Tissue Characterization of Glioma by Proton MR Spectroscopy: Glioma Grading and Histological Correlation

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Introduction

Magnetic resonance (MR) images can reveal the diffuse neoplastic proliferation of glial cells while preserving anatomical architecture. Due to the absence of a normal blood-brain barrier function, the degree of enhancement is a useful clue in the radiological grading of glioma; however, glioblastoma multiforme (GBM) does not always generate contrast enhancement. On the other hand, some low-grade gliomas demonstrate strong enhancement. Therefore, the degree of enhancement does not always predict the glioma grade. Recently, proton MR spectroscopy (MRS), which focuses on the metabolic environment of the tumor, has been shown useful in predicting the glioma grade (1, 2).

In this study, our aim was to compare the metabolite ratios from proton MRS with histological grading of gliomas and to clarify the usefulness of proton MRS in the grading of gliomas.

Materials and Methods

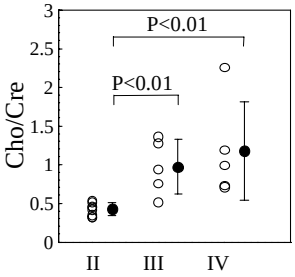
Nineteen consecutive patients (8 men and 11 women, aged 16-87 years) with gliomas were investigated. The patients were divided into three groups based on histologic subtype (WHO classification). For proton MRS, single-voxel spectra were acquired using the point-resolved spectroscopic pulse (PRESS) sequence (TR/TE=2000/136 ms, NEX=128, 20x20x20 mm^3 voxels) with a 1.5 T MR system. Voxels of interest were localized in the solid portion of the tumors. For quantitative analysis, metabolite ratios (choline [Cho]/creatine [Cr], N-acetylaspartate [NAA]/Cr and lactate [Lac]/Cr) were estimated by LCModel (S-Provencher, V6.02). Differences among the three ratios were evaluated with a two-tailed analysis of variance (ANOVA) using the Tukey-Kramer multiple-comparison test.

Results

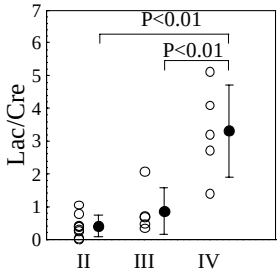
Nine cases were diagnosed as WHO grade II, 5 cases as grade III and 5 cases as grade IV. Significant difference was noted in the mean Cho/Cr ratio between grade II and grades III ($P<0.01$). Regarding the mean Lac/Cr ratio, significant difference was noted between grades III and grade IV ($P<0.01$). However, in the NAA/Cr ratio, differences were not significant. These results are summarized in the Table 1 and Figure 1.

	Cho/Cre	Lac/Cre	NAA/Cre
Grade II (N=9)	0.42 ±0.08	0.41±0.33	1.12 ±0.46
Grade III (N=5)	0.97 ±0.35	0.86±0.70	0.70 ±0.53
Grade IV (N=5)	1.18 ±0.64	3.31±1.41	0.61 ±0.19

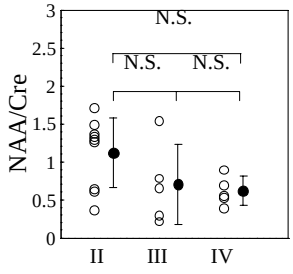
Table 1. Summary of the three ratios. The means ± S.D. is shown.



A: Cho/Cr ratio



B: Lac/Cr ratio



C: NAA/Cr ratio

Figure 1A-C. Graphs show the ratio for each of three tumor grades in all patients (n = 19): Cho/Cr ratio (A), Lac/Cr ratio (B), and NAA/Cr ratio (C).

Discussion and Conclusion

The Cho/Cr ratio was useful in discriminating between grade II and grade III. Choline is the metabolite of phosphatide, which relates to the cell membrane metabolism. Thus, the increased amount of choline may indicate the breakdown or enhancement of cell membrane metabolism. Therefore, choline may be a useful index of malignancy in conjunction with proliferation potency and the cell density of neoplastic cells.

The Lac/Cr ratio was useful in differentiating grade III from grade IV. The metabolite lactate has a close relationship with anaerobic glycolysis. Therefore, lactate may be a useful index of grade IV.

Although the number of patients was limited, we could tentatively conclude that the combination of Cho/Cr and Lac/Cr ratios may be useful in predicting glioma grade.

References

1. Meyerand ME, et al. AJNR 1999; 20:117.
2. Law M, et al. AJNR 2003; 24: 1989.