Utility of diffusion-weighted MRI in distinguishing benign and malignant breast lesions.

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**Purpose**

The basic method used for scanning of the breast cancer is conventional mammography. It has been reported that mammography has a sensibility of 69 - 90% in scanning and diagnosis of the breast lesions. However, in cases of dense breast parenchyma, the sensibility may be reduced by 48%. On the other hand, only 5 to 40% of the palpable lesions, which can be diagnosed by clinical examination, have a malignant character, and 10% of the cancer cases cannot be diagnosed through mammography. In dense breast tissue where the mammography remains incapable, ultrasonography must be the first imaging technique that must be applied. However, there are certain limitations regarding this technique: it cannot detect the microcalcifications and ductal carcinoma in situ cases; it can be incapable to differentiate the cysts with dense contents from solid lesions and it is a user-dependent technique. Mammography and ultrasonography remain incapable in the evaluation of the cellular and vascular characteristics of the lesions, in the assessment of the real dimensions and extensiveness, in planning of the preventive breast cancer surgery, and in the differentiation of the residue cancer from granulation tissue and fat necrosis.

Magnetic resonance imaging (MRI) is a supplementary diagnostic method which is used in imaging of the breast lesions. In the breast, the sensibility of the magnetic resonance (MR) examination in the differentiation of the malignant lesions from the benign ones is 90-95%, and its specificity is between 46% and 97%. Today, the only imaging method which can be used for the purpose of detection of the cellularity of the lesion is the diffusion MRI.

Our purpose was to determine whether focal breast lesion could be differentiated as benign or malignant on the basis of diffusion-weighted imaging (DWI).
Methods and Materials

- A total of 45 patients with focal breast lesions were scanned using 1.5 T magnetic resonance imaging (MRI), using dedicated bilateral breast coil.

- DWI was performed with b values of 0, 600 and 1000. The apparent diffusion coefficient (ADC) of the lesion was measured.

- The breast lesions were diagnosed on histology or had characteristic mammography and ultrasonography/MRI findings and follow up of more than 6 months.

- The analyzed lesions were ductal carcinoma in situ (n = 5), invasive ductal carcinoma (n = 11), invasive lobular carcinoma (n = 9), adenofibromas (n = 15), cysts (n = 5).
Results

RESULTS:

- The mean ADC values of all the disease groups were statistically significant when compared with the mean ADC value of the normal ones.
- There were also statistically significant differences among the ADC values of different tumors grading.
- However, there was no statistically significant difference between benign lesions.

DISCUSSION:

It is known that the evaluation of the morphological characteristics of the breast lesions together with the dynamic contrast retention pattern increases the MRI specificity. However, it must be taken into consideration that the morphologies of certain malignant lesions, such as mucinous carcinoma, lymphoma and metastases to the breast bear resemblance to the benign lesions. The inflammatory breast carcinoma which constitutes a special group of breast cancers is not differentiated from the mastitis by means of the dynamic breast MR examination with contrast. Besides, MRI remains incapable for the differentiation of the malignant and benign in hypervascular benign lesions and in cases where the lesion contours cannot be observed clearly by insufficient MRI resolution. The technique based on the dynamic contrast is directly related to the vascularity of the lesions; however, any direct relationships do not exist between the tumor cellularity and contrast retention pattern.

In the breast, DWI is administered for the determination of the cellular density of the solid lesion and the width of the interstitial space. The malignant tumors are developed by the dense and disorganized cells. The cellular density narrows the extracellular space in the tumor tissue and as a result, the movement of the water molecules between the cells is restricted and a signal loss occurs in the ADC images.

In the literature there are several studies with respect to the ADC values of the malignant breast lesions. In the study where Guo et al. [14] assessed the "b" value as 0 and 1000 s/mm², the average ADC value of the 31 malignant lesions was reported as $0.97 \pm 0.20 \times 10^{-3}$ mm²/s and the average ADC value of the 24 benign lesions was reported as $1.57 \times 0.23 \times 10^{-3}$ mm²/s. In addition, in this study it has also been reported that the malignant and benign lesions can be diagnosed with 93% sensibility, 88% specificity and
91% accuracy with the application of a threshold value of $1.30 \times 10^{-3}$ mm$^2$/s. In their study carried on 52 patients, 27 malignant and 33 benign lesions, Luo JD et al. with a "b" value determined as 0 and 1000 s/mm$^2$, the average ADC value of the malignant lesions was reported as $0.87 \pm 0.23 \times 10^{-3}$ mm$^2$/s and the average ADC value of the benign lesions was reported as $1.59 \pm 0.26 \times 10^{-3}$ mm$^2$/s; and the sensibility, specificity and accuracy were reported as 88.9%, 87.9% and 83.3%, respectively with a threshold value of $1.22 \times 10^{-3}$ mm$^2$/s between the malignant and benign lesions.

The common result acquired from all studies demonstrates that the ADC values of the malignant tumors are significantly low compared to the values of the benign tumors.

In our study, the mean ADC values of all the disease groups were statistically significant when compared with the mean ADC value of the normal ones. There were also statistically significant differences among the ADC values of different tumors grading. However, there was no statistically significant difference between benign lesions.

In their study, Reiko W. et al. have reported that ADC is a criteria which is still insufficient in qualitative evaluation of the lesion; the ADC values are unreliable especially in cases of fibrocystic diseases, ductal ectasy, intraductal papilloma and some types of fibroadenoma; and it is possible to obtain high ADC values also in mucinous carcinoma, DCIS and malign filloid tumor cases. And they have asserted that the reasons of this situation are indistinctive small necrotic focuses or conditions which cause sensitivity artifacts such as bleeding.

In the breast lesions, when the sensitivity of the MRI is high, its specificity is low. The parameters which are capable of increasing the specificity are the kinetic and morphological values of the lesion and the DWI. All three parameters had insufficiencies with respect to the differentiation of the benign and malignant masses, and in the literature we could not find any studies carried out on large-scale histopathological series with the application of the three parameters.
Fig. 1: Case 1: A 31-year-old woman with an invasive ductal carcinoma of the left breast. T1W, dynamic 3D FLASH sequence and diffusion weighted (DW) image.

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Fig. 2: Case 1: A 31-year-old woman with an invasive ductal carcinoma of the left breast. T1W, dynamic 3D FLASH sequence and diffusion weighted (DW) image.

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Fig. 3: Case 1: A 31-year-old woman with an invasive ductal carcinoma of the left breast. T1W, dynamic 3D FLASH sequence and diffusion weighted (DW) image.

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Fig. 4: Case 2: Mucinous carcinoma in the right breast. the DWI result was in accordance with the pathological finding. Both DWI and the ADC colored map clearly showed the lesion at b=1000 mm²/s.

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Fig. 5: Case 2: Mucinous carcinoma in the right breast. the DWI result was in accordance with the pathological finding. Both DWI and the ADC colored map clearly showed the lesion at b=1000 mm²/s.

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**Fig. 6:** Case 2: Mucinous carcinoma in the right breast. The DWI result was in accordance with the pathological finding. Both DWI and the ADC colored map clearly showed the lesion at b=1000 mm²/s.

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**Fig. 7:** Case 3: Bilateral invasive lobular microcarcinoma.

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**Fig. 8:** Case: Bilateral invasive lobular microcarcinoma.

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Fig. 9: Case 3: Bilateral invasive lobular microcarcinoma.

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**Fig. 10:** Case 3: Bilateral invasive lobular microcarcinoma.

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Conclusion

The present study showed that ADC measurement has the potential to differentiate benign and malignant focal breast lesions. We propose to add DW sequence in the MR protocol for the detection and quantitative discrimination of breast pathologies.
References


