DSC MR-mammography: Tumor characterization using quantitative R2* analysis

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INTRODUCTION

Dynamic contrast-enhanced MR imaging (DCE MRI) is an evolving diagnostic tool for assessment of breast cancer and the dynamic contrast enhancement curves obtained from T1-weighted images have been shown to be predictive of tumor malignancy [1]. High diagnostic accuracy has also been obtained from qualitative assessment of signal loss in T2*-weighted images using dynamic susceptibility contrast (DSC) MRI [2,3]. The purpose of this study was to introduce the transverse relaxation rate R2*, obtained from a double echo dynamic DSC sequence, as a quantitative biomarker for distinguishing between malignant and benign breast cancer.

MATERIALS & METHODS

Forty-one patients with verified lesions underwent breast MRI. The study was approved by the regional ethics committee. The MR examination was preformed on a Philips Achieva (1,5 T) system with NOVA gradients. The protocol consisted of both a high spatial resolution THRIVE sequence for tumor identification and a high temporal resolution sequence for parameter quantification. The two sequences were run in an interleaved fashion during contrast enhancement (MultiHance 0,2 mmol/kg body weight , Milan, Italy). High temporal resolution images in the axial plane were created by a 3D T1 multi shot EPI sequence with two echoes using the following parameters: repetition time = 42ms, echo times = 5.5 ms / 23 ms, flip angle = 28°, voxel size = 1,69*1,48*4 mm^3, number of slices=30, temporal resolution = 2.8 s/image volume with a total of 77 dynamic series acquired. A PROSET fat suppression technique was applied along with a SENSE factor of 2,5. The transverse relaxation rate, R2*, was calculated on a pixel-by-pixel basis by assuming a mono-exponential dependence of signal change on echo time and parametric images representing the peak change in R2* were generated. Volume of interest (VOI) delineating all lesions were manually drawn by an experienced radiologist. Mann-Whitney U tests, and receiver operator characteristic (ROC) curve statistics were used on the 95-percentile value in each VOI to determine the significance and the diagnostic accuracy for establishing or excluding malignancy.

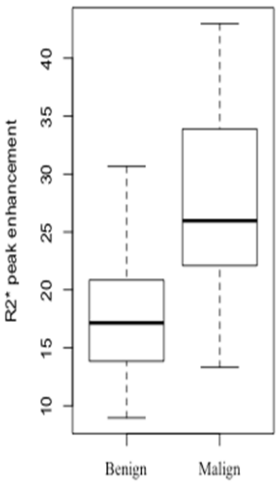

Fig. 1. Box plot showing the four quartiles and the mean value of R2-peak enhancement for malign and benign tumors.*

RESULTS

Histology identified 22 lesions (54%) as malignant and 19 (46%) as benign. The 95-percentile peak R2*- value showed a significant correlation to malignancy ($p < 0.0001$), and a good diagnostic accuracy with an area under the ROC curve of 0.85.

DISCUSION & CONCLUSION

The study suggested that peak change in the transverse relaxation rate is a sensitive biomarker for tumor malignancy in DSC MR-mammography. An additional echo in a T1-weighted perfusion sequence with a high temporal resolution may therefore improve the diagnostic accuracy by allowing quantitative assessment of tumor specific changes in R2*following contrast administration..

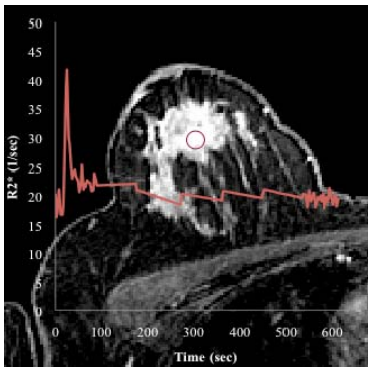

Fig. 3. Invasive ductal carcinoma (IDC). The dynamic R2 versus time curve of the illustrated ROI is shown as an overlay on a THRIVE image. The distinct first-pass R2* response is observed.*

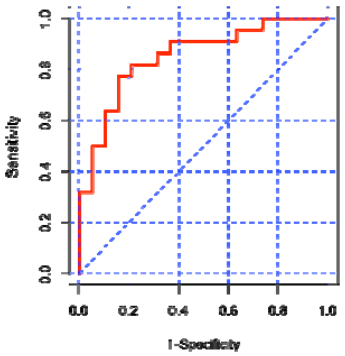

*Fig.2: Receiver operator characteristic curve (ROC) for the 95-percentile R2*peak value. The area under the ROC curve was estimated to 0.852.*

REFERENCES

[1] Kuhl et al. *Radiology* 1999;**211**:101-110. [2] Kuhl et al. *Radiology* 1997;**202**:87-95. [3] Kvistad et al. Acta Radiol 1999;40:45-51