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COMPARISON OF DIAGNOSTIC ACCURACY OF MAMMOGRAPHY VERSUS TOMOSYNTHESIS IN DIAGNOSIS OF BREAST LESIONS KEEPING HISTOPATHOLOGY AS GOLD STANDARD

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Abstract

OBJECTIVES: *to compare the diagnostic accuracy of digital mammography (DM) and digital breast tomosynthesis (DBT) in detecting breast lesions, using histopathology as the gold standard.* ***STUDY SETTINGS AND DURATION***: *This cross-sectional study was conducted over six months at the Department of Diagnostic Radiology, CMH Lahore from July 2024 to December 2024.* ***METHODOLOGY***:*A total of 123 patients with palpable breast lumps or a family history of breast cancer were enrolled through non-probability consecutive sampling. Each patient underwent dm and dbt, followed by biopsy for histopathological confirmation. Imaging findings were categorized using bi-rads classification. sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated.* ***RESULTS***: *DBT demonstrated superior diagnostic performance compared to dm, with sensitivity of 85.25% vs. 70.49%, specificity of 80.65% vs. 66.13%, ppv of 81.25% vs. 67.19%, and npv of 84.75% vs. 69.49%. The overall accuracy was higher for dbt (82.93%) than dm (68.29%).* ***CONCLUSION***: *DBT outperforms dm in detecting breast lesions with improved accuracy, particularly in dense breast tissue. While some studies report no significant difference, our findings support dbt as a preferred imaging modality. Future research should focus on multi-center validation, long-term outcomes, and ai integration to optimize breast cancer detection.*

INTRODUCTION

Globally, breast cancer continues to pose a major public health challenge, ranking among the leading causes of cancer-related mortality in women across diverse socioeconomic settings.[1] In 2011, studies found that developed nations had higher breast cancer incidence rates, surpassing 80 cases per 100,000 women, while developing nations generally had rates below 40 cases per 100,000. In Pakistan, breast cancer remains the most common malignancy among women, accounting for 34.6% of all female cancers, with an estimated 90,000 new cases reported annually.[2]

Breast cancer diagnosis and screening typically rely on digital mammography (DM), which is the most preferred technique for detection of breast cancer. However, mammography has certain limitations that

are well-known in the medical field. One of the challenges is reduced sensitivity in dense breast tissue, where overlapping fibro glandular tissue can obscure abnormalities, making them less conspicuous. Additionally, tumours that do not form a distinct mass can be difficult to detect using mammography. To address these limitations, alternative imaging modalities have been utilized. The evolution of digital imaging, particularly digital mammography (DM), has paved the way for digital breast tomosynthesis (DBT), a three-dimensional imaging technique. DBT captures various low-dose projections from multiple angles, generating a detailed reconstruction of breast tissue. This advanced technique enhances anatomical differentiation and minimizes the superimposition effect observed in conventional mammography, leading to improved lesion detection.[3–5]

According to Asbeutah et al., the sensitivity of DM and DBT was 73.5 and 100%, the specificity was 67.7 and 94%, and the diagnostic accuracy was 73% and 97% respectively. ROC curve analysis demonstrated a clear diagnostic advantage of DBT over DM, with a highly significant difference ($p < 0.001$). DBT enhances mammographic accuracy by increasing both sensitivity and specificity, making it a valuable tool in breast cancer detection.[6] Siminiak et al. found that while mammography exhibited high sensitivity (97%) and NPV (99%), it had lower specificity (63%) and accuracy (70%). In contrast, DBT achieved 100%sensitivity, 60%specificity, 32%PPV, 100%NPV, and 66%accuracy. Despite differences in individual parameters, they concluded that both modalities have comparable diagnostic accuracy.[7] Another study reported DBT sensitivity and specificity at 86% and 73.1%, respectively, with 53.5% of detected cases being malignant.[8]

Despite numerous studies comparing DM to DBT in Western populations, there is a significant gap in the literature regarding the evaluation of these imaging modalities specifically in the context of Pakistani women. To date, no studies have been conducted to assess the performance and diagnostic accuracy of DM and DBT in this specific population as per literature research. Therefore, there is a clear need to investigate and understand how these imaging techniques perform in detecting and diagnosing breast lesions among Pakistani women. By conducting this research, we aim to provide valuable insights into the potential benefits of DBT as an imaging modality and its potential impact on improving breast cancer detection rates.

Methodology

This cross-sectional study was conducted at the department of diagnostic radiology, cmh lahore, over six months following the approval of the study synopsis from July 2024 to December 2024. A sample size was calculated based on a 95% confidence level, an expected prevalence of breast cancer at 53.5%, an expected sensitivity of dbt at 86%, and specificity at 73.1%, with a 10% margin of error. The study employed non-probability consecutive sampling, and a total of 123 patients meeting the inclusion criteria were enrolled after obtaining informed consent.

Regardless of age/gender, all cases having palpable breast lumps on clinical examination or known family history of breast cancer, were enrolled for this trial. Patients who were pregnant or lactating, had a history of malignant breast lesions, prior breast surgery or chemotherapy, or had breast implants were excluded from the study. We documented the informed consent, patient demographics, including gender, age, duration of symptoms, breast quadrant involvement, and tumor size.

Histopathological examination was performed by consultant histopathologists with over five years of experience to serve as the gold standard. Malignant lesions were identified based on the absence of the myoepithelial cell layer, invasive growth patterns, increased mitotic activity, and necrosis, while benign lesions exhibited well-defined morphology without suspicious features. Imaging assessments using digital mammography (DM) and dbt were conducted by a consultant radiologist with at least five years of experience. The breast imaging-reporting and data system (bi-rads) classification was used to categorize imaging findings. according to this classification, bi-rads categories 1 to 3 were considered negative for malignancy, while categories 4 and above were considered positive for malignancy. Bi-rads category 0 indicated the need for additional imaging, category 1 was classified as negative (smooth, well-circumscribed lesions with benign calcifications), category 2 represented benign non-cancerous

findings, and category 3 was categorized as probably benign. Categories 4, 5, and 6 were indicative of malignancy, ranging from suspicious abnormalities to biopsy-proven malignancy.

Each participant underwent both digital mammography (DM) and dbt following standardized imaging protocols. DM was performed using conventional two-dimensional x-ray imaging, obtaining craniocaudal and mediolateral oblique views. DBT was conducted using multiple low-dose x-ray images taken at different angles, which were then reconstructed into a three-dimensional volume to enhance lesion visualization. Imaging findings were recorded based on the bi-rads classification, and all patients were scheduled for breast tissue biopsy for histopathological confirmation.

Based on histopathological correlation, imaging results were classified into true positive (TP), true negative (TN), false positive (FP), and false negative (FN) categories.True positive cases were those in which both imaging modalities correctly identified malignant lesions confirmed by histopathology. True negative cases were those where the imaging modalities correctly identified benign lesions that were histopathologically confirmed. False positive cases referred to lesions categorized as malignant on imaging but were determined to be benign on histopathology. Conversely, false negative cases were lesions deemed benign on imaging but were later confirmed to be malignant on histopathological examination.

We used 26th version of SPSS for computd our data. Continuous variables, including age, symptom duration, and tumor size, were summarized as mean ± standard deviation (SD), while categorical variables, such as gender and diagnosis (benign/malignant), were presented as frequencies and percentages. The study compared the diagnostic performance of both imaging modalities by analyzing their sensitivity, specificity, and overall accuracy.

The data were stratified based on age, gender, duration of symptoms, and tumor size, followed by post-stratification analysis of diagnostic performance. This stratification enabled a more comprehensive assessment of how these factors influenced the effectiveness of digital mammography and dbt in detecting breast malignancies.

RESULTS:

Table 1: Descriptive Statistics (n=123)

Mean age of our patients was calculated as 48.50±14.39 years whereas female patients were (94.3%), and males constituted only 5.7%. Classification of tumor was evaluated, with the right upper quadrant being the most common site (31.7%), followed by the left upper quadrant (25.2%), lower right quadrant (24.4%), and lower left quadrant (18.7%). Mean tumor size was 3.01 ± 1.48 cm, indicating moderate variation in lesion size among the patients.

Table 2: Frequency Distribution of Histopathology, Mammography, and Tomosynthesis Findings

Histopathology showed 62 cases (50.4%) to be benign and 61 cases (49.6%) to be malignant. When assessed using mammography, 59 cases (48.0%) were identified as benign, and 64 cases (52.0%) as malignant, indicating a slight overestimation of malignancies. Similarly, DBT classified 59 cases (48.0%) as benign and 64 cases (52.0%) as malignant, mirroring the mammography findings. These findings suggest that both mammography and tomosynthesis provided comparable results when diagnosing breast lesions.

Table 3: Diagnostic Performance for Mammography vs. Tomosynthesis (n=123)

Table 3 provides a comparative evaluation of the diagnostic performance of mammography (DM) and tomosynthesis (DBT). Mammography detected 43 true positive cases (35%), 41 true negatives (33.3%), but also showed 21 false positives (17.1%) and 18 false negatives (14.6%), indicating limitations in specificity and sensitivity. Conversely, DBT demonstrated higher accuracy, with 52 true positives (42.3%) and 50 true negatives (40.7%), while reducing the number of false positives (9.8%) and false negatives (7.3%).

Table 4: Diagnostic Performance Comparison of Mammography and Tomosynthesis

Tomosynthesis demonstrated superior diagnostic accuracy across all parameters. DBT achieved a sensitivity of 85.25%, significantly higher than mammography's 70.49%, indicating its improved ability to detect true positive cases. Similarly, DBT exhibited greater specificity (80.65%) compared to mammography (66.13%), suggesting a lower false positive rate. The PPV and NPV for DBT were 81.25% and 84.75%, respectively, outperforming mammography's PPV of 67.19% and NPV of 69.49%. Overall, DBT demonstrated higher diagnostic accuracy (82.93%) than mammography (68.29%), reinforcing its effectiveness as a superior imaging modality for breast cancer detection. These findings suggest that DBT offers a more reliable approach in differentiating malignant from benign breast lesions, potentially reducing misdiagnosis and improving clinical outcomes.

Figure 1: ROC Curve Comparison of Mammography and Tomosynthesis

The receiver operating characteristic (ROC) curve illustrates the comparative diagnostic performance in both modalities while detecting breast malignancies. The x-axis represents the false positive rate (1 - specificity), while the y-axis represents the true positive rate (sensitivity), allowing for a graphical representation of each modality's discriminatory ability. A key observation from the ROC analysis is that DBT demonstrates superior diagnostic performance compared to mammography, as reflected by the area under the curve (AUC) values. DBT achieves an AUC of 0.83, significantly higher than the AUC of 0.68 for mammography. A greater AUC suggests enhanced sensitivity and specificity, meaning that DBT is more effective in distinguishing malignant from benign lesions, reducing both false positives and false negatives.

The DBT curve (red line) lies consistently above the mammography curve (blue line), particularly in the early stages of the curve where sensitivity improves rapidly with minimal increases in false positive rates. This indicates that DBT has a higher true positive rate at lower false positive rates, making it a more reliable imaging modality for breast cancer detection. Overall, the ROC curve findings reinforce that DBT outperforms conventional mammography in diagnostic accuracy, supporting its potential as a superior tool for early breast cancer detection. Its higher AUC value and improved sensitivity suggest that integrating DBT into clinical practice could enhance detection rates and reduce the likelihood of misdiagnosis, ultimately leading to better patient outcomes..

Table 1: Descriptive Statistics (n=123)

Variables	Mean+SD/Count (%)
Age(years)	48.50±14.39
Gender	Male: 7(5.7%)
	Female: 116(94.3%)
Lesion Quadrant	Upper Right: 39(31.7%) Lower Right: 23(24.4%) Upper Left: 31(25.2%) Lower Left: 23 (18.7%)
Tumor Size (cm)	3.01±1.48

Table 2: Frequency Distribution of Histopathology, Mammography, and Tomosynthesis Findings

Category	Histopathology	Mammography	Tomosynthesis
Benign	62 (50.4%)	59 (48.0%)	59 (48.0%)
Malignant	61 (49.6%)	64 (52.0%)	64 (52.0%)
Total	123 (100.0%)	123 (100.0%)	123 (100.0%)

TABLE 3: Diagnostic Performance for Mammography vs. Tomosynthesis (n=123)

Modality	True Positive (TP)	True Negative (TN)	False Positive (FP)	False Negative (FN)
Mammography (DM)	43(35%)	41(33.3%)	21(17.1%)	18(14.6%)
Tomosynthesis (DBT)	52(42.3%)	50(40.7%)	12(9.8%)	9(7.3%)

Table 4: Diagnostic performance comparison of mammography and tomosynthesis

Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Overall Accuracy (%)
Mammography (DM)	70.49	66.13	67.19	69.49	68.29
Tomosynthesis (DBT)	85.25	80.65	81.25	84.75	82.93

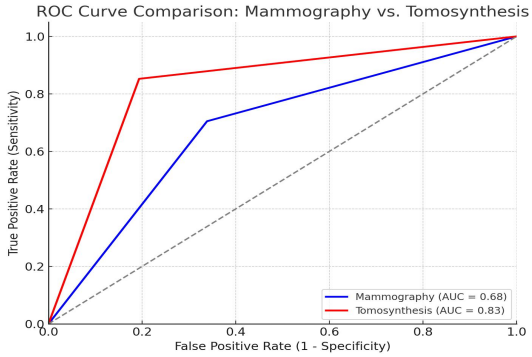

Fig. 1

DISCUSSION:

Breast cancer continues to be a major global health concern, with early and accurate diagnosis playing a pivotal role in reducing mortality. This study evaluated the diagnostic accuracy of digital mammography versus digital breast tomosynthesis (DBT) in detecting breast lesions, using histopathological confirmation as the reference standard. Our results indicate that DBT provides superior sensitivity, specificity, and overall diagnostic performance. These findings support the adoption of DBT as a more effective imaging modality for improving lesion characterization and optimizing patient management.

Our results align with multiple studies[9-12] that have assessed the diagnostic efficacy of digital breast tomosynthesis in breast imaging. Several researchers have reported that digital breast tomosynthesis enhances lesion detection by reducing tissue superimposition, thereby improving sensitivity and specificity. A study by Nadia Gul and colleagues[9] reported digital breast tomosynthesis sensitivity and specificity values that closely match our findings, confirming its superior accuracy over mammography. Junqiang Lei et al[10] conducted a meta-analysis emphasizing digital breast tomosynthesis's higher sensitivity and specificity across multiple studies, further reinforcing our conclusions. Rana M. Naeim et al[11] also reported a greater diagnostic advantage of digital breast tomosynthesis, particularly in dense breast tissue. Waleed Abd El-Fattah Mousa and colleagues[12] found similar improvements, particularly in the classification of lesions using the BIRADS system. These studies confirm that digital breast tomosynthesis significantly improves lesion visualization and reduces false-negative and false-positive diagnoses, supporting its role as an advanced imaging tool in breast cancer detection.

While our study supports the superior diagnostic performance of digital breast tomosynthesis, some research presents contrasting findings. A study by Sahar Mansour et al[13] acknowledged the advantages of digital breast tomosynthesis but did not find a significant difference in sensitivity and specificity

between digital breast tomosynthesis and mammography. This suggests that digital breast tomosynthesis may not always provide major improvements over digital mammography, particularly in non-dense breast tissue, where conventional mammography remains effective. Another study by Tamer F. Taha Ali et al[14] raised concerns regarding the increased recall rates associated with digital breast tomosynthesis, which could lead to unnecessary biopsies in certain patient groups. While our study suggests that digital breast tomosynthesis reduces false positives, this research indicates that in some cases, digital breast tomosynthesis might increase false alarms, particularly for benign lesions that appear suspicious on three-dimensional imaging. These differences highlight the need for further investigation into the specific contexts in which digital breast tomosynthesis provides the greatest benefit.

Despite the promising findings, our study has certain limitations. As a single-center study conducted at CMH Lahore, is restricted for generalizability. A multi-center study incorporating different populations and imaging protocols would provide more robust data. The sample size of 123 patients, while sufficient for statistical analysis, may not capture the full spectrum of breast lesion variability. A larger sample size could improve result validity and strengthen the conclusions. Additionally, our study focused on the immediate diagnostic performance of digital breast tomosynthesis and digital mammography without long-term follow-up, which could provide insights into the rate of false-negative and false-positive findings over time. Furthermore, while dense breast tissue is known to affect mammography's effectiveness, our study did not stratify patients based on breast density, which could provide a clearer understanding of the specific subgroups that benefit most from digital breast tomosynthesis. Observer bias remains another limitation, as imaging assessments were conducted by a single radiologist, and the subjective nature of interpretation may have influenced results. A multi-reader study involving multiple radiologists with interobserver agreement analysis would enhance reliability. Cost considerations also need to be addressed, as digital breast tomosynthesis is more expensive and less widely available than conventional mammography. The study did not evaluate the cost-effectiveness of digital breast tomosynthesis, which is a critical factor for its widespread clinical implementation.

Future research should address these limitations by conducting larger, multi-center studies that evaluate digital breast tomosynthesis in diverse populations. Longitudinal follow-up studies are necessary to determine the long-term effectiveness of digital breast tomosynthesis in detecting clinically significant malignancies and to assess its impact on patient outcomes. Stratifying results by breast density could help determine which patient groups benefit the most from digital breast tomosynthesis. The integration of artificial intelligence in digital breast tomosynthesis interpretation is an emerging area that could enhance diagnostic accuracy, reduce radiologist workload, and minimize observer variability. Future studies should also assess the cost-effectiveness of digital breast tomosynthesis to determine its feasibility for widespread use in different healthcare settings.

CONCLUSION:

Digital breast tomosynthesis outperforms digital mammography in detecting breast lesions, demonstrating higher diagnostic accuracy. These findings align with multiple international studies, though some research suggests that digital breast tomosynthesis may not always provide a substantial advantage in all patient groups. Despite certain limitations, the study supports the adoption of digital breast tomosynthesis as a preferred imaging modality, particularly for patients with dense breast tissue or equivocal mammographic findings.

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