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Original Research Article

Role of MRI and Mr Spectroscopy in the Diagnosis of Cerebral Ring Enhancing Lesions- A Prospective Study

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Abstract

Background: Ring-enhancing lesions are one of the most commonly encountered neuroimaging abnormalities visualized on MRI. The most common etiologies causing ring enhancing lesion include tuberculomas, neurocysticercosis, and abscess, infarct and demyelination disorders. Mostly the ring-enhancing lesions are located at junction of the gray and white matter but in few cases they are seen in the sub-cortical area& deep brain parenchyma. Few specific features of ring enhancing lesions seen in sequences of MRI brain coupled with clinical history helps in narrowing down our diagnosis.

Material and Methods: 50 patients with ring enhancing lesions on MR imaging were considered in our study conducted at government general hospital. MRI along with MRS was performed in patients ranging from ages of 2-69 years.

Results: Out of the 50 (34 were male and 16 were Female) patients evaluated 20 cases were tuberculomas, 10 were NCC, 5 abscesses, 5 metastasis, 6 cases of primary brain tumors and 2 cases of multiple sclerosis, 2 cases of sub-acute hemorrhage. The highest incidence of REL's were found in 25-40years age group accounting for 30 cases and least was seen in age group of >60 years. Seizures are the most common presenting complaint in 50% of cases. 14 (35%) of them presented with a single lesion. Majority 35(70%) of them showed RELs < 2cm. Choline peak was observed in 10cases, Lipid in 20 cases, Lactate in 22 cases, reduced NAA peak in 7 cases and amino acids in 3 cases.

Conclusion: MRI is the most sensitive modality which can characterize the intracranial ring enhancing lesions RELs. Based on characteristic imaging findings MRI and MRS plays a pivotal role in the correct diagnosis and accurate management of patient.

Keywords: Magnetic Resonance Imaging, Magnetic Resonance spectroscopy, Ring enhancing Lesions.

Introduction

Multiple ring-enhancing lesions are one of the commonly encountered neuro imaging abnormalities. Noninvasive imaging techniques like computed tomography and magnetic resonance imaging (MRI) are used to detect these lesions. Ring enhancing lesions may result from a wide range of etiologies. On neuroimaging, these lesions appear as hypodense or isodense space occupying lesions on noncontrast computed (plain) tomography studies.

After contrast administration, there is a ring- or a homogeneous disk-like enhancement within the region of central hypodensity. The enhancing lesions are often of variable size and are usually surrounded by a varying amount of perifocal vasogenic edema. Typically, the ring-enhancing lesions are located at the junction of the gray and white matter, but they could be located in the sub-cortical area, deep in the brain parenchyma or may even be superficial. Owing to MRIs high inherent soft tissue contrast and its ability to image in multiple planes, MRI has a clinical advantage in early detection of disease as it can differentiate tumor, ischemia/infarct, edema, MS plaques, infection/abscess and hemorrhage. MR spectroscopy employs the principle of chemical shift imaging in order to detect metabolites within a ring enhancing lesion and serves as a potential tool for differentiating between various RELs. [1]

Magnetic Resonance Spectroscopy (MRS) is a non-invasive technique that provides valuable information about tissue chemistry. It offers the advantage of being patient-friendly, as it does not involve ionizing radiation. Instead of producing

images, MRS captures high-quality spectra. It enables the measurement of various metabolites such as NAA, lactate, phosphocreatine, choline-containing compounds, and adenosine triphosphates. MRS quantification relies on comparing relative spectral peak regions to reference metabolites, which generally show minimal variation with most pathologies. Additionally, absolute metabolite concentrations can be measured by referencing them to the concentration of unbound water in the tissue, assuming that this concentration remains relatively constant across different diseases. [2] These features enhance the specificity and sensitivity of MRS compared to MRI. [3,4,5]

Material and Methods

It was a prospective descriptive study in patients from DSR general and teaching hospital of ACSR medical college all patients referred to the department of Radio diagnosis with clinically suspected ring enhancing lesions of brain in a period of January 2024 to December 2024. Inclusion Criteria were all ring enhancing lesions of brain detected on contrast MR studies are taken up and cases of all age groups irrespective of sex. Exclusion Criteria were patients who had history of claustrophobia, patients having history of metallic implants insertion, cardiac pacemakers and metallic foreign body, allergic to gadolinium based contrast agents and patients with poor kidney function (GFR <30 ml/min/1.73m2). The MRI scan was performed on MR Siemens Magnetom Area MRI machine using a standard brain coil. Statistical analysis was performed using percentages and proportions.

Results

Total 50 patients presented with various ring enhancing lesions. Tuberculomas 20 (40%) was the most common pathology followed by NCC 10(20%), Abscesses 5(10%), metastasis 5(10%), primary brain tumour6 (4 %), multiple sclerosis 2(4%),Sub acute hemorrhage 2(4%) and The highest incidence of REL's were found in 25-40 years age group accounting for 30 cases and least was seen in age group of >60 years constituting 2 cases(4 %). 34(68%) were males and 16 (32%) were females. Seizures are the most common presenting complaint in 25 (50%) of cases. 14 (28%) of them presented with a single lesion. Majority 30(60%) of them showed RELs < 2cm. Evaluated spectroscopy was possible only 48 cases and was not performed in 2 cases because of presence of the lesion close to the bone. Choline peak was observed in 10 cases, Lipid in 20 cases, Lactate in 22 cases, reduced NAA peak in 7 cases and amino acids in 3 cases.

Table 1: Characteristics of the Lesions

Characteristics	No of patients
Number of Lesions	
Single	14(28%)
Multiple	36(36%)
Size of lesion	
<2 cm	30(60%)
2-4 cm	12(24%)
>4cm	8(16%)
Pathology of Lesions	
Tuberculosis	20 (40%)
Neurocystcercosis	10(20%)
Abscess	5(10%)
Primary tumour	6(12%)
Multiple sclerosis	2(4%)
Sub-acute hemorrhage	2(4%)
Metabolic peaks in various lesions	
Choline	10(20%)
Lipid	20(40%)
Lactate	22(44%)
Decreased NAA	7(14%)
Amino acids	3(6%)
Symptoms	
seizures	25(50%)
Headache	15(30%)
Weakness	5(10%)
Fever	5(10%)

Figure 1: Tuberculoma: T2, FLAIR hyperintense lesion with hypointense rim with restriction on DWI with lipid and lactate peak on MRS in left occipital lobe

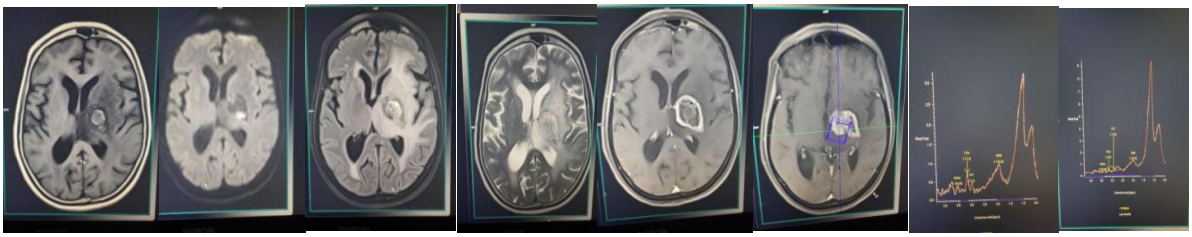

Figure 2: Primary tumour T1, T2 FLAIR Mixed intensity lesion with hypointenserim, moderate adjacent edema, on post contrast thick nodular peripheral enhancement with central necrosis in the left capsuloganmglionic region s/o Primary tumour.

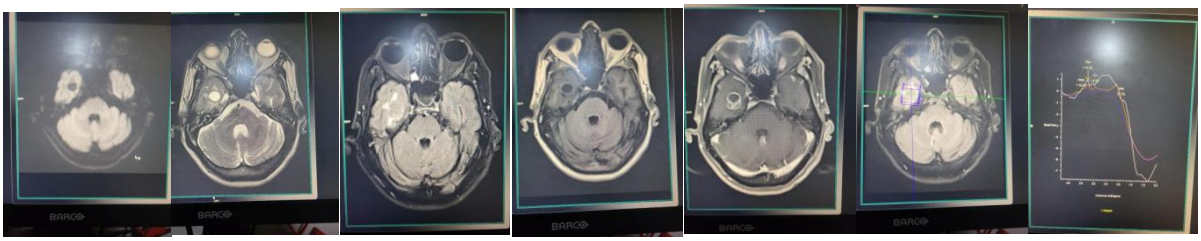

Figure 3: Shows No restriction on DWI with adjacent perilesional edema noted in right temporal lobe region with Cholin peak on MRS S/O Metastasis, in T1 hypointense, T2 FLAIR hyperintense lesion with hypointense rim

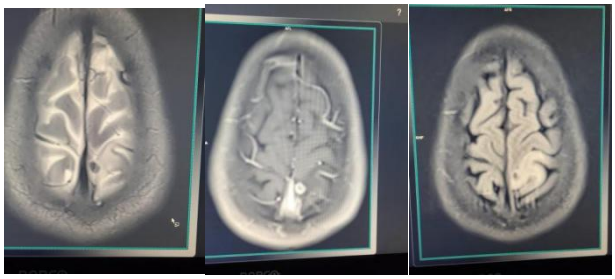

Figure 4: shows Round small T1, T2 hypointense, FLAIR hyper intense lesion, not showing diffusion restriction, on post contrast ring enhancement noted. S/o Neurocysticercosis.

The lesion is accurately demonstrated by magnetic resonance imaging which is a noninvasive, multiplanar and highly accurate method with better inherent contrast. In various ring enhancing lesions, MRI helps in accurately assessing the changes in brain and for accurately diagnosing and introducing treatment immediately. The present study was a prospective study done in the Department of Radiodiagnosis and Imaging, government medical college aimed at studying the MR appearances in various ring enhancing lesions of the brain.

In our study, 50 patients were evaluated whose age group ranged from 2 to 69 years. The highest incidence of REL's were found in 25-40 years age group accounting for 60% of cases and least was seen in age group of >60 years constituting 4%. 34(68%) were males and 16 (32%) were females. Seizures are the most common presenting complaint in 25 (50%) of cases.

Headache15 (30%), fever5 (10%), and 5 motor weakness (10%) were the other presenting complaints. These findings were similar to a study conducted by archana et al [6]. Seizures are 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. Tuberculomas 20(40%) is the most common

pathology followed by NCC 10 (20%), Abscesses 5 (10%), metastasis [5] (10%), primary brain tumour 6(12 %) and multiple secleorosis 2(4%), subacute hemorrhage 2(4%). In a study conducted by Schwartz et al 4 40% cases were gliomas. The most prevalent lesions in this study were tuberculomas (36%) and neurocysticercosis (22%). These findings align with previous studies conducted by Bava JS et al. and Mirchandani S et al. [7,8].

In India, the higher incidence of tuberculomas is because of the higher prevalence of tuberculosis. Fifty patients were evaluated, out of which, single lesion was seen in 14 (28 %) patients. In 36 (72%) of cases, 2-4 lesions were noted. Majority 30 (6 0%) of them showed RELs < 2cm, lesions of sizes between 2-4 cm was seen in 12(24%) and only in 8 (16%) lesions size is greater than 4 cm. Size of the maximum number of lesions which were falling in one category were considered in case of multiple lesions. In present study evaluated spectroscopy was possible in only 48 cases and was not performed in 2 cases because of presence of the lesion close to the bone.

MRS plays a crucial role in identifying various metabolites (such as choline, lipid, lactate, reduced NAA, amino acids, creatine, and succinate) that assist in determining the specific type of ring enhancing brain lesion [7]. Tuberculoma and neurocysticercosis share clinical and neuroimaging similarities, posing a diagnostic challenge for radiologists. To differentiate and characterize these lesions, the key lies in the distinct metabolite peaks they exhibit. Tuberculomas typically display lipid peaks and a choline/creatine ratio greater than 1. [9,10,11,12] The tuberculoma can also be identified on MRI with the help of T2 weighted images whether the stage of the tuberculoma is caseous or non caseous. In identifying the size of the tuberculomas, post contrast images are very helpful because of its excellent spatial resolution and its ability to differentiate the granuloma from its surrounding edema Conversely, neurocysticercosis is characterized by elevated levels of lactate, succinate, and choline, while lipid peaks are either absent or insignificant.12,13 This differentiation based on metabolite patterns aids in resolving the diagnostic enigma associated with distinguishing between tuberculoma and neurocysticercosis. NCC On T1 weighted images, all the lesions were hypo to isointense and hyperintense. Inversion on FLAIR was shown by 5 lesions suggesting that the contents are similar to that of CSF. In all cases suggestive of active lesions, intense ring enhancement with surrounding perilesional edema was seen

In this study, 20 patients diagnosed with tuberculoma exhibited higher levels of lipid peaks, which can be attributed to the presence of lipid fractions in tuberculosis bacillus, as reported in previous studies. [10,14] These tuberculoma patients showed increased lipid/lactate peaks and decreased choline/NAA peaks. On the other hand, patients with neurocysticercosis displayed elevated lactate, succinate, and choline levels, with little to no lipid peaks. Primary brain tumors were associated with high choline peaks, while cerebral abscesses showed lactate and amino acid peaks. Primary brain tumors were associated with high choline peaks, while cerebral abscesses showed lactate and amino acid peaks. An increase in the choline/creatine ratio, rather than the absolute concentration of choline, indicates higher cellular turnover and density associated with tumor cell proliferation. Therefore, the choline/creatine ratio is commonly used to differentiate between low-grade and high-grade tumors. A ratio greater than 2.0 is considered a strong indicator of a high-grade neoplasm. [15,16] Incorporating MRS into standard MRI protocols during initial diagnostic imaging could enhance the accuracy of diagnosis. However, the implementation of MRS has been hindered by the lack of standardized acquisition protocols, analysis techniques, and quality control measures for specific clinical scenarios.

Challenges include processing and presenting information, assessing spectrum quality, and accurately interpreting data. Currently, there is limited research available to support the implementation of MRS as a standard diagnostic tool, highlighting the need for further investigation. [17] In this study, MRS was proved to be valuable in differentiating between neoplastic and infectious brain lesions, particularly in cases of tuberculoma and neurocysticercosis. This accurate diagnosis facilitated appropriate medical management for the patients, allowing for more informed decision-making.

Conclusion

The most sensitive modality which can characterize the intracranial ring enhancing lesions RELs is MRI's. To differentiate between benign and malignant lesions, hypointensity on T2 with partial or complete restriction on DWI images and lipid peak on MRS, pattern of signal intensity on T2 and FLAIR, DWI and MRS is more in favor of Tuberculoma. NCC is suggested by hyperintensity on T2 with no diffusion restriction, presence of scolex on Balanced FFE/ FIESTA. Abscesses show a hypointense rim on T2 with complete diffusion restriction. MRS shows Lactate and Amino Acids. MRI being noninvasive and nonradiating is an ideal imaging modality. Magnetic Resonance Spectroscopy (MRS) has shown promise as a valuable tool for diagnosing ring enhancing brain lesions. It has provided guidance in distinguishing between lesions with similar presentations, such as tuberculoma and neurocysticercosis. However, additional research is needed to establish MRS as a primary diagnostic tool in this context. In the

meantime, MRS sequences can be used as a supplementary tool alongside other conventional techniques. Further studies will contribute to the understanding and utilization of MRS in the accurate diagnosis of these lesions.

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