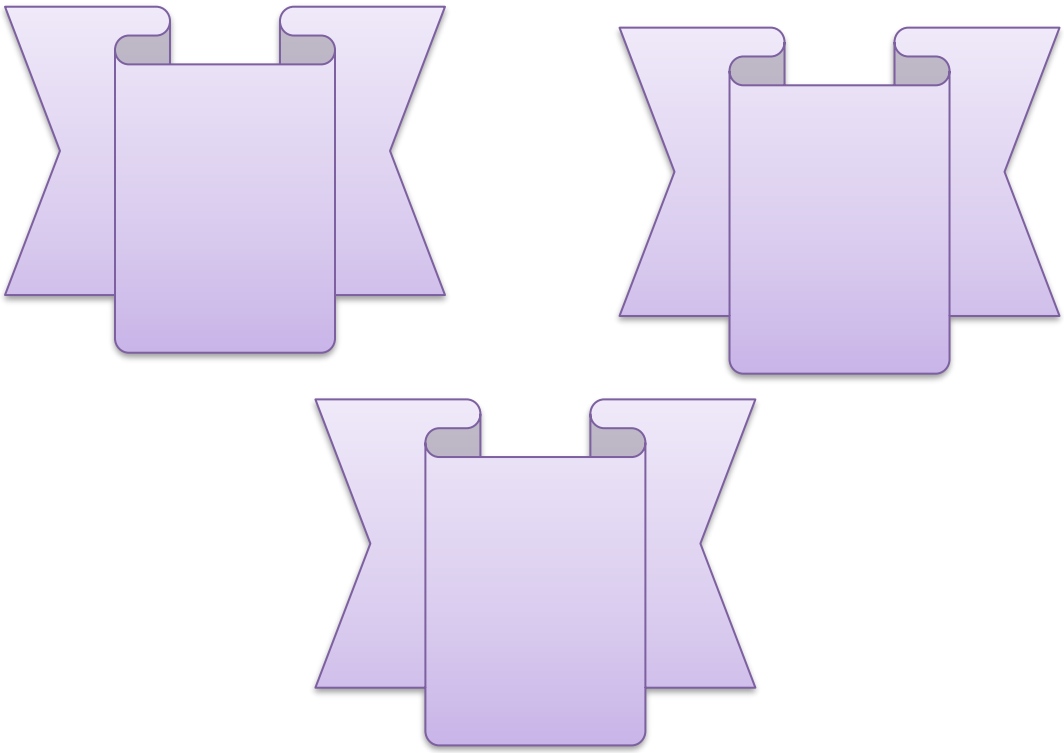
International Journal of Medical Arts

Volume 5, Issue 3, March 2023

https://ijma.journals.ekb.eg/



Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Neurosurgery]

Original Article

Magnetic Resonance Spectroscopy versus Histopathology in Diagnosis of Intracranial Lesions

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Article information

Received: 28-12-2022

Accepted: 01-05-2023

DOI: 10.21608/IJMA.2023.184057.1584.

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Citation: Elabd MYM, Elsamouly H, Mansour MH. Magnetic Resonance Spectroscopy versus Histopathology in Diagnosis of Intracranial Lesions. IJMA 2023 March; 5 [3]: 3079-3084. doi: 10.21608/IJMA.2023.184057.1584.

ABSTRACT

Background: Intracranial lesions are a serious health issue that worsens yearly. it may be difficult or even impossible to distinguish between various tumors by MRI which is made by histopathology. The ability to identify various brain metabolites is provided by magnetic resonance spectroscopy [MRS], a non-invasive imaging tool used to evaluate brain pathologies.

Aim of the work: To compare between magnetic resonance spectroscopy [MRS] and histopathology in diagnosis of intracranial lesions.

Patients and Methods: This research is a retrospective trial including [20] patients with intracranial lesions who have done magnetic resonance spectroscopy preoperatively and operated by open surgery.

Results: Our study revealed that the mean age was 39.3 ± 20.3 years. As regards symptoms there was headache in 10 patients [50%], vomiting in 5 patients [25%], fits in 2 patients [10%], weakness in 3 patients [15%], anosmia in 1 patient [5%], visual disturbances in 3 patients [15%] and behavioral changes in 2 patients [10%]. Histopathology confirmed the following MRS finding; 3 high-grade gliomas [15 %], 5 crainopharyngioma [25 %], one central neurocytoma [5 %], 6 meningioma [30 %], 2 brain Abscesses [10 %] and 1 inflammation [5 %]. There was a statistically substantial variation between final results of MRS and histopathology [P value = 0.009]. The sensitivity, specificity of the MRI to diagnose brain tumor was found to be 88.2%, 100 respectively. As regard the tumor markers, the median and IQR CHO / NAA ratio and CHO/Cr ratio was 2.3 [1.8 - 2.8], and 1.7 [1.6 - 3] respectively.

Conclusion: MRS accurately identifies various lesions depending on the metabolic spectrum and ratios as well as distinguishing neoplastic and non-neoplastic brain lesions. It might be used for grading tumors, guiding stereotactic biopsy, and monitoring postoperative patient.

Keywords: Magnetic resonance spectroscopy [MRS]; Histopathology; Intracranial lesion.

INTRODUCTION

Intracranial lesions are a serious health issue that worsens yearly. The most prevalent primary brain tumors are gliomas. The determination of the best treatment options depends on tumor grading [1].

It is quite challenging to distinguish a single intra-axial brain tumor from another, to confirm if it is primary or metastatic, Low or high grade. Conventional MRI may provide some findings that are distinctive, but it may be challenging or even impossible to differentiate between different tumors. In these situations, complete tumor resection or stereotactic biopsy is necessary for making a definitive diagnosis [2-5].

Since pathology is the most accurate way to determine the type of lesion, many patients underwent invasive procedures. The final diagnosis of the lesion is made through histopathological evaluation following a biopsy or surgical excision [6].

The ability to identify and measure various brain metabolites is provided by MRS, a non-invasive diagnostic imaging tool that has been primarily employed in the evaluation of brain pathologies [7, 8].

By measuring cellular metabolites and examining their dispersion in the tissues, MRS can evaluate neurological disorders at microscopic scales. Proton [1H; hydrogen] spectroscopy is the most extensively used MRS technique [9].

A long list of metabolites, like choline, N-acetyl-aspartate, lipids, lactate, creatine, alanine, and myo-inositol, may be helpful in the MRS examination of brain tumors [10].

In this research, MRS and histology was compared in the identification of cerebral lesions.

PATIENTS AND METHODS

A retrospective study including [20] patients with intracranial lesions who have done MRS preoperative and operated by open surgery at AL-Azhar university hospitals within a period from March 2022 to November 2022. Patients with intracranial lesions who have done MRS preoperative and operated by open surgery, and all patients who accepted the procedure were taken part in the study. We selected patients based on the following criteria;

Inclusion criteria: 1] Both genders. 2] Any age. 3] Diagnosed with intracranial lesion.

Exclusion criteria: 1] Patients having conditions that preclude MRI testing. 2] Patients with contraindications to intravenous contrast agents.

Sample size: 20 patients fulfilling the inclusion criteria who have done MRS preoperatively and operated by open surgery.

Data collection: Full detailed history including **[**Personal history, complaint, present history of current illness and past history of pervious injury, operations or diseases of the brain]. Full examinations were done [general and neurological]. Radiological [CT, MRI with contrast and MRS] and laboratory [CBC, liver and kidney functions tests, coagulation profile, ECG and ECHO if needed and ABO group].

Magnetic Resonance Spectroscopy: Spectroscopy data is obtained using point resolved spatial. Selection [PRESS] during either short or intermediate or long time. MRS may performed as single or multivoxel [chemical shift imaging-CSI].

Post-operative care: Regular post-operative care clinically and radiologically was done [neurological examination including conscious level]. Follow up done postoperative and every3 months for 6 months.

Statistical analysis: Version 24 of the Statistical Program for Social Science [SPSS] was utilized to analyze the data. Mean ± SD was utilized to represent quantitative data. Frequency and percentage were utilized to convey qualitative data. As opposed to a high SD, which shows that the results are dispersed across a greater range, a low SD suggests that the results tend to be near to the established mean. If the p value for the analysis was less than 0.05, the findings were deemed significant.

RESULTS

Our study included 20 patients with intracranial lesions who have done MRS preoperative and operated by open surgery. Regarding age, the mean age was 39.3 ± 20.3

years. There were 7 males [35%] and 13 females [65%]. There was headache in 10 patients [50%], vomiting in 5 patients [25%], fits in 2 patients [10%], weakness in 3 patients [15%], anosmia in 1 patient [5%], visual disturbances in 3 patients [15%] and behavioral changes in 2 patients [10%] [table 1].

Regarding the finding of MRS in relation to the histopathology results, the histopathology confirmed the following finding of MRS; 3 high grade gliomas [15 %], 5 crainopharyngiomas [25 %], one central neurocytoma [5 %], 6 meningioma [30 %], 2 brain abscesses [10 %], and 1 inflammation [5 %]. However, the MRI misdiagnosed 2 cases with high grade glioma by diagnosing them as a low-grade glioma as presented in tables [2,3].

Regarding the comparison of the final results of MRS and histopathology, there was a substantial variation between them [P value = 0.009]. The sensitivity, specificity, PPV, NPV, and accuracy of the MRI to diagnose the brain tumor was found to be 88.2%, 100%, 100%, 60%, and 85% respectively [table 4].

Regarding tumor markers, we found that the medians and IQRs of CHO / NAA ratio, and CHO/Cr ratio were 2.3 [1.8 - 2.8], and 1.7 [1.6 - 3] respectively as presented in tables [5].

Table [1]: Demographic data and clinical characteristics among studied patients

		Studied patients [n = 20]	
Age [years] [Mean ±SD]		39.3 ± 20.3	
Sex	Male	7	35%
	Female	13	65%
Symptoms	Headache	10	50%
	Vomiting	5	25%
	Fits	2	10%
	Weakness	3	15%
	Anosmia	1	5%
	Visual disturbances	3	15%
	Behavior changes	2	10%

Table [2]: Comparison between the finding of MRS and Histopathology of the studied patients

		MRS	Histopathology	P value
Histopathology	Low grade Glioma	2 [10 %]	0 [0 %]	**0.001***
	High grade Glioma	3 [15 %]	5 [25 %]	
	Crainopharyngioma	5 [25 %]	5 [25 %]	
	Central Neurocytoma	1 [5 %]	1 [5 %]	
	Meningioma	6 [30 %]	6 [30 %]	
	Brain abscess	2 [10 %]	2 [10 %]	
	Inflammation	1 [5 %]	1 [5 %]	

Table [3]: Comparison between the final results of MRS and Histopathology

		Histopathology		P value
		Positive	**Negative**	
MRS	Positive	15 [75%]	0 [0%]	**0.009***
	Negative	2 [2%]	3 [15%]	
Total		17 [85%]	3 [15%]	**20**

Table [4]: Sensitivity, specificity and Accuracy of the MRS

Measure	Finding
Sensitivity %	88.2%
Specificity %	100%
Positive Predictive Value %	100%
Negative Predictive Value %	60%
Accuracy %	85%

Table [5]: Description of CHO/NAA and CHO/Cr among studied patients

		Studied patients [N = 20]
CHO/NAA	Median ± IQR	2.3 [1.8 - 2.8]
CHO/Cr	Median ± IQR	1.7 [1.6 - 3]

DISCUSSION

Magnetic resonance imaging [MRI] or computed tomography [CT] scans are two common neuroimaging examinations used to detect focal lesions and parenchymal anomalies in the brain. Only morphological information, which might vary greatly, is provided by these scans. As a consequence, it was unable to make a firm diagnosis using just MRI and CT images [11]. MRS is frequently used in conjunction with conventional MRI to clarify the diagnosis of various brain lesions. Stereotactic brain biopsy is an established technique for obtaining tissues for histopathologic analysis [12].

Conventional MR imaging is the industry standard for identifying suspected brain lesions because it provides very detailed anatomical information with unmatched soft tissue contrast. Proton MR Spectroscopy [H-MRS] provides details on the metabolic makeup of a study region. The neuroradiologist may learn vital details about the density and viability of neuronal cells, cell membrane turnover, metabolic fuel, and potential necrosis in the region of interest by comparing the comparative levels of certain metabolites. This helps in diagnosis by giving a biochemical picture of the underlying condition [13].

When compared to normal tissue, brain lesions have aberrant values for several metabolites. MR Spectroscopy may be useful in determining either neoplastic and non-neoplastic brain lesions [14]. Numerous researches have been conducted around the globe on the use of MR Spectroscopy in classifying and discriminating localized non-neoplastic lesions such infarct, hemorrhage, and infected lesions from neoplastic lesions [15].

This study was a retrospective study including 20 patients with Intracranial lesions who have done MRS and operated at Al-Azhar University Hospitals in order to compare between MRS and histopathology in identification of intracranial lesions.

In our research, the average age of all patients who were being investigated was 39.3 ±20.3 years, with a minimal age of 9 years and a maximal age of 66 years. regarding sex, there were 7 males [35%] and 13 females [65%] in the investigated patients.

Nearly similar to our findings, the study of **Onyambu *et al.*** [16] and **Rafique *et al.*** [17] revealed that the oldest and youngest patients ranging in age from [90 to 5 years old] and [80 to 13 years old] Patients with cerebral lesions were, on average, 45.33 and 49.6 years old, respectively. Male to female ratio was 32 [50.8%] and 31 [49.2%] in **Onyambu's** study and 57.5% male whereas 42.5% female in **Rafique's** study.

In common brain disorders, MRS can provide clinically relevant information about metabolites. It is clinically appropriate for use in the diagnosis, prognosis, and treating of brain tumours, demyelinating diseases, and infectious brain lesions. The most significant ratios are Cho/Cr, Cho/NAA, NAA/Cho, and NAA/Cr. This may aid in the identification and differentiation of many lesions that are difficult to distinguish on standard MRI imaging [18].

In the current research, the description of CHO/NAA & CHO/Cr in all studied patients revealed that as regard CHO/NAA of all studied patients, the mean was 2.3 [1.8 - 2.8]. As regard CHO/Cr, the mean CHO/Cr of all studied patients was 1.7 [1.6 - 3]. As opposed to that, **Alam *et al.*** [13] revealed that neoplastic lesions had higher Cho/Cr [5.38 ±6.10] and Cho/NAA [11.33 ±16.3] ratios than non-neoplastic lesions [Cho/Cr = 2.85± 2.47] and 3.15 ± 2.67 respectively, with a considerable p of 0.005. This goes in line with **Rafique *et al.*,** [17] and **Kumar *et al.*** [19].

Additionally, **Ahmad *et al.*** [20] revealed that the Mean Cho/ Cr ratio was enhanced in meningiomas, metastases, and high-grade gliomas while remaining normal in infections and low-grade gliomas. In high grade gliomas, the mean Cho/Cr value was highest [6.27]. The meningiomas [10.20] and gliomas [5.81] had the highest Mean Cho/NAA ratio which was high in all lesions. The meningioma and metastasis had the lowest values [1.89 and 1.22, respectively] of the NAA/Cr ratio, which was variable and inconclusive in most lesions.

The standard method often used to show the degree of necrosis, proliferative areas, collagen, and vascularity inside the tumor area is histopathological analysis [21].

The current study found that histopathology results were 2 patients [10%] of atypical

meningioma GII, 2 patients [10%] of brain abscess, 5 patients [25%] of Crainopharyngioma, 5 patients [25%] of GBM, 4 patients [20%] of meningioma, 1 patient [5%] of meningitis and 1 patient [5%] of Neurocytoma.

According to **Mansour *et al.* [6],** granulomatous infections [n = 2], hematoma [n = 1], bacterial abscesses [n = 1], and fungal infections [n = 1] were among the histopathologically non-neoplastic patients [n = 5]. In 2 cases, the histopathologic diagnosis was different from the MRS diagnosis. As a result, there were two issues. The first was that the biopsy sites could have been different from the lesion's center to its edge or outside of it [sampling errors]. Reading by various pathologists is the second. Multivoxel MRS has been effectively utilized to direct stereotactic biopsy, allowing sampling of areas with higher choline levels, which indicate increased tumor activity and are the best sites for biopsy, in order to overcome sampling errors. A high success rate and higher diagnostic confidence can be achieved if the biopsy is carried out at the location where the Cho/NAA is greatest as reported by **Martin *et al.* [22]**.

According to the MRS findings, **Ahmed and Mokhtar,** categorized the 100 lesions under study as either non-neoplastic or neoplastic, and then further classified neoplastic tumors as either primary or metastatic. Cho/Cr, Cho/NAA, NAA/Cr, Cho/NAA + Cr, and NAA/Cho ratios [M ±SD] had statistical relevance for differentiating between neoplastic and non-neoplastic lesions by MRS with $P< 0.001$ [significant]. While lactate peaks were identified in 49 neoplastic lesions and in 26 non-neoplastic lesions, and improved with tumor aggressiveness, lipid peaks were observed in 42 neoplastic lesions and 27 non-neoplastic lesions. Furthermore, **Ahmed and Mokhtar,** reported that however, there is statistical importance for distinction as regards the evaluated Cho/NAA and Ch/Cr ratios, [P value < 0.001], when evaluated in the pre lesional areas outside the tumor margin. All spectroscopic parameters were non-significant in differentiating between primary and metastatic neoplastic lesions when the voxel evaluated inside the lesions **[23]**. This was coincidence with **Solanki *et al*. [24]** revealed that a rise in Cho values, Cho/Cr ratios, and Cho/NAA ratios strongly suggests the presence of cancer.

In conclusion the current work has demonstrated that MRS can accurately identify various lesions depending on the metabolite spectrum and ratios as well as convincingly distinguish between neoplastic and non-neoplastic cerebral lesions. It might be used for grading tumours, guiding stereotactic biopsy, and monitoring postoperative patient. When traditional MR imaging and contrast tests are inconclusive, it may be very helpful since it adds to the information they provide.

Conflict of Interest and Financial Disclosure: None.

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International Journal of Medical Arts

https://ijma.journals.ekb.eg/
Print ISSN: 2636-4174
Online ISSN: 2682-3780