Low power adiabatic T1rho imaging

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Introduction

T1 relaxation in the rotating frame (T1rho) (Michaeli S et al, 2006) is sensitive to slow molecular dynamics on the ms time scale which is relevant for many important biological reactions, such as receptor binding, water exchange, binding of contrast agents to proteins. In many studies its use has been related to protein content, and has been exploited to investigate pathology of stroke (Jokivarsi et al, 2010), Alzheimer's Disease (Haris et al, 2011), liver cirrhosis (Xiang et al, 2011), and cartilage damage (Wang et al, 2011). However, since the T1rho contrast is created by the application of a long spin lock RF field, or by a train of adiabatic inversion pulses this results in sequence that have high specific absorption rate (SAR). As a result, typically long TR needs to be used, which leads to long scanning times, low spatial resolution, reduced brain coverage, in many cases due to these limitations the measurements are single slice. Here we propose a T1rho pulse sequence based on low power gradient offset independent adiabatic pulses GOIA-W(16,4) (Andronesi et al, 2010) which decreases the SAR, and allows shorter TRs and multislice acquisition in feasible amount of time.

Methods

Pulses sequences were implemented on whole-body 3T Tim Trio clinical scanners (Siemens, Erlangen, Germany) running IDEA VB17A software. The body coil was used for transmit and the 32-channel head coil for receive. GOIA-W(16,4) adiabatic pulses [7] of 2.5 ms duration, 10 kHz bandwidth, 1 kHz maximum amplitude were used to construct a T1rho module according to MLEV-16 or MLEV-4 [8] schemes. The readout is realized with single shot 2D EPI. Typical acquisition parameters of T1rho images were: TR = 1s (per slice), TE = 18 ms, FOV = 240x240 mm^2, 96x96 matrix, in plan resolution of 2.5x2.5 mm^2, 10 slices, 5 mm slice thickness, 10 increments of the spin lock time, total acquisition time of 1:30 min:sec. The T1rho maps were obtained by fitting the equation for longitudinal relaxation in the rotating frame $I(t_{sl}) = I(0)*\exp(-t_{sl}/T1rho)$. Details of the pulse sequence diagram are provided in Figure 1. Human subjects were scanned with informed consent approved by IRB.

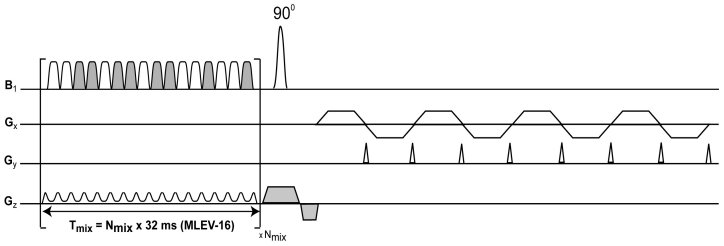

Figure 1. Low power adiabatic T1rho sequence with GOIA-W(16,4) pulses and EPI readout

Results

Multislice acquisition of T1rho weighted images has been performed at 3T in the brain of healthy volunteers. By fitting voxel-wise the exponential relaxation curves we are able to obtain maps of T1rho in the brain.

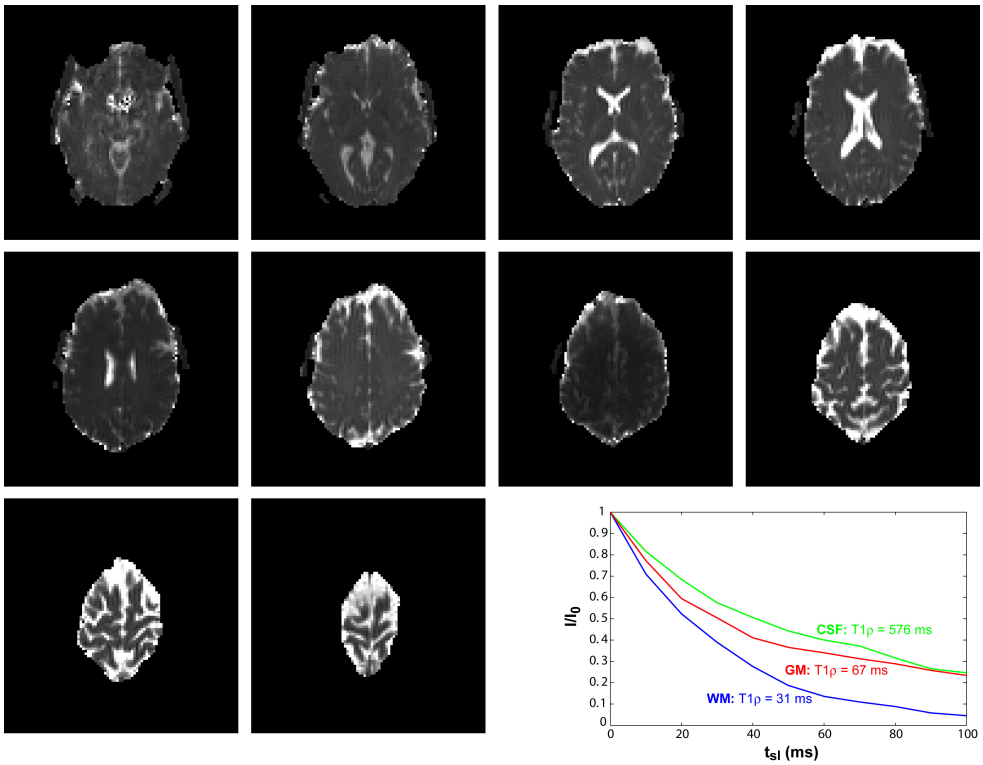

Figure 2. Brain T1rho maps calculated by fitting the T1rho weighted images acquired in a healthy volunteer at 3T. Signal decay for gray matter, white matter and CSF are shown in the lower left corner.

Conclusions

A low power adiabatic T1rho sequence has been demonstrated at 3T for human use, enabling multislice acquisition in a feasible amount of time. It is expected that this sequence will be useful for investigating pathology in the brain and other organs.