International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2023; 6(3): 04-09
Received: 09-04-2023
Accepted: 13-05-2023

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Study of magnetic resonance spectroscopy imaging technique in evaluating ring enhancing lesion in brain

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DOI: https://doi.org/10.33545/26644436.2023.v6.i3a.332

Abstract
Introduction: Ring-enhancing lesions is the most common abnormality faced in neuro-imaging. Imaging modalities commonly used to diagnose such lesions are Computed Tomography (CT) and MRI. However, these lesions are considered challenging for the radiologists. Diagnosing ring enhancing lesions by conventional MRI is challenging, especially when neoplastic, non-neoplastic lesions and infections are to be differentiated. Differentiation between tuberculoma and neurocysticercosis is still a problem for radiologist as both look similar on conventional MRI. Magnetic resonance spectroscopy (MRS) may able to clearly differentiate them based on metabolite level. Present study was conducted to study characteristics of various ring enhancing lesions of brain using conventional MRI and magnetic resonance spectroscopy (MRS) to differentiate neoplastic, infections, inflammatory and vascular lesions
Materials and Methods: 50 patients between age 10 to 70 years diagnosed with ring enhancing lesions of brain based on MR studies fulfilling inclusion and exclusion criteria were enrolled. MRI scan was performed using the MRI GE optima 360-16 channel in all. Single voxel magnetic resonance spectroscopy (MRS) used instead of multi-voxel which was placed on the lesion in a way that the maximum area of the lesion, its margin and the normal brain tissue will be covered.
Observations and Results: Primary Brain Tumors found in 16 (32%) cases, Metastasis in 22 (44%), Abscess in 8 (16%), Neurocysticercosis (NCC) in 2 (4%), Tuberculoma in 1 (2%) & Tumefactive Demyelination in 1 (2%) case. In majority of cases i.e. 38 (76%) size of the lesion was <2 cm. In about 26 (52%) cases number of lesions were 2 to 4 in number. Restriction on diffusion was found in 29 (58%) cases. In majority choline 26 (52%) & lipid 24 (48%) was the metabolite peak found
Conclusion: Magnetic Resonance Spectroscopy (MRS) was found a useful tool in the diagnosis of ring enhancing lesions especially in case of delineating lesions with similar presentations such as tuberculoma and neurocysticercosis.

Keywords: MRS, MRI, NCC

Introduction

Ring enhancing lesions of the brain are located at the junction of the gray and white matter. They are located in the sub-cortical area, deep in the brain parenchyma or may be superficial [1]. They may be confined to a single location or may be in multiple locations. Imaging modalities commonly used to diagnose such lesions are Computed Tomography (CT) and MRI [2]. However, these lesions are considered challenging for the radiologists [3, 4]. On non-contrast CT these lesions may appear as hypodense or isodense mass and within the hypodensity region, there is a ring- or a homogeneous disk-like enhancement after contrast administration. On MRI they are characterised by a non-enhancing centre surrounded by a contrast enhancing halo with central region presenting a low intensity signal on T1 and a high intensity signal on T2 weighted images [3].

Diagnosing ring enhancing lesions by conventional MRI is challenging, especially when neoplastic, non-neoplastic lesions and infections are to be differentiated [5]. It also lacks information regarding tumoral vascularity, metabolism and cellularity [6, 7]. Combining advanced techniques with conventional MRI can increase the precision to detect lesions[5]. Magnetic resonance spectroscopy (MRS) is a non-invasive technique which provides information regarding tissue chemistry which is patient–friendly & safe as devoid of ionising radiations. MRS interpretation is obtained in the form of a high-quality spectra rather than images. Various metabolites like NAA, lactate, phosphocreatine, choline containing compounds and adenosine triphosphates can be measured with magnetic resonance

spectroscopy (MRS). With the reference of metabolites, quantification in MRS is obtained through relative spectral peak regions which do not vary mostly with different pathologies. Absolute metabolite concentration can also be measured [8]. Considering this features, specificity and sensitivity of MRS is enhanced in comparison to MRI [9, 10, 11]. In case of ring enhancing lesions, the differentiation between tuberculoma and neurocysticercosis is still a problem for radiologist as both look similar on conventional MRI [12, 13]. Magnetic resonance spectroscopy (MRS) may able to clearly differentiate them based on metabolite level [14]. On CT and conventional MRI scans they can be differentiated on the basis of location, number of lesions, enhancement pattern and constitutional symptoms, in comparison to MRS based on metabolite levels [15]. But the work becomes time-consuming & with less precision too. Considering this scenario, the present study was conducted to study characteristics of various ring-enhancing lesions of the brain using conventional MRI and magnetic resonance spectroscopy (MRS) to differentiate neoplastic, infections, inflammatory and vascular lesions.

Aim

To study conventional MRI and magnetic resonance spectroscopy (MRS) imaging findings in evaluating ring-enhancing lesion

Objectives

1. To study characteristic imaging findings & assess differential diagnosis using conventional MRI and magnetic resonance spectroscopy (MRS)
2. To differentiate neoplastic from non-neoplastic lesions using conventional MRI and magnetic resonance spectroscopy (MRS)

Material and Methods

Present study is a cross-sectional prospective study conducted between duration August 2022 to February 2023. Institutional ethics committee permission was taken prior to start of study. 50 patients diagnosed with ring-enhancing lesions fulfilling inclusion and exclusion criteria were enrolled. Study was explained to all participants and written informed consent was obtained from all.

Inclusion criteria

Patients between ages 10 to 70 years diagnosed with ring enhancing lesions of brain based on MR studies.

Exclusion criteria

1. Patients with a medical history of claustrophobia, chronic kidney diseases, schizophrenia
2. Patients with metallic implants, cardiac pacemakers

Procedure

After obtaining all demographic variables & data on clinical history, all patients were posted for MRI scans. MRI scan was performed using the MRI GE optima 360-16 channel possessing an ultra-compact, superconducting, active shielded superconducting magnet with a magnetic field strength of 1.5 Tesla (T). Conventional spin echo sequences used for axial T1, T2. Fluid Attenuated Inversion Recovery (FLAIR) used for Coronal T2, Sagittal T1. Post-contrast axial, coronal and sagittal images captured. Diffusion Weighted Imaging (DWI) used for T2 Gradient Echo Sequences (GRE) spectroscopy at echo time (TE) of 20ms and 144 ms. To obtain quicker and easier operation, single-voxel magnetic resonance spectroscopy (MRS) was used instead of multi-voxel MRS. Voxel was placed on the lesion in a way that the maximum area of the lesion, its margin and the normal brain tissue will be covered in a single voxel. Magnetic resonance spectroscopy (MRS) was avoided in small lesions close to the bone.

Statistical analysis

Statistical analysis was performed using SPSS software, version 20. Data were expressed as mean ± SD and frequency with percentages N (%). $\chi 2$-test was used to evaluate qualitative data and to study association between two variables. Statistical significance was assumed if P value less than 0.05.

Observation and Result

Table 1: Age & gender distribution

Sr. No.	Age (Years)	Male N (%)	Female N (%)	Total N (%)
1	10-30	18 (36%)	10 (20%)	28 (56%)
2	31-50	7 (14%)	4 (8%)	11 (22%)
3	51-70	4 (8%)	3 (6%)	7 (14%)
4	>70	3 (6%)	1 (2%)	4 (8%)
Total N (%)		32 (64%)	18 (36%)	50 (100%)

As shown in Table 1 maximum cases i.e., 28 (56%) were from age group 10 to 30 years followed by 11 (22%) cases from 31 to 50 years old. Male cases were 32 (64%) & female cases were 18 (36%).

Table 2: Clinical features

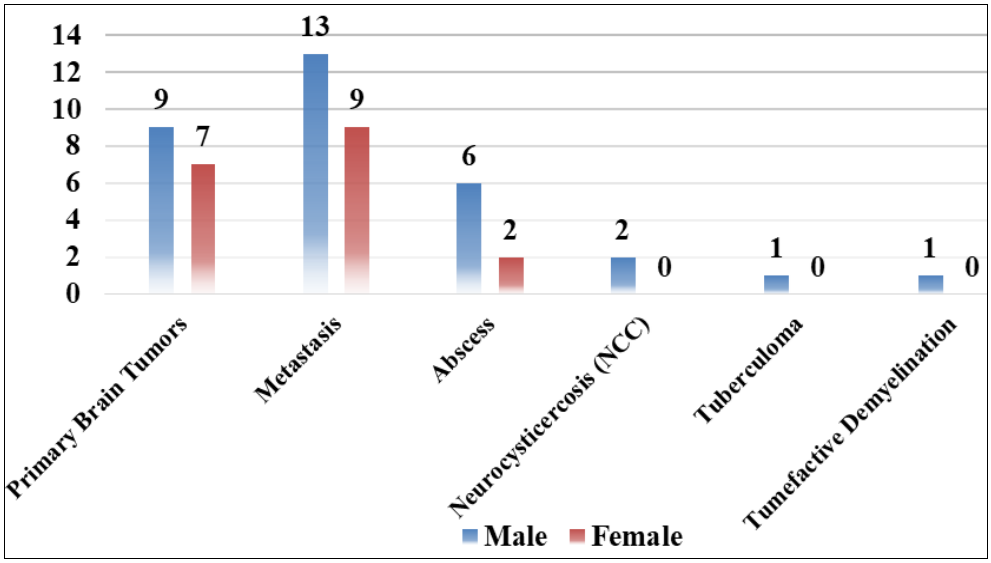
Sr. No.	Clinical features	Present N (%)	Absent N (%)
1	Seizure	29 (58%)	21 (42%)
2	Headache	22 (44%)	28 (56%)
3	Vomiting	5 (10%)	45 (90%)
4	Weakness	4 (8%)	46 (92%)
5	Fever	2 (4%)	48 (96%)
6	Ataxia	2 (4%)	48 (96%)

As shown in Table 2 seizure in 29 (58%) & headache in 22 (44%) were the dominant symptoms.

Table 3: Type of lesion

Sr. No.	Type of lesion	Male N (%)	Female N (%)	Total N (%)
1	Primary Brain Tumors	9 (18%)	7 (14%)	16 (32%)
2	Metastasis	13 (26%)	9 (18%)	22 (44%)
3	Abscess	6 (12%)	2 (4%)	8 (16%)
4	Neurocysticercosis (NCC)	2 (4%)	0 (0%)	2 (4%)
5	Tuberculoma	1 (2%)	0 (0%)	1 (2%)
6	Tumefactive Demyelination	1 (2%)	0 (0%)	1 (2%)
Total N (%)		32 (64%)	18 (36%)	50 (100%)

Table 3 showing type of lesion, shows Primary Brain Tumors in 16 (32%) cases, Metastasis in 22 (44%), Abscess in 8 (16%), Neurocysticercosis (NCC) in 2 (4%), Tuberculoma in 1 (2%) & Tumefactive Demyelination in 1 (2%) case. (Graph 1)

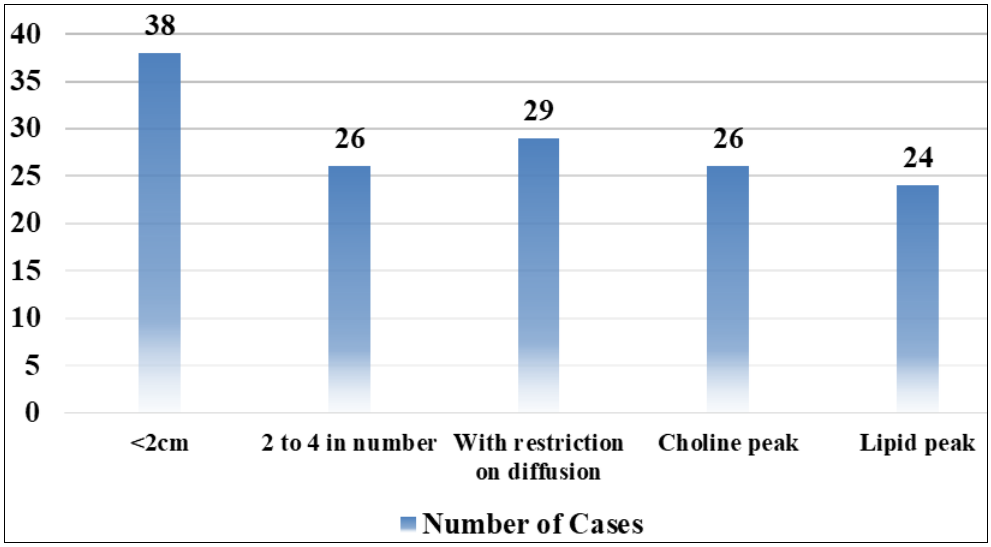


Graph 1: Type of lesion

Table 4: MRI findings

Sr. No.	USG findings	Number of cases N (%)
1	**Size (cm)**	
	<2	38 (76%)
	2 to 4	9 (18%)
	>4	3 (6%)
2	**Number**	
	1	13 (26%)
	2 to 4	26 (52%)
	>4	11 (22%)
3	**Diffusion**	
	Showing restriction	29 (58%)
	No restriction	21 (42%)
4	**Metabolite Peak**	
	Choline	26 (52%)
	Lipid	24 (48%)
	Lactate	21 (42%)
	Reduced NAA	13 (26%)
	Amino acids	4 (8%)

Table 4 showing MRI findings shows that, in majority of cases i.e. 38 (76%) size of the lesion was <2 cm. In about 26 (52%) cases number of lesions were 2 to 4 in number. Restriction on diffusion was found in 29 (58%) cases. In majority choline 26 (52%) & lipid 24 (48%) was the metabolite peak found (Graph 2).



Graph 2: MRI findings

Discussion

Ring-enhancing lesions is the most common abnormality faced in neuro-imaging. Magnetic resonance imaging (MRI) is one of new imaging techniques widely used to detect these lesions. Diagnosing ring-enhancing lesions by conventional MRI is challenging, especially when neoplastic, non-neoplastic lesions and infections are to be differentiated. MR spectroscopy plays a pivotal tool in differential diagnosis between brain abscesses and non-infectious lesions such as primary brain tumors, lymphoma, brain metastasis, and tuberculoma. The present study was planned in 50 ring-enhancing lesions patients with the objective to study conventional MRI and magnetic resonance spectroscopy (MRS) imaging findings in evaluating ring-enhancing lesions. In present study maximum cases i.e., 28 (56%) were from age group 10 to 30 years followed by 11 (22%) cases from 31 to 50 years old. Male cases were 32 (64%) & female cases were 18 (36%). Seizure in 29 (58%) & headaches in 22 (44%) were the dominant symptoms found. In a similar study by D Rajasree *et al*. (2020) [16] 50 patients were evaluated by MRS. The mean age of patients was 36.76±21.62 years, where 20% of the patients belonged to the age group of 21-30 years. The study involved a large number of male patients (66%). A significant number of patients experienced seizures (66%) followed by headache (38%) and vomiting (24%). RR. Archana *et al*. (2018) [17] in their study evaluated 40 patients whose age group ranged from 7 to 66 years. Highest incidence was found in 21-30 years age group accounting for 25% of cases and least was seen in age group of >60 years constituting 5%. 24(60%) were males and 16 (40%) were females. Seizures were the most common presenting complaint in 70% of cases. Headache (30%), fever (10%), vomiting (25%), ataxia (5%) and motor weakness (10%) were the other presenting complaints. In present study primary Brain Tumors were found in 16 (32%) cases, Metastasis in 22 (44%), Abscess in 8 (16%), Neurocysticercosis (NCC) in 2 (4%), Tuberculoma in 1 (2%) & Tumefactive Demyelination in 1 (2%) case. majority of cases i.e. 38 (76%) size of the lesion was <2 cm. In about 26 (52%) cases a number of lesions were 2 to 4 in number. Restriction on diffusion was found in 29 (58%) cases. In majority choline 26 (52%) & lipid 24 (48%) was the metabolite peak found. In a similar study by Rajasree *et al*. (2020) [16] found Tuberculoma (36%) and neurocysticercosis (22%) were the most prevalent lesions. Overall, higher choline peaks were noted in 66% of the patients. RR. Archana *et al*. (2018) [17] in their study found Tuberculomas (45%) were the most common pathology followed by NCC (25%), Abscesses (10%), metastasis (10%), primary brain tumour (5%) and toxoplasmosis (5%). In 18 (45%) cases, 2-4 lesions were noted and > 4 in 8 (20%) cases. Majority 28 (70%) showed RELs < 2cm, 2-4 cm was seen in 8 (20%) and in 4 (10%) size was greater than 4 cm. Sachin L *et al*. (2018) [18] in their study found tuberculomas (44%) was the most common pathology followed by NCC (32%), Abscesses (10%), metastasis (10%), primary brain tumor (2%) and tumefactive demyelination (2%). In a study by Schwartz *et al*. (2006) [19] they found 40% of cases were gliomas

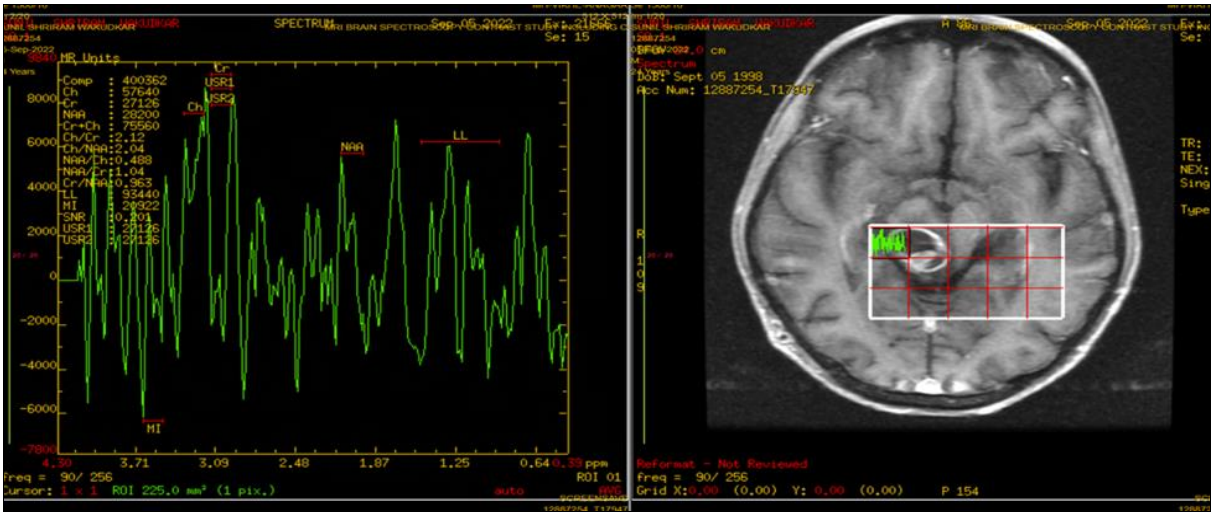


Fig 1: Infective aetiology likely tubercular - ring-enhancing lesion showing T2 hypointense signal and mild perilesional oedema involving bilateral cerebral, cerebellar hemispheres and pons, largest measuring 13 x 12 mm

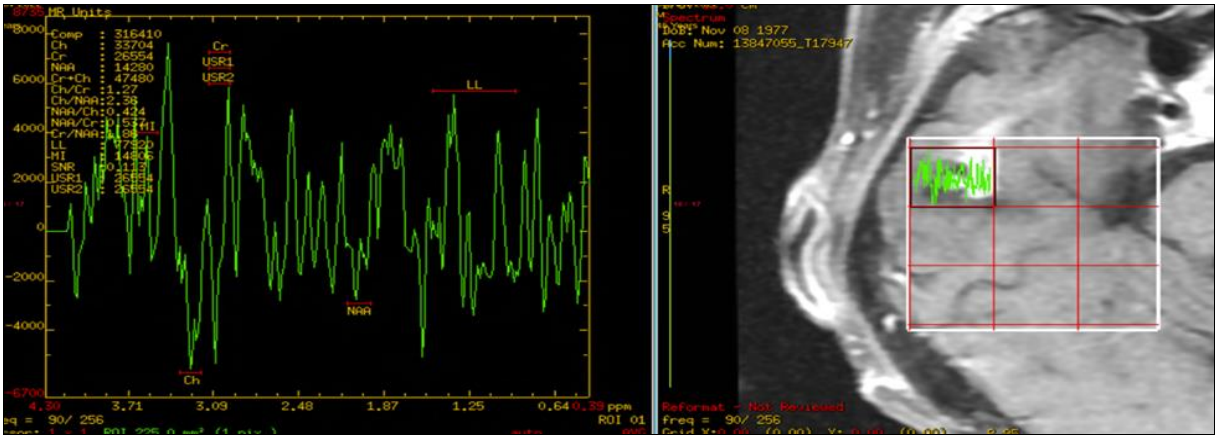


Fig 2: Astrocytoma – well-defined thick-walled peripherally enhancing lesion is seen in the right temporal lobe with a central non-enhancing necrosis

Conclusion

Magnetic Resonance Spectroscopy (MRS) was found as most sensitive modality which can characterize intracranial ring-enhancing lesions. It was found a useful tool in the diagnosis of ring-enhancing lesions, especially in the case of delineating lesions with similar presentations such as tuberculoma and neurocysticercosis

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article
Shinde B, Jadhav D, Kachewar S. Study of magnetic resonance spectroscopy imaging technique in evaluating ring-enhancing lesion in brain. International Journal of Radiology and Diagnostic Imaging 2023; 6(3): 04-09.

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