Quantitative Short Echo Time Spectroscopy of Untreated Pediatric Brain Tumors

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Introduction: It has been suggested that the biochemical information provided by MRS may be useful in differential diagnosis, prognosis, and therapeutic decision-making of tumors (1). Indeed, several studies found that in many cases ^{1}H MRS can be used to differentiate cerebellar medulloblastoma, low-grade tumors, and ependymomas (2,3). Most of the earlier studies focused on the N-acetyl-aspartate (NAA), creatine (Cr), and choline (Cho) and only ratios of metabolite intensities were reported. We investigated whether quantitative short echo time (TE) ^{1}H MRS aids to the pre-surgical differentiation of common brain tumors in pediatrics.

Materials and Methods: 51 patients with newly diagnosed, untreated brain tumors and six age-matched controls were studied on a 1.5T GE clinical scanner. Single voxel ^{1}H spectra were acquired using a PRESS sequence with TE = 35 ms, a repetition time of TR = 1.5 s, and 128 signal averages. The regions of interest (ROIs) were placed in the center of solid lesions and did not include any partial volume with surrounding normal appearing tissue in all cases. Spectra were processed using the LCModel V6.0 software (4) with water as the internal reference for absolute quantitation. Since metabolites are deemed to be intracellular, concentrations were corrected for the fraction of necrotic/cystic volume within the ROI. This measurement was based on the differences in the T_2 relaxation time of tissue water and necrotic/cystic fluid (5). All tumors were resected within 3 days of the MR examination and tumor histology was determined.

Results: (i) Choroid plexus papillomas were separated completely from other tumors by their low [Cr] and high myo-inositol (mI). (ii) [Cr] was the statistically most significant indicator to separate pilocytic astrocytomas from other tumors. (iii) Elevated taurine (Tau) was the most significant differentiator of primitive neuroectodermal tumors (PNET) of the medulla (medulloblastoma) from all other tumors (Fig.1, Tab.1). Generally, ratios proved to be less powerful differentiators than absolute concentrations.

Tab. 1: Metabolite concentrations (mmol/kg) of pediatric brain tumors

Subjects/spectra		[NAA]	[Cr]	[Cho]	[mI]	[Tau]
Choroid Pl. Papilloma	3/6	2.4±1.4	1.3±0.8	1.8±0.4	20.7±3.8	0.8±1.1
p vs. all other tumors		*n.s.*	*<0.0001*	*<0.0001*	*<0.0001*	*n.s.*
Pilocytic Astrocytoma	17/17	2.1±1.3	1.0±0.8	2.3±1.3	4.2±2.3	0.5±0.6
p vs. all other tumors		*<0.05*	*<0.0001*	*<0.001*	*<0.0001*	*<0.0001*
[a](Ana) Astrocytoma	9/10	2.0±1.5	5.7±2.4	4.0±2.7	10.9±5.4	1.1±1.1
p vs. all other tumors		*n.s*	*<0.05*	*n.s.*	*n.s.*	*n.s.*
[b](Ana) Ependymoma	9/13	0.2±0.4	5.3±2.8	3.5±1.6	12.7±6.1	1.7±1.8
p vs. all other tumors		*<0.0001*	*<0.05*	*n.s.*	*n.s.*	*n.s.*
Medulloblastoma	13/13	1.0±0.8	4.9±1.7	5.3±1.6	7.7±4.1	6.1±2.2
p vs. all other tumors		*n.s.*	*<0.05*	*<0.005*	*n.s.*	*<0.0001*
All tumors	51/59	1.4±1.3	3.6±2.8	3.5±2.0	9.7±6.6	2.1±2.6
p vs. controls		*<0.0001*	*<0.0001*	*<0.0001*	*<0.01*	*n.s.*
Controls (cerebellum)	6/6	7.9±1.0	8.3±1.0	2.3±0.3	7.2±0.9	1.4±0.7

[a,b]Non-anaplastic and anaplastic astrocytoma (ependymoma) pooled

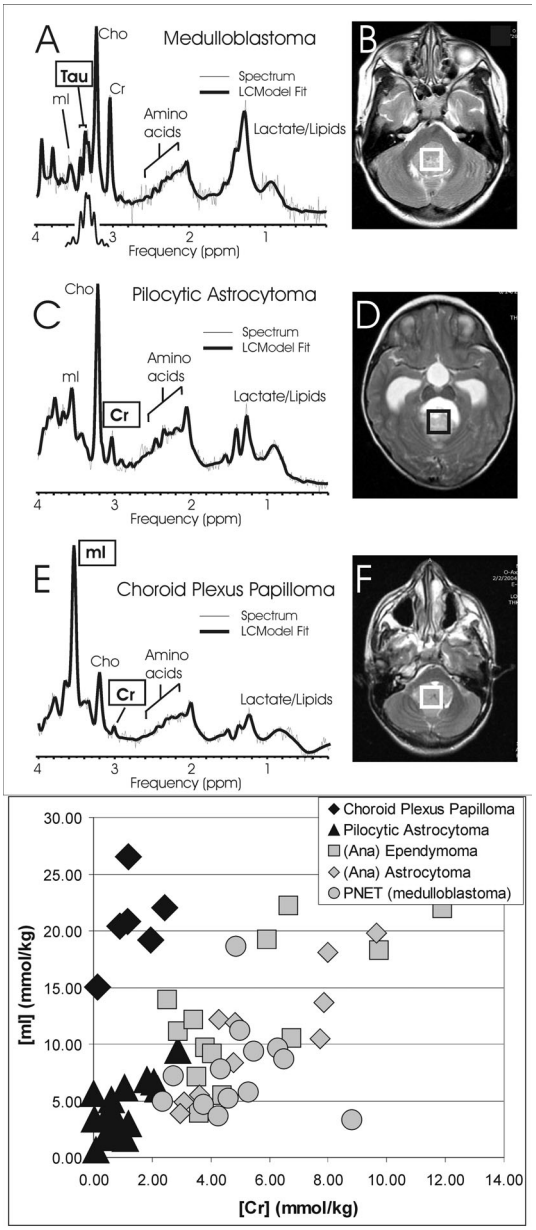

FIG. 1: ^{1}H MRS of untreated pediatric brain tumors Elevated [Tau] is a marker for medulloblastoma, whereas low [Cr] is a feature of pilocytic astrocytoma and choroid plexus papilloma. [mI] is elevated in choroid plexus papilloma. Note the different patterns of MRS in contrast to the similar appearance of brain lesions on MRI.

Discussion: Accurate initial diagnosis of tumors has important repercussions in therapeutic decisions and prognosis (6). Short TE MRS with absolute quantitation uncovered three previously not reported metabolic features of untreated pediatric brain tumors. MRS of tumors may also provide quantitative markers to assess tumor aggressiveness and to individualize treatment. To investigate this role of MRS, larger cohorts of patients will be needed.

References: 1. Negendank WG, Sauter R, Brown TR, et al. J Neurosurgery 1996;84:449-458. 2. Wang Z, Sutton LN, Cnaan A, et al. AJNR Am J Neuroradiol 1995;16(9):1821-1833. 3. Sutton LN, Wang Z, Gusnard D, et al. Neurosurgery 1992;31(2):195-202. 4. Provencher SW. Magn Reson Med 1993;30(6):672-679. 5. Ernst T, Kreis R, Ross BD. J Magn Reson 1993;102:1-8. 6. Gajjar A, Sanford RA, Bhargava R, et al. Pediatr Neurosurg 1996;25(4):182-187.

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