Metabolite T_2 values from single-voxel, single-echo PRESS acquisitions

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Introduction

Metabolite T_2 (= $1/R_2$) measurements with PRESS sequences have conventionally been made using acquisitions at multiple echo times, reading out the right side of each spin echo followed by Fourier transformation and spectral analysis. For long enough echo times, however, a single echo can suffice for T_2 measurement by using the left as well as the right side of a spectroscopically-sampled spin echo[1]. Here we compare the conventional multi-echo approach with the single-echo method for measuring the T_2 of the metabolite resonances choline (Cho) and creatine (Cr) in muscle.

Methods

Single-voxel (2 cm^3) PRESS data were acquired at TEs of 144, 288, 360, 432 and 576 ms (TR = 3 s, 64 averages, BW = 2000 Hz, right-side duration = 512 ms, no water suppression) in gastrocnemius muscle of four consented, healthy adult volunteers scanned at 1.5 T with a standard knee coil. These data provided right-side spectra whose Cho and Cr resonances were fitted with Lorentzian functions. Monoexponential fits of area-under-the-Lorentzian vs. TE yielded multi-echo relaxation rates (R_{2multi}). For the single-echo approach[1], R_2* values via the right-side spectral widths, in conjunction with the height ratio (α) of left- over right-side metabolite peaks, yielded single-echo relaxation rates ($R_{2single}$).

Results

For Cho and Cr, respectively, Tables 1 and 2 provide measurements of α, R_2* and $R_{2single}$ from the single-echo approach (for selected echo times), as well as R_{2multi} as calculated from the conventional multi-echo approach. Though somewhat smaller R_2 values are found with the single-echo approach, the agreement is quite reasonable given the generally low SNR of these metabolite resonances.

	TE (ms)	α	R_2* (s^{-1})	$R_{2single}$(s^{-1})	R_{2multi} (s^{-1})
Subject A	576	1.7	17.3	3.8	4.2
Subject B	------	-----	------	------	-----
Subject C	432	1.5	16.8	3.3	4.3
Subject D	288	1.4	18.9	4.5	4.4

Table 1: Choline results, with $R_{2single}$ calculated from single-echo data for the TE shown in the 2nd column and R_{2multi} calculated using all TEs. Subject B's Cho peaks were too small to quantify reliably.

	TE (ms)	α	R_2* (s^{-1})	$R_{2single}$(s^{-1})	R_{2multi} (s^{-1})
Subject A	288	1.3	15.8	3.8	7.1
Subject B	432	1.7	21.4	4.9	5.9
Subject C	576	2.0	11.8	3.8	4.4
Subject D	432	1.6	18.6	4.0	5.8

Table 2: Creatine results ($R_{2single}$ from data with the TE in the 2nd column, R_{2multi} via data from all TEs).

Discussion

Though metabolite T_2 values have been measured previously[2], their sensitivity to pathology has been largely uninvestigated due to the prolonged acquisitions required for multi-echo PRESS approaches. T_2 estimation from a single echo (albeit with long TE) may enable clinical assessment of these values.

Conclusion

R_2 (= $1/T_2$) estimates of Cho and Cr in muscle were made from single-echo PRESS acquisitions, and were found to agree reasonably well with conventional measures made from multi-echo PRESS data.

References

1) Mulkern RV, Balasubramanian M. Spectroscopic sampling of long-TE spin echoes: A free lunch? *Magn Reson Mater Phy* 2018;31:321-340.
2) Frahm J, Bruhn H, Gyngell ML, Merboldt KD, Hanicke W, Sauter R. Localized proton NMR spectroscopy in different regions of the human brain in vivo. Relaxation times and concentrations of cerebral metabolites. *Magn Reson Med* 1989;11:47-63.