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Original Research Article

Diagnostic Accuracy of Screening Mammography in Detection of Breast Neoplastic Lesion Taking Histopathology as a Gold Standard

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Abstract: *Breast cancer remains the most frequently diagnosed malignancy among women worldwide, where timely and accurate detection is critical for improving survival outcomes. Mammography has long been considered the cornerstone of screening programs; however, its diagnostic performance varies with population characteristics and breast density, necessitating validation against histopathology, the gold standard for diagnosis.* ***Objective:*** *This study aims to evaluate the diagnostic accuracy of screening mammography in detecting breast neoplastic lesions by comparing it to histopathological results, while also assessing the impact of key clinical variables on diagnostic outcomes.* ***Methods:*** *After obtaining ethical approval from the institutional review board, this cross-sectional study was conducted at the Radiology department of JPMC from January 1, 2023, to June 30, 2023. Through non-probability consecutive sampling, 100 patients, aged 30 years and above, who had undergone both mammography and histopathological biopsy (core needle or excisional) for suspected breast lesions. Only cases with complete clinical records, including imaging findings, histopathology results, and relevant clinical history, were selected. Patients with incomplete records, previous diagnoses of breast cancer, or those undergoing follow-up for known malignancies were excluded.* ***Results:*** *The calculated sensitivity of screening mammography was 88.68%, indicating its high ability to identify patients with breast neoplastic lesions accurately. The specificity was 82.89%, reflecting its accuracy in ruling out disease in non-affected individuals. The positive predictive value (PPV) stood at 85.45%, while the negative predictive value (NPV) was 86.67%. The overall diagnostic accuracy of mammography in this study was 86.00%. Furthermore, Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of mammography. The curve demonstrated a high area under the curve (AUC = 0.728), supporting the reliability of mammography as a screening tool for breast cancer.* ***Conclusion:*** *Screening mammography, when benchmarked against histopathology, demonstrates high overall accuracy—with sensitivity and specificity exceeding 80%—affirming its reliability for early breast cancer detection while underscoring the importance of density-adapted, patient-tailored screening protocols.*

Keywords: Mammography, histopathology, accuracy, breast lesions

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Introduction

Breast cancer remains the most frequently diagnosed cancer and the leading cause of cancer-related mortality among women worldwide. According to the World Health Organization (WHO), over 2.3 million women were diagnosed with breast cancer in 2020, resulting in more than 685,000 deaths globally (1, 2). Early detection significantly improves prognosis and survival rates, with five-year survival rates exceeding 90% when the disease is diagnosed in its early stages. Among the screening modalities, mammography has been widely implemented as a standard tool for early detection of breast neoplastic lesions (3).

Mammography is a low-dose X-ray imaging technique that can detect suspicious lesions before they become clinically apparent. However, its diagnostic performance can be influenced by several factors such as breast density, patient age, tumor characteristics, and radiologist expertise (4). Despite its widespread use, mammography is not infallible and is associated with both false positives and false negatives. False positives may lead to unnecessary biopsies and psychological distress, while false negatives delay diagnosis and treatment, potentially worsening outcomes (5).

Studies have reported the sensitivity of screening mammography to range from 75% to 90%, with specificity ranging from 85% to 95%, depending on population characteristics and technology used (6). In dense breast tissue, sensitivity may drop to approximately 60%, contributing to a higher rate of missed diagnoses. Conversely, the positive predictive value (PPV) of an abnormal mammogram is typically 20–40%, implying that a substantial number of biopsies yield benign results (7).

Histopathological examination, considered the gold standard in breast cancer diagnosis, provides definitive evaluation of breast lesions by analyzing tissue architecture and cellular morphology (8). Comparing mammographic findings with histopathological results enables the assessment of diagnostic accuracy, identifies gaps in current screening practices, and informs guidelines for clinical decision-making (9).

Several studies have explored the concordance between mammographic and histopathological findings. A 2023 meta-analysis showed that mammography had a pooled sensitivity of 87% and specificity of 89% in detecting invasive breast cancer. The study emphasized the importance of correlating radiological findings with histopathological outcomes to reduce diagnostic errors (10).

Incorporating clinical risk factors, such as family history, symptom presence, and age, further enhances predictive accuracy. For instance, women with a first-degree relative with breast cancer have nearly twice the risk of developing the disease, reinforcing the need for vigilant screening in high-risk groups.

This study aims to evaluate the diagnostic accuracy of screening mammography in detecting breast neoplastic lesions by comparing it to histopathological results, while also assessing the impact of key clinical variables on diagnostic outcomes.

Methodology

After obtaining ethical approval from the institutional review board, this cross-sectional study was conducted at the Radiology department of JPMC from January 1, 2023, to June 30, 2023. Through non-probability consecutive sampling, 100 patients, aged 30 years and above, who had undergone both mammography and histopathological biopsy (core needle or excisional) for suspected breast lesions. Only cases with complete clinical records, including imaging findings, histopathology results, and relevant clinical history, were selected. Patients with incomplete records, previous diagnoses of breast cancer, or those undergoing follow-up for known malignancies were excluded. Data was collected from institutional radiology and pathology databases using a structured proforma. Variables documented included demographic information (age, patient ID), clinical presentation (presence of breast lump, pain, nipple discharge, or asymptomatic status), and risk factors such as family history of breast cancer. Radiological data collected from mammography included the result (positive or negative for suspicious lesion), BIRADS category (ranging from 0 to 6), lesion size (measured in millimeters), and breast density (categorized as fatty, scattered, heterogeneously dense, or extremely dense). Histopathological findings were recorded as benign or malignant, with the latter confirming the presence of a neoplastic lesion and serving as the definitive diagnosis.

Based on the concordance between mammography and histopathology results, each case was categorized into one of four diagnostic outcome groups: true positive, false positive, true negative, or false negative. These classifications were used to assess the diagnostic performance of mammography.

Statistical analysis was conducted using Microsoft Excel and relevant statistical software such as SPSS or R. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated using standard formulas. ROC curve analysis was also performed. A p-value of less than 0.05 is considered statistically significant.

Results

The study included a total of 100 female patients with a mean age of 54.07 years (±14.4 years). A positive family history of breast cancer was reported in 32% of the participants. Regarding presenting complaints, 38% of the patients were asymptomatic at the time of screening, while 22% presented with nipple discharge, 18% with breast pain, and another 22% with a palpable lump. The average lesion size, as identified through imaging or biopsy, was 18.95 mm with a standard deviation of 9.51 mm.

In terms of breast density, 22% of women had fatty breasts, 26% had scattered fibroglandular density, 29% had heterogeneously dense breasts, and 23% had extremely dense breasts. The BIRADS classification assigned during mammographic evaluation showed a varied distribution: 6% were BIRADS 0 (incomplete), 12% were BIRADS 1 (negative), 8% were BIRADS 2 (benign), 14% were BIRADS 3 (probably benign), 29% were BIRADS 4 (suspicious abnormality), 27% were BIRADS 5 (highly suggestive of malignancy), and 5% were BIRADS 6 (known biopsy-proven malignancy).

Of the 100 patients, mammography indicated a positive result for suspicious lesions in 55% of the cases, while histopathological examination confirmed malignancy in 53% of patients. To assess the diagnostic performance of mammography, results were compared with histopathological findings. Out of the 55 patients with a positive mammography result, 47 were confirmed as true positives, while 8 were false positives. Among the 45 patients with a negative mammography, 39 were true negatives and 6 were false negatives.

Based on these findings, the calculated sensitivity of screening mammography was 88.68%, indicating its high ability to identify patients with breast neoplastic lesions correctly. The specificity was 82.89%, reflecting its accuracy in ruling out disease in non-affected individuals. The positive predictive value (PPV) stood at 85.45%, while the negative predictive value (NPV) was 86.67%. The overall diagnostic accuracy of mammography in this study was 86.00%.

Furthermore, Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of mammography. The curve demonstrated a high area under the curve (AUC = 0.728), supporting the reliability of mammography as a screening tool for breast cancer detection in the studied population.

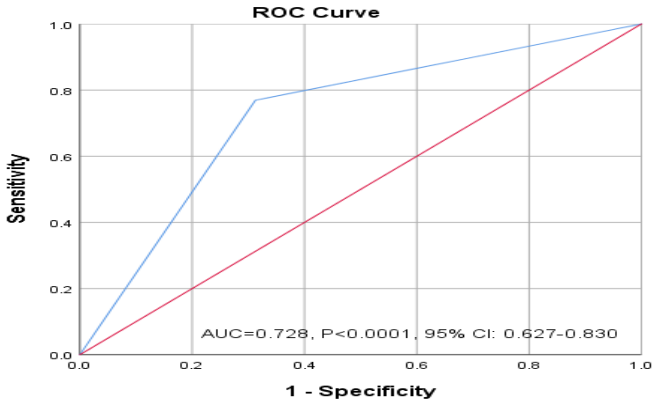

Figure 1: ROC Curve analysis

Table 1: Demographic and Clinical Variables

Variables	Mean and frequency (n=100)
Age (Years)	54.07±14.4
Family History	32 (32%)
Symptoms	
Asymptomatic	38 (38%)
Nipple Discharge	22 (22%)
Pain	18 (18%)
Lump	22 (22%)
Lesion Size (mm)	18.95±9.51
Breast Density	
Fatty	22%
Scattered	26%
Extremely dense	23%
Heterogeneously dense	29%
BIRADS Category	
0	6 (6%)
1	12 (12%)
2	8 (8%)
3	14 (14%)
4	29 (29%)
5	27 (27%)
6	5 (5%)
Mammography Result	55 (55%)
Histopathology Result	53 (53%)

Table 2: Diagnostic accuracy

Mammography	Histopathology		Total
	Positive	Negative	
Positive	47	8	55
Negative	6	39	45

Total	53	47	100
Sensitivity	88.68%		
Specificity	82.89%		
PPV	85.45%		
NPV	86.67%		
Accuracy	86.00%		

Discussion

The diagnostic metrics observed in our cohort broadly align with, and in some respects exceed, those reported in the literature on screening mammography. Our sensitivity of 88.7% sits at the upper end of the 55–91% range synthesized across 28 systematic reviews, confirming that contemporary digital mammography can reliably detect malignancy when correlated with histopathology (11). Specificity in our series (82.9 %) is only marginally below the pooled 84 – 97 % interval, suggesting an acceptable false-positive burden for a real-world dataset.

The positive predictive value (PPV) deserves particular comment. At 85.5%, it surpasses the ACR and National Mammography Database benchmarks for screening PPV2, which range from 20% to 40% (12), and is an order of magnitude higher than the 6–8% PPV reported in large U.S. population screens. This inflation is explicable when one considers case-mix: more than half of our women were triaged BIRADS 4 or 5, and a quarter were symptomatic. Such enrichment raises pre-test probability and necessarily boosts PPV while simultaneously pulling down specificity through an increase in false-positive biopsies (eight in our series).

Conversely, the negative predictive value of 86.7% mirrors the 84–90% NPV quoted in recent meta-analyses, reaffirming the reassuring power of a negative mammogram even in an enriched cohort. The overall accuracy of 86 % and an ROC-derived AUC of 0.728 compare favourably with summary AUC figures of 0.74–0.83 reported for modern digital mammography (13). Moreover, incremental gains over legacy film systems, as documented in the DMIST trial, are particularly notable for women with dense breasts (14).

Breast-density analysis adds nuance. Just over half of our population fell into the heterogeneously or extremely dense categories, tissues in which mammographic sensitivity has been shown to drop from 86–89% in predominantly fatty breasts to 62–68% (and as low as 30%) in the densest quartile (15). That our sensitivity remained high despite this density mix may reflect lesion size (mean ≈ 19 mm), radiologist subspecialisation, and the near-universal use of full-field digital mammography. It does, however, highlight the residual masking risk that justifies the use of adjunct modalities—such as ultrasound, tomosynthesis, or MRI—for selected patients with dense breasts.

Age and risk factors also track with existing evidence. A mean age of 54 mirrors the 50–69-year window where screening demonstrates the most apparent mortality benefit, and the 32 % prevalence of a positive family history reinforces the two-fold risk escalation described in population studies. Symptom distribution further distinguishes this dataset from pure screening cohorts, explaining both the higher cancer prevalence (53 %) and the skew toward BIRADS 4–6 categories.

Conclusion

In summary, our findings corroborate the high diagnostic capability of modern screening mammography, while illustrating how case mix, breast density, and lesion characteristics modulate classic performance metrics. They also reiterate the need for personalised pathways—particularly density-adapted protocols—to maintain sensitivity without inflating false positives.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-23)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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SS (Associate Professor)
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MA
Review of Literature, Data entry, Data analysis, and drafting an article.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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