

Correlation of 1H MRSI, rCBV, and ADC to Image Guided Biopsies of Human Brain Tumors

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Introduction

Proton MRS, relative cerebral blood volume, and apparent diffusion coefficient can each provide additional information about brain tissue as compared to conventional MRIImaging and can thus be used to futher study human brain tumors. The goal of this study is to correlate proton MRS spectral patterns, rCBV, and ADC with histologic analysis from biopsy samples of human primary brain tumors. The locations of the biopsies were recorded via a surgical guidance system on the treatment planning MR images. The role of MRSI, rCBV, and ADC in detecting primary brain tumors was assessed.

Methods

Fifteen patients with primary brain tumors were studied with MR imaging and spectroscopy prior to image guided surgery. Diffusions were acquired in 9 cases and rCBVs in 4 cases. All MR data were acquired with a 1.5T GE Signa scanner. For the 3D-CSL, a PRESS selection with 8x8x8, 12x12x8 or 16x8x8 phase encoding steps was used to obtain 1cc spectra. (TR/TE=1000/144). The spectra were automatically phased, frequency aligned, baseline flattened and spectral parameters calculated off-line on a Sun SPARC workstation. Choline, creatine, and NAA peak areas were estimated by integrating the spectra over a window around 3.2, 3.0 and 2.0 ppm respectively. For the rCBV, an FOV of 400x200, an acquisition matrix of 256x64, 6mm, skip 0 slices, and a TR/TE of 1700/100 were used. For the diffusion weighted images, an FOV of 36x21, an acquisition matrix of 256x128, 5mm, skip 1 slices, a b value of 1000, and a TR/TE of 5000/113 were used.

During surgery, 1-4 biopsies were taken from each patient, totalling 47. Each biopsy position was recorded by placing the arm/tool of the navigational device at the biopsy point and saving the corresponding aligned images. The biopsies were analyzed by a pathologist and assessed for tumor grade, presence of normal tissue, and presence of astrogliosis/necrosis.

The spectral data, ADC, and rCBV were analyzed at each of these biopsy locations and were correlated with the pathology results. For each patient, average and standard deviations of Cho, Cr, and NAA were calculated for normal tissue (no T1 or T2 abnormality present) and noise estimates were made for all metabolites. Then, for each voxel, the following were calculated: voxel Cho/normCho and voxel NAA/normNAA. On the ADC and rCBV maps, ROIs roughly the size of the spectral voxel (~10mm on side) as well as a smaller ROI (roughly the size of an average biopsy sample) were chosen at the biopsy sites. Normal white matter ROIs were also chosen from the ADC and CBV maps.

Results

The results are summarized below.

	Cho/ nCho	NAA/ nNAA	ADC	rCBV
Normal*	1	1	729	1
Tumor n=45	1.65	0.30	1413	1.24

Table 1 - Mean values for different tissue types

*normal appearing white matter (not sampled)

Table 1 shows that, spectrally, there is a difference between normal and tumor tissue ($p<0.001$) and that the ADC for normal white matter is significantly ($p<0.001$) lower than it is for tumor tissue. The ADC values range from 569-1868. The rCBV values range from .01-5.5.

ADC vs Normal White ADC

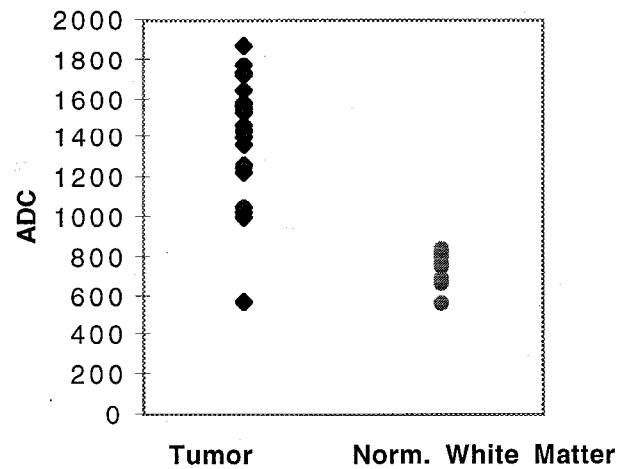


Figure 1 - Tumor ADC vs Normal White ADC

Figure 1 shows elevated ADC values of tumor relative to normal white matter. All normal ADC values were < 840 and all tumor ADC values were > 990 except in one case.

The mean rCBV value for the small ROIs (~4mm on a side) compared to the large ROIs (~10mm on a side) was 1.84 vs. 1.24, respectively, demonstrating heterogeneity within the lesion. The mean ADC value for the small ROIs compared to the large ROIs, however, was not very different, at 1374 vs. 1412, respectively.

Discussion

MRSI, ADC and rCBV were all elevated in histologically confirmed tumor relative to normal tissue and may thus be important diagnostic tools for human primary brain cancer.

The results of this study support adding the metabolic and functional data obtained from 3D MRSI, ADC, and rCBV in a multimodality approach to the radiologic assessment of human brain tumors.

Acknowledgments

This work was supported by American Cancer Society grant EDT-34