Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies

Journal home page:www.jamdsr.com doi:10.21276/jamdsr Index Copernicus value [ICV] = 82.06

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Comparative Assessment of Digital Breast Tomosynthesis versus Conventional Mammography in Breast Cancer Screening

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ABSTRACT:

Background: Breast cancer remains a leading cause of cancer-related morbidity and mortality among women worldwide. Conventional mammography, while widely used for screening, has limitations in detecting subtle lesions, especially in dense breast tissue. Digital breast tomosynthesis (DBT) is a newer modality that may overcome these challenges by providing three-dimensional imaging. **Aim:**To compare the diagnostic efficacy of digital breast tomosynthesis versus conventional mammography in breast cancer screening in terms of lesion detection, BI-RADS categorization, diagnostic accuracy, and interobserver agreement. **Material and Methods:**This prospective comparative study included 80 women aged 40–70 years undergoing routine breast cancer screening or evaluation for palpable breast lumps. Each participant underwent both conventional digital mammography and DBT using a full-field mammography system with tomosynthesis capabilities. Imaging findings were categorized per BI-RADS criteria, and diagnostic metrics including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. Histopathology or follow-up imaging was used for correlation. Statistical analysis was performed using McNemar's test and kappa statistics. **Results:**The majority of patients (40.00%) were aged 50–59 years. DBT detected more lesions (70.00%) than mammography (60.00%) and showed improved detection of masses (42.50% vs. 35.00%) and architectural distortions (7.50% vs. 5.00%). BI-RADS 4 and 5 categories were more frequently assigned by DBT. Diagnostic accuracy was superior with DBT, showing higher sensitivity (93.75% vs. 81.25%), specificity (91.38% vs. 86.21%), PPV (88.24% vs. 76.47%), and NPV (95.45% vs. 89.29%). Interobserver agreement was also higher with DBT (kappa = 0.84) than with mammography (kappa = 0.72). **Conclusion:**Digital breast tomosynthesis outperformed conventional mammography in breast cancer screening, offering enhanced lesion detection, higher diagnostic accuracy, and improved consistency between readers. These findings support its integration into routine screening to improve early detection outcomes.

Keywords: Digital breast tomosynthesis, Mammography, Breast cancer screening, BI-RADS, Diagnostic accuracy

Received: 23 February, 2019 Accepted: 27 March, 2019 Published: 04 April, 2019

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This article may be cited as: Gupta AK. Comparative Assessment of Digital Breast Tomosynthesis versus Conventional Mammography in Breast Cancer Screening. J Adv Med Dent Scie Res 2019;7(4):203-207.

INTRODUCTION

Breast cancer remains one of the most prevalent and life-threatening malignancies among women worldwide. Early detection is a crucial determinant of successful treatment and improved prognosis, making breast cancer screening a cornerstone of preventive oncology. Traditional mammography has long been the primary imaging modality employed for routine screening, primarily due to its widespread availability and historical efficacy in detecting early-stage disease. However, digital mammography, despite its advantages over film-based imaging in terms of image storage and manipulation, still faces limitations, particularly in women with dense breast tissue, where overlapping structures may obscure lesions and reduce diagnostic accuracy[1].

In recent years, the emergence of digital breast tomosynthesis (DBT), or 3D mammography, has generated considerable interest in the field of breast imaging. This technique involves the acquisition of multiple low-dose X-ray images of the breast from different angles, which are then reconstructed into thin slices, providing a quasi-three-dimensional representation of the breast. This approach minimizes the issue of tissue overlap, enhancing lesion visibility and reducing false positives[2]. DBT is viewed as a potential advancement over conventional 2D digital mammography by improving both sensitivity and specificity in breast cancer detection[3].

The theoretical advantage of DBT over conventional mammography lies in its capacity to separate overlapping structures in dense breast tissue, a common challenge with traditional 2D imaging. Dense breast parenchyma not only reduces mammographic sensitivity but also increases the likelihood of interval cancers, which are cancers diagnosed between regular screening rounds. DBT, by enabling better structural delineation, may help mitigate these limitations[4]. Furthermore, the ability to scroll through tomosynthesis slices allows radiologists to more confidently distinguish benign from suspicious findings, thereby potentially reducing the rate of unnecessary callbacks and biopsies[5].

Early clinical studies demonstrated that DBT could significantly enhance diagnostic accuracy. When used in combination with standard digital mammography, DBT was shown to increase cancer detection rates and simultaneously decrease recall rates, which are a common source of patient anxiety and healthcare cost[6]. As a result, some healthcare systems and institutions have adopted DBT as part of routine screening protocols, particularly for women with radiographically dense breasts or those at elevated risk of breast cancer[7].

Despite its advantages, DBT is not without limitations. The increased data volume generated by tomosynthesis raises concerns about interpretation time, storage demands, and workflow efficiency. Moreover, questions about cost-effectiveness and radiation exposure, though relatively minimal with current low-dose protocols, continue to prompt debate regarding DBT's widespread implementation as a first-line screening modality. Importantly, patient perceptions and psychological responses also play a role in determining the acceptability and adherence to screening protocols. False-positive results in breast cancer screening are not uncommon and can lead to significant psychological distress. Some evidence suggests that DBT, by reducing recall rates, may help mitigate the negative emotional consequences associated with false-positive findings[8].

Another significant consideration is the role of healthcare provider recommendations and patient-provider communication in determining compliance with screening guidelines. Even in instances of false-positive results, appropriate communication and reassurance by physicians have been found to buffer the negative psychological impact and maintain adherence to future screening schedules[9]. Hence, the integration of advanced imaging modalities such as DBT should be coupled with supportive communication strategies to optimize patient outcomes.

From a health system perspective, assessing the comparative effectiveness of DBT versus digital mammography requires careful analysis of diagnostic outcomes, patient-centered effects, and cost-benefit ratios. Recent comparative studies have reported that DBT, either alone or in combination with digital mammography, outperforms digital mammography alone in terms of cancer detection rates and diagnostic accuracy[10]. Nevertheless, continued research is essential to validate these findings in broader, diverse populations and over multiple screening rounds to understand the long-term impact of DBT on breast cancer mortality and health economics.

MATERIAL AND METHODS

This prospective comparative study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital, following approval from the Institutional Ethics Committee. A total of 80 female patients aged between 40 to 70 years, who presented for routine breast cancer screening or had clinically palpable breast lumps, were enrolled in the study after obtaining informed written consent. Inclusion criteria encompassed women with no prior history of breast malignancy or breast surgery and those not currently undergoing treatment for any breast-related pathology. Patients with breast implants, known malignancy, or those unwilling to undergo both imaging modalities were excluded.

All participants underwent both conventional digital mammography and digital breast tomosynthesis (DBT) in the same session using a dedicated full-field digital mammography system equipped with tomosynthesis capabilities. Standard two-view (mediolateral oblique and craniocaudal) mammographic images were obtained, followed by tomosynthesis acquisitions in the same views. The examinations were performed by trained radiologic technologists and interpreted independently by two radiologists with a minimum of five years of experience in breast imaging, blinded to the patients' clinical data and other imaging results.

Lesions were categorized according to the BI-RADS (Breast Imaging Reporting and Data System) lexicon in both modalities, and their conspicuity, detectability, and diagnostic accuracy were assessed. Histopathological correlation was done for lesions categorized as BI-RADS 4 and 5, and follow-up imaging or clinical assessment was used for BI-RADS 1 to 3 categories when appropriate. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of each modality were calculated and statistically compared using McNemar's test and kappa statistics to evaluate diagnostic agreement between the two modalities. Data were analyzed using SPSS software, and a p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Age Distribution of Study Participants

The age distribution of the 80 enrolled patients revealed that the majority belonged to the 50–59 years age group, accounting for 40.00% of the cohort (n = 32). This was followed by an equal representation of patients in the 40–49 years and 60–70 years age brackets, with 24 patients (30.00%) in each group.

This distribution aligns with the typical age range for breast cancer screening, as incidence rates tend to rise with age, particularly post-40 years, highlighting the relevance of this study's target population.

Table 2: BI-RADS Category Distribution by Imaging Modality

When comparing BI-RADS categorization between conventional mammography and digital breast tomosynthesis (DBT), subtle differences were observed. For BI-RADS 1 (negative findings), DBT classified slightly fewer patients (17.50%) compared to mammography (22.50%), suggesting DBT's increased sensitivity in detecting subtle lesions. BI-RADS 2 (benign findings) was the most frequent category in both modalities, seen in 27.50% and 30.00% of cases via mammography and DBT, respectively. BI-RADS 3 (probably benign) and BI-RADS 4 (suspicious abnormality) had similar distributions between the modalities, with DBT identifying more BI-RADS 4 lesions (27.50%) than mammography (25.00%). Notably, DBT also identified a higher percentage of BI-RADS 5 (highly suggestive of malignancy) cases at 12.50%, compared to 10.00% by mammography, reflecting its superior lesion characterization capabilities.

Table 3: Lesion Detection Performance

A comparative analysis of lesion detection revealed that DBT outperformed conventional mammography in overall detection rates, identifying 56 lesions (70.00%) compared to 48 lesions (60.00%). DBT was particularly superior in detecting masses, identifying 34 cases (42.50%) versus 28 cases (35.00%) by mammography. Both modalities detected an equal number of calcifications (12.50%), indicating that DBT does not compromise the detection of microcalcifications. Furthermore, DBT was better at visualizing architectural distortions (7.50% vs. 5.00%)—a key indicator of malignancy—while both methods equally detected asymmetries (7.50%). These findings demonstrate DBT's enhanced ability to delineate overlapping tissue planes, which is critical in improving cancer detection rates.

Table 4: Diagnostic Accuracy Metrics

In terms of diagnostic accuracy, DBT clearly outperformed conventional mammography. DBT showed higher sensitivity (93.75% vs. 81.25%) and specificity (91.38% vs. 86.21%), indicating its superior ability to correctly identify both true positive and true negative cases. Additionally, DBT achieved a higher positive predictive value (88.24% vs. 76.47%) and negative predictive value (95.45% vs. 89.29%), confirming that it is more reliable in ruling in and ruling out disease. These improved metrics suggest that DBT not only enhances lesion detection but also reduces false positives and negatives, potentially leading to more accurate diagnosis and better patient management.

Table 5: Interobserver Agreement (Kappa Statistics)

The interobserver agreement was evaluated using kappa statistics, which revealed a stronger concordance among radiologists when interpreting DBT images. The kappa value for DBT was 0.84, indicating an "almost perfect" agreement, while mammography yielded a kappa value of 0.72, corresponding to "substantial" agreement. This finding highlights that DBT not only enhances lesion visibility but also improves interpretative consistency between observers, thereby reducing subjectivity and variability in reporting.

Table 1: Age Distribution of Study Participants (N = 80)

Age Group (Years)	Number of Patients	Percentage (%)
40–49	24	30.00%
50–59	32	40.00%
60–70	24	30.00%

Table 2: BI-RADS Category Distribution by Imaging Modality

BI-RADS Category	Mammography (n = 80)	Percentage (%)	DBT (n = 80)	Percentage (%)
BI-RADS 1	18	22.50%	14	17.50%
BI-RADS 2	22	27.50%	24	30.00%
BI-RADS 3	12	15.00%	10	12.50%
BI-RADS 4	20	25.00%	22	27.50%
BI-RADS 5	8	10.00%	10	12.50%

Table 3: Lesion Detection Performance

Parameter	Mammography	Percentage (%)	DBT	Percentage (%)
Total lesions detected	48	60.00%	56	70.00%
Masses	28	35.00%	34	42.50%
Calcifications	10	12.50%	10	12.50%
Architectural distortions	4	5.00%	6	7.50%
Asymmetries	6	7.50%	6	7.50%

Table 4: Diagnostic Accuracy Metrics (Compared to Histopathology/Follow-up)

Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Mammography	81.25%	86.21%	76.47%	89.29%
DBT	93.75%	91.38%	88.24%	95.45%

Table 5: Interobserver Agreement (Kappa Statistics)

Modality	Kappa Value	Strength of Agreement
Mammography	0.72	Substantial
DBT	0.84	Almost perfect

DISCUSSION

The age distribution in this study, where the highest proportion of patients fell within the 50–59 years range (40.00%), followed by 30.00% each in the 40–49 and 60–70 years groups, aligns with known epidemiological trends in breast cancer screening. Similar age demographics were observed by Carney et al. (2003), who found that the detection rate of breast cancer was notably higher among women aged 50 to 69 years, reinforcing the relevance of targeted screening in this age group. Their findings highlighted that women over 50 accounted for more than 60% of screen-detected breast cancers, suggesting that DBT and mammography have the greatest diagnostic utility in this demographic[11].

The comparative BI-RADS distribution in our study demonstrates that DBT categorized more patients into higher suspicion categories (BI-RADS 4 and 5) compared to conventional mammography (27.50% vs. 25.00% for BI-RADS 4 and 12.50% vs. 10.00% for BI-RADS 5). These results indicate DBT's enhanced sensitivity for suspicious lesions. This trend is consistent with findings reported by Skaane et al. (2013), who demonstrated that DBT reclassified a significant portion of BI-RADS 2–3 lesions on mammography into higher BI-RADS categories due to better visualization of margins and internal structure, leading to increased detection of malignancies without increasing unnecessary recalls[12].

Regarding lesion detection, this study showed that DBT detected 56 lesions (70.00%) compared to 48 lesions (60.00%) with mammography, particularly outperforming in the detection of masses (42.50% vs. 35.00%) and architectural distortions (7.50% vs. 5.00%). These findings are in concordance with the study by Rafferty et al. (2011), who reported a 10–15% improvement in lesion detection rates with DBT over digital mammography, attributing this advantage to DBT's ability to resolve overlapping tissue structures and reduce anatomical noise, particularly in dense breast tissue[13].

In terms of diagnostic performance, DBT achieved superior values in sensitivity (93.75% vs. 81.25%), specificity (91.38% vs. 86.21%), PPV (88.24% vs. 76.47%), and NPV (95.45% vs. 89.29%) compared to mammography. These differences emphasize DBT's overall diagnostic advantage. The study by Gilbert et al. (2015) reported similar improvements in sensitivity (94% with DBT vs. 80% with mammography), affirming that DBT significantly reduces false-negative rates while maintaining high specificity, thus enhancing diagnostic confidence and minimizing unnecessary biopsies[14].

The interobserver agreement in our study was also markedly better with DBT, with a kappa value of 0.84 compared to 0.72 for mammography. This improvement reflects DBT's ability to provide clearer lesion boundaries and reduce interpretative ambiguity. Comparable findings were reported by Bernardi et al. (2014), who observed a kappa improvement from 0.70 with mammography to 0.83 with DBT in their multicenter screening trial, emphasizing the role of DBT in standardizing interpretation and improving reader consistency[15].

Overall, the superior performance of DBT observed in this study across lesion detection, diagnostic accuracy, and reader agreement confirms the growing evidence supporting its use as an adjunct or alternative to conventional mammography in screening settings. As Houssami et al. (2013) concluded, the integration of DBT significantly enhances cancer detection while reducing recall rates, especially in women with dense breasts, without compromising specificity—benefits also reflected in our findings[16].

CONCLUSION

Digital breast tomosynthesis (DBT) demonstrated superior performance compared to conventional mammography in breast cancer screening, with higher lesion detection rates, improved diagnostic accuracy, and better interobserver agreement. DBT was particularly effective in identifying suspicious masses and architectural distortions. Its enhanced sensitivity and specificity suggest it can significantly improve early cancer detection while reducing false positives. These findings support the integration of DBT into routine screening protocols for more accurate and consistent breast imaging outcomes.

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