Sensitivity Encoding for Fast MR Spectroscopic Imaging Water Reference Acquisition

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Introduction

Magnetic Resonance spectroscopic imaging (MRSI) is a non-invasive metabolite imaging method, providing information on a number of brain pathologies[1]. Whilst MRSI is popular in the research community, clinical adoption has been slow, due to long acquisition times. Faster water reference scans are required for absolute metabolite quantification[2] to be part of routine investigations. Scan time increases with the number of phase encoding steps and fast-methods have been developed which reduce this number. In this study, two fast-MRSI methods; reduced k-space acquisition and parallel imaging are evaluated. Reduced k-space acquisition (reduced resolution) samples fewer points in k-space and interpolates the missing data back by zero-filling[3]. Sensitivity encoding (SENSE) is a parallel imaging technique; k space sampling density is reduced using the sensitivity information from the multiple receiver coils which spatially encodes the data using the magnetic field inhomogeneities across the coils. A reduction factor R defines by how much the k space sampling is decreased. Algorithms then reconstruct the missing information in order to reproduce the full data set[4]. Quantitative assessment of fast MRSI water reference data collection to our knowledge has not previously been evaluated. In this study, we compare the default reduced resolution technique currently implemented for the scanner and SENSE R=3 in their ability to obtain a fast MRSI water reference scan.

Methods

MRSI Water reference data was collected for a standard GE MRS "braino" phantom and 3 volunteers using a 3T Philips Clinical MR system. T1 weighted 3D Fast Low Angle SHot (FLASH) MRI 1mm isotropic reference scans were obtained for the SENSE reconstruction to accurately assess the coil weighting for SENSE and obtain receiver coil sensitivity information. A 2D MRSI 15x 13 voxel (voxel size=13mmx13mmx13mm) grid was then placed manually above the corpus callosum (figure 1a). Water suppressed and unsuppressed data was collected for a full acquisition MRSI (t=10mins 16 seconds), Reduced resolution MRSI factor 2 in both dimensions (t=6mins 14 seconds), SENSE R=1 (t=10 minutes 16 seconds) and SENSE R=3 (t=1 minute 56 seconds) in both left-right and anterior-posterior directions. A 7x7 voxel volume selection was achieved using PRESS, TE=35ms, TR=2s,13mm slice thickness, receiver bandwidth 2000Hz, pencil beam shimming and an elliptical shutter in k-space was applied to reduce the scan time with minimal loss in resolution. MRSI spectra were extracted and inputted into TARQUIN MRS Quantization software[5]. The amplitude and line widths were extracted for the water data from this software. Grid maps of intensities were produced in MATLAB and Bland-Altman plots generated.

Results

Data was successfully collected from the MRSI grid and intensity maps for water amplitude and line widths were produced (figure1b and 1c). Analysis showed an apparent scaling (~ x10) between full acquisition and SENSE reconstructed data. This scaling factor was eliminated by using SENSE R=1 (full acquisition with SENSE reconstruction) as a comparator with the fast MRSI scans SENSE R=3 and reduced resolution x2. Reduced resolution was proven to be less successful in its reconstruction of the full acquisition water reference data, systematic errors were found to be up to a 1/3 less than the reduced resolution method and no significant loss in information for SENSE R=3 was found in comparison with SENSE R=1 (figure 2).

Conclusion

This study aimed to validate the use of SENSE for collecting fast 2D MRSI water reference data, for the absolute quantitation of metabolite data. In comparison with the default, reduced resolution technique, SENSE R=3 was shown to provide more accurate water maps in a shorter time (56 seconds). The improved accuracy and reduction in scan time makes absolute quantitation of MRSI metabolites viable for routine clinical 2D MRSI scans.

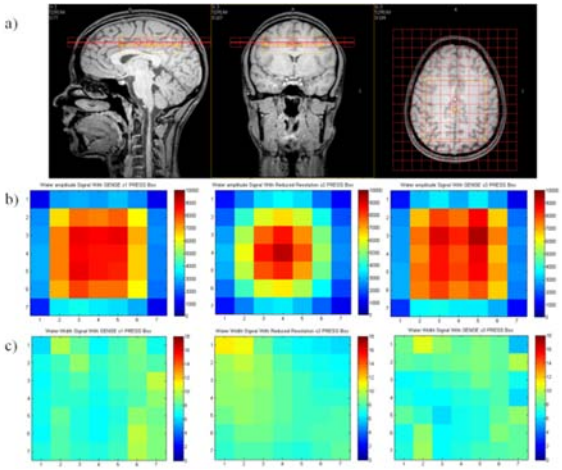

Figure 1 (a) Volunteer MRSI Plan including 7x7 voxel PRESS box (b) Volunteer amplitude maps for SENSE R=1, Reduced Resolution x2 and SENSE R=3 (c) Volunteer water line width maps for SENSE R=1, Reduced Resolution x2 and SENSE R=3

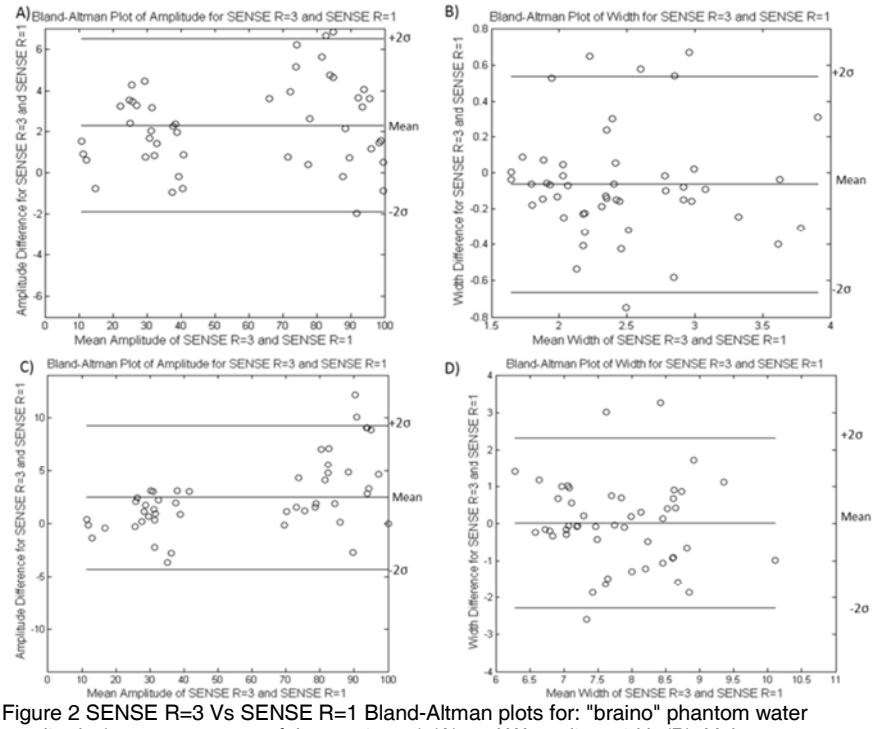

Figure 2 SENSE R=3 Vs SENSE R=1 Bland-Altman plots for: "braino" phantom water amplitude (as a percentage of the maximum) (A) and Water line width (B). Volunteer water amplitude (as a percentage of the maximum) (C) and Water Line Width (D)

References

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