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Original research article

Role of magnetic resonance imaging with MR spectroscopy in the evaluation of cerebral ring enhancing lesions

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Abstract

Background: The ring enhancing lesions of the brain are one of the most commonly encountered abnormalities on neuroimaging and pose a challenging group of lesions with the variable possibilities of diagnosis under conventional Magnetic Resonance Imaging (MRI). Employing advanced techniques such as Magnetic Resonance Spectroscopy (MRS) could increase the success rates of the diagnosis.
Materials and Methods: 40 patients were evaluated in this study who are referred to department of radiodiagnosis, Kurnool Medical college from December 2023 to May 2024 over a period of 6 months. MRI along with MRS was performed on PHILIPS INGENIA 1.5 T.
Inclusion Criteria: All suspected cerebral ring enhancing lesions detected on MR studies were taken up for MR Spectroscopy.
Exclusion Criteria: Patient having contraindications to MRI.
Results: Out of the 40 patients who were evaluated, tuberculoma 18 (45%) is the most common pathology followed by NCC 10(25%), Abscesses 5 (12.5%), metastases 5(12.5%) and primary brain tumors 2(5%).
Conclusion: MRI along with MRS is the most sensitive modality in the characterization of intracranial ring enhancing lesions.
Keywords: MRI, MR Spectroscopy, neurocysticercosis, tuberculoma, abscess, neoplastic

Introduction

Ring enhancing lesions of the brain are considered challenging neuroimaging abnormalities for the radiologists. Imaging modalities like the Computed Tomography (CT) and MRI are commonly used to diagnose such lesions. Identifying varying ring enhancing lesions by conventional MRI can be challenging, as the technique cannot distinguish between neoplastic, non-neoplastic lesions and infections. It does not provide any information regarding the tumoral vascularity, metabolism and cellularity. Advanced techniques such as Diffusion Weighted Imaging (DWI) and perfusion and proton MRS (1H-MRS) have been employed for the differential diagnosis of lesions, with varying success rates. A combination of the advanced techniques with conventional MRI can increase the specificity to detect lesions. MR spectroscopy is a potential tool for differential diagnosis between brain abscesses and non-infectious lesions such as primary brain tumors, lymphoma, brain metastasis, and tuberculoma. Magnetic resonance spectroscopy (MRS) provides information about the possible extent and nature of changes on routine MRI scans by analyzing the presence and/or ratio of tissue metabolites such as NAA, creatine, choline, lactate etc.

Aims & Objectives

- 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 and advanced MR imaging techniques (MR spectroscopy).
- To study the role of MR spectroscopy in the evaluation of various ring-enhancing lesions in the brain.

Materials and Methods

- 40 patients were evaluated in this study who are referred to department of radiodiagnosis, Kurnool Medical college from December 2023 to May 2024 over a period of 6 months. MRI along with MRS was performed on PHILIPS INGENIA 1.5 T.

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Inclusion Criteria

- All suspected cerebral ring enhancing lesions detected on MR studies were taken up for MR Spectroscopy.
- All patients with incidentally diagnosed ring-enhancing lesion by CT.

Exclusion Criteria

- Patients with history of allergic reactions to contrast in the past.
- Patient having contraindications to MRI.

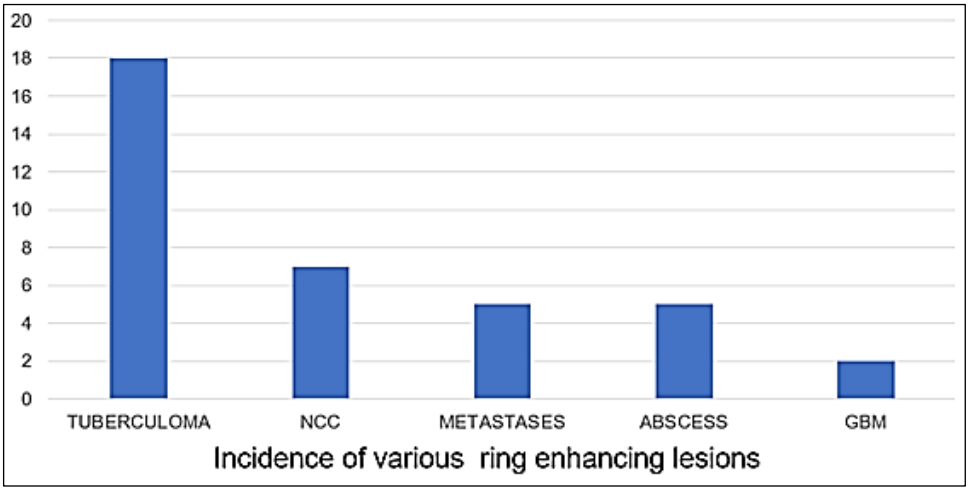
Results

- Out of 40, 22 (55%) were males and 18 (45%) were females.
- Out of the 40 patients who were evaluated, tuberculomas 18 (45%) is the most common pathology followed by NCC 10(25%), Abscesses 5 (12.5%), metastases 5(12.5%) and primary brain tumours 2 (5%).
- Out of 40, 14 (35%) of patients show diffusion restricting lesions (partial/complete) and 26 (65%) of cases shows no diffusion restriction.
- Out of the 40 patients evaluated, choline peak was observed in 17cases, Lipid in 19 cases, Lactate in 12 cases, reduced NAA peak in 14 cases and amino acids in 5 cases.
- **Tuberculoma:** Lipid peak plays an important role in identification of tuberculomas from other infective granulomas.
- **NCC:** Choline peak and reduced NAA peak. Cho/Cr ratio was less than 1.1 in all NCCs and more than 1.2 in all tuberculomas.
- **Abscess:** Lactate peak and amino acids peak.
- **Metastases:** Showed high Cho/Cr and Cho/NAA levels.
- **Primary Brain Tumor/GBM:** Increased choline, decreased NAA.

Incidence of various Ring-enhancing lesions

Total cases: 40.

LESIONS	NO.OF CASES
TUBERCULOMA	18
NEUROCYSTICERCOSIS	10
METASTASES	5
ABSCESS	5
PRIMARY BRAIN TUMOR (GBM)	2



T1 Signal Intensity

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	HYPOINTENSE	ISOINTENSE	TOTAL
TUBERCULOMA	15	03	18
NCC	10	0	10
METASTASES	05	0	05
ABSCESS	05	0	05
PRIMARY BRAIN TUMOR/GBM	02	0	02
	37	03	

T2 Signal intensity

	HYPERINTENSE	HYPOINTENSE	HETEROINTENSE	TOTAL
TUBERCULOMA	06	11	01	18
NCC	10	0	0	10
METASTASES	05	0	0	05
ABSCESS	05	0	0	05
GBM	02	0	0	02

Type of ring enhancement

	COMPLETE THICK RING ENHANCEMENTS	COMPLETE THIN RING ENHANCEMENT
TUBERCULOMA	8	10
NCC	0	10
METASTASES	5	0
ABSCESS	0	5
PRIMARY BRAIN TUMOR/GBM	2	0
TOTAL	15	25

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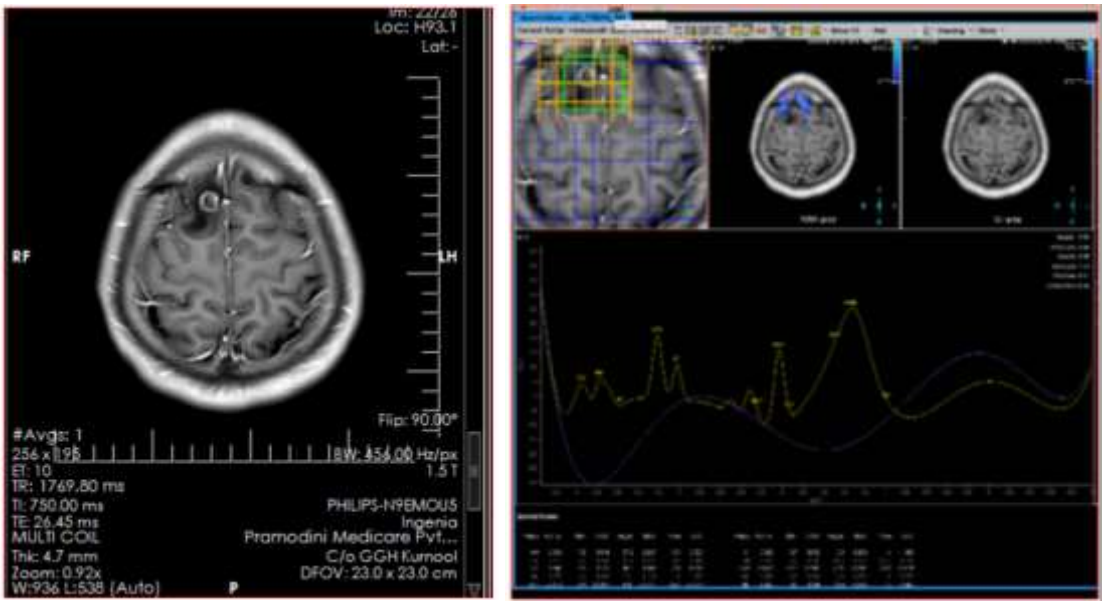
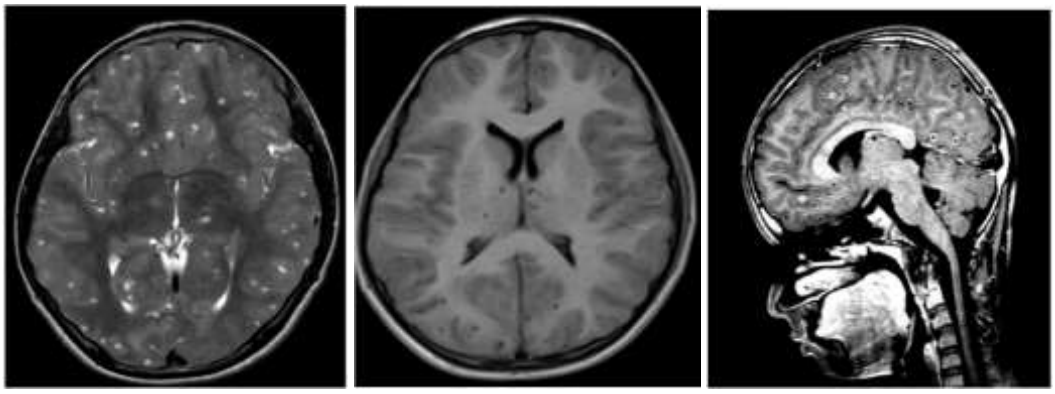
Case 1. Tuberculoma



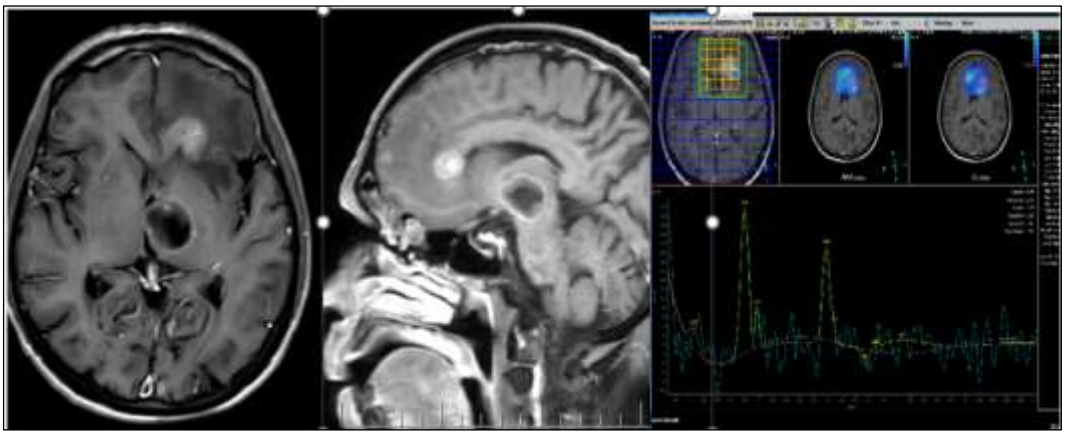
MRI shows smooth thin ring enhancing lesion in right high frontal lobe with lipid peak.

Case 2: Neurocysticercosis



MRI shows multiple T1 hypo, T2 hyperintense lesions showing thin ring enhancement.

Case 3. Metastases



MRI Shows multiple ring enhancing leisons, MRS shows increased choline and decreased NAA.

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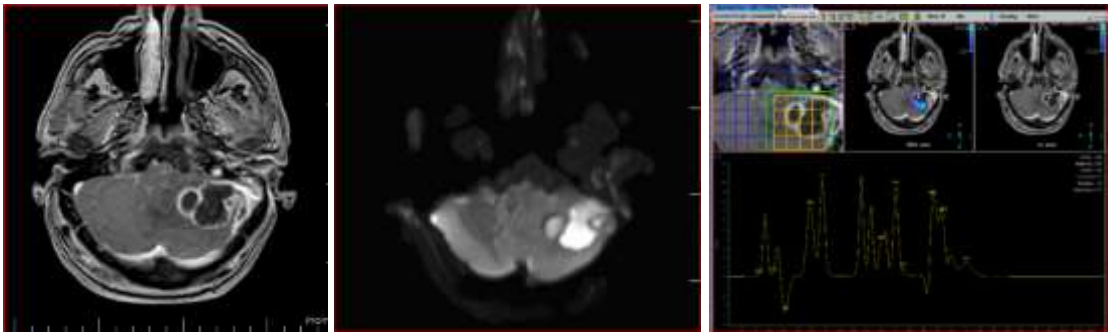
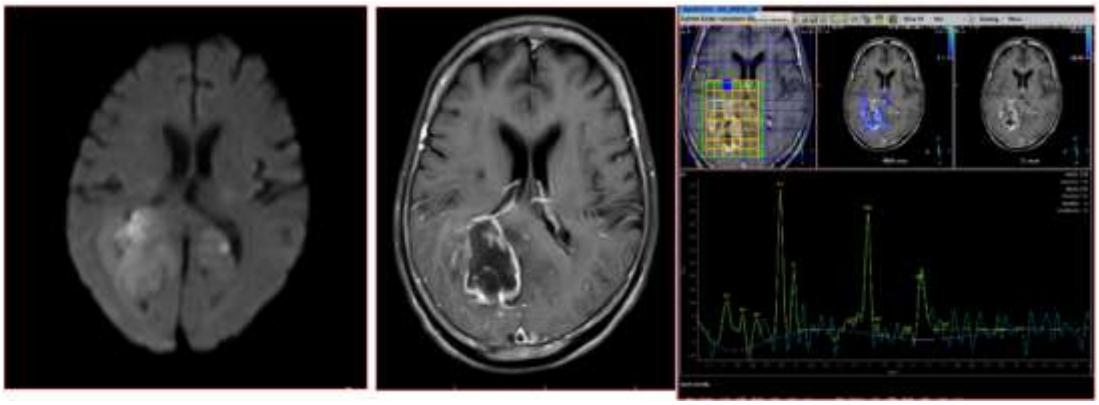
Case 4. Abscess



MRI is showing irregular Ring Enhancing leison with diffusion restriction.

Case 5. Glioblastoma Multiforme



MRI shows peripheral irregular ring enhancing lesion with increased choline and decresed NAA peak.

Discussion

Multiple Cerebral ring-enhancing lesions are caused by a variety of infectious, neoplastic, inflammatory or vascular diseases. Distinguishing non-neoplastic causes from neoplastic lesions is extremely important because a misdiagnosis can lead to unwarranted neurosurgery and exposure to toxic chemotherapy or potentially harmful brain irradiation.

Tuberculomas may be single or multiple, and can be seen anywhere in the brain parenchyma. Intracranial tuberculomas usually show hypo-or iso intensity or central hyperintensity with a hypointense rim on T2W images and iso intensity and /or hypo intensity on T1W images. The postcontrast T1W images show rim enhancement. MRS shows only lipid in T2 hypointense tuberculomas, whereas lesions with a heterogeneous appearance show Cho along with lipid.

NCC has four main stages, Vesicular, Colloidal vesicular, Granular nodular and Nodular calcified which show ring enhancement. MRS shows elevated lactate, succinate and choline levels with no or insignificant lipid peaks.

Abscess has central liquefied active necrosis which is hyperintense to CSF, whereas the surrounding edematous brain is slightly hypointense to normal brain parenchyma on T1 with smooth ring enhancement. MRS shows a Lactate peak and an amino acid peak.

Cerebral metastases are typically T1 iso- to hypointense, T2 hyperintense with ring enhancement. MRS shows an intra-tumoral choline peak with no choline elevation in the peritumoral edema.

Glioblastoma typically has thick, irregularly enhancing margins and a central necrotic core, which may also have a hemorrhagic component, surrounded by vasogenic-type edema, and usually contains infiltration by neoplastic cells. MRS shows increased choline, lipids, lactate with decreased NAA peak with choline elevation in the peritumoural edema too.

Demyelinating lesions show an open ring or incomplete ring enhancement. MRS is nonspecific and shows a decreased NAA/Cr ratio, increased Cho/Cr ratio, and variable lactate and lipid peaks.

Radiation necrosis shows T2 hyperintense signal with soap-bubble/ Swiss-cheese enhancement/ ring-enhancement. MRS shows low choline, creatine, and NAA.

In our study, out of the 40 patients who were evaluated, tuberculomas 18 (45%) were the most common pathology followed by NCC 10(25 %), Abscesses 5 (12.5%), metastases 5(12.5%) and primary brain tumors 2 (5%).

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Out of the 40 patients evaluated, choline peak was observed in 17 cases, Lipid in 19 cases, Lactate in 12 cases, reduced NAA peak in 14 cases and amino acids in 5 cases.

Conclusion

- MRI is the most sensitive modality in the characterization of intracranial ring enhancing lesions.
- MR spectroscopy is a potential tool for differential diagnosis between brain abscesses and non-infectious lesions such as primary brain tumour, lymphoma, brain metastasis and tuberculoma by analysing the presence and/or ratio of tissue metabolites such as NAA, creatine, choline, and lactate etc.

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