Simultaneous fitting of the individual spectra recorded by multichannel receive arrays in ^{1}H MRS investigations of global brain pathology

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Introduction

In non-focal disease, choosing a large voxel size (VS) can maximize Signal to Noise Ratio (SNR) as well as quality and stability of the acquired spectra and the derived metabolite data. For very large VS, however, the spectral resolution deteriorates and outer-volume artefacts (spurious lipids) may arise[1-3]. In a previous study[4] the effect of VS on Cramer-Rao Lower Bounds (CRLB), reflecting optimal acquisition parameters, was investigated and optimal VS of around 70 cm^3 was found. In addition, substantial differences between the signals recorded by the individual elements of a multichannel receiver coil were found. Therefore, it was suggested that simultaneous evaluation of individual coil element spectra might improve fitting accuracy when using individual lineshape information for modelling spectra with different spectral quality. This has now been evaluated quantitatively.

Methods

Ten human volunteers (supraventricular volume of interest), 3T MR scanner (Prisma, Siemens), 64 channel receive head coil (44 used), semi-Laser localization sequence[5], accurate and misset 2nd order shim to simulate limited field homogeneity; 8 different VS (8 to 99 cm^3 with 32 acquisitions each). Additional recording of non water-suppressed signals to acquire lineshape information. Data processing by jMRUI[6] and model fitting using FiTAID[7,8].

Results

CRLB were reduced by fitting the individual spectra from all coil elements simultaneously, compared to fitting the overall averaged spectra from all elements, as obtained from the scanner by default. The extent of improvement depends on VS, and the effect is more expressed for large VS. For a VS of 88 cm^3 CRLB decreased by 12-16 % for accurately shimmed spectra and 13-17 % for misset shim. For the smaller VS's of 48 cm^3 and 75 cm^3 the decrease in CRLB was higher for misset shim (8-12% and 13-15%, respectively) compared to accurate shim (1-7 % and 8-11%, respectively).

Discussion

Simultaneous fitting of the individual coil element spectra and using the reference lineshape for each coil corrects for the individual frequency shifts and distortions of the lineshape in each coil channel and therefore improves the fitting accuracy. In FiTAID, a combined fit of interrelated datasets is possible, so that an overall quantification of the metabolites is feasible with this method, as the differences in signal intensity are taken directly into account by the reference lineshapes. Decreasing CRLB showed that this method is superior to fitting the averaged spectrum, especially when it comes to large VS and non-ideal shims. Further consideration is given to elimination of data from channels that show large outer-volume artefacts (a feature that is not reflected in CRLBs) – though automatic detection of artefact levels is challenging.

Conclusion

For the investigation of global brain pathologies, where the use of relatively large VS is recommended, a simultaneous fit of subspectra enforcing lineshape and coil sensitivity information showed to be superior to traditional signal combination with subsequent fitting.

References

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Acknowledgements

Supported by the Swiss National Science Foundation (#320030_156952, #320030_175984)