Role of DWI with increased b value in detection of breast malignancies without use of contrast media; assessment with ADC values and background suppression MR mammogram.

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Aims and objectives

Introduction:
Diffusion-weighted imaging (DWI) is a technique that derives its image contrast from differences in diffusion rate of water molecules in normal and pathologic tissue. It relies on differences in cellularity to distinguish between benign and malignant lesions. Malignant lesions, which frequently have a higher degree of cellularity compared with benign lesions, often demonstrate restricted diffusion. High cellular proliferation in the malignant lesions increases cellular density and barrier to extracellular water diffusion which causes reduction of ADC and signal loss [1]. It shows bright signals on DWI and dark signals on corresponding ADC map[2,3]. DWI provides quantitative and qualitative information which reflects the tumour cellularity and integrity of cell membrane. Using the DWI-MR we can calculate the apparent diffusion coefficient (ADC), a quantitative measure which is directly proportional to water diffusion [2,4].

Aims and objectives:
To evaluate the role of DWI in detection of malignant lesions of the breast. To evaluate the enhancement of tumour detection with increased b value to 1500 sec/mm². To evaluate the ADC values in malignant and benign breast lesions. Assessment of tumour detection with background suppression of breast tissue.
Methods and materials

Study Design - Cross sectional analytical study

Setting - Department of Radiology, Dr. D.Y. Patil Medical College, Pune, India

Sample Volume - 30 cases

The study included 30 cases in which 10 cases were known biopsy proven breast malignancies, 10 cases known benign lesions. 10 control cases were evaluated for Diffusion weighted sequences in normal breast tissue and to evaluate the ADC values in normal breast parenchyma. All the cases underwent for breast MRI on 1.5 Tesla Siemens's Avanto machine using dedicated breast coil with patient in prone position. Field of view was 340 mm and slice thickness was 3mm. Before diffusion weighted imaging, standard MR breast sequences were acquired to observe the lesion. Axial T1-weighted spin-echo sequence and T2WI axial were obtained with 3mm slice thickness. After the initial evaluation Diffusion Weighted MR imaging was acquired in axial section with 3mm slice thickness. Initially DWI study was done with b value 0, 500 & 800 sec/mm² and then the DWI images obtained with b value 300, 800 & 1500 sec/mm². Assessment of the tumor or lesion were done in both the DW MRI studies.

ADC values in the malignant lesion, benign lesion and in the control breast tissue were calculated.

The images were interpreted by radiologist with more than 10 years of experience in breast imaging.
Results

The lesions, which showed diffusion restriction were considered positive whereas lesions did not show restriction were considered as benign lesions. The sensitivity of DWI-MRI was 96%, specificity was 91.3%, PPV 92.3% and NPP 94.4%.

The mean age of all the patient who were part of the study was 42.6 ± 13.2 years with the age range of 20-68 years. Out of 30 cases, 10 were histopathology proven malignant cases whereas 10 cases were benign. The mean age of the women who constituted the benign lesions was 36.9 ± 5.2 years whereas the mean age of women with malignant lesions was 47.4 ± 4.6 years. Of all the benign lesions, 4 lesions were proven to be fibroadenoma; 3 lesions were mastitis of which one was granulomatous mastitis; 2 were abscess and 1 was sclerosing adenosis.

Infiltrating ductal carcinoma was the most common malignant lesion; 5 out of 10 were IDC, followed by Ductal carcinoma in situ which were 3 and 2 cases were of invasive lobular carcinoma.

Mean ADCs of malignant lesions was 0.611 ± 0.47 × 10^-3 mm^2/s which was significantly lower than of benign lesions was 1.135 ± 0.59 × 10^-3 mm^2/s, for b value 800. When b value was increased from 800 to 1500, mean ADC value of malignant lesions was 0.609 ± 0.35 × 10^-3 mm^2/s and of benign lesions was 1.732 ± 0.53 × 10^-3 mm^2/s. Mean ADC of normal breast tissue was 1.391 ± 0.27 × 10^-3 mm^2/s (b=800) and 1.348 ± 0.56 × 10^-3 mm^2/s(b=1500). Mean ADC values were significantly low in malignant lesions as compared to benign lesions in both the b value combinations, though improved detection of the lesion with increased confidence when we have done DWI with increased b value to 1500 sec/mm^2

Tumour detection was also improved with the background suppression with black and white inversion.
**Images for this section:**

**Fig. 1:** a: Axial T1WI Fat suppressed image of the lobular carcinoma seen in the right breast b: Diffusion weighted image showing bright signals in the mass with c: showing corresponding low value on ADC d: Tumour detection improved with background suppression with black and white inversion.

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**Fig. 2:** a. Axial DWI image of carcinoma of breast showed improved detection of multiple lesions in the right breast upper outer quadrant b. Corresponding ADC image (b value 1500) showing better localisation of the multiple lesions with low ADC value

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Fig. 3: a. Axial DWI image of the breast showing fibroadenoma in left breast which did not show restriction on diffusion. b. Corresponding ADC mapping showing high ADC value consistent with benign lesion.

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Conclusion

Discussion:

When we increase the b value the signal to noise ratio is decreased. In our study ADC calculation with higher b value showed lower ADC value and study with lower b value demonstrated higher ADC. ADC value is helpful in differentiating malignant from the benign lesion. When we increase the b value signal, intensity of the normal breast decreased. So higher b value demonstrates improved contrast resolution between malignant lesion and normal tissue of breast.

Conclusion:

DW MRI in evaluation of breast lesions is very sensitive diagnostic modality in differentiation of breast malignant and benign lesions.

DWI can be use as an adjunct with the mammography in screening of the breast lesions to detect the malignancies with more confidence and it may reduce the number of biopsy. It is an excellent non invasive investigation to detect malignant lesion specially in dense breast and in high risk patients.
Authors of this scientific paper are happy to exchange experience and receive a valuable feedback.

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