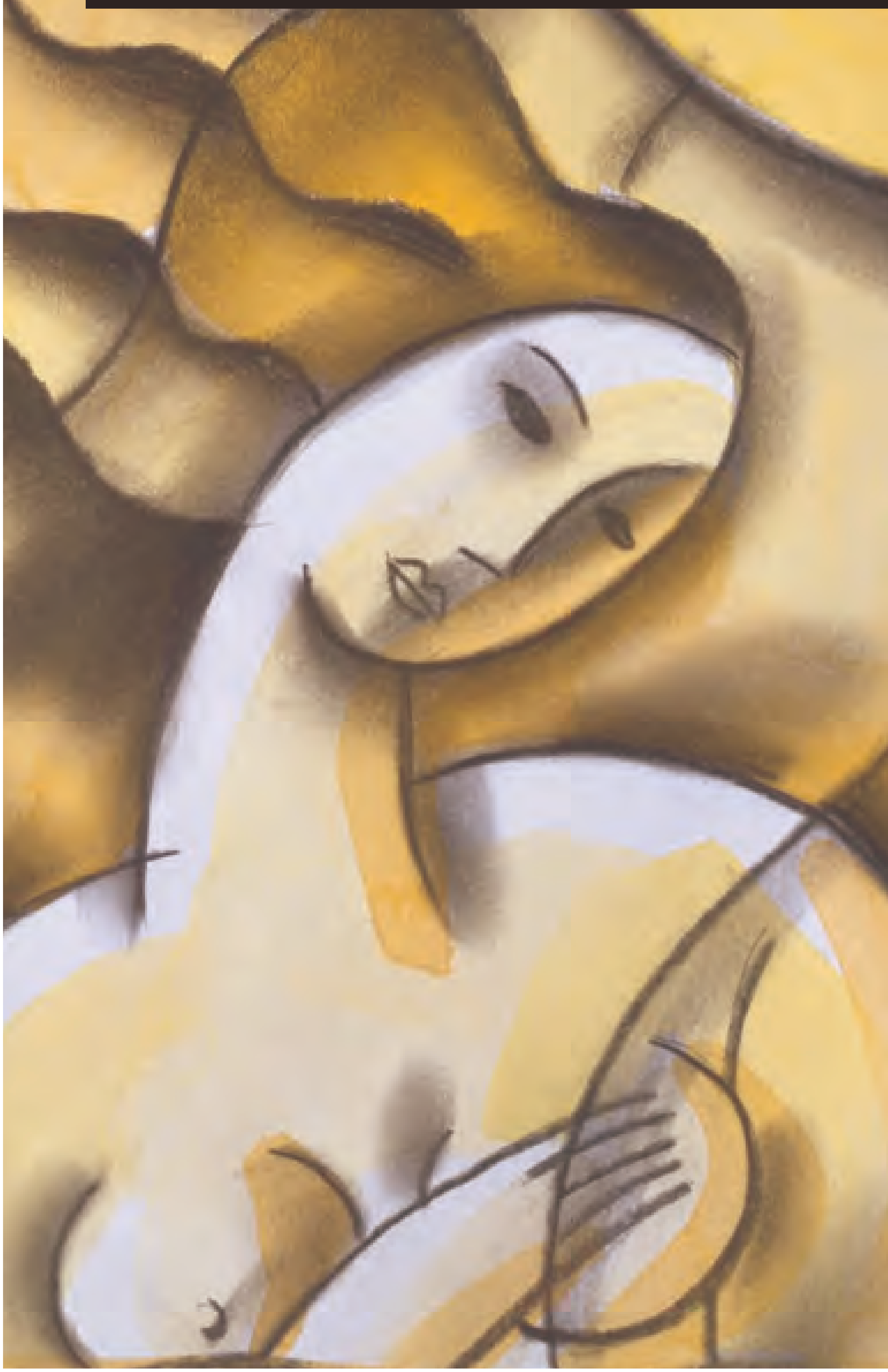
# Apparent Diffusion Coefficient Potential in Differentiating Benign and Malignant Breast Lesions



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## Introduction

Magnetic Resonance Imaging (MRI) shows good sensitivity in detecting breast tumors, with results ranging from 89% to 100% and superior to 95% for invasive cancer.[1,2] However, its specificity is limited due to the existence of contrast uptake pattern overlapping of benign and malignant lesions.[1,3,4] There is also the influence of the female hormonal cycle and the use of hormonal therapy.

Recently, the emergence of new imaging techniques has allowed for the improvement of breast MRI specificity. For two decades, diffusion-weighted imaging (DWI) has been used to evaluate intracranial diseases, such as stroke. In the 1990s, technological breakthroughs allowed the use of diffusion in extracranial sites,[5,6] including the breast.

Images derive from the difference of movement of water molecules (Brownian motion) across tissues,[4,7] enabling qualitative and quantitative information that reflect changes at the cellular level. The value of water diffusion into tissues is measured by the apparent diffusion coefficient (ADC). ADC reduction reflects the histological pattern of higher cell density, which inhibits the effective movement of water, restricts diffusion, and causes signal fall.[7,8]

## Examination and Image Processing

Breast MRI examinations were performed on a GE Healthcare Signa® HD 1.5T system, Echo Speed Plus 33/120 gradient, employing an 8-channel HD Breast coil. Following the standard protocol (T1 and axial STIR, T2 with sagittal fat suppression and axial VIBRANT™) and, preferably, prior to the endovenous administration of contrast, SE-EPI diffusion sequence was performed in the detected lesions.

### Protocol:

Ten 5 mm axial sections, 0 spacing,
36 x 36 cm FOV
160 x 192 matrix
NEX 16
rBW 250 kHz
TR 1800 ms
TE 93.8 ms, fixed for all b values of 0, 250, 500, 750, and 1000 s/mm$^2$
Total time: 3 min, 44 s

In theory, it is known that the more b values sampled, the more accurate the apparent diffusion coefficient (ADC) map measure.[3,5] All images were transferred to a workstation, with the execution of black/white and colored ADC maps; the latter with a Puh-thalium color scheme, ranging from black (diffusion restriction) to red (without diffusion restriction).

Visual inspection of the signal and ADC calculation using Functool for b values 0, 250, 500, 750 and 1000s/mm$^2$ were performed after the placement of regions of interest (ROIs) on the lesion to obtain the mean and one ROI in the glandular parenchyma. The ADC value found in each lesion was correlated with the imaging findings and histopathological diagnosis.

We evaluated the diffusion sequence capacity of locating breast lesions, calculated the ADC value for lesions and gland parenchyma, and compared malignant and benign lesions' ADC values, highlighting a cutting value. P values $< 0.05$ were considered statistically significant. The diffusion's sensitivity, specificity, and accuracy were calculated in order to differentiate benign and malignant lesions.

## Results

In a preliminary study with 35 female patients (25 to 72 years old; mean, 45.7 years) 37 lesions were observed, of which 16 were benign (fibroadenoma, fibroadenolipoma, phyllode tumor, epidermoid cyst), measuring 0.8 to 9.5 cm (mean, 2.0 cm), and 21 were malignant (CDI, CDIS, tubular carcinoma, adenoid cystic carcinoma, mucinous colloid carcinoma), measuring 1 to 11.2 cm (mean, 2.8 cm). Two benign lesions measuring 0.6 and 0.9 cm were excluded, as they could not be located in the diffusion sequence. Of the 37 lesions, 11 showed movement artifacts, most of which were corrected in image processing. ADC values' mean was significantly lower for malignant lesions (0.89 +/- 0.20 x $10^{-3}$ mm$^2$/sec) when compared with benign lesions (1.46 +/- 0.26 x $10^{-3}$ mm$^2$/sec) with $p < 0.001$.

There was one false-positive, epidermoid cyst with ADC of 1.39 x $10^{-3}$ mm$^2$/sec and one false-negative, mucinous colloid carcinoma with ADC of 0.72 x $10^{-3}$ mm$^2$/sec, with the latter easily explained due to the distinct tumor composition.[7] Presuming a cutting value of 1.2 x $10^{-3}$ mm$^2$/sec to distinguish benign and malignant breast lesions, we observed sensitivity, specificity, and accuracy superior to 90%. ADC values' mean for gland parenchyma was 1.13 +/- 0.39 x $10^{-3}$ mm$^2$/sec.

## Conclusion

Diffusion sequence can help with the characterization in differentiating malignant and benign breast lesions, increasing breast magnetic resonance imaging specificity, and reducing the number of false-positives and unnecessary biopsies. It is performed without significantly increasing examination time and can be easily introduced into the standard breast MRI protocol.

## Perspectives

Neoadjunctive chemotherapy treatment results in lysis, loss of cell membrane integrity, increase of extracellular space, and therefore, increase of water diffusion. For this reason, there is growing interest in applying diffusion to detect tumor response.[5,8]

There are preliminary works showing that diffusion can detect lymph nodes affected by neoplastic cells, once the change and increase of lymph nodal cellularity results in diffusion restriction.[5] ■

**The author presented a breast DWI study as a scientific poster presentation in the category Breast Imaging, MR at the 2008 Annual Scientific Sessions of the Radiological Society of North America.**

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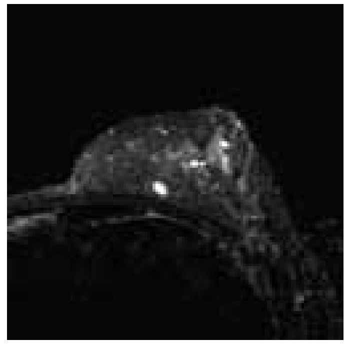
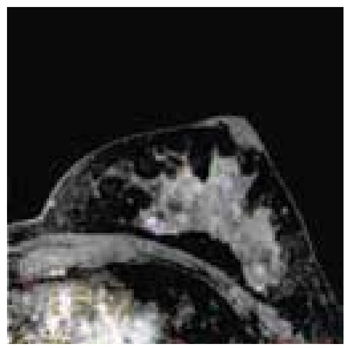
## Benign Nodule

36 year-old patient, right mastectomy, with 0.8 cm stable nodule showing benign characteristics suggesting fibroadenoma in the internal superior quadrant of the left breast.



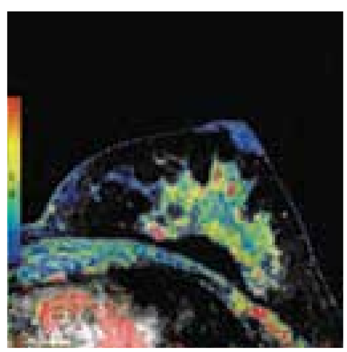
Axial T2 STIR

Axial T1 FSE

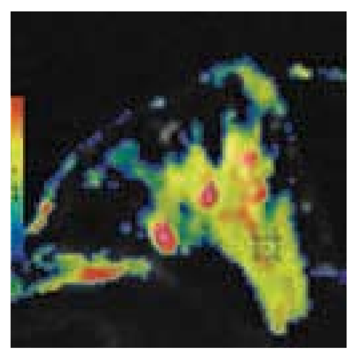


Reference ROI Curve

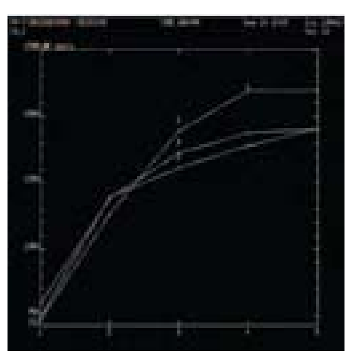
Sagittal T2 Fat Sat



Maximum Slope of Increase



ADC Map



Dynamic Curve