ACCELERATED MULTI VOXEL MR SPECTROSCOPY

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Introduction: MR spectroscopy (MRS) is commonly used to obtain metabolic information in both clinical and research studies. Typically, when using single voxel (SV) MRS, several voxel locations are acquired in a single examination, for example from a brain lesion and a contralateral region for comparison. However, since each acquisition is typically on the order of 5 minutes, the acquisition of multiple voxels rapidly becomes very time consuming. In this work we present a method for simultaneous acquisition of two voxels by using a 'multi-band' approach adapted for MRS localization.

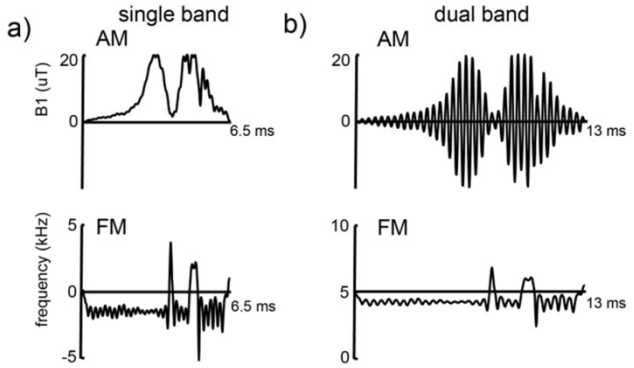

Figure 1; high bandwidth, dual-band RF pulses used for excitation in a single voxel localization sequence

Methods: Dual-band MRS was performed by designing a high bandwidth dual-band excitation pulse, which replaced the normal 90˚ excitation pulse in the localization sequence. Pulses were calculated for each experiment by point-by-point summation of the two individual RF pulses used to excite voxels in the left and right hemispheres (Figure 1). Signals were collected using 32-channel receiver coils, and the separation of the signals simultaneously recorded from both regions was accomplished using the SENSE algorithm [1] based on the receiver sensitivities. Experiments were performed at 3T (L+R hippocampus; PRESS localization, data not shown) and 7T (L+R motor cortex; sLASER localization; TE/TR=43ms/5s, 2x2x2cm^3, 32 avg). SENSE 'g-factor' maps were also calculated using the receiver coil sensitivity profiles.

Results: Based on g-factor maps (figure 2), effective unfolding of the dual voxels was possible in all experiments with no or minimal SNR loss. Dual volume excitation of the motor cortex at 7T could be unfolded at a g-factor of 1.0 (figure 2). Separate measurements were performed with excitation of only the right (figure 3a) and left voxel (figure 3b), and compared to a simultaneous dual voxel excitation (figure 3c). From this, a leakage factor of 0.4%, and identical SNR levels (~100%) were observed. Unfolding of the 3T data in the hippocampus was also possible (spectra not shown) however due to the lower field and the smaller left-right separation of the voxels, a g-factor of 1.14, leakage of 1.2%, and an SNR of 85% of the separate acquisitions was found.

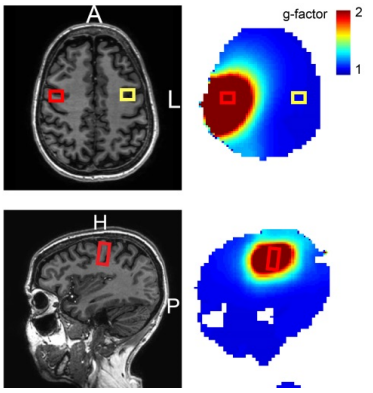

Figure 2. g-factor map for dual volume MRS. Left and right motor cortex voxels can be unfolded with g-factor=1.0 (i.e. no noise increase)

Discussion: Dual-voxel excitation and unfolding was possible at 3T and 7T by replacing the localization sequence excitation pulse with a dual-band pulse, and unfolding the resultant signals through the SENSE algorithm. The method can in principle be extended to simultaneously recording 3 or more voxel locations through appropriate RF pulse design, and extending the method to more than 1 dimension. Compared to interleaving 2 voxels within 1 TR [2], the current method is truly simultaneous, and has lower SAR. One disadvantage of the current implementation was the lower bandwidth of the dual-band pulses, which resulted in increased chemical shift displacement artifact. This limitation may be overcome by more advanced dual band pulse design.

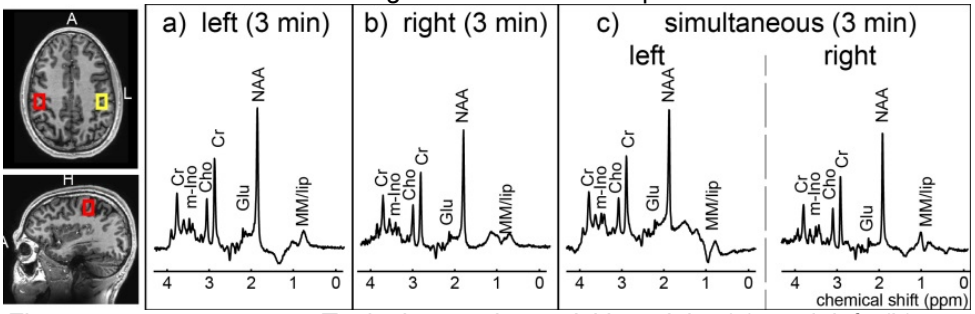

Figure 3, motor cortex 7T single voxel acquisition right (a) and left (b) and simultaneous dual voxel acquisition (c) result in similar spectra in half of the acquisition time. SNR was similar in the dual volume acquisition (g-factor = 1.0)

References:

1. Pruessmann MRM 1999
2. Ernst MRM 1991

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