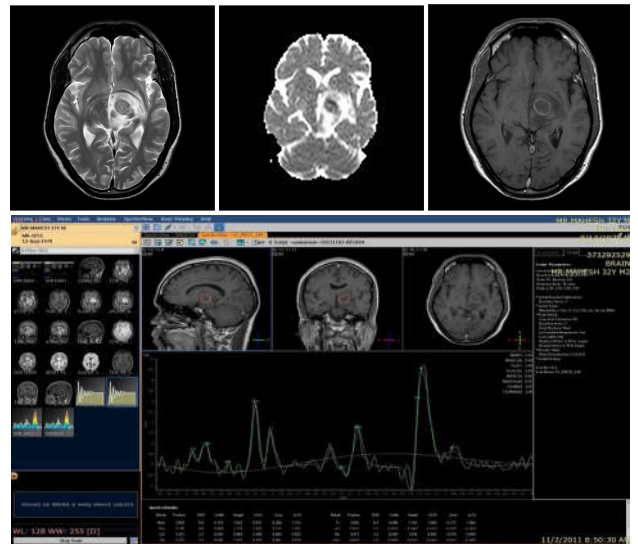
Photographs



Image 1 Philips Achieva-1.5 TMRI Unit

Image 2

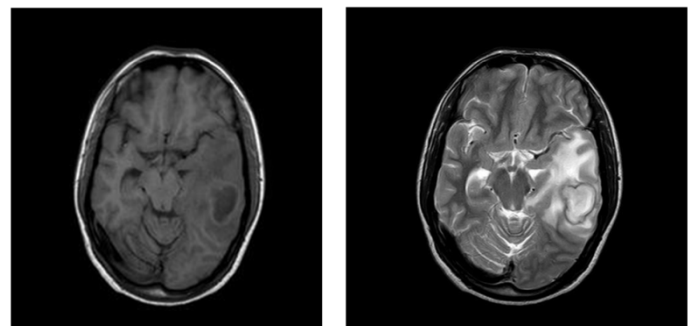
Tuberculoma

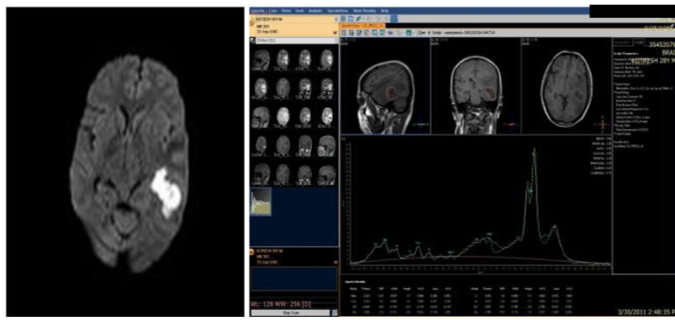


Single T2 hypointense lesion in the left thalamus showing partial diffusion restriction and elevated lipid, lactate and choline levels suggestive of tuberculomas

Image 3

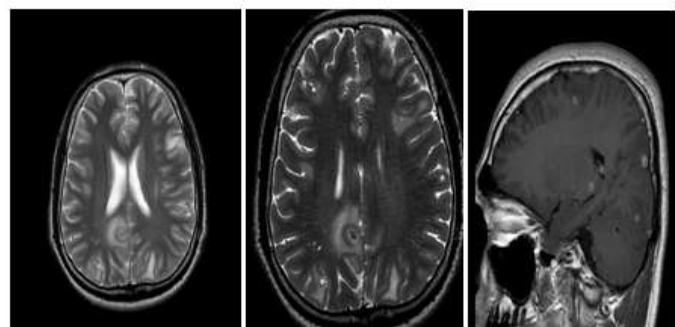
Abscess





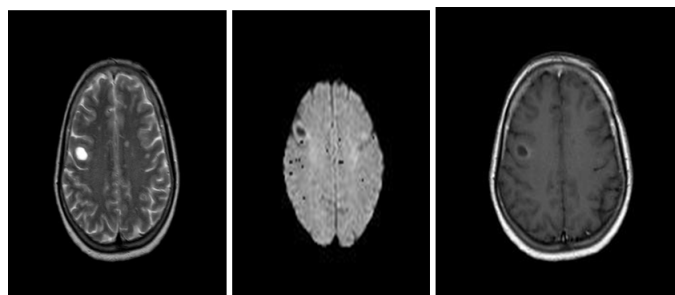
T1 shows a hypointense lesion with hyperintense rim and T2 shows a hyperintense rim. Diffusion restriction present. MRS shows lipid lactate peak AA and reduced NAA suggestive of abscess.

Image 4
NCC



Multiple ring enhancing lesions showing choline peak and NAA CISS3D suggestive of NCC granuloma.

Image 5
Cystic Metastasis



T2 Hyperintense lesion with rim showing diffusion restriction and spectroscopy showing high choline levels suggestive of cystic metastasis

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 prospective study done in the Department of Radio diagnosis and Imaging, Bapuji Hospital, Davangere aimed at studying the MR appearances in various ring enhancing lesions of the brain. In our study of MR imaging of ring enhancing lesions of the brain, we evaluated 50 patients.

Clinical features

Seizures are the most common presenting complaint in 84% of cases. Headache (22%), fever (18%), vomiting (6%), ataxia (8%) and motor weakness (6%) were the other presenting complaints.

Pathologies

Out of the 50 patients who were evaluated, tuberculomas (44%) is the most common pathology followed by NCC (32%), Abscesses (10%), metastasis (10%), primary brain tumour (2%) and tumefactive demyelination (2%).

In a study conducted by Schwartz *et al*⁴ 40% cases were gliomas. The higher incidence of tuberculomas probably due to the higher prevalence of tuberculosis in India.

Number of lesions

Fifty patients were evaluated-17 (34%) of them presented with a single lesion. 2-5 lesions were noted in 21 (42%) of cases and >5 RELs were seen in 12 (24%) of cases.

Size of the lesion

Fifty patients were evaluated - majority 34 (64%) of them showed RELs < 2cm, 11 (22%) of them showed lesions of sizes between 2-4 cm and only in 5 (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.

Diffusion restriction

Fifty patients were evaluated - 27 (54%) of patients show diffusion restricting lesions (partial/complete) and 23(46%) of cases shows no diffusion restriction.

MR Spectroscopy

Out of the fifty patients evaluated spectroscopy was possible in only 46 cases and was not performed in 4 cases because of presence of the lesion close to the bone. Choline peak was observed in 28 cases, Lipid in 27 cases, Lactate in 25 cases, reduced NAA peak in 17 cases and amino acids in 3 cases.

Tuberculoma

Out of fifty patients evaluated tuberculomas were seen in 22 (44%) of cases. Among the 22cases (males = 15:females= 7). Single lesions were noted in 6 cases (27.2%) and multiple in 16 cases (72.7 %). They are seen as conglomerate lesions which are hypointense on both T1 and T2. On T1 weighted images they show a isoto hyperintense ring which was seen in 12 cases in our study. They may show partial or complete restriction seen in 17 cases – 77.2 %.

The lesions may show a nodular or irregular ring like enhancement. All our cases presented with presented with ring like enhancement. Nodular enhancement is also seen in 2 cases in addition to the ring enhancing lesions. MRS showed a Lipid peak in 15 (68.1%) cases and it plays an important role in identification of tuberculomas from other infective granulomas. The stage of the tuberculoma whether it is caseous or non caseous can also be identified on MRI with the help of T2 weighted images. Post contrast images are very helpful in identifying the size of the tuberculomas due to its excellent spatial resolution and differentiates the granuloma from its surrounding edema.

Tae KyoungKim, Kee Hyun Chang, Chong Jai Kim, JinMo Goo, MyeongCherlKook, and Moon HeeHan (1995) 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.⁵

Jayasundar R, Singh VP, Raghunathan P, Jain K, Banerji AK (1999) concluded that presence of lipid can be used for differentiating tuberculomas from both non-specific IG and NCC⁶. Follow up scan (CT/MRI) was performed in 16 patients which shows resolution of the lesion as well as perilesional oedema.

Neurocysticercosis

Out of fifty patients evaluated neurocysticercosis was seen in 16 (males=10; females=6) cases. 6 patients presented with single lesions whereas 9 patients presented with multiple lesions. All the cases were showing intraparenchymal forms of NCC with spinal cysticercosis seen in one case and subarachnoid cysticercosis seen in 2 cases. Scolex was identified in 8 cases using CISS 3D sequence. MRS shows Choline peak and reduced NAA peak. Gradient echo imaging played a significant role in identifying calcified lesions which

were seen in 6 cases (37.5 %). All the lesions were hypo to isointense on T1 weighted images and 12 cases were hyperintense on T2. Out of these 12 lesions 9 lesions showed inversion on FLAIR suggesting that the contents are similar to that of CSF. Intense ring enhancement with surrounding perilesional edema was seen in all cases suggestive of active lesions. We did not find a single case of intraventricular cysticercosis probably because of the small sample of study. Martinez *et al* reported intraventricular neurocysticercosis in 22 % of cases. (7)

Parenchymal cysticercosis better identified on MRI than CT in our study as compared to the study done by SussRa *et al*.⁽⁸⁾ Features of parenchymal forms of NCC in our study are similar to the study done by do Amarall *et al*.⁽⁹⁾

Cho / Cr ratio was less than 1.1 in all NCC and more than 1.2 in all tuberculoma which is similar to the study performed by Kumar *et al* and Jayasunder *et al*^{10,11}

Abscess

Out of the 50 patients, abscess were found in 5 cases – 10 % (males=3; females =2). Single abscess was found in 2 cases (40%) whereas the other 3 cases had multiple abscesses. One patient presented with history of congenital heart disease - tetralogy of fallot. All the cases showed sizes >2 cm and one case was >4 cm. All were hypointense on T1 weighted images with a hyperintense rim noted in 3 patients and were hyperintense on T2 weighted images with a surrounding hypointense rim (5 cases). They showed complete diffusion restriction and MRS showed Lactate peak in all 5 cases suggesting anaerobic glycolysis with amino acids like glutamine seen in 3 cases. Halmes *et al* described the appearance of abscesses on MR. We correlated our findings with those described and distinguished the peripheral oedema, central necrosis and the characteristic pattern of peripheral enhancement of the abscess capsule.¹²

Our findings were similar to the study conducted by Tsui EY *et al*, Shukla-Dave A *et al* 55) and Leuthardt EC *et al*¹³.

Metastasis

Out of the 50 patients, 5 cases were metastasis (males=2; females=3). Multiple lesions were identified in all the five cases. All the cases showed high Cho /Cr and Cho /NAA levels. All 5 cases were hyperintense on T2 with 2 cases showing inversion on FLAIR suggestive of cystic metastasis. Primary was identified in three cases in breast, lung and prostate. Thick, irregular type of ring enhancement was noted after contrast administration. Our findings were similar to the study conducted by Vieth RG *et al*¹⁴

Limitations

MRS could not be performed in 4 cases due to presence of lesion close to the bone.

MR perfusion and MTR which were not included in the study are also useful in differentiation of neoplastic and non neoplastic lesions.

Most of our cases 45 (90%) were <4 cm, so single voxel spectroscopy was sufficient. But in larger lesions multivoxel spectroscopy helps in differentiating the characteristics of the internal contents as well as the wall.

CONCLUSION

MRI is the most sensitive modality in the characterization of intracranial ring enhancing lesions– RELs Irregular type of ring enhancement is the most common feature noted in most of the lesions. Most common lesion seen is Tuberculoma(44%) followed by neurocysticercosis(32%), abscess(10%),metastasis(10%), pilocyticastrocytoma (2%) and tumefactivedemyelination (2%). 21-30 years is the most common age group involved(28% ofcases) and seizures is the most common presenting complaint(84%).

Single lesion was noted in 34% of patients whereas the rest 66% presented with multiple cases.

Pattern of signal intensity on T2 and FLAIR,DWI andMRS help to differentiate between benign and malignant lesions. Hypointensity on T2 with partial or complete restriction on DWI images and lipid peak on MRS is more in favour of Tuberculoma. Hyperintensity on T2 with no diffusion restriction, presence of scolexon CISS3D suggests NCC.

Abscesses show a hypointenserim on T2 with complete diffusion restriction. MRS may show Lactate and Amino Acids. Metastasis are well defined hyperintense lesions onT2 which show high choline peak on MRS. MRI being non invasive and non-radiating is an ideal imaging modality.

CISS3D and MRS are to be routinely used in evaluation of ring enhancing lesions.

Multiplanar capability of MRI was helpful in identifying precise anatomical location and the exact extent of 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.

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