The added value of MRS in brain tumor diagnosis

M. Julià-Sapé[1], I. E. Coronel[1], M. Serrallonga[2], C. Majós[2], A. Candiota[1], M. Cos[2], O. Godino[3], J-J. Acebes[3], C. Aguilera[2], C. Arús[1]

[1]Bioquimica i Biologia Molecular, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain, [2]IDI-Bellvitge, Institut de Diagnòstic per la Imatge, L'Hospitalet del Llobregat, Barcelona, Spain, [3]Servei de Neurocirurgia, Hospital Universitari de Bellvitge, L'Hospitalet del Llobregat, Barcelona, Spain

Introduction:
No previous studies have prospectively tested whether there is added value in using MRS data for typing and grading brain tumors.

Purpose:
To prospectively test the added value of using SV MRS data at 1.5 T in the neuroradiological orientation of human brain tumors.

Methods:
Cases were prospectively acquired with a Philips Intera Master at 1.5 T during a 15-month period in one institution. Acquisition parameters for the SV exam: PRESS, TE= 30 ms and 136 ms, TR= 2000 ms, Num of acquisitions= 128-192 for metabolites and 16 for water, SW= 1000 Hz, VOI size= (1.5-2.0 cm)^3. The MRI exam was performed using the standard radiological examination at the institution: sagittal T1SE, axial T2 SE, axial FLAIR, axial T1 SE, axial T1-Gd and coronal T1-Gd, and DWI if considered necessary. Each case was evaluated at 4 different phases. Phase 1: radiologist analyzed MRI data and clinical information with the usual diagnostic protocol of the institution; phase 2: spectroscopist analyzed MRS SV PRESS 30 and 136 ms blind to any other clinical or image information; phase 3: spectroscopist received results of phase 1 and reevaluated; phase 4: radiologist received results of phase 2 and reevaluated. Comparison between phases 1 and 4 assessed the added value of MRS. All phases were conducted before histopathology results were known. At each phase, the following diagnoses were rated through a 5-point confidence scale (0: definitely not; 4: definitely yes): Benign meningioma (grade I), low-grade astrocytoma, anaplastic astrocytoma, glioblastoma, metastasis, abscess, lymphoma, PNET, low-grade oligodendroglioma, anaplastic oligodendroglioma and two additional free diagnostics, if necessary. Phases 2 and 3 were performed fusing several automated classification and decision-support systems (DSS) (1-5) and expert spectroscopist knowledge, using a previously established decision protocol that had to be followed to ensure uniform rating of MRS data. Results were analyzed with ROC curves (SPSS 11.5). A binary scale was constructed for analyzing the accuracy for each pathology. Differences between curves were tested with the Hanley-McNeil test (6), and a $p \leq 0.05$ was considered as significantly different.

Results:
51 cases completed the 4 phases. A histopathological diagnosis was available in 35 cases, allowing calculation of ROC curves for some of the diagnostics on the list. Area Under the Curve (AUC) and p values are shown in Table 1. MRS non-significantly helps MRI (phases 1 vs. 4) in metastases, meningiomas grade II and anaplastic astrocytomas, and does not help in glioblastomas. MRS significantly helps MRI in the following grouped pathologies: grouped low and intermediate grade glial tumors (glial of WHO grades II-III), glial tumors of WHO grade III, glioblastomas and metastases taken together, and tumors of WHO grade IV. No significant differences were found between phases 1 vs. 2 for any of the individual pathology comparisons.

Conclusion:
SV MRS information at 1.5T helps MRI in discriminating high-grade vs. low-grade tumors. It also helps in identifying when a glial tumor is of grade IV. With the present automated classification and DSS systems, MRS is not able yet to provide an statistically significant added value in the distinction between WHO types of glial tumors and between glioblastomas and metastases. However, MRS alone distinguishes between individual tumor types as well as the MRI examination with the clinical information.

References:
1. Tate AR, Majós C, et al. [2003] Magn. Reson. Med. 49(1):29-36.
2. Tate AR, Underwood J, et al. [2005] NMR Biomed. (submitted)
3. INTERPRET-SV prototype v1.0 http://azizu.uab.es/INTERPRET/prototype3.html.
4. Majós C, Julià-Sapé M, et al. [2004] AJNR 25(10):1696-1704.
5. Candiota AP, Majós C, et al. [2005] MAGMA 18:S193.
6. Hanley JA, McNeil BJ [1983] Radiology 148(3):839-843.

Table1: n, number of cases; PHASE 1, 2, 3 and 4 show the AUC values obtained at the different phases. 1-2, 1-3 , 1-4, 2-3, 2-4 and 3-4 show the p for the comparisons between two different phases when equal or smaller than 0.05.

individual pathologies	**n**	**PHASE1**	**PHASE2**	**PHASE3**	**PHASE4**	**1-2**	**1-3**	**1-4**	**2-3**	**2-4**	**3-4**
MENINGIOMA I	6	0.98	0.99	0.99	0.99						
MENINGIOMA II	2	0.50	0.74	1	0.73		*0.02*				
METASTASIS	5	0.72	0.74	0.75	0.89						
GLIOBLASTOMA	7	0.91	0.81	0.84	0.88						
ASTROCYTOMA III	9	0.66	0.71	0.69	0.78						
OLIGOASTROCITOMA III	2	0.50	0.50	0.49	0.50						
ABSCESSES	2	1	0.74	1	1						
combined pathologies	**n**	**PHASE1**	**PHASE2**	**PHASE3**	**PHASE4**	***1-2***	***1-3***	***1-4***	***2-3***	***2-4***	***3-4***
LOW-GRADE MENINGIOMAS	8	0.98	0.98	1	1						
GLIOBLASTOMAS AND METASTASES	12	0.83	0.88	0.89	0.93			*0.03*			
WHO GRADE IV	14	0.85	0.85	0.87	0.93			*0.04*			
GLIAL III	12	0.70	0.73	0.77	0.84			*0.05*			
GLIAL II-III	13	0.81	0.90	0.92	0.93			*0.04*			
GLIAL III-IV	19	0.89	0.63	0.70	0.91	*0.02*	*0.01*			*0.00*	*0.00*
OLIGODENDROGLIAL TUMORS	3	0.84	0.87	0.85	0.91						
GLIAL	20	0.95	0.84	0.88	0.98	*0.05*				*0.01*	*0.03*
AGGRESSIVE(GRADES III-IV)	26	0.95	0.77	0.82	0.95	*0.02*				*0.01*	*0.02*