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AUGMENTING CLINICAL ROLE OF MAGNETIC RESONANCE IMAGING IN THE EVALUATION OF RING-ENHANCING LESIONS OF THE BRAIN IN CORRELATION WITH MAGNETIC RESONANCE SPECTROSCOPY

Neurology

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ABSTRACT

Introduction: Ring-enhancing lesions (RELs) of the brain present a diagnostic challenge for radiologists as well as for neurologists. Conventional MRI alone often fails to distinguish between various types of RELs, necessitating the use of advanced techniques like Magnetic Resonance Spectroscopy (MRS) in clinical setting. **Objective:** To assess the role of MRI in evaluating ring-enhancing brain lesions in correlation with MRS on a 3 Tesla MRI machine.**Methods:** This prospective cross-sectional study involved 60 patients with suspected RELs, examined using a GE SIGNA Architect 3T MRI. MRI and MRS findings were analyzed and compared to differentiate between neoplastic and non-neoplastic lesions. **Results:** The study found that tuberculomas were the most common RELs (45%), followed by neurocysticercosis (23.3%). MRS provided additional diagnostic information, especially in differentiating tuberculomas from other lesions. The mean Cho/Cr and Cho/NAA ratios were significantly higher in neoplastic lesions compared to abscesses and granulomas. **Conclusion:** Combining conventional MRI with MRS enhances diagnostic accuracy for RELs, aiding in early and precise treatment planning.

KEYWORDS

Ring-enhancing lesions, Brain, MRI, MRS, Neoplastic lesions, Non- Neoplastic lesions, Tuberculoma, NCC, Abscess, DWI

INTRODUCTION

Ring-enhancing lesions (RELs) of the brain are a frequent diagnostic challenge in neuroradiology. These lesions can be due to various etiologies, including infections, inflammatory diseases, and neoplasms. Conventional imaging techniques like Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are often used, but they lack the specificity to differentiate between the diverse types of RELs. Advanced imaging techniques, such as Diffusion-Weighted Imaging (DWI) and Magnetic Resonance Spectroscopy (MRS), have shown promise in improving diagnostic accuracy.[1]

The size, shape, wall thickness of ring-enhancing lesions, the extent of surrounding edema, and, more importantly, clinical history and age of the patient should be taken into consideration to help distinguish the condition.2 The two most common etiologies of inflammatory granulomas encountered in clinical practice include neurocysticercosis (NCC) and tuberculomas.[3]

Magnetic Resonance Spectroscopy- MRS is an MRI sequence that can measure metabolic changes in the brain. MRS data are presented as line spectra, with the area beneath each peak denoting the relative concentration of nuclei seen for a particular chemical species.4 Different lesions show different MRS peaks. Based on the peak, we can differentiate different cerebral lesions. For example, the presence of a choline peak indicates a potential tumor, amino acid peaks such as acetate or succinate in a ring-enhancing lesion allude to NCC, and a lipid lactate peak indicates a potential tuberculoma.[5]

AIM: To study the role of MRI in the evaluation of ring-enhancing lesions of the brain in correlation with MRS on a 3 Tesla machine.

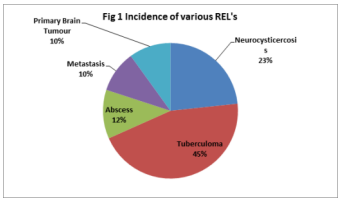
Objectives: To assess the various resonances of chemical components of RELs using MRS, to evaluate signal intensity, diffusion motion of content, and Apparent Diffusion Coefficient (ADC) values in patients with brain RELs.

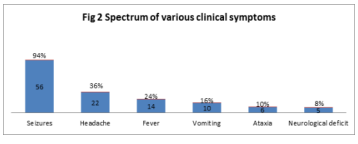
Materials and Methods:- This was a prospective cross-sectional study conducted in the Department of Radiodiagnosis at SMS Medical College and Hospital, Jaipur. Study Population: All patients referred from Neurosurgery, Medicine, and Neurology Departments with brain RELs were included, irrespective of age and sex, given they consented to participate.

SAMPLE SIZE:-60 patients were selected based on a power calculation for an 80% power at a 95% confidence level, considering the prevalence of tuberculosis among the referred cases.

Imaging Protocol:- MR imaging was performed using a GE SIGNA Architect 3T MRI with a standard head coil. Conventional MRI sequences included T1WI, T2WI, and FLAIR sequences. Advanced techniques such as DWI, ADC mapping, and MRS were also employed.

DATA ANALYSIS:- Data were analyzed using SPSS and MedCalc software. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. Kappa analysis was performed to evaluate the agreement between MRI and MRS findings.





RESULTS

The majority of patients (23.3%) were in the 11-20 year age group. with a male predominance (58%). Various Ring-Enhancing Lesions are present like Tuberculoma 45%, Neurocysticercosis (NCC) 23.3%, Abscess 11.7%, Metastasis 10% and Primary Brain Tumor are 10% with clinical symptoms of seizures 94%, headache 36% and fever 24%

In the present study, seizures are the commonest symptoms (94%), followed by headache (36%), fever (24%), vomiting (16%), ataxia (10%) and neurological deficit (8%).

MRS Findings on T1 Morphology most tuberculomas (89%) were hypointense, while all abscesses were hypointense.

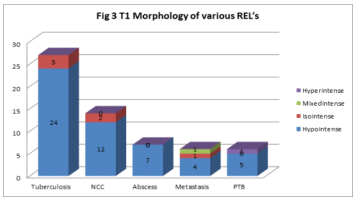


Table 1 T2 Morphology of various REL's

Pathology	Total	Hypointense		Mixed Intensity		Hyperintense	
Tuberculoma	27	17	63%	5	18.5%	5	18.5%
NCC	14	0	0%	2	14.3%	12	85.7%
Abscess	7	0	0%	1	14.3%	6	85.7%
Metastasis	6	0	0%	0	0%	6	100%
Primary Brain Tumor	6	0	0%	1	17%	5	83%

In the present study on T2 weighted imaging, 63% (17) cases of tuberculoma are hypointense while 18.5% (05) cases are mixed intense and 18.5%(05) cases are hyperintense, 85.7%(12) cases of NCC are hyperintense while 14.3%(2) cases are mixed intense, 85.7%(6) cases of abscesses are hyperintense while 14.3%(1) cases are mixed intense, 100%(6) cases of metastasis are hyperintense, 83%(5) cases of primary brain tumors are hyperintense and 17%(1) are mixed intense.

DWI and ADC; Tuberculomas showed restriction in 63% of cases, while all abscesses showed true diffusion restriction. MRS Metabolite Ratios: Neoplastic lesions had significantly higher Cho/Cr and Cho/NAA ratios compared to abscesses and granulomas.

Table 2 List of metabolite peak noted in various REL's

Pathology	Total cases	Choline		Reduced NAA		Lipid		Lactate		Alanine		Other Amino acids	
Tuberculoma	27	12	43.4%	5	18.5%	21	78.2%	12	43.4%	0	0%	0	0%
NCC	14	10	71%	0	0%	0	0%	7	50%	0	0%	0	0%
Abscess	07	0	0%	5	71%	5	71%	7	100%	0	0%	3	42%
Metastasis	06	6	100%	6	100%	0	0%	5	83%	0	0%	0	0%
Primary Brain Tumor	06	6	100%	6	100%	0	0%	6	100%	0	0%	0	0%

In the present study, all cases of abscess and primary brain tumors show lactate peak, 83% cases of metastasis show lactate peak. In patents with NCC and tuberculoma, 50% and 43.4% of cases had lactate peaks respectively. 78.2% cases of tuberculoma had lipid peak, 71% cases of abscesses had lipid peak while none of the cases of NCC or neoplasms included in the study had lipid peak. 42% cases of abscess show amino acids. Choline peak and reduced NAA peak was observed in all cases of primary brain tumors and Metastasis. 71% cases of NCC and 43.4% cases of tuberculoma had prominent choline peaks. MRS could not be performed in 3 patients due to location of the lesion close to the bone.

Discussion

This study demonstrated that combining conventional MRI with MRS significantly improves the diagnostic accuracy for RELs. Tuberculomas were the most common lesions, frequently presenting with seizures. MRS provided critical metabolic information, differentiating neoplastic from non-neoplastic lesions effectively. The elevated Cho/Cr and Cho/NAA ratios in neoplastic lesions, compared to non-neoplastic ones, underscore the diagnostic value of MRS.

The higher incidence of tuberculomas is probably due to the higher prevalance of tuberculosis in India. Similar findings also shown by Schwartz KM et al (2006) 6in 221 patients most common associated pathologies in their study were gliomas (40%), metastases (30%), abscesses (8%) and multiple sclerosis (MS; 6%). They concluded that trends in T2 hypointensity may aid in distinguishing among etiologies of ring-enhancing lesions, although there is overlap between the MR appearance of these various pathologies.[7]

D Rajasree et al. (2020) 8 in their study the Role of Magnetic Resonance Spectroscopy in the Evaluation of Ring Enhancing Lesions of the Brain found that among the 50 patients screened, the most prevalent pathologies were tuberculoma (36%) and neurocysticercosis (22%).[8]

Marais S et al 2019 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. While on postcontrast T1-weighted images, there were single or multiple conglomerate ring enhancements within a tuberculoma in all six patients.9 Diker S et al 2022 concluded that presence of lipid can be used for differentiating tuberculomas from NCC.[10]

Conclusion

MRI, when combined with MRS, offers a powerful tool for evaluating RELs of the brain. This multiparametric approach enhances diagnostic specificity and sensitivity, facilitating early and accurate diagnosis and treatment planning, ultimately reducing patient morbidity and mortality.

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