Dynamic Breast MR imaging at 3.0T: Intra-individual comparative study compared to 1.5T

C. K. Kuhl[1], J. Gieseke[1], N. Morakkabati[1], R. Blömer[1], C. Leutner[1], C. Sonntag[1], H. H. Schild[1]

[1]Radiology, University of Bonn, Bonn, Germany

Summary: The detection and characterization of benign and malignant breast lesions with MR requires imaging with both, a high temporal and a high spatial resolution – this is difficult to achieve within acceptable SNR limits. Recently, high field whole-body MR systems have become available that offer higher SNR, and, thus, promise to allow imaging with higher spatial resolution. We report on our first experiences with dynamic bilateral breast MR imaging at 3T. A prospective intra-individual comparative study was performed on 24 patients with a total 30 contrast enhancing lesions who were imaged both, on a 1.5T and a 3.0T system. At both systems, dynamic bilateral subtracted contrast enhanced MR mammography was performed with equivalent geometric parameters; at 3.0T, SENSE was used to reduce RF load. In addition, ultra-high-resolution pulse sequences with active fat suppression were acquired at 3.0T. Detectability of lesions, their morphologc features and enhancement patterns were compared for the 1.5T and the 3.0T study. All lesions were identified on both systems. Lesion enhancement rates and time course kinetics were equivalent. The ultra-high-resolution studies at 3.0T allowed the assessment of morphologic lesion features with unprecedented detail.

Introduction: Breast MR imaging is evolving as the most sensitive imaging technique for diagnosing primary and recurrent breast cancer. It becomes increasingly clear that MRI, due to its higher sensitivity compared to mammography and breast ultrasound, should be ideally suited not only as second line imaging modality, but also as primary tool e.g. for high risk screening or staging. This requires, however, that the technique´s specificity and PPV is improved. One way to achieve this is by improving morphologic analysis of enhancing lesions eg by using higher imgaing matrices. However, this is hardly feasible even with current advanced imaging techniques because the necessity to image in a dynamic mode means that acquisition times have to be kept short, ie at about 60-120 sec per dynamic scan. MR systems operating at higher magnetic fields (e.g. 3.0T) become increasingly available in clinical settings. High field systems promise to offer higher SNR, but also go along with stronger susceptibility effects, longer T1 relaxation times, and higher RF deposition. Aim of this study was first, to establish a clinically useful and stable pulse sequence for bilateral dynamic contrast enhanced breast MRI at 3.0T that would provide about the same diagnostic information as breast MRI at 1.5T, regarding morphologic and kinetic lesion features. Then we strived to establish pulse sequences that would provide a higher spatial resolution compared to what is currently attainable at 1.5T.

Materials and Methods: Prospective intra-individual study on so far 24 patients with a total 30 contrast enhancing lesions who were imaged twice, once on a 1.5T system (Intera 1.5), and, on a separate day, on a 3.0T system (Philips Intera 3.0). At 3.0T, a SENSE-compatible bilateral breast surface coil was used (MRIDevices). On both systems, dynamic GE techniques were used, with TR/TE/FA 290/4.6/90° at 1.5T and 320/2.3/67° at 3.0T (with SENSE factor 2), imaging matrix 400x512 at 1.5T, full 512 at 3.0T; all other geometric parameters were kept identical, including FoV (350 mm). At 3.0T, after the dynamic series, further 3D GE pulse sequences were acquired with active fat suppression (SPAIR), sagittal and axial orientation, bilateral and uni-lateral FoV, with non-interpolated voxel sizes down to 0.5 x 0.4 x 1.0 mm, all with an acquisition time within the dynamic time frame of 120 sec. We compared image quality, SNR, lesion conspicuity/delineatin of morphologic details.

Results: SENSE breast MR imaging at 3.0T was successful in all 24 patients. SI was homogeneous across the entire FoV. With exact in-phase TEs , susceptibility and chemical shift artifacts were within acceptable limits. No SENSE-related artifacts were encountered at 3T. All 30 enhancing lesions were identified also at 3.0T; in one patient who presented for staging of a right-sided breast cancer, an incidental 8 mm contra-lateral ductulo-lobular invasive breast cancer was only identified at 3.0T due to motion artifacts at 1.5T. There was a tendency towards lower relative enhancement rates at 3.0T (yet not statistically significant). Time course kinetics were otherwise equivalent.The pulse sequences with very high spatial resolution allowed the depiction of fine lesion morphologic details (internal septations in the fibroadenoma, spicules in the breast cancer) with unprecedented accuracy. The active fat suppression with SPAIR worked reliably also on the bilateral studies; the image quality was considered excellent in all cases.

Conclusions: Our very initial experiences with bilateral dynamic contrast-enhanced breast MR imaging with SENSE acquisition at high magnetic fields (3.0T) are encouraging. The 3T breast imaging technique proposed herein is ready for clinical use and offers at least the same diagnostic information compared to the 1.5T standard. Moreover, with the high-resolution, actively fat suppressed images that are obtainable in a dynamic mode at 3T, we hope to further improve the diagnostic accuracy compared to 1.5T.

Fig. 1 a

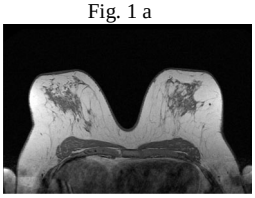

Fig. 1 b

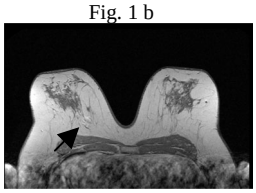

Fig. 1 c

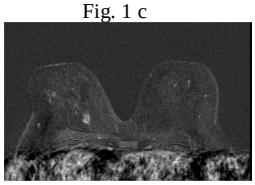

Fig. 1 d

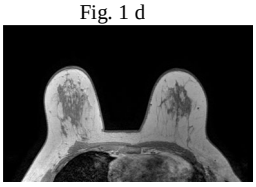

Fig. 1 e

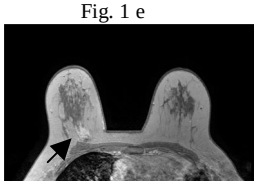

Fig. 1 f

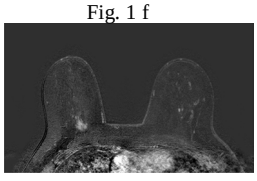

Fig. 1: Dynamic contrast enhanced GE series in a patient with invasive breast cancer. 1.5T study (1 a-c); 3.0T study (1d-e). Pre-contrast images (left), first post-contrast non-subtracted images (middle) with arrow indicating the enhancing cancer, and post-contrast subtracted images (right). Note the stronger enhancement in the 3T study.

Fig. 2 a

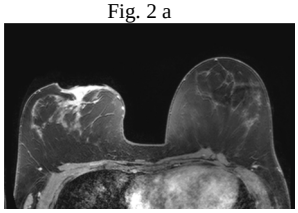

Fig. 2: Active fat suppression with SPAIR at 3.0T with bilateral FoV (Fig. 2a) and uni-lateral FoV (Fig. 2b).

2a: Chronic mastitis. Note the homogeneous bilateral fat suppression. Voxel size: 0.6 x 0.6 x 1.0 mm; acqu. time: 2 min.

2b: Fibroadenoma. Note the excellent resolution of internal architecture. Voxel size: 0.5 x 0.4 x 1.0 mm; acqu. time 2 min.

Fig. 2 b