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Original Research Article

DIGITAL MAMMOGRAPHY VERSUS DIGITAL BREAST TOMOSYNTHESIS: INITIAL EXPERIENCE AT A TERTIARY CARE HOSPITAL IN INDIA

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ABSTRACT

Background: Previous studies comparing digital mammography (DM) and digital breast tomosynthesis (DBT) have reported conflicting results regarding cancer detection and false-positive findings, particularly across different breast density categories. Most of this evidence derives from asymptomatic population screening programmes, and data from symptomatic women undergoing diagnostic mammography remain limited. This study aimed to evaluate and compare cancer detection and false-positive findings of DM alone versus combined DM and DBT in symptomatic women, stratified by BI-RADS breast density.

Materials and Methods: This single-institution prospective diagnostic study included 358 symptomatic women (383 breasts) referred for mammography between April 2023 and March 2024 with clinical features suggestive of breast cancer. Each examination was acquired in combined mode and interpreted twice, once using 2D images alone and once using 2D plus 3D images. Breast density was categorised according to the BI-RADS 4th edition into four groups: A (almost entirely fatty), B (dispersed fibroglandular densities), C (heterogeneously dense) and D (extremely dense). True-positive and false-positive interpretations were compared between 2D-only and combined 2D plus 3D reading across density categories.

Results: Cancer was detected in 32 women (37 breasts). Combined 2D plus 3D reading identified 37 cancer-positive breasts compared with 30 by 2D alone, and reduced false-positive interpretations from 35 to 20. No difference in true positives was seen in almost entirely fatty breasts, and the increase in breasts with dispersed fibroglandular densities did not reach significance (8 to 9; +12.5%; $p = 0.06$). In heterogeneously dense and extremely dense breasts, the addition of DBT increased true positives by 30.0% (10 to 13; $p = 0.04$) and 50.0% (6 to 9; $p < 0.001$) respectively. False positives fell with combined reading in types A, B and C (by 33.3%, 55.6% and 60.0% respectively), reaching significance only in type C ($p = 0.04$), but rose from 4 to 6 in extremely dense breasts ($p = 0.05$). DBT more frequently detected malignancies presenting as spiculated masses and architectural distortion, whereas overlapping glandular tissue on DM accounted for a greater proportion of false-positive findings.

Conclusion: Compared with DM alone, the addition of DBT improved cancer detection, with the largest gains in heterogeneously dense and extremely dense breasts, and reduced false-positive interpretations in all categories except extremely dense breasts. These findings support the use of DBT as an adjunct to DM in the diagnostic assessment of symptomatic women, particularly those

with dense breasts. Because the cohort was symptomatic, the absolute figures reported here should not be read as estimates of screening performance.

Keywords: Digital breast tomosynthesis; Digital mammography; Breast density; BI-RADS; Symptomatic breast disease

INTRODUCTION

Carcinoma breast has emerged as the most commonly diagnosed cancer in women worldwide.[1] The last decade has seen a sharp rise in breast cancer cases. As per GLOBOCAN 2022, breast cancer accounts for 23.8% of all new cancers diagnosed in women, with a 5-year prevalence of 15.3 per 100,000 population. In India, breast cancer accounts for 26.6% of all new cancer cases in women, with a 5-year prevalence of 16.2 per 100,000 population.[2,3]

Digital breast tomosynthesis and digital mammography are two widely used imaging modalities to detect and diagnose breast cancer.[4] Digital breast tomosynthesis, often known as 3D mammography, is a medical procedure that creates a three-dimensional representation of the breast by combining several images taken from various angles.[5] Among the many benefits of this method are higher detection rates. It frequently results in fewer false positives and minimises the requirement for extra imaging, which can reduce medical expenses and patient concerns.[6] Accurate location and characterisation of breast lesions can be aided by digital breast tomosynthesis, which offers a sharper picture of overlapping breast tissues.[7]

Digital breast tomosynthesis is capable of detecting cancers that might be missed with digital mammography, especially in women with dense breast tissue.[8] It leads to a reduction in false-positive results, which means fewer women are recalled for additional testing. By providing clearer images of the breast tissue layers, it makes it easier to identify and characterise abnormalities.[9] However, a slightly higher radiation dose compared with standard digital mammography, although still within safe limits, together with higher cost and longer procedure time, make it less widely acceptable than digital mammography.[10]

The most widely used screening method utilising 2D imaging for carcinoma breast is digital mammography (DM). It is frequently utilised because of its well-established effectiveness, affordability, and ability to obtain two-dimensional images of the breast at a lower cost in comparison with DBT.[4] However, it has some limitations. Dense breast tissues can overlap in 2D images, potentially hiding tumours and leading to missed diagnoses.[11]

With a proven track record, digital mammography is considered the gold standard for screening of carcinoma breast.[12] Generally, the cost is lower than that of digital breast tomosynthesis. However, in women with dense breasts, its efficacy in identifying malignancies may be reduced when compared with digital breast tomosynthesis, owing to more false positives, which increase recall rates for follow-up testing.[12] Because it only offers 2D pictures, it can occasionally be challenging to distinguish between malignant and benign lesions.[4]

Both methods are acceptable for screening for breast cancer, and which one to use may depend on a patient's unique circumstances, such as breast density, risk factors, and technology accessibility. To optimise the advantages, some medical professionals combine the two methods.[13]

Most published comparisons of the two modalities derive from asymptomatic population screening programmes, and evidence from symptomatic women referred for diagnostic mammography remains comparatively limited. Through this study, we assess how effectively a combination of full-field digital mammography and digital breast tomosynthesis improves BI-RADS scoring interpretation across all breast densities in symptomatic women presenting to a tertiary care hospital. The outcomes of the study will help shape future recommendations for clinical practice and will add to the current conversation about improving breast cancer detection.

MATERIALS AND METHODS

A prospective diagnostic study was conducted between April 2023 and March 2024 to determine the effectiveness of digital breast tomosynthesis in detecting breast cancers in symptomatic women, and to report our initial single-institution experience.

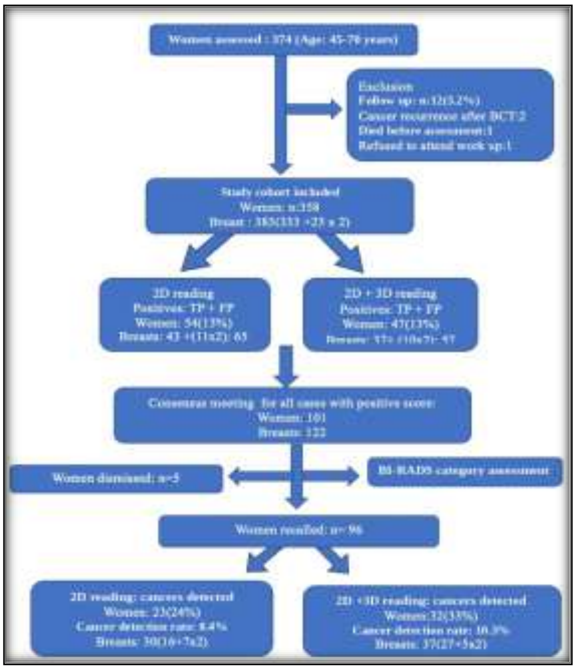

Figure 1: Methodology: flow chart showing the overall recall and cancer detection for two-dimensional (2D) and two-dimensional plus three-dimensional (3D) combined reading among the symptomatic women

examined. Cancer detection figures are expressed as a percentage of the 358 women included. Breast-conserving therapy (BCT), breast imaging reporting and data system (BI-RADS), false positive (FP), and true positive (TP).

Study cohort: From April 2023 to March 2024, 374 women aged 45–70 years who presented with symptoms suggestive of breast cancer and were referred to our department for mammography were assessed for eligibility. Women with breast implants, women with pacemakers, women who were unable to stand, and those who did not give consent for enrolment were not enrolled. Sixteen women (4.3%) were subsequently excluded: 12 whose examination was performed for follow-up, 2 with suspected cancer recurrence after breast-conserving therapy, 1 who died before assessment, and 1 who declined to attend work-up. The remaining 358 women, comprising 383 breasts (333 imaged unilaterally and 25 imaged bilaterally), were included in the analysis [Figure 1]. The mean age of the included participants was 56.2 years.

Two radiologists with approximately 15 and 3 years of experience in mammography reporting participated in the study. Each radiologist underwent individualised training before the study using a malignancy-enriched set of 100 cases.

Mammographic imaging: The imaging procedure employed a mammography machine (Selenia Dimensions, Hologic) in "combo" mode, in which a single breast compression is used to acquire both the DM and the DBT dataset. Mediolateral oblique and craniocaudal projections of the breasts were acquired. Using a standard screening setting (auto filter), the mean average glandular dose was 2.10 mGy for DBT views and 1.74 mGy for DM views.

Image evaluation: Each examination was interpreted twice by two radiologists working independently: once in 2-dimensional mode alone, and once in 3-dimensional mode together with the 2-dimensional images. Women with suspicious findings underwent further assessment (termed recall in Figure 1). A biopsy was performed to confirm carcinoma breast. Where the radiologists disagreed, a single conclusion was reached at a consensus meeting. Breast density was categorised using the density scores from the BI-RADS 4th edition as follows: A, virtually completely fatty; B, dispersed fibroglandular densities; C, heterogeneously dense; and D, highly dense.

Statistical analysis: Data were entered in a Microsoft Excel sheet and the Statistical Package for the Social Sciences (SPSS) version 24.0 was used for the analysis. Categorical data are presented as frequency with percentage, and differences between categorical variables (distributions of breast density) were assessed using the chi-square test. Agreement between the two radiologists was assessed using Cohen's kappa statistic and Spearman correlation coefficients. For all analyses, a p-value of less than 0.05 was considered statistically significant.

RESULTS

Of 374 symptomatic women assessed for eligibility, 358 (383 breasts) were included in the analysis [Figure 1]. Cancer was detected in 32 women (8.9%), corresponding to 37 cancer-positive breasts (9.7% of 383 breasts); 27 women had unilateral and 5 had bilateral disease. All 37 cancer-positive breasts were identified by combined 2D plus 3D reading, whereas 30 were identified by 2D alone, so that combined reading detected 7 additional cancer-positive breasts in 9 additional women. Expressed against the 358 women included, cancer-positive breasts were identified in 8.4% by 2D reading and in 10.3% by 2D plus 3D reading [Figure 1].

Table 1: Distribution of BI-RADS breast density by age group and by positive mammographic reading (n = 358 women).

Women (n = 358)	Total	Type A	Type B	Type C	Type D
All women included	358	43	190	98	27
45–55 years	96	6	42	36	12
56–65 years	180	24	99	45	12
66–70 years	82	13	49	17	3
Positive mammographic readings taken to consensus	101	8	49	34	10

Positive mammographic readings taken to consensus represent the pooled total of readings called positive in the 2D arm (54) and the 2D plus 3D arm (47), as shown in [Figure 1].

Overall, 190 of the 358 women (53.1%) had breasts with dispersed fibroglandular densities (type B) and 98 (27.4%) had heterogeneously dense breasts (type C); 43 (12.0%) were almost entirely fatty (type A) and 27 (7.5%) were extremely dense (type D). The largest number of women in each of types A, B and C fell in the 56–65 year age group; among extremely dense breasts, women were divided equally between the 45–55 and 56–65 year groups (12 each). Of the women taken to consensus for a positive mammographic reading, the largest proportions were in type B (49 of 101; 48.5%) and type C (34 of 101; 33.7%). [Table 1]

Total positive interpretations were 65 breasts (17.0% of 383) with 2D and 57 breasts (14.9%) with 2D plus 3D. True positives were 30 breasts (7.8%) with 2D and 37 breasts (9.7%) with 2D plus 3D, while false positives fell from 35 breasts (9.1%) to 20 breasts (5.2%). At the level of individual women, 54 women (15.1%) were called positive on 2D and 47 (13.1%)

on 2D plus 3D, of whom 23 and 32 respectively proved to have cancer.

The true-positive count was higher for type C and type D breasts with 2D plus 3D reading than with 2D alone. For women in the type A category no difference was observed, and the increase in type B did not reach statistical significance (8 to 9 breasts; +12.5%; p = 0.06). In type C and type D breasts we observed increases in true positives of 30.0% (10 to 13 breasts; p = 0.04) and 50.0% (6 to 9 breasts; p < 0.001) respectively. False-positive interpretations were lower with 2D plus 3D reading in types A, B and C, falling by 33.3% (3 to 2 breasts; p = 0.07), 55.6% (18 to 8 breasts; p = 0.06) and 60.0% (10 to 4 breasts; p = 0.04) respectively, the reduction reaching statistical significance only in type C. In type D breasts, false positives increased from 4 to 6 (+50.0%; p = 0.05). [Table 2]

Table 2: True-positive and false-positive breast interpretations for 2D and 2D plus 3D reading, stratified by BI-RADS density category (n = 383 breasts).

BI-RADS category	True positive (breasts)					False positive (breasts)				
	With 2D (n = 30)	With 2D + 3D (n = 37)	Difference	% change from 2D	p-value	With 2D (n = 35)	With 2D + 3D (n = 20)	Difference	% change from 2D	p-value
Type A	6 (20.0%)	6 (16.2%)	0	0.0%	NA	3 (8.6%)	2 (10.0%)	−1	−33.3%	0.07
Type B	8 (26.7%)	9 (24.3%)	+1	+12.5%	0.06	18 (51.4%)	8 (40.0%)	−10	−55.6%	0.06
Type C	10 (33.3%)	13 (35.1%)	+3	+30.0%	0.04	10 (28.6%)	4 (20.0%)	−6	−60.0%	0.04
Type D	6 (20.0%)	9 (24.3%)	+3	+50.0%	<0.001	4 (11.4%)	6 (30.0%)	+2	+50.0%	0.05

Percentages in the “With 2D” and “With 2D + 3D” columns are column percentages, that is, the proportion of all true-positive (or false-positive) breasts in that reading arm falling within the density category. “% change from 2D” is calculated relative to the corresponding 2D count. NA, not applicable (no difference between arms). All counts are at breast level; the 37 true-positive breasts identified by 2D plus 3D reading occurred in 32 women.

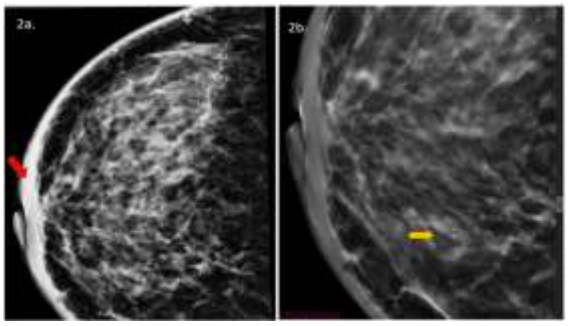

Figure 2: Case of inflammatory carcinoma of the right breast. 2a – right breast mammography CC view shows skin thickening (red arrow) in a type C breast; 2b – tomosynthesis in CC view shows pleomorphic calcifications not visible with conventional mammography.

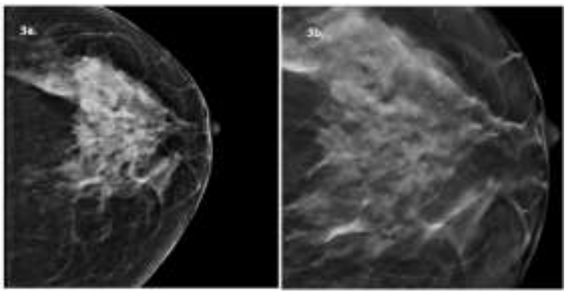

Figure 3: Case of bilateral fibrocystic disease. 3a – left breast mammography CC view shows a type C breast and a few calcifications that were labelled suspicious; 3b – tomosynthesis in CC view shows diffuse benign amorphous calcifications.

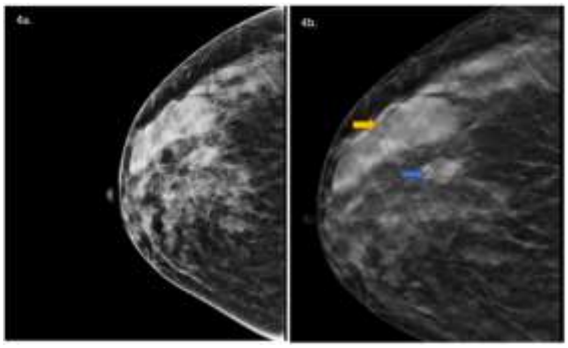

Figure 4: Case of sclerosing adenosis of the right breast. 4a – right breast mammography CC view shows a type C breast; Fig 4b – tomosynthesis in CC view shows a well-defined, isodense, wider-than-tall lesion with smooth margins (yellow arrow) and another irregular hyperdense lesion with spiculated margins (blue arrow).

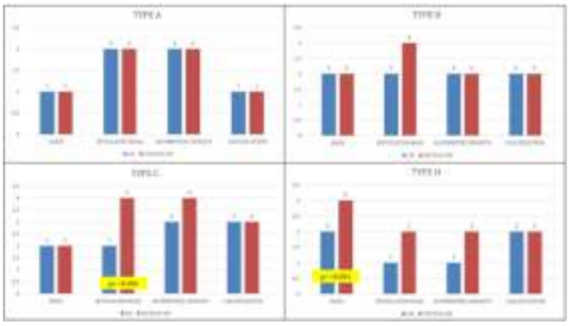

Figure 5: Number of cancers detected by lesion morphology for two-dimensional (2D) and two-dimensional plus three-dimensional (3D) reading, stratified by BI-RADS density category. A: virtually completely fatty; B: dispersed fibroglandular densities; C: heterogeneously dense; and D: highly dense.

DISCUSSION

Because the findings of previous literature have been conflicting, and because that literature is drawn almost entirely from asymptomatic screening populations, we evaluated the frequencies of cancer detection and false-positive findings of digital mammography (DM) and digital breast tomosynthesis (DBT) in a symptomatic cohort, stratified according to BI-RADS scoring. Breasts were categorised using the density scores from the BI-RADS 4th edition as A, virtually completely fatty; B, dispersed fibroglandular densities; C, heterogeneously dense; and D, highly dense.

According to our findings, for women with almost entirely fatty breasts and those with dispersed fibroglandular densities we observed no significant difference in true positives between 2D-only and 2D plus 3D reading. However, for women with heterogeneously dense breasts and extremely dense breasts we observed increases in true positives of 30.0% and 50.0% respectively with 2D plus 3D compared with 2D-only reading. This implies that women are more likely to have malignancies detected when DBT is added to DM. False-positive interpretations were also lower for 2D plus 3D reading in type A, type B and type C breasts, although only the reduction in type C reached statistical significance.

According to previous research, radiologists found more cancers in the form of spiculated masses while using DBT as opposed to DM. Research from across the globe has suggested that, in screening populations, DBT lowers the recall rate for all BI-RADS breast density categories.[14-16] We similarly found a reduction in false-positive results in heterogeneously dense breasts, which coincides with the findings of Rafferty et al.[17] The Malmö trial,[14] reported significantly lower recall or false-positive rates for women with extremely dense, or type D, breasts; in our cohort, by contrast, false-positive interpretations in this category rose from 4 to 6, although the numbers involved are small. The wide variation in recall rates among nations may account for variations in the false-positive rate among women with very dense breasts. Similar to our results, several other studies have demonstrated that unequal densities are the primary cause of recall and higher false-positive rates.[18,19] In digital mammography, overlapping glandular tissue can create false appearances of lesions, whereas digital breast tomosynthesis often clarifies these as distinct glandular tissue structures. We found fewer false-positive results characterised as architectural distortion or spiculated mass, in contrast to the Malmö study.[14] More false-positive results were observed in breasts with calcifications. This might have resulted from the synthetic 2D imaging method's emphasis on calcifications. It was confirmed that women with highly dense breasts had better cancer detection rates with the addition of DBT. Additionally, a majority of tumours showed up as spiculated masses or architectural distortion. Tumour spiculations and masses at DM may be obscured by the texture of normal tissue, such as fibroglandular tissue.[20] DBT makes apparent the in-plane tumour and its spiculations by removing out-of-plane structures. It has been reported that for DBT to be effective in dense breasts, there must be at least some peritumoral fat.[21]

There are certain limitations to our study. Most importantly, our cohort comprised symptomatic women undergoing diagnostic mammography, whereas the published comparisons of DM and DBT against which we have set our findings derive from asymptomatic population screening programmes. The pre-test probability of malignancy in our cohort was correspondingly far higher, cancer being confirmed in 32 of 358 women (8.9%), and the absolute detection and false-positive figures reported here should therefore not be interpreted as estimates of screening performance. Comparisons with the screening trials cited above are indicative rather than direct. Secondly, the present study was a single-institution study, which limits its generalisability. Thirdly, the number of women in the extremely dense category was small (n = 27), so the estimates for this group, including the observed rise in false-positive interpretations, are imprecise and should be interpreted with caution. Fourthly, only two radiologists participated, and their experience differed substantially. Additionally, we classified breast density using the fourth edition of BI-RADS. If a breast is dense and can mask lesions, it is categorised into a higher category in the 5th edition. Since very dense areas can mask malignancies, the 5th edition may be more closely linked to decreased sensitivity in both DM and DBT.

In summary, compared with digital mammography alone, the addition of digital breast tomosynthesis revealed more tumours, especially in BI-RADS type C and type D categories, because digital breast tomosynthesis showed more architectural distortion and spiculated masses than digital mammography did. There was a higher number of true positives with 2D plus 3D reading than with 2D alone, and a lower number of false-positive interpretations overall. Based on these findings, we conclude that, in symptomatic women, the addition of digital breast tomosynthesis to digital mammography improves the detection of carcinoma breast, particularly in heterogeneously dense and extremely dense breasts, and reduces false-positive interpretations in all but the extremely dense category.

CONCLUSION

In this single-institution study of symptomatic women undergoing diagnostic mammography, the addition of digital breast tomosynthesis to digital mammography increased the number of cancer-positive breasts identified from 30 to 37 and reduced false-positive interpretations from 35 to 20. The gain in cancer detection was confined to heterogeneously dense and extremely dense breasts, in which tomosynthesis more often demonstrated spiculated masses and architectural distortion obscured by overlying fibroglandular tissue on two-dimensional imaging. False-positive interpretations fell in every density category except the extremely dense, where the small number of women limits interpretation. Combined 2D and 3D reading therefore appears to be a useful adjunct in the diagnostic assessment of symptomatic women, particularly those with dense breasts. Because this cohort was symptomatic and drawn from a single centre, these figures should not be extrapolated to screening populations.

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