Localised *In Vivo* Relaxometry with Fast Field-Cycling

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In biomedical applications, knowledge of the NMR relaxometric behaviour of tissue is widely used to distinguish diseased from healthy states. Fast field-cycling (FFC) promises access to new sorts of endogenous information. The familiar dispersion plot of T_1 (or R_1) versus evolution field B_0^{E} can be used to quantify protein [1], and to inform the selection of field strengths and pulse sequence parameters for field-cycled MR imaging. In this work, we have compared two approaches to producing dispersion plots for localised volumes.

One method of acquiring dispersion plots involves conventional spin-echo two-dimensional Fourier transform imaging preceded by periods with the main magnetic field switched to the evolution field of interest [2]. The sequence is repeated at several evolution time steps before being repeated at each field of interest. The dispersion plot can be determined after manual selection of a region of interest (ROI) on the image and fitting mean signal intensity to a monoexponential approach to equilibrium. While we have an implementation of this method for comparison purposes, it suffers from clinically infeasible scan times (approximately 2 hours based on 4 minutes imaging time per field point and 32 field points) and partial volume errors. Data are acquired for the entire field of view.

We have investigated an alternative approach, which borrows methods from point resolved spectroscopy (PRESS) [3] and combines them in a pulse sequence with field-cycled inversion-recovery to produce dispersion plots of volumes of interest (VOIs) selected on pilot MR images. An adiabatic fast passage (AFP) inversion is applied, followed by field-cycling for an evolution period of the order of T_1. A series of RF pulses (90-180-180) is then applied in the presence of orthogonal gradients. The sequence is repeated without inversion, and the two resultant spin echo signals used to estimate T_1. The entire sequence is repeated at each evolution field step. The typical acquisition time for a localised T_1 dispersion plot (32 field points) comprises 2 minutes for the pilot images, plus 4 minutes for the dispersion plot.

Implemented on our home-built 59 mT whole-body field-cycling MRI system [4], the image-selected volume-localised method was sufficiently sensitive to observe quadrupole dips on T_1 dispersion plots in regions of human thigh. The technique offers the possibility of acquiring localised NMR relaxometry data from human subjects in clinically viable scan times.

References
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