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MRI STUDY OF VARIOUS BREAST LESIONS – A PROSPECTIVE STUDY FROM NORTHERN INDIA

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Abstract

BACKGROUND: Female patients presenting to the OPD of the departments of General Surgery and Radiation Oncology who presented with breast masses, that were either palpable or radiologically documented were included in the study. All the patients were managed as per the set proforma before a contrast MRI of breasts was done on them to see for detection and characterization of breast disease (type, localization and staging) along with assessment of local extent of the disease, evaluation of treatment response and guidance for biopsy and localization of disease .

AIM: To evaluate and study the usefulness of contrast kinetics of various breast lesions using MRI e.g. In differentiating benign from malignant lesions etc,and to study the usefulness of MRI in identifying additional synchronous breast lesions, not otherwise suspected e.g. as in multicentric carcinomas as well as staging of malignant breast lesions.

METHODS: We performed a prospective study for a total period of two years which included total of 60 patients from varied age groups, ranging from adolescents to elderly. Female patients with breast masses, where worked up as per the set proforma before the contrast MRI of breasts was done . 1.5-Tesla MRI system with a dedicated four-channel dual breast coilwas used . Chest survey was done with STIR and T1W sequences acquired in an axial plane. Precontrast fat-suppressed T1W gradient-echo images were first obtainedand this was followed by intravenous contrast injection. Gadodiamide (GdDTPA-BMA), 0.1 mmol/kg body weightbolus, using a pressure injector with a flow rate of 2.0 ml/s, followed by a flush of 20 ml of saline was used and dynamic scans were then obtained. All observations where made note ofto see for type, extend and staging of breast diseases in these patients.

RESULTS : We inferred that MRI Showing masses with lobulated or irregular shape and spiculations had more chances of being malignant and on the contrary, masses with round or oval shape with smooth margins were more likely to be benign. Also lesions with heterogeneous, rim and central enhancement pattern on MRI in a breast lesion favored malignancy. While as homogenus internal enhancement was mostly a feature of benign breast masses. We also found that MRI demonstrated a high sensitivity (100%) for picking up nodal involvement, however, it had a lower specificity (75%). So MRI can emerge as a vital tool in ruling out local node involvement with a high negative predictive value of 100%.

CONCLUSION: MRI can be a useful tool for detecting multifocal breast diseases with their type and extent of involvement. It also facilitates disease staging and hence assists in changing the treatment plans and assessing the prognosis of disease in the patients

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Keywords: MRI, Gadodiamide contrast, breast lesions

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INTRODUCTION

Breast disease in women encompasses a spectrum of benign and malignant disorders. With intensive public education about breast cancer and the growing acceptance of routine breast self-examination (BSE), an increasing number of women can be expected to seek medical advice for the evaluation of breast symptoms. Because of early detection of breast cancers from widespread screening mammography and improvements in treatment, the mortality from breast cancer has decreased almost 30 % since 1990.[1] A long list of factors contribute to woman's risk for breast cancer including early menarche, late menopause, childbirth after age 30years, nulliparity, lactation for <2 years, alcohol ingestion, obesity, low socioeconomic status, particular ethnicity, hormone replacement therapy (HRT), family history, radiation exposure, and prior history of proliferative breast disease or breast cancer.[2] Vast majority of lesions that occur within the breast are benign.[3] Skin lesions like sebaceous cysts, epidermal inclusion cysts may sometimes be confused with true breast lesions. Benign lesions of the breast include, lymph nodes, solitary /multiple intraductalpapillomas and sclerosingadenosis .[4][5] Radial scars and fat necrosis, both, can mimic cancer by producing a palpable mass or a density on mammography that may contain calcifications. A palpable cyst is another common benign lesion of the breast and develops in at least 1 in every 14 women. Fibrocystic disease is the most common, most often bilateral, disorder of the breast. It is the result of distortion and exaggeration of normal menstrual cyclic changes of ductal epithelium and stroma.[6] Atypical hyperplasias, are included in the spectrum of fibrocystic disease, and may be associated with a slight increased risk for cancer .[7][8]Infections of the breast may be, lactational infections and chronic subareolar infections associated with duct ectasia[9].

The invasive breast carcinomas consist of several histologic subtypes; the estimated percentages are from a contemporary population-based series of 135,157 women with breast cancer reported to the Surveillance Epidemiology and End Results (SEER) database of the National Cancer Institute between 1992 and 2001 :Infiltrating ductal - 76 %, Invasive lobular – 8%, Ductal/lobular – 7 %, Mucinous (colloid) - 2.4%, Tubular - 1.5%, Medullary - 1.2 % and Papillary - 1 %.[10] Other subtypes, including metaplastic breast cancer and invasive micropapillary breast cancer, all account for fewer than 5 percent of cases.[11]

Imaging is essential for accurate breast diagnosis and the early detection of breast cancer. The combination of imaging, clinical examination and needle biopsy—known as 'triple assessment'—is the expected standard for breast diagnosis. Mammography has been the cornerstone in breast imaging but a normal appearing mammogram cannot thus exclude a carcinoma.[12]

Over the last decade breast MRI has developed as a clinically useful imaging tool. Breast MRI is fast emerging from the research scenario onto the clinical scenario. Because of its high sensitivity and effectiveness in dense breast tissue, MRI can be a valuable addition to the diagnostic work up of a patient with a breast abnormality or biopsy-proven cancer for the detection, characterization, assessment of local extent, evaluation of treatment response, and guidance for biopsy and localization.[13] Clinical trials from the United States and Europe have demonstrated that breast MRI can significantly improve the detection of cancer that is otherwise clinically, mammographically, and sonographically occult.[14][15] For patients with a new breast malignancy - Screening of the contralateral breast with MRI in patients with a new breast malignancy can detect occult malignancy in the contralateral breast in at least 3% to 5% of breast cancer patients .[16] MRI evaluation of breast carcinoma prior to surgical treatment may be useful in both mastectomy and breast conservation candidates to define the relationship of the tumor to the fascia and its extension into pectoralis major, serratus anterior, and/or intercostal muscles [17][18]. Clinical trials demonstrate that breast MRI can locate primary tumor in the breast in over half of women presenting with metastatic axillary adenopathy and an occult primary .[19] MRI also gives accurate size estimation for invasive carcinoma.[20] Neoangiogenesis by the tumor cells forms the basis of breast cancer detection by MRI, as increased permeability results in early contrast uptake by the tumor. Three general types of curves are noted that rely less on the absolute value of the enhancement than on the shape of the enhancement curve after giving the contrastcategorised according to the Assessment Categories based BI-RADS categories.[20][23]

MATERIALS AND METHODS:

This prospective study was conducted in a tertiary hospital institute in north India for a total period of two years. Female patients with breast masses, that were either palpable or radiologically documented who presented to the OPD of the departments of General Surgery and Radiation Oncolgy were included in the study. Before a contrast MRI of breasts was done all the patients were managed as per the set proforma that included documenting detailed history of each patient including age, sex, residence, occupation, presenting complaints. Baseline investigations included Complete blood count, kidney and lung function tests. MRI of the breast was done on a 1.5-Tesla (Magnetom AVANTO™, Siemens Germany) MRI system with a dedicated four-channel dual breast coil (Siemens, Erlangan, Germany) using a standardized protocol. Chest survey was done with STIR and T1W sequences acquired in an axial plane. Precontrast fat-suppressed T1W gradient-echo images were first obtained (DynaView®) and this was followed by intravenous contrast injection. Gadodiamide(GdDTPA-BMA, Omniscan), 0.1 mmol/kg body weight, was injected as a bolus, using a pressure injector with a flow rate of 2.0 ml/s, followed by a flush of 20 ml of saline. Gradient-echo images were obtained at 1 minute and 2 minutes, followed by high-resolution Inter-VIEWS (volume imaging with enhanced water signal) and again at 6 minutes and 7 minutes. Postprocessing was done by digitally subtracting the precontrast images from the sequential postcontrast images, along with 2D and 3D maximum intensity projection (MIP) reconstructions and kinetic analysis using the mean curve technique. The MRI breast findings were interpreted in conjunction with the clinical history and other breast imaging studies, including mammograms and USG when available, and reported according to the breast imaging reporting and data system for MRI (MRI-BIRADS) based on the morphologic and kinetic features of the lesion. The extent of disease in the index breast and the contralateral breast was measured in all three planes (anteroposterior, craniocaudal, and transverse planes).

RESULTS:

The minimum age of a patient observed was 18 years and the maximum age observed was 70 years. 10% of the patients were <20 years of age, and all lesions in this age group were proven benign on pathological examination. In the 20 to 45 yr age group,(n=29), 68 percent of the lesions were of malignant aetiology. In the >45 yr agegroup only 9 out of 25 patients had benign disease. This suggests a statistically significant relation between age and malignancy (p value =0.017), i.e, increasing chances of malignant disease with advancing age of the individual. The results are depicted as shown in Table 1 and fig.1.

Table 1 : Age distribution of patient population (n=60).

Age group (yrs)	No of patients (%)	HPE benign	HPE malignant
<20	6(10)	6	0
20 - 35	14(23.3)	4	10
36-45	15(25)	5	10
>45	25(41)	9	16
Total	**60**	**24**	**36**

$x^2 = 10.206$; df = 3; p = 0.017; Significant

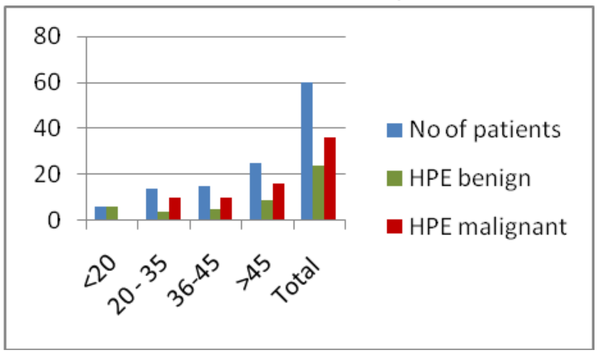

Fig. 1 Age distribution of patient population

Table 2 : Presenting complaints among the patient population (n=60)

Nature of the complaint	No. of patients(%)	HPE Benign	HPE Malignant
Lump	44(73)	18	26
Pain	20(33)	15	5
Nipple discharge	11(18.3)	5	6
Nipple retraction	5(8.3)	1	4
Upper limb edema	1(1.6)	0	1
Axillary swelling	3(5)	0	3
Pathological fracture	1(1.6)	0	1

Table 3: Distribution according to shape of lesion on MRI (n=60)

Shape	No. of cases (%)	HPE Benign	HPE Malignant
Round	12(20)	8	4
Oval	12(20)	10	2
Lobulated	9(15)	3	6
Irregular	27(45)	3	24
Total	60	24	36

$x^2 = 22.500$; df = 3; p < 0.001; Highly Significant

The table 3 depicts that 20% of the patients had round masses on MRI, out of these 66% had benign nature (n=12), same was true of oval lesion.15 % of the lesions were lobulated in shape, out of these 66% were malignant (n=9).Among the irregularly shaped lesions (n =27), 89 % were malignant. This suggested that the relationship between shape of the lesion and its pathological nature was statistically highly significant (p value <0.001). Masses with lobulated or irregular shape had more chances of being malignant and on the contrary, masses with round or oval shape were more likely to be benign. These results are illustrated in the fig 2

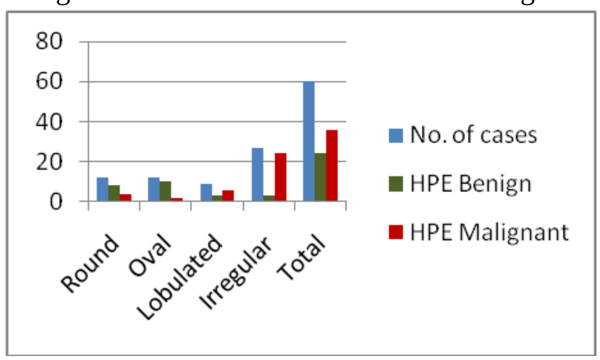

Fig. 2 : Distribution according to shape of lesion

Table 4 : Distribution according to margin on MRI (n=60)

Type of margin	No. of cases (%)	HPE benign	HPE malignant
Smooth	21(35)	18	3
Irregular	29(48)	6	23
Spiculated	10(16)	0	10
Total	60	24	36

$x^2 = 29.458$; df = 2; p < 0.001; Highly Significant

The table 4shows the relationship between margins of the lesion and the nature of pathology. Out of the 60 cases in our study, 35 % of the lesions had smooth margins, 48 % had irregular and16 % had spiculated margins. So, 76 % of the lesions with smooth margins(n=21) were benign ,whereas, only 20% of lesions with irregular margins(n=29) were benign. All the lesions (n=10) with spiculated margins (n=10)were malignant. This demonstrates a high association of margin irregularity and spiculations with malignancy. On the other hand, lesions with smooth margins were more likely to be benign. These conclusions were statistically highly significant (p value = <0.001)

These observations are illustrated in the Fig. 3

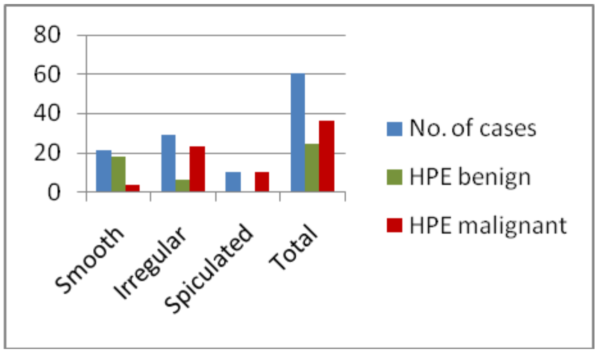

Fig 3 : Distribution according to type of lesion margin

Table 5: Distribution according to signal intensity characteristics on T1 weighted images on MRI (n=60)

Signal intensity	No. of cases	HPE benign	HPE malignant
High signal	5(8.3)	4	1
Intermediate signal	15(25)	7	8
Low signal	40(66)	13	27
Total	60	24	36

$x^2 = 4.549$; df = 2; p = 0.103; Not Significant

Thetable 5 shows the distribution of lesions with respect to signal characteristics on T1 weighted images. 66% of the cases were of low signal , 15 % were of intermediate signal intensity and 5 % were of high signal intensity. Out of the 40 lesions that were hypointense on T1W images, 67.5 % were malignant. In the intermediate signal group (iso-intense) (n=15), 53 % were malignant. Out of the 5 cases that were hyperintense on T1W, only 1 was malignant (20%). These findings were statistically insignificant witha p value of 0.103. Fig 4 describes the above findings

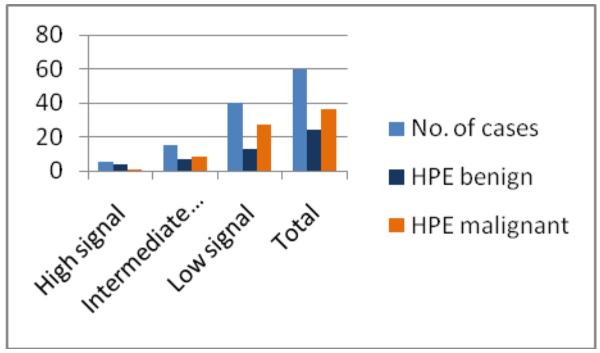

Fig. 4: Distribution according to T1 signal characteristics on MRI

Table 6 :Distribution according to T2 characteristics on MRI(n=60)

Signal intensity	No. of cases (%)	HPE benign	HPE malignant
High signal	15(25)	12	3
Intermediate signal	15(25)	7	8
Low signal	30(50)	5	25
Total	60	24	36

$x^2 = 17.083$; df = 2; p < 0.001; Highly Significant

Thetable 6 shows the distribution of lesions with respect to signal characteristics on T2weighted images. 50% of the cases were of low signal , 15 % were of intermediate signal intensity and 15 % were of high signal intensity. Out of the 30 lesions that were hypointense on T2W images, 83.3 % were malignant. In the intermediate signal group (iso-intense) (n=15), 53 % were malignant. Out of the 15 cases that were hyperintense on T2W, only 3 were malignant (20%). These findings were statistically significant witha p value of <0.001. Fig 5 describes the above findings

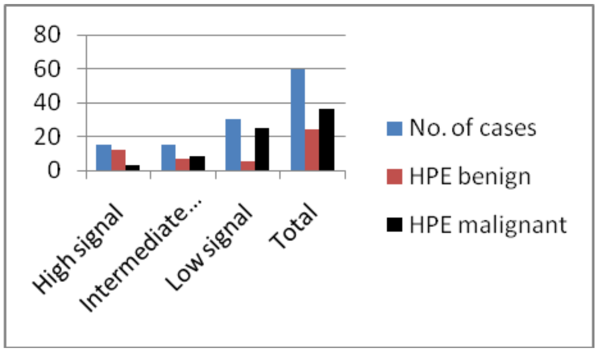

Fig 5: Distribution according to T2 signal characteristics on MRI

Table 7: Distribution according to enhancement pattern of masses on MRI (n=60)

Enhancement pattern	No. of patients (n=60)	HPE Benign	HPE Malignant
Homogenous enhancement	16(26)	14	2
Heterogenous enhancement	30(50)	7	23
Rim enhancement	8(13.3)	2	6
Central enhancement	6(10)	1	5
Total	60	24	36

$x^2 = 20.625$; df = 3; $p < 0.001$; Highly significant

In the table 7 , lesions have been distributed according to the internal enhancement characteristics on MRI. 16 lesions showed homogenous internal enhancement, 14 of these turned out to be benign. 30 lesions showed heterogenous internal enhancement and most of these lesions(23) were proven to be malignant of histopathology.8lesions demonstrated rim enhancement pattern, 6 out of these were malignant (75%,n=8), also 5 out of 6 lesions with central enhancement were malignant (83.3%, n=6).

These findings were statistically highly significant and showed that heterogenous, rim and central enhancement pattern in a breast lesion favoured malignancy. While as homogenus internal enhancement was mostly a feature of benign breast masses (fig. 6).

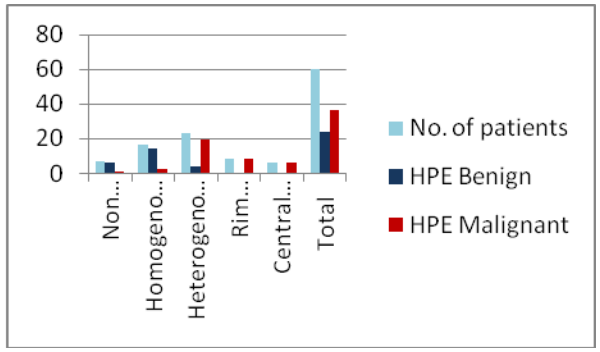

Fig 6: Distribution according to enhancement pattern of masses on MRI

Table 8: Distribution according to type of kinetic curve on MRI (n=60)

TYPE OF CURVE	No. of patients (%)	HPE Benign	HPE Malignant
Type 1	24(40)	18	6
Type 2	22(36)	4	18
Type 3	14(23)	2	12
Total	60	24	36

$x^2 = 20.471$; df = 2; $p < 0.001$; Highly Significant

The table 8 shows the distribution of lesions according to the time-signal intensity curve as depicted by the post contrast dynamic T1 images. After optimal region of interest placement, kinetic curves were described for each lesion. Type 1 curve was seen in 24 cases, 75% of these were proven benign. Out of the 22 lesions that demonstrated a Type 2 curve, 81 % were malignant. 12 out of 14 lesions with a type 3 kinetic curve were malignant (85%). These findings were statistically highly significant with a p value of <0.001 (fig. 7)

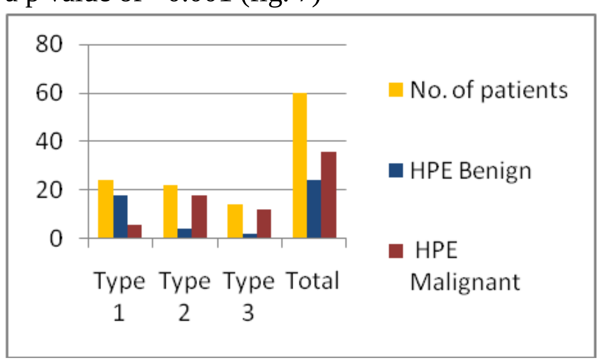

Fig. 7 : Distribution according to type of kinetic curve on MRI

Table 9: summary of patients with ipsilateral additional breast lesions detected on MRI which were otherwise occult (n=12)

Age of the patient	Index lesion laterality	Size of additional lesion (mm)	HPE of index lesion	HPE of additional lesion
46	R	5	IDC	IDC
36	L	10	IDC	IDC
64	L	20	IDC	IDC
52	R	15	IDC	ADH
37	L	20	IDC	ADH
48	R	5	FA	FA
60	L	8	FA	FN
50	R	9	IDC	FN
48	R	30	IDC	IDC
39	R	20	IDC	ADH
70	L	16	FA	CYST
45	L	8	IDC	CYST

The data shown in table 9shows that a total of 12 patients out of 60(20%), showed an additional lesion in the ipsilateral breast, 4 of these additional lesions detected were malignant on histopathology, thereby, suggesting multicentricity of disease in these patients. This finding had a definite impact on thepre-op surgical planning of these patients.

Table 10: types of lesions in our study population

Pathological diagnosis	Number of patients
Invasive ductal carcinoma	32
Invasive lobular carcinoma	02
Fibroadenoma	10
Abscess	03
Intraductal papilloma	04
Galactocele	01
Angiosarcoma	01
Phyllodes tumor	01
Lactational adenoma	01
Fibrocystic disease	01
Sclerosingadenosis	01
Fat necrosis	02
Cyst	01
TOTAL	60

DISCUSSION:

In our study we had a total of 60 patients from varied age groups, ranging from adolescents to elderly.The minimum age of a patient observed was 18 years and the maximum age observed was 70 years. All lesions in the 20 yr age group were proven to be benign on pathological examination. In the 20 to 45 yr age group,(n=29), 68 percent of the lesions were of malignant aetiology. In the >45 yr age group 16 out of 25 i.e. 64 % patients had malignant disease. This suggested a statistically significant relation between age and malignancy (p value =0.017) ,i.e, increasing chances of malignant disease with advancing age of the individual. These results are consistent with the statistics provided by the American Cancer Society,Breast Cancer Facts & Figures 2011-2012 .[1] Masses with irregular borders and rim enhancement were associated with carcinoma, while masses with lobulated borders and internal septations were associated with fibroadenomas. The results are also in keeping with those of Guitterez and colleagues , who in 2009, performed a statistical analysis of 258 lesions and found out that there were higher odds of malignancy in lesions with lobular or irregular shape , or irregular or spiculated margins and heterogenous or rim enhancement.[24]On unenhanced T1-weighted sequences both the normal breast tissue and fibrous tissue show low signal intensity and fat shows intermediate to high signal intensity. Most benign and malignant lesions also show low signal intensity on T1-weighted sequences and cannot be differentiated from normal breast tissue on unenhanced T1-weighted images We also studied the signal intensity characteristics of breast lesions on unenhanced T2 weighted images . 50% of the cases demonstrated low signal , 15 % were of intermediate signal intensity and15 % were of high signal intensity. Out of the 30 lesions that were hypointense on T2W images, 83.3 % were malignant. In the intermediate signal group (iso-intense) (n=15), 53 % were malignant. Out of the 15 cases that were hyperintense on T2W, only 3 were malignant (20%). These findings were statistically significant with a p value of <0.001 and denoted that in a contrast-enhancing breast lesion, careful analysis of T2-weighted TSE images can improve the differential diagnosis .These findings were consistent with those of Kuhl CK, et al in 1999who carried out a study to determine whether T2-weighted images are a useful diagnostic adjunct for lesion characterization in dynamic breast MRI.[25] Distribution of lesions according to the time-signal intensity curve was depicted by the post contrast dynamic T1 images. After optimal region of interest placement, kinetic curves were described for each lesion. Type 1 curve was seen in 24 cases, 75% of these were proven benign. Out of the 22 lesions that demonstrated a Type 2 curve, 81 % were malignant. 12 out of 14 lesions with a type 3 kinetic curve were malignant (85%). These findings were statistically highly significant with a p value of <0.001.Our findings were mostly consistent with Kuhl and colleagues in 1999where they analysedearly,intermediate and late enhancement in breast lesions on MRI.[25] Also the specificity of MRI breast has increased likely because of improvement in technology and increase reader experience and interest.[26]

CONCLUSION:

MRI helps in studying morphological characteristics of benign and malignant breast masses using various sequences. Evaluating contrast kinetics of various breast lesions e.g. helps in differentiating benign from malignant lesions, identifying additional synchronous breast lesions, not otherwise suspected and staging of malignant breast lesions. MRI of breast not only assists in specific diagnosis, it is also useful in planning the treatment and assessing the prognosis of disease in the patients.

CONFLICT OF INTERESTS

Theauthors declare that there is no conflict of interests regarding publication of this paper.

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