Study of Role of Magnetic Resonance Spectroscopy in Evaluation of Intracranial Space Occupying Lesions

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Abstract: *Background: Intracranial space occupying lesions (ICSOLs) include a wide spectrum of neoplastic and non-neoplastic pathologies. Conventional MRI provides excellent anatomical characterization; however, overlapping imaging features may limit definitive diagnosis. Magnetic Resonance Spectroscopy (MRS) provides metabolic information which improves lesion characterization. Aim: To evaluate the role of Magnetic Resonance Spectroscopy in characterization of intracranial space occupying lesions. Materials and Methods: This observational cross-sectional study included 52 patients evaluated using 1.5 Tesla MRI with MRS. Conventional MRI sequences were followed by spectroscopy. Diagnostic accuracy of MRI alone and MRI combined with MRS was compared using histopathology and follow-up data. Results: MRI alone showed diagnostic accuracy of 86.5%, whereas combined MRI + MRS showed diagnostic accuracy of 96.2%. Conclusion: MRS significantly improves diagnostic confidence and helps reduce misclassification of lesions, potentially reducing the need for invasive procedures.*

Keywords: Intracranial space occupying lesion, Magnetic Resonance Imaging, Magnetic Resonance Spectroscopy, Brain tumors, metabolite markers.

1. Introduction

Intracranial space occupying lesions refer to abnormal masses causing displacement or compression of adjacent brain structures. These lesions include:
- Neoplastic lesions (primary tumors, metastasis)
- Non-neoplastic lesions (infections, cysts, vascular malformations)
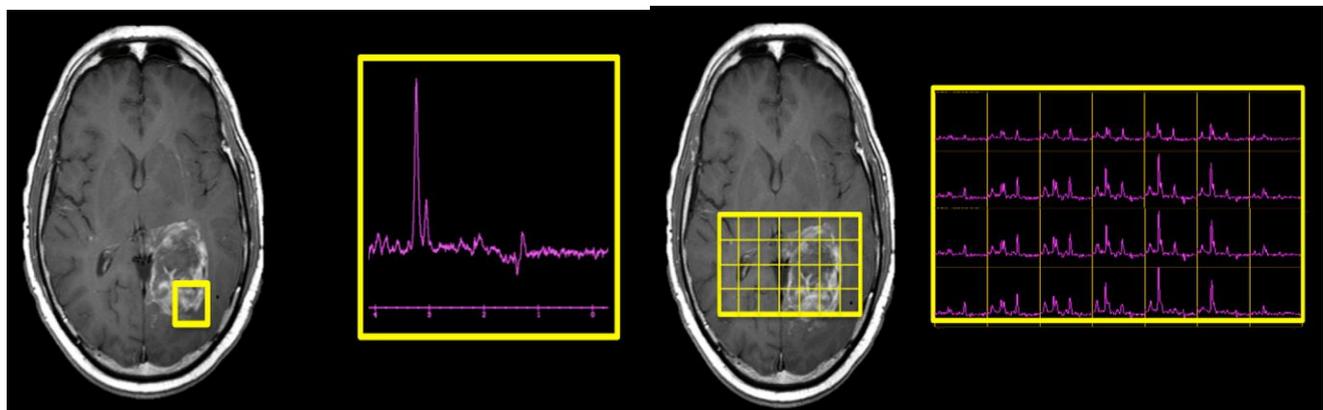
MRI is the primary imaging modality for evaluating ICSOLs due to superior soft tissue resolution and anatomical detail. However, conventional MRI may not always differentiate between lesions with similar imaging characteristics.

Magnetic Resonance Spectroscopy is a non-invasive imaging technique that evaluates biochemical composition of tissues. It helps differentiate:
- High grade glioma vs low grade glioma
- Tumor vs abscess
- Lymphoma vs glioma

Principle of MRS
- ROI voxel placement within lesion
- Short TE (~35 ms): Detects broad metabolite range
- Long TE (135–270 ms): Highlights major metabolites (Cho, NAA, Lactate)
- Metabolites measured in ppm spectrum

Volume 15 Issue 2, February 2026
Fully Refereed | Open Access | Double Blind Peer Reviewed Journal
www.ijsr.net

Paper ID: SR26209183833   DOI: https://dx.doi.org/10.21275/SR26209183833   600

2. Aim and Objectives

Aim
To study the role of Magnetic Resonance Spectroscopy in characterizing intracranial space occupying lesions.

Objectives
- To study imaging findings of ICSOLs using MRI and MRS
- To establish differential diagnosis based on imaging
- To differentiate lesion types using MRS
- To compare diagnostic accuracy of MRI vs MRI + MRS

3. Materials and Methods

Study Design: Observational cross-sectional study

Study Period: November 2023 – February 2025 (16 months)

Study Location: Department of Radiodiagnosis, MIMS

Sample Size: 52 patients

Equipment: 1.5 Tesla Philips Ingenia MRI

MRI Protocol
Sequences used:
- T1
- T2
- FLAIR
- DWI
- ADC
- GRE
- Post contrast T1 FS
- MRS

Inclusion Criteria
- All age groups
- Patients with clinical or imaging features of ICSOL
- Incidentally detected ICSOL

Exclusion Criteria
- MRI contraindications (pacemaker, aneurysm clip, metallic implants)
- Severe claustrophobia
- No tissue diagnosis or lost follow-up
- Hemorrhagic stroke or trauma cases
- Patients refusing MRI or study participation

4. Observations and Results

Table 1: Age Distribution of Patients (n = 52)

Age Group (Years)	Number of Patients	Percentage
0 – 10	1	1.9%
11 – 20		
21 – 30		
31 – 40		
41 – 50		
51 – 60	12	23.1%
> 60	12	23.1%
Total	52	100%

Table 2: Gender Distribution

Gender	Number	Percentage
Male	27	51.9%
Female	25	48.1%
Total	52	100%

Table 3: Clinical Presentation Distribution

Clinical Feature	Number	Percentage
Headache		Most Common
Focal Neurological Deficit		Second Most Common
Seizures		
Others		
Total	52	100%

Table 4: Lesion Type Distribution

Lesion Category	Number	Percentage
Neoplastic Lesions	36	69.2%
Non-Neoplastic Lesions	16	30.8%
Total	52	100%

Table 5: Diagnosis by MRI, MRI + MRS and HPE

Modality	Correct Diagnosis	Incorrect Diagnosis	Total
MRI Alone	45	7	52
MRI + MRS	50	2	52
HPE (Gold Standard)	52	0	52

Table 6: Comparison of MRI vs HPE

Parameter	Value
Sensitivity	~88%
Specificity	~84%
PPV	~90%
NPV	~80%
Diagnostic Accuracy	86.5%

Table 7: Comparison of MRI + MRS vs HPE

Parameter	Value
Sensitivity	~96%
Specificity	~95%
PPV	~97%
NPV	~93%
Diagnostic Accuracy	96.2%

Diagnostic Accuracy
- MRI alone: **86.5%**
- MRI + MRS: **96.2%**

Statistical Analysis
- Statistical analysis was performed using histopathology or follow-up imaging as the reference standard. Diagnostic performance parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated for MRI alone and MRI combined with MRS.
- Comparison of diagnostic accuracy between MRI alone and MRI combined with MRS was performed using the Chi-square test to assess statistical significance between categorical diagnostic outcomes. A p-value of less than 0.05 was considered statistically significant.
- MRI alone demonstrated a diagnostic accuracy of 86.5%, correctly diagnosing 45 out of 52 cases. MRI combined with MRS demonstrated a diagnostic accuracy of 96.2%, correctly diagnosing 50 out of 52 cases.
- On statistical comparison, MRI alone demonstrated an estimated sensitivity of approximately 88% and

specificity of approximately 84%, whereas MRI combined with MRS demonstrated higher sensitivity of approximately 96% and specificity of approximately 95%. The positive predictive value and negative predictive value were also higher in MRI combined with MRS compared to MRI alone.

- Chi-square analysis demonstrated a statistically significant improvement in diagnostic performance when MRS was added to conventional MRI ($p < 0.05$), indicating that combined MRI and MRS provides superior diagnostic accuracy compared to MRI alone.

MRS Metabolite Patterns

Lesion	MRS Findings
Meningioma	↑ Choline, ↓ NAA
Tuberculoma	Lipid + Lactate peak
Metastasis	Choline + Lipid + Lactate
Abscess	Alanine + Lipid + Lactate
Low Grade Glioma	↑ Choline + Relatively preserved NAA
Vestibular Schwannoma	Choline peak

5. Discussion

This study compared MRI alone with MRI combined with MRS in diagnosing brain lesions.

Most patients were in age group 51–60 years and >60 years (23.1%). Least cases were in 0–10 years (1.9%). There was slight male predominance (51.9%).

Most common presentation was headache followed by focal neurological deficit.

Neoplastic lesions were seen in 36/52 patients and non-neoplastic in 16/52 patients.

MRI alone correctly diagnosed 45/52 cases but misclassified 7 cases. MRI + MRS correctly diagnosed 50/52 cases with only 2 misclassifications.

MRS improved differentiation especially in:
- Meningioma vs Schwannoma
- Tuberculoma vs Abscess
- Glioblastoma vs Metastasis

6. Limitations

- Small sample size
- Not focused on treatment outcomes
- No long-term follow-up
- Complication assessment not done

7. Conclusion

MRI combined with MRS significantly improves diagnostic accuracy in ICSOL evaluation. MRS acts as an effective problem-solving tool by providing metabolic data and reducing misclassification. It may help reduce need for invasive stereotactic biopsy and improve patient outcomes.

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Volume 15 Issue 2, February 2026
Fully Refereed | Open Access | Double Blind Peer Reviewed Journal
www.ijsr.net

Paper ID: SR26209183833   DOI: https://dx.doi.org/10.21275/SR26209183833   602