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# Sol Brain, Pre-Operative Magnetic Resonance Spectroscopy and Surgical Biopsy Yield

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## ABSTRACT

***Objective:*** To ascertain the positive predictive value (PPV) of magnetic resonance spectroscopy (MRS) in diagnosing neoplastic intracranial masses by taking histopathology as a benchmark.

***Study Design:*** Cross-sectional study.

***Place and Duration of Study:*** Combined Military Hospital, Rawalpindi Pakistan, from Jan 2019 to Jun 2021.

***Methodology:*** After approval from the Ethical Review Committee, 64 patients with neoplastic intracranial mass lesions on MRI were incorporated into the study. Patients with a history of brain surgery done previously, breastfeeding females, claustrophobia, already diagnosed type of tumour, and contraindication to MRI were excluded. MR Spectroscopy was performed, and findings were correlated with histopathology.

***Results:*** Of 64 patients, 39(60.94%) were males, and 25(39.06%) were females. Magnetic Resonance Spectroscopy (MRS) supported the diagnosis of neoplastic brain lesions in all 64 patients. Histopathology confirmed malignant brain lesions in 59 cases, whereas 05 cases had benign lesions. PPV of MRS in the diagnosis of neoplastic brain lesions was 92.19%.

***Conclusion:*** This study concluded that MRS is a non-invasive option having a very good PPV in determining neoplastic brain lesions.

**Keywords**: Brain, Histopathology, Magnetic resonance spectroscopy, Tumour.

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## INTRODUCTION

On imaging studies, intracranial mass lesions have many differential diagnoses like benign and malignant tumours, inflammatory masses, arteriovenous malformations, aneurysms and tumefactive plaques of multiple sclerosis.[1] In many cases, it is impossible to base a specific diagnosis solely on clinical and radiologic findings, and a biopsy has to be performed for confirmation.[2] central nervous system (CNS) imaging has endorsed a breakthrough that has influenced all features of neuroscience practice in general and specifically, the management of intra-axial brain tumours.[3]

Magnetic resonance imaging (MRI) is the prime imaging modality utilized to identify and assess intracranial lesions. It allows proper delineation of the tumour extent owing to the multi-sequential and multiplanar imaging and greater soft tissue contrast.[4] However, MRI is unable to distinguish neoplastic from non-neoplastic intra-cranial lesions.[5]

MR spectroscopy juxtaposes the chemical constitution of normal brain tissue with abnormal tumour tissue. Amino acids, Lactate, Choline, Lipids, N-acetyl aspartate (NAA), Alanine, Creatine and Myoinositol are important metabolites.[6] The quantity of these products is measured in units called parts per million (ppm).[7] NAA is a marker of neuronal integrity and is as high as 2.02 ppm. Choline peaks at 3.22 ppm, a sign of cell turnover. Creatine peaks at three ppm, and it is responsible for cell functioning. Lipid and lactate crests are commonly not present in brain tissue and, if present, crest at 1.33 ppm and may intersect each other.[6,8] Lesions can be classified into Neoplastic and non-Neoplastic about Choline/NAA and Choline/Creatine ratios and NAA and Choline peaks.[9]

The available literature on this was very scarce. Physicians routinely do not recommend this technique to assess the lesion type; for confirmation, patients have to go for a biopsy. Therefore, this study was conducted to demonstrate the role of MRS in intracranial mass lesions and confirm its positive predictive value in neoplastic lesions using histopathology as the gold standard.

## METHODOLOGY

The cross-sectional study was conducted at the Combined Military Hospital, Rawalpindi Pakistan, from January 2019 to June 2021. After approval from the Ethical Review Committee (No. 109/09/20) and

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informed consent, 64 patients were recruited for the study. The sample size was calculated using the WHO sample size calculator, taking the expected positive predictive value taken was 91.1%,[10] of MRS for diagnosing neoplastic brain lesions considering histopathology as a gold standard. The patients were selected through non-probability, consecutive sampling.

**Inclusion Criteria**: Patients of either gender, aged 30 to70 years presenting with neoplastic intracranial mass lesions on MRI were included in the study.

**Exclusion Criteria**: Patients with a history of previous brain surgery, breastfeeding females, claustrophobia, already diagnosed type of tumour and contraindication to MRI were excluded from the study.

Single voxel MR Spectroscopy was performed after post-contrast MRI to localize the lesion; TE (echo time) and TR (repetition time) of 135 and 1500, respectively, were used with the Point-resolved spectroscopy (PRESS) method. The interpretation was made by the same consultant radiologist, having more than five years of post-fellowship experience. Then, all patients were subjected to intracranial biopsy in the neurosurgical department of combined military hospital Rawalpindi, and histo-pathological analysis from AFIP and findings of MRS were correlated with histopathology report.

SPSS-20.0 was employed for data analysis. Standard deviation and mean were determined for quantitative variables, for qualitative variables, frequency and percentage were calculated. The positive predictive value of MRS in diagnosing neoplastic brain lesions was calculated using the 2×2 contingency table by taking histopathology as a benchmark. The *p*-value of ≤0.05 was taken to be significant.

## RESULTS

A total of 64 patients diagnosed with neoplastic brain lesions on MRS were included in the study. The mean age was 47.14±10.44 years (Range 30-70 years). The mean duration of disease was 4.47±2.15 months with 45.3% (n=29) patient had disease of <3-months while 54.7% patients (n=33) had disease of more than 3-months duration. The mean size of the lesion was 22.72±6.37mm, with 51.56% of patients (n=33) having lesions <20mm while 48.44% of patients (n=31) had lesions >20mm, as shown in Table-I. All the patients were subjected first to magnetic resonance Imaging (MRI). MRS supported the diagnosis of neoplastic brain lesions in all 64 patients. Histopathology diagnosed malignant brain lesions in 59 cases (true positive), whereas 05 cases (False Positive) had benign lesions on histopathology. MRS had a PPV of 92.19% in diagnosing neoplastic brain lesions, as shown in Table-II.

**Table-I: Distribution of Patients according to the Duration of Disease and Size of Lesion (n=64)**

| According to Duration of Disease | |
|---|---|
| **Duration of disease (Months)** | **n(%)** |
| ≤3 months | 29(45.3%) |
| >3 months | 35(54.7%) |
| Mean±SD | 4.47±2.15 months |
| **According to Size of Lesion** | |
| **Size of Lesion (mm)** | **n(%)** |
| ≤20 mm | 33(51.56%) |
| >20 mm | 31(48.44%) |
| Mean±SD | 22.72±6.37 mm |

**Table-II: Magnetic Resonance Spectroscopy (MRS) in Diagnosing Neoplastic Brain Lesions taking histopathology as Gold Standard (n=64)**

| | Positive result on MRS | Negative result on MRS |
|---|---|---|
| Positive Results on Histology | 59 | 0 |
| Negative Results on Histology | 05 | 0 |

*Sensitivity=TP/(TP+FN)=59/(59+0)*100=100%, Specificity=TN/(TN+FP)= 0/ (0+5)*100=0%, Positive Predictive Value= TP/ (TP+FP) *100=59/(5 9+5)= 92.19%, Negative Predictive Value=TN/ (TN+FN) *100=0/(0+0)= 0%, Diagnostic Accuracy=(TP+TN)/All patients *100=(59+0)/64x 100=92.19%*

## DISCUSSION

The determination of intracranial mass lesions' categories using MRI only may be difficult without the histopathological examination.[3] Therefore, advanced MRI techniques such as Perfusion Weighted Imaging (PWI), Diffusion Weighted Imaging (DWI), and Proton Magnetic Resonance Spectroscopy (1HMRS) have been taken on board to differentiate such lesions.[11] Proton MR spectroscopy (1H-MRS) determines the relative concentrations of the metabolites of different tissues. It produces a non-invasive analysis of the metabolism of the tissue, which may be used in tumour diagnosis. This has been proved in different studies to be quite sensitive in identifying malignant tumours.[1-7]

Magnetic resonance spectroscopy (MRS) in determining brain tumours is considered for investigation because there is insufficient evidence to demonstrate its effectiveness in the published clinical literature. In our study, MRS has 92.19% PPV in diagnosing neoplastic brain lesions. Previous studies demonstrated fluctuating patterns for MRS with a sensitivity between 79%-100% and a specificity of 76%-100% in heterogeneous groups of patients, some with known prior tumours and others with unknown new masses. The

negative predictive values ranged bet-ween 60%-100%, while the positive predictive values were 92%-100%.[7,12]

The sensitivity, specificity, and positive predictive value of MRS for distinguishing between neoplastic from non-neoplastic brain lesions, as observed in a previous study, 97%, 90% and 91.1%, respectively.[10] In comparison, Alam *et al*.[5] have found a sensitivity of 93.02%, specificity of 70%, PPV of 93.02%, NPV of 70% and diagnostic accuracy of 88.67 % of MRS for all brain lesions. Another study suggested that MRS might non-invasively contribute to differentiating between brain abscesses and cystic or necrotic brain tumours with sensitivity, specificity, PPV, NPV and diagnostic accuracy as 93.2%, 85.7%, 100%, 100%, 88.5% respectively.[13]

A study conducted on 51 patients with intracranial cystic lesions by Shukla-Dave *et al*.[14] explained that in vivo proton MRS could correctly recognize the underlying lesion in 92% of their subjects. In the same way, in another study with 98 patients having intracranial mass lesions, conducted by Hellström *et al*.[15] an 89% positive predictive value of proton MR spectro-scopy was reported. While another study has reported specificity, sensitivity, PPV and NPV of MRS as48%, 76%, 81% and 40%.[16]

MRI and MRS were analyzed retrospectively in 62 patients with ring-enhancing intra-cerebral lesions. The study concluded that 2D CSI 1HMRS is very effective in diagnosing ring-enhancing intracerebral lesions, and the combined application of MRI and MRS has a higher diagnostic value.[17] The study by Ahmed *et al.* showed a diagnostic Accuracy of the MRI alone to be 78%. In contrast, the combined diagnostic Accuracy of the MRI+MR Spectroscopy was reported to be 84.6%.[18] In a study of 135 patients, MRI with MRS sensitivity and specificity for tumours were 91.7% and 94.3%, respectively.[19]

Our results proved that MRS is a helpful diagnostic tool for diagnosing brain lesions pre-operatively. Therefore, we recommend that MRS be done routinely for accurate pre-operative assessment and appropriate surgical approach in all suspected cases of neoplastic brain lesions.

## CONCLUSION

This study concluded that MRS has a high positive predictive value and is the investigation of choice in diagnosing neoplastic brain lesions.

**Conflict of Interest:** None.

**Authors' Contribution**

Following authors have made substantial contributions to the manuscript as under:

KAB: Supervision, Conception, Study design, analysis and Interperitation of data, Critically reviewed manuscript & approval for the final version to be published.

NY: Co-supervision, Data entry, analysis and interpretation, manuscript writing & approval for the final version to be published.

SI & RM: Critically reviewed, Drafted manuscript & approval for the final version to be published.

IP & AY: Data colllection, Entry and analysis of data, preparation of rough draft & approval for the final version to be published.

AK & SN: Data collection and entry & approval for the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investi-gated and resolved.

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