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Original Research Paper | Medical – Radio Diagnosis

"DIFFERENTIATING BENIGN FROM MALIGNANT BREAST LESIONS- CLINICAL, HISTOPATHOLOGICAL AND IMAGING CORRELATION"

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ABSTRACT

Introduction: Breast cancer is the second most common cancer in Indian women. Breast cancer is a significant cause of worldwide morbidity and mortality. Mammography and ultrasound are used as the first line of investigation for the early detection and localization of breast tumors. Mammography has high sensitivity in case of patients with fatty parenchyma however low sensitivity in case of patients with dense breasts, implants, and post-surgical scar, thus breast MRI with higher sensitivity and specificity due to its ability to depict excellent soft-tissue contrast has become increasingly important in the detection of breast cancer. DCE-MRI has improved specificity in characterizing breast lesions by analysis of time-intensity curves. Diffusion-weighted imaging can improve the sensitivity and specificity of MRI in the evaluation of breast lesions by calculating the ADC values a quantitative measure that is a useful tool for tumor detection and differentiating between benign and malignant breast lesions. **Objective:** To evaluate the role of diffusion-weighted MRI and dynamic contrast-enhanced MRI in differentiating benign from malignant breast lesions and to compare the findings of diffusion-weighted MRI and dynamic enhanced MRI with histopathological or FNAC findings. **Material And Methods:** A total of 30 patients with palpable breast lumps with either positive or negative findings on mammography and ultrasound were included in this study. All patients included in this study first underwent film-screen mammography. Ultrasonography was done with convex and linear probes. This was followed by MRI. T1W axial, T2W axial, SPAIR/ Fat Saturated T2 weighted axial images were acquired in appropriate imaging planes. Diffusion-weighted images were obtained using b values of 0 and 1000 and ADC values were calculated. Dynamic contrast-enhanced MR was performed using fat-suppressed 3D T1 weighted images after injection of gadolinium and time-intensity curves were generated. A single precontrast scan was followed by 4 post-contrast scans which were obtained for a total duration of 4 min 24 seconds. Findings of the MRI (Diffusion-weighted and dynamic contrast enhancement) were analyzed and correlated with histopathological and FNAC findings to evaluate their use as a diagnostic modality. **Results:** A total of 30 female patients presenting with palpable breast lumps were included in the study. Out of 30 patients, 20 cases were malignant (66.67%) and 10 cases were benign (33.3%). Fibroadenoma accounted for a majority of benign lesions (4 out of 10 benign lesions) while IDC accounted for the majority of malignant lesions (15 out of 20 malignant lesions). Dynamic CE-MR is a reliable tool for differentiating between benign and malignant lesions based on kinetic curves. 7 out of 10 benign lesions showed a type I curve while the rest showed a type II curve while the majority (15/20) of malignant lesions showed a type III curve. 8 out of 10 benign breast lesions did not show restricted diffusion on DWI while all malignant lesions showed restricted diffusion on DWI. In our study, the mean ADC value for benign lesions was 1.59 x 10 mm/s while the mean ADC value for malignant lesions was 0.88 x 10 mm/s. Using the ROC curve, the cut-off value of ADC was calculated to be 1.19 x 10 mm/s which gives sensitivity and specificity of 95% and 90% respectively. The individual sensitivity for DCE-MRI and DWI was calculated to be 95% and 95% while the individual specificity for DCE-MRI and DWI was calculated to be 70% and 90% respectively. After a combined analysis of DCE-MRI and DWI using a positive result from any of the two techniques as malignancy, the sensitivity and specificity were 95% and 80% respectively.

KEYWORDS : Breast Lesions, Imaging and histopathological correlation

INTRODUCTION

Breast cancer is the second most common cancer in Indian women. According to the National Cancer Registry project report, about 52,000 women develop breast cancer in India per year.

Breast cancer is a significant cause of worldwide morbidity and mortality.

Mammography is the most commonly used method and is the only currently known means of proven effectiveness, especially in patients with non-palpable carcinoma.

Conventional mammography and ultrasound are known to have high false-positive rates in the detection of breast malignancy (60–80%), resulting in unnecessary biopsies being performed. So, MR techniques have shown strong potential to improve the sensitivity and specificity in the diagnosis of breast cancer [1].

Breast magnetic resonance imaging (MRI) is recommended by the American Cancer Society as an adjunct to mammography for screening women who are at high risk of developing breast cancer [2]. MRI seems to be ideally useful for breast imaging due to its ability to depict excellent soft-tissue contrast. On the contrary, contrast-enhanced MRI and dynamic MRI are more accurate in the detection of malignancy within dense breast tissue, differentiation of malignancy versus scarring, and also in the detection of implants. In addition, MRI can also be used to assess axillary lymph mode metastasis.

DCE-MRI of the breast is a very sensitive method for detecting even small lesions which are not visualized by other methods. Breast malignancies have variable vascularization patterns. These patterns are classified due to the internal enhancement pattern, distribution of the enhancement, and kinetic studies on DCE-MRI. According to the BIRADS lexicon, kinetic curves are classified as exhibiting a "washout," "plateau," or "persistent" shape. Type 1, a persistent enhancing curve, which shows a persistent increase in signal intensity, is associated with benign lesions. Type 2, a plateau curve, which demonstrates a slow or rapid increase in the beginning and then exhibits a plateau, which can indicate malignant pathology. Type 3 is a washout curve, which demonstrates an initial increase followed by a subsequent decrease in signal intensity approx. 2 minutes after injection, thus this curve is highly suggestive of malignancy [3]

DWI has shown promise for the detection and characterization of breast cancer Apparent diffusion coefficient (ADC) values allow quantification of diffusion signal and can facilitate differentiating benign and malignant breast tumors as well as identifying early response in tumors undergoing preoperative treatment. [4]

Usually, DWI 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. Thus, there is no consensus as to how many and which b values to be used in differentiating benign and malignant breast lesions using DWI. [5]

MATERIALS AND METHODS

The study was carried out in PGIMS Rohtak. A total of 30 Patients with palpable breast lump referred from various wards and outpatient departments of PGIMS, Rohtak were included in the study.

Inclusion Criteria

Patients with palpable breast lump with either positive or negative findings on mammography and ultrasound.

Exclusion Criteria:

1. Patients who had received treatment (Post Chemotherapy, Post Radiotherapy, Post-Surgical)
2. Pregnancy or lactating women.
3. Patients with impaired renal function.
4. Patients with allergy to contrast medium
5. Patients with a cardiac pacemaker or other contraindication to MRI.

METHODOLOGY

A complete history was taken at the time of presentation. A thorough clinical examination was carried out. Relevant laboratory investigations were noted. All patients were to undergo a film-screen mammography

Equipment
1. Ultrasonography (USG): - with convex and linear probes.
2. Magnetic resonance imaging (MRI)

Patients underwent MRI using a dedicated breast array coil. T1w, T2w, SPAIR/ Fat Saturated T2 weighted images inappropriate imaging planes were acquired. Diffusion-weighted images were obtained using b values of 0 and 1000 and the ADC value was calculated. Dynamic contrast-enhanced MR was performed using fat-suppressed 3D T1 weighted images after intravenous injection of gadolinium. A single pre-contrast scan was followed by 4 post-contrast scans were obtained for a duration of 4 min 24 seconds. The conventional MR images and DW images were evaluated for the presence of a breast mass/lesion, its signal characteristics, and diffusion restriction.

Time-intensity curves (TIC) were generated from dynamic contrast-enhanced images.

Findings of the MRI scan were recorded in the Performa attached and a diagnosis was made.

Findings of the MRI (Diffusion-weighted and dynamic contrast enhancement) were analyzed and correlated with histopathological and FNAC findings to evaluate their use as a diagnostic modality.

Statistical Analysis

Data were described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases), and relative frequencies (percentages) as appropriate. A comparison of quantitative variables between the study groups was done using the Student t-test and ANOVA. For comparing categorical data, the Chi square (□2) test was performed and the exact test was used when the expected frequency is less than 5. Logistic regression analysis and linear regression were used for the analysis of independent factors with the outcome variable. A probability value (p-value)less than 0.05 was considered statistically significant. All statistical calculations were done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA)statistical program for Microsoft Windows.

Case 1- IDC

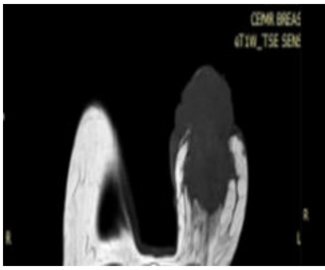


Figure 1a T1WI

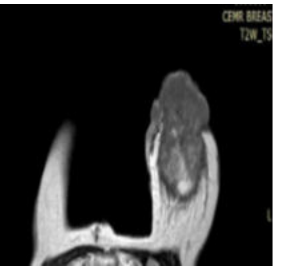


Figure 1b T2WI

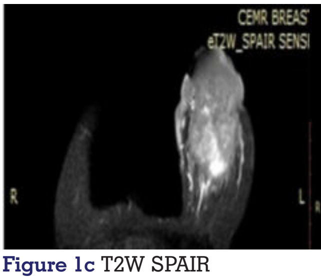


Figure 1c T2W SPAIR

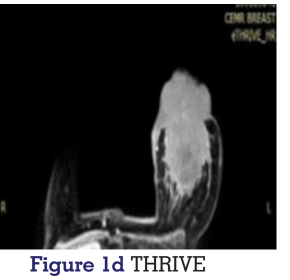


Figure 1d THRIVE

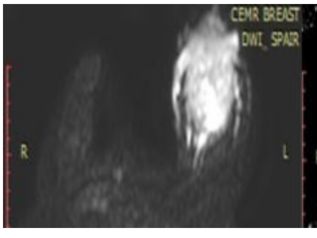


Figure 1e DWI

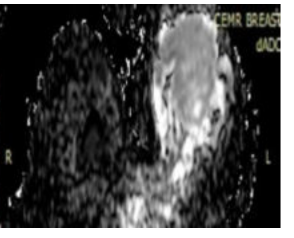


Figure 1f ADC

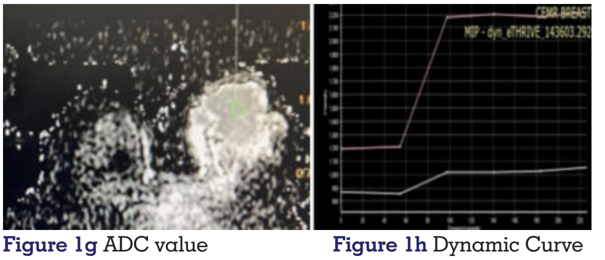


Figure 1g ADC value **Figure 1h** Dynamic Curve

CASE 1 (IDC)-

MRI findings-

The left breast shows a large irregular mass with spiculated margins seen in the retro areolar region measuring at least 6.9cm x 6.1cm x 6.7cm. the lesion appears hypointense on T1WI and hypointense on T2WI with few hyperintense areas likely necrotic areas. It appears hyperintense on SPAIR. The lesion is extending superiorly involving the skin with nipple retraction. Architectural distortion is seen. No pectoral/chest invasion was seen. The lesion shows restricted diffusion on DWI with an ADC value of 0.84 x $10^{-3}mm^2/s$. it shows heterogeneous enhancement on post-contrast scans and shows a type II kinetic curve.

Case 2- Mucinous Carcinoma

Figure 2a T1WI

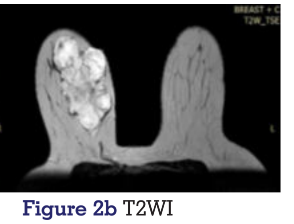
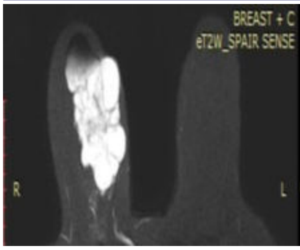


Figure 2b T2WI



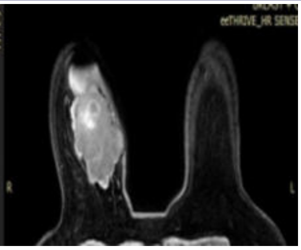
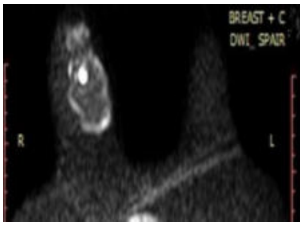


Figure 2c T2W SPAIR **Figure 2d** THRIVE



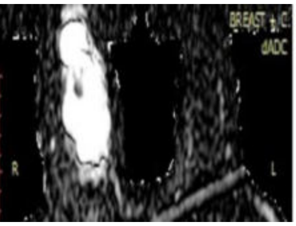
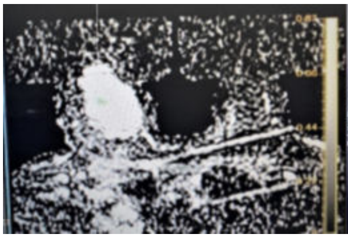


Figure 2e DWI **Figure 2f** ADC



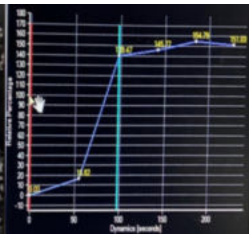


Figure 2g ADC value **Figure 2h** Dynamic TIC

CASE 2 (MUCINOUS CARCINOMA)-

MRI FINDINGS:

The right breast shows a large multilobulated enhancing heterogeneous mass seen in the upper inner quadrant at a 12-2° clock position measuring at least 9.2cm x 5.6cm x 7.6cm. The lesion appears hyperintense on T2WI, hypointense on T1WI, and hyperintense on SPAIR. There is architectural distortion. Superiorly the lesions are extending to the skin surface however no chest wall/ pectoral muscle invasion was seen. On DWI small nodular area of restricted diffusion is seen with an ADC value of 0.98 x 10^{-3} mm^2/s. On post-contrast study, it shows heterogeneous enhancement and shows type II kinetic curve.

OBSERVATIONS AND RESULT

Out of the total 30 lesions, FNAC/biopsy analysis revealed 10 benign lesions (33.3%) and 20 malignant lesions (66.7%). Among the benign lesions, fibroadenoma was the most common pathology seen in 4/10 cases (40%), while intraductal carcinoma accounted for most of the malignant lesions seen in 15/20 cases (75%). The study consisted of 30 females with the youngest patient being 20 years old and the oldest being 75 years old. All patients with benign lesions were less than 40 years of age.

The majority of the benign lesions in this study were either of type II and III breast composition.

The majority of the malignant breast lesions in this study were either of type I or type II breast composition.

Table 1: Mammographic Features Of Benign And Malignant Lesions According To Shape, Margins, And Density Of The Lesions.

		Benign/ malignant				Total	Chi-square value	p-value
		Benign (n=10)		Malignant (n=20)				
Shape	Irregular	4	40.0%	18	90.0%	22	9.273	0.010
	Oval	2	20.0%	0	0.0%	2		
	Round	4	40.0%	2	10.0%	6		
Margin	Circumscribed	5	50.0%	0	0.0%	5	23.000	0.001
	Indistinct	2	20.0%	7	35.0%	9		
	Multilobulated	0	0.0%	2	10.0%	2		
	Obscured	3	30%	0	0.0%	2		
	Spiculated	0	0.0%	11	55.0%	11		
Density	HIGH	2	20.0%	18	90.0%	20	17.400	0.0001
	ISO	2	20.0%	2	10.0%	4		

MAMMOGRAPHIC FEATURES OF BENIGN AND MALIGNANT LESIONS ACCORDING TO ASSOCIATED FEATURES.

- Architectural distortion was seen in only 2 out of 10 patients (20%) with benign lesions on mammography as compared to 13/20 patients with malignant lesions (65%) on mammography.
- Calcification was observed in 4 out of 10 cases with benign lesions (40%) as compared to 19 out of 20 malignant lesions (95%) seen on mammography.
- Skin thickening was seen in only 1 out of 10 benign lesions which were seen in a case of granulomatous mastitis while skin thickening was present in 9 out of 20 malignant breast lesions (45%).
- Axillary lymphadenopathy was present in only 1 out of 10 benign lesions (10%) as compared to 16 out of 20 malignant lesions (80%) showing axillary lymphadenopathy.
- No benign lesions showed nipple retraction while it was present in 8 out of 20 malignant lesions.

Comparison Of Birads Assessment On Mammography With Histopathological Diagnosis

- Mammography correctly characterized 6 out of 10 breast lesions as benign (BIRADS II AND III). One case of granulomatous mastitis was falsely characterized as BIRADS V. 2 cases of fibroadenomas and one case of intraductal papilloma was falsely characterized as BIRADS IV.
- Mammography correctly characterized 17 out of 20 lesions as malignant breast lesions (BIRADS IV and V). 3 cases of intraductal carcinoma were falsely characterized as benign breast lesions.

Table 2: Diagnostic Performance Of Mammography.

Statistic	Value	95% CI
Sensitivity	60.00%	26.24% to 87.84%
Specificity	85.00%	62.11% to 96.79%
Positive Likelihood Ratio	4	1.25 to 12.75
Negative Likelihood Ratio	0.47	0.22 to 1.03
Disease prevalence (*)	33.33%	17.29% to 52.81%
Positive Predictive Value (*)	66.67%	38.55% to 86.44%
Negative Predictive Value (*)	80.95%	66.06% to 90.27%
Accuracy (*)	76.67%	57.72% to 90.07%

Table 3: MRI Features Of Benign And Malignant Lesions

		Benign/ malignant				Total	Chi-square value	p-value
		Benign (n=10)		Malignant (n=20)				
Size	< 2	1	10.0%	0	0.0%	1	4.666	0.097
	2-5.0	7	70.0%	9	45.0%	16		
	> 5	2	20.0%	11	55.0%	13		
Shape	Irregular	4	40.0%	17	85.0%	21	9.429	0.024
	Multilobulated	0	0.0%	1	5.0%	1		
	Oval	2	20.0%	0	0.0%	2		
	Round	4	40.0%	2	10.0%	6		
Margin	Circumscribed	5	50.0%	0	0.0%	5	16.875	0.0001
	Indistinct	5	50.0%	7	35.0%	12		
	Spiculated	0	0.0%	13	65.0%	13		
T1 SI	Heterogenous	3	30.0%	1	5.0%	4	60.160	0.049

	Hypointense	5	50.0%	18	90.0%	23		
	Isointense	2	20.0%	1	5.0%	3		
T2 SI	Hyperintense	6	60.0%	4	20.0%	10	7.832	0.020
	Hypointense	3	30.0%	16	80.0%	18		
	Isointense	1	10.0%	0	0.0%	1		

MRI ASSOCIATED FEATURES OF BENIGN AND MALIGNANT LESIONS

- Architectural distortion was seen in only 2 out of 10 patients (20%) with benign lesions on mammography as compared to 18/20 patients with malignant lesions (90%).
- Skin thickening was seen in only 1 out of 10 benign lesions which were seen in one case of granulomatous mastitis while skin thickening was present in 11 out of 20 malignant breast lesions (45%).
- One benign lesion showed nipple retraction while it was present in 10 out of 20 malignant lesions.

Table 4: Enhancement Pattern Of Benign And Malignant Lesions

		Benign/ malignant				Total	Chi-square value	p-value
		Benign (n=10)		Malignant (n=20)				
Non mass enhancement (NME)	Absent	8	80.0%	18	90.0%	26	0.577	0.448
	Present	2	20.0%	2	10.0%	4		
Mass enhancement (ME)	Heterogenous	2	20.0%	20	100.0%	22	21.818	0.0001
	Homogenous	6	60.0%	0	0.0%	6		
	RIM	2	20.0%	0	0.0%	2		
Kinetic curve (KC)	I	7	70.0%	1	5.0%	8	18.348	0.001
	II	3	30.0%	4	20.0%	7		
	III	0	0.0%	15	75.0%	15		

DIFFUSION PROPERTIES AND ADC VALUES OF BENIGN BREAST LESION

- Out of 10 benign breast lesions, 8 lesions did not show diffusion restriction on diffusion-weighted imaging.
- 2 cases of granulomatous mastitis showed diffusion restriction.
- The least ADC value was 0.98 x 10^{-3} mm^2/s seen in granulomatous mastitis while the maximum ADC value was 2.2 x $10^{-3}mm^2/s$ seen in the case of fibroadenoma.
- The mean ADC value for benign breast lesions is 1.59 x $10^{-3}mm^2/s$.

DIFFUSION PROPERTIES AND ADC VALUES OF MALIGNANT BREAST LESIONS

- All the malignant breast lesions show diffusion restriction on diffusion-weighted imaging.
- 15 out of 20 malignant lesions had ADC values below 1 x 10^{-3} mm^2/s.
- The least ADC value was 0.6 x 10^{-3} mm^2/s seen in intraductal carcinoma.
- While the maximum ADC value was 1.21 x 10^{-3} mm^2/s seen in intraductal carcinoma.
- The mean ADC value was calculated as 0.88 x 10^{-3} mm^2/s for malignant breast lesions.

COMPARISON OF DIFFUSION RESTRICTION ON BENIGN AND MALIGNANT LESIONS

- 8 out of 10 benign lesions do not show restricted diffusion on DWI while 2 cases of granulomatous mastitis show restricted diffusion on DWI. while the mean ADC value calculated in the benign lesion was 1.59
- All the malignant lesions show restricted diffusion on DWI with a mean ADC value calculated was 0.88

COMPARISON OF BIRADS ASSESSMENT ON MRI WITH HISTOPATHOLOGY.

- MRI correctly characterized 9/10 benign lesions as BIRADS II/III while one case of granulomatous mastitis was characterized as BIRADS IV.
- MRI correctly characterized all malignant lesions as BIRADS IV/V

Table 5: Diagnostic Performance Of Diffusion Weighted Imaging

Statistic	Value	95% CI
Sensitivity	95.00%	75.13% to 99.87%
Specificity	90.00%	55.50% to 99.75%
Positive Likelihood Ratio	9.5	1.48 to 61.16
Negative Likelihood Ratio	0.06	0.01 to 0.38
Disease prevalence (*)	66.67%	47.19% to 82.71%
Positive Predictive Value (*)	95.00%	74.69% to 99.19%
Negative Predictive Value (*)	90.00%	56.85% to 98.40%
Accuracy (*)	93.33%	77.93% to 99.18%

Table 6: Diagnostic Performance Of Dynamic Contrast Enhanced MRI

Statistic	Value	95% CI
Sensitivity	95.00%	75.13% to 99.87%
Specificity	70.00%	34.75% to 93.33%
Positive Likelihood Ratio	3.17	1.22 to 8.21
Negative Likelihood Ratio	0.07	0.01 to 0.50
Disease prevalence (*)	66.67%	47.19% to 82.71%
Positive Predictive Value (*)	86.36%	70.97% to 94.26%
Negative Predictive Value (*)	87.50%	49.82% to 98.01%
Accuracy (*)	86.67%	69.28% to 96.24%

DISCUSSION

The present study was undertaken to evaluate the role of MRI in characterizing benign and malignant breast lesions in Diffusion-weighted imaging (DWI) and dynamic contrast enhancement (DCE) MRI and to correlate these findings with pathological diagnosis. A total of 30 female patients presenting with palpable lumps were included in the study. In the study five patients presented with multiple lesions.

MAMMOGRAPHY

The most common shape seen in benign lesions was either round or oval which were accounting for 6 out of 10 benign breast lesions (60%). 5 out of 10 benign breast lesions showed well-circumscribed margins. Our findings were similar to those of Evans et al [6] who reported that features seen in the majority of benign lesions on mammography were round, oval, low density, or slightly lobulated with well-defined margins. 6 out of 10 benign lesions show low density on mammography. Our result was similar to that of Evans et al [6] who reported that the majority of benign breast lesions showed low density on mammography.

In this study 18 out of 20 malignant lesions showed irregular shape with 11 out of 20 malignant lesions showing spiculated margins on mammography. 18 out of 20 malignant lesions showed high density on mammography. This result is in concordance with Woods et al [7] who also concluded that high density, irregular shape, and spiculated margin were significantly associated with the probability of malignancy.

In our study calcification was seen in 4 out of 10 benign lesions (40%) while 19 out of 20 malignant lesions shows calcification on mammography. Yunus et al [8] stated that clustered microcalcifications were significantly associated with malignancy.

In our study architectural distortion was observed as an associated finding in 13 out of 20 malignant cases (65%). Other associated features of malignancy like skin thickening, nipple retraction, and axillary lymphadenopathy were seen in 55%, 40%, and 80% respectively. In the study conducted by Sickles [9] found that almost 20% of the cancers were detected primarily by indirect mammographic signs of malignancy, such as focal architectural distortion, asymmetry, and developing density signs.

Morphology Of Breast Lesions On MRI

6 out of 10 benign breast lesions (60%) were either round or oval in shape. 5 out of 10 benign breast lesions were well-circumscribed margins. Our results are in concordance with Hockman et al [10] who observed that 19 out of 23 fibroadenomas were lobular, oval, or round in shape.

In our study 5 out of 10 benign lesions showed a hypointense signal on T1WI, while 6 out of 10 benign lesions showed a hyperintense signal on T2WI. Our result was in concordance with Westra et al [11] who reported that most masses with high signal intensity at T2WI were benign.

In our study 17 out of 20 malignant breast lesions (85%) had an irregular shape and 13 out of 20 malignant lesions (65%) showed spiculated margins while 7 out of 20 malignant lesions (35%) showed indistinct margins. Our findings are similar to those reported by Gutierrez et al [12] 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 18 out of 20 malignant lesions showed a hypointense signal on T1WI while 16 out of 20 malignant lesions showed a hypointense signal on T2WI. This result was in concordance with a study by Westra et al [11] who reported that most malignant lesions do not show high signal intensity on T2WI because of their high cellularity and low water content.

Enhancement Pattern And DCE-MRI

All the benign breast lesions showed enhancement on post-contrast scans. The most common enhancing pattern was homogenous enhancement which was seen in 6 out of 10 benign breast lesions (60%). Guiterrez et al [12] 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 heterogeneous enhancement. Pinker-Domenig et al [13] also observed that heterogeneous enhancement was positively associated with malignancy. Gutierrez et al [12] also concluded that heterogeneous enhancement was a strong predictor of malignancy.

In our study 7 out of 10 benign lesions showed type I dynamic curve enhancement (70%) followed by 3 benign lesions showing type II dynamic curve. On the other hand, 15 out of 20 malignant breast lesions shows type III dynamic curves (75%) followed by 4/20 lesions showing type II dynamic curve. One case of IDC showed a type I curve. Our findings are in concordance with Pinker-Domenig et al [13] who stated that the final diagnosis of malignancy was positively associated with a type III dynamic curve. In our study p-value for DCE-MRI is 0.001.

In our study, the sensitivity and specificity of DCE-MRI for the detection and characterization of breast lesions were calculated to be 95% and 70% respectively. Our results are comparable to those of Peters et al [14] who performed a meta-analysis to determine the diagnostic performance of contrast material enhanced magnetic resonance imaging in patients with breast lesions and calculated a pooled sensitivity of 90% and specificity of 72%.

DIFFUSION-WEIGHTED IMAGING

In our study 8 out of 10 benign lesions do not show restricted diffusion on DWI. The mean ADC value among the benign lesion was 1.59 x 10^{-3} mm^2/s. All the malignant breast lesions showed restricted diffusion on DWI. The mean ADC value for malignant was 0.88 x 10^{-3} mm^2/s. These values are well in correlation with the results of Woodhams et al [15] in whose study the mean ADC value of benign lesions was 1.67 +/- 0.54 x 10^{-3} mm^2/s and of malignant lesions was 1.22 +/- 0.31 x 10^{-3} mm^2/s.

In our study, the sensitivity and specificity of diffusion-weighted imaging to differentiate between benign and malignant lesions were 95% and 90% respectively. The corresponding PPV and NPV were 90.91% and 100% respectively. Our results were similar to that of Abdul Ghaffar et al [16] who found that DWI was 95.4% sensitive and 97.5% specific.

In our study, the cut-off value of ADC to differentiate between benign and malignant lesions was calculated to be 1.19 x 10^{-3} mm^2/s using the ROC curve. This yielded in a sensitivity of 90% and specificity of 95%. In comparison, Tan et al [17] calculated the cut off ADC values for benign and malignant lesions as 1.21 x 10^{-3} mm^2/s for b=500 s/mm^2 and 1.22 x 10^{-3} mm^2/s for b= 1000 s/mm^2, respectively. In their study, the sensitivity of DCE-MRI alone was 100% with a specificity of 66.7%. when DCE-MRI was combined with b=1000s/mm^2, the specificity rose to 100% while only mildly affecting sensitivity (90.6%).

Comparison Of Mammography And MRI For Diagnosis Of Breast Lesions

Mammography correctly categorized 6 out of 10 lesions as benign (BIRADS- II/III), one case of granulomatous mastitis was characterized as BIRADS V while one case of intraductal papilloma and two cases of fibroadenoma were falsely characterized as BIRADS IV. On MRI they showed either type I or II dynamic curves, although two cases of granulomatous mastitis showed restricted diffusion on DWI.

Mammography correctly characterized (85%) 17 out of 20 lesions as malignant (BIRADS IV/V). 3 cases were falsely characterized as benign breast lesions These lesions were correctly characterized on MRI as BIRADS V showing restricted diffusion. All the malignant lesions were correctly characterized as BIRADS 5 on MRI. Thus, MRI could assess the probability of malignancy in these lesions more accurately than mammography.

Liberman et al [18] assessed the positive predictive value of mammographic features and final assessment categories described in the Breast Imaging Reporting and Data System (BIRADS) and correlated it with the biopsy results. They observed that of the 492 lesions subjected to biopsy, BIRADS final assessment categories were category 3 in eight lesions (2%), category 4 in 355(72%), and category 5 in 129 (26%). The frequency of carcinoma was higher in category 5 than in category 4 lesions for all mammographic lesion types.

Combined Analysis Of DCE-MRI And DWI

We did a combined analysis of DCE-MRI and DWI to differentiate between benign and malignant breast lesions. The individual sensitivity of DCE-MRI and DWI was 95% which remained 95% when a positive result from any of the modalities was accepted as malignancy. While the specificity of DWI and DCE-MRI was 90% and 70% respectively which increased to 80% when a positive result from any of the modalities was accepted as malignancy.

Our results are similar to those of Tezca, Ozturk, Uslu, et al [3] where the sensitivity of DCE-MRI and DWI was calculated to be 100% and 92% respectively while the specificity of DCE-MRI and DWI was calculated to be 59.4% and 95% respectively. Combined analysis of both DCE-MRI and DWI gave a sensitivity and specificity of 100% and 81% respectively.

CONCLUSION

MR morphology, DCE-MRI, and DWI are useful to characterize various breast lesions. MRI features of signal intensity of hypointensity on T2WI with other associated features of irregular shape, spiculated margins, heterogenous enhancement on DCE-MRI, Type III dynamic curve, and reduced ADC value are strong predictors of malignancy.

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