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Original Research Article

Diagnostic Accuracy and Comparative Analysis of Sonography and Digital Mammogram in Diagnosing Breast Carcinoma in Screening Population Taking Histopathology as Gold Standard

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Abstract: **Objective:** To determine the diagnostic accuracy of sonography and digital mammography in diagnosing breast carcinoma taking histopathology as gold standard. **Study Design:** Cross sectional validation study. **Place and Duration of Study:** This study was carried out from 5th June 2025 to 5th December 2025 in the Department of Radiology Liaquat University Hospital Jamshoro. **Methodology:** A total of 156 female patients aged 30–60 years who were suspected for breast carcinoma were included. All patients first underwent breast sonography followed by digital mammography. Tissue biopsy was performed and histopathological examination was taken as gold standard for confirmation of carcinoma. Diagnostic parameters including sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were calculated using 2×2 contingency tables with statistical analysis done using Statistical Package for Social Sciences version 20. **Results:** The mean age of patients was 44.81 ± 8.62 years. Histopathology confirmed breast carcinoma in 31 (19.9%) patients. Sonography showed sensitivity of 97%, specificity of 43%, diagnostic accuracy of 54%, positive predictive value of 30% and negative predictive value of 98%. Digital mammography also showed sensitivity of 97% but higher specificity of 65% with diagnostic accuracy of 71%, positive predictive value of 41% and negative predictive value of 99%. **Conclusion:** Both sonography and digital mammography show high sensitivity for detection of breast carcinoma however digital mammography shows better specificity and overall diagnostic accuracy.

Keywords: Breast neoplasms, Diagnostic imaging, Mammography, Sensitivity and specificity, Ultrasonography.

INTRODUCTION

Breast carcinoma is one of the most common malignant disorders in women worldwide and is one of the leading causes of malignant disease-related mortality.1 It is an abnormal and uncontrollable growth of epithelial cells in the ducts and/or lobules of the breast, leading to the slow development of a malignant tumor that spreads to adjacent tissues and distant sites via the lymphatic and circulatory systems, respectively.2 A number of factors are implicated in the development of breast carcinoma, and these include increased age, positive family history of breast cancer, hormonal influences, early menarche, late menopause, and certain lifestyle factors.3 The presenting symptoms of patients with breast carcinoma include painless lump in the breast, nipple discharge, breast pain, skin changes, and palpable axillary lymph nodes.4 The detection of breast carcinoma at an early stage is essential, as the prognosis and survival rates are directly related to the stage of the disease.

Sonography, or breast ultrasonography is an imaging modality that is commonly employed in the evaluation of abnormalities in the breast particularly in younger women and in women whose breasts are dense in whom mammography tends to be less

sensitive.5 The modality uses high-frequency sound waves to visualize structures in the breast and helps in differentiation between cystic and solid lesions in the breast.6 It is non-invasive, cost-effective, and accessible, and does not involve the use of ionizing radiation, making it an important modality in the evaluation of abnormalities in the breast.7 Sonography also helps in the characterization of abnormalities by assessing their morphology, margins, echogenicity, and orientation.

Digital mammography has emerged as an important imaging technique in the screening and diagnosis of breast carcinoma especially in women above the age of forty.8 In digital mammography, film is replaced with electronic media that converts the penetrating x-rays to digital images, which can be processed and displayed on computer screens.9 It has the advantage of providing better image quality with improved contrast resolution, which helps the radiologist to better visualize subtle changes in breast tissue.10 It has been found to be particularly helpful in detecting microcalcifications, architectural distortions, and small masses that may suggest breast carcinoma. It also has the advantage of manipulating the images to improve diagnostic results. The incidence of breast carcinoma is increasing in Pakistan, and the early detection of the disease is important to decrease the morbidity and mortality rates associated with it. Ultrasonography and digital mammography are commonly used diagnostic methods for the detection of breast abnormalities but the diagnostic accuracy of these methods has not been well studied locally. Therefore, the aim of the study was to determine the diagnostic accuracy of ultrasonography and digital mammography with histopathology being the gold standard for the early detection of the disease locally.

METHODOLOGY

A Cross sectional validation study was carried out in the Department of Radiology Liaquat University Hospital Jamshoro from 5th June 2025 to 5th December 2025. The approval certificate number was LUMHS/REC/-802 dated 02-06-2025. The required sample size was calculated as 156 patients by taking reference from previous study where sensitivity and specificity of digital mammography were reported as 97.44% and 93.75% respectively and proportion of breast cancer confirmed on histopathology was 16/55 (29.1%).11 Patients were enrolled using consecutive non-probability sampling. Female patients aged 30–60 years who were referred for ultrasonography and digital mammography because of suspected breast carcinoma were included in the study. Women who refused to participate, patients having previous history of lung or nasopharyngeal malignancy, already diagnosed cases of breast carcinoma undergoing follow-up mammography and those with inconclusive mammographic findings due to increased breast density were excluded from study. Patients were considered suspected for breast carcinoma when they presented with one or more clinical findings including breast mass felt on palpation for more than 1-month, palpable lymph node on examination, nipple discharge, breast pain assessed on visual analogue scale or having strong risk such as family history of breast cancer. After explaining the purpose of study written informed consent was obtained from all participants. Demographic information was recorded including age, residence status and parity. Detailed clinical history was taken and clinical examination of breast was performed. All suspected women first underwent breast sonography followed by digital mammography. Digital mammography examination was done in two standard views including craniocaudal (CC) and mediolateral oblique (MLO) views for both breasts and tomosynthesis was also obtained in one MLO view using digital mammography unit (Planned Clarity 2D). Additional mammographic views such as spot compression, cleavage view and axillary tail view were taken whenever required to further evaluate abnormal area. After imaging, suspicious lesions were subjected to tissue sampling for confirmation by histopathology. Biopsy was performed either by stereotactic guided 14G core biopsy, 10G vacuum assisted stereotactic biopsy, ultrasound guided core biopsy or treheand biopsy for palpable lesions by radiologists using 14G BARD Magnum instrument or 10G Mammotomy Revolve biopsy device.

After the completion of the imaging procedure and biopsy, the results were classified based on the criteria established. For the ultrasonography procedure, the presence of carcinoma in the breast was determined if the tumor showed a round configuration, a long-to-short axis ratio of less than 2, hypoechoic appearance, disappearance or compression of the fatty hilum, cortical thickening, or asymmetry. For the digital mammography procedure, the results were evaluated on a computer workstation where the signals received were converted into digital mammography images, and a computer-aided detection system was employed to identify densities, masses, or calcifications associated with carcinoma. For the histopathology procedure, the results were based on the reference standard where the presence of carcinoma in the breast was indicated by the presence of invasive ductal carcinoma, invasive lobular carcinoma, or ductal carcinoma in situ. All collected information was entered and analyzed using SPSS version 20. Continuous variables such as age were summarized as mean ± standard deviation. Categorical variables including residence status, parity, family history of breast cancer, menopausal status, clinical examination findings, ultrasonography results, digital mammography results and histopathology findings were expressed as frequency and

percentages. Diagnostic parameters including sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy for ultrasonography and digital mammography were calculated using 2×2 contingency tables by taking histopathology as gold standard.

RESULTS

The mean age of the patients were 44.81 ± 8.62 years, and mean parity was found to be 3.05 ± 1.63. In terms of residence, the patients were almost equally distributed, with 77 (49.4%) belongs to urban areas and 79 (50.6%) were from rural background. On clinical examination, breast mass on palpation was the commonest finding, observed in 90 (57.7%) patients, followed by palpable lymph nodes in 28 (17.9%), nipple discharge in 20 (12.8%), and breast pain in 18 (11.5%) patients. Family history of breast cancer was present in 37 (23.7%) of the participants (Table 1).

Table 1. Patient Demographics.

Demographics	Mean ± SD / n (%)
Age (Years)	44.81 ± 8.62
Parity	3.05 ± 1.63
Residence Status	
Urban n (%)	77 (49.4%)
Rural n (%)	79 (50.6%)
Menopausal Status	
Pre-Menopausal n (%)	116 (74.4%)
Post-Menopausal n (%)	40 (25.6%)
Clinical Examination	
Breast mass on palpation n (%)	90 (57.7%)
Palpable lymph node n (%)	28 (17.9%)
Nipple discharge n (%)	20 (12.8%)
Breast pain n (%)	18 (11.5%)
Family History of Breast Cancer	
Yes n (%)	37 (23.7%)
No n (%)	119 (76.3%)
Site	
Right n (%)	68 (43.6%)
Left n (%)	80 (51.3%)
Both n (%)	8 (5.1%)

On overall diagnostic testing results, ultrasonography gives positive result in 101 (64.7%) and negative results in 55 (35.3%) patients. Digital mammography was positive in 74 (47.4%) and negative in 82 (52.6%) of the cases. Histopathology, which served as the gold standard, confirmed positive breast carcinoma in 31 (19.9%) and negative findings in 125 (80.1%) patients out of total 156 (Table 2).

Table 2. Overall Results of Ultrasonography, Digital Mammography and Histopathology in Diagnosing Breast Carcinoma n=156

Diagnostic Test	Positive n (%)	Negative n (%)	Total
Ultrasonography	101 (64.7%)	55 (35.3%)	156 (100 %)
Digital Mammography	74 (47.4%)	82 (52.6%)	156 (100 %)
Histopathology	31 (19.9%)	125 (80.1%)	156 (100 %)

When ultrasonography results were compared against histopathology, among patients which was positive on ultrasonography, 30 (19.2%) were true positives and 71 (45.5%) were false positives. Among patients that were negative on ultrasonography, 1 (0.6%) were false negative and 54 (34.6%) were true negatives. Total histopathologically confirmed positive cases were 31 (19.9%) (Table 3).

Table 3. Comparison of Ultrasonography versus Histopathology in Diagnosing Breast Carcinoma.

Ultrasonography	Histopathology		Total
	Positive	Negative	
Positive	30 (19.2%) (TP)	71 (45.5%) (FP)	101 (64.7%)
Negative	1 (0.6%) (FN)	54 (34.6%) (TN)	55 (35.3%)
Total	31 (19.9%)	125 (80.1%)	156 (100%)

Key: *TP = True positive, FP = False positive, FN = False negative, TN = True negative*

In comparison of digital mammography with histopathology, among those patients who were positive on digital mammography, 30 (19.2%) cases were true positives and 44 (28.2%) was false positives. Among negative digital mammography results, 1 (0.6%) were false negative and 81 (51.9%) were true negatives, from a total of 31 (19.9%) histopathologically confirmed positive cases (Table 4).

Table 4. Comparison of Digital Mammography versus Histopathology in Diagnosing Breast Carcinoma.

Digital Mammography	Histopathology		Total
	Positive	Negative	

Positive	30 (19.2%) (TP)	44 (28.2%) (FP)	74 (47.4%)
Negative	1 (0.6%) (FN)	81 (51.9%) (TN)	82 (52.6%)
Total	31 (19.9%)	125 (80.1%)	156 (100%)

Key: *TP = True positive, FP = False positive, FN = False negative, TN = True negative*

The diagnostic performance of ultrasonography shows a sensitivity of 97% and specificity of 43%. The diagnostic accuracy of ultrasonography was calculated to be 54%, with positive predictive value (PPV) of 30% and negative predictive value (NPV) was 98% (Table 5).

Table 5. Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of Ultrasonography in Diagnosing Breast Carcinoma.

Diagnostic Parameter	Result
Sensitivity	97%
Specificity	43%
Diagnostic Accuracy	54%
PPV	30%
NPV	98%

Key: *TP = True positive, FP = False positive, FN = False negative, TN = True negative*

For digital mammography, the sensitivity was also found to be 97% while specificity was higher as compared to ultrasonography, which was 65%. The diagnostic accuracy of digital mammography was 71%, and the PPV and NPV were calculated as 41% and 99% respectively (Table 6).

Table 6. Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of Digital Mammography in Diagnosing Breast Carcinoma

Diagnostic Parameter	Result
Sensitivity	97%
Specificity	65%
Diagnostic Accuracy	71%
PPV	41%
NPV	99%

DISCUSSION

In the present study, histopathological examination revealed that only 31(19.9%) of 156 patients had histopathologically proven breast carcinoma. This implies that most of the breast lesions among the screening population are benign. The low prevalence of malignancy has a significant impact on the predictive values of various imaging modalities. Ultrasonography had a high sensitivity of 97%, but its specificity was low, i.e., 43%, with a diagnostic accuracy of 54%, while PPV was as low as 30%. The low specificity of ultrasonography is because it is difficult to differentiate between benign and malignant lesions, as many benign conditions such as fibroadenoma and fibrocystic changes have similar ultrasonographic features to malignancy. This results in a large number of false positives, i.e., 71. Digital mammography also had a sensitivity of 97%, but its specificity was higher, i.e., 65%, with a diagnostic accuracy of 71%, which is higher than ultrasonography, while PPV was 41%, with an NPV of 99%. The mean age of patients was 44.81 ± 8.62 years, which is comparable to findings of Vafapour et al. 12 where mean age of breast cancer patients was 53.72 ± 18.26 years, though slight difference in age may be related to variation in study population and geographic differences in breast cancer onset.

Ultrasonography showed sensitivity of 97% with specificity of 43%, diagnostic accuracy of 54%, PPV of 30% and NPV of 98% in present study. The high sensitivity but low specificity of ultrasonography agrees with meta-analysis conducted by Azarpey 13 where pooled sensitivity of ultrasonography was 87% and specificity was 75%, confirming that ultrasound is more sensitive but less specific modality for breast malignancy detection. Similarly, Quratulain et al. 14 reported sensitivity of 91.07% and specificity of 83.57% for ultrasonography, which is somewhat higher than present study specificity, and this difference may be because their study population had different demographic characteristics and possibly higher proportion of malignant lesions that could improve specificity. Malik et al. 15 also reported sensitivity of 75% and specificity of 82% using ultrasound BI-RADS classification, which again shows better specificity as compared to present study, possibly because BI-RADS categorization provides more structured criteria for differentiating benign from malignant lesions and reduces false positive rate. The very high NPV of 98% in present study is particularly important clinically, as it suggest that negative ultrasonography result can reliably rules out malignancy, which is also supported by Khalid et al.16 where true negative rate was 98.8% for BI-RADS 2 lesions on high-resolution ultrasound.

Digital mammography in present study demonstrated sensitivity of 97%, specificity of 65%, diagnostic accuracy of 71%, PPV of 41% and NPV of 99%. These values show that digital mammography has better specificity and diagnostic accuracy as compared to ultrasonography in present study, which is consistent with findings of Azarpey 13 where mammography showed pooled specificity of 78% as compared to 75% for ultrasonography. Nair et al. 17 reported sensitivity of 80.48% and specificity of 88.88% for digital mammography, where specificity was notably higher than present study, and this may be explained by the fact that their study used MRI as additional comparison modality and included

patients from tertiary care setting with possibly more advanced or distinct lesions that are easier to characterize on mammography. Abo Al-Shiekh et al. 18 reported sensitivity of 94.9% and specificity of 66.7% for digital mammography alone, which is closely comparable to present study findings and suggests that digital mammography performance in similar clinical settings tends to produce consistent results. The improved specificity of digital mammography over ultrasonography in present study can be explained by ability of mammography to detect microcalcifications and spiculated margins, which are more specific radiological features of malignancy, as also highlighted by Vafapour et al. 12 where mammography was the only modality capable of reliably detecting calcifications in breast lesions.

Schmidt et al. 19 reported that mammography estimated tumor size accurately in 83.44% cases compared to 73.96% for ultrasonography, further supporting superiority of mammography in certain diagnostic parameters, although their study focused on neoadjuvant chemotherapy patients which makes direct comparison with present screening population somewhat limited. Jayalal et al. 20 and Yamakanamardi et al. 21 both emphasized that combining ultrasonography with mammography improves overall diagnostic accuracy, which is also supported by Abo Al-Shiekh et al. 18 where combined modality showed sensitivity of 100% and diagnostic accuracy of 92.7%, significantly better than either modality alone.

Limitations

The limitations of the current study should also be recognized. The current study was carried out at a single center within a single institution. This may limit the current study's generalizability to other populations. The current study's sample was composed of 156 patients. The sample may be small, which may limit the statistical power of the results. In addition, the current study did not use MRI of the breast as a comparison method. MRI of the breast is recognized as a sensitive method. The exclusion of MRI of the breast limits the comprehensive evaluation of diagnostic performance with all the modalities.

CONCLUSION

The present study concludes that the sensitivity of ultrasonography and digital mammography is similar and high for the diagnosis of carcinoma of the breast; however, the specificity of digital mammography is higher compared to ultrasonography. The negative predictive value of both diagnostic techniques is high.

Disclaimer: There was no disclaimer for this study.

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Conflict of Interest: The author declared that they do not have any conflict of interest related to this research.

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