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Multiparametric breast MRI with 3T: Effectivity of combination of contrast enhanced MRI, DWI and 1H single voxel spectroscopy in differentiation of Breast tumors

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ABSTRACT

Objectives: To evaluate the diagnostic accuracy of dynamic contrast enhanced breast MRI (DCE-MRI) combined with diffusion weighted imaging (DWI) and 1H single-voxel magnetic resonance spectroscopy (1HMRS) in differentiating malignant from benign breast lesions.
Methods: One hundred twenty-nine patients with 138 lesions were included in the study. Multiparametric MRI of the breast was performed with a 3T unit. A DWI is followed by DCE-MRI and 1HMRS. All lesions were biopsied within one week after MRI. Histopathologic findings were accepted as the standard of reference. Probability of malignancy was assessed according to BI-RADS for DCE-MRI. ADC values were measured for DWI and choline peaks were assessed using a semi-quantitative method in 1HMRS. Two blinded radiologists evaluated findings in consensus. Diagnostic performance of DCE-MRI, DWI and 1HMRS alone or in combination for multiparametric imaging were statistically evaluated.
Results: Histopathology revealed malignancy in 54.4% of lesions (75/138). DCE-MRI showed the highest AUC (0.978), sensitivity (97.33%) and specificity (88.89%) compared to DWI and 1HMRS. Sensitivity was 100% when a positive result from any one of three techniques was accepted as malignancy, albeit with a trade-off for 65.1% specificity. Highest specificity (98.4%) was attained when all three techniques were required to be positive, though with a lower sensitivity (82.7%) as trade-off. Logistic regression analysis confirmed significant association with DCE-MRI ($p < 0.001$) and 1H MRS ($p = 0.009$) but not with DWI ($p = 0.127$). There was one case of fat necrosis which was false positive in all three techniques.
Conclusions: Multiparametric imaging with combination of DCE-MRI, DWI and 1HMRS does not improve, and may even reduce the diagnostic accuracy of breast MRI. Although, the specificity may be improved with a trade-off for lower sensitivity, we have not set a convenient algorithm for the combined use of these techniques.

1. Introduction

Breast MRI has become an important breast imaging modality within the last decade. Dynamic contrast enhanced MRI (DCE-MRI) of the breast is the standard technique enabling detailed morphologic and, to some extent, functional assessment of breast lesions with a very high sensitivity [1–6]. However, some reports on low specificity of DCE-MRI and the challenge in interpretation is underscored the ongoing search for new and quantitative parameters [1,4,5,7]. Diffusion weighted imaging (DWI) provides information on a molecular level and has become a promising tool in differen-

Abbreviations: DCE-MRI, dynamic contrast enhanced MRI; DWI, diffusion weighted imaging; 1H-MRS, 1H MR spectroscopy; NME, non mass enhancement.

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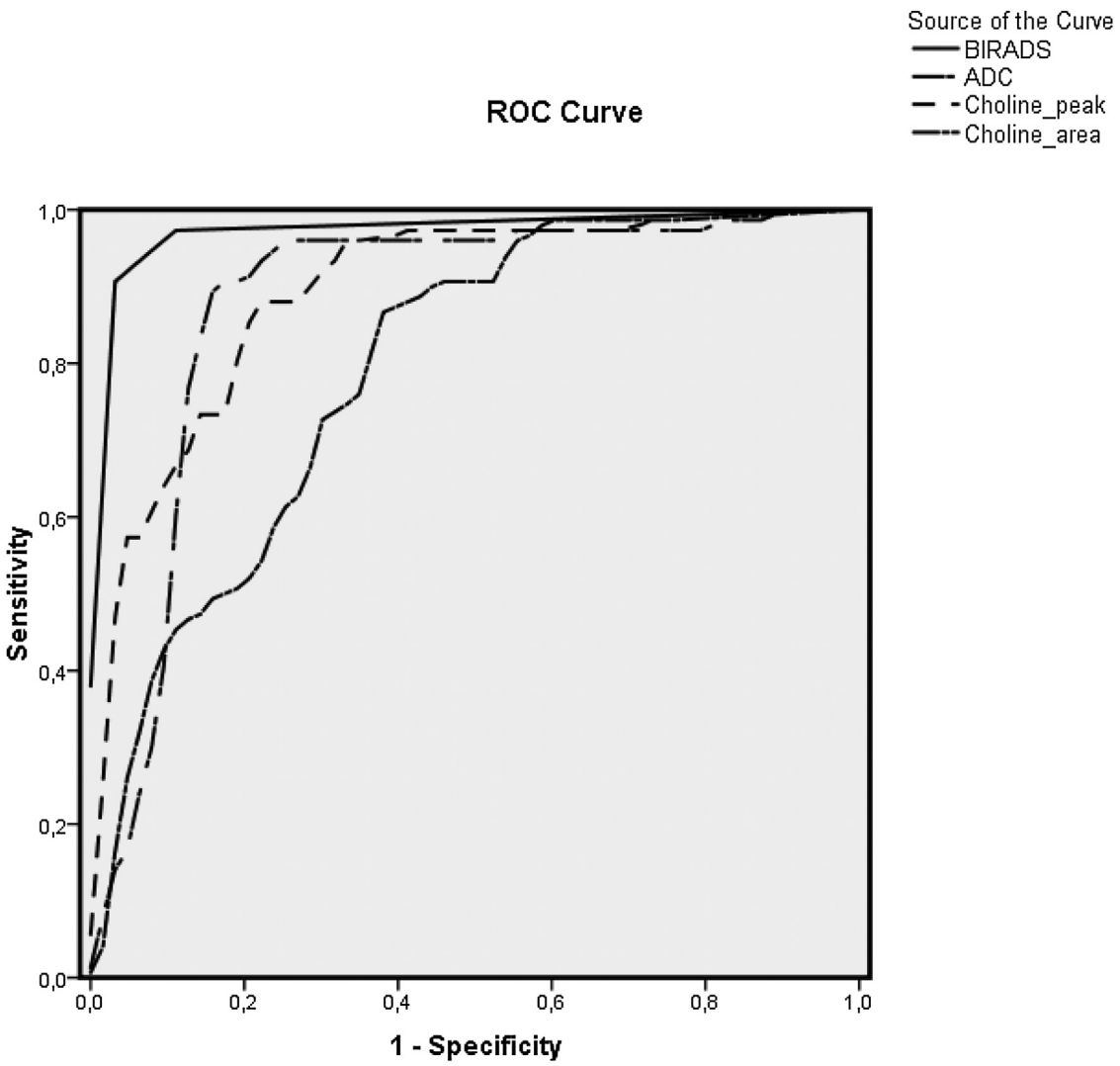

Fig. 1. ROC analyses for BI-RADS category of DCEMRI (AUC = 0.978), ADC measurements in DWI (AUC = 0.878), 1H-MRS choline peak value (choline peak)(AUC = 0895) and choline peak area under curve (choline area)(AUC = 0792) measurements.

tiation of breast lesions. Studies confirmed that DWI, as an adjunct tool, increases specificity of DCE-MRI of the breast [6,8–12]. Despite the positive results from these studies, it has not yet been included in BI-RADS MRI lexicon due to lack of robust data [13]. 1H MR Spectroscopy (1H-MRS), a far less familiar parameter for breast radiologists, showed promising results in various studies. 1H-MRS investigates choline containing compounds (tCho) which are abundant in malignant tumors but less likely to be found in benign lesions [6,14–17]. Although its diagnostic value has been asserted by previous studies with different field strengths and it has been announced as a promising tool in detecting and managing breast cancer in BI-RADS, 1H-MRS has not yet been widely adopted in clinical settings [13]. Multiparametric MRI of the breast is a relatively new approach to diagnosis of breast lesions and utilizes different parameters from that of standard DCE-MRI. These adjunct methods are sensitive in providing additional molecular information and a combination of such techniques with DCE-MRI has the potential to improve differentiation of benign from malignant lesions. Thus, multiparametric breast MRI stands as a promising diagnostic modality in detection and classification of breast lesions [6,18].

The aim of this study was to evaluate the diagnostic accuracy of DCE-MRI combined with DWI and 1HMRS in differentiating malignant from benign breast lesions.

2. Materials and methods

2.1. Patients

This prospective single-center study was approved by the institutional review board and a written informed consent was obtained from all patients during the inclusion process. Patients with BI-RADS [13] 4 or 5 lesions, detected by mammography and/or sonography, were consecutively included in the study during the period of January 2013–June 2015. Lesions had at least one diameter $\geq$10 mm and were classified as masses or non-mass enhancing lesions (NME). All patients underwent MRI examination before ultrasound-guided core needle biopsy.

Exclusion criteria were: age <18, general contraindications for MRI and contrast agent administration, history of previous surgery, radiation or chemotherapy for breast cancer. One-hundred forty six consecutive women with 155 breast lesions underwent breast MRI including DWI, DCE-MRI and single-voxel 1HMRS. A total of 129 patients with 138 breast lesions were included in the analysis. Seventeen patients were excluded from the study; 10 due to technical failure of 1H-MRS, 4 due to suboptimal image quality caused by motion artifacts and 3 patients due to non-enhancing lesions on