Can MR Spectroscopy of Extra-Axial Intracranial Tumors Differentiate Meningiomas from Non-Meningiomas?

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SYNOPSIS

The goal of the study is to determine a magnetic resonance spectroscopy (MRS) feature which may help discriminating meningiomas from non-meningiomatous extra-axial tumors. Qualitative and quantitative retrospective analysis of MRS data from a 0.5T scanner was performed on 49 patients, who had imaging features of extra-axial tumors and histopathological results. The data from 8 normal subjects were also included for comparison. Both the qualitative evaluation and the quantitative evaluation that was based on the metabolite-to-water peak amplitude ratio (MWPR) of 6 metabolites revealed that high glutamine-glutamate (Glx) peak may favor the diagnosis of meningioma over non-meningioma.

INTRODUCTION

Imaging modalities such as MRI and CT are usually adequate to differentiate between intra- and extra-axial tumors. It is not uncommon that this differentiation is difficult, particularly when the tumor is large. Imaging often times can not differentiate meningiomas from other extra-axial tumors. The study was performed to identify a MR spectroscopic parameter, if any, that would help to define extraaxial intracranial tumors as meningioma and non-meningioma.

METHODS

MRS data of 8 healthy volunteers and 49 patients (31 females and 18 males, mean age: 52 yrs.) who had histopathological results were retrospectively reviewed. The MRI and/or CT had demonstrated findings of extra-axial intracranial lesions in all patients. MRS had been performed on a 0.5 T clinical MR scanner with no contrast administration immediately before spectroscopic measurements (figure 1). The parameters for spectroscopic acquisition included a point-resolved spectroscopic pulse sequence (PRESS) with two cycle phase alteration, three chemical-shift-selective pulses for water suppression (50-Hz bandwidth), and a repetition time of 1500 msec and an echo time of 41 msec. The acquisition bandwidth was 1000 Hz with 1024 points acquired. The MRS data were evaluated both qualitative and quantitatively. In the qualitative evaluation, two readers reviewed the spectra visually and assigned a score for each metabolite peak from a seven-point scale (-3 to +3) with –3 indicating marked decrease and +3 marked increase. The 0.0 ppm level was used as a reference point. Quantitative evaluation was done in only 39 of 49 patients who had retrievable data and in 8 normals. In the quantitative evaluation, the amplitudes of each metabolite peak and the water peak were determined and the metabolite-to water peak ratios (MWPR) were obtained for N-acetyl aspartate (Naa), Glutamine-Glutamate (Glx), Creatine (Cr) , Choline (Cho), Myo-Inositol (M-Ins), and 3.8 ppm. The ratios were arbitrarily multiplied by 10,000 for the ease of computation. Comparative statistical analyses of meningioma and nonmeningioma groups (with final histopathological diagnoses) were done by two-tailed student's t-test, where $p < 0.05$ was considered statistically significant. Quantitative data from 4 female and 4 male normal subjects were also used in these comparisons. Single and multiple regression analysis were performed to test if the histopathologic diagnosis correlated with the reading scores and the MWPRs. The analysis aimed to identify the change in the metabolite peaks that shows the strongest association with histopathologic diagnosis.

RESULTS

Thirty-two patients had histopathologic diagnosis of meningioma and 17 patients had nonmeningioma, including 2 ependymomas, 2 schwannomas, 2 craniopharyngiomas, 4 sinonasal carcinoma, 4 gliomas, 1 malignant lymphoma, 1 medulloblastoma and 1 pseudoneoplasm of neural axis. Glx was the only peak showing significantly different visual reading scores between two groups ($p<0.001$) (table 1). The single and multiple regression analysis of the reading scores also demonstrated the Glx to have the most significant and the strongest correlation with the diagnosis of meningioma (coefficient: 0.14 and $p<0.001$).

Among 39 patients with retrievable quantitative data, 29 had meningioma and 10 had non-meningioma. There was no statistically significant difference in water peak amplitude between the groups. MWPRs of Naa, M-Ins and Cr were all significantly lower in meningioma group compared to normal group, whereas Glx and Cho were not different. The MWPRs of Glx ($p<0.001$) and 3.8 ppm ($p<0.05$) were significantly higher in meningioma group compared to non-meningioma group (table 2). Single variant regression analysis revealed that Glx was the only metabolite that correlated with meningioma. While both Glx and Cho correlated with meningioma on multivariate regression analysis, the Cho-meningioma correlation disappeared when glx was left out of the regression model.

DISCUSSION

High Alanine peak or high Alanine/Creatine ratio (which are difficult to detect by 0.5 T MRS) had been suggested as specific indicators of meningiomas in 1.5 T MRS. Increase in Glx has also been suggested in meningiomas by some studies. Glx increase is not readily detectable in 1.5 T MR systems, but it can easily be detected in 0.5 T MRS and may favor the diagnosis of meningioma according to our results. In our study group, there was no leptomeningeal metastatic lesions which are considered in the differential diagnosis of extra-axial lesions. The value of MRS in differentiating meningioma from metastatic lesions would require further investigation.

Figure 1. 0. 5 T MRS of a Convexity Meningioma

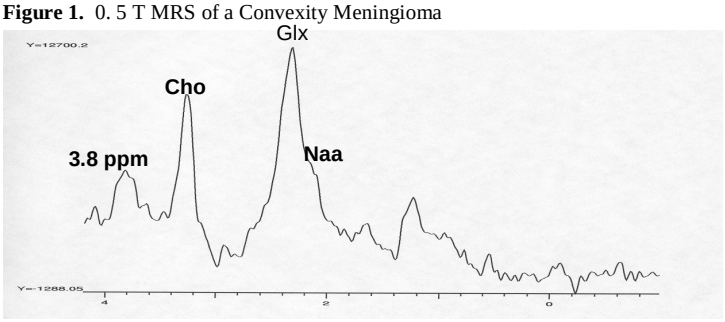

Table 1. Reading Scores in Meningioma vs. Nonmeningioma Groups

Metabolite	Meningioma *(n = 32)*	Nonmeningioma *(n = 17)*	*P* value
Lipid	1.66 ± 1.3	1.05 ± 1.4	0.49
1.15 ppm	0.72 ± 0.72	0.82 ± 0.65	0.34
1.5 ppm	0.71 ± 0.66	0.82 ± 0.65	0.33
Naa	- 2.56 ± 0.45	- 2.47 ± 0.5	0.33
Glx	1.5 ± 3.4	- 0.8 ± 2.8	<0.001
Cr	- 1.9 ± 1.1	- 1.9 ± 1.4	0.5
Cho	1.1 ± 3.5	1.05 ± 5.05	0.48
M-Ins	- 1.3 ± 1.5	- 0.94 ± 3.6	0.24
3.8 ppm	0.6 ± 3.35	0.12 ± 1.99	0.18

Table 2. MWPRs Comparison in Three Groups.

Metabolite	Normal *(n=8)*	Meningioma *(n = 29)*	Non-mening *(n = 10)*	*P* value (Mening vs. non-mening)	P value (Mening vs. N)
NAA:Water	56 -/+ 9	15 -/+ 13	10 -/+ 7	0.07	<0.001
Glx:Water	26 -/+ 5	24 -/+ 16	11 -/+ 8	0.0005	0.233
Cr:Water	26 -/+ 6	9 -/+ 9	8 -/+ 5	0.29	<0.001
Cho:Water	25 -/+ 6	25 -/+ 17	28 -/+ 20	0.33	0.461
M-Ins:Water	23 -/+ 11	14 -/+ 12	11 -/+ 8	0.17	<0.001
3.8 ppm:Water		16 -/+ 13	9.7 -/+ 6	0.018	

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