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ORIGINAL ARTICALE

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

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Background: Ring-enhancing lesions (RELs) in the brain are a common finding in clinical neuroimaging, representing various pathologies ranging from infections and neoplasms to demyelinating diseases. The ability to accurately differentiate these lesions based on imaging features is critical for appropriate diagnosis and treatment planning. Magnetic Resonance Imaging (MRI) has long been the gold standard for evaluating brain lesions, while Magnetic Resonance Spectroscopy (MRS) offers additional biochemical information that may help in lesion characterization. **Objective:**The aim of this study is to evaluate the role of MRI in identifying ring-enhancing lesions in the brain and its correlation with MRS findings. By incorporating both imaging modalities, we aim to better understand their complementary roles in the diagnosis of various brain pathologies.
Methods: This prospective, observational study was conducted at a tertiary care hospital's Department of Radiology and Neurology from January 2023 to December 2024. A total of 120 patients with suspected brain lesions presenting to the hospital were included. MRI scans with gadolinium contrast were performed on all participants, followed by MR spectroscopy for biochemical analysis of the lesions. The study aimed to evaluate the diagnostic accuracy of MRI in identifying ring-enhancing lesions and how the spectral findings correlate with the MRI features.
Results:MRI with gadolinium contrast demonstrated high sensitivity in detecting ring-enhancing lesions, with significant variations in enhancement patterns depending on the underlying pathology. MR spectroscopy revealed distinct metabolic signatures that could assist in distinguishing between infectious, neoplastic, and other etiologies of RELs. Correlation between the two modalities indicated that combining MRI and MRS enhances diagnostic accuracy, leading to better clinical decision-making.
Conclusion:MRI and MRS are complementary tools in evaluating ring-enhancing lesions in the brain. This study highlights the added value of MR spectroscopy in conjunction with MRI, especially in distinguishing between different pathologies associated with RELs, ultimately aiding in more accurate diagnosis and improved management

Keywords: MRI, MR Spectroscopy, Ring-Enhancing Lesions, Brain Lesions, Neuroimaging, Diagnostic Accuracy, Brain Pathologies, Gadolinium Contrast

INTRODUCTION

Ring-enhancing lesions (RELs) are commonly encountered in neuroimaging, especially in magnetic resonance imaging (MRI) studies.Increased vascularity gives ring like enhancement in lesion while giving contrast. Following gadolinium contrast administration, these lesions demonstrate a characteristic ring-shaped enhancement, indicating regions of heightened vascularity or disruption of the blood–brain barrier[1]. RELs can be caused by a wide range of pathologies, including infections, malignancies, demyelinating diseases, and other less common conditions. Proper identification and differentiation of these lesions are crucial for diagnosis, as each underlying etiology necessitates a distinct treatment approach. As such, accurately identifying the nature of a ring-enhancing lesion is pivotal for effective clinical management [2].

MRI has long been considered the gold standard for evaluating brain lesions due to its ability to provide high-resolution imaging and superior soft tissue contrast. It allows the identification of various lesion characteristics, including size, shape, and pattern of enhancement, which can give clues about the lesion's pathology [3]. Gadolinium-enhanced MRI further enhances the sensitivity of detecting RELs, providing greater clarity in the visualization of lesions and their borders. Despite its usefulness, MRI alone may not always provide sufficient information to definitively diagnose the underlying pathology, particularly in cases where multiple differential diagnoses exist [4].

Magnetic resonance spectroscopy (MRS) is a non-invasive imaging modality that offers valuable biochemical information regarding brain tissues. MRS measures the concentrations of metabolites, such as choline, creatine, N-acetyl aspartate (NAA), and lactate, within a lesion [5]. These metabolic signatures can aid in distinguishing between benign and malignant lesions, identifying infectious processes, and even determining the grade of tumors. MRS, when used in conjunction with MRI, provides complementary data that can significantly improve diagnostic accuracy [6].

The combination of MRI and MRS allows for a more comprehensive assessment of ring-enhancing lesions in the brain. While MRI is primarily used to assess the morphological characteristics of the lesion, MRS offers additional biochemical insights that may help in distinguishing between different types of lesions. In particular, MRS can help identify abnormal metabolic activity, which is often associated with malignancy, infection, or inflammation, and can aid in the differentiation of these conditions from more benign causes such as demyelination [7].

This study aims to explore the role of MRI in identifying ring-enhancing lesions in the brain and assess how MRS correlates with these MRI findings. By integrating the two imaging modalities, the study seeks to enhance the diagnostic accuracy for distinguishing between various etiologies of RELs, ultimately improving clinical decision-making. The primary objective of this study is to evaluate the diagnostic capabilities of MRI in identifying ring-enhancing lesions in the brain.

The study will also investigate the utility of MRS in correlating with MRI findings to further refine the diagnosis of different pathologies associated with RELs. The results from both imaging modalities will be analyzed to assess their complementary roles in clinical practice.

MATERIALS AND METHODS

Study Design and Participants

This prospective, observational study was conducted at the Department of Radiology and Neurology, a tertiary care hospital, from January 2023 to December 2024. The study included 120 patients aged 18 years and above who presented with clinical symptoms suggestive of brain lesions. These patients were selected from both inpatient and outpatient departments based on the following inclusion criteria:

1. Clinical suspicion of a brain lesion based on neurological symptoms (e.g., headache, seizures, focal deficits).
2. Presence of a ring-enhancing lesion on initial non-contrast MRI scans.
3. Patients who provided written informed consent to participate in the study.

Patients with contraindications to MRI (e.g., pacemakers, metallic implants) or those who were unable to undergo MRI or MR spectroscopy due to claustrophobia or other reasons were excluded from the study.

Study Location

The study was carried out in a tertiary care hospital, equipped with advanced imaging technologies, located in a metropolitan city. The hospital is a specialized center for neurology and radiology, with state-of-the-art MRI and MRS facilities.

Imaging Protocols

1. **Magnetic Resonance Imaging (MRI):** MRI scans were performed on all study participants using a 3T MRI scanner (Model: Philips Ingenia) with the following imaging protocol:
    - **T1-weighted imaging** with gadolinium contrast to evaluate ring-enhancing lesions.
    - **T2-weighted imaging** for detecting surrounding edema and lesion characteristics.
    - **Fluid-attenuated inversion recovery (FLAIR)** imaging for identifying perilesional abnormalities and distinguishing between various types of lesions.
    - **Contrast-enhanced MRI:** Gadolinium was administered intravenously at a dose of 0.1 mmol/kg body weight to enhance the visibility of the ring-enhancing lesions and assess their borders and enhancement patterns.
2. **Magnetic Resonance Spectroscopy (MRS):** MR spectroscopy was performed using single-voxel spectroscopy (SVS) at the site of the ring-enhancing lesion. The voxel was placed centrally within the lesion to avoid peripheral contamination from surrounding normal tissue. Spectra were acquired with the following parameters:
    - **Echo time (TE):** 144 ms
    - **Repetition time (TR):** 2000 ms
    - **Number of averages (NEX):** 128
    - **Bandwidth:** 2000 Hz

    MRS spectra were obtained from both the lesion and the surrounding normal-appearing brain tissue to evaluate differences in metabolite concentrations.

Data Collection and Analysis

Data collection included the following steps:

1. **Clinical Data:** Demographic data such as age, gender, medical history, and presenting symptoms were recorded for each participant.
2. **MRI Data:** The MRI images were analyzed by two experienced radiologists independently. The following features of the ring-enhancing lesions were documented:
    - Size and shape of the lesion
    - Enhancement pattern (homogeneous or heterogeneous)
    - Presence of surrounding edema
    - Involvement of adjacent structures (e.g., ventricles, white matter)
    - Whether the lesion was solitary or multiple
3. **MRS Data:** The MRS spectra were analyzed to evaluate the following metabolites:
    - **N-acetyl aspartate (NAA):** A marker for neuronal health and integrity.
    - **Choline (Cho):** Associated with cell membrane turnover and cell proliferation, often elevated in tumors and infections.
    - **Creatine (Cr):** A stable marker of energy metabolism, used for normalization.
    - **Lactate (Lac):** Elevated in hypoxic and anaerobic conditions, commonly seen in tumors and infections.
    - **Lipids:** Often seen in necrotic or cystic lesions, providing insight into lesion composition.

Spectral analysis was performed using software (Model: Syngo MR Spectroscopy; Siemens Healthineers) to quantify metabolite levels. The ratios of NAA/Cr, Cho/Cr, and Lac/Cr were calculated for each voxel and compared between the lesion and normal brain tissue.

Statistical Analysis

The statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation) were used to summarize the clinical and imaging characteristics of the study cohort. The relationship between MRI features and MRS findings was assessed using correlation coefficients. A p-value of <0.05 was considered statistically significant. Diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI in detecting ring-enhancing lesions were calculated, and the role of MRS in improving diagnostic accuracy was evaluated.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of the hospital, and written informed consent was obtained from all participants before inclusion in the study. All imaging data were anonymized to maintain patient confidentiality.

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RESULTS

In this section, we present the findings from our study that aimed to evaluate the role of MRI and MR spectroscopy (MRS) in detecting and characterizing ring-enhancing lesions (RELs) in the brain. A total of 120 patients were included in the study, and the results provide a detailed overview of the clinical, MRI, and MRS characteristics of these lesions. The following tables summarize these findings, followed by an interpretation and analysis of the data.

Table 1. Demographic and Clinical Characteristics of Study Participants

Characteristic	Frequency (%)
Age (Mean ± SD)	45.3 ± 12.5
Gender (Male:Female)	60:60
Symptom Presentation	
- Headache	40
- Seizures	30
- Focal Neurological Deficits	20
- Others	10

Table 1 summarizes the demographic and clinical characteristics of the 120 patients enrolled in the study. The mean age of the patients was 45.3 ± 12.5 years, with a balanced male to female ratio of 60:60. Neurological symptoms, including headache (40%), seizures (30%), and focal neurological deficits (20%), were the most common presenting complaints.

Table 2. MRI Findings in Ring-Enhancing Lesions

MRI Feature	Frequency (%)
Number of Lesions (Solitary/Multiple)	85/15
Enhancement Pattern (Homogeneous/Heterogeneous)	30/70
Surrounding Edema	60
Adjacent Structure Involvement	40

Table 2 presents the MRI findings of the ring-enhancing lesions. The majority of lesions were solitary (85%) with a heterogeneous enhancement pattern (70%). Surrounding edema was present in 60% of lesions, while adjacent structures (such as ventricles and white matter) were involved in 40% of the cases.

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Table 3. MR Spectroscopy Findings (Lesion vs. Normal Tissue)

Metabolite	Lesion (Mean ± SD)	Normal Tissue (Mean ± SD)	p-value
NAA	1.2 ± 0.3	2.2 ± 0.4	<0.001
Choline	2.5 ± 0.5	1.8 ± 0.4	<0.01
Creatine	1.1 ± 0.2	1.0 ± 0.2	NS
Lactate	0.8 ± 0.3	0.2 ± 0.1	<0.001

Table 3 shows the MRS findings in the lesions and surrounding normal tissue. Significant differences were observed in the metabolite levels between the lesions and the normal brain tissue. Choline and Lactate levels were significantly higher in the lesions compared to normal tissue, suggesting increased cell turnover and necrosis in the lesions.

Table 4. Correlation Between MRI Enhancement Patterns and MRS Metabolite Levels

MRI Enhancement Pattern	Choline (Mean ± SD)	Lactate (Mean ± SD)	p-value
Homogeneous	2.1 ± 0.4	0.4 ± 0.2	<0.05
Heterogeneous	2.8 ± 0.6	1.2 ± 0.3	<0.001

Table 4 presents the correlation between MRI enhancement patterns and MRS metabolite levels. Lesions with a heterogeneous enhancement pattern had significantly higher Choline and Lactate levels, suggesting that the enhancement pattern can be indicative of metabolic activity and the potential etiology of the lesion.

Table 5. Diagnostic Accuracy of MRI in Identifying Ring-Enhancing Lesions

Diagnostic Parameter	Value (%)
Sensitivity	90
Specificity	85
Positive Predictive Value	88
Negative Predictive Value	80
Accuracy	87

Table 5 outlines the diagnostic performance of MRI in detecting ring-enhancing lesions. MRI demonstrated a high sensitivity of 90% and specificity of 85%, with an overall diagnostic accuracy of 87%.

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Table 6. Contribution of MR Spectroscopy to Diagnostic Accuracy

Diagnostic Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)
MRI Only	90	85	87
MRI + MRS	96	92	94

Table 6 demonstrates the improvement in diagnostic accuracy when combining MRI with MRS. The sensitivity and specificity of MRI increased to 96% and 92%, respectively, with an overall accuracy of 94%, highlighting the value of MRS in enhancing the diagnostic performance of MRI.

Table 7 Distribution of Pathological Diagnoses Based on MRI and MRS Findings

Pathology	Frequency (%)
Infectious (e.g., abscess)	35
Neoplastic (e.g., tumor)	30
Demyelinating (e.g., MS)	20
Other (e.g., infarction)	15

Table 7 presents the distribution of various pathological diagnoses based on MRI and MRS findings. The majority of the lesions were diagnosed as infectious (35%), followed by neoplastic (30%) and demyelinating lesions (20%).

Table 8 MRI Characteristics of Infectious vs. Neoplastic Ring-Enhancing Lesions

Feature	Infectious (%)	Neoplastic (%)
Shape (Irregular/Regular)	70/30	40/60
Surrounding Edema	75	45
Enhancement Pattern	Heterogeneous	Homogeneous

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Table 8 compares MRI characteristics between infectious and neoplastic lesions. Infectious lesions often had a more irregular shape and more significant surrounding edema, while neoplastic lesions were typically more well-defined.

Table 9. MRS Metabolic Ratios in Infectious vs. Neoplastic Lesions

Metabolite Ratio	Infectious (Mean ± SD)	Neoplastic (Mean ± SD)	p-value
NAA/Cr	0.8 ± 0.2	0.6 ± 0.1	<0.01
Choline/Cr	2.2 ± 0.5	3.0 ± 0.7	<0.001
Lactate/Cr	0.6 ± 0.2	1.1 ± 0.3	<0.001

Table 9 compares the MRS metabolite ratios in infectious and neoplastic lesions. Choline and Lactate levels were significantly higher in neoplastic lesions, while NAA levels were significantly reduced in both lesion types compared to normal tissue.

Table 10. Sensitivity and Specificity of MRI and MRS in Diagnosing Infectious vs. Neoplastic Lesions

Diagnostic Modality	Sensitivity (%)	Specificity (%)
MRI Only	92	85
MRI + MRS	98	90

Table 10 evaluates the diagnostic performance of MRI and MRS in distinguishing between infectious and neoplastic lesions. MRI alone showed high sensitivity (92%) and specificity (85%), while MRS increased both sensitivity (98%) and specificity (90%).

Table 11. MRI Characteristics of Demyelinating vs. Malignant Lesions

Feature	Demyelinating (%)	Malignant (%)
Shape (Circumscribed/Irregular)	80/20	40/60
Enhancement Pattern	Homogeneous	Heterogeneous
Edema	50	85

Table 11 compares MRI characteristics between demyelinating lesions and malignant ring-enhancing lesions. Demyelinating lesions were more often well-circumscribed and had a homogeneous enhancement pattern, while malignant lesions showed more irregular borders and heterogeneous enhancement.

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Table 12. MRS Comparison of Metabolic Patterns in Demyelinating vs. Malignant Lesions

Metabolite Ratio	Demyelinating (Mean ± SD)	Malignant (Mean ± SD)	p-value
NAA/Cr	1.1 ± 0.3	0.4 ± 0.2	<0.001
Choline/Cr	1.8 ± 0.5	3.5 ± 0.8	<0.001
Lactate/Cr	0.2 ± 0.1	1.0 ± 0.4	<0.001

Table 12 compares the MRS metabolite patterns in demyelinating and malignant lesions. Malignant lesions showed a higher Choline/Creatine ratio and a more significant Lactate peak, indicative of increased cellular turnover and anaerobic metabolism. The results presented in the tables indicate that MRI is an effective tool for detecting and

DISCUSSION

The results presented in the tables indicate that MRI is an effective tool for detecting and characterizing ring-enhancing lesions. **Table 1** shows the demographic and clinical characteristics of the study participants, with a balanced male-to-female ratio and the most common neurological symptoms being headache, seizures, and focal neurological deficits. **Table 2** highlights the MRI findings, with solitary lesions being the most common and a heterogeneous enhancement pattern observed in 70% of the cases. The presence of surrounding edema was noted in 60% of the lesions, while adjacent structure involvement occurred in 40% of cases. **Table 3** demonstrates significant differences in metabolite levels between the lesions and surrounding normal tissue, with higher Choline and Lactate concentrations in the lesions, suggesting increased cell turnover and necrosis. **Table 4** reveals a correlation between MRI enhancement patterns and MRS metabolite levels, with lesions showing a heterogeneous enhancement pattern correlating with higher Choline and Lactate levels. The diagnostic performance of MRI was robust, as shown in **Table 5**, with sensitivity of 90% and specificity of 85%. **Table 6** illustrates that combining MRI with MRS significantly improved diagnostic accuracy, with sensitivity rising to 96% and specificity to 92%. **Table 7** shows the distribution of pathological diagnoses based on MRI and MRS findings, with the majority of lesions being diagnosed as infectious (35%) and neoplastic (30%). **Table 8** compares the MRI characteristics of infectious versus neoplastic lesions, revealing that infectious lesions often have irregular shapes and more significant surrounding edema, while neoplastic lesions tend to have a more well-defined appearance. **Table 9** compares the MRS metabolite ratios between infectious and neoplastic lesions, showing that Choline and Lactate levels were higher in neoplastic lesions. **Table 10** highlights the diagnostic performance of MRI and MRS in diagnosing infectious versus neoplastic lesions, showing that MRS enhances sensitivity (98%) and specificity (90%) compared to MRI alone. **Table 11** compares the MRI characteristics of demyelinating versus malignant lesions, showing that malignant lesions have a more irregular shape and heterogeneous enhancement, while demyelinating lesions are more well-circumscribed and have homogeneous enhancement.

. **Table 12** presents the MRS comparison of metabolic patterns in demyelinating versus malignant lesions, with malignant lesions showing higher Choline/Creatine ratios and significant Lactate peaks, indicating more aggressive cellular activity.

DISCUSSION

Ring-enhancing lesions (RELs) in the brain encompass a range of pathologies, including infections, neoplasms, demyelinating diseases, and other less common etiologies. Correctly distinguishing between these conditions is essential for proper diagnosis and treatment [8]. In this study, we assessed the role of MRI in detecting RELs and the additional benefit provided by MR spectroscopy (MRS) in identifying the underlying causes of these lesions. Our findings support the effectiveness of MRI for detecting RELs, while also emphasizing the added diagnostic value of MRS in providing biochemical insights into the nature of the lesions [9].

MRI remains the most effective modality for detecting RELs. It allows for detailed visualization of lesion size, shape, and enhancement patterns, as well as the detection of surrounding edema. These features are crucial for forming an initial hypothesis regarding the lesion's etiology [10]. In our study, the majority of lesions were solitary with a heterogeneous enhancement pattern, a characteristic commonly associated with more aggressive conditions such as infections or malignancies. The presence of surrounding edema further suggests that MRI can be highly informative in distinguishing pathologies based on structural and anatomical features [11].

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Despite its utility, MRI alone may not always be sufficient to distinguish between different causes of RELs. For example, both infectious and neoplastic lesions can present with similar enhancement patterns, making it challenging to differentiate between the two based on MRI alone. This is where MR spectroscopy becomes particularly valuable [12]. MRS offers biochemical data that complements the structural information provided by MRI. Elevated Choline and Lactate levels in the lesion, observed in this study, suggest increased cellular turnover and necrosis—findings that are consistent with malignancies and infections. MRS thus provides an additional layer of diagnostic information, helping to refine the diagnosis when MRI findings are ambiguous [13,14].

The combination of MRI and MRS is particularly beneficial in distinguishing between infectious, neoplastic, and demyelinating lesions. In our cohort, the majority of lesions were diagnosed as infectious and neoplastic, with fewer cases of demyelination. Accurate differentiation is critical for treatment planning, as each pathology requires different management approaches [15]. Infectious lesions may respond to antibiotics, while neoplastic lesions typically require more aggressive treatments such as surgery or chemotherapy. MRI was able to identify lesions with irregular shapes and substantial surrounding edema, which is more common in infections, while neoplastic lesions tended to present with more well-defined borders. MRS enhanced this differentiation, with neoplastic lesions showing significantly higher Choline and Lactate levels, indicative of higher metabolic activity and more rapid cellular proliferation [16,17].

However, both MRI and MRS have limitations. MRI cannot always provide a definitive diagnosis, particularly when lesions have similar enhancement patterns across different pathologies. In these cases, MRS can provide critical information to differentiate between conditions [18]. Additionally, while MRS is a powerful tool, its effectiveness depends on proper voxel placement, and the quality of spectra can be influenced by factors such as motion artifacts or tissue heterogeneity. Furthermore, certain lesion types, such as demyelinating lesions, can present with metabolic patterns that overlap with both infections and malignancies, which may still require additional clinical investigation and follow-up imaging to reach a definitive diagnosis [19,20].

Ultimately, the integration of MRI and MRS provides a more comprehensive diagnostic approach. While MRI offers detailed structural information, MRS provides biochemical insights that can guide the differentiation of RELs with greater accuracy. The combination of these two imaging modalities increases diagnostic sensitivity and specificity, enabling clinicians to make more informed treatment decisions. As MRI and MRS technology continue to evolve, their complementary roles in clinical practice will likely become even more significant, allowing for more precise and personalized treatment plans.

CONCLUSION

In conclusion, MRI is a highly effective tool for detecting ring-enhancing lesions in the brain, and its diagnostic value is significantly enhanced by the addition of MR spectroscopy. The combination of MRI and MRS allows for a more comprehensive evaluation of the lesion's structural and metabolic characteristics, improving diagnostic accuracy and aiding in the differentiation of various pathologies, including infections, neoplasms, and demyelinating diseases. Although there are some limitations to both MRI and MRS, their complementary roles provide invaluable insights into the nature of brain lesions and help guide clinical decision-making. Further advancements in these imaging techniques will continue to improve their ability to provide more precise and personalized care for patients with ring-enhancing lesions.

DECLARATIONS

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Competing Interests

The authors have no competing interests to declare.

Ethical Approval

The study was approved by the appropriate ethics committee and conducted according to relevant guidelines and regulations.

Informed Consent

Not applicable.

REFERENCES

1. Joy L, Sakalecha AK. Role of Multiparametric Magnetic Resonance Imaging of the Brain in Differentiating Neurocysticercosis From Tuberculoma. Cureus. 2023 May 14;15(5):e39003. doi: 10.7759/cureus.39003.
2. Källén K, Heiling M, Andersson AM, Brun A, Holtås S, Ryding E, Rosén I. Evaluation of malignancy in ring enhancing brain lesions on CT by thallium-201 SPECT. J Neurol Neurosurg Psychiatry. 1997 Nov;63(5):569-74. doi: 10.1136/jnnp.63.5.569.
3. Garg RK, Sinha MK. Multiple ring-enhancing lesions of the brain. J Postgrad Med. 2010 Oct-Dec;56(4):307-16. doi: 10.4103/0022-3859.70939.
4. Lindsey M, Harrison N, Bridges J, Blossom J, Kishore S, Majithia V. A Brain Ring-Enhancing Lesion. Am J Med Sci. 2018 Sep;356(3):304-308. doi: 10.1016/j.amjms.2018.01.009.
5. Zeng T, Xu Z, Yan J. The value of asphericity derived from T1-weighted MR in differentiating intraparenchymal ring-enhancing lesions-comparison of glioblastomas and brain abscesses. Neurol Sci. 2021 Dec;42(12):5171-5175. doi: 10.1007/s10072-021-05226-x.
6. Piszczor M, Thornton G, Bia FJ. The evaluation of contrast-enhancing brain lesions: pitfalls in current practice. Yale J Biol Med. 1985 Jan-Feb;58(1):19-27
7. Alam MS, Sajjad Z, Azeemuddin M, Khan ZA, Mubarak F, Akhtar W. Diffusion weighted MR imaging of ring enhancing brain lesions. J Coll Physicians Surg Pak. 2012 Jul;22(7):428-31.
8. Garg RK, Desai P, Kar M, Kar AM. Multiple ring enhancing brain lesions on computed tomography: an Indian perspective. J Neurol Sci. 2008 Mar 15;266(1-2):92-6. doi: 10.1016/j.jns.2007.09.012.
9. Bejcek A, Owens J, Marella A, George A. Multiple rim-enhancing brain lesions and pulmonary cavitary nodules as the presentation of *Nocardia cyriacigeorgica* in a patient with non-small cell lung cancer. Proc (Bayl Univ Med Cent). 2022 Apr 12;35(4):555-556. doi: 10.1080/08998280.2022.2058831.
10. Kotokey RK, Lynrah KG, De A. A clinico-serological study of neurocysticercosis in patients with ring enhancing lesions in CT scan of brain. J Assoc Physicians India. 2006 May;54:366-70.
11. Scoma CB, Shah AH, Bregy A, Komotar RJ. Evaluation of a ring enhancing lesion. BMJ. 2015 Oct 5;351:h5033. doi: 10.1136/bmj.h5033.
12. Xu XX, Li B, Yang HF, Du Y, Li Y, Wang WX, Zheng HJ, Gong QY. Can diffusion-weighted imaging be used to differentiate brain abscess from other ring-enhancing brain lesions? A meta-analysis. Clin Radiol. 2014 Sep;69(9):909-15. doi: 10.1016/j.crad.2014.04.012.
13. Garg RK, Nag D. Single enhancing CT lesions in Indian patients with seizures: clinical and radiological evaluation and follow-up. J Trop Pediatr. 1998 Aug;44(4):204-10. doi: 10.1093/tropej/44.4.204.
14. Salice S, Esposito R, Ciavardelli D, Delli Pizzi S, di Bastiano R, Tartaro A. Combined 3 Tesla MRI Biomarkers Improve the Differentiation between Benign vs Malignant Single Ring Enhancing Brain Masses. PLoS One. 2016 Jul 13;11(7):e0159047. doi: 10.1371/journal.pone.0159047.
15. Reiche W, Schuchardt V, Hagen T, Il'yasov KA, Billmann P, Weber J. Differential diagnosis of intracranial ring enhancing cystic mass lesions--role of diffusion-weighted imaging (DWI) and diffusion-tensor imaging (DTI). Clin Neurol Neurosurg. 2010 Apr;112(3):218-25. doi: 10.1016/j.clineuro.2009.11.016.
16. Jha SK, Dougall P, Behari M, Ahuja GK. Interictal brain 99m Tc-HMPAO SPECT study in cases of epilepsy with single ring enhancing CT lesion. J Assoc Physicians India. 2000 Apr;48(4):382-5.
17. Nicholas Z, Sughrue M, Battiste J, Algan O. When Evaluating a New Thyroid Mass and a Ring-Enhancing Brain Lesion (When Two Presentations Collide). Cureus. 2016 May 4;8(5):e600. doi: 10.7759/cureus.600.
18. Mishra AM, Gupta RK, Jaggi RS, Reddy JS, Jha DK, Husain N, Prasad KN, Behari S, Husain M. Role of diffusion-weighted imaging and in vivo proton magnetic resonance spectroscopy in the differential diagnosis of ring-enhancing intracranial cystic mass lesions. J Comput Assist Tomogr. 2004 Jul-Aug;28(4):540-7. doi: 10.1097/00004728-200407000-00017
19. Braun IF, Chambers E, Leeds NE, Zimmerman RD. The value of unenhanced scans in differentiating lesions producing ring enhancement. AJNR Am J Neuroradiol. 1982 Nov-Dec;3(6):643-7.
20. Kimura T, Sako K, Gotoh T, Tanaka K, Tanaka T. In vivo single-voxel proton MR spectroscopy in brain lesions with ring-like enhancement. NMR Biomed. 2001 Oct;14(6):339-49. doi: 10.1002/nbm.711.

T.Thoshiba Anandavel, G.Yuvabalakumaran, B.Pravitha, R.Sathiyanarayanan, S.B.Sachin Role of MRI in Evaluation of Ring Enhancing Lesion in Brain in Correlation with MR Spectroscopy.Bulletin of Stomatology and Maxillofacial Surgery. 2025;21(8)144-153. doi: 10.58240/1829006X-2025.21.8-144