

# Implementation of Multiparametric Magnetic Resonance Imaging with High-Resolution Dynamic Contrast-Enhanced and Diffusion-Weighted Magnetic Resonance Imaging at 7T Improves the Assessment of Breast Tumors: A Feasibility Study

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## Introduction

The current study was undertaken to ascertain whether multiparametric magnetic resonance (MRI) of the breast combining high-resolution dynamic contrast-enhanced (DCE) MRI and diffusion-weighted imaging (DWI) at 7T is feasible and improves diagnostic accuracy.

## Material and Methods

From December 2011 to December 2013 40 patients with a suspicious breast lesion were included in this IRB-approved prospective study. All patients gave written informed consent and underwent bilateral multiparametric MRI of the breast at 7T. The sequence protocol consisted of a contrast-enhanced high temporal and spatial resolution 3D T1-weighted sequence (TWIST; fat-sat; TR/TE 6.05/ 2.86, 11°, SI 3T: 1mm SI 7T: 0.7mm; isotropic; temporal resolution 28sec, examination time 9min). The contrast agent used was Gd-DOTA, (generic name: Gadoteratemeglumine; Dotarem®, Guerbet, France), injected intravenously as a bolus (0.1 mmol per kilogram body weight) and administered with a power injector (Spectris Solaris EP, Medrad, Pittsburgh, PA, USA) at 4 mL/s, and followed by a 20-mL saline flush. Lesions were classified according to the revised BI-RADS atlas, and assessed for apparent diffusion coefficient (ADC) values by two readers independently. For the combined analysis of DCE MRI and DWI, we used the BI-RADS-adapted reading algorithm, which adapted ADC thresholds to the assigned BI-RADS assessment category to estimate the likelihood of malignancy. Sensitivity, specificity, and diagnostic accuracy of multiparametric DCE MRI and DWI were calculated and ROC analysis was performed. Image quality and inter-reader agreement was assessed. Histopathology was used as the standard of reference.

## Results

There were 29 malignant and 17 benign breast lesions (6-95 mm; mean 23.3mm). Multiparametric MRI yielded a sensitivity of 100% (29/29) and a specificity of 88.2% (16/18) and an AUC of 0.941, that was greater than DCE MRI ( $p=0.003$ ) with a sensitivity of 100% (29/29) and a specificity of 53.2% (9/17) and an AUC of 0.765, and DWI with a sensitivity of 93.1% (27/29) and a specificity of 88.2% (15/17) and an AUC 0.907. Multiparametric MRI of the breast at 7T eliminated all false-negatives, reduced false-positives from eight with DCE-MRI to two, thus if used clinically, could potentially have obviated unnecessary breast biopsies in 6/8 lesions ( $p=0.031$ ). Multiparametric MRI demonstrated either excellent or good image quality and inter-reader agreement ( $\kappa = 0.89-1.00$ ).

## Conclusion

The clinical use of multiparametric MRI at 7T is feasible with good or excellent image quality. Multiparametric MRI of the breast with DCE MRI and DWI at 7T seems to have the potential to diagnose breast cancer with high diagnostic accuracy (AUC 0.941). Multiparametric MRI of the breast at 7T improves specificity as compared to interpretation of DCE MRI alone ( $p=0.031$ ). Multiparametric MR imaging of the breast with DCE MR imaging and DWI at 7T can avoid unnecessary breast biopsies recommended with DCE MR imaging, in our series in 6/8 (75%,  $p=0.031$ ) of benign breast tumors.

## References

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2. Bogner W, Pinker K, Zanic O, et al. Bilateral Diffusion-Weighted Magnetic Resonance Imaging of Breast Tumors with Sub-Millimeter Resolution using Readout-Segmented Echo-Planar Imaging at 7 Tesla. *Radiology*. 2014 Oct 23:132340.

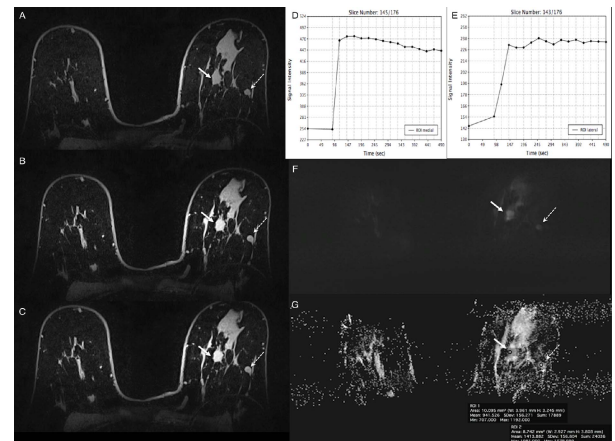


Fig.1: Lesion 1 IDC/G3 medially and lesion 2 fibroadenoma laterally in the left breast in a 57-year-old woman: Lesions 1: (A-C) On DCE MRI the irregular-shaped and marginated mass medially (arrow) demonstrated (D) an initial fast heterogeneous CE followed by a wash-out, had restricted (F) diffusivity and (G) decreased ADC values ( $0.941 \times 10^{-3} \text{ mm}^2/\text{s}$ ). DCE MRI and DWI were concordant and multiparametric MRI correctly classified the mass as malignant. Lesion 2: (A-C) The circumscribed, round mass lesion laterally (dashed arrow), demonstrated (E) rather homogeneous initial fast CE followed by a plateau. (F) On DWI, the lesion was bright on  $b=850$  images due to "T2-shine through," but had (G) no decreased ADC values ( $1.413 \times 10^{-3} \text{ mm}^2/\text{s}$ ). According to the BI-RADS -adapted reading algorithm, the assessment category assigned based on DCE MR imaging was overruled and multiparametric MRI correctly classified the mass as benign.