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Diagnostic value of MRI and MRS in characterization of brain tumors

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Abstract: The objective of this study was to evaluate the effectiveness of perfusion and magnetic resonance spectroscopy in the characterization of brain tumors. The study was conducted during the period extended from 2014 up to 2017, using 1.5 Tesla superconducting Syngo MRI system at Neuro-Surgery and Oncology department at Jazan- Saudi Arabia.

The study was designed by obtaining a spectrum, that was analyzed, and was influenced by many parameters, including chemical characteristics of each metabolite and the compounds in which they are located; *N*-acetyl aspartate (*NAA*) , choline (*Cho*), creatine (*Cr*) *Cho/ NAA, Cho/ Cr, NAA/ Cr* , Lactate and Lipid at the selection of the lesion area to be studied. The perfusion MRI (rCBV) was characterized as normal, hyper, and hypo-perfused. Choice of the technique type to be employed was (PRESS and STEAM) and the choice of the echo time was (short and long). The diagnostic strategy was evaluated based on results of imaging of 128 patients who had completed data including age, tumor tertiary in the brain. Conventional MRI with standard diagnostic criteria, findings and application of scan with T_1:TR<500ms and TE <50ms and T_2 :TR>1500 and TE>80ms were obtained.MRI with contrast enhancement in T_1 weighted image and nullify the signal from CSF were also been achieved . Adequate scan was attained with Short echo times (TEs) less than 30ms for STEAM and TE as long as 144ms and 288ms milliseconds for PRESS technique. For MRS long TE (1500/144ms) was used; for identification (*Cho), (Cr), (NAA*), and lactate. Conversely, short TE (2000/35ms) was applied for identification of Lipids, lactate, ALA, myoinositol, glutamate, and glutamine.

The current study showed that the most common affected age was age between 41-50 years old constituting 34(26.6%). Distribution of tumor territory in the brain site has significant relation with age at *p*-value= 0.006.The entire lesions were diagnosed according to the standard criteria of diagnosis done by radiologist. Astrocytomas, were found in 58(45.3%) of the cases, Gliomatosis Cerebri,Glioblastic Multiform (GBM) and Oligodendroglioma were 44 (34.4%) ,where the Lymphoma and Meningioma were found in 2(1.6%) and 8(6.3%) of the cases in respectively , where the metastases constituting 3(2.3%).Ependymal tumors were found to be 13(10.1%) 5 cases were Ependymoma and 8 were Subependymoma. Significant results between the perfusion findings and the MRS values regarding *Cho/ NAA* at *p*= (0.000) and *Cho/ Cr* at *p* = (.000).Astrocytomas showed a relative reduction in *NAA* and *Cr*, and *Cho* comparing with the lymphoma .The spectra of metastases are similar to those of meningioma and gliomatos cerebri and ependemal tumors, with low *NAA*, low *Cr*, and high *Cho* levels. The difference was found to be significant in the *NAA* values at different brain lesions with no significant reduction or increasing in *Cho* and *Cr*. *Cho/Cr* has significant impact in differentiation of lymphoma from other lesions at *p* value = 0.004 where the other parameters including *Cho/ NAA, NAA/ Cr,* Lactate and Lipid showed no significant relations. By combining both MRS and perfusion MRI, the diagnosis of lesions was achieved with value of 0.94±.89 for *NAA* and *Cho/ NAA* 1.83±1.22. A significant relation was found between the diagnosis and tumor character in Perfusion-MRI (rCBV) as normal, hypo-perfused and hyper- perfused at *p-value=0.001 as* well; the STEAM and PRESS results at *P*-value = 0.042 and 0.042 in respectively. Perfusion-MRI (rCBV) and MRS are useful for establishing the differential diagnosis between brain metastases and brain tumors. Both has significant relation in differentiation and diagnosis of brain tumors regarding its perfusion as well in chemical characteristics of each metabolite and the compounds in which they are located; *N*-acetyl aspartate (*NAA) , Cho/ NAA, Cho/ Cr* at the selection of the area to study. So the combination of MRS and perfusion-weighted imaging may improve characterization of brain lesions

Keywords - *Brain tumors, MRI, perfusion, MRS*

I. INTRODUCTION

Brain tumors can be defined as the development of abnormal cells within different parts of the brain. Several studies and investigation have been done to rule out various aspects of brain tumors. Brain tumors usually develop, when the tumors cells escape from the normal physiological control and invade nearby

healthy cells [1]. Any healthy cerebral cell, membrane, or covering of brain can be converted into benign or malignant tumor. The two major types of brain tumors include benign tumors and malignant tumors. [2].

Gliomas are considered as the most primary type of brain tumors. These types of tumors are divided into various categories according to their aggressiveness and morphology. This type of tumor always originates from glial cells, which include astrocytes and oligodentrocytes. The nature of Gliomas is infiltrative, which has the capability to result in neuronal cell damage and decreased N-acetyl aspartate (NAA). The actual cause of this tumor is still unknown; however, presence of genetic disorders is the leading cause for the occurrence of gliomas [3].

It is extremely difficult for the health care professionals to make a strong prognosis of malignant gliomas. The reason is that malignant glioma has increased relapse rate and infiltration nature. Therefore, the therapeutic approaches are always different for every different type of the tumor [4]. There are various in vivo approaches, which are used in the clinical settings for diagnosis of brain toumers [5]. The use of conventional magnetic resonance imaging with contrast media makes positive effects in the process of characterization. However, detection of malignancy does not require any area of contrast media enhancement [6].

The reason behind this statement is that some low-grade tumors have shown contrast enhancement; whereas, few glioblastomas have not shown any contrast enhancement. Therefore, high and low grade brain tumors cannot be distinguished with the help of contrast enhancement consistently. Inappropriate signals around tumors on T2-weightes images will be non-specific, since they can represent vasogenic edema, neoplastic infiltration, or both. The data, which is derived out by diffusion weighted imaging, MRS, and perfusions are totally dependent upon one another [7]. However, all of these approaches are complementary to magnetic resonance imaging.

There are two classes of spatial localization techniques for MR spectroscopy; single-voxel (SV) techniques commonly used methods includes PRESS[8] and STEAM[9] which record spectra from one region of the brain at a time, or multi-voxel techniques called 'Chemical Shift Imaging' (CSI)[10,11] which simultaneously record spectra from multiple regions and thereby map out the spatial distribution of metabolites within the brain.

Furthermore, conventional MRI is also used in the clinical settings to detect tumors of brains. However, MRA, functional MRI, PET/CT, and PET/MRI are also used for differential diagnosis. For accurate and final diagnosis, histopathology (invasive technique) is widely used in the hospital settings with the guides of MRS to correct area [12]. The current study, aimed to evaluate the assumption that the combination of MR spectroscopy with a single voxel spectroscopy (SVS), chemical shift imaging (CSI) measurement and perfusion technique, could improve the diagnostic value brain tumor character and diagnosis.

II. MATERIALS AND METHODS

MRI cases with brain tumors were reviewed, and performed descriptive analytical (case-control) study on patients (study group) presented to neuro-surgery & Oncology departments. All of the selected patients submitted their comprehensive clinical history and clinical examination report. Moreover, MRI of brain tumors was discussed and evaluated by the radiologist, oncologist, neuro-surgeons, and the researcher. Tabulation and discussion of the results have been ruled out. Analysis of the results was also done with the help of acquired data.One hundred twenty eight participants were selected for the purpose of investigation. 89(69.5%) were males individuals and 39(30.5%) were females individuals were selected who were suffering from different types of gliomas. The participants were mean age was 47.08 ±18.1 ranged from 3-86years. No participant had undergone radiotherapy or chemotherapy.

World Health Organization has categorized the malignancy of glioma into four grades from 1 to 4. Grade 1 brain tumors are known as gliomas [13]. Grade 2 brain tumors are known as anaplastic astrocytomas, Grade 3 brain tumors are mostly known as anaplastic oligodedrogiomas Grade 4 brain tumors are known as anaplastic gangliogliomas and anaplastic ependymomas. [14].

We have utilized a 1.5 Tesla superconducting syngo MRI system with 25mT/m maximum gradient potential and slandered head coil.It is a fact that general slope towards the base line in MRS spectrum is demonstrated in the case of unsuccessful water suppression.

The study used two different techniques for spectroscopy examination with syngo MRI system, which include SVS and CSI. Both of these methods differ in their localization properties.

A. With a single voxel spectroscopy (SVS) measurement, we acquire the MR spectrum of small volume of interest (VOI).
B. With chemical shift imaging (CSI) measurement, we acquire several spectrum arranged in a matrix in the volume of interest (VOI).

MRS: Phase-encoding gradients use to encode spatial information after the RF pulses and the gradient of slice selection. MRS is acquired using only slice selection and phase encoding gradients, besides the spoiler gradients.Spectroscopic study was carried out using chemical shift imaging (CSI) and acquiring a localized

scan at the lesion's equator. as well investigation with single voxel acquisition was used as the lesions were localized in areas where multi-voxel acquisition had proved difficult (cerebellum, brainstem or in supratentorial cortico-subcortical site). To get an accurate assessment of the tumor chemistry, the spectroscopic voxel was placed over an enhancing region of the tumor, avoiding areas of necrosis, hemorrhage, calcification, and cysts. Each patient was examined by both short TE (2000/35) (TR/TE) and long TE (1500/144) sequences.Perfusion and spectroscopy imaging quantitative data were analyzed blindly by experienced neuroradiologist using a dedicated post-processing workstation. Perfusion CBV maps were evaluated by detecting the normalized maximum value of the lesion in relation to the contra lateral normal white matter value (rCBV). With reference to spectroscopy, the maximum Cho/NAA ratio of a voxel selected in the solid tumor area was calculated. In addition, the presence of lactate peak was also taken into account.

III. RESULTS

Table No (1) Distribution of study sample according to age, frequency and percentages

Age	*Frequency*	*Percentages (%)*
<10	5	3.9
11-20	9	7.0
21-30	10	7.8
31-40	16	12.5
41-50	34	26.6
51-60	30	23.4
61+	24	18.8
Total	128	100.0(%)

Table No (2) Detailed distribution of Tumor territory in the brain site Cross tabulated with Age

		Age						Total
		11-20	21-30	31-40	41-50	51-60	>60	
Right Parietal	Count	1	0	0	3	8	2	14
	% of Total	.8%	.0%	.0%	2.3%	6.3%	1.6%	10.9%
Left Temporal	Count	2	0	0	4	4	3	13
	% of Total	1.6%	.0%	.0%	3.1%	3.1%	2.3%	10.2%
Right Temporal	Count	0	0	1	2	0	2	5
	% of Total	.0%	.0%	.8%	1.6%	.0%	1.6%	3.9%
Extra-axial	Count	0	0	3	0	1	3	7
	% of Total	.0%	.0%	2.3%	.0%	.8%	2.3%	5.5%
Left Parietal	Count	0	0	4	2	0	3	9
	% of Total	.0%	.0%	3.1%	1.6%	.0%	2.3%	7.0%
Left Frontal	Count	1	0	5	1	3	3	13
	% of Total	.8%	.0%	3.9%	.8%	2.3%	2.3%	10.2%
Right Frontal	Count	0	2	0	6	1	2	11
	% of Total	.0%	1.6%	.0%	4.7%	.8%	1.6%	8.6%
Occipital	Count	0	1	1	5	6	1	14
	% of Total	.0%	.8%	.8%	3.9%	4.7%	.8%	10.9%
Intra- axial	Count	0	2	1	0	3	0	6
	% of Total	.0%	1.6%	.8%	.0%	2.3%	.0%	4.7%
Thalamus	Count	0	0	0	0	2	0	2
	% of Total	.0%	.0%	.0%	.0%	1.6%	.0%	1.6%
Left middle and Interior cranial fossa	Count	0	1	0	0	1	0	2
	% of Total	.0%	.8%	.0%	.0%	.8%	.0%	1.6%
Left parasagittal	Count	0	0	0	1	0	0	1
	% of Total	.0%	.0%	.0%	.8%	.0%	.0%	.8%
Posterior fossa	Count	0	1	0	0	0	1	2

	% of Total	.0%	.8%	.0%	.0%	.0%	.8%	1.6%
Trigone of right lateral ventricle	Count	1	0	0	0	0	0	1
	% of Total	.8%	.0%	.0%	.0%	.0%	.0%	.8%
Level of Sylvain aqueduct	Count	0	0	0	0	0	1	1
	% of Total	.0%	.0%	.0%	.0%	.0%	.8%	.8%
Superior vermis of left cerebi	Count	1	0	0	0	1	0	2
	% of Total	.8%	.0%	.0%	.0%	.8%	.0%	1.6%
Left cerebellopontine angle and petrus apex	Count	0	0	1	2	1	0	4
	% of Total	.0%	.0%	.8%	1.6%	.8%	.0%	3.2%
Left orbital apex	Count	0	0	0	0	0	1	1
	% of Total	.0%	.0%	.0%	.0%	.0%	.8%	.8%
Right cerebellar hemisphere	Count	1	0	0	0	0	0	1
	% of Total	.8%	.0%	.0%	.0%	.0%	.0%	.8%
Hypothalamus	Count	1	0	0	0	0	0	1
	% of Total	.8%	.0%	.0%	.0%	.0%	.0%	.8%
Under flax	Count	0	0	0	1	0	0	1
	% of Total	.0%	.0%	.0%	.8%	.0%	.0%	.8%
Bi-frontal lobes	Count	0	1	0	2	0	2	5
	% of Total	.0%	.8%	.0%	1.6%	.0%	1.6%	4.0%
Corpus Callosum	Count	1	0	1	0	0	0	2
	% of Total	.8%	.0%	.8%	.0%	.0%	.0%	1.6%
Basal ganglia	Count	0	1	2	1	1	0	5
	% of Total	.0%	.8%	1.6%	0.8%	.8%	.0%	3.9%
Fronto-temporal and Insular cortex	Count	0	0	1	0	2	0	3
	% of Total	.0%	.0%	.8%	.0%	1.6%	.0%	2.4%
Anterior horn of lateral ventricle	Count	0	0	0	1	0	1	2
	% of Total	.0%	.0%	.0%	.8%	.0%	.8%	1.6%
Total	Count	9	9	20	31	34	25	128
	% of Total	7.0%	7.0%	15.6%	24.2%	26.6%	19.5%	100.0%
	P-value= 0.006							

Table No (3) Distribution of study sample according to Radiologist Diagnosis for the brain lesions

Diagnosis	***Frequency***	***Percentages (%)***
Astrocytoma*	58	45.3
Gliomatosis Cerebri/ Glioblastic Multiform/ (GBM)/ Oligodendroglioma	44	34.4
Meningioma	8	6.3
Metastatic	3	2.3
Lymphoma	2	1.6
Ependymal tumors **	13	10.1
Total	128	100.0 (%)

**The Classification of astrocytoma is divided basically into Astrocytoma, WHO grade I (AI), Astrocytoma, WHO grade II (AII),Anaplastic astrocytoma, WHO grade III (AA III), Glioblastoma multiforme, WHO grade IV (GBM IV) ,pilocytic astrocytoma and Giant cell astrocytoma*.

** Ependymal tumors (including Ependymoma *and Subependymoma)*, 5 cases were Ependymoma and 8 were Subependymoma

Table No (4) Perfusion-MRI (rCBV) for lesions characteristics

Perfusion Character	*Frequency*	*Percentages (%)*
Normal	56	43.8
Hypo- perfused	38	29.7
Hyper- perfused	34	26.6
Total	128	100.0 (%)

Table No (5) Cross tabulation between the MRS Metabolite values and Perfusion-MRI (rCBV),* STEAM and PRESS Techniques*Long TE (1500/144) and Short TE (2000/35)***

	NAA	*Cho*	*Cr*	*Cho/ NAA*	*Cho/ Cr*	*NAA/ Cr*	*Lactate*	*Lip*
Perfusion-MRI (rCBV) P-Value	.944 ±.8 (.032)	1.25 ±1.1 (.309)	1.30 ±1.2 (.800)	1.83 ±1.2 (.000)	2.45 ±.96 (.000)	1.28 ±.68 (.677)	1.33 ±.33 (.225)	.97 ±.33 (.865)
STEAM P-Value	.94 ±.89 (.380)	1.25 ±1.1 (.659)	1.30 ±1.2 (.139)	1.83 ±1.2 (.403)	2.45 ±.9 (.291)	1.28 ±.6 (.770)	1.33 ±.3 (.994)	.97 ±.3 (.822)
PRESS P-Value	.94 ±.89 (.380)	1.25 ±1.1 (.659)	1.30 ±1.2 (.139)	1.83 ±1.2 (.403)	2.45 ±.96 (.291)	1.28 ±.68 (.770)	1.33 ±.33 (.994)	.97 ±.33 (.822)

Table No (6) Cross tabulation between the MRS Metabolite values and the diagnosis of brain tumors*Long TE (1500/144) and Short TE (2000/35)

Diagnosis	*NAA*	*Cho*	*Cr*	*Cho/ NAA*	*Cho/ Cr*	*NAA/ Cr*	*Lactate*	*Lip*
Astrocytoma	1.05 ±1.04	1.41 ±1.44	1.35 ±1.34	1.67 ±1.01	2.23 ±.87	1.23 ±.61	1.40 ±.41	.865 ±.12
GliomatosisCerebri/ GlioblasticMultiform/ (GBM)/and Oligodendroglioma	0.71 ±.43	1.04 ±.74	1.22 ±.91	2.21 ±1.57	2.87 ±1.01	1.35 ±.867	1.28 ±.30	1.08 ±.46
Meningioma	0.76 ±.27	0.72 ±.31	0.91 ±.44	1.26 ±.349	2.07 ±.950	1.14 ±.203	1.33 ±.00	.900 ±.00
Metastatic	0.97 ±.56	1.22 ±.104	1.41 ±1.703	2.04 ±.505	2.88 ±.085	1.55 ±.593	-	-
Lymphoma	2.73 ±2.92	2.22 ±2.19	3.41 ±3.79	1.08 ±.25	1.39 ±.30	1.19 ±.00	-	-
Ependymoma	0.83 ±0	1.15 ±.00	0.41 ±.00	1.38 ±.00	2.80 ±.00	2.02 ±.00	-	-
P-value	0.029	0.369	.187	0.141	0.004	0.818	0.736	0.624

***Table No (7) Cross tabulation between the radiologist diagnosis of brain tumors* and the lesion Perfusion-MRI (rCBV) results**

Diagnosis * Perfusion-MRI (rCBV) Cross tabulation					
Diagnosis /***P-value=0.001***		**Perfusion-MRI (rCBV)**			Total
		Hyper-perfusion	**Normal**	**Hypo-perfusion**	
Astrocytoma	Count	12	20	26	58
	% of Total	9.4%	15.6%	20.3%	54.7%
GliomatosisCerebri/	Count	21	18	5	44

GlioblasticMultiform/ (GBM)/and Oligodendroglioma	% of Total	16.4%	14.1%	3.9%	34.4%
Meningioma	Count	1	2	5	8
	% of Total	0.8%	1.6%	3.9%	6.2%
Metastatic	Count	0	3	0	3
	% of Total	0.0%	2.3%	0.0%	2.3%
Lymphoma	Count	0	0	2	2
	% of Total	0.0%	0.0%	1.6%	1.6%
Ependymal Tumor	Count	0	13	0	13
	% of Total	0.0%	10.2%	0.0%	10.2%
Total	Count	34	56	38	128
	% of Total	26.6%	43.8%	29.7%	100.0%

***Table No (8) Cross tabulation between the radiologist diagnosis of brain tumors* and PRESS and STRESS results**

Diagnosis	**STEAM**		**Total**	**PRESS**		Total
	Normal	**Above**		**Normal**	**Under**	
Astrocytoma	55	3	58	55	3	58
	42.9%	2.3%	45.3%	42.9%	2.3%	45.3%
Gliomatosis Cerebri/ GlioblasticMultiform/ (GBM)/and Oligodendroglioma	44	0	44	44	0	44
	34.4%	0.0%	34.4%	34.4%	0.0%	34.4%
Meningioma	6	2	8	6	2	8
	4.7%	1.6%	6.2%	4.7%	1.6%	6.2%
Metastatic	3	0	3	3	0	3
	2.3%	0.0%	2.3%	2.3%	0.0%	2.3%
Lymphoma	2	0	2	2	0	2
	1.6%	0.0%	1.6%	1.6%	0.0%	1.6%
Ependyal Tumor	13	0	1	13	0	13
	10.2%	0.0%	0.8%		0.0%	10.2
	123	5	128	123	5	128
	96.1%	3.9%	100.0 %	96.1%	3.9%	100.0 %
	P-value =0.042			**P-value=0.042**		

IV. DISCUSSION

The study was designed by obtaining a spectrum, that was analyzed, and was influenced by many parameters, including chemical characteristics of each metabolite and the compounds in which they are located; NAA ,Cho, Cr Cho/ NAA, Cho/ Cr, NAA/ Cr , Lactate and Lipid at the selection of the area to study. Lesions to be considered are cystic, solid, homogeneous, and heterogeneous. And the perfusion character to be as hyper-perfusion, normal and hypo- perfused. Choice of the technique type to be employed was (monovoxel or multivoxel) and of the sequence to be used (PRESS and STEAM) and the choice of the echo time (short or long). Table (1) presented the distribution of the sample age; the most common affected age was age between 41-50 years old constituting 34(26.6%).Table (2) showed detailed distribution of tumor territory in the brain site cross tabulated with age where a significant relation was detected between the site and age at *p*-value= 0.006.

All the lesion were diagnosed according to the standard criteria of diagnosis done by radiologist, the astrocytomas, were found in 58(45.3%) of the cases where the ependymoma and lymphoma were found in 13(10.1%) and 2(1.6%) of the cases in respectively (table 3)

Classification of astrocytoma is divided basically into Fibrillary astrocytomas including Astrocytoma, WHO grade I (AI), Astrocytoma, WHO grade II (AII),Anaplastic astrocytoma, WHO grade III (AA III), Glioblastoma multiforme, WHO grade IV (GBM IV), and Other astrocytomas: Gliomatosis cerebri, pilocytic astrocytoma ,Giant cell astrocytoma ,subependymal tumor and other types[15]. In our sample the astrocytoma included (diffused anaplastic ,Glioblastoma multiforme ,pilocytic astrocytoma and giant cell astrocytoma and are constituting most of the cases 58 out of 128 (45.3%).Anaplastic astrocytomas are mostly located in the cerebral hemispheres with imaging features as heterogeneous mass with edema appears in most of the cases with good enhancement after contrast .Glioblastoma multiforme (GBM) also was located is in the hemispheres with imaging features appears as heterogeneous mass highly contrast enhancement with extensive vasogenic edema and mass effect. The Pilocytic astrocytomas appear in the cerebellum and are usually appear as cystic and have intense mural enhancement. Gliomatosis cerebri was found in 44(34.4%) of the cases and is characterized as diffuse growth of glial neoplasm within brain, with no gross mass lesions but a diffuse infiltration of brain tissue by tumor cells are present; it appears as non-enhancing lesions. Ependymal tumors were found to be 13(10.1%) out of the 128 case, 5 cases were Ependymoma and 8 were Subependymoma, it was located adjacent to ventricles within the parenchyma and periventricular area with imaging features resemble astrocytoma . Our trend in the classical diagnosis depend upon the T_1 and T_1 after contrast it allows differentiation of lesions by the difference in the standard criteria of diagnosis and signal intensity[15] .The current study used the perfusion technique and were characterized as moderate ,poor and well perfused ,this was noticed in table(4).

Because conventional MRI allows for only indistinguishable identification and localization of tumors, biopsies were routinely required to diagnose tumors. Unfortunately, many tumors may be unapproachable for biopsy; therefore another method is needed. MRS had the advantage of being a noninvasive diagnostic procedure. [16,17] For that reason we investigate the value of this technique in diagnoses of brain tumors by comparing the radiologist reports at perfusion ,STEAM and PRESS with the MRS chemical results, Table No (5) .

Studies showed that MRS can show the abnormal findings in nearly 100% of brain tumors, as well it is useful in the differential diagnosis of brain tumors and in characterization of metabolic changes associated with tumor progression, degree of malignancy, and response to treatment .[18-23]

At present study, the best possible pulse sequence parameters when using MRS for characterizing tumors are controversial. The parameter that largely influences the spectrum is TE. A long TE allows the observation of a reduced number of metabolites and has less baseline distortion, yielding a spectrum that is easy to process, analyze, and interpret. At approximately 144 TE, Ala and Lactate doublets are inverted because of J-coupling, making it easier to differentiate these resonances from lipids and other molecules. On the other hand, more resonances are visible at short TE because the signal intensity from compounds with strong J-modulation may be lost at long TE. Accordingly, a short TE is used for better evaluation of lipids, myo-inositol, glutamine, and glutamate. In this study, we tested the influence of TE; Long TE (1500/144) and Short TE (2000/35) in the classification of the most common tumor types found in the brain.

In Normal spectroscopy Cho/Cr ratio is near 1; ratio 2:1 and in high grade tumors decreased NAA Cho/Cr ratio > 2:1[15] and in cases of brain tumors it showed multiple metabolic changes including high Cho ,low NAA, low Cr, high Lactate and Lipids.[24]

Diffusion-weighted imaging provides a way to evaluate the diffusion properties of water molecules in tissue and has been used for diseases [25]. In recent publications, diffusion-weighted imaging is believed to be valuable in the diagnosis of different lesions and tumors. [26, 27]. The current study was obtained to compare MRS findings with those of diffusion-weighted imaging to determine which technique is more effective in characterization and diagnosis of brain tumors. The current study showed significant results between the perfusion findings and the MRS values regarding *Cho/ NAA* 1.83±1.224 at *p*= (0.000) and *Cho/ Cr value* 2.45±.968 at *p* = (.000) with no significant relation between other MRS parameters with STEAM and PRESS techniques.

In our clinical practice we used short echo times (TEs) less than 30ms and adequate scan was obtained with TE as long as 144ms and 288ms milliseconds for PRESS technique. For MRS using Long TE (1500/144ms); the signal from most metabolites in the brain is lost except that of choline (Cho), creatine (Cr), *N*-acetyl aspartate (NAA), and lactate. Conversely, short TEs (2000/35ms) allow for identification of many other metabolites Lipids, lactate, ala, myoinositol, glutamate, and glutamine. For this important value, MRS is better to be included as part of a routine imaging study. At our institution, we have created a set organized work which allows the technologist to perform the study easily by setting the location of the voxel and

tailoring its size to correspond grossly to the abnormality in question. A voxel should include as much of the abnormality as possible and little normal surrounding brain tissue.

Astrocytomas show a relative reduction in NAA and Cr, and Cho comparing with the lymphoma .The spectra of metastases are similar to those of meningioma and gliomatos cerebri and ependemal tumors, with low NAA, low Cr, and high Cho levels. The difference was found to be significant in the NAA values at different brain lesions with no significant value in the reduction or increasing of Cho and Cr these were noticed in table (6)

Similarly; regarding astrocytomas, several studies, have suggested an association between tumor character and Cho levels, the higher grade tumors having greater Cho concentrations. [28] Some studies have found high-grade tumors glioblastoma multiforme (GBM)) to have lower levels of Cho than grade II or grade III astrocytoma.[29] This may be due to the presence of necrosis in high-grade tumors, particularly those with necrotic cores, since necrosis is associated with low levels of all metabolites.[30,31,32] Our opinion is that tumors are commonly heterogenous, with necrotic cores, proliferative rims and invasion of surrounding brain tissue and the spectrum may vary greatly depending on the region that is sampled by MRS therefore, the region-of interest chosen for analysis may have a large influence on the results. One study used MR perfusion imaging to guide the spectral measurement location; and they found no significant relation between changes in NAA,Cho, Cr, NAA/Cr, lactate and lipids were detected in normal or hypoperfused tumor regions while the Cho/NAA and Cho/Cr has significant impact [33] But our study showed a significant relation between the diagnosis and the character of the tumors to be hyper or hypo or normal perfusion as noticed in table(7)

The current study results was consistent with previous studies [34,35] who have mentioned that for characterization of metastases from other brain tumors, it has been suggested that gliomas showed elevation in Cho in surrounding tissue where metastatic lesions tend to be more encapsulated and therefore show high Cho signals or other abnormalities outside the region of enhancement as well metastatic lesions always elevated lipid peaks; thus, if the lesion does not exhibit mobile lipid signals,anaplastic glioma is more likely.[36].

The current study showed that Cho/Cr has significant impact in differentiation of lymphoma from other lesions with p value = 0.004 where the other parameters Cho/ NAA, NAA/ Cr, Lactate and Lipid have no significant relationship. By combining both MRS and perfusion MRI, the diagnosis of lesions was achieved with value of 0.944±.896 for NAA and Cho/ NAA 1.83±1.224 however another study showed that the cutoff points of NAA/Cho $\leq$ 0.61 and rCBV $\geq$1.50 in corresponding to tumor diagnosis.[37] and another one showed that presence of tumor was indicated when Cho/NAA ratio was greater than 1.9.[38] .Table (7,8) showed a significant relation between the diagnosis of tumors and Perfusion-MRI (rCBV) , STEAM and PRESS results at P-value=0.001,0042 and 0.042 in respectively.

V. CONCLUSION

The diagnostic strategy was evaluated; Perfusion-MRI (rCBV) and MRS are useful as additional imaging techniques for establishing the differential diagnosis between brain metastases and brain tumors. Both has significant relation in differentiation and diagnosis of brain tumors; as hyper-hypo or normally perfused as well in chemical characteristics of each metabolite and the compounds in which they are located; *N*-acetyl aspartate (NAA) , Cho/ NAA, Cho/ Cr at the selection of the area to study. MRI-based techniques including results from perfusion MRI, and MRS were proposed to improve the diagnosis and characterizing of brain lesions as astrocytoma, gliomatosis cerebri ,meningioma, lymphoma ,ependymal tumors and metastases.

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References

[1]. Atlas SW (2009) Magnetic resonance imaging of the brain and spine. Vol. 1, Lippincott Williams & Wilkins. Retrieved from http://books.google.com/books?hl=en&lr=&id=Mu7MmTXkPeAC&oi=fnd&pg=PA2&dq=Magnetic+Resonance+Imaging+of+the+Brain+and+Spine+&ots=r-HF5m9Ljk&sig=4kyZ3_v7isCJ_RucvOLgI4voALo

[2]. Andreasen NC (1988) Brain imaging: applications in psychiatry. Science 239:1381-1388.

[3]. Brant WE, Helms CA (1999) Fundamentals of diagnostic radiology. Lippincott Williams & Wilkins. Retrieved from http://books.google.com/books?hl=en&lr=&id=o_4eoeOinNgC&oi=fnd&pg=PP2&dq=Fundamentals+of+Diagnostic+Radiology&ots=mmWiwMw7XB&sig=XsHaiOG23xGMoYnHaLU4C8OPad4

[4]. Howe FA, Barton SJ, Cudlip SA et al (2003) Metabolic profiles of human brain tumors using quantitative in vivo 1H magnetic resonance spectroscopy. Magn Reson Med 49:223-232.

[5]. Nelson SJ, McKnight TR, Henry RG (2002) Characterization of untreated gliomas by magnetic resonance spectroscopic imaging. Neuroimaging Clin N Am 12:599-613.

[6]. Poptani H, Gupta RK, Roy R, Pandey R, Jain VK, Chhabra DK (1995) Characterization of intracranial mass lesions with in vivo proton MR spectroscopy. AJNR Am J Neuroradiol 16:1593-1603.

[7]. Law M, Cha, Knopp EA, Johnson G, Arnett J, Litt AW (2002) High-Grade Gliomas and Solitary Metastases: Differentiation by Using Perfusion and Proton Spectroscopic MR Imaging Radiology 222:715-721.
[8]. Bottomley PA. Spatial localization in NMR spectroscopy in vivo. Ann N Y Acad Sci 1987;508:333–348. [PubMed: 3326459]
[9]. Frahm J. Localized Proton Spectroscopy using stimulated echoes. J Magn Reson 1987;72(3):502– 508.
[10]. Brown TR, Kincaid BM, Ugurbil K. NMR chemical shift imaging in three dimensions. Proc Natl Acad Sci U S A 1982;79(11):3523–3526.
[11]. Alena Horská, Peter B. Barker, D. Phil. 2010 Imaging of Brain Tumors: MR Spectroscopy and Metabolic Imaging Neuroimaging Clin N Am. August ; 20(3): 293–310.
[12]. Graves EE, Nelson SJ, Vigneron DB et al (2001) Serial proton MR spectroscopic imaging of recurrent malignant gliomas after gamma knife radiosurgery. AJNR Am J Neuroradiol 22:613-624.
[13]. Louis DN, Holland EC, Cairncross JG (2001) Glioma classification: a molecular reappraisal. Am J Pathol 159:779.
[14]. Brandao L, Domigues R (2003). MR Spectroscopy of the Brain, Lippincott Williams & Wilkins. http://www.amazon.com/Spectroscopy-Brain-Lara-Brand-27/dp/0781746167/ref=sr_1_1?s=books&ie=UTF8&qid=1407910432&sr=1-1&keywords=MR+Spectroscopy+of+the+Brain.+Lippincott+Williams+%26+Wilkins%2C+2003
[15]. Ralph Weissleder, Jack Wittenberg, Mukesh G. Harisinghani, John W. Chen, PRIMER OF DIAGNOSTIC IMAGING, FIFTH EDITION Printed in United States of America 2007, by Mosby, Inc. ISBN: 978-0-323-06538-2.
[16]. Ahmed Shokry(2012) MRS of brain tumors: Diagrammatic representations and diagnostic approachThe Egyptian Journal of Radiology and Nuclear Medicine 43, 603–612.
[17]. Nelson SJ. Multivoxel magnetic resonance spectroscopy of brain tumors. Mol Cancer Ther 2003;2:497–507.
[18]. Butzen J, Prost R, Chetty V, et al. Discrimination between neoplastic and nonneoplastic brain lesions by use of proton MR spectroscopy: the limits of accuracy with logical regression model. AJNR Am J Neuroradiol 2000;21:1213–1219
[19]. Kimura T, Sako K, Gotoh T, Tanaka K, Tanaka T. In vivo singlevoxel proton MR spectroscopy in brain lesions with ring-like enhancement. NMR Biomed 2001;14:339–349
[20]. Dowling C, Bollen AW, Noworolski SM, et al. Preoperative proton MR spectroscopic imaging of brain tumors: correlation with histopathologic analysis of resection specimens. AJNR Am J Neuroradiol 2001;22:604–612
[21]. Tzika AA, Zarifi MK, Goumnerova L, et al. Neuroimaging in pediatric brain tumors: Gd-DTPA-enhanced, hemodynamic, and diffusion MR imaging compared with MR spectroscopic imaging. AJNR Am J Neuroradiol 2002;23:322–333
[22]. Moller-Hartmann W, Herminghaus S, Krings T, et al. Clinical application of proton magnetic resonance spectroscopy in the diagnosis of intracranial mass lesions. Neuroradiology 2002;44:371– 381
[23]. Sener RN. Longstanding tectal tumors: proton MR spectroscopy and diffusion MRI findings. Comput Med Imaging Graph 2002;26:25–31
[24]. Janet Cochrane Miller 2012 Magnetic Resonance Spectroscopy in the Brain volume 10issue 7
[25]. Rowley HA, Grant PE, Roberts TP. Diffusion MR imaging: theoryand applications. Neuroimaging Clin N Am 1999;9:343–361
[26]. Noguchi K, Watanabe N, Nagayoshi T, et al. Role of diffusionweighted echo-planar MRI in distinguishing between brain abscess and tumour: a preliminary report. Neuroradiology 1999;41:171–174
[27]. Desprechins B, Stadnik T, Koerts G, Shabana W, Breucq C, Osteaux M. Use of diffusion-weighted MR imaging in differential diagnosis between intracerebral necrotic tumors and cerebral abscesses. AJNR Am J Neuroradiol 1999;20:1252–1257
[28]. Hourani R, Horska A, Albayram S, et al. Proton magnetic resonance spectroscopic imaging to differentiate between nonneoplastic lesions and brain tumors in children. J Magn Reson Imaging 2006;23(2):99–107.
[29]. Howe FA, Barton SJ, Cudlip SA, et al. Metabolic profiles of human brain tumors using quantitative in vivo 1H magnetic resonance spectroscopy. Magn Reson Med 2003;49(2):223–232.
[30]. Preul MC, Leblanc R, Caramanos Z, et al. Magnetic resonance spectroscopy guided brain tumor resection: differentiation between recurrent glioma and radiation change in two diagnostically difficult cases. Can J Neurol Sci 1998;25(1):13–22.
[31]. Ricci PE, Pitt A, Keller PJ, et al. Effect of voxel position on single-voxel MR spectroscopy findings. AJNR Am J Neuroradiol 2000;21(2):367–374.
[32]. Senft C, Hattingen E, Pilatus U, et al. Diagnostic value of proton magnetic resonance spectroscopy in the noninvasive grading of solid gliomas: comparison of maximum and mean choline values. Neurosurgery 2009;65(5):908–913. discussion 13.
[33]. Chawla S, Wang S, Wolf RL, et al. Arterial spin-labeling and MR spectroscopy in the differentiation of gliomas. AJNR Am J Neuroradiol 2007;28(9):1683–1689.
[34]. Fan G, Sun B, Wu Z, et al. In vivo single-voxel proton MR spectroscopy in the differentiation ofhigh-grade gliomas and solitary metastases. Clin Radiol 2004;59(1):77–85.
[35]. Chiang IC, Kuo YT, Lu CY, et al. Distinction between high-grade gliomas and solitary metastases using peritumoral 3-T magnetic resonance spectroscopy, diffusion, and perfusion imagings. Neuroradiology 2004;46(8):619–627.
[36]. Ishimaru H, Morikawa M, Iwanaga S, et al. Differentiation between high-grade glioma and metastatic brain tumor using single-voxel proton MR spectroscopy. Eur Radiol 2001;11(9):1784– 1791.
[37]. Hourani R, Brant LJ, Rizk T, et al. Can proton MR spectroscopic and perfusion imaging differentiate between neoplastic and nonneoplastic brain lesions in adults? AJNR Am J Neuroradiol 2008;29(2):366–372. [PubMed: 18055564]
[38]. Majos C, Aguilera C, Alonso J, et al. Proton MR spectroscopy improves discrimination between tumor and pseudotumoral lesion in solid brain masses. AJNR Am J Neuroradiol 2009;30(3):544– 551.

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