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ORIGINAL ARTICLE

Role of Magnetic Resonance Spectroscopy in Supratentorial Brain Lesions

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ABSTRACT

Aim: To identify the specificity and the sensitivity of MRS in diagnosing supratentorial brain lesions and will help the surgeons to rely on the respective diagnostic modality

Method: A cross-sectional study was conducted in the Neurosurgery Department, at Jinnah Postgraduate Medical Center. The patients with conventional MR imaging showing space-occupying lesions which show a malignant diffusion restriction and enhancement were included. The histopathological diagnosis and the metabolites of the brain were detected by MR Spectroscopy were recorded. To find the association of the ratios of the brain metabolites, the chi-square test was used where a p-value of <0.05 was considered significant. The sensitivity and specificity of the MRS were evaluated then.

Result: Overall, 112 patients were included in our study. 76(67.9%) patients were male. Headache (34.8%) was found to be the most common symptom. 39(34.8%) patients were diagnosed with Oligodendroglioma on histopathology. The Cho/Cr ratio >2 was found in 70(82.4%) patients diagnosed with neoplastic lesions. In 62(72.9%) patients diagnosed to have a neoplastic lesion on histopathology reported increased lipid peak and 67(78.8%) with the neoplastic lesion showed to have increased Cho/NAA ratio on MRS. The Cho/Cr ratio was found to be significantly associated with the neoplastic lesions with a significant p-value of <0.001. The MRS was determined to be 82.4% sensitive and 70.4% specific in the diagnosis of supratentorial brain lesions.
This study will be quite beneficial as it will help surgeons rely on the more accurate method of diagnosing brain lesions and provide an outlook of a non-invasive method to diagnose the lesions.

Conclusion: The study concludes that MRS has high diagnostic accuracy in diagnosing neoplastic and inflammatory lesions and is **Keywords:** Spectroscopy, brain lesions, medical resonance imaging

INTRODUCTION

The yearly cases of both CNS neoplasms the primary one as well as the secondary one vary from 10 people to 17 persons per 100,000 persons[1]. The brain lesions are further categorized into supra-tentorial and infra-tentorial brain tumors[2]. The supratentorialependymoma (STE) is quite rare in its nature and its nature, it is regarded as a primary glial tumor that arises from ependymal cells. It results in 30-50% of all cases of intracranial ependymomas[3,4]. The histologic findings reveal that the STE has been graded as World Health Organization (WHO) Grade II or III (anaplastic). Although they are quite aggressive lesions having increased chances of recurrence, they are well-demarcated as well[5].

The MRI provides excellent soft tissue contrast, but the specificity and sensitivity with which it defines the type and grade of the tumor are quite limited[6]. As new imaging technologies are emerging, molecular-level tumor detection comes into reality which can show substantial evidence for theglioma'spreoperative grading. Magnetic Resonance Spectroscopy (MRS), conversely, provides histopathological and immunohistochemical analysis noninvasively which is beyond what can be achieved with plain anatomic images. MRS is an advanced diagnostic toolthat enables the study of the metabolites within the brain or neoplasms that reflect the nature of these lesions and the grading of brain tumors which further helps in the follow-up and to assess the response of the treatment of these lesions[7].

The recent literature relate to the MRS supports the utilization of this advanced technique in the characterization of the metabolic changes that are related to the progression and grading of the tumor particularly raised levels of choline (Cho) with reduction of N-acetyl aspartate (NAA) is a highly reliable indicator of the tumor characterization[8]. MRS yields information that is subjected to in-depth analysis of the biochemical content which explains its increasing role in the clinical setting and that is the reason it has been considered as an alternative diagnostic modality for the grading of tumors. For enhanced reliability of the procedure of MRS, methods of spectroscopic localization and the acquisition of the data ought to be adequately adjusted[9].

This study will help us identify the specificity and the sensitivity of MRS in diagnosing supratentorial brain lesions and assess the surgeons to enhance the reliability of the respective diagnostic modality.

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METHOD

Study Design: A cross-sectional study was conducted in the neurosurgery department, at Jinnah Postgraduate Medical Center for the period of 5 months from August to December 2022. The non-probability, convenience sampling technique was administered.

Sample size: A Raosoft sample size calculator was utilized to estimate the sample size for this study. The margin of error of 5%, the 95% confidence interval, and the expected incidence of the supratentorial lesions to be 156[10] were used to calculate the sample size of 112 patients.

Inclusion Criteria: The inclusion criteria of our study include patients withconventional MR showing space-occupying lesions (SOL)and malignant diffusion restriction along with enhancement, and patients of age 18 or above.

Exclusion Criteria: We excluded the patients of age less than 18, who did not give consent, those patients with known hematological/systemic conditions or stroke, pregnant women, patients who had undergone radiation therapy or brain surgery, and those with any other malignancy suspected to be metastasized to the brain.

Data Collection and Data Analysis: The data collection was conducted using a pre-designed proforma. All the patients who fulfill the inclusion criteria will be included in our study and informed consent was taken from them. For those patients with altered levels of consciousness, informed consent was taken from

their family members. The data collected included the demographics of the patients, their clinical presentation and symptoms, their histopathological diagnosis, and its relation with the metabolites of the brain detected by MR Spectroscopy. The collected data was analyzed using the SPSS version 22 (IBM Corp., Armonk, NY, USA). The simple frequency and percentages were evaluated for the categorical variables. To find the association of the ratios of the brain metabolites, the chi-square test was used where a p-value of <0.05 was regarded as significant. The sensitivity and specificity of the MRS were evaluated then.

RESULTS

Tables 1 show the demographical variables of the patients. Overall, 112 patients were included in our study. 76 (67.9%) patients were male while 36 (32.1%) patients were female. 41 (36.6%) patients were from the age group of 18-40 years, 34 (30.4%) were from the age group 41-60 and 37 (33%) were from the age group>60 years.

Table 1: Demonstrates the demographical variables of the patients

Variables	Frequency (n=112)
Age	
18-40	41 (36.6%)
41-60	34 (30.4%)
>60	37 (33%)
Gender	
Male	76 (67.9%)
Female	36 (32.1%)
Comorbid	
Diabetes	40 (35.7%)
Hypertension	46 (41%)
Smoking	20 (17.9%)
Ischemic heart disease	43 (38.4%)
None	20 (17.9%)

Table 2 shows the presentation of the patients and their histopathological classification of the tumor. The most common symptom in the patients was found to be a headache in 102 (91.1%) patients followed by seizures in 56(50%) patients, body weakness in 47(41.9%) patients, vertigo in 35(31.25%) patients, vomiting and decreased vision in 34(30.35%) patients each and lastly decreased hearing in 27(24.1%) patients. The 62(55.4%) patients had 13-15 GCS upon their admission, 27(24.1%) patients had 9-12 GCS and 23(20.5%) patients had 3-8 GCS. The most common tumor diagnosed on histopathology includes Oligodendroglioma in 39(34.8%) patients.

Table 2: Patient's symptoms and the tumor classification

Variables	Frequency(n=112)
Symptoms	
Headache	102 (91.1%)
Vertigo	35 (31.25%)
Seizures	56 (50%)
Vomiting	34 (30.35%)
Decreased vision	34 (30.35%)
Decreased hearing	27 (24.1%)
Body weakness	47 (41.9%)
Initial GCS	
3-8	23 (20.5%)
9-12	27 (24.1%)
13-15	62 (55.4%)
Tumor Classification (On histopathology)	
Neoplastic	
Oligodendroglioma	39 (34.8%)
Astrocytoma	12 (10.7%)
Glioblastomas	15 (13.4%)
Metastatic tumor	11 (9.8%)
Lymphoma	8 (7.1%)
Inflammatory	
Tuberculoma	8 (7.1%)
Abscess	13 (11.6%)
Fungal Infection	6 (5.3%)

Table 3 shows the relationship between specific ratios of the MRS with the histopathological findings. The Cho/Cr ratio >2 was found in 70(82.4%) patients diagnosed with neoplastic lesions. In 62(72.9%) patients diagnosed to have a neoplastic lesion on histopathology reported increased lipid peak and 67(78.8%) with the neoplastic lesion showed to have increased Cho/NAA ratio on MRS. The Cho/Cr ratio was found to be significantly associated with the neoplastic lesions with a significant p-value of <0.001.

Table 3: The relationship of MRS metabolites with histopathological findings

Metabolites	Metabolites		P value
	Neoplastic	Inflammatory	
Cho/Cr ratio			
>2	70 (82.4%)	8 (29.6%)	<0.001
<2	15 (17.6%)	19 (70.4%)	
Lipid peak			
Yes	62 (72.9%)	10 (37%)	0.056
No	23 (27.1%)	17 (63%)	
Cho/NAA			
Increased	67 (78.8%)	12 (44.4%)	0.062
Decreased	18 (21.2%)	15 (55.6%)	

Tale 4 shows that the sensitivity of MRS was 82.4% and the specificity is 70.4%. The positive predictive value of MRS was found to be 87.4% and the negative predictive value was 55.9%.

Table 4: Diagnostic parameters of metabolite ratio detecting supratentorial brain lesions

The parameters of the Cho/Cr ratio indicating the neoplastic lesions for the diagnosis	Results
Sensitivity	82.4%
Specificity	70.4%
Positive predictive value	87.74%
Negative predictive value	55.9%

DISCUSSION

MR spectroscopy is an ideal tool for analyzing the chemicals of the cerebral lesion that allows non-invasive diagnosis. This tool is utilized in separately identifying the cerebral inflammatory lesions and the neoplastic lesions. The diagnosis of the lesion by analyzing the concentration of specific chemical markers on the spectroscopy and their ratios. According to most of the literature, the Choline to NAA ratio of more than 1 is categorized as a diagnostic value for the neoplastic lesion. However, a significant amount of literature suggests different markers and ratios as diagnostic tools. Additionally, several other cut-off values are assigned for these markers to diagnose the accuracy of MRS[11,12].

Our patients were predominantly male (67.9%) of the patients which was consistent with the other studies[10,11]. In our study, the sensitivity was reported to be 82.4% and the value of specificity was 70.4%. The sensitivity was higher in our studies as compared to the sensitivity of 77% in the studies conducted by Rafique et al[13].

Our study describes an alternative to the invasive methods of open biopsy, which can be utilized as an important technique in predicting the grading of the supratentorial brain lesions to avoid the circumstances[14]. Therefore,we used the MRS to determine the metabolites within the brain. The findings of one study suggest that the short-time echo has a significantly higher diagnostic precision as compared to the intermediate-time echo. Brain lesions like gliomas are graded by the analysis of the different metabolites. The ratio of Cho/Cr, Cho/NAA, and lipid peak were used in our study to predict the supratentorial lesions[15].

In the study conducted by Zeng et al., the best diagnostic tools predicting the supratentorial brain lesions were indicated to be Cho/NAA and Cho/Cr ratios[16] that were consistent In our study as well. It was done as the study conducted in 2008 to evaluate the usefulness and effectiveness of MRS in evaluating the grading of gliomas reported that Cho and other metabolites related to it

including Cho/Cr along with Cho/Naa the better markers as compared to the other ratios of the metabolites[17].

In the previous literature, Cho/NAA, as well as Cho/Cr, were reported as having high values that can be utilized to differentiatea low-grade tumor from a tumor that is high-grade while considering the deviation in the spectroscopic approaches[(18)]. According to one of the American studies, the CT scan and the MRI contrast measurements methods are quite comparable in the assessment of tumors. As the CT scan and MRI can not accurately diagnose canine brain tumors, histopathology is required[(19)]. MRSI is a non-invasive procedure, which enables information related to the metabolic features and insights into the physiology of the malignancy in brain tumors.

The major limitation of our study was that it did not include patients aged <18 years. We would be able to assess the sensitivity and specificity of the MRS in diagnosing the supratentorial brain lesions in the pediatric age group as well. The unicentric approach of this study was another limitation due to which a small sample size was approached and limited variables were tested. The results of the MRS were a single-voxel technique due to which there are chances of inter-observer interpretation bias unlike in the multi-voxel technique. We tested only limited ratios of the metabolites. Studying the increased number of metabolites individually and assessing different ratios might have given different diagnostic accuracy.

CONCLUSION

The study concludes the high diagnostic accuracy of the neoplastic and inflammatory lesions and is the non-invasive method as compared to histopathology. Even in cases where the differentiation of the lesions is difficult, the application of MRS can play a significant role in the pre-operative diagnosis and timely treatment.

Conflict of interest: Nil

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