

Diffusion Weighted Imaging of the Breast: Can it Decrease the Number of Unneeded Biopsies?

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Objective: To date, breast MRI is analyzed according to morphologic criteria, enhancement kinetics and the T2 characteristic of the breast lesion (1, 2). However, all these criteria show an overlap between benign and malignant lesions and the characterization of the lesion can be challenging. Diffusion weighted imaging (DWI) and ADC values are highly influenced by the lesions' cellularity and thus they can differentiate between benign and malignant lesions (3). The objective of our study is to determine whether ADC values would be a valuable tool in the characterization of breast lesions thus sparing the patients from unneeded biopsies.

Materials and Methods: Using a 1.5T Philips Intera scanner with a 4-element phased array breast coil, 30 patients and 42 lesions with inconclusive mammographic and ultrasonographic evaluation [Breast Imaging Reporting and Data System (BIRADS) 3 or 4] were subjected to a routine breast MRI study including a dedicated dynamic post contrast study with dynamic time intensity curves plotted for each lesion. The DWI EPI STIR sequence was performed prior to the dynamic scan as the T1 relaxation due to the contrast agent would cause changes to the inversion of the tissue and thus can have a strong impact. The parameters included TR/TE/TI = 2750/68/180, FOV = 37x 27 cm, slice /gap = 3/0mm, voxel size = 5 mm, NEX=4. Prone positioning and oblique transverse phase-encoding direction minimized respiratory and cardiac motion, respectively. Diffusion-gradients were employed along 3 orthogonal directions (P, M, S) with b values of 500, 1000 s/mm². And +/-36 axial slices were taken to cover the entire breast. Interpretations of DWI were done through correlating areas of restricted diffusion with areas of contrast enhancement. ADC maps were generated and ADC values were measured through ROI's drawn at sites of maximum signal intensity (i.e. maximum restricted diffusion) and copied to the ADC maps. Conventional images including dynamic time intensity curves were interpreted by an experienced MR radiologists on one setting then re-read after addition of DWI's and ADC values in another setting. Receiver operating characteristic curves (ROC) were generated.

Results: Using the histopathological results as the gold diagnostic reference, there were 23 malignant and 19 benign lesions. The mean ADC values were significantly lower in malignant lesions compared to benign lesions (Figure).

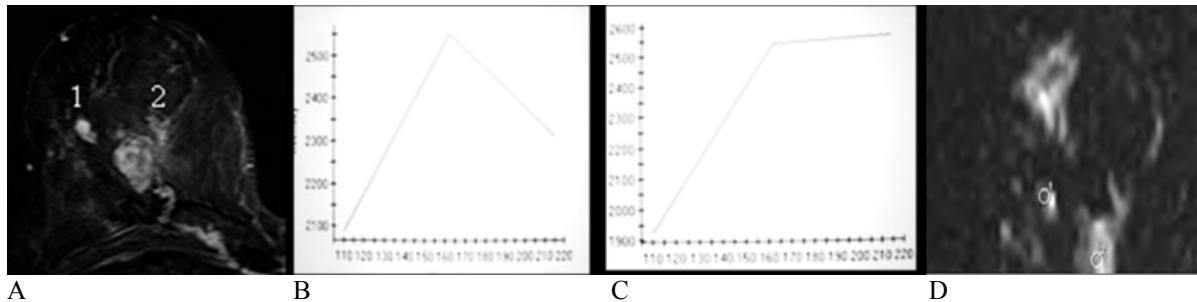


Figure: A 48 year old female patient with 2 breast lesions (A). Mean ADC value of the smaller lesion (1) is $0.51 \times 10^{-3} \text{ mm}^2/\text{s}$ and $1.49 \times 10^{-3} \text{ mm}^2/\text{s}$ for the larger lesion (2). Time intensity curves for the most enhancing part of the larger lesion (B) and the smaller lesion (C) are shown. (D) DWI image showing focal areas of restricted diffusion. Both lesions were surgically excised with the larger lesion verified to be a fibroadenoma and the smaller lesion as invasive ductal carcinoma.

Based on the conventional morphological criteria including the dynamic time/intensity curves (without the addition of DWI and ADC values), there were 8 lesions were false positive (three benign post therapeutic changes, two atypical fibroadenomas, one intraductal papilloma one chronic infected galactocoele and one chronic abscess) and 3 were false negative (two ductal carcinoma in situ and one medullary carcinoma) with a sensitivity and specificity of 87% and 58% respectively. On adding the DWI and ADC values, the diagnostic sensitivity and specificity of ADC values were 87% and 89% respectively with a cut off value of $1.05 \times 10^{-3} \text{ mm}^2/\text{s}$. The main causes of 3 false negative lesions were susceptibility artifacts because of bleeding and tumor structure (necrosis and cystic components). The 2 false-positive lesions were intraductal papilloma and chronic infected galactocoele. The mean ADC value for benign lesions was $1.62 \pm 0.41 \times 10^{-3} \text{ mm}^2/\text{s}$, $0.79 \pm 0.28 \times 10^{-3} \text{ mm}^2/\text{s}$ for malignant lesions and $2.06 \pm 0.26 \times 10^{-3} \text{ mm}^2/\text{s}$ for normal tissue. This additional sequence with its post processing was capable of raising the specificity of MRI from 58% to 89%. In addition, it spared 6 patients from unneeded biopsies, three were benign post therapeutic changes, two were atypical fibroadenomas and the sixth was a chronic abscess.

Conclusion: Adding DWI sequence and ADC values of breast lesions to the conventional breast MRI protocol are considered valuable qualitative and quantitative tools in raising the specificity and diagnostic accuracy of characterizing and differentiating benign from malignant breast lesions and thus avoiding unnecessary invasive diagnostic procedures.

References: 1) Colagrande S et al. 2005. La Radiologia Medica, 109:1-16. 2) Shantanu S et al. 2002. Journal of Magnetic Resonance Imaging, 15:693-704. 3) Guo et al. 2002. Journal of Magnetic Resonance Imaging, 16: 172-178.