Proton MR Spectroscopic Imaging in Border Zone of Gliomas: Correlation of Metabolic and Histological Changes at Low Tumor Infiltration

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Purpose: We sought to investigate differences in correlation of absolute metabolites concentrations and metabolite ratios with histopathologic parameters of stereotactic biopsies from the border zone of gliomas.

Materials and Methods: Proton magnetic resonance spectroscopic imaging (^{1}H-MRSI) with high spatial resolution was performed in 10 glioma patients at 1.5 Tesla. MRSI data were co-registered to a 3D MR data set used for stereotactic procedures. Metabolite concentrations of choline-containing compounds (Cho), creatine (Cr) and total N-acetyl-aspartate (tNAA) and metabolite ratios of Cho/Cr, tNAA/Cr, and Cho/tNAA were calculated for voxel positions at biopsy loci with low tumor cell infiltration. Metabolite values were correlated with histopathologic findings expressed as a relative (% tumor infiltration, %TI) and an absolute parameter (tumor cell number, TCN).

Results: We found a strong negative linear correlation for tNAA with %TI (R = -0.773, $P < 0.001$) and TCN (R = -0.769, $P < 0.001$) but no correlation for Cho ($P > 0.05$). On the other hand metabolite ratio of Cho/Cr showed a moderate positive linear correlation with %TI (R = 0.523, P = 0.012) and TCN (R = 0.486, P = 0.019), but we got no correlation for tNAA/Cr ($P > 0.05$). Differences in correlation between tNAA and Cho as well as tNAA/Cr and Cho/Cr were significant for both %TI (P = 0.012 and P = 0.024) and TCN (P = 0.016 and P = 0.040) using a t test.

Conclusions: We conclude that absolute values of tNAA are more significant than Cho in the detection of low tumor cell infiltration. Hence neuronal damage is more distinct than cell membrane proliferation in the border zone of gliomas. Furthermore the calculation of metabolite ratios versus Cr for the border zone may yield to misleading results because Cr is not constant in this area.

Figure 1:

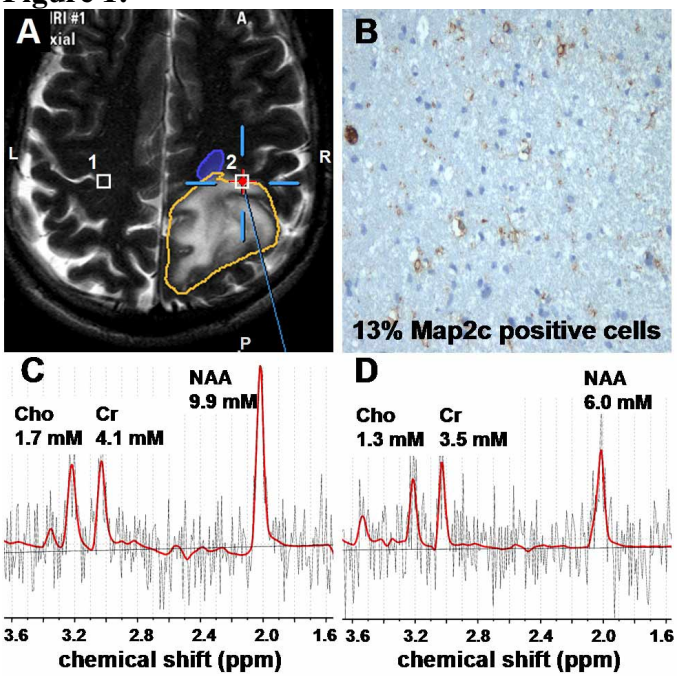

Figure 1. MRSI and stereotactic biopsy astrocytoma WHO II patient. (A) T2w MRI overlaid with the biopsy sampling point (red cross), tumor border (orange line), and voxel positions (white squares) in contralateral normal appearing brain tissue (voxel #1) and at the biopsy sampling point (voxel #2). (B) Histopathologic results of the biopsy. (C) and (D) Spectra of voxel positions #1 and #2.

Figure 2. Correlation of absolute metabolite concentration and metabolite ratios with % tumor infiltration (%TI). (A) Scatterplot of tNAA, Cr, and Cho (top down) versus %TI. (B) Scatterplot of tNAA/Cr, Cho/Cr and Cho/tNAA (top down) versus %TI. Overlaid on these plots are the individual correlation coefficient (R) calculated using a linear regression model (black lines).

Figure 2: