



Parallel Imaging of Mice on a Clinical 3-Tesla System with a Dedicated 8-Channel Small-Animal Coil Array

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Introduction: Parallel imaging is routinely used for clinical and research MRI of humans. For investigation of small animals, however, parallel acquisition techniques are not well established since many high-field MRI systems still lack the required multi-channel capabilities as well as appropriate multi-element RF coils, and because of substantial signal-to-noise ratio (SNR) limitations associated with parallel MRI.

The purpose of this study was to demonstrate the feasibility and advantages of parallel imaging for MRI of mice on a clinical 3-Tesla MRI system with a dedicated multi-channel coil array.

Materials & Methods: Imaging was performed on a clinical 3-Tesla whole-body MRI system (Magnetom Tim Trio, Siemens, Erlangen, Germany) equipped with 32 parallel receiver channels and a clinical gradient system (45 mT/m, 200 T/m/s). A dedicated volumetric small-animal coil for mice (up to approximately 30 g) with a length of 80 mm and an inner diameter of 35 mm was used for data acquisition. The cylindrical 2D coil array consists of 8 elements arranged in two rings of 4 elements; the rings are turned by 45° against each other. The coil elements have an element size of about 40 × 29 mm².

In vivo parallel imaging of mice was performed with a T_2 -weighting half-Fourier-acquisition single-shot turbo-spin-echo (HASTE) sequence (with external acquisition of autocalibration data to shorten the echo-train length) and with a 3D gradient-echo (GRE) sequence (with integrated acquisition of autocalibration data); imaging parameters are summarized in Table 1. The GRAPPA algorithm was used for image reconstruction.

Results: T_2 -weighted HASTE images with parallel-imaging acceleration factors (R) from 1 to 4 are shown in Fig. 1. Sharpness improves considerably with increasing parallel-imaging acceleration. The visually assessed SNR is acceptable up to at least $R = 3$, at $R = 4$ central areas appear slightly noisy; we did not observe any residual aliasing artifacts. Coronal, sagittal, and axial images reconstructed from the 3D GRE data with $R = 2$ are shown in Fig. 2. The complete 3D data set was acquired in only 47.7 s (in contrast to an acquisition time of 76 s without parallel imaging).

Conclusions: Parallel imaging with acceleration factors up to $R = 4$ is feasible with the presented small-animal coil array. MRI of mice in a clinical whole-body MRI system can substantially benefit from parallel imaging in spite of the intrinsic low SNR of such examinations. In particular single-shot acquisitions with HASTE sequences profit from reduced blurring due to the shortened echo-train length as previously described for MRI in humans [1, 2]. Similar improvements of image quality and additional benefits such as substantially reduced distortion artifacts can be expected in small-animal echo-planar imaging experiments.

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References:

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Table 1: Parameters of T_2 -weighting half-Fourier single-shot turbo-spin-echo (T_2 -w. HASTE) and of 3-dimensional gradient-echo (3D GRE) sequence.

	T_2 -w. HASTE	3D GRE
Matrix	256 × 128	192 × 96 × 64
Voxel size (mm ³)	0.4 × 0.4 × 2.0	0.5 × 0.5 × 0.5
# slices	10	64
TR (ms)	2000	12.4
TE (ms)	107	6.0
Phase-enc. direction	LR	LR, AP
Acceleration factor (R)	1, 2, 3, 4	2

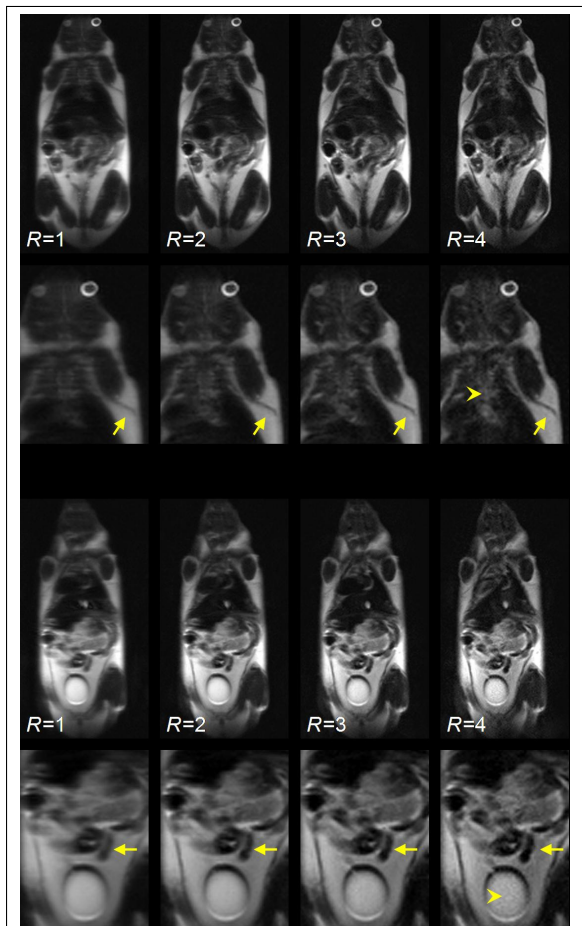


Figure 1: Example images of a mouse at two different slice positions acquired with the T_2 -weighting HASTE sequence with parallel-imaging acceleration factors of $R = 1, 2, 3, 4$. First and third row: full field of view; second and fourth row: detail view (magnification). Note the improved sharpness with increasing acceleration factor (arrows), but also the reduced signal-to-noise ratio in particular at $R = 4$ (arrow head).

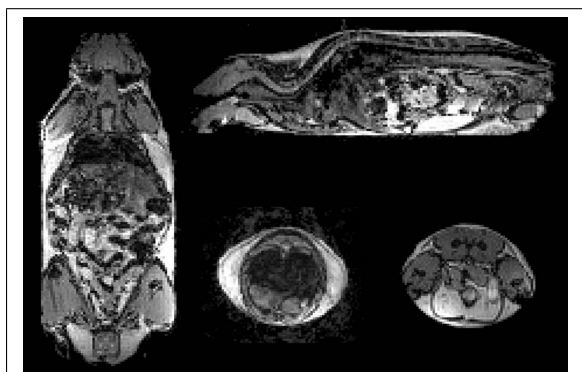


Figure 2: Multiplanar reconstructions of 3D GRE acquisition of a mouse with parallel-imaging acceleration factor $R = 2$ and isotropic spatial 0.5-mm resolution.