Section: Radiology

Original Research Article

MRI EVALUATION OF RING-ENHANCING BRAIN LESIONS WITH MR SPECTROSCOPY CORRELATION IN A TERTIARY CARE TEACHING HOSPITAL

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ABSTRACT

Background: Ring-enhancing brain lesions represent a diverse group of infectious, neoplastic, and demyelinating pathologies that pose significant diagnostic challenges. Conventional MRI provides excellent anatomical detail but often lacks specificity in differentiating these lesions. MR spectroscopy (MRS), by evaluating tissue metabolites, offers additional diagnostic insights. **Materials and Methods:** This prospective observational study was conducted on 62 patients presenting with intracranial ring-enhancing lesions at Department of Radiology at Sharda Hospital, School of medical sciences & Research, Sharda University, Greater Noida. All patients underwent detailed MRI protocols including T1, T2, FLAIR, DWI, and contrast-enhanced imaging, followed by MRS to assess metabolite peaks (choline, creatine, N-acetylaspartate, lactate, lipids, and amino acids). Statistical analysis was performed using SPSS v-26, with significance set at $p<0.05$. **Results:** Clinically, seizure with fever was the most common presentation (56.4%). Radiologically, tuberculomas (35.5%) and neurocysticercosis (33.9%) were the predominant etiologies, together accounting for nearly 70% of cases. Metastases (17.7%), abscesses (6.5%), pilocytic astrocytomas (3.2%), and demyelinating disease (3.2%) were less frequent. On MRS, lactate (29%) and lipid (25.8%) peaks were most common, reflecting infective pathology, while elevated choline (16.1%) and reduced NAA (25.8%) were strongly associated with neoplastic lesions. Statistically significant correlations were observed between metabolite patterns and specific etiologies, particularly tuberculomas ($p=0.044$), metastases ($p=0.007$), and pilocytic astrocytomas ($p<0.001$). **Conclusion:** MRI remains the most sensitive modality for characterizing intracranial ring-enhancing lesions, offering precise anatomical localization and lesion extent. MRS, though not diagnostic in isolation, significantly enhances specificity by identifying characteristic metabolic signatures. The combined use of MRI and MRS provides a robust, non-invasive approach for differentiating infective from neoplastic lesions, thereby improving patient management in tertiary care settings.

INTRODUCTION

Ring-enhancing lesions of the brain are considered challenging neuroimaging abnormalities for the radiologists.[1] Imaging modalities like the Computed Tomography (CT) and MRI are commonly used to diagnose such lesions.[2] These lesions are typically located at the junction of grey-white matter in the superficial or deeper areas of the brain parenchyma in the sub-cortical area. Lesions may be confined to a

single location or may be in multiple locations when detected on MRI that are characterised by a non-enhancing centre surrounded by a contrast enhancing halo. The central region may present a low intensity signal on T1 and a high intensity signal on T2 weighted images.[3]

'Ring-enhancing lesion' (REL) is used to represent variety of infective and non-infective processes, displaying a distinct contrast enhancement pattern acquiring shape of ring on cross sectional neuro-imaging.[4] Highest incidence of ring enhancing intra cerebral lesion in the world reported is that of gliomas (40%) followed by metastatic tumors (30%), brain abscesses (8%) and multiple sclerosis (6%), respectively.[5] In Indian series, the incidence of various ring enhancing lesions was tuberculoma accounting for 46.6%, followed by GBM (20%), metastasis (13.3%) and abscesses (10%). Tuberculosis continues to be the leading cause of ring-enhancing lesions in the Indian subcontinent as compared to tumors in the Western world.[6,7] The most common neuroimaging finding in children with partial epilepsy from India is single enhancing lesions (SEL) with perifocal density suggestive of edema.[2] Wadia et al reported that 26.1% of Indian patients with focal seizures had enhancing ring or disc lesions visible in CT scans.[8] Ring enhancing lesions are a common problem seen worldwide and in all age groups. The lesions were first reported by Tandon and Bhargav in 1980 and at that time these CT lesions were presumed to be tuberculomas.[9]

Identifying varying ring enhancing lesions by conventional MRI can be challenging, as the technique cannot distinguish between neoplastic, non-neoplastic lesions and infections.[10] It does not provide any information regarding the tumoral vascularity, metabolism and cellularity.[11,12] 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.[10]

MRS is a non-invasive technique that can provide information regarding tissue chemistry. Its patient–friendly feature can be highlighted as it is devoid of ionising radiations. Information is acquired in the form of a high-quality spectra and not images. Metabolites such as NAA, lactate, phosphocreatine, choline containing compounds and adenosine triphosphates can be measured by MRS. The quantification in MRS is due to the relative spectral peak regions compared to the reference metabolites, which do not vary pointedly with most pathologies. Absolute metabolite concentration can also be measured with a reference to that of unbound water in the tissue, which as an approximation, is assumed not to vary distinctly with the disease.[13] These features enhance the specificity and sensitivity of MRS in comparison to MRI.[14]

MATERIALS AND METHODS

This prospective observational study was conducted on 62 patients presenting to the Department of Radiology at Sharda Hospital, School of medical sciences & Research, Sharda University, Greater Noida over a period of 4 months from October 2025 to January 2026.

Inclusion Criteria: Patients with recurrent seizures, visual impairment, focal neurological deficit, raised intracranial pressure (severe headache, vomiting and papilledema), loss of sensorium and posturing of limbs suggestive of intracranial lesions. All cerebral ring-enhancing lesions were detected on contrast MR studies. All patients incidentally diagnosed to have ring-enhancing lesions by CT. All age groups included irrespective of age or sex.

Exclusion Criteria: Patient having history of claustrophobia. Patient having a history of metallic implants insertion, cardiac pacemakers and metallic or foreign body in situ.

All subjects underwent detailed imaging on MRI scanner, which was equipped with advanced MR Spectroscopy capabilities to ensure high diagnostic accuracy. The imaging protocol included acquiring standard MRI sequences such as T1-weighted, T2-weighted, fluid-attenuated inversion recovery (FLAIR), diffusion-weighted imaging (DWI), and contrast-enhanced T1-weighted imaging. These sequences were meticulously optimized to highlight structural abnormalities, edema, and contrast enhancement patterns, providing a comprehensive assessment of the brain lesions. MR Spectroscopy was subsequently performed to evaluate the metabolic profile of the lesions. Key metabolite ratios, including choline (indicative of cell membrane turnover and malignancy), creatine (a marker of energy metabolism), N-acetylaspartate (NAA, a neuronal marker), and lactate (suggestive of anaerobic metabolism or necrosis), were analyzed. The combination of structural imaging with MR Spectroscopy facilitated a deeper understanding of the underlying pathological processes, aiding in accurate differentiation and diagnosis of various ring-enhancing brain lesions.

By the conclusion of the study, the role of MR Spectroscopy in differentiating various ring-enhancing brain lesions was elucidated. It provided insights into the diagnostic utility and clinical application of MR Spectroscopy in improving management strategies for such cases.

Collected data were entered into Microsoft Excel 2013 and analyzed using SPSS software version 26. Qualitative variables were represented as frequencies and percentages, while quantitative variables were expressed as mean ± standard deviation. Comparisons of continuous variables were performed using an unpaired Student's t-test. Associations between categorical variables were evaluated using Pearson's chi-square test or Fisher's

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exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

This study was conducted in accordance with ethical guidelines and principles governing human research. Informed written consent was obtained from each participant, ensuring that they fully understood the study's purpose, procedures, and potential risks. The confidentiality and privacy of the participants were maintained throughout the study, and all data were anonymized to protect the identities of the subjects.

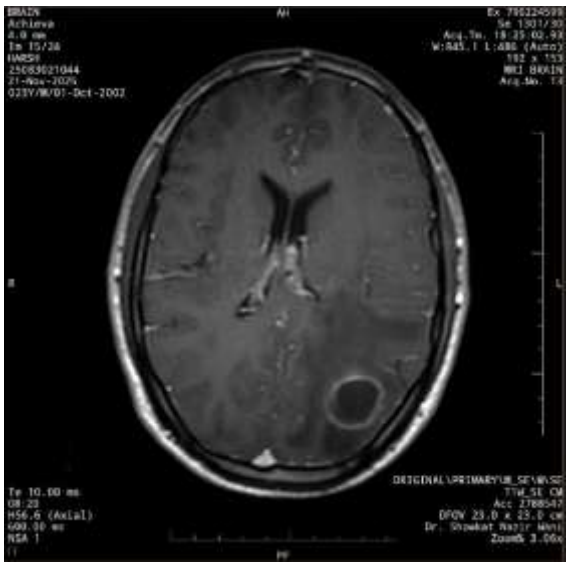

Figure 1: A 23-year-old male patient presented with complaints of fever and seizure for last 3 months. CE-MRI Brain shows Ring enhancing lesion in the parieto-occipital lobe on the left side with surrounding edema. Based on Clinical features and MRI Findings a diagnosis of Tuberculoma was made.

Figure 2: On MRS correlation lipid peak is noted

RESULTS

The majority of patients were ≤20 years (40.3%) with a mean age of 29.18±17.72 years; females slightly outnumbered males (53.2%). [Table 1] Clinically, seizure with fever was the most common presentation (56.4%). [Figure 1] Radiologically, tuberculomas (35.5%) and neurocysticercosis (33.9%) were the predominant etiologies, together accounting for nearly 70% of cases. Metastases (17.7%), abscesses (6.5%), pilocytic astrocytomas (3.2%), and demyelinating disease (3.2%) were less frequent. [Figure 2] On MRS, lactate (29%) and lipid (25.8%) peaks were most common, reflecting infective pathology, while elevated choline (16.1%) and reduced NAA (25.8%) were strongly associated with neoplastic lesions. [Table 3] Statistically significant correlations were observed between metabolite patterns and specific etiologies, particularly tuberculomas (p=0.044), metastases (p=0.007), and pilocytic astrocytomas (p<0.001). [Table 4]

Table 1: Baseline characteristics of the studied cases

Variables		No. of cases (n=62)	Percentage
Age in years	≤20	25	40.3
	21-35	17	27.4
	36-50	10	16.1
	51-65	7	11.3
	>65	4	6.5
Mean age		29.18±17.72	
Gender	Male	29	46.8
	Female	33	53.2
Side of pathology	Unilateral	38	61.3
	Bilateral	21	33.9
	Midline	3	4.8
Number of lesions	Few	29	46.8
	Multiple	15	24.2
	Solitary	18	29.0

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Table 2: Radiological findings after incorporating MRS with MRI

Radiological Findings	No. of cases (n=62)	percentage
Tuberculoma	22	35.5
Neurocysticercosis	21	33.9
Metastasis	11	17.7
Abscess	4	6.5
pilocytic astrocytoma	2	3.2
Demyelinating disease	2	3.2

Table 3: Metabolite Peak MR Spectroscopy

Metabolite Peak	No. of cases (n=62)	percentage
Choline	10	16.1
Lipid	16	25.8
Lactate	18	29.0
Reduced NAA	16	25.8
Amino Acids	2	3.2

Table 4: Metabolites on MR Spectroscopy in various Ring-enhancing lesions of the brain

	Choline (n=10)	Lipid (n=16)	Lactate (n=18)	Reduced NAA (n=16)	Amino Acids (n=2)	p-value
Tuberculoma (n=22)	2	12	10	8	0	**0.044**
Neurocysticercosis (n=21)	1	8	6	4	0	0.198
Metastasis (n=11)	6	2	4	10	0	**0.007**
Abscess (n=4)	1	2	2	1	0	0.960
pilocytic astrocytoma (n=2)	0	1	2	0	2	**<0.001**
Demyelinating disease (n=2)	0	1	1	2	0	0.768

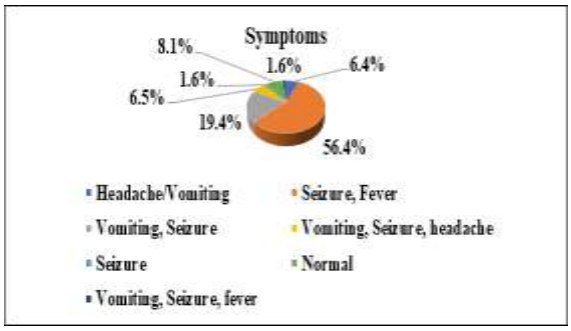

Figure 2: Distribution of the studied cases based on symptoms

DISCUSSION

In the present study, the analysis of 62 cases of ring-enhancing brain lesions shows that the majority of patients were young, with 40.3% aged ≤20 years and a mean age of 29.18±17.72 years, indicating a predominance in the younger population. Females slightly outnumbered males (53.2% vs. 46.8%). Most lesions were unilateral (61.3%), while bilateral involvement was seen in about one-third of cases (33.9%), and midline lesions were relatively rare (4.8%). In terms of lesion number, nearly half of the patients (46.8%) had few lesions, 29% had solitary lesions, and 24.2% presented with multiple lesions. Our findings were comparable to the findings of Yadav VK et al,[15] who studied the role of MRI in ring-enhancing lesions in the brain in correlation with MR spectroscopy and reported that the majority of patients were males. Out of the total 50 patients,31 were males and thus contributes ~ 62%. The male-to-female ratio was 1.63:1. Out of 50 patients evaluated in their study, the maximum number of patients was in the age group of 21- 30 years and 11-20 years, comprising 28% and 22%, respectively. Similarly, Kumar N et al,[16] reported that the mean age was 31.78±21.48 years. Median age was 26 (15-50.75) years. Range was 2-80 years. The total 14.3% of the participants had age 1-10 Years, 25% of the participants had age 11-20 Years, 20.2% of the participants had age 21-30 Years, 8.3% of the participants had age: 31-40 Years, 7.1% of the participants had age: 41-50 Years, 10.7% of participants had age 51-60 years and 14.3% of the participants had age >60 Years. Male: female distribution was almost equal, with a male: female ratio of 1:1.1. Likewise, Rajasree D et al,[17] reported that the age group of 21-30 years was most prevalent. 66.0% were males and 34.0% were females. Also, Archana R et al,[18] reported that the highest incidence of REL's was found in the 21-30 years age group, accounting for 10 cases, and the least was seen in age. group of >60 years, constituting 5%. 28(70%) were males and 12 (30%) were females. According to Rajasree D et al,[17] the ring enhancing lesions were positioned on the right side of the brain for 13 (26%) patients, on the left side for 20 (40%), bilateral for 15 (30%) and midline region of the brain for 2 (4%) of them. About 16 (32%) patients presented a single lesion, 22 (44%) patients had 2-4 and 12 (24%) of them presented >4 lesions in the study.

In the present study, the most common clinical profile was the combination of seizure and fever, accounting for more than half of the cases (56.4%), followed by vomiting with seizure and fever in 19.4%. Less frequent presentations included vomiting with seizure (8.1%), isolated seizure (6.4%), and vomiting with seizure plus headache (6.5%). Headache with vomiting and completely asymptomatic cases were rare, each seen in only 1.6% of patients. Our findings were consistent with the findings of Kumar N et al,[16]

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who reported that Seizure (81; 96.4%) and headache (46; 54.8%) were two most common clinical pictures while fever was present in 43 (51.2%) subjects and vomiting was reported by 24 (28.6%) cases. Similarly, Sachin L et al,[19] reported that seizures was the most common symptom (84.0%) followed by headache (22.0%), vomiting (18.0%), and weakness (6.0%). 42.0% had 2 to 4 lesions, followed by 34.0% had only one lesion, and 24.0% had more than 4 lesions. According to Rajasree D et al,[17] seizures were the most prevalent presentation (33, 66%) followed by headache (19, 38%), vomiting (12, 24%), fever (11, 22%), weakness (5, 10%), and ataxia (2, 4%). Mishra R et al,[20] reported that the most common symptom was headache (65.6%), followed by seizure episodes (40.6%). Other clinical features reported by patients were ataxia, weakness, vomiting and visual disturbance, and fatigue.

In the present study, tuberculomas (35.5%) and neurocysticercosis (33.9%) together accounting for nearly 70% of cases. Neoplastic causes were less frequent, with metastases observed in 17.7% and pilocytic astrocytomas in 3.2%. Abscesses contributed to 6.5% of cases, while demyelinating disease was identified in 3.2%. Our findings were supported by Yadav VK et al,[15] who reported that out of the 50 patients evaluated, 22 cases were tuberculomas, 16 were NCC, 5 abscesses, 5 metastasis, 1 case of pilocytic astrocytoma, and 1 case was of tumefactive demyelination. Similarly, Sachin L et al,[19] reported that tuberculoma was the most common lesion (44.0%) followed by Neurocysticercosis (32.0%), Abscess (10.0%), Metastasis (10.0%), and Tumefactive Demyelination (2.0%). Rajasree D et al,[17] reported that the majority of patients presented with tuberculoma (18, 36%) followed by Neurocysticercosis (22.0%), Metastasis (20.0%), Primary brain tumour (16.0%), Cerebral abscess, Tumefactive demyelination, and Radiation necrosis with 2.0% each. Mishra R et al20 in their study out of 32 patients, 12 (37.5%) patients were diagnosed NCC followed by tuberculoma in 8 (25%) patients. Abscess was found in 3 (9.4%), demyelination and neurotoxoplasmosis each in 1 (3.1%), glioblastoma in 2 (6.3%), and metastasis was found in 5 (15.6%) patients. Archana RR et al,[18] reported that total 40 patients presented with various ring enhancing lesions. Tuberculomas (45%) was the most common pathology followed by NCC (25%), Abscesses (10%), metastasis (10%), primary brain tumour (5%) and toxoplasmosis (5%). Also, Gowda C et al,[21] in their study reported that various ring enhancing lesions (REL's) detected on MRI were tuberculomas (20, 45%) which were the most common followed by, NCC (8, 18%), abscesses (6, 14%), metastases (5, 11%), primary brain tumors (3, 7%) and toxoplasmosis (2, 5%).

In the present study, MR spectroscopy revealed that lactate was the most frequently observed metabolite peak (29%), followed closely by lipid (25.8%) and reduced NAA (25.8%), all of which are strongly associated with infective or necrotic pathology. Choline elevation was seen in 16.1% of cases, typically indicating neoplastic lesions, while amino acid peaks were rare (3.2%), but highly specific for abscesses. Our findings were in concordance with the findings of Gowda C et al,[21] who reported that on MR spectroscopy, Choline peak was observed in 20 (45%) cases, Lipid peak was present in 31 (70%) cases, Lactate peak in 27 (61%) cases reduced NAA peak in 7 (16%) cases and amino acids in 6 (14%) cases. Archana RR et al,[18] reported that Choline peak was observed in 15 cases, Lipid in 18 cases, Lactate in 22 cases, reduced NAA peak in 7 cases and amino acids in 3 cases. In Mishra R et al,[20] study, out of 32 participants, in maximum i.e., 18 (56.3%) patients lactate peak was observed on MRS. Succinate peak was observed in 5 (15.6%) patients, Lipid peak was found in 8 (25%) patients, rNAA peak was found in 7 (21.9%) patients, Acetate peak was observed in 2 (6.3%) patients and Choline peak was found in 7 (21.9%) patients. In study by Sachin L et al,[19] out of 50 patients, spectroscopy was possible in only 46 cases and was not performed in 4 cases because of the presence of the lesion close to the bone. Choline peak was observed in 28 cases, Lipid in 27 cases, Lactate in 25 cases, reduced NAA peak in 17 cases and amino acids in 3 cases.

In the present study, Tuberculomas showed a predominance of lipid (12 cases) and lactate (10 cases), with statistical significance ($p=0.044$), while neurocysticercosis also demonstrated lipid and lactate peaks but without significant association ($p=0.198$). Metastatic lesions were strongly linked to elevated choline and reduced NAA ($p=0.007$), reflecting their neoplastic nature. Abscesses exhibited mixed peaks, including amino acids, but without statistical significance ($p=0.960$). Pilocytic astrocytomas showed unique associations with lactate and amino acid peaks, reaching high significance ($p<0.001$). Demyelinating disease demonstrated reduced NAA and occasional lipid/lactate peaks, though not statistically significant ($p=0.768$). Our findings were similar to the findings of Kumar N et al,[16] who reported that it can be estimated that Lipid-peak was highly seen in 24 cases of tuberculoma and 2 cases of toxolplasmosis. Acetate peak was seen in all 10 cases of brain abscess. Lactate MRS peak was seen in all 10 cases of brain abscess, 2 cases of granuloma, 13 cases of Neurocysticercosis, 2 cases of toxoplasmosis, and all 25 cases of tuberculoma. Choline MRS peak was seen in all 7 neoplastic lesion (glioma and metastases), 2 cases of granuloma, 1 case of Glioblastoma Multiforme, 2 cases of multiple sclerosis, 3 cases of Neurocysticercosis, and 1 case of toxoplasmosis. NAA peak was seen in all 4 cases of metastases, 6 cases of brain abscess, 2 cases of multiple sclerosis, and 2 cases of toxoplasmosis. Special peaks like succinate and alanine peaks were seen in 19 and 8 cases of Neurocysticercosis. Likewise, in the study of metabolite peak of Patil YP et al,[22] all tuberculoma cases showed lipid peak except one case in which lipid peak was not seen. As

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per study conducted by Khan S et al,[23] for Brain abscess, MRS showed lipid and lactate peak in all five cases suggesting anaerobic glycolysis. It also showed special peaks like amino acids, aspartate and acetate in all five patients. In the Kumar N et al,[16] study, lactate & acetate peaks were seen in all,[10] cases of brain abscess. So, in their study results for brain abscess were 100% similar in MRS peak. Sachin L et al,[19] also performed a relevant study & concluded that most common symptom was seizures in 84% of cases. Headache (22%), fever (18%), vomiting (6%), ataxia (8%), and motor weakness (6%) were the other presenting complaints. In the current study most common symptom was seizure (96.4%) followed by headache. Statistically no significant difference was seen.

Strengths

- MRS enables the assessment of key metabolites such as choline, creatine, N-acetyl aspartate (NAA), lactate, and lipids, which aids in distinguishing infectious lesions from tumors.
- Unlike biopsy, MRI with MRS offers a non-invasive approach to lesion characterization, reducing patient risk and discomfort.

Limitations

- Relatively smaller sample size
- MRS requires expertise for accurate interpretation, and metabolite variations can sometimes overlap between different pathologies, leading to potential diagnostic uncertainty.

CONCLUSION

MRI proved to be the most sensitive imaging technique for characterizing intracranial ring-enhancing lesions in this study. Its non-invasive, radiation-free nature and multiplanar capability allowed accurate localization and assessment of lesion extent, thereby guiding clinical management. Characteristic MRI features often suggested the correct diagnosis, while MR spectroscopy added further value by analyzing metabolite patterns such as NAA, creatine, choline, and lactate. Although MRS alone cannot definitively establish a diagnosis, it significantly aids in narrowing the differential by highlighting specific metabolic signatures, making it a complementary tool alongside conventional MRI in evaluating ring-enhancing lesions

REFERENCES

1. Elsadway ME, Ibrahim Ali H. Verification of brain ring enhancing lesions by advanced MR techniques. Alexandria J Med. 2018;54(2):167-71.
2. Garg RK, Sinha MK. Multiple ring-enhancing lesions of the brain. J Postgrad Med. 2010;56(4):307-16.
3. Smirniotopoulos JG, Murphy FM, Rushing EJ, Rees JH, Schroeder JW. Patterns of contrast enhancement in the brain and meninges. Radiographics. 2007;27(2):525-51.
4. Fauci A. (2008). Harrison's Principles of Internal Medicine, New York, McGraw Hill Medical, page 3429.
5. Schwartz KM, Erickson BJ, Lucchinetti C(2006). Pattern of T2 hypointensity associated with ring-enhancing brain lesions can help to differentiate pathology. Neuroradiology; 48:143-9
6. Mahato PS, Dabhi AS, Thorat PB. Clinical and investigative profile of ring-enhancing lesions on neuroimaging. Indian J Clin Pract. 2012;22: 512-8.
7. Garg V, Ramdas GV, Bindra GS, Mittal A, Singal S, Chaudhary RK et al. Evaluation of Intracranial Ring Lesions by Diffusion-Weighted Imaging and in Vivo Proton Magnetic Resonance Spectroscopy. Journal of Medical Science and Clinical Research JMSCR. 2016;4(11):13929-34
8. Sethi PP, Wadia RS, Kiyawat DP, Ichaporia NR, Kothari SS, Sangle SA, Wadhwa P. Ring or disc enhancing lesions in epilepsy in India. J Trop Med Hyg. 1994;97(6):347-53.
9. Tandon PN. CNS tuberculosis: lessons learnt from CT studies. Neurology (India). 1980;28:225-30.
10. Seth S, Mahesh P, Raju A. Role of MRI and MR spectroscopy in the evaluation of ring enhancing lesions in brain. Glob J Res Anal. 2017;6(6):127-29.
11. Burger PC. Malignant astrocytic neoplasms: Classification, pathologic anatomy, and response to treatment. Semin Oncol. 1986;13(1):16-26.
12. Choudary GP, Lakshmi AY, Bodagala VL, Chandra VV, Thota N, Chowhan AK. Perfusion-weighted imaging in differentiating ring-enhancing lesions in brain. J Dr NTR Univ Health Sci. 2019;8(3):162-69
13. Condon B. Magnetic resonance imaging and spectroscopy: How useful is it for prediction and prognosis? EPMA J. 2011;2(4):403-10.
14. Hellstrom J, Romanos ZR, Libard S, Wikstrom J, Ortiz-Nieto F, Alafuzoff I, et al. The value of magnetic resonance spectroscopy as a supplement to MRI of the brain in a clinical setting. PloS ONE. 2018;13(11):e0207336.
15. Yadav VK, Verma H, Saini AK, Randhawa AS. Role of mri in ring enhancing lesions in brain in correlation with mr spectroscopy. Int J Acad Med Pharm 2024; 6 (3); 727-730
16. Kumar N, Jain RK, Kumar G, Ahmad K, Shukla VP, Kumar A. Role of magnetic resonance spectroscopy in the evaluation of ring enhancing lesions of brain. Int J Acad Med Pharm 2023; 5 (3); 2081-2087
17. RajaSree D, Kumar TL, Vijayalakshmi K. Role of Magnetic Resonance Spectroscopy in the Evaluation of Ring Enhancing Lesions of the Brain. J Clin Diagn Res. 2020;14(33):1-6
18. Archana RR, Kumar SP, Kishore A. Role of MRI in evaluation of ring enhancing lesions of brain in correlation with MR spectroscopy. International Journal of Contemporary Medicine Surgery and Radiology. 2018;3(4):D33-D37
19. Sachin L, Jeevika MU, Gurumurthy B and Fahid Rahman CH. Role of mri in evaluation of ring enhancing lesions in brain in correlation with MR spectroscopy. International Journal of Recent Scientific Research 2018;9(5):26840-26845
20. Mishra R, Puri J, Ismail SB, Sharma R. Role of MRI in Characterisation of Intracranial Ring Enhancing Lesions in correlation with MR Spectroscopy. International Journal of Contemporary Medical Research 2022;9(6):F1-F6
21. Gowda CHP, Mutu G, Anuraj. Role of MRI in Evaluation of Ring Enhancing Lesions of Brain in Correlation with MR Spectroscopy. International Journal of Scientific Development and Research. 2024;9(1):517-526
22. Patil YP, Patel CR, Kuber RS, Sekhon RK. Characteristics of Ring enhancing lesions in brain in correlation with MRI and MR spectroscopy. International Journal of Health and Clinical Research, 2021;4(1):120-127
23. Khan S, Banode P, Phatak S, Sabir H, Gupta N, And Lohchab P. Role of magnetic resonance spectroscopy (mrs) in various ring enhancing lesions in brain. International Journal of Scientific Research. 2018;7(11):56-58.

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