Quantitative Diffusion Imaging in Breast Cancer: A Clinical Prospective Study

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Introduction: In breast cancer, characterization of lesions is always challenging. Malignant and benign lesions have different microstructure and MR diffusion-weighted imaging may help to characterize it. Apparent diffusion coefficient (ADC) reflects mobility of water protons and might contribute to distinguish malignant from benign lesions. This has been already showed in other studies but no such a large cohort of patients with breast lesions was studied. In this study, we selected patients with undefined breast lesions and studied the correlation between ADC and pathology. The purpose is to validate how accurately ADC is related to histology. We tried to define a threshold value of ADC to distinguish malignant from benign lesions.

Materials and methods: From October 2002 to January 2004, 78 patients (110 lesions) were referred to us for a suspicious finding at dynamic contrast enhanced MRI. They were scanned on a 1.5 T clinical MR-scanner (Symphony, Siemens, Erlangen, Germany). T2 TSE fat saturation (fs)(TR/TE = 6000 ms /68 ms, matrix = 512, slice thickness (SL) = 3 mm) was applied before contrast injection. Gd-DTPA was injected at 0.3 mmol/kg during the second acquisition of 6 consecutive 3D-Flash (3D-FL x 6) (9 ms /4.4 ms, matrix = 512, SL = 2mm). EPI diffusion with fat saturation (2600 ms /110 ms, b = 0, 200, 400, 600, 1000, matrix = 128, SL = 4 mm) was performed in a control group of 5 cases before and after injection of contrast agent and in the other cases, only after the injection. ROI was selected on subtraction images of 3D-FL x 6 between the third and first acquisition and copied on the ADC map. Inter-observer and intra-observer analysis was performed. ROC curves were used for statistical study.

Results: At pathology, from 110 lesions, 20 were benign and 68 malignant and 22 were excluded of the study because pathology results were not available**.** ADC before and after contrast administration (even if it does influence the ADC values) didn't show any statistically significant difference. In malignant tumors ADC was (mean ± SEM) 0.99 ± 0.027 x 10^{-3} mm^2/s, range [0.37 ± 0.050 x 10^{-3} mm^2/s – 1.92 ± 0.230 x 10^{3} mm^2/s] and in benign tumors 1.48 ± 0.079 x 10^{-3} mm^2/s, range [1.02 ± 0.054 x $10^{-3}$$mm^2/s$ – 1.94 ± 0.060 x 10^{-3} mm^2/s]. We found an optimal threshold value between malignant and benign lesions of 1.20 ± 0.10 x 10^{-3} mm^2/s (Figure 1). For this value, the sensitivity was 81%, the specificity 93%. The area under the ROC curve was 0.90 (lower bound 0.804, upper bound 0.989). The inter and intra-observer study showed a good repeatability of the measures.

Conclusions: These results show a difference between ADC of benign and malignant lesions with limited overlap. Therefore, ADC may be considered as a useful parameter in characterization of breast lesions.

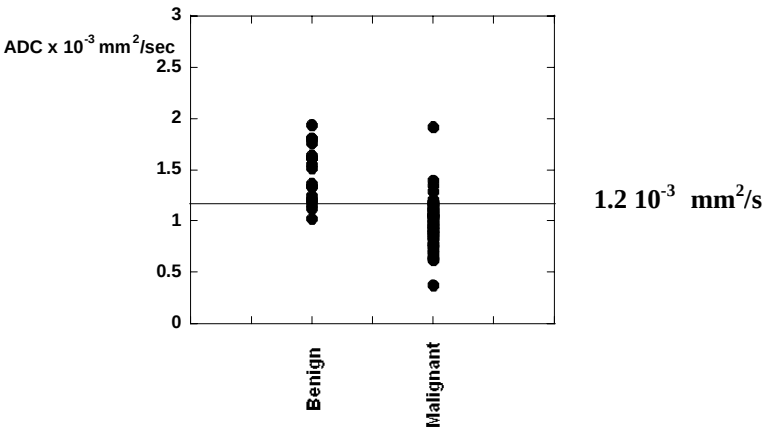

Figure 1: ADC (10^{-3} mm^2/s) of malignant and benign lesions. We found an optimal threshold of 1.2 x 10^{-3} mm^2/s. For this value the sensibility was 81%, the specificity 93%.

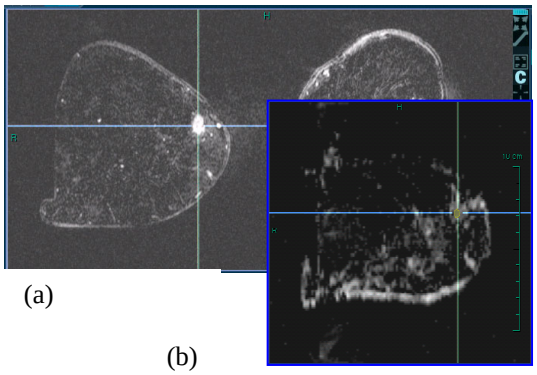

Figure 2 : (a) T1-W FL 3D subtraction image of breast with a lesion that appears enhanced. (b) ADC map linked to the subtraction image with the ROI used for ADC measurement. In this case, ADC is 1.1 +/- 0.09 10^{-3} mm^2/s; it is an invasive adenocarcinoma SBR 7, grade II of malignancy.