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MRI Roles in the Differentiation Between Benign and Malignant Breast Lesions in Baghdad City

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Abstract

Background: BC is the first most common cancer in females. Dynamic contrast enhanced MRI (DCE-MRI) has improved specificity in characterizing breast lesions. Diffusion weighted imaging (DWI) can improve the sensitivity and specificity of MRI in the evaluation of breast lesions thus distinguishing between benign and malignant breast lesions. The aim of the study was to evaluate the role of DW-MRI and DCE- MRI in differentiating benign from malignant breast lesions.

Methods: A descriptive study enrolled 50 females of palpable breast lumps with positive findings. This was followed by MRI (Magnetom Aera; Siemens Healthineers, Erlangen, Germany) 1.5 T) using a dedicated breast array coil.

Results: Fibroadenoma accounted for most benign lesions (8/20) while IDC accounted for majority of malignant lesions (30/30). 16/20 benign breast lesions did not show restricted diffusion on DWI while all malignant lesions showed restricted diffusion on DWI. In our study, the mean apparent diffusion coefficient (ADC) value for benign and malignant lesions was 1.58 x 10^{-3} mm^2/s and 0.89 × 10^{-3} mm^2/s, respectively.

Conclusions: MR morphology, DCE-MRI and DWI are useful to characterize various breast lesions. MRI features of SI of hypointensity on T2WI with other associated features of irregular shape, spiculate margins, heterogeneous enhancement on DCE-MRI, and reduced ADC value are strong predictors of carcinoma.

Keywords: MRI, DWI, Breast cancer, Benign, Malignant

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Introduction

BC is the first most common cancer in women. According to the NCCN project report about 2 million women develop BC in world per year. It is a significant cause of worldwide morbidity and mortality. MR techniques have shown strong potential to improve the sensitivity and specificity in the diagnosis of BC [1].

MRI is recommended by the ACS as an adjunct to mammography for screening females who are at high risk of developing BC [2]. It seems to be ideally useful for breast imaging due to its ability to depict excellent soft tissue contrast. Contrast enhanced MRI and dynamic MRI have been found to be more accurate in the detection of malignant lesions and differentiation of malignancy vs. scarring. In addition, MRI can also be used to assess ALN metastasis. DCE-MRI of breast is a very sensitive method for detecting small lesions which are not visualized by conventional MR. BC have variable vascularization DCE-MRI patterns, which are divided due to the internal enhancement pattern, enhancement distribution, and kinetic studies on DCE-MRI. According to BIRADS lexicon, kinetic curves are classified as “washout,’ “plateau,” or “persistent” shape [3].

DWI has shown promise for the detection and characterization of BC. Apparent diffusion coefficient (ADC) values allow quantification of diffusion signal and can facilitate in differentiating benign and malignant breast lesions as well as identifying early responses preoperative treatment [4]. It is performed using at least two b values. Theoretically, the error in ADC calculation can be reduced by using more b values. However, the more b values used, the longer the DWI sequence will be [5, 6].

The aim was to estimate the roles of DWI-MRI and DCE-MRI in distinguishing benign from malignant breast lesions.

Methods

Design and setting

A descriptive radiological study was conducted in the department of radiology between June 2023 and December 2023 at Medical City. A total of 50 cases with palpable breast lump referred from various hospitals were included in the study.

Inclusion criteria

Cases with palpable breast lump with either positive findings on mammography or US.

Exclusion criteria

- ✔ Cases who had received chemotherapy, radiotherapy and surgery.
- ✔ Impaired renal function.
- ✔ Allergy to contrast medium.
- ✔ Pacemaker and shells.

Complete history and clinical examination were done. Relevant laboratory investigations were noted.

Equipment and protocols

MRI examination was performed utilizing the 1.5 Tesla Siemens system (Magnetom Aera; Siemens Healthineers, Erlangen, Germany). The protocol applied included: T1(t1-fl2d) axial, T2 (t2-tse) axial, T2 fat suppression (t2-haste-fs) axial, T2 (t2-tse) coronal/or sagittal and T1 fat suppression (t1-tse-fs) axial and coronal /or sagittal before and after injection of IV contrast (gadolinium) at a dose of 0.1 mmol/kg.

The post contrast images were taken in the early phase (45-60 sec post injection) for all the cases, and additional post contrast images were taken in the delayed phase (5 minutes post injection) in cases that showed masses with very hyperintense signal in T2WI.

Diffusion weighted images (DWI) and Apparent diffusion coefficient (ADC) values

DWI were performed for all the included cases before giving IV contrast using single shot echo planer imaging sequence EPI in axial plane. The parameters were: TR = 5580 ms, TE = 75 ms, slice thickness = 4 mm, b values (50, 400, and 800 mm/sec^2). All diffusion images and conventional images were obtained at the same slice locations. The ADC value was measured by applying region of interest (ROI) on the solid part of the tumor avoiding any area of necrotic, cystic or hemorrhagic changes and encircling in the most prominent restrictive diffusion. Three ROIs were applied for each tumor and the mean of the ADC values was calculated.

Statistical analysis

All statistical calculations were done using (Statistical Package for the Social Science) SPSS 24 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows. Data was described in terms of range; mean ± SD, frequencies (number of cases) and relative frequencies (percentages) as appropriate. Comparison of quantitative variables between the study groups was done using Student t-test. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value were also calculated. A probability value (P- value) less than 0.05 was considered statistically significant.

Results

Out of the total 50 breast lesions, FNAC or biopsy analysis revealed 20 benign lesions (40%) and 30 malignant lesions (60%). Among the benign lesions, fibroadenoma was the most common pathology seen in 8/20 cases, while IDC accounted for most of the malignant lesions seen in 30/30 cases. The youngest case being 18 years old and oldest being 65 years old (Table 1).

Diffusion and ADC values of benign and malignant lesions

Out of 20 benign breast lesions 16 lesions did not show diffusion restriction on DWI. 2 cases of granulomatous mastitis showed diffusion restriction. The minimum ADC value was 0.96 x 10^{-3} mm^2/s seen in granulomatous mastitis while maximum ADC value was 2.2 x 10^{-3} mm^2/s/s seen in case of fibroadenoma. The mean ADC value for benign breast lesion was 1.58 x 10^{-3} mm^2/s.

All the malignant breast lesions show diffusion restriction on DWI. 15 out of 30 malignant lesions had ADC values >1 x 10^{-3} mm^2/s. The least ADC value was 0.7 x 10^{-3} mm^2/s seen in IDC. While the maximum ADC value was 1.22 x 10^{-3} mm^2/s seen in IDC. The mean ADC value was calculated as 0.89 x 10^{-3} mm^2/s. 16 out of 20 benign lesions did not show restricted diffusion on DWI while 2 cases of granulomatous mastitis showing restricted diffusion on DWI. The mean ADC value calculated in benign lesion was 1.58. All the malignant lesions show restricted diffusion on DWI with mean ADC value calculated as 0.89 (Figure 1).

Table 1: MRI features of benign and malignant lesions.

Parameter		Benign	Malignant	P value
Size (cm)	2-5	12	8	0.1
	> 5	8	22	
Shape	Irregular	8	27	0.02
	Lobulated	0	0	
	Oval	5	3	
	Round	7	0	
Margin	Circumscribed	10	7	< 0.0001
	Spiculated	10	23	
T1SI	Heterogeneous	5	2	0.05
	Hypointense	10	28	
	Isointense	5	0	
T2SI	Hyperintense	12	4	0.01
	Hypointense	6	26	
	Isointense	2	0	
Enhancement	Heterogeneous	2	30	< 0.0001
	Homogeneous	12	0	
	Absent	6	0	

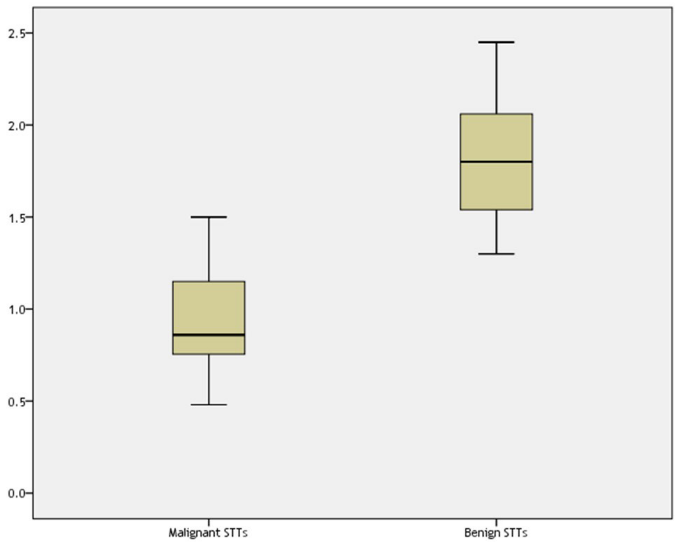

Figure 1: Box plot of ADC values for malignant and benign BC.

Accuracy values

In this study the sensitivity and specificity of MRI with contrast was calculated as 96% and 71% respectively. In our study 16/20 benign lesions did not show restricted diffusion on DWI. All the malignant breast lesions showed restricted diffusion on DWI. In our study the sensitivity and specificity of DWI to differentiate between benign and malignant lesions were 96% and 92% respectively. In our study the cutoff value of ADC to differentiate between benign and malignant lesions was calculated to be 1.20 x 10-3 mm^2/s. This yielded a sensitivity of 90% and specificity of 95%. The accuracy for MRI with contrast was 86% whereas for DWI was 94% (Table 2).

Table 2: Diagnostic performance of DWI and DCE-MRI.

Values	DWI-MRI	DCE-MRI
Sensitivity	96	96
Specificity	92	71
PPV	95	85
NPV	90	88
Accuracy	94	86

Discussion

12 out of 20 benign lesions were either round or oval. 10 out of 20 benign lesions were well circumscribed margins. Our data are in concordance with Qu et al. [7] who observed that 19 out of 23 fibroadenomas were lobular, oval or round.

In this study 10/20 benign lesions showed hypointense signal on T1WI, while 12/20 lesions showed hyperintense signal on T2WI. These are in concordance with Westra et al. [8] who reported that most masses with high signal intensity at T2WI were benign.

In our study 27 out of 30 malignant lesions had irregular shape and 23/30 malignant lesions showed spiculated margins. Our data are like those reported by Zhang et al. [9] who found that larger mass size, irregular shape and irregular or spiculated margins were associated with higher odds of malignancy than smaller, smooth marginated masses.

In our study 28 out of 30 malignant lesions showed hypointense signal on T1WI while 26 out of 30 malignant lesions showed hypointense signal on T2WI. These are in concordance with a study by Westra et al. [8] who reported that most malignant lesions do not show high signal intensity on T2WI because of their high cellularity and low water content.

All the benign lesions showed enhancement on post contrast scans. The most common enhancing pattern was homogenous enhancement which was seen in 12 out of 20 benign breast lesions (60%). Zhang et al. [9] also pointed out that lesion measuring more than 1 cm in size and showing homogenous enhancement was more likely to be benign.

All the malignant breast lesions in this study showed heterogenous enhancement. Pinker-Domenig et al. [10] also observed that heterogenous enhancement was positively associated with malignancy. Zhang et al. [9] also concluded that heterogeneous enhancement was a strong predictor of malignancy.

In this study the sensitivity and specificity of MRI with contrast was calculated as 96% and 71% respectively. These are comparable to those of Ahmadinejad et al. [11] who performed a meta- analysis to determine the diagnostic performance of contrast material enhanced magnetic resonance imaging in cases with breast lesions and calculated a pooled sensitivity of 90% and specificity of 72%.

In our study 16/20 benign lesions did not show restricted diffusion on DWI. The mean ADC value among the benign lesion was 1.58 x 10^{-3} mm^2/s. All the malignant breast lesions showed restricted diffusion on DWI. The mean ADC value for malignant was 0.89 x 10^{-3} mm^2/s. These values were well in correlation with the results of Shin et al. [12] in whose study the mean ADC value of benign lesions was $1.67 \pm 0.54 \times 10^{-3}$ mm^2/s and of malignant lesions was $1.22 \pm 0.31 \times 10^{-3}$ mm^2/s.

In our study the sensitivity and specificity of DWI to differentiate between benign and malignant lesions were 96% and 92% respectively. Our data are like that of Abdulghaffar et al. [13] who found that DWI sensitivity and specificity were 95.4% and 97.5%, respectively.

In our study the cutoff value of ADC to differentiate between benign and malignant lesions was calculated to be 1.20 x 10^{-3} mm^2/s. This yielded a sensitivity of 90% and specificity of 95%. In comparison, Tan et al. [14] calculated the cut off ADC values for benign and malignant lesions as 1.21 x 10^{-3} mm^2/s. In their study, the sensitivity of DCE-MRI alone was 100% with a specificity of 66.7%.

Conclusions

MR morphology, DCE-MRI and DWI are helpful to characterize various breast lesions. MRI features of SI of hypointensity on T2WI with other associated features of irregular shape, spiculate margins, heterogeneous enhancement on DCE-MRI, and reduced ADC value are strong predictors of carcinoma.

Acknowledgements

None.

Conflict of Interest

None.

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