Parallel imaging of mice on a clinical 3-Tesla MRI system with a dedicated 8-channel small-animal coil array

O. Dietrich[1], T. Lanz[2], H. M. Reinl[1], F. Berger[1], M. Peller[1], M. F. Reiser[1], and S. O. Schoenberg[1]

[1]Department of Clinical Radiology - Grosshadern, Ludwig Maximilian University of Munich, Munich, Germany, [2]RAPID Biomedical, Rimpar, Germany

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 and 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 average element size of 40×29 mm².

In vivo parallel imaging of mice was performed with a T2-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: T2-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 (and potentially with EPI techniques) profit from reduced blurring due to the shortened echo-train length.

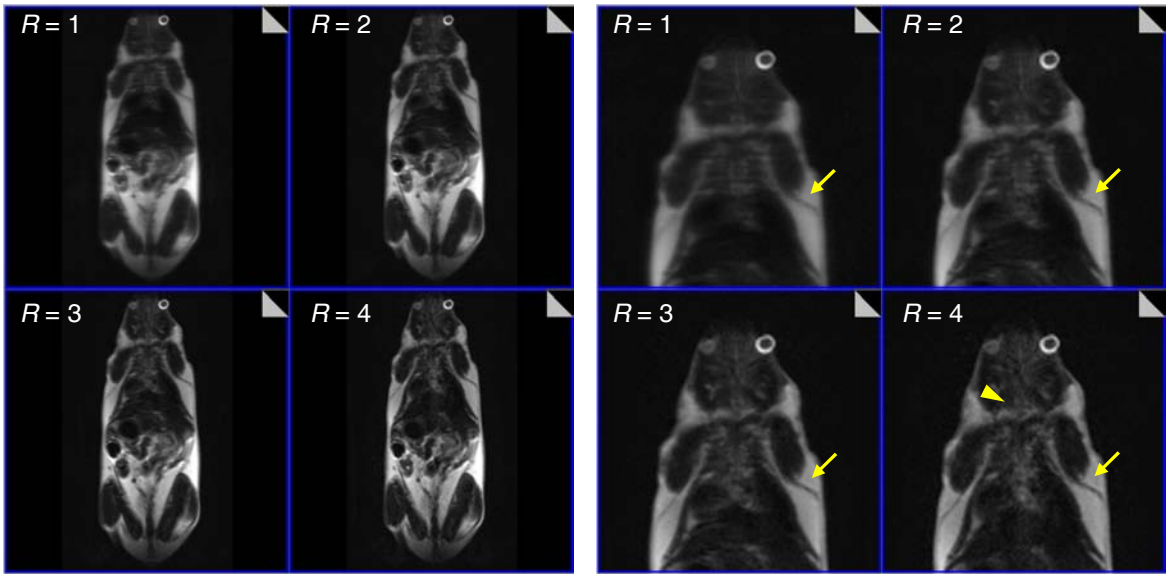

Figure 1: Example images from T2-weighted HASTE acquisitions of a mouse with parallel-imaging acceleration factors R = 1, 2, 3, 4. Left-hand side: full field of view; right-hand side: detail view (magnification). Note the improved sharpness with increasing acceleration factor (arrows), but also the reduced signal-to-noise ratio in particular at $R = 4$ (arrow head).

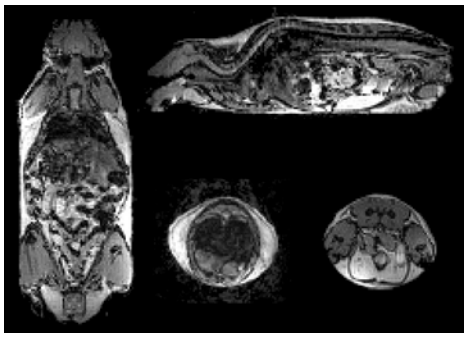

Figure 2: Multiplanar reconstructions of 3D GRE acquisition of a mouse with parallel-imaging acceleration factor $R = 2$ and isotropic spatial 0.5-mm resolution.

Table 1: Sequence parameters.

	T2-w. HASTE	3D GRE
Matrix	256×128	192×96×64
Voxel size (mm³)	0.4×0.4×2.0	0.5×0.5×0.5
# slices	10	64
TR (ms)	2000	12.4
Acceleration factor (R)	1, 2, 3, 4	2
TE (ms)	107	6.0