ORIGINAL RESEARCH ARTICLE

Dynamic MR Evaluation of Breast Lesions: A Single Centre Prospective Study

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ABSTRACT

Introduction: Magnetic resonance imaging is one of the finest breast imaging techniques that not only offers cross sectional morphological imaging information of lesions but also provides information on tissue perfusion, pre and postoperative lesion morphological analysis and kinetic curve enhancements. The main aim was to differentiate, categorize and compare the morphology and kinetic analysis of breast lesions and correlation with histopathology.

Material and methods: The present study was approved by our hospital ethics committee, and informed consent from all the patients was obtained. 46 female patients between August 2017 and July 2019 were involved in the study and MRI was done with the patient in prone position with a dedicated double breast coil.

Results: Findings in the present study were that 34% of them were ductal/linear types of non-mass enhancements. In malignant lesions 88.9% of them were irregular, 85.2% were spiculated, whereas in benign lesions, 37.5% were round in shape and 81.3% were with a smooth margin. Among those 37.8% showed heterogeneous enhancement, and most of the malignant lesions i.e. 75.9% showed a washout curve and in benign lesions 81.1% showed progressive (type 1) curve.

Conclusion: In the present study breast MR imaging improved the evaluation of the lesion by means of kinetic curve analysis and detected multifocal, multicentric and lesions in contra lateral breast. MRI differentiated between postoperative scar and Recurrent lesions even in the high risk and dense breast cases.

Keywords: Breast Cancer, Magnetic Resonance Imaging, Lesions, Scar

INTRODUCTION

Great diversity in the tumors of breast often describes the heterogeneity of the disease that requires various tumor profiles, specific diagnosis, and certain degrees of treatment sensitivities. Age is the main factor for increasing breast cancer incidence and it became the second leading cause of death in women. Breast cancer is associated with multiple tumor entities, each one is characterized with distinctive morphology, definitive behavior and clinical inference.[1] An increased risk of breast cancer is seen with additional breast lesions which are generally not diagnosed at early stages or sometimes not even with conventional diagnostic tools. Some of the previous studies on mastectomy specimens revealed that the associated breast lesions occurred in the ipsilateral breast and few of them occurred in the contra lateral breast.[2,3] Treatment of cancer type varies with the multiple number of cancer sites, recurrence, and the number of lesions. Here imaging plays a crucial role, therefore it is essential to identify, evaluate the disease and associated risks preoperatively through screening, diagnosis, image guided biopsy, treatment planning and follow up.

Mammograms are the best used diagnostic method for early detection of breast cancer but the problem persisting with this method is that the lesions are detectable if the size is larger than 1.5cms and sometimes there is a chance of giving false positive results.[4] Magnetic Resonance Imaging (MRI) is an extensively used method now for the detection of preoperative breast cancer because of its high sensitivity.[5] Precisely they are used to diagnose the index cancer and additional breast lesions when compared to the conventional imaging techniques.[6,7,8] This technique also calculates the high negative predictive value and further characterizes the appropriate equivocal findings of breast lesions.[9]

The basic version of MR tissue characterization does not play a major role in the differentiation of other lesions as there is a significant overlap between benign and malignant lesions. So, it is crucial to characterize additional lesions over detecting them with advanced MRI methods like Gd-DTPA enhanced MRI.[10] Lesions that are present in different quadrants or in the contralateral breast should be identified preoperatively and checked for their malignant nature. The undiagnosed additional cancerous lesions may require

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extensive excision and a more conservative type of surgery. Additional breast lesions are visible on MRI as focus, mass and non-mass enhancement as per the American college of radiology suggested Breast Imaging Reporting and Data System (BI-RADS).[11]

MRI is extensively in use since 2000 and it is superior over mammography in diagnosing, characterizing, staging, high risk screening and follow up of breast cancer. It is also helpful in identifying other tumors in the breast, size of the tumor, and tumors in the contralateral breast.[12] To differentiate benign lesions from the malignant lesions it is important to know the morphology of lesions, washout kinetics, and enhancement. This also can be achieved with the high sensitivity of MR imaging and its specificity in differentiating benign from malignant lesions. Some studies have attempted to reveal that MRI has a proven capacity in screening for high risk patients, assessing unknown primary tumors, in evaluating local extent of disease, to check for bilateral and multicentricity, in dense breast in differentiating scar from local recurrence, to check the neoadjuvant chemotherapy response, and to check for the integrity of implants.[13,14,15] The present objective of the study was to compare morphologic and kinetic analysis for categorizing breast lesions, to evaluate role of MRI in preoperative evaluation of known breast cancer, to study the role of MRI in differentiating postoperative scar and local recurrence.

MATERIAL AND METHODS

The present study was conducted at ESIC Medical College and Super specialty hospital, Hyderabad. The study was conducted from August 2017 to July 2019 after obtaining ethical committee clearance as well as informed consent from all patients.

Study Design and Procedure

After all the approvals, 46 female patients with breast lumps in the age group between 10 to 80 years were chosen for the study. MR imaging was performed on the 3.0T MAGNETOM VERIO (M/S SIEMENS). All patients were imaged in the prone position in a dedicated double breast coil. Pulse sequences were taken as follows.

A transverse T1 weighted spin echo sequence was performed for localization purposes.

Axial T2 weighted Turbo spin echo sequences with the parameters: TR/TE 3630/100, the field of view 35cm, matrix 384 X 160, slice thickness 4mm with an interslice gap of 1 mm.

Tirm coronal and axial sequences with TR/TE 3570/61, the field of view 32cm, matrix 320 X 272, slice thickness 4mm with an interslice gap of 1.2mm.

A three dimensional axial fat suppressed T1 weighted Flash echo sequence was obtained before and 6 sets of images after a bolus injection of 0.1 mmol/kg of gadodiamide (Omniscan, GE health care) with an acquisition time of 60 seconds for each set of 88 images. The parameters were TE minimum PREP time 30 sec, flip angle 10 degrees, the field of view 36cm, matrix size 448 X 354, slice thickness 1.6mm with overlapping of 0.8mm.

Fat suppression and subtraction of precontrast from the first set of postcontrast images were done. Bilateral imaging was done for all sequences. Morphological analysis was done on post processed subtracted images. The detailed morphologic analysis was done using MRI BI-RADS Lexion proposed by the American College of Radiology. Visual kinetic analysis of time signal intensity was done for each patient.

RESULTS

Age distribution

Female patients between age 10 years and 80 years with suspicious malignancy were considered for the study. Out of 45 patients, 28 of them were between 40 to 60 years, and the least number were in 10-20 years age group. The next highest breast cancer patients are from 30 to 40 years of age group. An observation made from figure 1 is that the disease seems to be progressing from 30 years age group (fig-1).

MRI by BI-RADS lexicon

A highly suspicious method of reporting MRI results as depicted in figure 2. It revealed that among 45 patients 93%

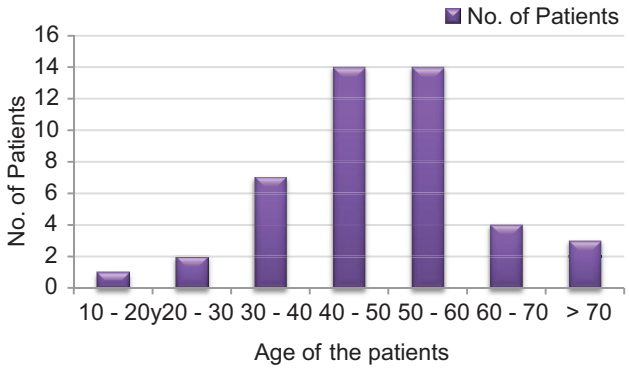

Figure-1: Age distribution of the patients.

Histology	No. of lesions	Percentage (%)
1. Invasive Breast Cancer		
Ductal	27	93.1
Lobular	2	6.9
Medullary	0	0
Mucinous	0	0
2. Non Invasive Cancer	0	0
3. Benign		
Fibradenoma	7	53.8
Intraductal Papilloma	1	7.6
Fibrocystic Disease	5	38.4

Table-1: Lesions histopathology.

Associated Findings	Benign lesions	Malignant lesions
none	7 (43.8%)	10 (34.4%)
nipple retraction	0	4 (13.8%)
skin thickening	2 (12.6%)	7 (24%)
edema	0	1 (3.4%)
lymphadenopathy	0	13 (44.9%)
pectoralis muscle invasion	0	3 (10.3%)
cysts	6 (37.5%)	0

Table-2: Associated complications of lesions.

of them were observed with the mass in MR imaging. Only 7% of them were having non mass like enhancement on imaging (fig-2).

MRI by non Mass Enhancement

Non mass enhancement lesions in MR imaging were having different characteristics as shown in figure 3. The highest type of lesions i.e. 34% of them were ductal/linear types of non-mass enhancements. The other type of non mass enhancement in the rest of 45 patients was diffuse and regional type of enhancement with 33% each. There was 0% segmental type of non-mass enhancement observed in the patients included in the study (fig-3).

Mass Morphology (shape)

The mass contains both benign and malignant types of lesions in 45 patients. It has resulted that out of 27 malignant types 88.9% of them were irregular in shape, 7.4% were oval and 3.7% were round. There were no lobular shaped lesions found in the malignant type. In 16 benign lesions, 37.5% were round in shape, each 25% of them were oval and lobular lesions. The least number i.e. 12.5% of them were irregular lesions. It was seen from the figure 4a that malignant irregular lesions were highest and benign irregular lesions occupied least in number, it is vice versa in case of round shaped lesions (fig-4a).

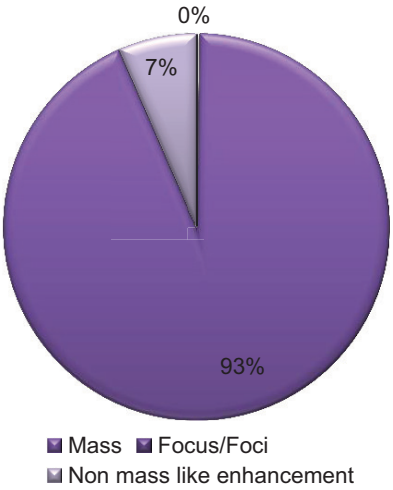

Figure-2: MRI description of type of lesions using BI-RADS lexion.

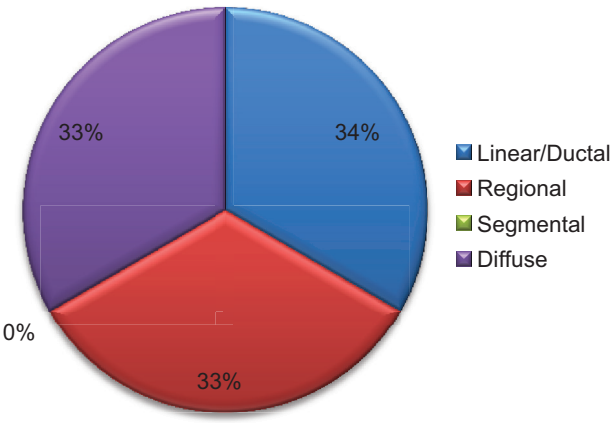

Figure-3: MRI description of non mass like enhancement.

Mass morphology (Margin)

Margins of the mass resulted in 3 various types in both malignant and benign lesions. Figure 4b depicts that the spiculated type of malignant lesions was higher in number with 85.2%, and irregular, smooth malignant type lesions occupied 11.2 and 3.7% respectively. Among benign lesions 81.3% were smooth, 6.3% were irregular and 12.6% were spiculated type. In malignant lesions, spiculated margins were higher and in benign lesions, smooth margins were occupied higher in number (fig-4b).

Mass Enhancement Type

The highest number of lesions i.e. 37.8% showed heterogeneous enhancement, 24.3% of them have shown rim enhancement which was mostly malignant. As shown in figure 5 and 6 A, B, C&D there was no central enhancement lesion in the present study. 16.2% of the lesions showed dark non enhancing internal septations that are mostly benign type. The least number of lesions are homogeneous types (fig-5).

The kinetic curve of lesions

In the present study, one patient was not included due to a lack of follow up. Among 45 patient lesions, 16 were benign and 29 were having a malignant type of lesions which was analyzed by kinetic curve assessment (Figure 7). In benign lesions, 81.1% of them were showing a type 1 curve which is a progressive pattern. Remaining 12.5% and 6.3% of them were showing type 2 and type 3 curves which are of a plateau and wash out curve patterns. Contrast results were observed in malignant lesions with the highest number (75.9%) was of the type 3 (washout) curve. The rest of the 20.7% and 3.4%

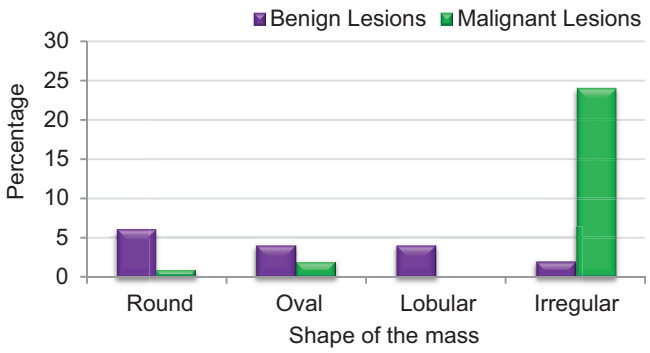

Figure-4a: Mass morphologic description of the shape of the lesion.

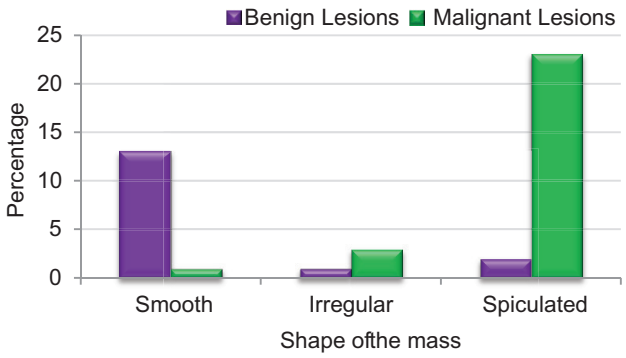

Figure-4b: Mass morphologic description of margin of lesion.

were showing plateau and progressive type of kinetic curves.

Lesions category by BI-RADS

All the lesions were categorized based on the BI-RADS. 54.3% of them were falling under category 5 which is highly suggestive of malignancy. Next to this 26% of the lesions were classified under category 2 which is suggestive of the benign type of lesion. Least number (6.5%) of lesions were in category 3, and 13% of them were in category 4. As shown in figure 8, no lesions were falling under the 0,1 and 6 categories.

Lesions Multicentricity

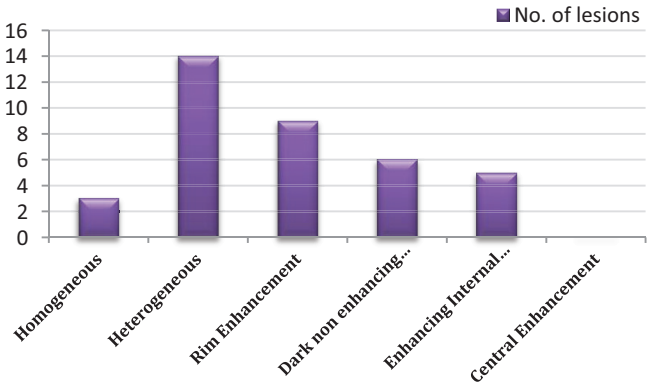

Figure-5: Type of mass enhancement description.

In the present 46 breast cancer patients, 43% of them were showing multifocality, 29% of them were showing synchronous breast lesions. Similarly, 28% of them were having multicentric breast lesions (Figure 9).

Histopathology of lesions

When observed the histopathology of the breast lesions, 27 out of 29 i.e. 93.1% of them were showing invasive ductal cell carcinoma in malignant breast lesions. Remaining 6.9% of the lesions were the lobular type of carcinomas (Table 1). Also, it was observed that the histopathology of benign lesions showing 53.8% (7 out of 13) of them were fibroadenomas. And 38.4% of them were a fibrocystic disease, 7.6% of them were intraductal papilloma type of lesions.

Postoperative histopathology of lesions

In the present study, 8 patients from 46 were postoperative. 37.5% of them were the recurrent type of lesions, 25% of them were metastatic and the other 25% were of scar tissue. Least number i.e. 13% was postoperative seromas.

Associated findings

Through MRI, it was detected that both benign and malignant type of lesions have various associated findings like lymphadenopathy, skin thickening, etc., In the malignant type of lesions, majority of them (44.9%) were associated with

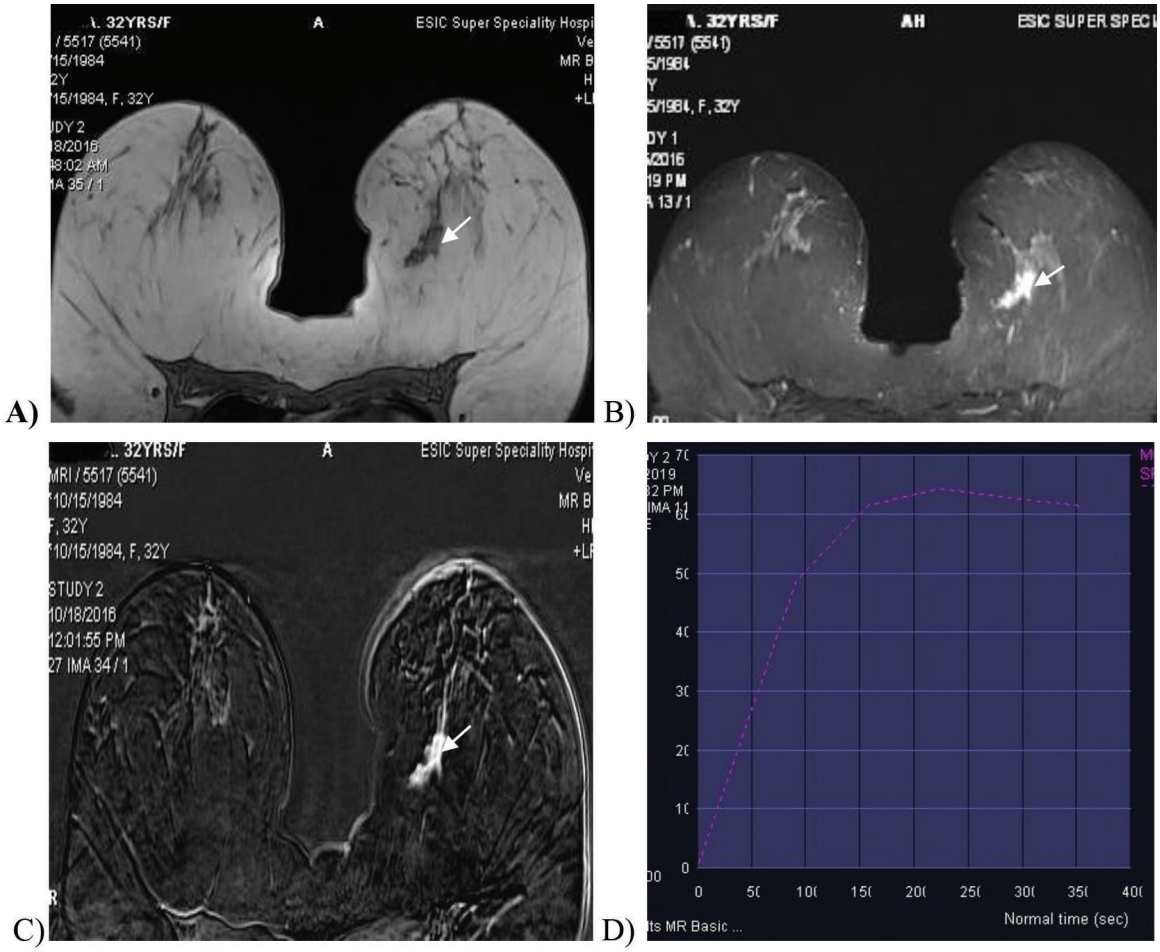

Figure-6a,b,c,d: A) T2 Axial: Image shows irregular spiculated homogenously hypointense lesion in lower and inner quadrant of left breast. B) Tirm axial shows the lesion is hyperintense. C&D) Post contrast image shows heterogeneous enhancement with type-II kinetic curve showing early rise and plateau. The lesion corresponds to BI-RADS – 5. HPE revealed invasive ductal cell carcinoma.

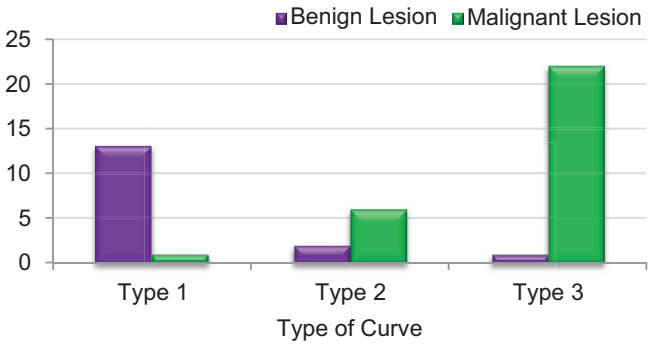

Figure-7: Kinetic curve assessment in benign and malignant lesions.

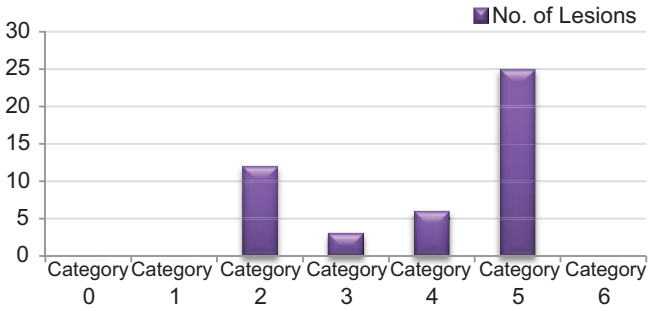

Figure-8: Lesions categorized based on the BI-RADS assessment.

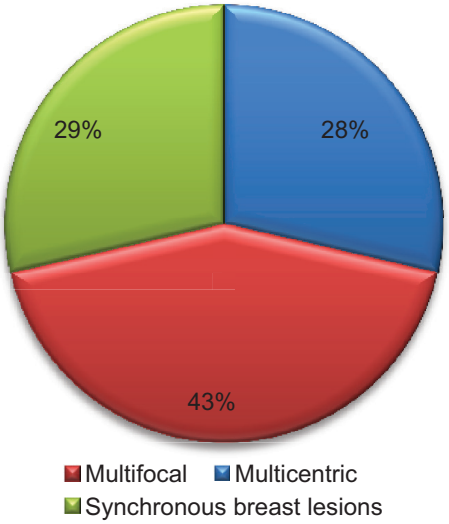

Figure-9: Multicentricity of the breast lesions.

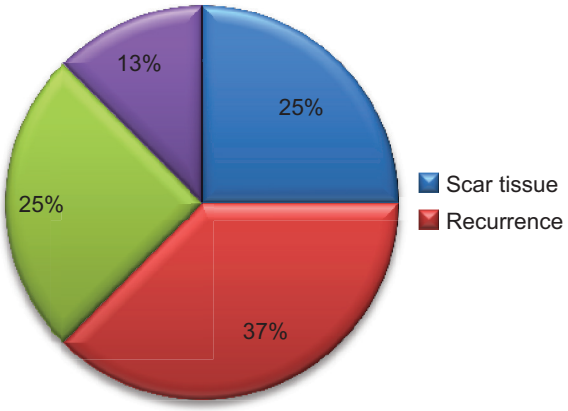

Figure-10: Postoperative histopathology of lesions.

lymphadenopathy, 13.8% had nipple retraction and 10.3% of them had pectoralis muscle invasion. 24% of them had skin thickening and 3.4% of them had edema. Distinguishingly, no lymphadenopathy, pectoralis invasion, edema and nipple retraction were seen in benign lesions. The majority (37.5%) had cysts and 12.6% of them had skin thickening.

DISCUSSION

Accurate diagnosis of breast cancer and its severity preoperatively became a complex issue for administering the definitive treatment. Clinicians need reliable data from the radiologist for taking crucial decisions in directing the precise treatment. Non mass enhancement lesions were found as additional lesions in the preoperative MRI. If we observe the mass morphology in the present study, major malignant lesions appeared to be irregular and spiculated type whereas benign lesions are round and smooth. A similar study by Yeong Yi An, et al.[16] has shown that mass like morphology lesions are round/irregular and spiculated types in malignant lesions, and they showed statistical significance in the published data. They demonstrated that most of the benign lesions were of oval and circumscribed which is similar to our study. The same study showed that malignant lesions were heterogeneous which correlated with our data of heterogeneity. The present morphological data of lesions predicts that the MRI detected that most number of patients had malignant breast tumors and the report increased the sensitivity without a specificity loss.

As previously mentioned, additional non mass enhancement (NME) lesions elucidate and alter treatment due to their malignant behavior. The present study reveals more or less, that the number of NME lesions was of a linear and diffused type which is similar to Kuhl C, and Gutierrez RL, et al study.[17,18] Our findings revealed that the linear distribution pattern of lesions indicates malignancy of the tumor. Some of the studies say that segmental lesions were also of malignant type but in the present case, there are no observed segmental NME lesions. Though several previous studies worked on NMEs in MRI to differentiate malignant and benign but the majority of them have failed in interpreting the criteria as per the BI-RADS MRI guidelines. However, present data resulted in additional NME lesions, succeeded by the clear demarcation of type of NMEs along with differentiating benign and malignancy of lesions.[19]

In the process of assessing and differentiating the type of the lesion as benign and malignant in MRI time signal intensity curves/kinetic curve will help in discriminating properly, due to its high sensitivity. In the present study, 81.1% of them were showing a progressive pattern of the curve which indicates the benign type of tumor and 75.9% of the lesions were washout curves. A drop in the signal intensity in washout curves indicates a malignancy of the lesions, a persistent increase in signal intensity indicates benignity.[20] In the present case, a clear demarcation of lesions with the MRI scanning was achieved and helped in identifying 22 out of 45 patients had malignant lesions. Many studies have employed kinetic curves to diagnose breast lesions better.[21]

To assess the severity of breast cancer patients, multifocality and multicentircity (MFMC) of the lesions located in the

same or different quadrants of the breast is considered as a measurement tool. In our present study, out of 46 patients majority i.e. 43% of them were having multifocal lesions. This means the patients belong to the high risk category. A study by Sardanelli, et al. (2004).[22] explained about the better sensitivity of MRI in detecting MFMC exclusively in dense breast cases over the mammogram. MRI diagnosis of the postoperative breast for identifying recurrence, scar and metastasis is mandatory to avoid unnecessary biopsies, therapies and surgeries. In the present case, 37% of recurrence and 25% of metastasis patients were identified with the MRI, these results achieved a sensitivity of MRI in differentiating the postoperative lesions.

CONCLUSION

MR imaging of breast provides necessary information for the diagnosis of lesions, morphological differentiation, and kinetic analysis. In the present study, a clear demarcation between benign and malignant lesion with a kinetic curve generation that improved the accuracy of breast lesion diagnosis. This could be a potential method of analysis in diagnosing benign and malignant lesions with high specificity and sensitivity. Preoperative analysis of breast through MRI differentiated the additional cancerous lesions from noncancerous lesions. Breast MRI differentiated postoperative scar and reccurent lesions even in the high risk and dense breast cases. MRI is considered a useful tool with its high sensitivity, specificity, and with high positive and negative predictive values over mammograms and ultrasonography through a kinetic analysis.

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