A New Method for Simultaneous Multislice Imaging

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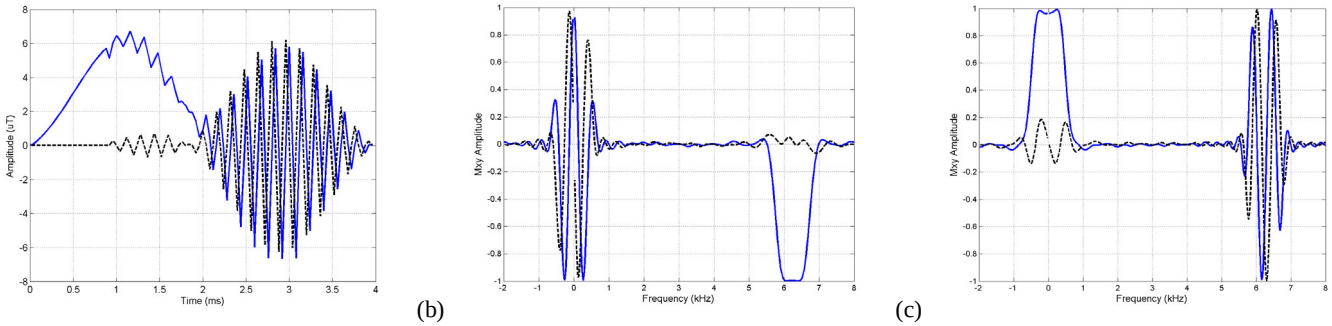
Introduction: Current methods of simultaneous multislice imaging use a single rf pulse to excite several slices, which are then unaliased using Hadamard phase cycling[1], multicoil methods[2], or the application of linear[3] or stepped magnetic fields[4]. We propose a new method of unaliasing slices by using extra slice select gradient lobe(s) to rephase and dephase individual slices during readout. A necessary requirement is a multislice rf pulse that imparts a different linear phase profile to each slice. The phase profiles must be such that when one slice is rephased, the other slice(s) is dephased/scrambled.

Method: RF pulse design: consider an asymmetrically truncated sinc-pulse (eg 1 lobe in 3) and its time-reversed equivalent. Both give different linear phase profiles requiring different refocusing lobes. By modulating one pulse before forming their sum, a simple two slice pulse is obtained (Fig 1a).



(a) (b) (c)

Fig 1. Real (solid), Imaginary (dashed): (a) rf pulse (b) Bloch simulation of pulse: excitation slice profile with rephase lobe = -0.304, the side-lobe is rephased (c) rephase lobe = -0.750, the central lobe is rephased.

This pulse was used in a sequence shown in Fig 2 on a 1.5T Eclipse (Philips Medical Systems), with echoes at 16.9 and 19.4 ms.

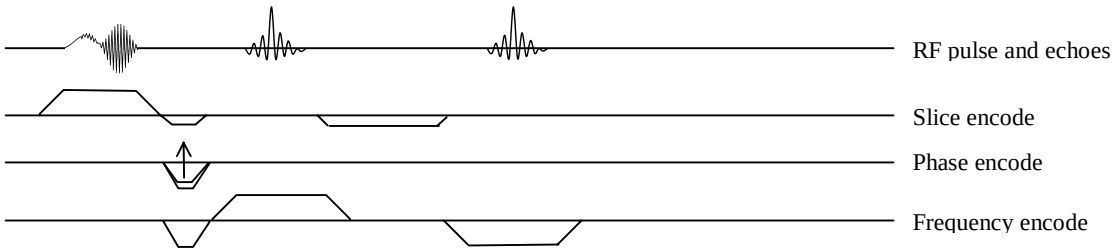
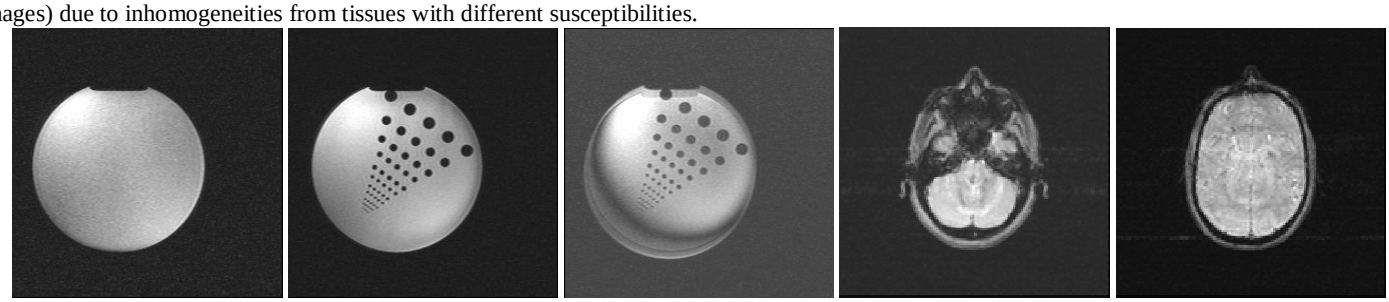


Fig 2. Pulse sequence diagram

Results: First phantom and in-vivo images are shown in Fig 3. Some crosstalk between slices is visible in the in-vivo images (but not the phantom images) due to inhomogeneities from tissues with different susceptibilities.



(a) (b) (c) (d) (e)

Fig 3. Phantom images: (a) first echo (b) second echo (c) second echo with only half the required second slice refocus showing aliasing between the two slices. In-vivo images: (d) first echo (e) second echo.

Discussion: Advantages of this new sequence are: unlike phase cycling[1], no extra views are required; unlike Weaver's method[3], no distorting z-gradient is on during readout; unlike MAMBA[4], no extra hardware is required; and unlike multicoil methods[2], it works with only one. Nevertheless, the method can also be used in conjunction with all other current multislice methods. The disadvantages of the method are: a slightly more complicated rf pulse, extra readout lobe(s), and possible crosstalk between slices from susceptibility artefacts. Crosstalk might be reduced by better pulse design, shorter echo times and thinner slices. Work is continuing on optimising rf pulses, and developing other versions of the method e.g. spin-echo.

References: [1] Souza, S.P., et al., J Comput Assist Tomogr, 1988. 12(6): p. 1026-1030. [2] Larkman, D.J., et al., J Magn Reson Imaging, 2001. 13(2): p. 313-317. [3] Weaver, J.B., Magn Reson Med, 1988. 8(3): p. 275-284. [4] Paley, M.N.J., et al., Magn Reson Med, 2002. 48(6): p. 1043-1050.