Single Voxel Spectroscopy in 5 year old children using an EPI vNav

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Introduction

Paediatric MRS can be particularly challenging with restless children. Subject movement causes voxel shifts, B0 changes, and FID dephasing. The EPI volume navigator (vNav) is capable of measuring and correcting both head movement and B0 changes in real time [1]. We assess the quality of spectra obtained using the vNav in 36 single voxel spectroscopy (SVS) scans acquired from 14 five year old children in three different volumes of interest (VOI). Further we demonstrate the motion, frequency and first order shim corrections applied by the vNav in one scan where the child was particularly restless.

Methods

We used an SVS PRESS sequence with an embedded vNav. Three VOIs were located in medial frontal grey matter (mfgm), peritrigonal white matter (ptwm), and basal ganglia (bg). All scans had a 15 x 15 x 15 mm³ voxel, 64 averages, TR of 2 s and TE of 30 ms. The vNav EPI protocol consisted of a FOV of 220 x 200 x 110 mm³, matrix 44 by 40 by 22 partitions, TE's of 8 ms and 12.8 ms, TR of 21 ms, bandwidth of 3906 Hz. The vNav was positioned over the brain for each subject. Residual frequency and phase shifts after online correction (from within TR movement) were removed offline, using a method presented separately. The spectra were then analysed in LCModel [2].

Results and discussion

Out of the 42 intended scans, four children were unable to remain in the scanner long enough to complete all three and thus 37 scans were acquired. In one of the scans the child moved more than the stable TR to TR limit detectable by PACE [3] (20 mm or 8°) and the scan was therefore not completed, leaving 36 completed scans. The voxel displacement in each scan was calculated from the vNav log and the maximum of the magnitude of the displacement vector for each scan is plotted in fig. A. Four of the 36 scans had a shift greater than 2 mm. Figure B is a scatter plot of the SNR (SN as reported by LCModel) vs. the linewidth as measured by LCModel, with a range of linewidths between 2 Hz and 5 Hz and an SNR range between 8 and 14.

The voxel displacement for the scan with the most continuous movement throughout is shown in fig. C. The B0 corrections applied by the vNav for the same scan are shown in figs. D and E, which represent the absolute voxel frequency (accounting for gradient adjustments) and the first-order shim adjustments, respectively. The resultant spectrum from this scan, after additional offline frequency and phase correction, is plotted in fig. F. The frequency shift is greater than the water suppression bandwidth and this would have resulted in a water-saturated spectrum had it not been corrected in real time. Without correction, the shim change of 15 μT/m on the axis perpendicular to the coronal plane would have increased the linewidth of those measurements by approximately 10 Hz. The linewidth as measured by LCModel in fig. F is 3.9 Hz with an SNR of 10.

Conclusion

We have shown how spectral quality can be maintained across 37 scans, with one failure due to the TR-to-TR motion detection limit. The consistent linewidths obtained demonstrate that the automatic and real time shim adjustment provided by vNavs results in reliable and consistent first order shimming.

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