Identification and exclusion of motion-corrupted data in J-difference editing using interleaved navigator scans

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Introduction

J-difference editing is a widely used method in identifying and quantifying metabolites that exhibit J-coupling(1-3). In this method, in principle, two separate sets of spectra are acquired -- one set is acquired with a frequency selective 180^0 pulse such that it affects only the resonances of coupled spins, and the other set of datum is acquired without the frequency selective pulse (or the pulse set at a very different frequency). At an echo time (TE) decided by the J-coupling constant and the nature of the coupling, the difference of the two spectra yields a spectrum with the J-coupled resonances. Subject motion or any kind of field instability are known to have adverse effect on magnetic resonance spectroscopy, and J-difference editing, being a subtraction based method, could be even more severely affected. We have performed a study using water signal based interleaved navigation to demonstrate the effect of motion on the spectral quality of GABA in data acquired with MEGA-PRESS sequence in a controlled setting. Our data show that water signal based navigator echoes can be used to identify and exclude motion corrupted acquisitions that can adversely affect GABA MRS studies.

Methods

MR scans were performed using a 3 Tesla Siemens whole body Trio scanner (Erlangen, Germany). A single subject was scanned five times with a MEGA-PRESS sequence (2) having water signal based interleaved navigator. The scan parameters for the 30×30×30 mm^3single voxel spectroscopy at occipital cortex were: TR = 3000 ms, TE = 68 ms, water suppression bandwidth = 35 Hz, editing pulse frequency = 1.90 ppm, editing frequency-selective pulse bandwidth = 41 Hz, NEX = 72, total acquisition time = 7 min 12 sec. The subject was instructed to move head during specific periods of the scan. Data were acquired in a shot by shot basis, and the first eight measurements were ignored in order to ensure steady state magnetization. The interleaved navigator was set up as in Thiel et al.(4), in which the same sequence is repeated within one repetition time but without any water suppression. Data analysis was done using jMRUI software package.

Results and Discussion

The unsuppressed water signal from the navigator scans are plotted in Fig.1. A drop in signal amplitude between measurement number 32 and 48 is indicative of subject motion. This is in agreement with the instruction given to the subject as well. The edited spectrum from the overall acquisition is shown in Fig.2a. The presence of Cho at 3.22 ppm and CH_2 resonance of Cr at 3.93 ppm is clear indication of poor spectral editing. Next we separated the component of the data obtained duringsubject motion (as obtained from Fig. 1), which yielded the spectrum in Fig. 2b. The 3.22 and 3.93 ppm peaks are much more prominent in Fig. 2b indicating inefficient subtraction and hence almost no editing at all. Fig. 2c shows the spectrum obtained from the measurements prior to motion – distinguishable and reliable GABA peak is characterized by efficient editing. This demonstrates that in J-difference editing it is very important to identify subject motion. In all scans we were able to identify motion and separate out the motion corrupted portion of the data. In one of our runs we even obtained apparently good edited spectrum, and a similar methodological treatment performed for that study revealed inefficient editing over the period of motion. Thus failure to identify motion resulted in false positive signal in that case. Also, once the motion corrupted data have are identified, in localized single voxel spectroscopy, only data preceding motion should be used since the measurements following motion may have been performed at a different voxel location. This is more important in quanitifcation of metabolites.

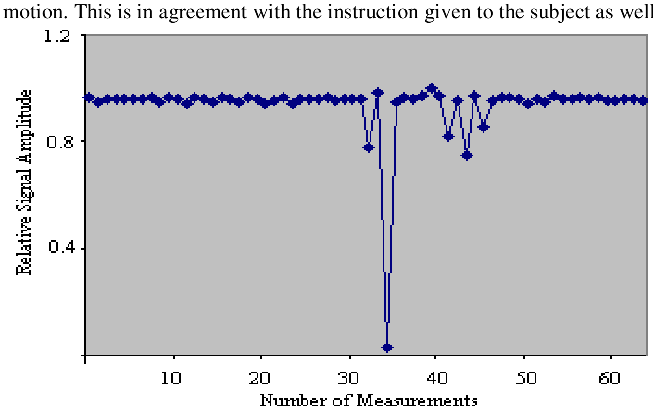
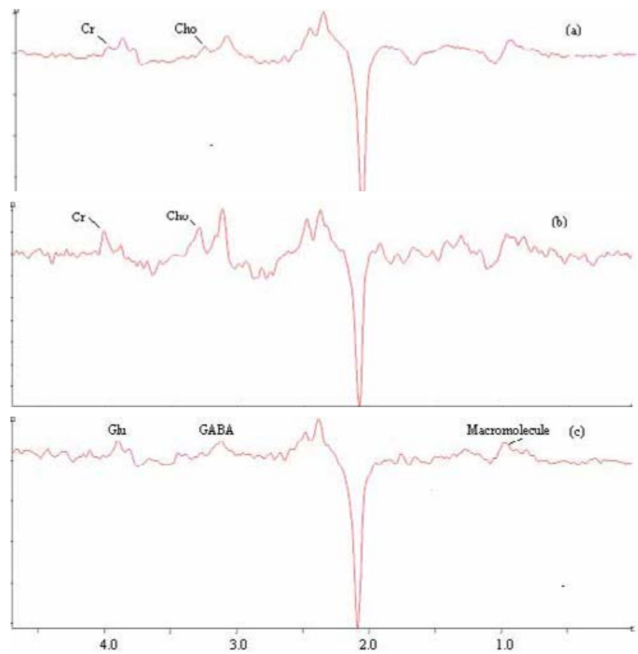


Fig. 1. Fluctuation of unsuppressed water signal with time.



Chemical Shift (ppm)

Fig. 2. Edited spectra from (a) all measurements, (b) measurements during subject motion, and (c) measurements preceding motion.

Conclusion

Performing shot by shot data acquisition and identification of subject motion can greatly improve spectral editing efficiency. Incorporating water-based navigator scans is an effective way to identify subject motion. Using this information, it is possible in many cases to recover a measurement that otherwise would be corrupted by motion artifact.

References

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