

## Diffusion weighted and dynamic contrast enhanced MRI in evaluation of treatment effects during neoadjuvant chemotherapy in breast cancer patients

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### Introduction:

Neoadjuvant chemotherapy (NAC) is administered to patients with locally advanced breast cancer to treat micrometastatic disease at an early stage, and for downstaging of primary inoperable disease. A major advantage with NAC is in situ monitoring of treatment response, and possible surrogate markers for prediction of tumor response may be achieved<sup>1-3</sup>. The purpose of this study was to use MRI for early evaluation of treatment effects in breast cancer patients undergoing neoadjuvant chemotherapy (NAC), and to identify MRI parameters at 3T that correlate to treatment response. In addition, the reproducibility of diffusion weighted MRI was assessed.

### Materials and Methods:

Diffusion weighted (DW) and dynamic contrast enhanced (DCE) MRI of breast cancer patients (n=14) were performed at 3T before and after the first cycle of NAC. The apparent diffusion coefficient (ADC) was calculated from the DW-MRI, and the parameters  $K^{\text{trans}}$  and  $v_e$  were calculated from two-compartment analysis of the DCE-MRI. ADC values from two baseline examinations prior to NAC were used in a reproducibility analysis, and the intraclass correlation coefficient (ICC) was calculated. Changes in statistical features derived from the distributions of MRI parameters, the tumor diameter and the volume after one cycle of NAC was assessed. In addition, the same features were used as input for a linear discriminant analysis (LDA) to find the best predictors for pathologic response.

### Results:

The ADC values from two baseline examinations showed good reproducibility, with ICC of 0.84. A reduction in both MRI defined longest tumor diameter and tumor volume were found after only one cycle of NAC. In addition, the treatment resulted in increased ADC mean, ADC maximum and  $v_e$  mean, and a reduction in  $v_e$  skewness. The best predictors of pathologic treatment response were the change in the longest diameter measured on MRI, followed by mean and skewness of ADC, and  $K^{\text{trans}}$  entropy.

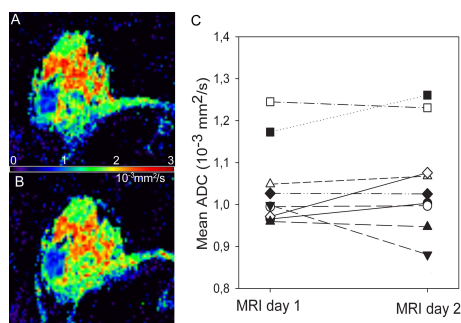


Figure 1: ADC map from the two MR examinations before treatment (A and B), and (C) ADC mean values from tumor ROI for all patients at the two time points.

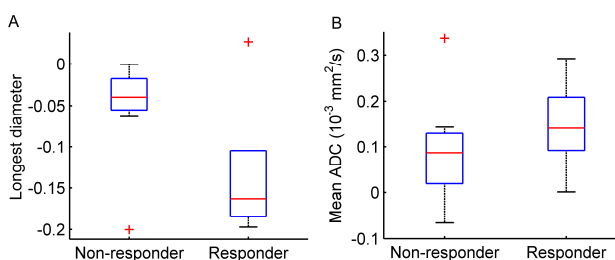


Figure 3. (A) Relative variation of the longest ROI diameter, and (B) change in mean ADC values vs pathologic responder/non-responder.

### DISCUSSION

This study investigates the ability for both DCE-MRI and DW-MRI on 3T to assess early treatment response of NAC in breast cancer patients. The ADC parameters showed very good reproducibility with high ICC values. After only one cycle of NAC a decrease in tumor diameter and volume, and an increase in ADC mean and maximum values were found for all patients. There was also a change in the volume fraction of EES ( $v_e$ ) mean and skewness. For the prediction of pathologic response, the change in MRI determined tumor diameter and mean ADC were the best predictors. In conclusion, early evaluation of treatment response at 3T showed promising results for MRI measured tumor diameter and ADC mean values.

### REFERENCES:

- 1: Padhani, et al. Radiology. 2006;239:361-374.
- 2: Pickles et al. Magn Reson Imaging. 2006;24:843-847.
- 3: Johansen et al. J Magn Reson Imaging. 2009;29:1300-1307.