

## Single-shot STEAM MRI combined with SENSE

J. Finsterbusch<sup>1</sup>, M. A. Koch<sup>1</sup>

<sup>1</sup>Dept. of Neurology, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany

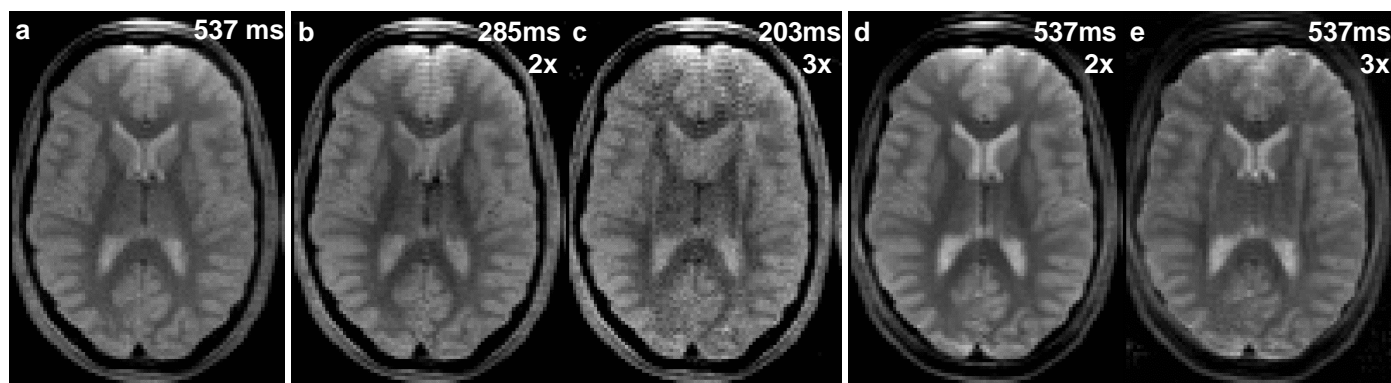
The signal-to-noise ratio (SNR) in single-shot STEAM MRI [1] is limited by the flip angle of the read-out RF excitation that depends on the desired resolution and the FOV in phase-encoding direction [2]. Parallel acquisition techniques like SENSE [3] allow to reduce the FOV in phase-encoding direction without aliasing. Thus, when SENSE is applied to single-shot STEAM, the read-out flip angle can be increased. The corresponding SNR gain compensates the loss related to the FOV reduction and to some extent that introduced by the geometry factor [3]. As a consequence, single-shot STEAM MRI can be accelerated with only minor or even without SNR penalty. Alternatively, the time saved for the k-space lines omitted in SENSE can be invested into a narrower receiver bandwidth to increase the SNR.

### Materials and Methods

Phantom and *in vivo* measurements were performed on a 3T MR system (Siemens Magnetom Trio) using the standard 8-channel head coil. Written informed consent was obtained from all volunteers prior to the examination. Single-shot STEAM images were acquired with a resolution of  $2 \times 2 \times 5 \text{ mm}^3$ . SENSE measurements involved a single-shot STEAM reference scan with full FOV to determine coil sensitivity maps and the imaging scan with a reduced FOV (acceleration factor 2-4). For all protocols, the read-out flip angle was adjusted for grey matter according to [2].

### Results

Figure 1 shows the results obtained for a healthy volunteer. SENSE considerably reduces the acquisition time with minor or even without SNR penalty: Figure 1b (acceleration factor 2) exhibits about the same SNR as STEAM without PAT (Fig. 1a) although the acquisition time was reduced from 537 ms to 285 ms. Alternatively, the time saved for the k-space lines omitted in SENSE can be invested into an improved receiver bandwidth, yielding a better SNR (Fig. 1d) for the same acquisition time as for Fig. 1a. However, for larger acceleration factors (Fig. 1c and e), the geometry factor increases considerably, and the SNR is reduced.



**Figure 1:** Single-shot STEAM MR images obtained (a) without PAT (280 Hz receiver bandwidth) and (b-e) using SENSE with acceleration factor of (b, d) 2 and (c, e) 3 with (b, c) reduced acquisition time (280 Hz) and (d, e) improved receiver bandwidth (101 Hz and 64 Hz, respectively).

### Discussion

Because single-shot STEAM with SENSE is based on an extra reference scan it allows to convert the full acceleration factor into a larger flip angle. This is in contrast to single-shot STEAM with GRAPPA [5, 6], that requires some additional reference lines in the centre of k-space to be acquired during the imaging scan: their sampling yields a distortion of the point-spread function and reduces the effective acceleration factor and thus the SNR [6]. The major drawback is the high geometry factor for larger acceleration factors. However, this (general) drawback of SENSE could be overcome with improved coil design.

### References

- [1] Frahm J et al, JMR 65, 130-135 (1985)
- [2] Nolte UG et al, MRM 44, 731-736 (2000)
- [3] Pruessmann KP et al, MRM 42, 952-962 (1999)
- [5] Griswold M et al, MRM 47, 1202-10 (2002)
- [6] Finsterbusch J et al, ISMRM 11, 1012 (2002)