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

DR. ADITYA SANGOLE, DR.YOGENDRA SACHDEV, DR.SYED YOUNUS UZ ZAMAN

DR.BALASAHEB VIKHE PATIL RURAL MEDICAL COLLEGE, LONI

ABSTRACT

BACKGROUND: Ring enhancing lesions of the brain are one of the most common imaging abnormalities encountered on neuroimaging. These lesions can occur due to infectious, neoplastic, vascular or inflammatory diseases.

MATERIALS AND METHODS: This was a descriptive study in patients from Dr. Balasaheb Vikhe Patil Rural Medical college, Loni. All patients referred to the department of Radiodiagnosis in last one year with clinical suspicion were included in the study irrespective of their age and sex after written informed consent from their parent/guardian. The MRI scan was performed on 3 TESLA MRI PHILIPS INGENIA ELITION X machine. Contrast enhanced images were requested for better delineation of these lesions. Initially we localized the lesion via a contrast MRI scan and a voxel was subsequently placed at its location.

RESULTS: Seizures was the most commonly encountered complaint in majority of cases. Out of the 45 patients evaluated, 21 were tuberculomas, 14 were NCC, 4 were cerebral abscesses, 4 were metastases and 2 cases comprised of primary brain malignancies. The highest incidence was found to be in the age group between 21-30 years of age while the lowest incidence was reported in age more than 60 years. Out of 45, 35 were males while 10 were females.

CONCLUSION: The use of MRI along with MR Spectroscopy is of vital importance and serves as a primary research tool in neurodiagnosis. The most common encountered ring enhancing lesions in developing country like India was found to be neurocysticercosis and tuberculomas.

Keywords : MRI, MR Spectroscopy, Ring enhancing lesions

Introduction:

Magnetic Resonance Imaging (MRI) has emerged as a powerful, non-invasive imaging modality that provides excellent soft-tissue contrast and detailed anatomical and functional information. In the evaluation of acquired cardiac pathologies, MRI plays a crucial role in precise diagnosis, guiding treatment strategies, and assessing prognosis. MRI is particularly advantageous due to its ability to provide comprehensive evaluation without exposure to ionizing radiation, making it safe for repeated assessments over time. (1,2)

MRI techniques, such as cine imaging, late gadolinium enhancement (LGE), T1 and T2 mapping, and myocardial perfusion imaging, enable detailed assessment of cardiac morphology, myocardial viability, fibrosis, infarction, and inflammatory changes. It accurately evaluates ventricular function, ventricular volumes, wall motion abnormalities, myocardial edema, and scar tissue formation, which are crucial parameters in managing various cardiac pathologies like myocarditis, cardiomyopathies, ischemic heart disease, and valvular heart disease.(3,4,5)

Specifically, in myocarditis, MRI can detect early myocardial inflammation and edema through sequences such as T2-weighted imaging and Late Gadolinium Enhancement (LGE), which are not easily appreciated on echocardiography. Similarly, in cardiomyopathies, MRI provides insights into myocardial composition and fibrosis, facilitating the differentiation between ischemic and non-ischemic etiologies. Moreover, in ischemic heart disease, cardiac MRI can precisely delineate the extent and severity of myocardial infarction, assess

myocardial viability, and guide revascularization decisions. For valvular diseases, MRI offers superior visualization of valve morphology, function, and the resulting cardiac remodeling.(6)

Methodology

This descriptive study was conducted at Dr. Balasaheb Vikhe Patil Rural Medical College, Loni, involving patients referred to the Department of Radiodiagnosis over a one-year period. Patients presenting with clinical suspicion of ring-enhancing lesions were enrolled in the study, regardless of age, gender, or underlying medical conditions. Ethical clearance was obtained from the institutional review board, and informed consent was secured from all participants or their guardians before inclusion in the study.

MRI examinations were performed using a state-of-the-art 3 Tesla MRI Philips Ingenia Elition X scanner. Standard imaging protocols included acquiring multiplanar sequences such as T1-weighted, T2-weighted, Fluid Attenuated Inversion Recovery (FLAIR), diffusion-weighted imaging (DWI), and gradient echo sequences. To enhance lesion visualization and characterization, contrast-enhanced MRI sequences were acquired using intravenous administration of gadolinium-based contrast media.

Following lesion localization using contrast-enhanced MRI, single voxel MR spectroscopy (MRS) was performed. The voxel placement was carefully guided by the findings from contrast MRI, targeting the most representative area within the lesion to obtain precise metabolic information. Voxel size varied depending on the lesion dimensions but was optimized to avoid contamination from adjacent structures. Spectroscopy sequences utilized included short and intermediate echo times (TE), typically employing TE values of 30 ms and 135 ms, respectively, to identify metabolic peaks effectively.

Data obtained from MRI and MRS scans were systematically recorded and analyzed. Metabolite peaks, including N-acetyl aspartate (NAA), choline (Cho), creatine (Cr), lipid-lactate, and any abnormal peaks, were documented. Ratios such as Cho/NAA and Cho/Cr were calculated to aid in distinguishing neoplastic, inflammatory, and infectious etiologies. Statistical analysis of collected data was conducted using appropriate descriptive statistical methods, and findings were tabulated and interpreted to evaluate diagnostic accuracy and clinical utility of MRI and MRS in identifying and differentiating various ring-enhancing lesions.

Results:

Table 1: Clinical Presentation of Patients (n=45)

Clinical Complaint	Number of Patients	Percentage (%)
Seizures	27	60%
Headache	10	22.2%
Neurological Deficit	5	11.1%
Vomiting	3	6.7%

Table 2: Distribution of Ring Enhancing Lesions (n=45)

Diagnosis	Number of Patients	Percentage (%)
Tuberculoma	21	46.7%
Neurocysticercosis (NCC)	14	31.1%
Cerebral Abscess	4	8.9%
Metastasis	4	8.9%
Primary Brain Tumor	2	4.4%

Table 3: Age and Gender Distribution (n=45)

Parameter	Number of Patients	Percentage (%)
Age (years)		
0-20	7	15.6%
21-30	18	40%
31-40	10	22.2%
41-50	6	13.3%
51-60	3	6.7%
>60	1	2.2%
Gender		
Male	35	77.8%
Female	10	22.2%

**Table 4: MR Spectroscopy Findings in Ring Enhancing Lesions**

| Lesion Type	MR Spectroscopy Findings
Tuberculoma	High lipid peak, elevated Choline/Creatine ratio (>1–2)
Neurocysticercosis (NCC)	Elevated lactate, succinate peaks, minimal or absent choline peak
Primary Brain Tumor	High choline peak, elevated Choline/Creatine ratio (>2)
Metastasis	Elevated choline peak
Cerebral Abscess	Increased amino acids, lipid-lactate peaks
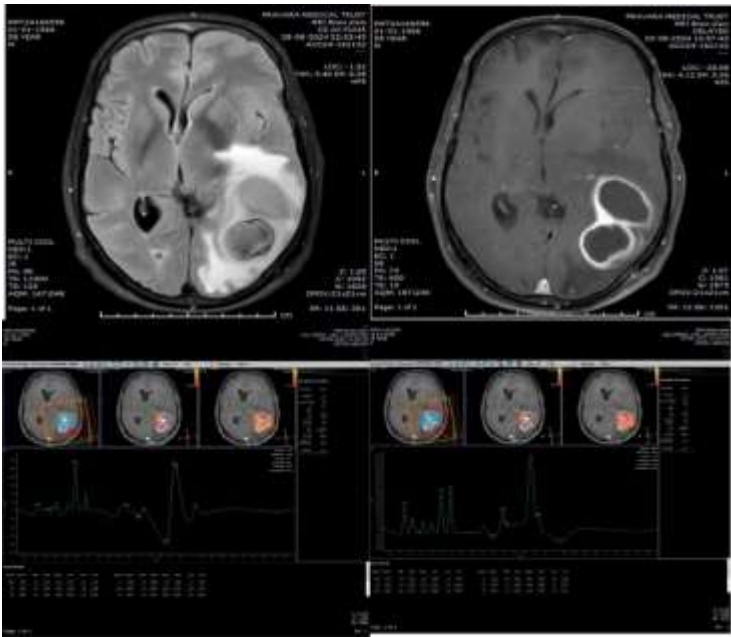
CASE 1: Representative case of cerebral abscess with choline and lipid lactate peak on MR Spectroscopy.
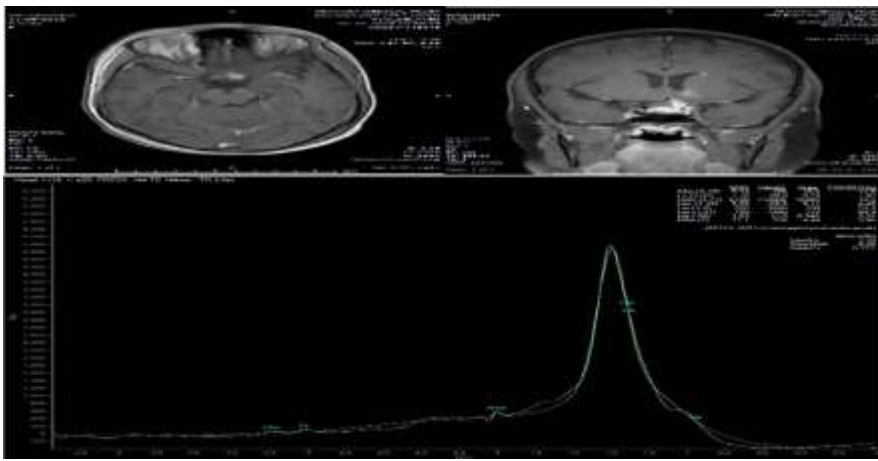
CASE 2: Representative case of tuberculoma with lipid lactate peak on MR spectroscopy.
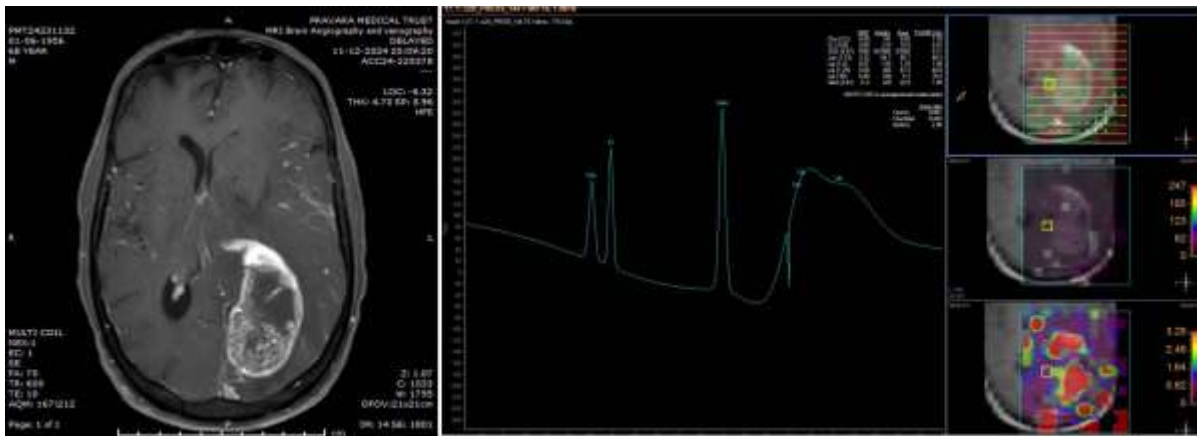
CASE 3: Case of primary brain malignancy, high grade glioma (HPR proven) with post contrast enhancement and choline peak at 3.2ppm.
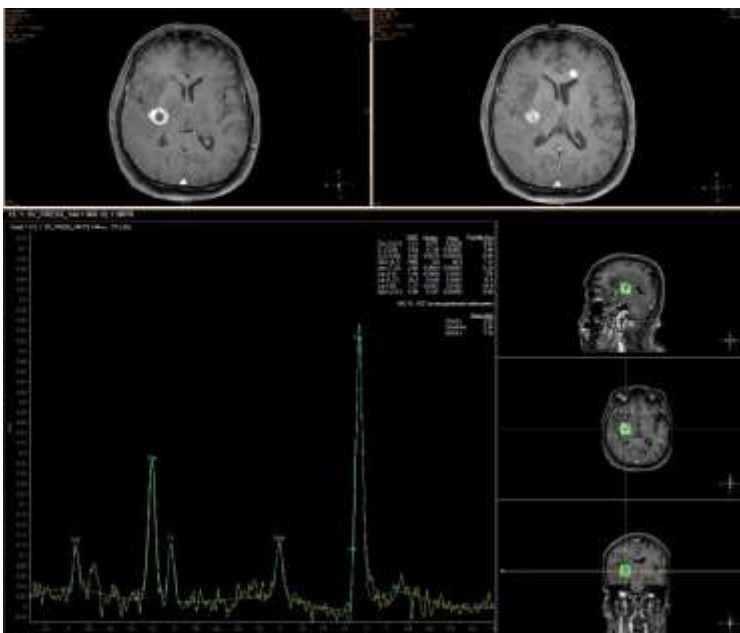
CASE 4: Representative case of Brain Metastases with carcinoma lung as primary malignancy showing multiple enhancing lesions of varying sizes with choline peak and increased choline/creatinine ratio on MR Spectroscopy.
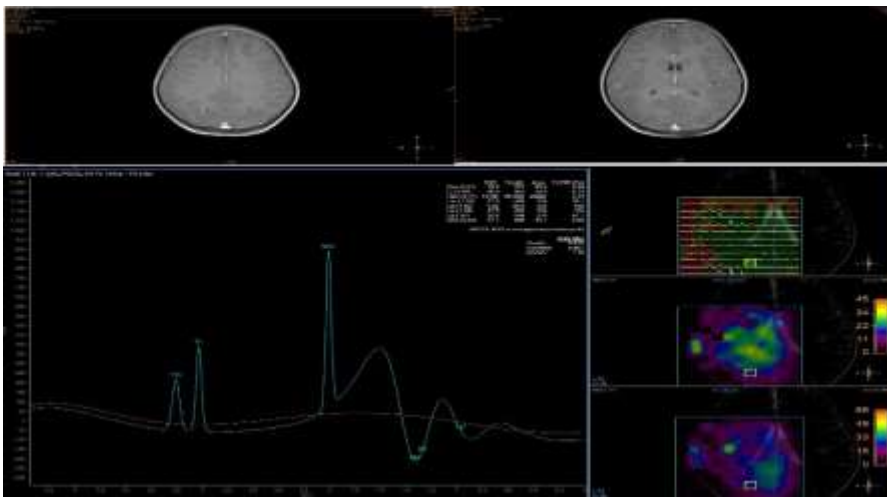
CASE 5: Representative case of Neurocysticercosis showing enhancing lesions along grey white matter junction with peripheral rim enhancement and choline peak at 3.2 ppm.

Discussion:

The present study evaluated the role of MRI and MR Spectroscopy (MRS) in differentiating various ring-enhancing brain lesions, emphasizing distinguishing neoplastic from non-neoplastic etiologies. The clinical spectrum of ring-enhancing lesions in our patient population was diverse, comprising tuberculomas, neurocysticercosis (NCC), cerebral abscesses, metastases, and primary brain tumors. Seizures emerged as the predominant clinical complaint, affecting approximately 60% of the participants, aligning with prior studies indicating seizures as a common neurological presentation in ring-enhancing brain lesions. (7,8)

Tuberculomas were the most frequently encountered lesions, constituting approximately 47% of cases. This finding reflects the high prevalence of tuberculosis in developing countries like India, consistent with existing literature. MR Spectroscopy characteristics of tuberculomas revealed distinctively elevated lipid peaks and choline-to-creatine (Cho/Cr) ratios ranging from >1 to 2. These findings corroborate previous studies that reported lipid peaks due to the presence of mycolic acids within the caseating granulomas typical of tubercular infection.

Neurocysticercosis represented the second most common etiology, identified in 31% of the patients. Spectroscopy findings characteristic of NCC included elevated lactate and succinate peaks, coupled with negligible or absent choline peaks. These metabolic signatures are indicative of parasitic infestation and anaerobic metabolism within the cystic lesions. Such spectroscopic markers are crucial for differentiating NCC from other infective or neoplastic lesions, thus significantly influencing therapeutic management decisions.

Primary brain tumors and metastatic lesions accounted for a smaller proportion of cases. Primary neoplasms showed significantly high choline peaks with markedly elevated Cho/Cr ratios (>2), emphasizing increased cell membrane turnover and proliferative activity typical of neoplastic tissues. Metastatic lesions similarly exhibited elevated choline peaks, albeit without a specific Cho/Cr threshold that could reliably differentiate them from primary tumors. These findings align with previous research demonstrating the difficulty of distinguishing metastatic lesions from high-grade primary brain tumors based solely on spectroscopy due to overlapping metabolic profiles.

Cerebral abscesses were characterized by pronounced elevations in amino acid peaks and lipid-lactate complexes. This metabolic profile can be attributed to proteolytic activity and anaerobic glycolysis within the abscess cavity. These findings were consistent with literature reports indicating that the presence of amino acids, especially valine, leucine, and isoleucine, is highly specific to bacterial abscesses, aiding in their differentiation from other etiologies.

Regarding demographics, the study showed a higher incidence of ring-enhancing lesions in males (approximately 78%) compared to females, mirroring trends reported in previous epidemiological studies. The age distribution indicated peak occurrence among young adults aged 21–30 years. The relative rarity of lesions

in the elderly (above 60 years) may reflect epidemiological and regional disease patterns rather than an inherent resistance of this age group to such pathologies. (9)

Overall, the integration of MR spectroscopy with conventional MRI significantly enhanced diagnostic accuracy, allowing for more definitive differentiation among various ring-enhancing lesions. This combination enabled precise characterization based on metabolic signatures, thus facilitating targeted therapeutic approaches and improved clinical outcomes. These findings underscore the critical utility of MR spectroscopy as a routine adjunct to MRI in evaluating complex brain lesions.

Conclusion:

In conclusion, the results of this study reinforce that MRI combined with MR Spectroscopy is invaluable for the accurate diagnosis and effective differentiation of ring-enhancing brain lesions. Given the high prevalence of infectious etiologies like tuberculomas and neurocysticercosis in developing regions, incorporating MR spectroscopy into routine neuroimaging protocols can substantially improve clinical management by providing metabolic insights that complement structural imaging findings.

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