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Original Research Article

MRI AND ULTRASOUND CHARACTERISATION OF BREAST LESIONS

Priyanshi Dave[1], Amlendu Nagar[2], Sheetal Singh[3], Bhushita Lakhar Guru[4]

[1]*Junior Resident, Department of Radiology, Index Medical College Hospital and Research Centre, Indore, India.*
[2]*Professor & HOD, Department of Radiology, Index Medical College Hospital and Research Centre, Indore, India.*
[3]*Professor, Department of Radiology, Index Medical College Hospital and Research Centre, Indore, India.*
[4]*Professor, Department of Radiology, Index Medical College Hospital and Research Centre, Indore, India.*

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Corresponding Author:
Dr. Priyanshi Dave,
Junior Resident, Department of Radiology, Index Medical College Hospital and Research Centre, Indore, India.
Email: priyanshi.dnp@gmail.com

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ABSTRACT

Background: Breast cancer is the most common cancer affecting women worldwide, with rising incidences in developing countries, including India. Early and accurate diagnosis is essential for effective treatment; however, limited access to advanced imaging technologies in resource-constrained settings poses a challenge. This study aimed to evaluate and compare the diagnostic accuracy of ultrasonography (USG) and magnetic resonance imaging (MRI) in distinguishing benign from malignant breast lesions, and to assess the potential benefits of combining these modalities.

Material & Methods: A prospective study was conducted involving 100 female patients aged 35 and older, presenting with breast lumps or suspicious lesions. Each participant underwent both USG and MRI. Findings were correlated with histopathology results to determine sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of each modality.

Results: In this study of 100 patients, most breast cancer cases occurred in the 56–65 age group, with malignant tumors predominantly on the left side and in the upper outer quadrant. MRI demonstrated higher sensitivity (100% vs. 78.05%) and NPV (100% vs. 47.06%) compared to USG, while both modalities showed comparable specificity (88.89%). MRI consistently identified malignant features like spiculated margins, skin involvement, and Type III enhancement curves, indicating more aggressive pathology. The combination of both modalities improved diagnostic accuracy to 89%, highlighting MRI's value in confirming malignancies.

Conclusion: MRI proved more effective in identifying malignant lesions, whereas USG offered value due to its accessibility and cost-effectiveness. These findings underscore the diagnostic advantage of MRI and the importance of combining imaging modalities for optimal breast cancer detection, especially in resource-limited settings.

Keywords: Breast lesions, Ultrasonography, MRI, breast imaging.

INTRODUCTION

Breast cancer (BC) is the most prevalent malignancy among women worldwide, recently surpassing lung cancer as the leading cause of global cancer incidence in 2020, with an estimated 2.3 million new cases, accounting for 11.7% of all cancer diagnosis.[1] Projections from epidemiological studies indicate that the global burden of BC could reach nearly 2 million cases by 2030.[2] In India, the incidence of breast cancer has risen markedly, with a nearly 50% increase observed from 1965 to 1985.[3]

The incidence of breast cancer is higher in developed countries compared to developing and underdeveloped nations. However, this disparity may be attributed to limited screening and diagnostic capabilities in less developed regions, due to factors such as insufficient awareness, inadequate infrastructure, lack of screening programs, and limited access to appropriate diagnostic facilities resulting from resource constraints.[4]

Breast cancer is the most common cancer among women in India, with an age-adjusted incidence rate of 25.8 per 100,000 women and a mortality rate of 12.7 per 100,000. A global report revealed that in 2012, there were 882,900 new breast cancer cases and 324,300 deaths worldwide, representing 25% of cancer cases and 15% of cancer-related deaths among females.[5]

With timely treatment, 20–30% of early-stage breast cancer patients can achieve a full lifespan with minimal future complications, highlighting the critical need for early and accurate diagnosis.[6,7] According to the Indian Council of Medical Research, one in 22 women in India may develop breast cancer in her lifetime, though pinpointing a specific cause is challenging due to its complex etiology. Although BRCA1 and BRCA2 mutation screenings are available, they are of limited benefit within the Indian demographic, making awareness and self-examination essential.[8]

Female breast cancer is a multifaceted disease, with causes rooted in environmental and genetic factors. While high-risk genes like BRCA1 and BRCA2 account for only 5-10% of cases, additional risk factors include family and personal history of breast cancer, fibrocystic conditions, significant radiation exposure, and cancers of the endometrium, ovary, or colon. Early onset of menstruation, delayed menopause, and low lactation rates are also associated risk factors. Diagnosing breast cancer in its early stages yields a significantly better prognosis; however, more than 90% of cases are identified at stages II through IV. [8,9]

The primary goal of breast imaging is to identify potential abnormalities and evaluate malignancy risk to guide the physician's recommendations. Early detection is essential to maximize treatment efficacy while minimizing unnecessary biopsies. This is best achieved by selecting the appropriate imaging methods based on the patient's age, breast density, and clinical concerns. Careful selection not only enhances specificity but also reduces both patient discomfort and diagnostic costs.[8,10]

As per the clinical guidelines on the diagnosis and treatment of breast cancer, clinical examination should be followed by imaging studies using conventional ultrasonography, X-ray mammography, multi-slice spiral computed tomography, magnetic resonance imaging (MRI) and Doppler ultrasound color flow imaging. However, each single method has various advantages and disadvantages, and the results obtained from different methods are often conflicting. Therefore, the combination of two or three diagnostic methods is commonly adopted in determining the properties of breast masses and for the clinical diagnosis of breast cancer.[11]

Ultrasonography (USG) which is easily accessible even in low resource settings plays an important role in evaluation of breast lesions. It can effectively distinguish solid masses from cysts, which account for approximately 25 percent of breast lesions.[12,13] One of the characteristic features of cancer tissue is its lower elasticity as compared to normal tissue. This difference in elasticity makes it possible to differentiate between malignant and benign lesions by studying the difference in elasticity of the lesions. Ultrasound (US) elastography provides information regarding tissue hardness and is expected to Fortunately, with the evolution of ultrasound elastography it has become possible to diagnose breast cancer tissue from normal and benign tissue and USG has become a novel diagnostic tool for assessing breast diseases.[14]

On the contrary, MR imaging (MRI) reflects tissue characteristics, including fibrotic changes. Fibrotic changes of the stroma are observed in many breast diseases and affect the hardness of the tissue.[15-17] MRI which is also highly sensitive, with sensitivity as high as 85 to 100% however it lacks specificity (47 to 67%).[18,19] Moreover, MRI is a highly expensive diagnostic modality and is inaccessible to a large proportion of population in less developed and low resource countries like ours.

With this background, this study has been carried out to evaluate, correlate and compare the role of ultrasonography and MRI in breast imaging.

MATERIALS AND METHODS

After approval from the institutional ethics committee, this prospective study was carried out in the Department of Radiodiagnosis at Index Medical College Hospital and Research Centre, Indore. The study included 100 female patients over 35 years old, presenting with a breast lump or suspicious palpable breast lesion at the OPD, or are referred for Ultrasonography (with color Doppler) and MRI during the period of study. A written informed consent was obtained from all patients after explaining the study protocol and enrolment was done.

Inclusion Criteria

- Woman who are 35 years of age or older, presenting with breast carcinoma related symptomatology.
- Women above 35 years of age having any of the risk factors of breast carcinoma.

Exclusion Criteria

- Patients unable to undergo diagnostic MR imaging. (Eg. Pacemaker, Metallic prosthesis);
- Non palpable breast lesion;
- Post-operative cases;
- Presence of breast haematoma (From either recent Surgery or Biopsy) adjacent to the suspicious lesion;
- Patients with ulcerated and fungating breast lesion;
- Moribund patients and proven cases of malignancy; and
- Unwilling patients to undergo the study.

Methodology

A thorough clinical history was taken followed by physical examination. For each patient, the recorded factors included age at menarche, pregnancy history, menopausal status, and family history of breast cancer. Patients underwent initial ultrasonography, followed by MRI, including both plain and contrast sequences as necessary. Then classification of breast lesions was based on the Breast Imaging Reporting and Data System (BI-RADS).

A. Ultrasound with colour doppler breast

The ultrasonography was performed using multi-frequency linear, curvilinear, and transvaginal transducers on an GE voluson S8 Ultrasound machine. Each patient underwent a B-mode ultrasound (USG) assessment, where key characteristics such as the side and area of involvement, lesion size and shape, margin type, echo pattern, echotexture, post-acoustic enhancement, architectural type, vascularity and pattern, duct extension, and height/width ratio were evaluated and diagnosis was prepared using BIRADS criteria.

B. Magnetic Resonance Imaging

MRI studies were performed using a 1.5 Tesla magnet (GE Company), employing primary T1-weighted imaging (T1WI) and T2-weighted imaging (T2WI) pulse sequences. All patients were placed prone on the MRI scanner equipped with a dedicated breast surface coil. The scanning range included the bilateral breast and the corresponding level of prothoraxes and bilateral axillae. On MRI size, shape, margins, texture, T1-weighted and T2-weighted intensity, contrast enhancement and axillary involvement was noted. Consequently, the lesion was categorized as benign, probably benign, malignant and probably malignant.

The diagnostic criteria that were used to classify lesions were based on lesion morphologic features (shape, margins, and internal architecture) and lesion enhancement kinetics (enhancement rate in the early post-contrast phase and signal intensity time course pattern in the intermediate and late post-contrast phase).

C. Breast Biopsies

Fine needle aspiration cytology (FNAC) or biopsy was performed for cytological or histopathological confirmation of the diagnosis. A radiologist analyzed all images and documented the observations within the research checklist. Finally, the preoperative MRI diagnosis was compared with the postoperative histopathology result following the surgical procedure. The MRI findings were then compared to those from the ultrasonography and correlated with operative and histopathological results when applicable.

Statistical Analysis

Data were recorded in Microsoft Excel 10.0 and analyzed using IBM SPSS version 22.0. Continuous parametric data were presented as means and standard deviations, while non-parametric data used medians and interquartile ranges. Categorical data were expressed as percentages, and the Chi-square test was applied to these for comparison. Category heterogeneity was evaluated through two-way ANOVA, with a significance threshold of $p < 0.05$, and further assessed using post hoc Bonferroni multiple comparisons. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of ultrasonography (USG) and MRI in diagnosing benign and malignant breast lesions were determined based on true positive, false positive, and false negative counts.

RESULTS

Clinicodemographic Profile: The study revealed that out of 100 patients, the majority of cases 40 (40%) were in the 56–65 age group, with additional cases distributed across older [20(20%) in ages 66 and above) and younger groups [28(28%) in 45–55 and 12(12%) in 35–45]. The patient ages ranged from 35 to 75 years, averaging 55.64 years.

Among the 100 participants, 82 (82%) had malignant and 18 (18%) had benign diagnosis, with most patients identifying as Hindu 80 (80%), followed by Muslim 14 (14%) and Christian 6 (6%). Notably, 10 (10%) had a history of hormone replacement therapy, 12 (12%) had a previous benign breast disease, and 4 (4%) had a family history of breast cancer. Early menarche and late menopause were present in 20 (20%) of patients, while 54 (54%) reported no associated risk factors. Carcinoma was more prevalent on the left side 47 (57.3%) than the right 35 (42.7%), and tumors most commonly appeared in the upper outer quadrant across all age groups, highlighting this as the quadrant with the highest incidence. [Table 1]

USG with Colour Doppler findings of breast lesions: In a sample of 100 cases, a total of 104 lesions were detected, with multiple lesions (2 per case) identified in four cases. Most benign lesions were wider than tall (L/AP ratio >1.4), while malignant lesions tended to be taller than wide (L/AP ratio <1.4), though this applied primarily to smaller lesions and was not consistent for larger malignant ones. Typically, benign lesions were round to oval with smooth or lobulated margins, except for one benign lesion that presented an irregular shape. Malignant lesions were generally irregular in shape and margins, with 24 malignant lesions presenting as round or oval. Spiculated margins were strongly indicative of malignancy, though one benign lesion also had this feature. Vascularity was observed in 60 lesions, all of which were malignant [Table 3].

Majority of malignant lesions displayed a heterogeneous echotexture, with only 14 (14%) showing hypoechoic echotexture. Most benign lesions were hypoechoic, though a small percentage i.e., 2 (2%) exhibited hyperechoic echotexture [Table 3 (b)]. Posterior acoustic shadowing was a predominant feature in malignant lesions, though 22

(22%) showed neither shadowing nor enhancement, and 2 (2%) exhibited enhancement. For benign lesions, only 2 (2%) showed posterior acoustic attenuation, 6 (6%) displayed enhancement, and 14 (14%) showed no sound transmission [Table 3]. Skin involvement was observed in 8 (8%) malignant lesions, presenting as skin thickening, induration, and puckering. Calcifications, evident as posterior shadowing, appeared in 12 (12%) malignant lesions and 6 (6%) benign lesions. Axillary lymphadenopathy, indicating potential malignant infiltration, was found in 10 (10%) malignant cases, characterized by the loss of the central fatty hilum in affected nodes. [Table 3]

MRI Features of Breast Lesions: Benign lesions predominantly displayed smooth or lobulated margins, while most malignant lesions had spiculated margins. However, 20 (20%) of malignant lesions also showed lobulated margins. Spiculation was the feature most consistently linked with malignancy. Skin or pectoralis involvement was observed in 30 (30%) lesions, all of which were malignant, highlighting its association with more aggressive pathology A Type I signal intensity curve was observed in 18 (18%) of benign lesions. Type II curves appeared in 10 (10%) of lesions, with 8 (8%) being malignant and 2 (2%) benign. Type III curves, associated with more aggressive pathology, were seen in 76 (76%) of lesions, of which 74 were malignant and only 2 benign, highlighting its significance as an indicator of malignancy. [Table 4]

Diagnostic Potential of USG & MRI: In assessing cancer detection accuracy for each modality, lesions classified as BIRADS I, II, and III were considered 'negative' for malignancy, while BIRADS IV and V lesions were considered 'positive' [Table 5]. Among the 100 cases, both imaging modalities showed concordance with the histopathological diagnosis in 74 (74%) cases regarding the nature of the neoplastic lesion [Table 6]. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy for ultrasonography were 78.05%, 88.89%, 96.97%, 47.06% and 80% respectively. For MRI, these values were 100%, 88.89%, 96.62%, 100% and 98% respectively. The combined modality study yielded sensitivity, specificity, PPV, NPV and accuracy of 89.02%, 88.89%, 96.79%, 73.53% and 89% respectively. MRI's sensitivity and NPV were significantly higher than those of ultrasonography, while both modalities shared the same specificity. The PPV for MRI was marginally higher than that of ultrasonography, underscoring MRI's superior diagnostic accuracy in detecting malignancies.

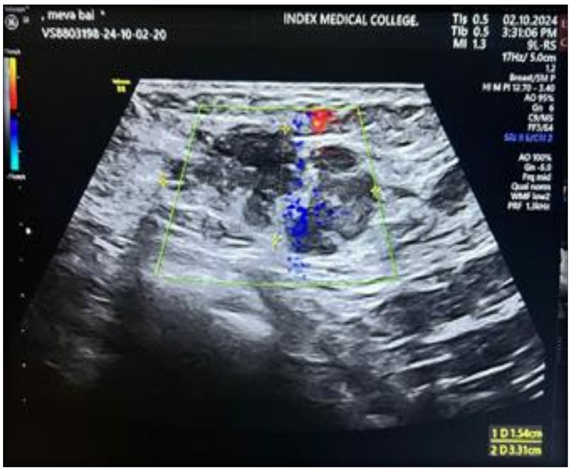
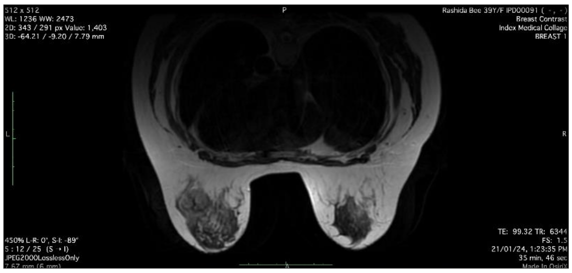


Figure 1: Ultrasonography of Left breast showed evidence of approx 3.1x1.5x1.7 cm of size spiculated irregular, ill defined, heterogeneous predominantly hypoechoic solid non-compressible mass lesion with central area of few echogenic foci of calcification within noted at the 2 & 3 o'clock position in upper outer quadrant of left breast. The lesion showed minimal central and peripheral vascularity on color doppler s/o BIRADS - IV in left breast

Figure 2: Approx 4.1x2.2x5.0 cm of size irregular marginated heterogeneous predominantly hypoechoic solid, non-compressible mass lesion with few echogenic foci of calcification within noted at 2-3 o'clock position of upper outer quadrant of left breast, which is showing internal vascularity on color doppler. Finding suggestive of BIRAD'S - IV lesion in left breast.



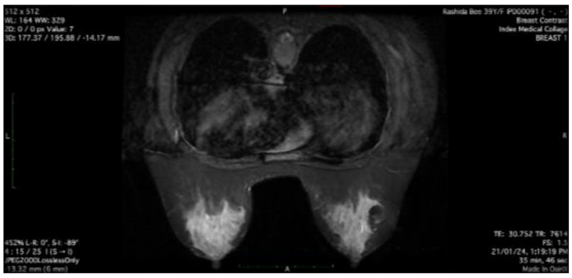
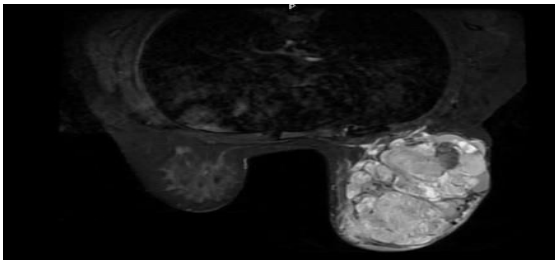


Figure 3: MRI showed Well defined round to oval lesion seen in outer quadrant of right breast in retroareolar region appearing hyperintense on T1 and suppressed on PD/FATSAT s/o lipoma. Multiple variable size lesions noted in left upper quadrant appearing hypointense on T1, hyperintense on T1/STIR s/o multiple fibroadenoma. Axial t2/stir image showing hyperintense I'll defined lobulated mass lesion in right breast showing few non enhancing areas. Small tiny cyst noted in retroareolar region of left breast.



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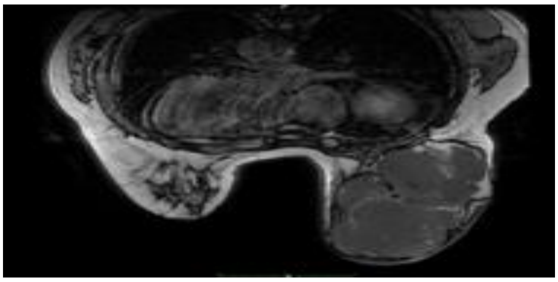

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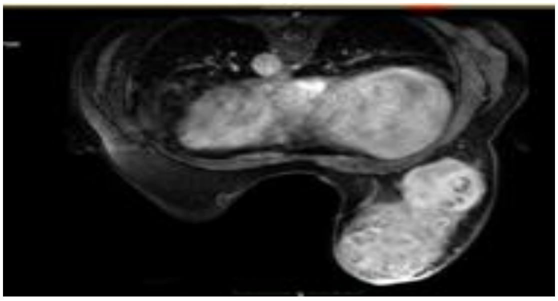

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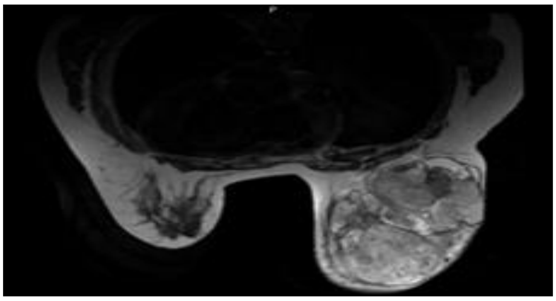

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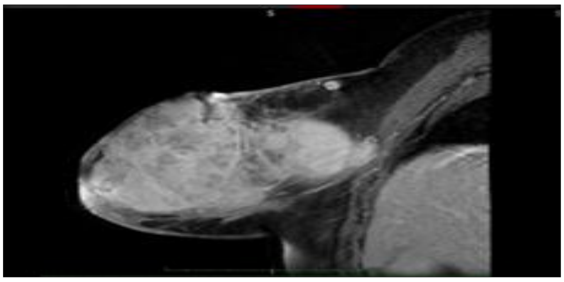

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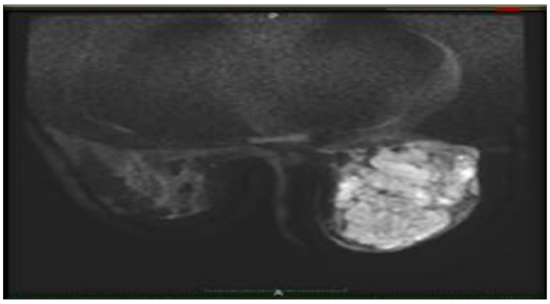

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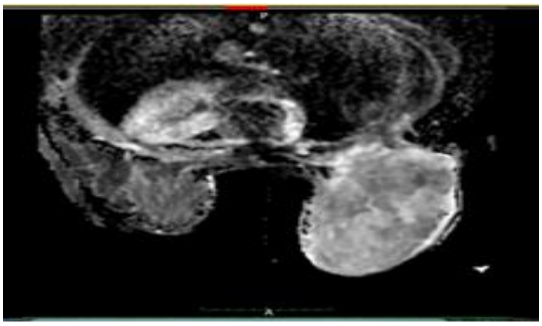

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Figure 5. A) MRI showed Axial T2/stir image showing hyperintense Ill defined lobulated mass lesion in right breast showing few non enhancing areas. Small tiny cyst noted in retroareolar region of left breast; B) Axial T1 weighted image showing ill-defined hypointense mass lesion involving entire right breast. Tiny retroareolar cyst noted in left breast; C) Axial T1 contrast image showing heterogenous enhancing large Ill defined mass lesion occupying entire right breast and fungating through skin; D) Axial T2 weighted image showing hyperintense Ill defined lobulated mass lesion with few non enhancing necrotic areas in right breast; E) Sagittal Image showing ill-defined hypointense mass lesion involving entire right breast. Tiny retroareolar cyst noted in left breast; G) This lesion is showing restriction on DWI and shows low to intermediate signals on ADC; (H) ADC image Findings suggest BIRADS V Lesion

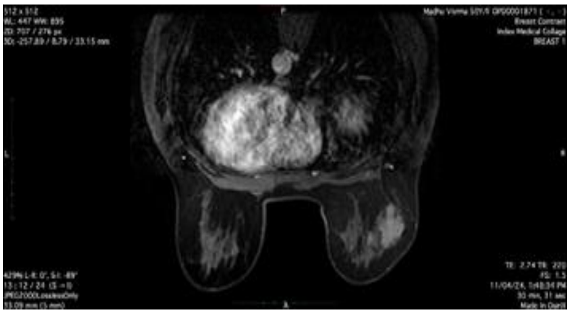

Figure 4: MRI showed Ill defined, spiculated lesion in upper outer quadrant of right breast appearing hyperintense on T2/PD FATSAT and hypointense on T1 causing retraction of nipple and shows intense post contrast enhancement s/o carcinoma right breast (BIRADS IV)

Table 1: Clinicodemographic distribution of study participants

Parameters	Number (%)
Age Group (Years)	
35-45	12 (12%)
46-55	28 (28%)
56-65	40 (40%)
66 and above	20 (20%)
Ethnic Distribution	
Hindu	80 (80%)
Muslim	14 (14%)
Christian	06 (6%)
Pathology	
Malignant	82 (82%)
Benign	18 (18%)
Associated features	
HRT	10 (10%)
Benign breast disease	12 (12%)
Family h/o breast cancer	04 (4%)
Early menarche	14 (14%)
Last menopause	06 (6%)
No risk factors	54 (54%)
Sidewise distribution of cases (Malignant) N=82	
Left	47 (57.3%)
Right	35 (42.7%)

Table 2: Gross quadrant location of malignant tumour

Quadrant	<55 years	≥ 55 years
Outer upper	18	26
Inner upper	6	6
Outer lower	0	2
Inner lower	2	10
Retroareolar	2	10
Total	28	54

Table 3: USG with Colour Doppler findings of breast lesions

USG features		No of lesions	Benign	Malignant
Size, shape, margin& vascularity assessment of mass lesion				
Size	L/AP >1.4	50	20	30
	L/AP <1.4	54	2	52
Shape	Round	24	10	14
	Oval	20	10	10
	Irregular	60	2	58
Margins	Smooth	10	10	0
	Lobulated	34	10	24
	Spiculated	60	2	58
Vascularity	Vascular	60	0	60 (RI>0.8)
	Avascular	44	22	22
Echotexture and posterior transmission				
Echogenicity	Hypoechoic	34	20	14
	Hyperechoic	2	2	0
	Heteroechoic	68	0	68
Posterior sound transmission	Attenuation	60	2	58

	Enhancement	8	6	2
	No change	36	14	22
Other associated findings				
Skin Thickening/Invasion of pectoralis		8	0	8
Calcification		18	6	12
Axillary lymphadenopathy (with loss of central fatty hilum		10	0	10

Table 4: MRI findings of breast lesions

MRI features		No of lesions	Benign	Malignant
Assessment of margins, skin involvement and pectoralis invasion				
Margins	Smooth	8	8	0
	Lobulated	34	14	20
	Spiculated	62	0	32
Time intensity curve on contrast enhanced MRI				
	Type I	18	18	0
	Type II	10	2	8
	Type III	76	2	74

Table 5: Accuracy of cancer detection cases by USG and MRI

Modality	True positive	False positive	True Negative	False Negative
Ultrasonography	64	2	16	18
MRI	82	2	16	0

Table 6: Concordance of all three modalities with the final histopathological diagnosis

	No of cases
Cases positive for malignancy by USG & MRI	60
Cases negative for malignancy by USG & MRI	14
Total	74

Table 7: Performance characteristics of each screening modality (USG and MRI)

Modality	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Accuracy
Ultrasonography	78.05%	88.89%	96.97%	47.06%	80%
MRI	100%	88.89%	97.62%	100%	98%
Combined	89.02%	88.89%	96.79%	73.53%	89%

DISCUSSION

This prospective study was conducted on 100 female patients referred to the radiology unit of a tertiary care hospital to evaluate and compare the accuracy of breast lesion assessments using ultrasonography (USG) and MRI. The study examines the imaging characteristics of palpable breast lesions across both modalities and correlates them with histopathological findings. Additionally, it aims to assess the risk-benefit ratio of each modality, providing insights into achieving optimal diagnostic outcomes by selecting the most suitable approach for each case.

In our study, patient ages ranged from 35 to 77 years, with a mean age of 55.64 years, and the most common age group was 56 to 65 years. This aligns with studies by Wiener JI et al,[10] and Nair et al,[8] who assessed the diagnostic efficiency of MRI compared to mammography and sonography for patients suspected of early-stage breast cancer. Their studies reported mean ages of 56.6 years and 56.24 years, respectively.

Among the 100 participants, 82 (82%) had malignant and 18 (18%) had benign diagnosis. Carcinoma was more prevalent on the left side 47 (57.3%) than the right 35 (42.7%), and tumors most commonly appeared in the upper outer quadrant across all age groups, highlighting this as the quadrant with the highest incidence. These findings are consistent with those of Nair et al,[8] and Fisher et al, whose study also had a slight left sided preponderance (58.54 % and 51.4%, respectively).

In our study, the location of cancer across quadrants was similar for patients younger than 55 years and those aged 55 and older, consistent with findings by Nair et al,[8] and Tellum et al,[21] Most studies, including these, indicate that the upper outer quadrant carries a higher cancer risk compared to other quadrants.

Ultrasonography proved to be the preferred modality for accurately measuring mass lesions, aligning with the findings of Fornage et al,[22] and Nair et al,[8] who demonstrated that real-time ultrasonography, compared to physical examination or mammography, provides the most precise preoperative assessment of breast cancer size.

Combining physical examination with either mammography or ultrasonography significantly enhances the accuracy of non-invasive tumor size assessment. In our study, most malignant lesions were found to be taller than they were wide, which aligns with the observations of Fornage et al,[22] and Nair et al.[8]

In our study, most benign lesions exhibited a round or oval shape with smooth or lobulated margins and posterior acoustic enhancement, while most malignant lesions were irregular in shape, with irregular margins, heterogeneous echotexture, and posterior acoustic shadowing. These findings align with previous studies by Nair et al,[8] Vlaisavljevic V et al,[23] and Chao TC et al.[24]

In our study, MRI findings indicated that most malignant lesions exhibited either spiculated (62 lesions) or lobulated (20 lesions) margins. 74 malignant lesions displayed a type III signal intensity (SI) curve, while eight showed a type II SI curve. In contrast, most benign lesions had smooth or lobulated margins with a type I SI curve, consistent with findings by Kinkel K et al.[25] Additionally, vascularity was observed in the majority of malignant lesions (60 out of 82), whereas all benign lesions were avascular, aligning with findings from other studies including study dine by Nair et al.[8]

In our study, there was discordance across both imaging modalities in 26 cases. Among these, 22 cases were confirmed as malignant on histopathology. MRI correctly identified all 22 malignant cases, though 10 of these were deemed low risk by sonography. Furthermore, 18 were classified as low risk by ultrasonography alone. The remaining four cases were benign on histopathology. In two of these, lesion was rated high risk by ultrasonography and MRI, showing a spiculated, taller-than-wide margin on ultrasound and a lobulated, heterogeneous enhancement on MRI, which was confirmed by biopsy. This was in concordance with study done by Nair et al,[8] who reported similar findings. Although they also utilised mammography as an additional imaging modality. In their study.

In our study, ultrasonography demonstrated a sensitivity of 78.05%, specificity of 88.89%, positive predictive value (PPV) of 96.97%, negative predictive value (NPV) of 47.06%, and diagnostic accuracy of 80%. MRI showed superior diagnostic performance with a sensitivity of 100%, specificity of 88.89%, PPV of 96.62%, NPV of 100%, and an overall accuracy of 98%. The combined modality (ultrasonography and MRI together) had a sensitivity of 89.02%, specificity of 88.89%, PPV of 96.79%, NPV of 73.53%, and accuracy of 89%. The sensitivity and diagnostic accuracy of MRI were significantly higher than those of ultrasonography, which aligns with findings by Nair et al,[8] as well as studies by Huang W et al,[26] and Malur S et al,[27] The significantly higher NPV and sensitivity for MRI, compared to ultrasonography, were consistent with findings from studies by Malur S et al,[27] Nair et al,[8] and Berg WA et al.[28] While the specificity of both modalities was equivalent in our study, MRI's PPV was slightly higher than that of ultrasonography, a result that concurs with the study by Nair et al.

The study's limitations include a small sample size of 100 cases, potential inter-observer variability in imaging interpretation, and restriction to a single-center setting, which may affect generalizability. Additionally, limited follow-up data and exclusive reliance on BIRADS classification could influence diagnostic accuracy.

CONCLUSION

This study highlights MRI's superior sensitivity and diagnostic accuracy in assessing palpable breast lesions compared to ultrasonography. While both modalities demonstrated high specificity, MRI showed significantly higher sensitivity and negative predictive values, making it a valuable tool for identifying malignant lesions that may be missed on ultrasonography. The combined use of ultrasonography and MRI further enhanced diagnostic accuracy, suggesting that an integrated approach may offer optimal diagnostic yield. These findings reinforce MRI's role as a complementary tool to ultrasonography in evaluating breast lesions, particularly for patients at high risk or with inconclusive findings on ultrasound alone. However, further research with larger, multi-center trials is necessary to confirm these results and refine diagnostic protocols for breast cancer evaluation.

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