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Magnetic Resonance Spectroscopic Evaluation of Intraaxial Neoplasms

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Abstract
Intraaxial neoplasms constitute a major chunk of intracranial neoplasms. As conventional imaging characteristics are sometimes similar especially when grade of tumor is taken into account, Magnetic Resonance Spectroscopy (MRS) helps in differentiating various neoplasms and their grades. Gliomas are the most commonly encountered neoplasms. Due to delay in diagnosis and/or magnitude of symptoms, usually grade IV gliomas are more prevalent. MRS helps to determine the extent of perilesional spread as well.
A total of 44 patients diagnosed with intraaxial brain neoplasms in conventional MRI were subjected to MRS. Study was done over a period of 2 years. Most common age group of presentation was 51-60yrs of age. Grade IV neoplasms were more frequently encountered.
Diagnostic accuracy of MRS with respect to grading of neoplasms reached 88% as compared to 58% in conventional MRI when 1st differential diagnosis was taken into account.
Keywords: *Grade IV glioma, Cho/Cr, Cho/NAA, Lipid lactate, MI/Cr.*

Introduction

Brain tumors show a rising trend on recent times. Although conventional CT and MRI can help reach at a specific diagnosis, confusion regarding the same is quite common. The advent of an advanced modality like MRS has helped a lot in solving this problem. MRS is helpful in distinguishing neoplastic and non-neoplastic lesions whose management differs a lot. A wide variety of intraaxial neoplasms such as gliomas, neuronal/ mixed glial and neuronal tumors, embryonal tumors and metastases is encountered in day to day practice. Gliomas being the most common are evaluated the most. Grading of gliomas in particular, is thus very essential for proper management.

Materials and Methods

A total of 44 patients diagnosed to harbour intraaxial lesion(s) in conventional MRI were subjected to MRS using 1.5 Tesla MRI machine over a period of 2 years i.e from October 2016 to September 2018. Patients with intracerebral haemorrhage/infarct, non-neoplastic lesions, vascular malformations and with metallic implants, fixators were excluded from the study.

Histopathological correlation was done wherever possible.

Results

A total of 44 cases with intraaxial neoplasms were studied over a period of 2years. Most common age group of presentation was 51-60 years of age. There was a definite male predominance. Grade IV Gliomas outnumbered other neoplasms (Table 1).

Table 1 Types of Neoplasm encountered in the Study Subjects

Neoplastic Lesions	Number of Cases	Percentage
Grade II Glioma	4	9.09
Grade III Glioma	6	13.63
Grade IV Glioma	28	63.63
Metastasis	4	9.09
PNET	2	4.54
Total	**44**	**100**

Grade IV Gliomas outnumbered the other neoplasms in frequency (63.63%).

Table 2 Choline/Creatine Ratio in Various Intra-axial Brain Lesions

Intraaxial BrainLesions	Mean Choline/Creatine Ratio ± SEM in Different Types of Intraaxialtumors	
	Lesional	Perilesional White Matter
Grade II Glioma	1.90±0.04	-
Grade III Glioma	2.18±0.19	1.51±0.08
Grade IV Glioma	2.87±0.15	1.71±0.09
PNET	3.75±0.15	6.60±0.15
Metastasis	2.30±0.15	0.80±0.06

*p<0.05 (significant difference) in Kruskall Wallis Test.

No difference was found in the Lesional Cho/Cr ratio between Grade II and Grade III Glioma (p = 0.588) and between Grade III and Grade IV Gliomas (p= 0.052). Also Perilesional Cho/Cr ratio between Grade III and Grade IV Gliomas was not significantly different (p=0.401).

Table 3 Choline/N-Acetyl Aspartate Ratio in Various Intra-axial Brain Lesions

Intra-axial Brain Lesions	Mean Choline/ NAA Ratio ± SEM in Different Types of Intraaxial Lesions	
	Lesional	Perilesional White Matter
Grade II Glioma	1.40 ± 0.04	-
Grade III Glioma	1.81± 0.44*	1.30 ± 0.19
Grade IV Glioma	3.50 ± 0.36*	1.59 ± 0.09
PNET	12.80 ± 6.70	6.60 ± 2.50
Metastasis	1.60 ± 0.15	0.82 ± 0.16

* p< 0.05 (significant difference) Kruskall Wallis Test.

There was no difference in the Cho/NAA ratio between Grade II and Grade III Glioma (p=1.00), but there was a significantly higher lesional Cho/NAA ratio in Grade IV Glioma than Grade III Glioma (p=0.011).There was no difference observed in perilesional Cho/NAA ratio between Grade III and Grade IV Gliomas (p=0.238).

Markedly elevated Cho/NAA ratios were observed in higher grade tumors such as PNET, Grade III and Grade IV gliomas. Mean ratio was also increased in perilesional white matter of PNET, Grade III and Grade IV Gliomas.

Table 4 LL/Creatine Ratio in Various Intra-axial Brain Lesions

Intra-axial Brain Lesions	Mean LL/ CreatineRatio ± SEM
Grade II Glioma	1.17 ± 0.04
Grade III Glioma	1.10 ±0.16*
Grade IV Glioma	5.10 ±0.79*
PNET	1.20 ±0.05
Metastasis	2.30 ±0.58

*p< 0.05 (significant difference) Kruskall Wallis Test.

Significantly higher LL/Cr ratio was observed in Grade IV glioma than Grade III (p=0.002).

But the LL/Cr ratio was not significantly different in Grade IV glioma and Metastasis (p=0.135)

Table 5 Myo Inositol/Creatine Ratio in Various Intra-axial Neoplasms

Type of Neoplasm	Mean MI / CreatineRatio ± SEM
Grade II	0.90 ± 0.04
Grade III	0.33 ± 0.04
Grade IV	0.52 ± 0.24
PNET	0.15 ± 0.05
Metastasis	0.30 ± 0.04

Mean MI/Cr ratio was elevated (>0.6) in Grade II Glioma which is considered characteristic for it

Table 6 Accuracy of MRI and MRS in Diagnosis and Grading of Neoplastic Lesions

Type of Investigation	No. of Cases Showing Positive Diagnosis	Sensitivity of the Test	Specificity of the Test	Positive Predictive Value	Negative Predictive Value
1st Differential MRI	21	58.33	100	100	0
MRS	32	88.88	100	100	0
Biopsy	36	100	100	100	0

Accuracy of MRS diagnosis with respect to Grading of Tumors was significantly higher than MRI diagnosis done alone.

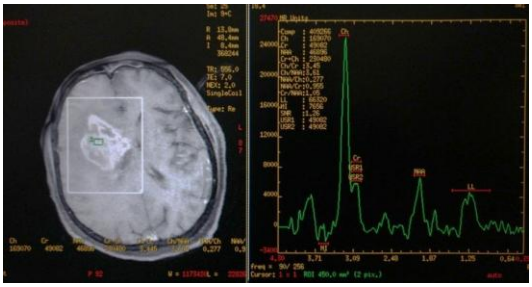


Fig 1. MRS spectrum shows elevated Cho/Cr and Cho/NAA ratios of 1.9 each with discernible Lactate Peak. This was proved as High Grade Glioma on post operative biopsy.

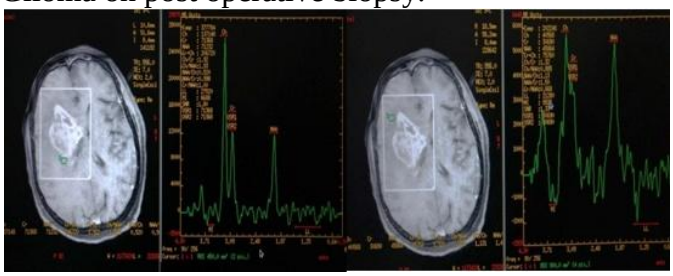


Fig 2. MRS spectrum in the same patient with voxel placed in perilesional white showing elevated Cho/Cr and Cho/NAA ratios indicative of perilesionaltumor infiltration. The spectrum on the right shows NAA peak consistent with relative preservation of neural tissue.

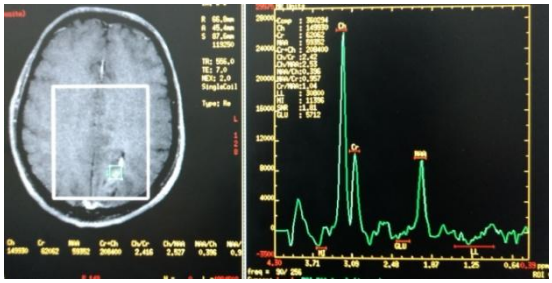


Fig 3.MRS showing markedly elevated Choline Peak. Lipid Peak was not significant. This was biopsy proven Anaplastic Astrocytoma. Note the excellent shimming in this image.

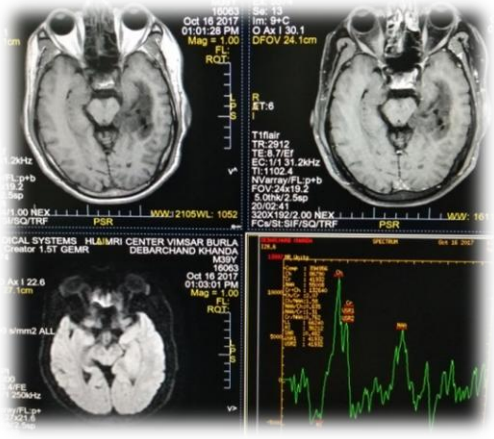
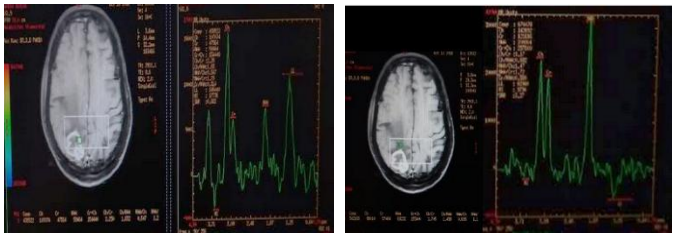


Fig 4 Spectral acquisition of a non-enhancing lesion in left temporal lobe reveals high Choline Peak and MI/Cr Ratio > 0.6 which is a characteristic feature of Low Grade Glioma.



(a) (b)

Fig 5(a),(b) show a case of metastases from Lung carcinoma. Fig 5(a) There was a high Lipid Lactate Peak which is more commonly found in Metastatic Lesions.Fig 5(b). When voxel was placed in perilesional area, Cho/Cr ratio of 1.1(within non neoplastic range) was seen consistent with Metastasis.

Discussion

Most common intraaxial neoplasm in our study was Grade IV Glioma which accounted for 63.63% (28 out of 44) of all cases.(Table 1). This was similar to a study conducted by Riyadh N Al-Okaili et al in which out of 111 patients 65 men were men. The mean age group of intraaxial brain lesions was 48.9 years[1].

In the present study, mean Cho/Cr ratio was 2.87±0.15 in Grade IV Glioma, 2.18±0.19in Grade III Glioma and 1.9±0.04 in Grade II Glioma in our study (Table 2). Fayed et al and Meng et al, demonstrated that, a value greater than 1.56 can differentiate high-grade from low-grade glial tumors which was slightly higher than the values obtained in our study[2,3]. The mean Choline/ Creatine Ratio in perilesional white matter of Grade III Glioma and Grade IV Glioma was found to be 1.51±0.08 and1.71±0.09 respectively. The regions presumed to have tumor infiltration had normalized Cho/NAA ratio >1, which was consistent with a study by Karnawat Shekhar et al[4].

Mean Cho/NAA ratioswere1.4±0.04, 1.81±0.44 and 3.5±0.36in Grade II, grade III and Grade IV Gliomas respectively (Table 3). In metastases, the ratio was 1.6±0.15. No significant difference was observed in the Cho/NAA ratios between Grade II and Grade III Glioma (p=1.00). There was a significantly higher lesional Cho/NAA ratio in Grade IV Glioma than Grade III Glioma (p=0.011). In comparison, in a research by Ahmed Shokry et al, the mean metabolic ratios of Cho/NAA and Cho/Cr

in Grade IV Gliomas were 3.63 and 3.99, in Grade III tumors 2.82 and 2.06, in grade II tumors 1.70 and 1.75, while in grade I astrocytoma 1.62 and 1.58, respectively[5].

LL/Cr ratio in our study for grade II, grade III and grade IV Gliomas were 1.17±0.04,1.1±0.16 and 5.1±0.79 respectively (Table 4). Statistically significant difference in LL/Cr ratio was found when Grade III Glioma was compared with Grade IV Glioma (p=0.002). This was in accordance with study by J. H. Kim, K. H. Chang et al who found significant differences in the ratio between Gr II and Gr IV as well as Gr III and Gr IV astrocytomas, but not between Gr II and Gr III[6].

In our study MI/Cr ratio in grade II glioma was 0.9±0.04 while in Grade III and Grade IV glioma they were0.33±0.04 and 0.52±0.24 respectively (Table 5). This was in accordance to a study by Mauricio Castillo et al who observed that levels of MI/Cr were higher (0.82±0.25) in patients with low-grade astrocytoma, intermediate (0.49±0.07) in control subjects, and lower in patients with anaplastic astrocytoma (0.33±0.16) and GBM (0.15±0.12)[7].

MRI had 58.3% sensitivity in detecting grade of tumor. On the other hand accuracy of MRS had 88.8% sensitivity in detection of tumor grade (Table 6). This was similar to study by Peter E et al who obtained an accuracy rate of 88% when margin of the tumor was included in the voxel[8].

Conclusion

MRS helps us differentiate neoplastic and nonneoplastic lesions thereby avoiding unnecessary brain biopsy and considerably improving management. With respect to grading of neoplastic lesions, MRS was significantly moreaccurate than MRI. Moreover, MRS predicts not onlythe perilesional spread of tumor but also the direction of spread.

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