Turbo-WEX Imaging

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INTRODUCTION:

While chemical exchange imaging is dominated by CEST-based approaches, the Water Exchange Spectroscopy (WEX)[1] method is commonly used for the spectroscopic estimation of exchange rates in phantoms and has also been extended for voxel-wise spectroscopy and used for in-vivo experiments[2]. In this work we show a proof of concept for accelerated Turbo-WEX imaging.

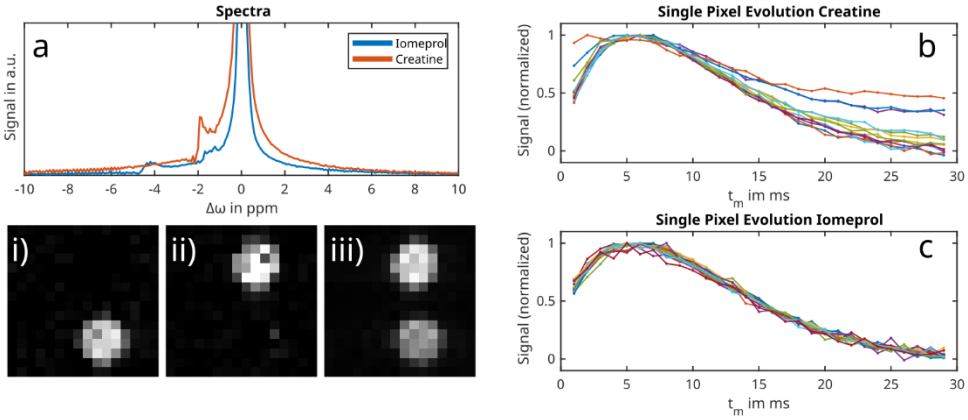

Figure 1a) Spectrum for each of the substances, b)+c) Turbo WEX signal evolution for each pixel in Creatine + Iomeprol, i-iii) Iomeprol (baseline corrected), Creatine (baseline corrected), 1H images.

WEX relies on the stimulated echo (STE) pathway. First, the water pool is prepared for a stimulated echo using a pair of pulses. In the subsequent exchange period magnetization can exchange to all available exchanging pools. As these pools are typically of much lower concentration than the water pool, the prepared magnetization remains largely unaffected. By changing the originally proposed readout from WATERGATE to a frequency selective pulse, multiple readouts can be used to accelerate the acquisition (see also abstract NMJ Plaehn). In this work we show a proof of principle experiment in which we accelerate the acquisition of the time steps to a single shot and use this gain in measurement time to acquire a 2D Turbo-WEX dataset, similar to chemical shift imaging.

METHODS:

All imaging was conducted on a 11.75 T MRI system (Bruker, Ettlingen Germany) using a birdcage rf-coil. The vendor's RARE sequence was modified to allow Turbo-WEX imaging.

As phantom two vials filled with a creatine solution (50 mMol, pH 6.3) and a iomeprol solution (85 mMol, pH 6.0) were used. Magnetization was prepared using two frequency selective gaussian 90°-pulses, the readout pulse was a multiband gauss with a bandwidth of 600Hz for each component. For each phase step N_{TD} = 29 different time delays were acquired (10 ms steps) after one preparation. A relaxation delay of 1s and a repetition time of T_R = 7s resulted in a measurement time of 30 min for a 2D dataset of 16 x 16 pixel (FOV 2 cm x 2 cm). The final dataset had the dimension of 256 x 16 x 16 x 29 ($Spectral \times Phase_x \times Phase_y \times N_{TD}$).

RESULTS / DISCUSSION:

In Fig. 1 a proof of principle Turbo-WEX image is shown. In a) the resulting spectra for the two vials are shown. In b) and c) the time evolution of all pixels in the creatine and iomeprol vial are shown. Figure 1 (i-iii) shows images from the dataset integrated over the peak position of iomeprol (i), creatine (ii) (both corrected for the baseline) and the central frequency showing the water pool (iii).

In this example all exchange delays were acquired in a single shot. Therefore, the acquisition time depends only on acquired matrix size and repetition time. For higher resolution imaging it is also possible to accelerate the imaging domain by acquiring multiple k-space-steps after a single preparation. Nevertheless, imaging times will exceed typical CEST imaging times at lower spatial resolution. However when the high spectral resolution in combination with exchange rate quantification is beneficial, Turbo-WEX imaging can be an interesting approach. The acceleration of the time domain leads to a stronger T_1-dependence, reducing the fit quality of Turbo-WEX. One possible approach to alleviate this can be the use of Turbo-PS-WEX (see abstract NMJ Plaehn and [3]) for imaging.

CONCLUSION:

The Turbo-WEX approach is demonstrated to enable relatively fast WEX-based imaging in a phantom experiment.

REFERENCES:

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