

Single-Shot 3D Gradient and Stimulated Echo Imaging

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Single-shot STEAM MRI [1] is insensitive to off-resonance effects because it is based on RF refocused echoes but suffers from an inherently low signal-to-noise ratio (SNR). Recently, gradient and stimulated echo (GRASTE) imaging [2] has been shown to ameliorate the limitations of single-shot STEAM by improving the SNR efficiency. Here, an extension of 2D GRASTE is presented that is capable of acquiring a 3D volume within a single acquisition.

Methods

The basic pulse sequence of single-shot 3D GRASTE is shown in Fig. 1. Compared to single-shot STEAM several gradient echoes are acquired in addition to the central stimulated echo like in the recently proposed 2D GRASTE technique [2]. In contrast to 2D GRASTE, all echoes within a readout interval have the same phase encoding in 2D direction, but are differently encoded in 3D (or slab) direction. The number of echoes per readout interval was chosen as the number sections acquired within the selected slab. Measurements were performed on a 3T MR system (Siemens Magnetom Trio) using the standard eight-channel head coil. Written informed consent was obtained from all volunteers prior to the examination. Six or 20 sections were acquired within a single shot of 751ms and 947ms with a spatial resolution of $2 \times 2 \times 5 \text{mm}^3$ and $3 \times 3 \times 5 \text{mm}^3$, respectively. One of the six and three of the 20 acquired sections had to be discarded due to RF pulse profile imperfections and aliasing in 3D direction. The flip angle of the readout RF excitation was adjusted to obtain a FWHM of the point-spread function in 2D phase-encoding direction that corresponds to the nominal spatial resolution [3]. Overall phase distortions between the echoes were corrected based on a single reference readout interval acquired without phase-encoding.

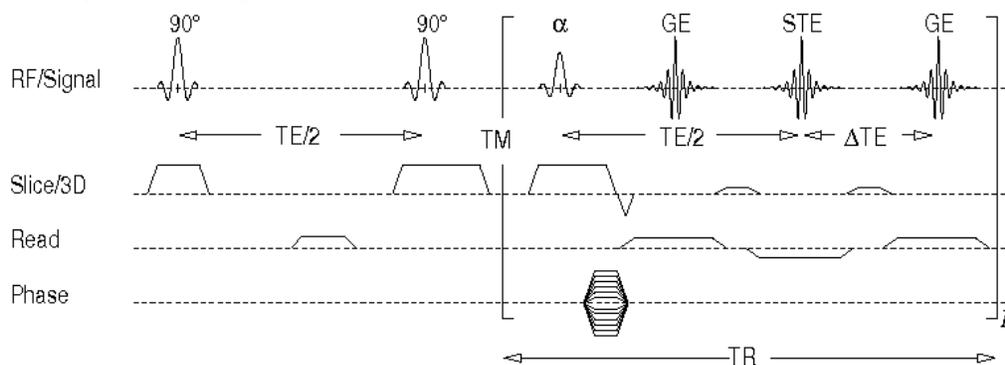


Figure 1: Basic pulse sequence for single-shot 3D GRASTE imaging.

Results and Discussion

Figure 2 shows single-shot 3D GRASTE images obtained for a healthy volunteer. For a large number of echoes per readout interval, i.e. a large number of sections, signal decay and phase distortions due to the increasing T_2^* -weighting of “outer” echoes cause intensity variations in the frontal brain close to major air cavities. However, compared to echo-planar imaging these artifacts may be considered as rather mild. Thus, 3D-GRASTE offers a quite robust access to large volume coverage within sub-second acquisition times. It may find applications in rapid diffusion-weighted and perfusion imaging.

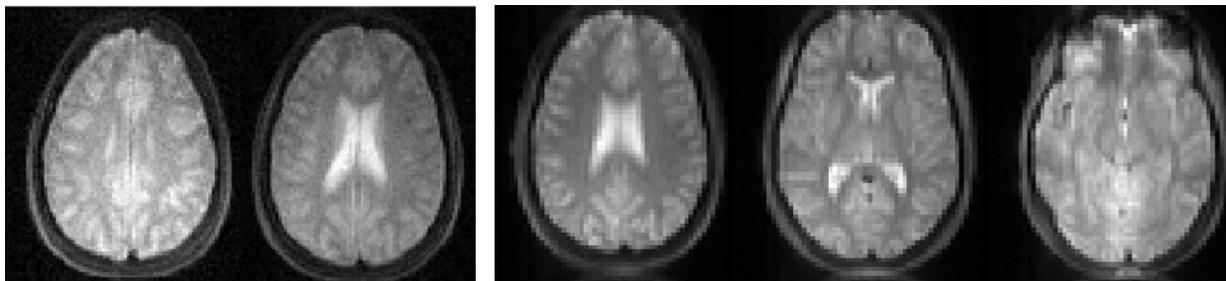


Figure 2: Two of five (left) and three of 17 (right) sections obtained within 751ms and 947ms and an in-plane resolution of $2 \times 2 \text{mm}^2$ and $3 \times 3 \text{mm}^2$, respectively.

References

[1] Frahm J et al, JMR 65, 130-135 (1985)

[3] Nolte UG et al, MRM 44, 731-736 (2000)

[2] Finsterbusch J et al, ISMRM 12, 2099 (2004)