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Research Article

ROLE OF ULTRASOUND AND MAMMOGRAPHY FOR EVALUATION OF BREAST MASSES: A COMPARATIVE OBSERVATIONAL STUDY

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ABSTRACT

Objectives: The aim of the study was to evaluate the diagnostic accuracy of ultrasound and mammography in the assessment of breast masses.

Methods: This was a comparative observational study conducted in the department of radiology of a tertiary care medical institute. Fifty women coming for imaging of breast lumps were included in this study after applying inclusion and exclusion criteria. The demographic data, including age, sex, family history of breast cancer, personal history of breast disease, and other relevant clinical details, were collected for each patient to understand the population's characteristics and ensure a comprehensive analysis. All patients underwent diagnostic mammography followed by sonography of the breast. Histopathological examination was done in 16 cases. Correlation between ultrasound features, mammography, and histopathological findings was done. $p<0.05$ was taken as statistically significant.

Results: The mean age of the patients was found to be 40.2±9.6 years. Twenty-three cases (28.75%) presented with only a lump. In addition, 15 cases (18.75%) reported experiencing pain along with the lump. There were 5 cases (6.25%) that had a lump accompanied by discharge, while 7 cases (8.75%) showed skin changes in addition to the lump. Nipple retraction was observed in 6 cases (7.50%). Among benign lesions, fibroadenoma was the most common and in the malignant category, invasive ductal carcinoma was the most prevalent, found in 7 patients (14%). Ductal carcinoma *in situ* was present in 5 patients (10%), invasive lobular carcinoma in 2 patients (4%), and triple-negative breast cancer in 1 patient (2%). On USG, 35 cases were having benign (70%) and 15 (30%) cases were having malignant pathologies. Mammography detected 34 benign (68%) and 16 malignant (32%) cases. When a combination of USG and mammography was used, 21 (42%) pathologies were having malignant pathologies.

Conclusion: Combined ultrasound and mammographic evaluation of breast lump was more helpful in the accurate evaluation of breast pathologies than when either modality was used alone.

Keywords: Breast lump, Ultrasound, Mammography, Carcinoma breast.

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INTRODUCTION

Breast masses are a common clinical finding, with etiologies ranging from benign to malignant pathologies. Among the benign breast lesions, fibroadenomas and cysts are most frequently encountered. Fibroadenomas are solid benign tumors that are particularly common in young women. Cysts can develop at any age but are most prevalent in women in their 30s and 40s. Other benign breast conditions include intraductal papilloma, lipomas, and fat necrosis [1]. On the malignant spectrum, invasive ductal carcinoma (IDC) and invasive lobular carcinoma (ILC) are the most common types of breast cancer. IDC, originating in the milk ducts, accounts for about 80% of all breast cancer cases, whereas ILC, starting in the milk-producing lobules, represents about 10–15% of cases. In addition, ductal carcinoma *in situ* (DCIS) is a non-invasive cancer that, if left untreated, can progress to invasive cancer. Imaging plays a crucial role in the identification, characterization, and management of these breast pathologies [2].

Breast cancer remains the most common cancer among women worldwide and a leading cause of cancer-related deaths. Early detection of breast cancer significantly improves the prognosis and survival rates. When detected early, breast cancer is more likely to be localized thereby allowing for less extensive surgery and more effective treatment options [3]. The 5-year survival rate for localized breast cancer exceeds 90% highlighting the critical impact of early diagnosis. Delays in diagnosis, however, often lead to advanced disease stages, with metastasis and poorer outcomes. Therefore, accurate and timely imaging is essential to identify malignancies at an early, more treatable stage, ultimately reducing mortality, and morbidity associated with breast cancer [4].

Several imaging modalities are employed for the assessment of breast masses, each with its own strengths and limitations. Mammography, ultrasound, and magnetic resonance imaging (MRI) are the primary tools used in breast imaging. Mammography, which uses low-dose X-rays, is the gold standard for breast cancer screening and has been shown to reduce mortality in women aged 40 and older [5]. Ultrasound is often used as an adjunct to mammography, particularly in women with dense breast tissue where mammography's sensitivity is reduced. MRI, which provides high-contrast images using magnetic fields and radio waves, is particularly useful for high-risk patients, such as those with BRCA gene mutations, and for evaluating the extent of known malignancies. In addition, tomosynthesis (3D mammography), positron emission tomography (PET), and other advanced techniques further enhance the diagnostic capabilities in breast imaging [6].

Among the various imaging modalities, ultrasound and mammography are the most widely used for the evaluation of breast masses. Mammography is highly effective in detecting microcalcifications and architectural distortions which are early signs of malignancy. It is particularly advantageous for identifying DCIS and small invasive cancers [7]. However, its sensitivity decreases in dense breast tissue where overlapping structures can obscure lesions. In contrast, ultrasound is highly effective in differentiating solid from cystic masses and provides real-time imaging allowing for targeted biopsies. It is particularly useful in evaluating palpable masses that are not visible on mammography and in guiding interventional procedures such as fine-needle aspiration or core needle biopsy [8].

Despite the advances in breast imaging, there remain gaps in knowledge regarding the optimal use of ultrasound and mammography in various clinical scenarios. While numerous studies have established the efficacy of these modalities individually, there is limited data regarding the role of combined imaging strategies in reducing diagnostic uncertainty and improving patient outcomes. This comparative observational study aims to fill these knowledge gaps by systematically evaluating the diagnostic accuracy of ultrasound and mammography in the assessment of breast masses.

METHODS

This was a comparative observational study conducted in the department of radiology of a tertiary care medical college. Women coming for imaging of breast lumps were included in this study after applying inclusion and exclusion criteria. The duration of the study was 1 year. The sample size for this study was calculated; taking into consideration, the number of cases included in the pilot study done on the subject of imaging of breast masses. Minimum sample size required was 44 patients. Based on the central limit theorem, sample size was calculated to be sufficient if it was more than 44 so we included 50 patients in our study.

The demographic data, including age, sex, family history of breast cancer, personal history of breast disease, and other relevant clinical details, were collected for each patient to understand the population's characteristics and ensure a comprehensive analysis. All patients underwent diagnostic mammography followed by sonography of the breast. The mammography protocol included craniocaudal (CC) and mediolateral oblique (MLO) views to ensure thorough visualization of the breast tissue. The imaging was performed using a digital mammography unit, which allowed for high-resolution imaging necessary for accurate assessment.

Mammography was conducted using a high-quality digital mammography machine. The procedure included obtaining two primary views: CC and MLO. Additional views were taken as needed, based on the initial findings and clinical indications. The equipment settings varied according to breast thickness, with exposure parameters ranging from a minimum of 23 kVp to a maximum of 26 kVp, and adjustments made to optimize image quality while minimizing radiation dose. Following mammography, all patients underwent breast ultrasonography using a high-frequency probe (4–12 MHz). The sonographic examination focused on a detailed assessment of the breast lesions identified during mammography. The ultrasound machine was equipped with color Doppler capabilities to evaluate the vascular characteristics of the lesions.

The evaluation of breast lesions was conducted using the Breast Imaging-Reporting and Data System (BI-RADS) criteria to standardize the interpretation and reporting. In mammography, several radiographic characteristics were assessed to provide a comprehensive analysis of each lesion. The location of the lesion was determined by identifying the specific quadrant of the breast where it was situated, such as superior, inferior, medial, or lateral. The overall shape and structure of the lesion were categorized under its appearance, while the margins were evaluated to determine if they were regular or irregular. The density of the lesion was also assessed, indicating whether it was radiopaque or radiolucent. Architectural distortion, which refers to any changes in the normal architecture of the breast tissue, was noted. In addition, the presence of enlarged lymph nodes, or lymphadenopathy, was evaluated to identify potential signs of malignancy.

For ultrasonography, similar criteria were applied to ensure a detailed assessment of the breast lesions. The margins of the lesion were evaluated to see if they were regular or irregular, aiding in the differentiation of benign from malignant characteristics. The width to anteroposterior diameter ratio was noted. The echotexture of the lesion was classified as either homogeneous or heterogeneous. Echogenicity was assessed to determine if the lesion was hyperechoic, hypoechoic, mixed echogenic, or anechoic. The presence and type of calcifications within the lesion were also recorded, as these can be indicative of malignancy. In addition, the presence of a pseudocapsule around the lesion was evaluated. The vascularity of the lesion was assessed using color Doppler to determine the blood flow within the lesion. The evaluation of axillary lymphadenopathy, or the presence of enlarged lymph nodes in the axilla, was performed to identify any potential signs of metastatic disease. Histopathological examination was done in 16 cases. Correlation between ultrasound features, mammography, and histopathological findings was done.

SPSS version 22.0 software was used for statistically analysis. Quantitative data were presented as mean and standard deviation. Qualitative data were presented with incidence and percentage tables. $p<0.05$ was taken as statistically significant.

Inclusion criteria

- Women presenting with palpable breast lump
- Age above 18 years
- Those who gave informed and written consent to be part of the study
- Females with signs of redness over the breast, nipple retraction, dryness, and altered contour of the breast.

Exclusion criteria

- Age <18 years
- Those whore refused consent to be part of the study
- Pregnant women
- Known cases of carcinoma breast who have already received chemotherapy or radiotherapy.

RESULTS

The analysis of the age group of the studied cases showed that out of a total of 50 patients, the most common age group was 41–50 years, comprising 19 patients, which accounted for 38.0% of the total. This was followed by patients in the age group of 31–40 years (26.0%), above 50-year age group (24.0%) and the 18–30 years (12.0%). The mean age of the patients was found to be 40.2±9.6 years. Out of the studied cases, 26 (52%) patients were postmenopausal (Table 1).

The analysis of patients based on the duration of palpable lumps showed that out of a total of 50 patients, 11 patients (22%) had a lump for <1 month, 35 patients (70%) had a lump for a duration between 1 month and 1 year, and 4 patients (8%) had a lump for more than 1 year (Table 2).

The analysis of patients based on their signs and symptoms revealed a variety of clinical presentations. Out of the total number of patients,

Table 1: Age distribution of studied cases

Age group (years)	Number of patients	Percentage
18–30	6	12.0
31–40	13	26.0
41–50	19	38.0
>50	12	24.0
Total	50	100

Table 2: Duration of breast lump in studied cases

Duration	Number of patients	Percentage
<1 month	11	22
1 month-1 year	35	70
Above 1 year	4	8

23 cases (28.75%) presented with only a lump. In addition, 15 cases (18.75%) reported experiencing pain along with the lump. There were 5 cases (6.25%) that had a lump accompanied by discharge, while 7 cases (8.75%) showed skin changes in addition to the lump. Nipple retraction was observed in 6 cases (7.50%). Some patients also presented with systemic symptoms such as weight loss, which was reported in 4 cases (5.00%). Finally, 2 cases (2.50%) had a family history of malignancy along with the presence of a lump (Table 3).

The analysis of breast lesions on USG showed that the majority of lesions (92%) were found to be hypoechoic, and only 4 cases (8%) exhibited heterogeneous echogenicity. When examining the margins of the lesions, a significant proportion (70%) had well-defined margins. However, 7 cases (14%) showed spiculated margins. Irregular margins were observed in 5 cases (10%), while diffuse margins, which were less distinct and spread out, were noted in 3 cases (6%). Additional features assessed included calcification, which was present in 16 cases (32%). Skin infiltration was observed in 4 cases (8%). Internal echoes were seen in 17 cases (34%). Posterior enhancement was noted in 5 cases (10%). Increased internal vascularity was present in 8 cases (16%). Finally, lymphadenopathy was observed in 5 cases (10%) (Table 4).

The mammography findings revealed various characteristics of breast lesions in the study population. Regarding density, 88% of the lesions (44 cases) were increased, while 12% (6 cases) showed decreased or mixed density. In terms of shape, 36% of the lesions (18 cases) were round, 34% (17 cases) were irregular, and 30% (15 cases) were oval. When assessing the margins, 66% of the lesions (33 cases) were circumscribed, 14% (7 cases) had irregular margins, 12% (6 cases) were spiculated, and 8% (4 cases) had irregular diffuse margins. The BI-RADS categorization indicated that 6% of the lesions (3 cases) were BI-RADS I, 40% (20 cases) were BI-RADS II, 28% (14 cases) were BI-RADS III, 14% (7 cases) were BI-RADS IV, and 12% (6 cases) were BI-RADS V (Table 5).

The comparative analysis of benign versus malignant lesion detection using different imaging modalities revealed that on the basis of USG, 35 cases were having benign (70%) and 15 (30%) cases were having malignant pathologies. Mammography detected 34 benign (68%) and 16 malignant (32%) cases. When a combination of USG and mammography was used 21 (42%), pathologies were having malignant pathologies (Table 6).

All these 21 (42%) patients who were found to have malignant lesions were further subjected to histopathological examination of the mass lesion. Out of 50 patients, 15 cases which were diagnosed to be having malignant lesions on ultrasound and underwent histopathological examination, nine cases turned out to be malignant, and six were found to be benign, whereas out of 16 cases which were diagnosed to be having malignant lesions on mammography and underwent histopath 11 turned out to be malignant and five were found to be benign. Out of 21 cases which were diagnosed to be malignant on USG and mammography and underwent histopath 15 turned out to be malignant and six were found to be benign. The positive predictive value for the detection of malignant lesions for ultrasound, mammography, and a combination of ultrasound and mammography was found to be 60%, 68.8%, and 71.4%, respectively. Although mammography could correctly identify more cases of malignant breast lesions, the difference was not statistically significant (p=0.6851) (Table 7).

Among benign lesions, fibroadenoma was the most common, observed in 14 patients (28%), followed by cysts in 10 patients (20%), fibrocystic changes in 8 patients (16%), and intraductal papilloma in 3 patients (6%). In the malignant category, IDC was the most prevalent, found in 7 patients (14%). DCIS was present in 5 patients (10%), ILC in 2 patients (4%), and triple-negative breast cancer in 1 patient (2%). These findings highlight that fibroadenoma was the most common benign lesion, while IDC was the most frequent malignant lesion among the patients studied (Fig. 1).

DISCUSSION

Palpable breast masses are common in females and they usually provoke intense fear and anxiety when first noticed. Evaluation of these

Table 3: Signs, symptoms, and history of studied cases

Signs and symptoms	No of cases	Percentage
Only Lump	23	28.75
Lump + Pain	15	18.75
Lump + Discharge	5	6.25
Lump + Skin Changes	7	8.75
Lump + Nipple Retraction	6	7.50
Lump + Weight Loss	4	5.00
Lump + Family History Of Malignancy	2	2.50

*In some patients more than 1 sign/symptom was present

Table 4: Ultrasound features of breast lesions in studied cases

Ultrasound features	Benign	Percentage
Echogenicity		
Hypoechoic	46%	92%
Heterogenous	4%	8%
Margins		
Well-defined margins	35	70%
Spiculated margins	7	14%
Irregular margins	5	10%
Diffuse margins	3	6%
Additional features		
Calcification	16	32%
Skin infiltration	4	8%
Internal echoes	17	34%
Posterior enhancement	5	10%
Increased internal vascularity	8	16%
Lymphadenopathy	5	10%

Table 5: Characteristic of lesion on mammography in studied cases

Characteristic of lesion on mammography	No of cases	Percentage
Density		
Increased	44	88
Decreased or Mixed	6	12
Shape		
Oval	15	30.00
Round	18	36.00
Irregular	17	34.00
Margins		
Circumscribed	33	66.00
Irregular	7	14.00
Spiculated	6	12.00
Irregular Diffuse	4	8.00
BIRADS category		
BIRADS I	3	6
BIRADS II	20	40
BIRADS III	14	28
BIRADS IV	7	14
BIRADS V	6	12

Table 6: Benign versus malignant lesions on ultrasound, mammography, and combination of USG and mammography

Imaging modality	Benign	Malignant
USG	35 (70%)	15 (30%)
Mammography	34 (68%)	16 (32%)
USG+Mammography	29 (58%)	21 (42%)

Table 7: True positive, false positive, and positive predictive value of USG and mammography

Modality	Diagnosed malignant	True positive (Malignant)	False positive (Benign)	Positive predictive value (%)
Ultrasound	15	9	6	60%
Mammography	16	11	5	68.8%
USG+Mammography	21	15	6	71.4%

p=0.6851 (Not Significant)

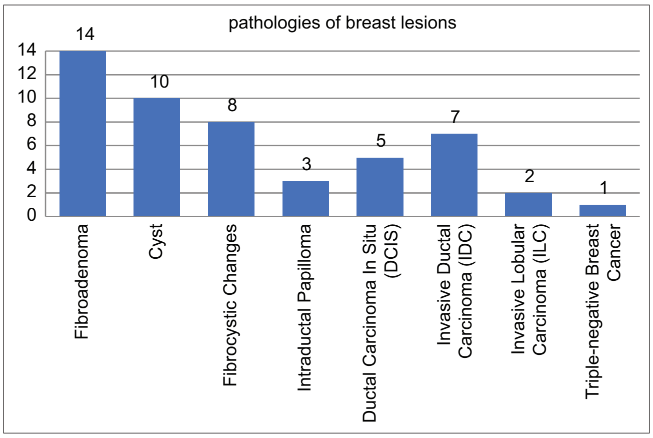

Fig. 1: Benign and malignant lesions in studied cases

breast masses is usually done by ultrasound and mammography. Both ultrasound and mammography are widely available and affordable modalities [9]. The other advanced modalities used for the assessment of breast masses include MRI, scintimammography, and PET which are now available [10]. However, these advance imaging modalities are not widely available and affordability is also an issue with these imaging modalities. Many studies have reported that the combined use of ultrasound and mammography can increase the positive predictive value as compared to when ultrasound and mammography are used alone [11].

In our study or imaging of palpable breast masses, the most common age group was 41–50 years, comprising 19 patients, which accounted for 38.0% of the total. The mean age of the patients was found to be 40.2±9.6 years. Yoon *et al*. conducted a prospective study to evaluate the diagnostic performance of the semi-quantitative strain ratio using one region-of-interest on breast ultrasonography (US) elastography images [12]. The study included 201 breast masses from 165 women with a mean age of 47.2 years. Elastography and US images were analyzed for elasticity patterns, strain ratios, and final BI-RADS assessments. Of the masses, 63.2% were benign and 36.8% were malignant. The mean age of patients having breast masses in this study was sound to be similar to our study. Similar mean age of the studied cases was also reported by the authors such as Won *et al*. [13] and Sain *et al*. [14].

In the study of breast lesions, 92% were hypoechoic on ultrasound, with 8% showing heterogeneous echogenicity. Well-defined margins were noted in 70% of cases, while spiculated, irregular, and diffuse margins were seen in 14%, 10%, and 6%, respectively. Calcifications were present in 32%, skin infiltration in 8%, internal echoes in 34%, posterior enhancement in 10%, increased internal vascularity in 16%, and lymphadenopathy in 10%. Mammography findings showed that 88% of lesions had increased density. Shapes included round (36%), irregular (34%), and oval (30%). The comparative analysis of benign versus malignant lesion detection using different imaging modalities revealed that on the basis of USG, 35 cases were having benign (70%) and 15 (30%) cases were having malignant pathologies. Mammography detected 34 benign (68%) and 16 malignant (32%) cases. When a combination of USG and mammography was used, 21 (42%) pathologies were having malignant pathologies.

Combination of USG and mammography could identify malignant lesions more often as compared to when one of these imaging modalities was used. Pushpakant *et al*. conducted a study to evaluate breast lesions using digital mammography and ultrasonography (USG) independently and in combination with fine-needle aspiration cytology (FNAC) correlation [15]. In this study population, 83.01% of breast lesions were benign, and of them, 77.27% were diagnosed by MG alone and 72.72% were diagnosed by USG alone. When these modalities were combined, 97.72% of the lesions were diagnosed. The correlation coefficients of MG alone (0.792), USG alone (0.631), and mammography and USG combination (0.884) with FNAC are all positive, and p values were significant of all the modalities. The study concluded that mammography and ultrasound (USG) when combined have significantly higher sensitivity and NPV than observed for a single modality in detecting both benign and malignant lesions of the breast. Similar findings were also reported by the authors such as Berg *et al*. [16] and Shetty *et al*. [17]

In our study among benign lesions, fibroadenoma was the most common, observed in 14 patients (28%), followed by cysts in 10 patients (20%), fibrocystic changes in 8 patients (16%), and intraductal papilloma in 3 patients (6%). In the malignant category, IDC was the most prevalent, found in 7 patients (14%). DCIS was present in 5 patients (10%), ILC in 2 patients (4%), and triple-negative breast cancer in 1 patient (2%). Taori *et al*. conducted a study to find the prevalence of various benign and malignant breast masses [18]. A total of 166 patients complaining of breast mass in one or both breasts were examined and evaluated with USG and mammography. The lesions were confirmed on histopathology (FNAC/biopsy). Out of 30 diagnosed malignancies, two lesions were missed on mammography and four lesions were missed on ultrasonography. One of them was missed on both. For malignancies, the specificity of mammography is 93.3% and that of ultrasonography was 86.67%. Combining both modalities specificity is near 97%. Out of a total of 92 abnormal breasts, 12 were missed on USG and 20 were missed on mammography. Combining both modalities, only two lesions were missed and were diagnosed on histopathology alone. Similar efficacy of the combination of ultrasound and mammography for the diagnosis of breast masses was also reported by authors such as Devolli-Disha *et al*. [19] and Glechner *et al*. [20].

CONCLUSION

Combining ultrasound and mammographic evaluation of breast lump is more helpful (although the difference was not statistically significant) in accurately defining breast pathologies than when either modality is used alone. This is particularly important in developing countries where advances imaging techniques such as tomosynthesis (3D mammography), MRI, and PET are not widely available.

CONFLICTS OF INTEREST

None.

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