Dynamic contrast enhanced imaging in breast cancer at 3 and 7 Tesla – a comparison.

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INTRODUCTION

Dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) is the most important MR-method to detect breast lesions and to differentiate between benign and malignant lesions with high sensitivity and specificity. Currently clinical DCE-MRI is performed at 1.5 or 3 Tesla (1, 2). 7 Tesla systems have the potential to improve imaging resolution and contrast-to-noise ratio (CNR) in breast MRI, which may further improve sensitivity and specificity in diagnosis, tumor staging and therapy monitoring. On the other hand, B_1-inhomogeneities and T_1-differences may hinder the translation of higher spatial resolutions and CNRs into increased diagnostic accuracy at 7 Tesla. Therefore, we compared DCE-MRI at 3 and 7 Tesla in seven patients with invasive ductal carcinomas (IDC) confirmed by histopathology.

MATERIAL AND METHODS

Seven female patients with IDCs were included in this study (age 65.8 ± 9 years; average lesion size 1.7cm, range 0.63 - 3,75 cm). Experiments were performed with 3 T and 7 T MR imaging systems (Siemens Healthcare, Erlangen, Germany) using dedicated, bilateral breast coils (3T: In Vivo, Orlando, Fla; 7T: Helmut Stark, Erlangen, Germany). For DCE-MRI a 3D T_1-weighted sequence (TWIST) with high temporal and spatial resolution and fat suppression with the following parameters was used (3T; 7T): TE/TR (6.05; 4.75ms), isotropic resolution (1.1; 0.7 mm^3), GRAPPA (2x), # of measurements (18), temporal resolution (14s), bandwith (600; 590 Hz/Px); measurement time. (~9 min). Gd-DOTA (Gadoterate meglumine; Dotarem®, Guerbet, France) contrast agent (CA) was injected intravenously as a bolus (0.2 ml per kilogram body weight) after 3 of 18 measurements. Signal intensity changes over time were calculated using the DCE-MRI signal from manually defined 3D regions of interest (ROIs). Subsequently, data were fitted and the maximum increase of the signal intensity compared to the baseline images was calculated and compared between 3 and 7 Tesla.

RESULTS

At 3 and 7 Tesla high resolution 3D-T_{1w} images with a time resolution of 14s could be acquired with high signal-to-noise ratios and good image quality in all seven patients. Fat suppression was satisfactory in a large fraction of the whole breast, indicating that B_1 inhomogeneities do not hinder T_{1w} imaging at 7 T (see Figure 1). The average increase of the signal intensity in the ROIs was 62 and 147% at 3 and 7 Tesla after contrast agent application compared to the baseline images. The increase in signal intensity was comparable or higher at 7 Tesla than at 3 Tesla (in average: 2.375 times higher; range: 0.95-5.8).
In addition the kinetic curve showed a wash out in four of seven patients at 3 T and a wash out in six of seven patients at 7 T, indicating higher specificity a 7 T compared to 3 T.

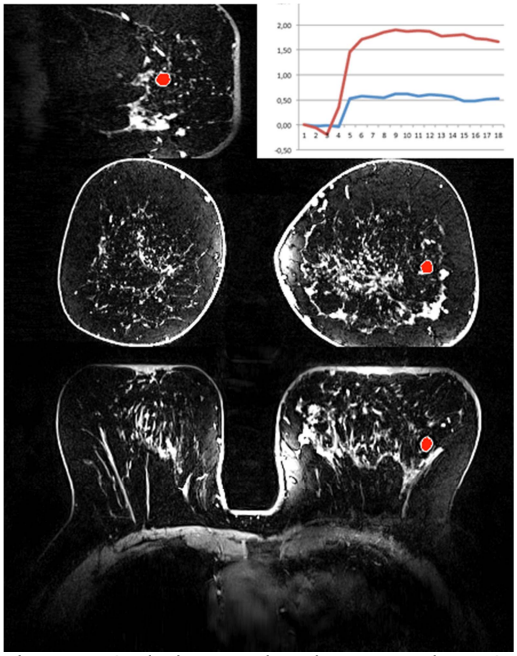

Figure 1. Sagittal, coronal and transversal TWIST images with an isotropic resolution of 0.7 mm^3. The ROI is indicated with red color. Top-left: The signal intensity plotted over time for 3 T (blue) and 7 Tesla (red).

CONCLUSION

This study shows that DCE-MRI at 7 T is feasible in patients with breast cancer. In our pilot data we could demonstrate increased signal enhancement after contrast agent application at 7 T compared to 3 T. Good image quality in combination with high spatial resolutions were acquired at both field strengths. Further studies on a higher number of patients may confirm higher diagnostic accuracy, which is important for tumor staging and early detection of therapy response. On the other hand, B_1 inhomogeneities may reduce the quality of fat suppression that could decrease specificity in dependence of the tumor location.

REFERENCES

1. Pinker K et al., Invest Radiol. 2009 Sep;44(9):553-8.
2. Kuhl CK et al., Radiology. 2006 Jun;239(3):666-76.