In vivo Transverse Relaxation Time measurements from Localized CT-COSY and JPRESS: a validation study

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Introduction: Transverse relaxation parameters play an important role in quantitative Magnetic Resonance Spectroscopy (MRS). They are always involved in 2D MRS signal equations and the study of these relaxation time weightings is advisable to conduct for further use of *in vivo* quantitative 2D NMR spectroscopy[1,2], as this implies to define a parameterized function that best depicts the acquired signal. In this work, we present the measurement of transverse relaxation parameters (metabolite T2 and T2inh due to the residual macroscopic magnetic field inhomogeneity) using two 2D MRS sequences (Localized Constant Time COSY (L-CTCOSY[3,4]) and J resolved PRESS (JPRESS[5]) at 7T in the rat hippocampus. We show how accurate the T2inh can be measured from these two 2D MRS spectra in comparison with direct field inhomogeneity measurement.

Material and Methods: Uncoupled spin system signals acquired with these two 2D-MRS sequences present different relaxation time weightings along the spectroscopic dimensions (equation 1). All experiments were performed on a 7T Bruker-Biospin magnet using a volume transmit coil and a surface coil in reception. A 4x4x4 cubic voxel was placed in the hippocampus of Spargue Dawley rat (N=6, m=293.7±21.4 g) and the two 2D-MRS methods were applied. The parameters used a) for 2D JPRESS were as follows: TR/TE=2500/20ms, 16 averages per Δt1, and 32 Δt1 increments with 5 ms spacing b) for CT-COSY were as follows: TR/tc=2500/70ms, 8 averages per Δt1, and 96 Δt1 increments with 0.666 ms spacing. 1/T2inh was measured using a B0 Field-Mapping (3D-double gradient echo dataset with phase difference calculation, Bruker FieldMAP). Acquisition time was about 30 minutes for each sequence. Relaxation times (T2*, T2 for JPRESS) and (T2*, T2inh) for CT-COSY were fitted for the main singlets of NAA, Choline and Creatine by time domain fitting in both dimension according to equation 1.

$$S_{L\text{-}CTCOSY}(t_1,t_2) \propto \exp(-t_1/T_{2inh})\exp(-t_2/T_{2*})\exp(-tc/T_2)$$
$$S_{JPRESS}(t_1,t_2) \propto \exp(-t./T_2)\exp(-t_2/T_{2*})$$

Equation 1: Time signal weighting for LCT-COSY (top) and JPRESS (bottom). T2*inh* weight LCT-COSY indirect time domain.

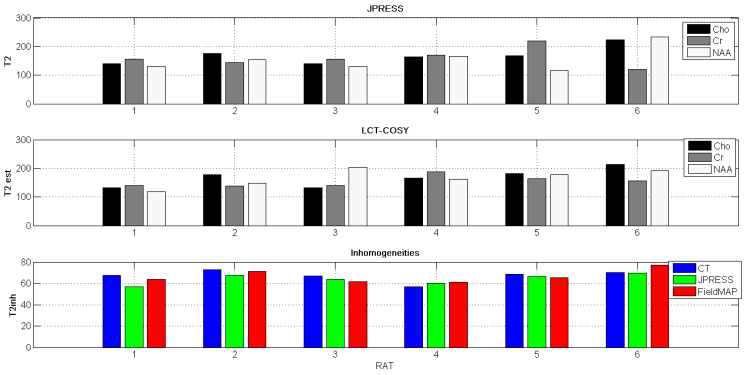

Figure 2: Result for Relaxation Times directly fitted (top), estimated using 1/T2* = 1/T2 +1/T2*inh* (middle) and T2*inh* found (bottom) for N=6 rats

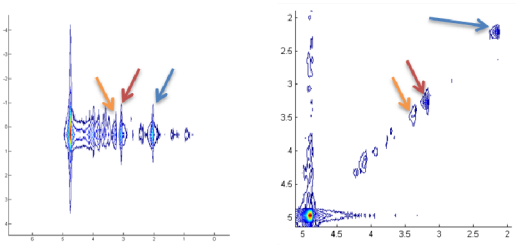

Figure 2:*in vivo* JPRESS (left) and L-CTCOSY(right) spectrum acquired in the rat hippocampus. Peak picking of NAA, Cr, Cho is marked respectively by blue, red and orange arrows.

T2 *inh* FieldMAP	66.7 ± 7.4%	
T2 *inh est*	67.0 ± 8.2%	64.0 ± 7.5%
Cho	167.2 ± 14.3	168.7 ± 12.2%
Cr	154.9 ± 9.5%	161.1 ± 13.8%
NAA	166.8 ± 14.9%	154.8 ± 19.4%
	JPRESS	L-CTCOSY

Table 1: Averaged *in vivo* transverse relaxation Times with coefficients of variation. T2*inh* est is the average of T2inh directly fitted on data for LCT-COSY and deduced for JPRESS using 1/T2* = 1/T2 +1/T2*inh*.

Results: L-CTCOSY and JPRESS spectra were acquired (Figure 1) on the same voxel for the 6 studied animals. Relaxation times for Cho, Cr and NAA were estimated and T2inh was measured with B0 Field-Mapping (Figure 2). On table 1 are reported means of measured and estimated value for T2 and T2inh as well as their respective coefficients of variation.

Discussion/ Conclusion: T2inh obtained with both sequences were in good agreement with direct measurements using B0 Field-Mapping. Estimated T2 values for Cho, Cr, and NAA were lower than expected[6]. Michaeli *et al.*[7] explained that apparent T2 can be reduced due to diffusion effect resulting in a loss of coherence which cannot be refocused in Hahn type spin echo sequence, which is our case. Future developments will be made to evaluate and minimize diffusion loss by introducing CPMG scheme in our 2D sequences. Relaxation weighting in correlation spectroscopy for coupled spin system have yet to be investigated. On top of offering spectral resolution enhancement and increased accuracy in the metabolite concentration estimation[1,2], *in vivo* quantitative 2D MRS provides accurate information about the transverse relaxation times which is highly valuable as these parameters can change in pathological conditions[8].

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References: [1] Schulte RF, *et al.*, 2006, NMR Biomed, 19(2) :255-63, [2] Gonen A, *et al,* 2010, Magn. Reson. Med, 64(3):623-8,[3] Girvin ME, et *al*, 1994, J.Magn.Reson. Ser. A, 108:99-102 [4] Chung HK, *et al.*. 2003, Proc. ISMRM [5] Ryner LN, et *al*, 1995, Magn.Reson.Imag, 13:853-869 [6] De Graaf RA *et al,* 2006, Magn Reson Med, 56(2) :386-94 [7] Michaeli S *et al*, 2002, Magn Reson Med, 47:629-633 [8] Lei H, *et al.*, 2003, Magn. Reson. Med, 49:979–984