A Correction Algorithm in the Hybrid Time-Space Domain Accounting for Z-Spatial Dependence of Respiration Induced Resonance Offsets in Sagittal EPI at 7 Tesla

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Introduction Echo Planar Imaging (EPI) is sensitive to off-resonances which induce apparent motion along the phase encoding direction. This occurs during respiration which induces B0 fluctuations in the brain, due to magnetic susceptibility phenomenons[1-4]. At 7 Tesla, such **R**espiration **I**nduced **R**esonance **O**ffset (RIRO) can reach up to 5 Hz in the brain[4], and a correction based on a linear phase shift in the k-space has been introduced[5]. However, while RIRO variation through a XY plane is limited, it increases substantially along Z towards the lungs[1,4]. A linear phase shift in the k-space is not expected to correct for components varying in space.
We introduce a correction in the hybrid Time-Space domain taking ΔB_0 variation along Z into account.

Principle
In sagittal EPI with readout along Z axis, k-space modulations due to RIRO are complex because ΔB_0 amplitude varies along Z. However, $\Delta B_0(z)$ is approximately constant within each level z of a sagittal slice. After a 1D-Fourier Transform of the k-space along the Readout axis, each resulting hybrid Time-Space line reflects an average $\Delta B_0(z)$ that can be corrected for with a linear phase shift prior to the next 1D-Fourier Transform along the phase encoding direction.

Methods 1200 sagittal EPI images of the occipital lobe were obtained at 7T with a surface coil, TR=0.2s, 64*64 matrix, 20*20cm2 FOV. B_0 modulation time-courses were derived in the Time-Space domain for each z-level. RIRO amplitude (between peak and through or respiration) was quantified as in ref[6] and data were corrected either with a global k-space linear phase shift[2], or with the Time-Space approach. Magnitude Spectra of signal intensity timecourses were also computed.

Results Fig1. shows RIRO amplitude (Hertz) in the Time-Space domain as a function of z (1 pair of bars/voxel, voxel size=3.14mm). Original values (**white bars**) show that, in addition to a large common component, RIRO amplitude varies with z-position. After correction with a global linear phase shift (**dark bars**) the average RIRO is removed but not the component varying along Z.

Fig.2 shows temporal Power Spectra of signal timecourses taken in an ROI of the slice. It can be seen that, in the range of respiration frequency (arrow), the residual variance is smaller with the Time-Space correction (**thick line**) than with the global linear phase shift (**thin line**).

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