Single-Shot STEAM MRI with Cross-Sectional RF Excitations

J. Finsterbusch[1,2], M. A. Koch[1,2]
[1]Dept. of Systems Neuroscience, University Medical Center Eppendorf, Hamburg, Germany, [2]Neuroimage Nord, University Medical Centers Hamburg-Kiel-Lübeck, Hamburg-Kiel-Lübeck, Germany

The main limitation of single-shot STEAM MRI [1] is the signal-to-noise ratio (SNR) because high flip angles in the read-out interval broad the point-spread function [2]. The applicable flip angle depends on the ratio of resolution and field-of-view (FOV) in phase-encoding direction and thus is lower for higher spatial resolution and a large FOV. This is in particular a problem if only a small FOV is of interest but a larger FOV must be acquired to avoid phase-encoding aliasing as for instance in spine imaging. To overcome this limitation, cross-sectional RF excitations can be used to restrict the field-of-view to a small inner volume. Due to the larger flip angle that can be used the SNR of the inner FOV can be increased.

Materials and Methods

Measurements were performed on a 3T MR system (Siemens Magnetom Trio) using the standard head coil. Written informed consent was obtained from all volunteers prior to the examination. Single-shot STEAM images were acquired with a resolution of 2x2x5 mm^3. For all acquisitions, the read-out flip angle was adjusted for grey matter according to [2]. For measurements of inner FOV, the first RF excitation was applied in phase-encoding direction, i.e. perpendicular to the slice (Fig. 1). Due to imperfections in its excitation profile, some phase-encoding oversampling had to be applied. Standard acquisitions with the full FOV covered 192 mm or 208 mm in phase-encoding direction, measurements with cross-sectional RF excitations covered 52 mm (plus 20 mm oversampling).

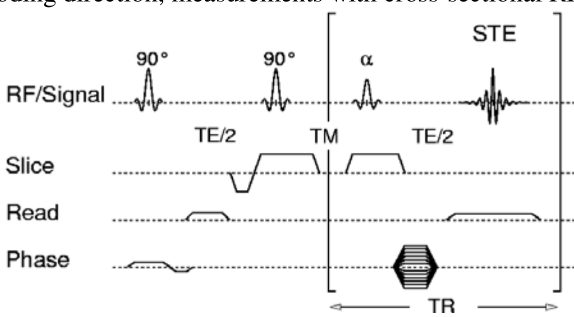

Figure 1: Basic pulse sequence for single-shot STEAM for inner FOV with the first RF excitation applied in phase direction, i.e. perpendicular to the slice.

Results and Discussion

Figures 2 shows the results obtained for an oil phantom and for a healthy volunteer, respectively. An SNR calculation for the phantom reveals a slight loss of about 20% for the reduced FOV (flip angle 16°) compared to the full FOV (8°) if the acquisition time was correspondingly reduced from 640 ms to 262 ms. However, using a narrower receiver bandwidth for the reduced FOV (13°, 640 ms), the SNR could be improved by about 50%.

Cross-sectional RF excitations can be used to improve the SNR of single-shot STEAM for inner FOV. A limitation is the restricted multi-slice capability due to saturation of adjacent sections with the RF excitation applied perpendicular to the slice. However, an extension to multi-slice acquisitions within a single shot is straightforward, e.g., adjacent section can be flipped back successively to the longitudinal direction with different readout predephasing so that in the readout interval echoes of different slices are rephased successively.

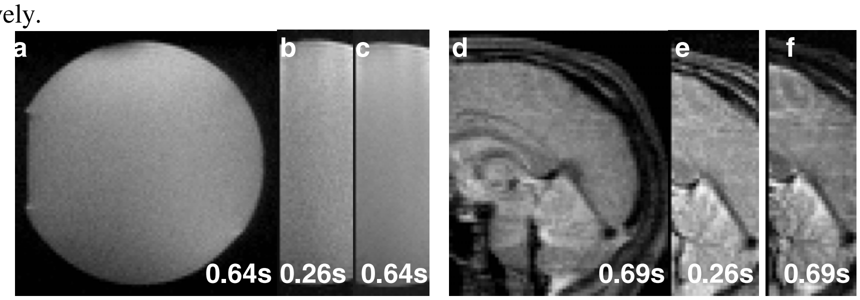

Figure 2: Single-shot STEAM MR images obtained (a-c) for an oil phantom and (d-f) for a healthy volunteer with (a,d) the full FOV and (b,c,e,f) a reduced FOV using cross-sectional RF excitations with (b,e) the same receiver bandwith and reduced acquisition time and (c,f) improved receiver bandwidth.

References

[1] Frahm J et al, JMR 65, 130-135 (1985)
[2] Nolte UG et al, MRM 44, 731-736 (2000)