

Real-time motion correction and B0 shim update for a spectral edited MEGA-LASER sequence

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Target Audience: Developers of pulse sequences for MRS; Scientists interested in applications for spectral edited sequences in vivo.

Introduction. J-difference spectral editing sequences such MEGA-PRESS [1,2] or MEGA-LASER [3,4] are necessary to detect important neurotransmitters and brain metabolites such as GABA, glutamate, 2-hydroxyglutarate, and glutathione which are otherwise obscured by more stronger signals. However, difference methods are susceptible to subtraction artifacts caused by subject movement, while the performance of narrow band MEGA pulses may be affected by drifts in the B0 field and shims. These challenges are likely to happen because editing low concentration metabolites requires long measurement times. Here we show that by acquiring in each TR an EPI volume navigator of the whole head prior to the MEGA-LASER excitation we can perform real-time correction of the head motion in human subjects and update dynamically the shims and scanner frequency.

Methods. All experiments were performed on a whole-body 3T MR scanner (Tim Trio with VB17 software, Siemens, Erlangen), using body coil for transmit and a 32 channel coil for receive. Measurements were performed in three volunteers, and a phantom that contained a compartment with brain metabolites surrounded by oil. A newly developed MEGA-LASER sequence [3] which employs low power Gradient Offset Independent Adiabaticity pulses GOIA-W(16,4) [5] was used for GABA and glutamate editing. A dual echo EPI navigator [6] using 2° flip angle was played in each TR before water suppression. A block diagram is shown in Figure 1. Acquisition parameters were: TR = 1.8s, TE = 75ms, (2x)96 averages, total acquisition time 5.8 min, voxel size 27 ml. The head pose and field maps were calculated in each TR and the localization (ie. GOIA-W(16,4) modulation functions) and shim values were updated accordingly. The EPI navigator together with update required 750 ms. The measurements were performed under static conditions and with the phantom and subjects moving while we did correct for motion and without correcting (motion included a total translation of 2 cm and rotation of 30°).

Motion was reproduced across trials. Human subjects were scanned with informed consent approved by IRB.

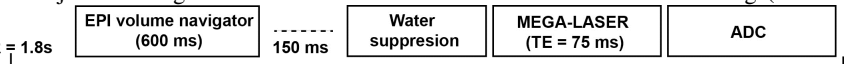


Figure 1. Schematic of the EPI navigated MEGA-LASER sequence.

Results. Phantom results are summarized in Figure 2. The MEGA-LASER difference spectra in the static and motion corrected cases are similar, albeit a minor smearing of the GABA and glutamate signals can be noticed. For the motion uncorrected case there is a large lipid contamination that negatively impact quantification. In the case of volunteer data shown in Figure 3 the effects of motion are even more dramatic when not corrected, precluding any quantification. The motion corrected spectra show residual un-subtracted signal coming from the averages where motion happened immediately after the EPI navigator and before the MEGA-LASER excitation.

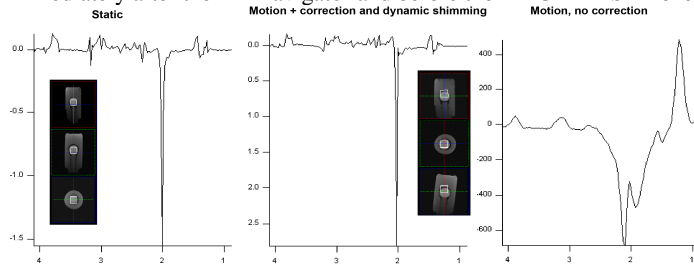


Figure 2. GABA and glutamate spectral editing in a brain phantom acquired with EPI navigated MEGA-LASER sequence in the static and motion case. The position of the voxel before and after motion is shown on the phantom.

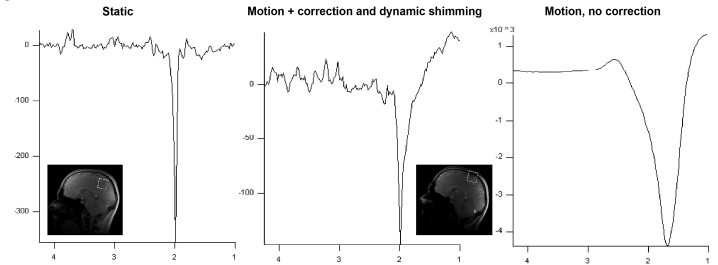


Figure 3. GABA and GLX (glutamate+glutamine) editing in human brain recorded with EPI navigated MEGA-LASER sequence. The position of the voxel before and after the motion is shown on the localizer image.

Discussions. Our preliminary results indicate that in vivo J-difference spectral editing might benefit largely from the possibility of tracking motion and update in real time the localization and shimming. The length of the navigator and update calculation fits within the TR length that is typical of MRS measurements, and hence it does not increase the acquisition time. A relatively small number of averages may be corrupted if motion happens between the EPI navigator and MEGA-LASER excitation. With small sequence modification these corrupted averages can be reacquired and contamination can be eliminated. In particular, a benefit is the update of the frequency which is important for the performance of narrow band selective MEGA pulses. Further validation and development is underway for quantification and use in clinical scans of brain.

References:

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