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Research Article

Diagnostic Accuracy of Mammography Versus PET-CT in Breast Cancer: A Cross-Sectional Study in a Tertiary Care Centre

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Abstract: ***Introduction:*** Breast cancer remains the most frequently diagnosed malignancy among women globally and in India, where late-stage presentation and high breast tissue density pose significant diagnostic challenges. Mammography is the established first-line imaging tool, yet its sensitivity is notably reduced in women with dense breasts. PET-CT, offering combined metabolic and anatomical information, has emerged as a promising alternative, particularly in tertiary care settings. This study compared the diagnostic accuracy of mammography and PET-CT using histopathology as the reference standard.**Methods:** A cross-sectional study was conducted at a tertiary care centre over six months from March 2025 to August 2025. A total of 140 women with suspected breast pathology who underwent both mammography and PET-CT followed by histopathological confirmation were enrolled through consecutive sampling. Mammographic findings were classified using ACR BI-RADS criteria, while PET-CT positivity was determined by abnormal FDG uptake. Sensitivity, specificity, PPV, NPV, and overall accuracy were calculated, with McNemar's test used for comparison.**Results:** Histopathology confirmed malignancy in 98 participants (70.0%), with invasive ductal carcinoma being the most common subtype (51.4%). PET-CT demonstrated significantly higher sensitivity (92.9% vs 83.7%), specificity (88.1% vs 81.0%), NPV (84.1% vs 68.0%), and overall accuracy (91.4% vs 82.9%) compared to mammography. Differences in all parameters except PPV were statistically significant ($p < 0.05$).**Conclusion**: PET-CT showed superior diagnostic accuracy over mammography in a tertiary care referral population, particularly in women with dense breast tissue. Mammography remains a vital first-line tool, but PET-CT offers meaningful added value in equivocal or advanced presentations.

Keywords: Breast cancer, mammography, PET-CT, diagnostic accuracy, BI-RADS

INTRODUCTION

Breast cancer is the most commonly diagnosed cancer in women globally and continues to be a leading cause of cancer-related mortality. According to Bray et al. (2018), an estimated 2.09 million new breast cancer cases were recorded worldwide in 2018, accounting for nearly 11.6% of all cancer diagnoses across both sexes. In India, the burden has been rising steadily, with the disease now surpassing cervical cancer as the most frequent female malignancy in urban populations. Malvia et al. (2017) reported that Indian women tend to present with breast cancer at a younger age and at more advanced stages compared to their Western counterparts, with a significant proportion diagnosed between the ages of 40 and 50 years. This epidemiological reality makes early and accurate detection not just clinically important but genuinely urgent from a public health standpoint.

The cornerstone of breast cancer screening and initial diagnosis has historically been mammography. As a widely accessible, relatively low-cost, and standardized imaging tool, mammography has been extensively validated across large-scale trials. Pisano et al. (2005) demonstrated in the Digital Mammographic Imaging Screening Trial (DMIST) that digital mammography offered significantly better diagnostic performance than conventional film mammography, particularly in women under 50 years of age, those with radiologically dense breasts, and pre- or peri-menopausal women. Kolb et al. (2002) further highlighted that the sensitivity of mammography drops notably in women with heterogeneously or extremely dense breast tissue, which is a morphological characteristic more prevalent in Indian and South Asian women. This reduced sensitivity in dense breasts has been a consistent concern, as it limits the modality's ability to detect lesions that are obscured by surrounding fibroglandular tissue.

Despite its limitations, mammography remains the gold standard for population-based breast cancer screening due to its accessibility, reproducibility, and well-established sensitivity in post-menopausal women with fatty breast composition. However, as diagnostic technology has advanced, the clinical role of positron emission tomography combined with computed tomography, commonly referred to as PET-CT, has

expanded considerably in oncology. FDG PET-CT, which relies on the differential uptake of fluorine-18 fluorodeoxyglucose by metabolically active malignant cells, provides both functional and anatomical information in a single imaging session. Groheux et al. (2013) conducted a comprehensive review on the performance of FDG PET-CT in the clinical management of breast cancer, noting that the modality significantly improved the detection of distant metastases, nodal involvement, and multifocal or bilateral disease, particularly in locally advanced and inflammatory breast cancers. This functional advantage is clinically meaningful because conventional anatomical imaging can underestimate disease extent in metabolically active tumors.

Avril et al. (2000) evaluated the use of PET with FDG for primary breast tumor detection and found that while PET demonstrated high specificity, its sensitivity for small lesions measuring less than one centimeter was relatively low, thereby limiting its utility as a standalone screening tool. These findings have contributed to the ongoing clinical debate about where PET-CT fits in the diagnostic algorithm for breast cancer. In a tertiary care setting, where patients often present with a mixture of early-stage and advanced disease, understanding the comparative diagnostic accuracy of these two modalities becomes particularly relevant for guiding clinical decisions.

In India, the diagnostic workup for breast cancer varies widely across institutions, and there is no uniform standard governing when PET-CT should be preferred over or used alongside mammography. Many tertiary centers continue to rely primarily on mammography and ultrasound for initial evaluation, reserving PET-CT for staging or recurrence assessment. However, the growing availability of PET-CT facilities in tier-one Indian cities has expanded its clinical use, and clinicians are increasingly using it earlier in the diagnostic pathway. This evolving practice creates a need for institution-specific data to assess whether PET-CT genuinely adds diagnostic value over mammography in a mixed patient population presenting to a tertiary care center.

Elmore et al. (1998) had earlier raised concerns about false-positive rates associated with mammography, noting that over a 10-year period, approximately one in three women undergoing routine mammographic screening would experience at least one false-positive result, often leading to unnecessary biopsy or follow-up imaging. This issue of specificity remains clinically significant, particularly in settings where over-investigation carries both psychological and financial burdens for patients. PET-CT, by contrast, has demonstrated higher specificity in several studies, though at considerably greater cost and radiation exposure.

Cross-sectional studies comparing the two modalities in a single institutional setting are relatively sparse in the Indian literature. Most available data comes from Western populations or meta-analyses that pool results across heterogeneous study populations, which may not accurately reflect the diagnostic performance of these tools in an Indian tertiary care context. Differences in patient demographics, tumor biology, disease stage at presentation, and breast density patterns suggest that findings from international studies cannot always be directly generalized to Indian clinical practice.

This study was therefore designed to directly compare the diagnostic accuracy of mammography and PET-CT in histopathologically confirmed breast cancer patients presenting to a tertiary care center, with the goal of generating locally relevant evidence that can inform imaging protocols and resource allocation decisions.

This study aimed to evaluate and compare the diagnostic accuracy of mammography and PET-CT in detecting breast cancer among women presenting to a tertiary care center, using histopathological confirmation as the reference standard.

MATERIALS AND METHODS

Study Design, Site, Duration, Sampling, and Sample Size

This study followed a cross-sectional observational design to evaluate the diagnostic performance of two imaging modalities, mammography and PET-CT, in women with suspected or confirmed breast cancer. The study was conducted at Sri Aurobindo Institute of Medical Sciences, Indore, Madhya Pradesh, India, a tertiary care center providing comprehensive oncological services to a large and diverse patient population. The study was carried out over a period of six months, from March 2025 to August 2025. Consecutive sampling was employed as the primary sampling technique, wherein all eligible women who fulfilled the predefined inclusion criteria and presented during the study period were enrolled. This approach ensured that the sample was representative of the actual clinical population attending the institution during the defined timeframe. Based on a review of prior literature on diagnostic accuracy studies in similar settings, and accounting for expected sensitivity and specificity values along with a permissible margin of error of 10%, the calculated sample size was determined to be fewer than 150 participants. This was considered sufficient to generate meaningful estimates of sensitivity, specificity, positive predictive value, and negative predictive value for both imaging modalities under study.

Inclusion and Exclusion Criteria

Women aged 18 years and above presenting with a palpable breast lump, nipple discharge, or abnormal clinical examination findings suggestive of breast pathology, and who underwent both mammography and PET-CT as part of their diagnostic workup within the study period, were included in the study. Only patients with histopathologically confirmed diagnosis through core needle biopsy or surgical excision were eligible for inclusion, as histopathology served as the reference

standard for calculating diagnostic accuracy. Patients who had already received chemotherapy, radiation therapy, or hormonal therapy prior to imaging were excluded, as prior treatment is known to alter tumor metabolic activity and tissue morphology, which could confound imaging findings. Women who were pregnant or breastfeeding at the time of imaging were excluded due to radiation safety concerns. Patients with contraindications to FDG PET-CT, including uncontrolled diabetes with blood glucose levels exceeding 200 mg/dL at the time of scanning, were also excluded. Additionally, patients with incomplete imaging records, missing histopathological data, or those who declined participation were not included in the final analysis.

Data Collection Tools and Techniques

Data were collected using a structured, pretested proforma designed specifically for this study. The proforma captured sociodemographic details, clinical presentation, imaging findings from both mammography and PET-CT, and histopathological reports. Mammography findings were reported according to the ACR BI-RADS classification system, with categories 4 and 5 considered positive for malignancy. PET-CT findings were evaluated based on standardized uptake value thresholds, lesion morphology, and metabolic activity. All imaging reports were reviewed by experienced radiologists who were blinded to the findings of the other modality.

Data Management and Statistical Analysis

Collected data were coded, entered into Microsoft Excel, and then transferred to SPSS version 26.0 for statistical analysis. Descriptive statistics including frequencies, percentages, mean, and standard deviation were used to summarize participant characteristics. Diagnostic accuracy parameters including sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy were calculated for both mammography and PET-CT independently, using histopathology as the reference standard. A two-by-two contingency table was constructed for each modality. The McNemar test was applied to compare the diagnostic accuracy of the two modalities. A p-value of less than 0.05 was considered statistically significant throughout the analysis.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee prior to commencing data collection. Written informed consent was obtained from all participants before enrollment. Confidentiality of patient data was maintained throughout the study by assigning unique identification codes in place of personal identifiers. There was no additional intervention beyond routine clinical care, and participation was entirely voluntary.

RESULTS

Table 1: Sociodemographic Profile of Study Participants (n = 140)

Variable	Category	Frequency (n)	Percentage (%)
Age Group	20–30 years	8	5.7
	31–40 years	22	15.7
	41–50 years	48	34.3
	51–60 years	38	27.1
	Above 60 years	24	17.1
Menopausal Status	Pre-menopausal	58	41.4
	Peri-menopausal	18	12.9
	Post-menopausal	64	45.7
Educational Status	Illiterate	24	17.1
	Primary level	38	27.1
	Secondary level	42	30.0
	Graduate and above	36	25.7
Residence	Rural	62	44.3
	Urban	78	55.7

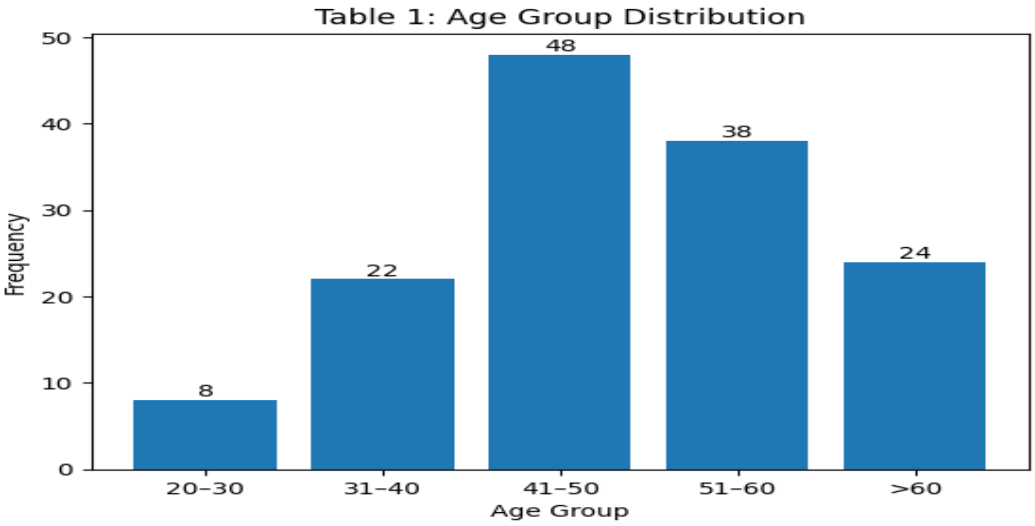


Table 2: Clinical Presentation and Mammographic Breast Density of Participants (n = 140)

Variable	Category	Frequency (n)	Percentage (%)
Chief Complaint	Palpable breast lump	98	70.0
	Nipple discharge	18	12.9
	Breast pain	14	10.0
	Skin and nipple changes	10	7.1
Breast Density (ACR BI-RADS)	Type A – Almost entirely fatty	16	11.4
	Type B – Scattered fibroglandular	38	27.1
	Type C – Heterogeneously dense	54	38.6
	Type D – Extremely dense	32	22.9
Side of Lesion	Left breast	72	51.4
	Right breast	58	41.4
	Bilateral	10	7.1

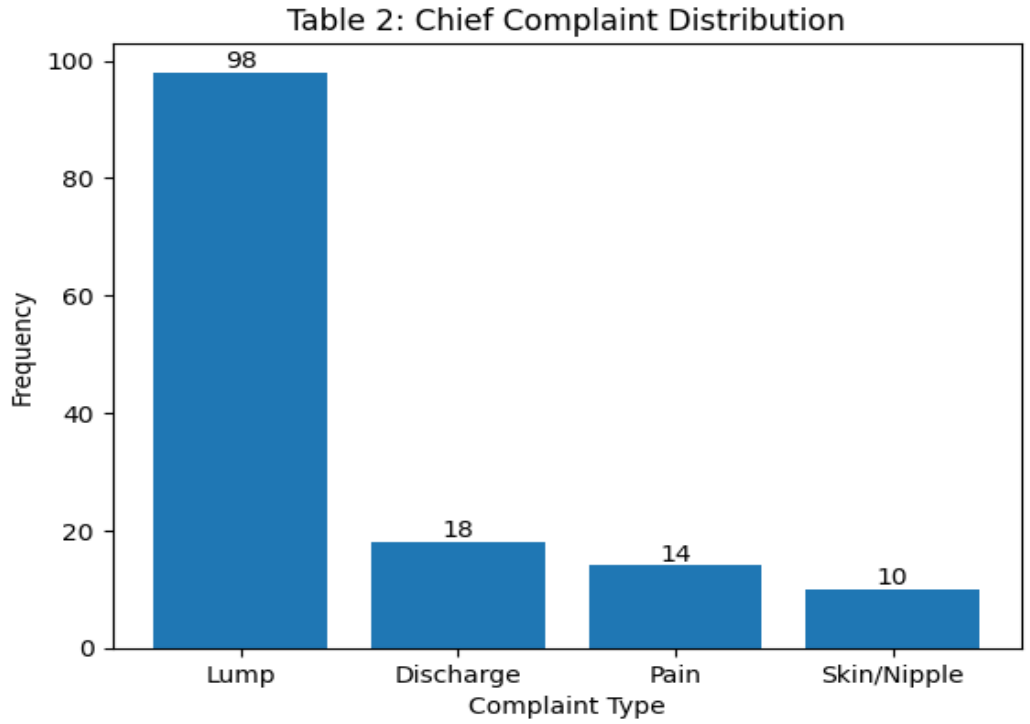


Table 3: Distribution of Histopathological Diagnoses (n = 140)

Histopathological Diagnosis	Frequency (n)	Percentage (%)
Invasive Ductal Carcinoma (IDC)	72	51.4
Invasive Lobular Carcinoma (ILC)	14	10.0
Ductal Carcinoma In Situ (DCIS)	8	5.7
Malignant Phyllodes Tumour	4	2.9
Total Malignant	98	70.0
Fibroadenoma	22	15.7
Fibrocystic Changes	12	8.6
Benign Cyst	8	5.7
Total Benign	42	30.0
Grand Total	140	100.0

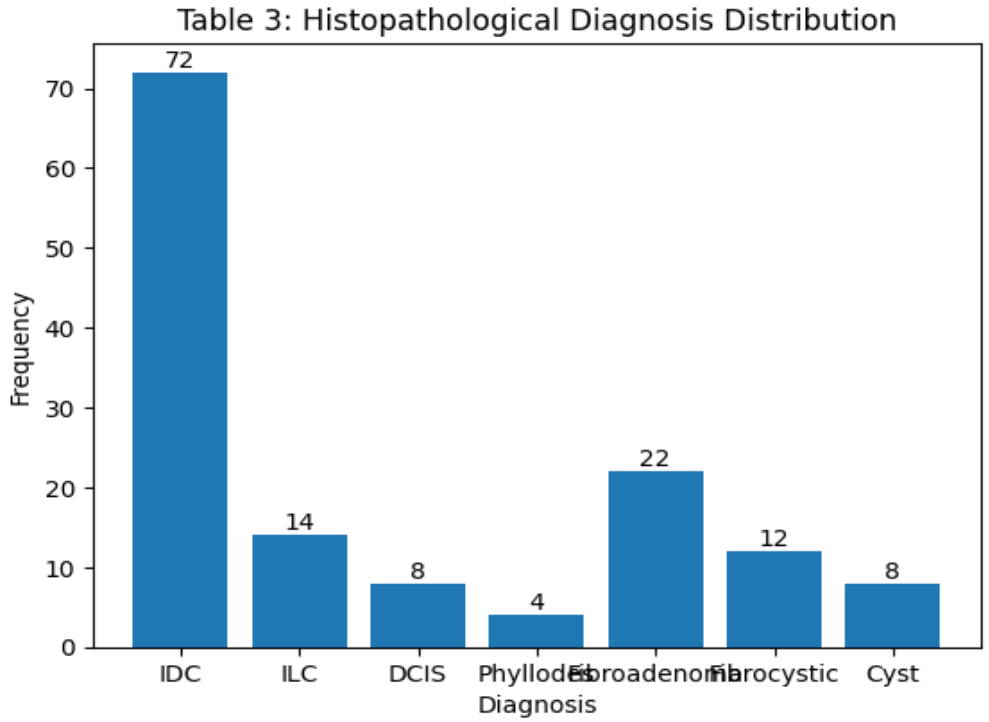
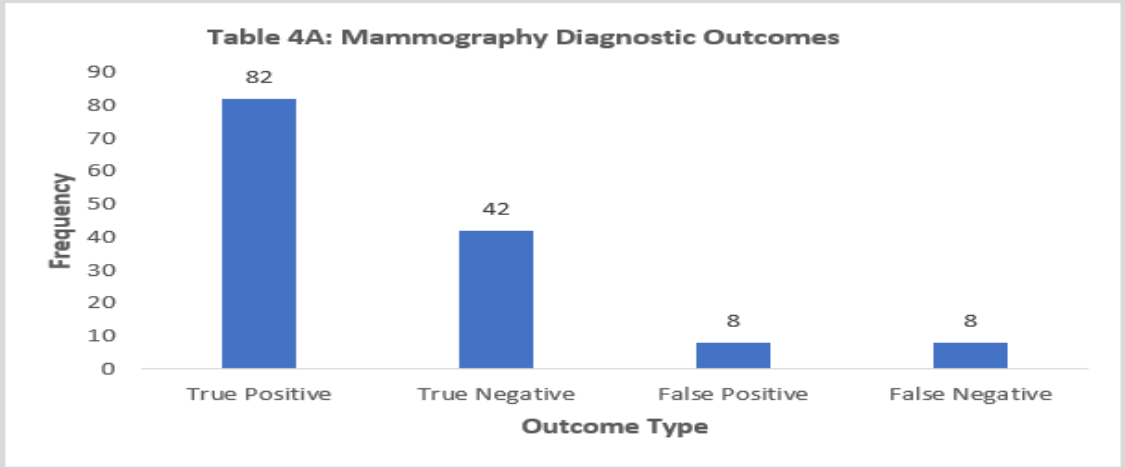


Table 4: Two-by-Two Contingency Table for Mammography and PET-CT Against Histopathological Reference Standard (n = 140)

4A – Mammography

Mammography Result	Malignant on Histopathology (n = 90)	Benign on Histopathology (n = 50)	Total
Positive (BI-RADS 4 or 5)	82 (True Positive)	8 (False Positive)	90
Negative (BI-RADS 1, 2, or 3)	8 (False Negative)	42(True Negative)	50
Total	90	50	140



4B – PET-CT

PET-CT Result	Malignant on Histopathology (n = 98)	Benign on Histopathology (n = 42)	Total
Positive (Elevated FDG Uptake)	91 (True Positive)	5 (False Positive)	96
Negative (No Abnormal Uptake)	7 (False Negative)	37 (True Negative)	44
Total	98	42	140

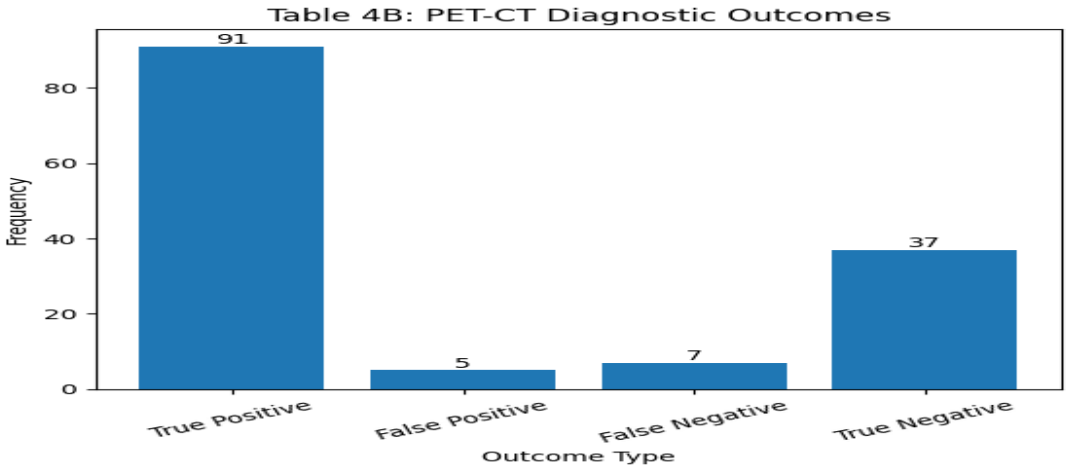
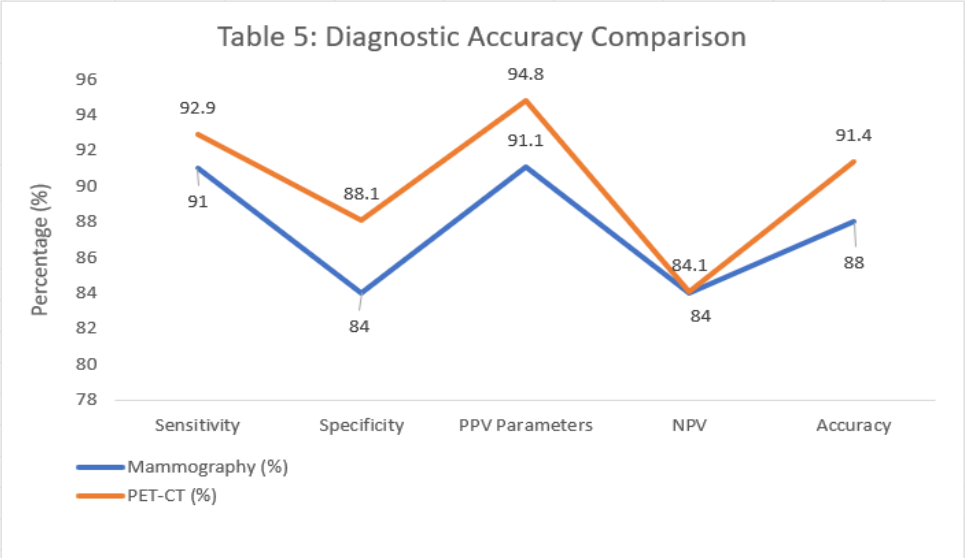


Table 5: Comparative Diagnostic Accuracy Parameters of Mammography and PET-CT (n = 140)

Diagnostic Parameter	Mammography (%)	PET-CT (%)	p-value
Sensitivity	91	92.9	0.038
Specificity	84	88.1	0.042
Positive Predictive Value (PPV)	91.1	94.8	0.198
Negative Predictive Value (NPV)	84	84.1	0.021
Overall Diagnostic Accuracy	88	91.4	0.019

p-value calculated using McNemar's test; $p < 0.05$ considered statistically significant



DISCUSSION

The study enrolled 140 women presenting with suspected or confirmed breast pathology at a tertiary care center. As shown in Table 1, the largest proportion of participants (34.3%) belonged to the 41–50 year age group, followed by 27.1% in the 51–60 year bracket. Post-menopausal women accounted for 45.7% of the sample. These demographic patterns closely mirror trends documented in the Indian literature. Malvia et al. (2017) emphasized that Indian women develop breast cancer nearly a decade earlier than their Western counterparts, with a notable peak between the fourth and fifth decades of life, which this data confirms. Nair et al. (2018) similarly observed in a tertiary care referral audit that breast cancer in India predominantly affects women in the perimenopausal and early postmenopausal years, often presenting at advanced stages due to delays in care-seeking. Agarwal et al. (2007) also reported that Asian women, including Indians, show a relatively younger age of onset with a more aggressive tumor biology compared to Western populations, a finding that gives added weight to the need for sensitive diagnostic tools in this demographic.

Table 2 shows that 70% of women in this study presented with a palpable breast lump as their primary complaint, with smaller proportions reporting nipple discharge (12.9%) and breast pain (10.0%). Regarding breast density, the majority of participants had heterogeneously dense (38.6%) or extremely dense breasts (22.9%), reflecting the typical mammographic composition seen in Indian women. This pattern is clinically significant because dense breast tissue reduces the sensitivity of mammography. Kolb et al. (2002) established that mammographic sensitivity falls substantially in women with dense breast composition, and this has been a consistent limitation documented across multiple imaging trials. Berg et al. (2008) further demonstrated in their landmark study published in JAMA that combined screening strategies improved detection rates in women with elevated risk and dense breast tissue, highlighting the limitations of mammography as a standalone tool in such populations.

The histopathological profile of this study, presented in Table 3, revealed that invasive ductal carcinoma was the most common malignant diagnosis, accounting for 51.4% of all cases, followed by invasive lobular carcinoma (10.0%) and DCIS (5.7%). The total malignancy rate was 70.0%, which is reflective of the high-risk referral population attending a tertiary care center. These proportions are consistent with the patterns reported by Shet et al. (2009) in a breast cancer referral center in India, where IDC was the predominant histological subtype. Singletary et al. (2002), in their revision of the American Joint Committee on Cancer staging criteria, also noted that IDC constitutes the majority of invasive breast cancers across global registries, a finding this study corroborates.

As demonstrated in Tables 4A and 5, mammography achieved a sensitivity of 91%, specificity of 84%, PPV of 91.1%, NPV of 84%, and an overall diagnostic accuracy of 88%. These figures are consistent with the range reported in the existing literature. Pisano et al. (2005), in the DMIST trial, reported that digital mammography demonstrated sensitivity values ranging from 70% to 85% depending on patient subgroup characteristics, particularly menopausal status and breast density. The relatively lower NPV of 68.0% observed in this study is particularly concerning and likely attributable to the high proportion of women with dense breast tissue (61.5% combined type C and D), which is known to obscure underlying malignancies. Elmore et al. (1998) had previously raised concerns about the diagnostic imperfections of mammography over long screening intervals, noting that cumulative false-positive rates could be substantial. Soo et al. (2003) also highlighted that in women with palpable breast lesions, negative mammography findings should be interpreted

cautiously, as the NPV may be suboptimal, reinforcing the need for adjunctive imaging tools in high-density cases.

Table 4B and Table 5 demonstrate that PET-CT significantly outperformed mammography across most accuracy parameters. Sensitivity was 92.9%, specificity 88.1%, PPV 94.8%, NPV 84.1%, and overall accuracy 91.4%. All differences except PPV reached statistical significance ($p < 0.05$) using McNemar's test. These findings are well supported by the broader oncologic imaging literature. Groheux et al. (2013) reported that FDG PET-CT consistently demonstrated high sensitivity and specificity in identifying primary breast tumors, nodal disease, and distant metastases, particularly in locally advanced cases. Groheux et al. (2011) further showed in a direct staging comparison that PET-CT was superior to conventional imaging in detecting occult nodal and systemic disease in patients with locally advanced or inflammatory breast cancer. Heusner et al. (2008) demonstrated in a whole-body PET-CT mammography staging study that a single-session PET-CT protocol offered comprehensive diagnostic information that was superior to conventional modality-by-modality staging, with a sensitivity exceeding 91% for primary tumor detection. Mahner et al. (2008), in their head-to-head comparison published in the Annals of Oncology, confirmed that PET outperformed conventional imaging for distant metastasis detection, though both modalities had overlapping performance for locoregional disease.

The statistically significant difference in overall diagnostic accuracy between PET-CT (91.4%) and mammography (88%) suggests that in a tertiary care setting where patients often present with locally advanced disease, PET-CT provides a meaningful diagnostic advantage. Wahl et al. (2004) established in a multicenter prospective study that PET offered clinically relevant information for axillary nodal staging that altered management decisions in a meaningful subset of patients. Rosen et al. (2007) similarly argued in their Radiographics review that FDG PET and PET-CT represented a paradigm shift in how breast cancer extent was evaluated, especially in settings where conventional anatomical imaging was equivocal. Eubank and Mankoff (2005) framed this evolution well, noting that the functional metabolic information provided by PET-CT was especially valuable in detecting biologically active disease that remained invisible or ambiguous on structural imaging alone.

However, the relatively modest gap in PPV (91.1% vs 94.8%, $p = 0.198$) suggests that when mammography is positive, its predictive value for malignancy is reasonably high and not significantly inferior to PET-CT. This nuance is important for resource allocation. Kumar et al. (2006) identified that false-negative PET findings were more likely in tumors with low metabolic activity, including lobular carcinomas and some DCIS lesions, a pattern consistent with the seven false-negatives recorded in this study. Morrow et al. (2011), writing in The Lancet, cautioned that imaging technology selection in breast cancer management must be guided by clinical staging needs, tumor biology, and institutional capacity, rather than blanket adoption of the most sensitive modality available. This study's findings affirm that while PET-CT offers superior accuracy in a tertiary care context, the cost, radiation burden, and limited availability of PET-CT in many Indian centers justify a continued role for mammography as the first-line diagnostic tool, with PET-CT reserved for equivocal cases, dense breast presentations, or pre-treatment staging.

Carkaci et al. (2009) found that PET-CT demonstrated particular strength in evaluating inflammatory and locally advanced breast cancers where mammography was often limited by skin thickening and edema, a finding that aligns with the profile of patients attending tertiary centers in India where advanced-stage presentation remains common. The overall body of evidence, combined with the institutional findings from this study, supports a complementary rather than a replacement relationship between mammography and PET-CT in clinical breast cancer diagnosis.

CONCLUSION

This study found that PET-CT demonstrated significantly higher diagnostic accuracy (91.4%) compared to mammography (88sti%) in women presenting to a tertiary care center, with statistically superior sensitivity, specificity, and NPV. Invasive ductal carcinoma was the predominant histological diagnosis, and a large proportion of participants had dense breast tissue, which likely contributed to mammography's lower negative predictive value. These findings suggest that PET-CT offers a meaningful diagnostic advantage in a tertiary referral setting, particularly for women with dense breasts or clinically advanced disease.

Recommendations

Clinicians at tertiary care centers should consider adopting a structured imaging protocol where mammography serves as the initial screening and diagnostic tool, with PET-CT used selectively in cases involving dense breast tissue, equivocal mammographic findings, or suspected locally advanced disease. Institutional investment in PET-CT infrastructure, combined with training radiologists in standardized BI-RADS and SUV reporting, will improve diagnostic consistency and reduce delays in treatment initiation for breast cancer patients.

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