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ROLE OF DIFFUSION WEIGHTED IMAGING AND ADC VALUES IN CHARACTERISING BREAST LESIONS ON MR MAMMOGRAPHY

Radio-Diagnosis

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ABSTRACT

Background- Dynamic contrast enhanced MRI (DCE MR) is an important imaging modality to detect and evaluate the breast lesions with high sensitivity. **Objective-** Aim of study was to characterize breast lesions detected on MR mammography by diffusion weighted imaging and quantify ADC values to differentiate benign and malignant mass and non mass lesions. **Methods-** This prospective study was performed in thirty female patients on 1.5T GE Healthcare HDXT MRI machine. Thirty three breast lesions were included in this study. Final diagnosis was correlated with histopathological diagnosis. **Results-** Out of total thirty three lesions, mean ADC value of malignant lesions was 1.01 ± 0.24 x 10-3mm2/sec and for benign lesions was 1.48 ± 0.29 x 10-3 mm2/sec. The calculated ADC cut off value of 1.22x 10-3 mm2/sec gave a sensitivity of 86.96% and specificity of 90% to differentiate malignant and benign breast lesions. **Conclusion-** As a conclusion Diffusion weighted imaging and quantitative analysis with ADC values can be used with conventional DCE MR to differentiate benign and malignant breast lesions with high sensitivity and specificity.

KEYWORDS

Dyanamic contrast enhanced MRI, Diffusion weighted imaging, ADC values, Breast lesions.

INTRODUCTION

Breast cancer is the second most common cause of cancer deaths after lung carcinoma in females.[1] It is the most common cancer of women in the urban cities and second most common cancer after the uterine cervix in the rural areas.[2] Breast lesions are evaluated by self examination, clinical breast examination, X- ray mammography, ultrasound, magnetic resonance imaging and positron emission tomography. X-ray mammography is the primary method of detection and diagnosis of breast disease with sensitivity of 85-95%.[3] The specificity of mammography is 88% and positive predictive value is 22%.[4]

However, dynamic contrast enhanced MR mammography is a problem solving imaging modality. It is used to differentiate benign and malignant lesions, scar tissue and recurrent cancer. It is also helpful to see invasion in surrounding soft tissues, multifocality and multicentricity of breast tumour and to evaluate breast implants. MR imaging has high sensitivity 89-100% in detection of breast tumours but variable specificity 50-90%.[5,6,7,8]This is due to menstrual cycle, hormone replacement therapy and proliferative alterations.

To improve the specificity of dynamic contrast enhanced MRI (DCMRI) in differentiating benign and malignant breast lesions role of functional diffusion weighted imaging has been studied. Guo[9] reported that diffusion weighted imaging (DWI) improved the specificity of dynamic contrast enhanced MR and can be combined with DCMRI without any significant increase in time. However, small lesions have difficulty in visualization on DWI due to its limited spatial resolution.

MATERIAL AND METHODS

A hospital based prospective analytical observational study was conducted at Department of Radiodiagnosis, SMS hospital Jaipur. Total thirty female patients with thirty three breast lesions were included in the study after obtaining consents. Patients having cardiac pacemaker, chochlear implants and deranged renal functions were excluded. All patients were instructed to fast for two hour before MRI. Scans were performed on a 1.5 Tesla GE Healthcare HDXT MRI machine using dedicated phased array 8 channel breast coil. Patients were explained to lie down in a prone position with breasts fitted in the coil.

Before DWI standard sequences axial T1WI, axial T2WI and STIR were acquired. The T1WI sequence was performed with TR/TE 617/8.2, NEX 2, FOV 30 x 30, matrix 320 x 224, slice thickness 3mm and 1mm inter slice gap. T2WI sequence was performed with TR/TE 8133/116, NEX 2, FOV 30 X 30, matrix 384 x 256, slice thickness 3 mm and 1 mm inter slice gap. STIR sequence was performed with TR/TE 8000/40, TI 130, NEX 2, FOV 30 x 30, matrix 320 x 192, slice thickness 3 mm and 1 mm inter slice gap. Diffusion weighted imaging was done at b value 0 and 800. Scan parameters used for DWI were TR/TE 6550/98, NEX 16, FOV 32 x 32, matrix 256 x 256, slice thickness 5mm and 1mm inter slice gap. Then five dynamic post contrast (vibrant) images at one minute interval each were acquired. Contrast was injected by pressure injector using 20 ml of gadoversatamide 0.1 mmol/kg dose followed by 25 ml of saline flush at a rate of 2 ml/sec.

Breast lesions were divided into mass and non mass lesions. Mass lesions were evaluated for morphology including the shape, margins, T2W signal intensity, internal enhancement patterns. Non mass breast lesions were evaluated for their distribution and internal enhancement patterns. Post processing was done on dedicated work station ADW 4.4 . Then ADC values were obtained by placing region of interest (ROI) on breast lesions.Breast lesion enhancement kinetics were obtained by five phases of post contrast images and curves were obtained by plotting signal intensity on Y axis and time in minute on X axis. Diagnosis of breast lesions were confirmed by FNAC, core biopsy or surgical specimen histopathology.

RESULTS

In this study total 33 breast lesions were detected. On histopathology seventy percent of lesions (23) were malignant and thirty percent (10) were benign. Only three benign lesions were non restricted out of total ten benign lesions. All malignant lesions showed restricted diffusion. Out of total thirty three detected breast lesions nine lesions were non mass and rest of twenty four lesions were mass. Breast lesions were graded according to BIRADS classification. (Figure 1). BIRADS 0 and 1 are excluded from the study.

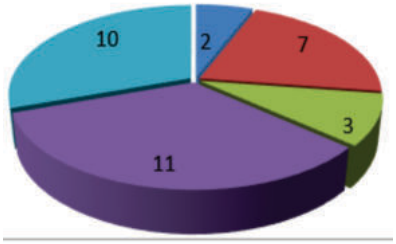

Figure 1.Distribution of lesions according to BIRADS

Mean ADC value of benign and malignant lesions was calculated and p value obtained using independent t test. Mean ADC value of benign breast lesion was 1.48 ± 0.29 mm^2/sec and mean ADC for malignant lesions was 1.01 ± 0.24 mm^2/sec.

Mean ADC value in mass breast lesions

Total mass breast lesions were twenty four, out of which eight were benign and sixteen were malignant. The mean ADC value was calculated for benign and malignant lesions and compared using independent t test. It was found to be statistically significant with p value <0.0005 (table 1)

Table 1- Mean ADC value of benign and malignant mass lesions

	Sample size	Min-max	Mean	p value
Benign	8	0.9 -1.89	1.51 ± 0.32	<0.0005
Malignant	16	0.68-1.54	0.98 ± 0.24	

Mean ADC value in non mass breast lesions

Total nine non mass breast lesions were detected, out of which two were benign and seven were malignant. Mean ADC values were compared using independent t test. p value 0.117 was obtained which was not statistical significant (table 2).

Table 2- Mean ADC value of non mass benign and malignant breast lesions

	Sample size	Min-Max	Mean	p value
Benign	2	1.35-1.42	1.39 ± .05	0.117
Malignant	7	0.82-1.5	1.07 ± 0.24	

Separate ADC cut off values were calculated for mass and non mass lesions. For mass breast lesions ADC cut off value of 1.22 x 10^{-3} mm^2/sec and for non mass breast lesions ADC cut off value 1.20 x 10^{-3} mm^2/sec was calculated. This ADC cut off value had sensitivity & specificity of 87.50% each in mass lesions and sensitivity & specificity of 85.71% & 100 % in non mass lesions. (Table 3)

Table 3- ADC cut off value with its sensitivity and specificity

	ADC cut off (10-3mm2/sec)	Sensitivity	Specificity
All	1.22	86.96%	90%
Mass	1.22	87.50%	87.50%
Non mass	1.20	85.71%	100%

Malignant and benign lesions are distributed accordingto ADC value and histo pathological diagnosis as shown in table 4.

Table 4 -Distribution of lesions according to ADC cutoff values

ADC cut off value (x10-3mm2/sec)	Malignant	Benign	Total
≤ 1.22	20	1	21
>1.22	3	9	12
Total	23	10	33

Total twenty one lesions have ADC value ≤ 1.22 x 10^{-3} mm^2/sec of which only one (duct papilloma) was benign. Two IDC and one DCIS showed ADC values > 1.22 x 10^{-3} mm2/sec.

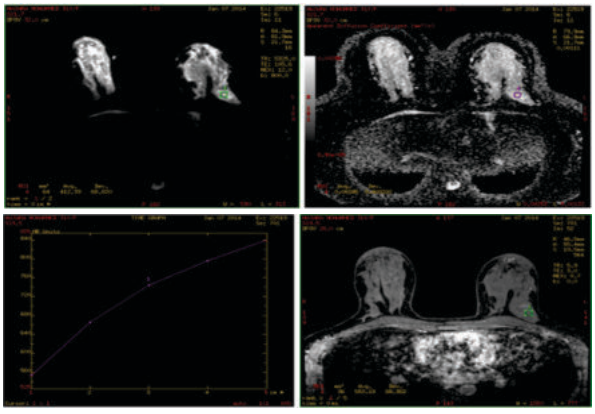

Figure 2. 31 year old female patient with complaints of non tender lump in left breast since 10 months. Diffusion weighted image shows hyper intense lesion in the upper and outer quadrant of left breast. The lesion is non restricted on ADC map with ADC value of 1.86 x 10^{-3} mm^2/sec. On DCE MR It shows only minimal enhancement with type I curve. On histopathology it is fibroadenoma.

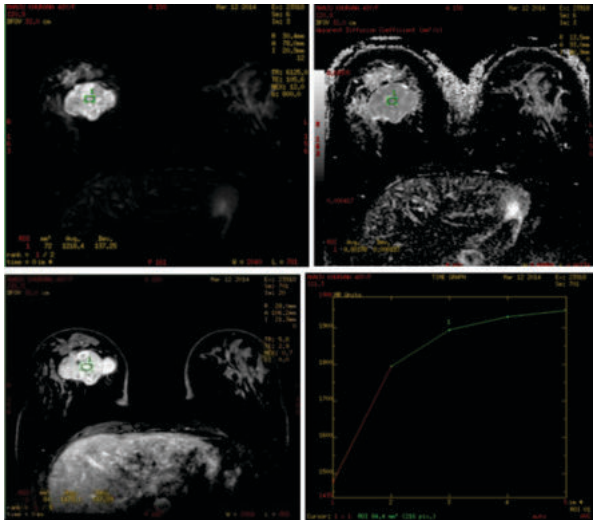

Figure 3. 48 years old female patient with complaints of right breast lump and tenderness since 2 months. Hyperintense lobulated lesion is seen in inferomedial quadrant of right breast on DWI. ADC map shows ADC value of 1.78 x 10^{-3} mm^2/sec. DCE MR shows lobulated intensely enhancing mass at 5-6 o' clock position of right breast. This lesion shows type I curve. On histopathology it is benign phyllodes tumour.

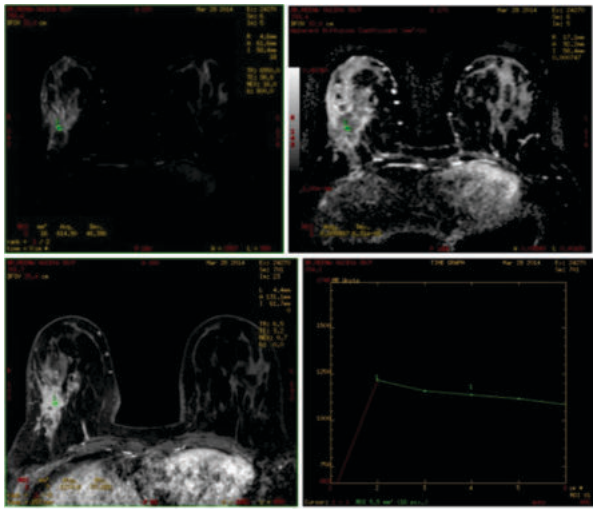

Figure 4. 38 years old female patient with complaints of right breast lump noted only three days back. ADC map shows restricted diffusion with ADC value of 0.89 x 10^{-3} mm^2/sec. DCE MR shows irregular poorly marginated heterogeneous moderately enhancing mass in inferolateral quadrant of right breast. On histopathology it is ductal carcinoma in situ.

DISCUSSION

In this study total thirty patients were included aged between 28-74 years and all patients were female. The mean age of patient was 51.35 ± 12.79. Age group 46-55 years showed highest number of malignant (26%) and ≤ 35 year age group showed highest number of benign lesions (40%).

Most commonly diagnosed breast lesion in this study was infiltrating ductal carcinoma (55%) followed by fibroadenoma (15%). Total thirty three breast lesions were detected and their diagnosis was confirmed by histopathology. Out of total thirty three lesions, ten were benign and twenty three were malignant.

For quantitative analysis of diffusion weighted imaging ADC values of both benign and malignant lesions were calculated. Benign breast lesions were showing higher mean ADC values compared to malignant lesions. The mean ADC value of benign lesions was 1.48 ± 0.29 x 10^{-3} mm^2/sec and malignant lesions was 1.01 ± 0.24x 10^{-3} mm^2/sec. In this study we found significant difference between the mean ADC values of benign and malignant lesions with p value <0.005. The ADC cut off value of 1.22 x 10^{-3} mm^2/sec was obtained which has highest sensitivity

and specificity of 86.96% & 90.00% respectively in differentiating benign and malignant lesions. The positive predictive value was 95.24% and negative predictive value was 75.00%. In this study one out of two duct papillomas showed mean ADC value of 0.90 x 10^{-3} mm^2/sec in malignant range. Woodhams[10] and Tozaki[11]also reported that duct papilloma can be misdiagnosed due to low ADC value.

The mean ADC value of benign and malignant non mass lesions were $1.39\pm0.05 \times 10^{-3}$ mm^2/sand $1.07 \pm0.24\times 10^{-3}$ mm^2/s. Separate ADC cut off value for non mass lesions was calculated. The ADC cut off value 1.20×10^{-3} mm^2/s was obtained to differentiate benign and malignant non mass lesions which gave 100 % sensitivity and 85.71% specificity. No statistically significant difference was found in the ADC values of non mass benign and malignant breast lesions as p value was 0.117.

CONCLUSION

Diffusion weighted imaging and quantitative analysis with ADC values can be used with conventional DCE MR to differentiate benign and malignant breast lesions with high sensitivity and specificity. DWI does not require contrast administration and is relatively fast. No statistical significant difference was found in mean ADC value of benign and malignant non mass lesions. However non mass benign lesions showed higher ADC values compared to malignant non mass lesions.

Limitation

Limitations of this current study are small sample size and less number of benign lesions. Hand drawn Region of interest (ROI) is difficult to reproduce, may not always be accurate and is time consuming. Patient movement may also affect the ADC value.

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Conflicts of interest- There are no conflicts of interest.

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