Role of breast tomosynthesis in the morphological analysis of breast lesions

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**Purpose**

**PURPOSE**

1. To assess the role of Breast Tomosynthesis (by 3D Combined View) versus 2D Full Field Digital Mammogram alone in the morphological analysis of breast lesions.

2. To evaluate the potential role of Tomosynthesis in BIRADS Categorisation and Final Histopathology.

In May 2011 we migrated from an Analogue Mammogram with a dedicated Mammogram CR system to a Full Field Digital System with 3D Tomosynthesis.

In India there is no official screening programme. All screening is opportunistic, self-initiated and self-funded. Most Mammograms done at our hospital, a Corporate Tertiary care Oncology facility, are performed as Diagnostic Mammograms followed by mandatory Breast Ultrasound and additional views, if necessary, on the same day obviating the need for recall.

Reducing the number of cases for additional views and breast ultrasound will help in decreasing the patient's waiting time, making reporting more efficient, without compromising on the accuracy. We used BIRADS categorisation as an evaluating tool and compared the BIRADS categorisation with the final HPE.
Methods and Materials

Combined view (2 D+ Tomosynthesis in CC and MLO views) was offered to all patients undergoing diagnostic mammogram (symptomatic patients) or who were in the high risk category and informed consent was got for the same after explaining the details of the procedure including the incremental dosage during the Tomosynthesis as opposed to a simple 2-view mammogram for each breast.

Whilst the superior diagnostic capabilities of Tomosynthesis have been reported in literature, it is an additional view/procedure with incremental dosage. Combo mode in our system (2D +3D) has a dose of 2.5 to 2.8mSv for a breast of average thickness.

The 3DTomosynthesis setting can be done separately after the 2D mammogram. However the Combo view includes the acquisition of 3D Tomosynthesis in the same compression wherein the x-ray tube moves along a limited arc from +7.5 to -7.5 degrees and takes 15 projections allowing 15 low-dose images to be acquired followed by the 2D Full Field Digital in the same CC or MLO position with the same compression in quick succession. The Combo View eliminates the need to reposition the breast but there is an additional time under compression during the acquisition of the 3D images.

After acquisition, the data from the projection images were used to reconstruct between 50 and 90 parallel 1-mm-thick slices (i.e., the 3D DBT data set), depending on the thickness.

Mammography was acquired with full-field digital technology (Selenia, Hologic) and the images were read in the Secure view work-station. Breast Ultrasound was performed with a dedicated high frequency probe (Philips IU22 or Siemens Antares).

Our study consisted of a convenience sample of 100 lesions in 95 patients. 5 of our patients had 2 lesions, the second one was located in the opposite breast. The youngest patient was 34 years old and the oldest was 87 years old (Fig 1).

All these patients with abnormal 2D digital mammogram had correlated breast ultrasound followed by Histopathological confirmation (Fig 3) by Image guided trucut core tissue biopsy with a 14 / 16 gauge needle or FNAC in those lesions in whom fluid was aspirated. 2D digital mammogram and 3D tomosynthesis were analysed for the following features - mass, margins, calcification, asymmetric density, focal asymmetry and architectural distortion.
The images were read by two Senior Radiologists with more than 7 years experience in reading mammograms. All the images including the Tomosynthesis reconstructions were reviewed in cine or manual scroll modes on a dedicated soft-copy mammographic workstation. The workstation, which is PC based, includes two 5-megapixel LCD displays with a mammography workflow keypad. The system includes tools for magnification, zoom and contrast adjustment as well as a drag-and-drop image display.

2D Full field Digital images and the Tomosynthesis images were read separately and independently by two Senior Consultant Radiologists & they alternated the modalities on a weekly basis to eliminate bias (i.e Radiologist A would do the 2D evaluation and BUS evaluation whilst Radiologist B would independently read the 2D with Tomosynthesis images for the week). The readings of the indexed lesions were documented and the BIRADS categorization was done independently after each modality for the lesion and the 2D BIRADS categorisation of the breast parenchyma was noted.

2D Digital Mammogram and 3D Tomosynthesis images were analysed for the following features:
- Lesion margins,
- Calcification,
- Architectural distortion,
- Diffuse asymmetry,
- Focal asymmetrical density,

A 5 point scale was provided and used to indicate the diagnostic efficacy of 3D tomosynthesis when compared to 2D FFDM.

- - Far inferior/Far worse
- Inferior/ worse
0 Same /Equivalent
+ Superior/ Better
+ + Far superior/Much better

For example, if the margins of a mass were clearly more visible with tomosynthesis, then tomosynthesis was rated superior to diagnostic mammography. Image quality was rated equivalent if the comparative benefit was questionable or marginal. This comparison was restricted to the 2D double view (CC and MLO views for each breast) of diagnostic mammography component and did not include additional views or evaluation by sonography. Readers were told to assume the 2D FFDM examination was the woman's baseline examination; hence, no prior FFDM examinations were provided for comparison.

Statistical analysis was done to evaluate the performance of Tomosynthesis versus 2D Digital Mammogram in terms of Morphology, BIRADS Categorisation and Histopathology.
Categorical data were presented by frequency with percentage and it was analyzed by using Chi-square and Fisher exact test. All the analysis was done by using SPSS 14.0 version. A p value less than 0.05 was considered as significant.
Fig. 1

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Fig. 2

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Fig. 3

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Results

2D vs 3D for morphological Analysis

Table 1. Frequency distribution

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Much better/ Far superior</th>
<th>Better/ Superior</th>
<th>Same/ Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margins</td>
<td>7</td>
<td>54</td>
<td>13</td>
</tr>
<tr>
<td>Calcification</td>
<td>0</td>
<td>36</td>
<td>6</td>
</tr>
<tr>
<td>Architectural distortion</td>
<td>5</td>
<td>43</td>
<td>0</td>
</tr>
<tr>
<td>Diffuse asymmetry</td>
<td>3</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Focal asymmetry</td>
<td>11</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Additional lesions</td>
<td>3</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

- 3D Tomosynthesis was superior for all the analysed parameters with highly significant p values, no case was inferior in 3D than 2D.
- In the analysis of margins of 100 abnormal findings, there were 74 mass lesions, out of which in 7 cases 3D was far superior (fig 4) to 2D, in 54 cases 3D was superior (fig 6) to 2D whereas in 13 cases 3D was equivalent (fig 5) to 2D.
- The pattern and distribution of calcification are better seen with 3D tomosynthesis (Fig 5,6).
- Diffuse asymmetry, architectural distortion and focal asymmetry (fig 7) were analysed better in 3D, which could further be categorised as either mass or normal breast parenchyma.

Table 2. Chi-square test for Equivalence rating

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Better or Much better</th>
<th>Same</th>
<th>P value</th>
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<tbody>
<tr>
<td>Margins</td>
<td>61</td>
<td>13</td>
<td>&lt;0.001</td>
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<tr>
<td>Calcification</td>
<td>26</td>
<td>6</td>
<td>&lt;0.001</td>
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<tr>
<td>Architectural distortion</td>
<td>40</td>
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<td>&lt;0.001</td>
</tr>
<tr>
<td>Diffuse asymmetry</td>
<td>10</td>
<td>0</td>
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Corelation with Final BIRADS after 2D, Ultrasound and HPE

Distribution of BIRADS in 2D, 3D and USG

<table>
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<tr>
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<th>3</th>
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<th>5</th>
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<tr>
<td>2D</td>
<td>30</td>
<td>1</td>
<td>2</td>
<td>20</td>
<td>29</td>
<td>18</td>
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<tr>
<td>3D</td>
<td>1</td>
<td>-</td>
<td>5</td>
<td>39</td>
<td>10</td>
<td>45</td>
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<tr>
<td>USG</td>
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<td>-</td>
<td>5</td>
<td>39</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>Final</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>38</td>
<td>12</td>
<td>45</td>
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</table>

Table 3.

Agreement of BIRADS in 2D, 3D and USG with final BIRADS

<table>
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<th>4</th>
<th>5</th>
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<tr>
<td>2D</td>
<td>-</td>
<td>2(100%)</td>
<td>17(85%)</td>
<td>2(6.9%)</td>
<td>18(100%)</td>
</tr>
<tr>
<td>3D</td>
<td>-</td>
<td>5(100%)</td>
<td>38(97.4%)</td>
<td>10(100%)</td>
<td>45(100%)</td>
</tr>
<tr>
<td>USG</td>
<td>-</td>
<td>5(100%)</td>
<td>38(97.4%)</td>
<td>11(100%)</td>
<td>45(100%)</td>
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</tbody>
</table>

NB ** the agreement in BIRAD 1 could not be computed as there was no corresponding HPE.

- 3DTomo BIRADS showed better correlation with final BIRADS than 2D BIRADS For morphological analysis of lesions.
- In case of BIRADS categorisation, 3D made a major contribution in the evaluation of BIRADS 0 cases. Of the 30 cases of BIRADS 0 in 2D, after 3D there was only one case in 0 category.
- 3D was able to correctly predict the final BIRADS in almost all the lesions which were categorised as Birads 0 in 2D.
- 3D and Ultrasound Birads showed high agreement (Table 3) with final BIRADS, in all BIRADS categories unlike 2D which showed very poor agreement in Birads category 4, with final BIRADS.

Table 4: HPE Predictability

<table>
<thead>
<tr>
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<th>Benign</th>
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- 3D and US were able to categorise lesions as benign and malignant better than 2D.

- Only 5 patients in 3D tomo did not co-relate with final BIRADS but however they correlated well with HPE (TAB.5)

TABLE 5:

<table>
<thead>
<tr>
<th>No.</th>
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<td>5.</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>INFLAMMATION</td>
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Images for this section:

Fig. 4: The 2D image shows a lesion with rounded margins and tent sign in a dense breast. On 3D tomo the spicules are better appreciated.

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**Fig. 5:** A 43 year old lady presented with palpable lump in right breast since 4-5 months. Malignant lesion with irregular margins and microcalcifications are seen in 2D, which are appreciated better in 3D tomo slice (bottom image).

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**Fig. 6:** The two slices of tomosynthesis show the spiculation (middle image) and the microcalcification with its branching pattern (right image) better than the 2D cc view (left image). The true extent and nature of the lesion can be assessed in 3D tomo.

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Fig. 7: Asymmetrical parenchymal density in the upper outer quadrant of left breast in 2D remained as parenchymal density in the 3D tomo slices with no evidence of a mass lesion. HPE showed Fibrocystic changes.

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Conclusion

• The primary reasons for the added benefit of tomosynthesis were lesion conspicuity, margin feature analysis, detection of additional findings.(Ref1)
• Morphological features in benign lesions like the halo sign in fibroadenoma with denser benign calcification around it (Fig 8), duct ectasia (Fig 9) are better identified especially in dense breast parenchyma in 3D tomo due to elimination of superimposing tissue.
• In carcinomas, the border of the mass (Figs. 4,5,6), the extent of accompanying microcalcifications (Ref 2) (Fig 5 & 6), fat within the mass in invasive lobular cancer (Ref 1) (Fig.10) are better depicted on breast tomosynthesis images than on 2D mammograms.
• Secondary signs like asymmetrical density and architectural distortion are better resolved (Fig 7)
• The depth of a lesion can be assessed by 3D Tomosynthesis, as the location of the lesion from the skin is automatically verified from the position of the reconstructed section obviating the need to take additional tangential views for superficial skin lesions(Ref 2)(Fig 12).
• 3D Tomosynthesis also showed greater accuracy in the prediction of benign and malignant cases which correlated better with histopathology (Fig 13).
• 3D tomo is better at predicting benign pattern of calcification in fibroadenomas. The pattern and distribution of calcification can be seen better and brighter as it is confined to a single slice. However indeterminate calcifications of the softer variety, the powdery type of fibrocystic disease and DCIS need the 2D magnified views for visualisation and analysis.

In conclusion the improvement in lesion perception and analysis by 3D tomosynthesis in the Combined mode increases the level of confidence in diagnosis, thereby reducing the need for additional time consuming examinations.
Fig. 8: A 47 year old lady presented with a nodule in the outer aspect of right breast. RCC in 2d and 3d shows this as a benign nodule. However there is another non palpable nodule obscured by the parenchyma in 2D which on 3D is seen as a well defined nodule clearly with a 'complete halo sign' in the line of nipple. This is seen as a well defined ovoid nodule with peripherally placed benign bright calcification within the lesion - calcified fibroadenoma.

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Fig. 9: A 43 year old woman presented with history of milky discharge from right breast since 6 months. Focal asymmetrical density in the upper quadrant of right breast is seen as multiple linear densities on 3D tomo slice.

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Fig. 10: The fat within the spiculated lesion is appreciated in this lobular carcinoma in the 3D tomo slice

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**Fig. 11:** 41 year old woman with family history of carcinoma breast felt a palpable abnormality. 2D shows an ovoid nodular lesion (Birads 3). USG was suggestive of a fibroadenoma (Birads 3). 3D- showed an 'incomplete halo sign' with tiny spiculated margins suggestive of parenchymal tethering (Birads 4). On histopathology it was confirmed as carcinoma.

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**Fig. 12:** Palpable nodule in left breast. Ovoid nodule is seen in the outer aspect of right breast which on tomosynthesis slices is seen in the superficial plane of left breast just beneath the skin (note the prominence of the skin pores in 3D). The location was
verified from the position of the reconstructed section on the slice locator in the viewing console. USG also confirmed the location and HPE confirmed it as an epidermal cyst.

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**Fig. 13**

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References
